Learnetic
Everyone learns differently

TABLE OF CONTENTS

UPPER SECONDARY

MATHEMATICS

CHAPTER	LESSON	DESCRIPTION
I. Numbers	Surds	At the end of this activity, students should be able to: understand and use surds use basic operations on surds simplify expressions with surds rationalise a denominator containing surds in fractions.
II. Quadratic functions	Quadratic functions, graphs	At the end of this activity, students should be able to: sketch the graph of a quadratic function represent a quadratic function in the general and factorised forms.
	Factorisation of quadratic functions	At the end of this activity, students should be able to: write a quadratic function in factor form with integer coefficients and rational x-intercepts find the vertex of a quadratic function written in factor form write a quadratic function in vertex form by completing the square write a quadratic function in vertex form by calculating the determinant of the function.
	Quadratic equations	At the end of this activity, students should be able to: solve a quadratic equation using different methods estimate the roots of a quadratic equation.
	Simultaneous equations	At the end of this activity, students should be able to: solve one quadratic—one linear systems of equations find graphical solutions of simultaneous equations find equations of given graphs.
	Inequalities	At the end of this activity, students should be able to: solve a system of one quadratic—one linear inequality with one unknown find the union and intersection of sets of numbers satisfying different inequalities check if the solution of an inequality includes another set of solutions find the graphic solution of an inequality with two unknowns find the graphic solution of a system of one quadratic—one linear inequality with two unknowns.
	Quadratic inequalities	At the end of this activity, students should be able to: solve quadratic inequalities in the vertex form solve quadratic inequalities by the test-point method solve quadratic inequalities by the sign graph method combine inequalities equations.
III. Polynomials	Presentation of polynomials	At the end of this activity, students should be able to: recognise polynomials determine the degree and coefficients of a polynomial calculate the value of a polynomial.
	Algebraic manipulation of polynomials	At the end of this activity, students should be able to: add, subtract and multiply polynomials find values of the sum, difference and product of polynomials understand and use the relationship between the degrees of two polynomials and the degrees of their sum, difference and product.
	Division of polynomials	At the end of this activity, students should be able to: perform algebraic operations fluently add, subtract and multiply polynomials.
	The factor and remainder theorems	At the end of this activity, students should be able to: use the factor theorem use the remainder theorem do synthetic division of polynomials.

	Factorisation of polynomials	At the end of this activity, students should be able to decompose a simple polynomial into factors with smaller degree, using various methods.
	Factorisation and roots of polynomials	At the end of this activity, students should be able to: find roots of polynomials using factorisation find rational roots of polynomials with rational coefficients solve simple polynomial equations and inequalities.
IV. Graphs of polynomials	Sketching graphs	At the end of this activity, students should be able to: estimate the end behaviour of a polynomial function find crucial points for the graph of a polynomial sketch a rough graph of a polynomial.
	Graphical solution of equations (1)	At the end of this activity, students should be able to: use graphical methods to solve simple equations use graphical methods to check algebraic solutions of equations.
	Graphical solution of equations (2)	At the end of this activity, students should be able to: use graphical methods to solve equations and systems of equations use graphical methods to check algebraic solutions of equations.
	Graphical solution of inequalities (1)	At the end of this activity, students should be able to: understand the notion of half-planes know how to define a half-plane using an inequality know how to find graphically the solution of an inequality in two variables.
	Graphical solution of inequalities (2)	At the end of this activity, students should be able to: understand the notion of inequality in two variables find the graphical solution of an inequality in two variables.
	Translations and graphs	At the end of this activity, students should be able to: understand the effect of a translation on a graph of a polynomial understand the effect of a translation on the equation behind the graph.
V. Coordinate geometry (1)	Equation of a straight line	At the end of this activity, students should be able to: define different positions of a straight line in the coordinate systém read out the gradient and the y-intercept from the formula and the graph write the equation of a line passing through two points change one form of the equation of a line to another.
	Parallel and perpendicular lines	At the end of this activity, students should be able to: recognise parallel lines by comparing their gradients recognise perpendicular lines by multiplying out their gradients.
	Coordinate geometry of a circle	At the end of this activity, students should be able to: place the circumference of the circle given by the equation (x — x0)2 + (y — y0)2 = r2 in the coordinate systém place the disc (x — x0)2 + (y — y0)2 ? r2 or (x — x0)2 + (y — y0)2< r2 in the coordinate systém represent the equation of the circle x2 + y2 — 2ax — 2by + c = 0 in the form (x — x0)2 + (y — y0)2= r2 find the equation of a circle with three points given.
	The tangent	At the end of this activity, students should be able to: understand the notion of a tangent to a circle and a curve know how to find the equation of the tangent to a given circle at a given point.
	The normal	At the end of this activity, students should be able to: understand the notion of a normal to a curve know how to find the equation of the normal to a given simple curve at a given point.
	Intersection points (1)	At the end of this activity, students should be able to find the coordinates of intersection points of a straight line and other figures given by equations.
	Intersection points (2)	At the end of this activity, students should be able to find the coordinates of intersection points of two figures given by equations.
VI. Differentiation (1)	The derivative	At the end of this activity, students should be able to: understand the notion of tangent and gradient of a curve understand what the derivative function is understand differentiation recognise a non-differentiable function by its graph

		visualise the graph of the derivative knowing the function.
	Differentiation of simple functions	At the end of this activity, students should be able to: find the derivatives of simple functions y = xn for any natural n find the derivative at a given point from the definition using the graph recognise graphs of derivatives of simple functions.
	Differentiation of polynomials	At the end of this activity, students should be able to: differentiate functions of the form y = xn for n natural differentiate a sum of monomials differentiate a polynomial sketch the graph of the derivative of a polynomial, knowing the function.
	Finding gradients, tangents and normal	At the end of this activity, students should be able to: use differentiation to find gradients of a curve find the equation of the tangent to the graph of a polynomial at a given point find the equation of the normal to the graph of a polynomial at a given point solve problems by using a tangent to a curve.
	Monotonicity	At the end of this activity, students should be able to: recognise increasing and decreasing functions understand the connection between the sign of the derivative and monotonicity of a function find intervals of monotonicity relate the graph of the function to the graph of the derivative.
	Local extrema, stationary points, critical points	At the end of this activity, students should be able to: understand the notion of local maximum and minimum understand the notion of stationary point and critical point use the derivative to find stationary points find the global maximum and minimum of a function.
	Finding local extrema	At the end of this activity, students should be able to: find local extrema at points of differentiability find local extrema at points of non-differentiability find local extrema in some more complex cases.
	Finding maximum and minimum values	At the end of this activity, students should be able to: find maximum and minimum values of a function in both closed and open intervals, if it exists.
	Second-order derivatives	At the end of this activity, students should be able to: find the second-order derivative of a polynomial use the second-order derivative to find and classify extrema decide on extrema when the second derivative is zero.
VII. Integration (1)	The anti-derivative	At the end of this activity, students should be able to: understand the notion of anti-derivative understand the inverse of differentiation calculate the integral of xn for natural n.
	Integrating	At the end of this activity, students should be able to: understand and use simple laws of integration integrate polynomials.
	The definite integral	At the end of this activity, students should be able to: understand the definite integral evaluate the definite integral of a polynomial use simple laws of definite integration.
	Area under the curve	At the end of this activity, students should be able to: use the definite integral to calculate areas delimited by function graphs and straight lines.
VIII. Numbers (2)	Laws of indices — rational exponents	At the end of this activity, students should be able to: understand and use roots of any order use powers of any rational exponent apply laws of indices in calculations.
IX. Graph transformations	Transformations of graphs (1)	At the end of this activity, students should be able to find the graph of the functions y = f(x) + a and y = f(x + a), given the graph of y = f(x) (a — constant).

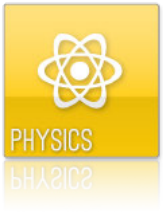
	Transformations of graphs (2)	At the end of this activity, students should be able to: find the graphs of the functions y = a f(x) and y = f(ax), if the graph of y = f(x) is given (a — constant) find the graph of the function y = a f(bx + c), if the graph of y = f(x) is given (a, b, c — constant values).
X. Sequences and series	Sequences	At the end of this activity, students should be able to: find the nth term of a sequence find the formula for the nth term of a sequence in easy cases understand the definition of terms depending on previous terms in a sequence recognise increasing and decreasing sequences.
	Arithmetic sequence	At the end of this activity, students should be able to define, recognise and use arithmetic sequences.A:A
	Arithmetic series	At the end of this activity, students should be able to: calculate the sum of the first n terms of a given arithmetic sequence use the rule for the sum to n of positive integers.
	Geometric sequence	At the end of this activity, students should be able to: define, recognise and use geometric sequences calculate the sum of the first n terms of a given geometric sequence.
	Geometric series	At the end of this activity, students should be able to: find the sum of the first n terms of a given geometric sequence find the sum of an infinite convergent geometric series.
	Infinite convergent geometric series	At the end of this activity, students should be able to: recognise convergent geometric series calculate the sum of a given convergent geometric series.
	The binomial expansion	At the end of this activity, students should be able to: formulate the binomial theorem perform calculations of the form 1.99n or positive integer n, — know some properties of Pascal's Triangle.
XI. Trigonometry (1)	General angles	At the end of this activity, students should be able to: find the distance covered in a given number of revolutions understand the notion of general angle as rotation.
	General angles, angle measures	At the end of this activity, students should be able to: find the distance travelled during a given number of revolutions understand the notion of general angle as rotation convert radian measure to degrees and vice versa.
	Basic trigonometric functions	At the end of this activity, students should be able to: understand and use the trigonometric functions of a general angle be able to calculate the trigonometric functions of an angle, given the value of one of the functions understand the basic trigonometric identities know how to prove simple trigonometric identities know how to use some reduction formulas.
	Graphs of trigonometric functions	At the end of this activity, students should be able to: sketch graphs of trigonometric functions— understand the relation between the formula and the transformation of a graph apply trigonometric functions in real-world situations.
	Simple trigonometric equations	At the end of this activity, students should be able to: solve trigonometric equations of the form sinx = a, cosx = a and tanx = a solve equations of the form psinx = qcosx solve real-world problems involving equations.
	Solving simple trigonometric equations	At the end of this activity, students should be able to: solve equations of the form sin(f(x)) = a, where f is a linear function solve equations of the form cos(f(x)) = a, where f is a linear function solve equations by introducing a new variable solve real world problems involving solving equations.
	The area of a triangle	At the end of this activity, students should be able to: find the area of a triangle using the formula Area = '— find the area of a polygon apply the relation between the area of a triangle and the radius of the inscribed circle.

	The sine rule	At the end of this activity, students should be able to: find the sides of a triangle using the sine rule find the angles of a triangle using the sine rule understand the ambiguous case of the sine rule apply the sine rule in real world problems.
	The cosine rule	At the end of this activity, students should be able to: find the missing sides of a triangle using the cosine rule find the angle of a triangle using the cosine rule apply the cosine rule in real-world problems (bearings).
	Measuring the circle	At the end of this activity, students should be able to: find the length of an arc find the area of a sector of a circle find the area of a segment of a circle apply the formulas for the length of an arc and the area of a sector in more complex problems.
XII. Exponentials and logarithms	Exponential functions	At the end of this activity, students should be able to: draw an exponential function use properties of exponential functions apply an exponential function in easy examples match a transformed graph with a formula.
	The logarithm	At the end of this activity, students should be able to: understand the notion of logarithms change exponential form to logarithmic form evaluate basic logarithms apply laws of logarithms change the base of a logarithm rewrite logarithms as a single logarithm.
	Basic exponential equations	At the end of this activity, students should be able to: solve basic exponential equations use logarithms to solve exponential equations apply appropriate techniques to solve real-world problems modelled by exponential equations.
	Exponential inequalities	At the end of this activity, students should be able to: solve basic exponential inequalities use logarithms to solve exponential inequalities.
XIII. Differentiation (2)	Derivatives of powers with rational exponent	At the end of this activity, students should be able to: find the derivative of a power with a negative integer exponent find the derivative of a root find the derivative of a power with a rational exponent.
XIV. Integration (2)	Integrals of powers with rational exponent	At the end of this activity, students should be able to: understand and be able to use anti-derivatives and integrals be able to use simple laws of integration be able to calculate the indefinite integral of a polynomial.
	Approximation of the area under a curve	At the end of this activity, students should be able to: approximate a definite integral using the trapezium rule approximate the area under a function graph using the trapezium rule.
XV. Functions	Functions — basic notions	At the end of this activity, students should be able to: understand functional dependence model simple phenomena using right functions identify the domain of a function and understand the range represent a simple function in various ways understand and sketch the graph of a function.
	Composition of functions	At the end of this activity, students should be able to: understand composition of functions calculate the value of a composite function for a given argument— find the formula for a composite function identify the domain of a composite function.
	Inverse function	At the end of this activity, students should be able to: state the existence of an inverse function and define it for a given function (simple cases sketch the graph of the inverse function, given the graph of the original function.
	The modulus function	At the end of this activity, students should be able to:

		understand the various meanings of the modulus understand how to use the modulus in computations understand how to solve simple equalities and inequalities involving the modulus.
	Transformation of graphs	At the end of this activity, students should be able to: fit the graph of a function to given data by altering the scale on the x or y-axis and by translating the graph along the x or y-axis find an algebraic representation for the function modified to fit the required graph.
XVI. Trigonometry (3)	Inverse trigonometric functions	At the end of this activity, students should be able to: graph inverses of basic trigonometric functions list the properties of inverse functions find an angle, given its trigonometric function.
	Other trigonometric functions	At the end of this activity, students should be able to: sketch the graphs of the reciprocals of basic trigonometric functions list the properties of reciprocal functions graph simple transformations of reciprocal functions.
	Identities for trigonometric functions	At the end of this activity, students should be able to: understand trigonometric identities introduced in the lesson use the trigonometric identities to find unknown values of trigonometric functions use trigonometric identities to prove simple new identities.
XVII. Exponentials and logarithms	The natural exponential function	At the end of this activity, students should be able to: recognise an exponential function with the base e apply an exponential function f(x) = ex in real-world situations transform and apply an exponential function f(x) = ex.
	The natural logarithmic function	At the end of this activity, students should be able to: recognise the natural logarithmic function state the domain and asymptote of a logarithmic function find inverses of exponential and logarithmic functions use the logarithmic function in solving problems.
XVIII. Differentiation (3)	Derivatives of exponential and logarithmic functions	At the end of this activity, students should be able to: find the derivative of the natural exponential function find the derivative of the natural logarithmic function find the derivative of linear combination of these functions.
	Derivatives of trigonometric functions	At the end of this activity, students should be able to: find the derivatives of the sine and cosine functions find the derivatives of the tangent and cotangent functions find the derivative of a linear combination of trigonometric functions.
	Differentiation rules (1)	At the end of this activity, students should be able to: differentiate the sum and difference of two or more functions differentiate the product of two functions differentiate the quotient of two functions.
	Differentiation rules (2)	At the end of this activity, students should be able to: differentiate composite functions.
XIX. Integration (3)	Integration of selected functions	At the end of this activity, students should be able to: integrate the exponential function integrate the function x —1 integrate the sine and cosine functions.
	Integration methods (1)	At the end of this activity, students should be able to: integrate by substitution integrate by parts.
	Integration methods (2)	At the end of this activity, students should be able to: calculate the definite integral by substitution calculate the definite integral by parts.
	Volumes of revolution	At the end of this activity, students should be able to: recognise a solid of revolution find the volume of a solid of revolution use the formula for the volume of a cone, the frustum of a cone, a sphere and a one-base segment of a sphere.

XX. Numerical methods	Zeros of a function	At the end of this activity, students should be able to: find the number of zeros of a function find intervals with zeros of a function approximate zeros of a function.
	Approximate solution of equations	At the end of this activity, students should be able to: use the secant method to find an approximate solution of an equation use Newton's method to find an approximate solution of an equation.
	Numerical integration — mid-ordinate rule	At the end of this activity, students should be able to approximate the area under a curve using the mid-ordinate method.
	Numerical integration — Simpson's rule	At the end of this activity, students should be able to use Simpson's rule to find the definite integral of a given function.
XXI. Rational functions	Rational expressions	At the end of this activity, students should be able to: recognise rational expressions simplify rational expressions.
	Rational functions	At the end of this activity, students should be able to: recognise rational functions define the domain of a rational function find asymptotes of a rational function recognise graphs of simple rational functions.
	Algebraic division	At the end of this activity, students should be able to: divide one polynomial by another, with a remainder use the algorithm of polynomial division in various situations.
	Partial fractions	At the end of this activity, students should be able to: recognise partial fractions decompose a rational expression into partial fractions.
XXII. Coordinate geometry (2)	Equations of curves	At the end of this activity, students should be able to: sketch a curve, given its equation understand the relationship between an equation and a curve in the coordinate systém recognise a basic curve from its equation.
	Parametric equations of curves	At the end of this activity, students should be able to: understand parametric equations of curves find parametric equations of simple common curves.
XXIII. Sequences and series	Binomial series	At the end of this activity, students should be able to: expand $(1 + x)n$ for rational n and $\|x\| < 1$ use the expansion to calculate approximate values of rational powers and roots.
	Expansion of rational functions	At the end of this activity, students should be able to: expand a rational function into a series in xn for natural n apply the series expansion of a rational function to find approximations of its value for a given x.
XXIV. Trigonometry (3)	Trigonometric functions of the sum and difference of angles (1)	At the end of this activity, students should be able to: understand the proof for the sine and cosine of the sum and difference of angles prove trigonometric identities involving sum and difference formulas use sum and difference formulas to find exact values of trigonometric functions.
	Trigonometric functions of the sum and difference of angles (2)	At the end of this activity, students should be able to: understand the proof for the sum and difference of a linear combination of the sine and cosine factorise the sum and difference of a linear combination of the sine and cosine use the sum and difference formulas to solve problems.
	Double-angle formulas	At the end of this activity, students should be able to: understand the proofs for double-angle formulas use double-angle formulas to solve problems rewrite $\sin A$, $\cos A$ and $\tan A$ in terms of tan use double-angle formulas to prove trigonometric identities.
XXV. Exponentials and logarithms	Exponential growth and decay	At the end of this activity, students should be able to: model exponential growth understand the logistic curve model of population growth

		understand the process of radioactive decay use the exponential curve in modelling real-world situations.
XXVI. Differentiation and integration	Differential equations	At the end of this activity, students should be able to: understand the notion of a differential equation understand the notion of the solution of a differential equation understand the notion of initial conditions solve simple differential equations by inspection solve the simplest differential equations.
	Equations with separable variables	At the end of this activity, students should be able to: solve linear homogeneous differential equations solve differential equations with separable variables find particular solutions of simple differential equations.
	Implicit differentiation	At the end of this activity, students should be able to: understand the notion of an implicit function understand the notion of the derivative of an implicit function differentiate implicit functions.
	Parametric differentiation	At the end of this activity, students should be able to: understand the notion of a parametrically defined function understand the notion of the derivative of a parametrically defined function differentiate parametrically defined functions.
	Tangents and normals for implicitly and parametrically defined curves	At the end of this activity, students should be able to: understand the notion of a tangent and a normal to a curve find the equation of the tangent to a given curve at a given point find the equation of the normal to a given curve at a given point.
	Integration using partial fractions	At the end of this activity, students should be able to integrate rational functions.
XXVII. Vectors	Vectors	At the end of this activity, students should be able to: recognise quantities that can be represented by vectors represent a given vector on the plane or in space in the form of a pair or a trio of numbers find the magnitude of a given vector on the plane or in space.
	Algebraic operations on vectors	At the end of this activity, students should be able to: perform vector addition perform multiplication of a vector by a scalar apply algebraic operations on vectors to geometry.
	Position vectors	At the end of this activity, students should be able to: understand and use the notion of a position vector describe the location of points, using vectors use position vectors to express the basic geometric properties of points and segments in the coordinate system.
	Vector equations of lines in 2-D	At the end of this activity, students should be able to: represent a line on the plane by its vector equation transform the vector equation of a straight line into Cartesian form and vice versa.
	Vector equations of lines in 3-D	At the end of this activity, students should be able to: present a line in space in the form of a vector equation transform the vector equation of a straight line in 3-D to the Cartesian form find the intersection points of two lines given in the form of vector equations.
	The scalar product (1)	At the end of this activity, students should be able to: understand the notion of the scalar product of two vectors find the scalar product of two vectors in 2-D or 3-D.
	The scalar product (2)	At the end of this activity, students should be able to use the scalar product to solve geometrical problems.
	Perpendicular distance from a point to a line	At the end of this activity, students should be able to find the perpendicular distance from a point to a line.



PHYSICS

CHAPTER	LESSON	DESCRIPTION
I. Statics	Forces	At the end of this activity, students should be able to: recognise forces as a measurement of the interaction between bodies describe the basic characteristics of a force vector specify different types of forces differentiate between the effects of the action of forces.
	Addition of forces	At the end of this activity, students should be able to: add and resolve forces determine graphically the resultant force and the component forces calculate the magnitudes of the resultant forces and the component forces in right-angled triangles.
	Torque	At the end of this activity, students should be able to: know that the moment of a force indicates the ability of a force to rotate a body be able to calculate the moment of a force— be able to add moments of forces know how levers operate.
	Equilibrium	At the end of this activity, students should be able to: understand the concept of a rigid solid determine the centre of gravity of a solid explain the different types of equilibrium.
	Forces and moments of forces in constructions	At the end of this activity, students should be able to: explain the difference between elements of a construction which are extended and those which are compressed use ropes to substitute some of the elements in constructions give examples of solutions that are applied in constructions.
II. Kinematics	Uniform motion	At the end of this activity, students should be able to: understand that motion is relative understand the concept of position, speed and average speed read and construct graphs of position calculate speed, given change in position and time convert speed units.
	Accelerating motion	At the end of this activity, students should be able to: understand the concept of uniform accelerating motion and non-uniformly accelerating motion read and construct graphs of speed calculate acceleration from a graph of speed in uniformly accelerating motion understand the concept of free fall.
	Distance in accelerating motion	At the end of this activity, students should be able to: calculate any quantity in accelerating motion interpret graphs of position in uniformly varying motion calculate the distance covered by a body moving with uniformly varying motion explain the equation of motion for uniformly accelerating motion.
	Description of motion in terms of vectors	At the end of this activity, students should be able to: describe velocity and acceleration as vector quantities describe the concept of position vector increment and velocity vector inkrement understand the relationship between the direction of the acceleration vector and the shape of the path of motion.
	Circular motion	At the end of this activity, students should be able to: describe circular motion at constant speed understand the concepts: period, frequency, angular speed, circular measure and centripetal acceleration calculate centripetal acceleration calculate angular speed when you are given the period, frequency, or speed and radius.

	Projectile motions	At the end of this activity, students should be able to: describe horizontal projectile motion and projectile motion at an angle calculate basic parameters of projectile motion.
III. Dynamics	The First and the Third Law of Motion	At the end of this activity, students should be able to: understand that forces always occur in pairs understand and apply the First and the Third Laws of Motion understand the concept of inertial and non-inertial systems understand the concept of inertia.
	Momentum	At the end of this activity, students should be able to: apply the principle of conservation of momentum use the principle of conservation of momentum to explain how a reaction engine works explain the relationship between force impulse and change in momentum.
	Newton's Second Law of Motion	At the end of this activity, students should be able to: understand Newton's Second Law of Motion describe the relationship between the principle of conservation of momentum and Newton's Second Law of Motion.
	Forces in curvilinear motions	At the end of this activity, students should be able to: understand the relationship between the behaviour of a body and the direction of the force exerted on it understand the concepts of centripetal force and centrifugal force describe the relationship between the curvature of a path and the magnitude of centripetal force.
	Friction	At the end of this activity, students should be able to: describe when friction occurs explain the concepts of static friction, kinetic friction ad rolling friction explain on what the force of friction depends calculate the coefficient of friction from the relationship between friction and the normal contact force calculate the coefficient of friction by measuring the angle of inclination.
	Air drag	At the end of this activity, students should be able to: understand drag explain how drag is affected by the velocity of a moving body, its cross-sectional area and the density of the medium explain the concept of terminal velocity.
IV. Energy	Work and energy	At the end of this activity, students should be able to: calculate the work done, and the change in potential and kinetic energy give examples of situations when work is not performed.
	Potential energy and kinetic energy	At the end of this activity, students should be able to: explain what mechanical energy is apply the principle of conservation of mechanical energy in practice.
	Internal energy	At the end of this activity, students should be able to:— define internal energy explain that temperature is a measure of changes in the internal energy calculate the efficiency of an appliance.
	Power	At the end of this activity, students should be able to understand the concept of power, calculate it and name its units.
	Collisions	At the end of this activity, students should be able to: distinguish between elastic and inelastic collisions give examples demonstrating the conservation of momentum during collisions and showing that during elastic collisions the total kinetic energy of the bodies does not change differentiate between head-on and oblique collisions.
	Simple machines	At the end of this activity, students should be able to: describe the operation of simple machines such as levers, pulleys, and inclined planes, and state the benefits of their application explain why the application of simple machines does not decrease the amount of work that needs to be done.
V. Rotational motion	Angular velocity and angular acceleration	At the end of this activity, students should be able to: give the definition of a radian, convert radians into degrees and vice versa describe how to calculate angular velocity explain the relationship between angular velocity and linear velocity describe how to represent an angular velocity vector explain how to calculate angular acceleration state the relationship between angular acceleration and linear acceleration.

	Newton's Second law for rotational motion	At the end of this activity, students should be able to: describe a force arm calculate the moment of a force, and give a specific example explain the concept of the moment of inertia describe Newton's First and Second Law for rotational motion.
	Angular momentum	At the end of this activity, students should be able to: describe the concept of angular momentum explain the relationship between angular momentum and change in angular momentum — provide examples to explain the principle of conservation of angular momentum.
	Energy of rotational motion	At the end of this activity, students should be able to: explain the concepts of kinetic energy of rotational motion describe how to calculate the total kinetic energy of a body moving simultaneously in rotational and translational motion apply the principle of conservation of energy using the concept of kinetic energy of rotational motion.
VI. Gravitational field	Gravitational force	At the end of this activity, students should be able to: understand that any two bodies attract one another due to gravitation calculate the magnitude of the gravitational force in a specific case understand how the gravitational field is represented distinguish between a central field and a uniform field.
	Gravitational acceleration	At the end of this activity, students should be able to: understand that the gravitational acceleration on the surface of the Earth is not constant explain the relationship between gravitational acceleration and distance from the surface of the Earth state the difference between the mass and the weight of a body determine the gravitational acceleration for a system of a few celestial bodies.
	Potential energy	At the end of this activity, students should be able to: explain the relationship between the potential energy of the gravitational field and the distance from the Earth state how to calculate changes in potential energy both close to and far from the surface of the Earth describe the relationship between the changes in potential energy in a gravitational field determine the potential energy of a system composed of several bodies.
	Potential	At the end of this activity, students should be able to: explain the concept of potential describe how potential depends on the distance from the Earth calculate the potential of a system of bodies— explain the concept of equipotential surfaces.
	Satellites	At the end of this activity, students should be able to: understand how a satellite revolves around the Earth without propulsion calculate the radius of the orbit of a satellite, given its period of revolution around the Earth, and calculate its period from the radius of its orbit calculate speed of a satellite in an orbit give a few examples of the application of satellites.
VII. Matter	Density	At the end of this activity, students should be able to: explain the concept of density describe how to determine the density of solids and liquids explain the relationship between density and the molecular structure of matter.
	Stresses	At the end of this activity, students should be able to: the concept of stress the concept of compression, tension and torsion the relationship between the properties of materials and their microscopic structure.
	Hooke’s Law	At the end of this activity, students should be able to: explain the calculation for strain and stress describe a strain-stress graph formulate Hooke's Law give an explanation of Young's modulus define ultimate strength calculate elastic potential energy.
	Temperature	At the end of this activity, students should be able to: describe the Celsius, Fahrenheit and Kelvin scales of temperature explain how to measure temperature describe the relationship between the temperature and the velocity of molecules explain the thermal expansion of various substances.
	Heat transfer	At the end of this activity, students should be able to:

		explain heat transfer by conduction, convection, and radiation explain thermal conductivity calculate the heat flux in heat transfer by conduction between layers of different thicknesses and different thermal conductivities.
	The states of matter	At the end of this activity, students should be able to: describe the states of matter of a substance name the phase transitions between the states of matter understand the concept of latent heat of vaporization and latent heat of fusion explain how temperature is related to pressure.
VIII. Mechanics of Fluids	Hydrostatic pressure	At the end of this activity, students should be able to: calculate the pressure exerted by solid bodies and by liquids give examples to explain how a liquid exerts pressure in all directions give examples to explain the hydrostatic paradox give examples of the application of combined vessels.
	Atmospheric pressure	At the end of this activity, students should be able to: state the definition of pressure understand the concepts of high pressure, low pressure, vakuum describe the devices that are used for measuring pressure explain how atmospheric pressure changes with altitude.
	Pascal's Law	At the end of this activity, students should be able to: state Pascal's law explain the operation of a hydraulic press and other devices that apply Pascal's law describe the phenomenon of water hammer.
	Archimedes' Principle	At the end of this activity, students should be able to: measure upthrust— calculate upthrust state Archimedes' Principle name the conditions that need to be met for a body to float explain what the depth of immersion of a floating body depends on.
	Bernoulli's Principle	At the end of this activity, students should be able to: how the principle of continuity and Bernoulli's Principle are applied in the mechanics of fluids how to calculate the magnitudes of pressure/velocity for selected simple cases of flow how a lift is generated on the wing of a plane or a bird.
	Movement of bodies in liquids	At the end of this activity, students should be able to: explain the difference between laminar flow and turbulent flow explain the concept of kinematic viscosity and dynamic viscosity of a fluid explain the concept of Reynolds number explain Stokes' Law explain how the type of flow affects the drag of a body.
IX. Gas Laws	Gas transformations	At the end of this activity, students should be able to: differentiate between and describe isothermal, isobaric and isochoric processes know how to apply the gas laws in practical calculations recognise the graphs of isoprocesses.
	The Ideal Gas Equation	At the end of this activity, students should be able to: define and use the gas equation of state prove that the gas laws which refer to isoprocesses constitute specific cases of the gas equation of state describe how an ideal gas differs from a real one.
	Kinetic theory of gases	At the end of this activity, students should be able to: explain the Maxwell velocity distribution of gas molecules describe the concept of mean velocity, root-mean-square velocity and probability state the relationship between the mean kinetic energy of gas molecules and the temperature state the relationship between gas pressure and pressure and root-mean-square velocity explain the basics of the kinetic theory of gases.
	Molar specific heat of a gas	At the end of this activity, students should be able to: explain the concept of molar specific heat at constant volume explain the concept of molar specific heat at constant pressure state the theoretical assumptions for calculating the molar specific heat of gases from the kinetic theory of gases explain the discrepancy between the values of the specific molar heat obtained in an experiment and those obtained from theoretical calculations explain the principle of equipartition of energy.

	Adiabatic transition	At the end of this activity, students should be able to: explain the significance of thermal insulation describe an adiabatic transition state the adiabatic equation describe the difference between an adiabatic transition and an isothermal transition name some examples of natural phenomena and technical processes in which we encounter an adiabatic transition.
X. Thermodynamics	The First Law of Thermodynamics	At the end of this activity, students should be able to: state The First Law of Thermodynamics calculate the work done in the gas transitions mentioned above explain the significance of The First Law of Thermodynamics describe the consequences of The First Law of Thermodynamics.
	Heat engine	At the end of this activity, students should be able to: explain how a heat engine operates describe the operation of an internal-combustion engine know the difference between reversible and irreversible processes calculate the efficiency of an ideal heat engine state some practical applications of heat engines.
	Specific heat	At the end of this activity, students should be able to: explain the principle of heat balance explain the zeroth law of thermodynamics calculate the heat needed to heat up or cool down a given mass of a substance to a given temperature explain the concept of specific heat capacity describe the methods of the measurement of the specific heat capacity of liquids and solids.
	Sources of heat	At the end of this activity, students should be able to: explain the reaction of combustion name the alternative sources of energy and the methods of their application.
	The Second Law of Thermodynamics	At the end of this activity, students should be able to: state the reasons for entropy increase in an isolated systém explain the physical interpretation of entropy state the significance of the Second Law of Thermodynamics explain the consequences of the Second Law of Thermodynamics.
XI. Electrostatics	Coulomb's Law	At the end of this activity, students should be able to: name the ways of charging bodies and explain what they involve give an example to explain the law of conservation of chargé give the unit of electric chargé explain what an elementary charge is state Coulomb's Law.
	Electric field	At the end of this activity, students should be able to: explain the concept of electric field strength explain what the electric field lines represent describe the movement of an electric charge in a homogeneous electric field.
	Potential	At the end of this activity, students should be able to: explain the concepts of electric field potential and equipotential surfaces explain why the potential of a homogeneous field changes linearly with distance state the formula for the potential in a field due to a point chargé describe the relationship between potential and electric field strength in the form of a gradient explain the concept of potential energy of a charge in an electric field.
	Capacitance	At the end of this activity, students should be able to: define capacitance explain how a capacitor works explain the meaning of dielectric describe the changes in the electric field inside a capacitor and the capacitance of the capacitor when a dielectric is placed in between the plates.
	Capacitors	At the end of this activity, students should be able to: explain why the capacitance of a capacitor depends on its dimensions and the distance between its plates describe the phenomenon of capacitor leakage state the formula for the energy of a capacitor state the formula for the capacitance of capacitors connected in series state the formula for the capacitance of capacitors connected in parallel.
XII. Direct current	Electric current	At the end of this activity, students should be able to: draw a scheme for an electric circuit containing the basic elements

		explain the concept of the flow of electrons calculate current explain the flow of current through a conductor from a microscopic point of view explain what an ammeter is, what it is used for and how it is operated give examples demonstrating Kirchhoff's First Law define direct current.
	Electrical resistance	At the end of this activity, students should be able to: state Ohm's Law explain what the resistance of a conductor depends on calculate the resistance of a conductor of specified dimensions and resistivity describe the relationship between the resistance of metals and their temperature explain the phenomenon of superconductivity.
	Resistors	At the end of this activity, students should be able to: recognise connection in series and connection in parallel calculate the combined resistance of a system of resistors name the characteristic features of connection in series and connection in parallel.
	Electromotive force	At the end of this activity, students should be able to: explain the structure of a cell and name its elements describe the EMF and the internal resistance of a cell and state the formulae for calculating the magnitudes of the two quantities state Ohm's Law for a whole circuit explain the concept of fault current describe the method of connecting cells.
	Work and power of electric current	At the end of this activity, students should be able to: calculate the work done by a current estimate the cost of work of a device of a given power determine the power of a given electrical device using an electric energy meter explain when overloading occurs and how we can protect household electrical wiring against its effects.
XIII. Magnetism	Magnetic field	At the end of this activity, students should be able to: explain the concepts of: magnetic field, flux density and uniform field understand the difference in behaviour of various materials placed in a magnetic field give a graphical representation of the magnetic field of the Earth and describe it.
	The magnetic field around current— carrying wires	At the end of this activity, students should be able to: describe magnetic field around current-carrying wires calculate the magnitude of magnetic flux density in simple cases describe how an electromagnet operates.
	Electromagnetic force	At the end of this activity, students should be able to: give the definition of electromagnetic force state Fleming's left-hand rule, — explain on what and in what way the magnitude of the electromagnetic force depends calculate the magnitude of the electromagnetic force.
	Application of electromagnetic forces	At the end of this activity, students should be able to: describe a commutator, a rotor, and brushes explain the operation of an electric engine calculate the moment of a couple of electromagnetic forces exerted on a frame.
	The movement of a charge in a magnetic field	At the end of this activity, students should be able to: describe the movement of a charge in a magnetic field calculate the magnitude of Lorentz force give and describe examples of the application of Lorentz force.
XIV. Alternating current	Phenomenon of electromagnetic induction	At the end of this activity, students should be able to: describe the phenomenon of induction calculate the induced EMF calculate the magnitude of flux describe the origin of eddy currents.
	Generator and alternating current	At the end of this activity, students should be able to: understand the concept of flux density calculate the EMF value of a rotating frame calculate the work and power of an alternating current understand how a generator operates describe an alternating current give the definition of r.m.s. voltage and r.m.s. current give the definition of inductance, ohmic resistance and reactance.

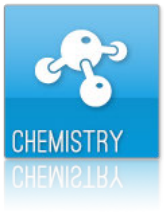
	Transformer	At the end of this activity, students should be able to: describe how a transformer operates explain the concepts of primary coil and secondary coil calculate the voltage across a transformer when the number of coil turns and the input voltage is given explain how an induction coil operates calculate the efficiency of a transformer explain the concept of eddy currents.
	Transmission of electrical energy	At the end of this activity, students should be able to: explain why high-voltage overhead lines are constructed describe the way in which a transformer transfers energy calculate power losses in a transmission line.
	Current in a household	At the end of this activity, students should be able to: state the advantages and disadvantages of batteries and mains as power supplies describe the structure of a household electric mains explain why circuit breakers are used state the purpose of the third wire in a cable of certain devices describe how a residual current circuit breaker is used explain how three-phase current is separated for use in different apartments.
XV. Electronics	Electronics	At the end of this activity, students should be able to: explain the concepts of semiconductor, doped conductor, p—n junction, diode explain how a diode operates explain how to use diodes to convert alternating current into direct current.
	Light and current	At the end of this activity, students should be able to: explain the concepts of a light-dependent resistor, photocell, light-emitting diode, semiconductor laser describe an internal photoelectric effect explain the abbreviations LDR, LED give examples of the application of light emission and absorption by a p-n junction.
	Transistors and gates	At the end of this activity, students should be able to: explain the concept of a transistor describe the operation of a bipolar junction transistor and a field-effect transistor explain how to amplify an electric signal using a transistor construct logic gates using transistors.
	Digital systems	At the end of this activity, students should be able to: explain the concepts of both an analogue and a digital signal describe the digital storage of sound state the advantages of digital signals over analogue ones.
XVI. Harmonic motion	Oscillations	At the end of this activity, students should be able to: describe harmonic oscillations state the equation for displacement, velocity and acceleration in simple harmonic motion.
	Pendulum	At the end of this activity, students should be able to: explain the theory of the simple gravity pendulum and the physical pendulum describe the movement of a simple pendulum state the changes in the force which cause a pendulum to oscillate explain on what quantities the period of a simple and a physical pendulum depend determine the gravitational acceleration given the T(L) measurement for a ball pendulum describe the concept of a Foucault pendulum.
	Energy of oscillations	At the end of this activity, students should be able to: plot a graph of energy as a function of time and position plot a graph representing the changes in amplitude and the displacement of damped oscillations.
	Resonance	At the end of this activity, students should be able to: describe free, damped and forced oscillations explain the phenomenon of resonance and also give examples.
XVII. Mechanical waves	Mechanical waves	At the end of this activity, students should be able to: describe mechanical waves state the relationship between the frequency, the wavelength and the velocity of a wave distinguish transverse and longitudinal waves give examples of mechanical waves explain what conclusions about the structure of the Earth can be drawn from the analysis of the propagation of seismic waves
	Reflection and refraction of waves	At the end of this activity, students should be able to: explain the movement of a wave reflected at a fixed and at a free end of a string

		describe the movement of a wave along a string made of segments of different density state Huygens' principle describe the reflection and the refraction of waves in two-dimensional areas explain the concepts of echo and reverberation.
	Diffraction and interference of mechanical waves	At the end of this activity, students should be able to: the concept of diffraction the concept of interference the concept of stationary waves where stationary waves occur in musical instruments the concept of beats.
	Oscillations of a string	At the end of this activity, students should be able to: state the formula for the velocity of a wave in a string state the formula for harmonic frequencies explain the concept of resonance.
	The intensity of a wave	At the end of this activity, students should be able to: the shape of spherical, circular and plane waves the meaning of the intensity of a wave how intensity and amplitude of a circular wave and a spherical wave change with the distance from the source what change in sound intensity is described by 1 bel = 10 dB.
	The Doppler effect	At the end of this activity, students should be able to: explain the Doppler effect decide whether in a given situation the frequency of the perceived wave is higher or lower than the frequency of the emitted wave give examples of the practical application of the Doppler effect state the definition of a shock wave.
	Electromagnetic waves	At the end of this activity, students should be able to: to characterise electromagnetic waves by comparing their properties with those of mechanical waves to name the particular ranges of electromagnetic waves to provide a short description of the ranges of electromagnetic waves by discussing various examples of their applications.
XVII. Electromagnetic waves	Diffraction and interference	At the end of this activity, students should be able to: state Huygens' Principle describe the phenomena of wave interference and wave diffraction describe Young's experiment explain the type of image that can be obtained when monochromatic light passes through a diffraction grating and also the type obtained when white light is used explain the idea of light wavelength measurement with a diffraction grating.
	Polarisation	At the end of this activity, students should be able to: describe a polarised wave and explain the difference between complete and partial polarisation describe polarisation by reflection and by refraction give examples of the application of the polarisation of light.
	Application of waves for communication	At the end of this activity, students should be able to: describe the Hertz's experiment state the range of radio waves and describe their propagation in the atmosphere of the Earth provide the basic information on the operation of mobile telephony, television broadcasting, satellite television, and satellite telephony.
	Signal encoding	At the end of this activity, students should be able to: describe amplitude modulation and frequency modulation explain the idea of digital encoding and give examples of digital encoding of both sound and images.
XIX. Optics	Reflection and refraction of light	At the end of this activity, students should be able to: describe the phenomenon of total internal reflection state Huygens' Principle calculate the refractive index explain how an image is produced in a mirror— state Snell's Law.
	Spherical mirrors	At the end of this activity, students should be able to: explain the principles of image formation in spherical mirrors define focal point and focal length calculate the distance and the size of an image when the size and location of the object and the parameters of the mirror are given describe how an image is formed by a mirror explain how to calculate the magnification of an image use the mirror equation.

	Lenses	At the end of this activity, students should be able to: explain the principle of the formation of images by lenses define focal point and focal length calculate the image distance and the size of an image when the size of the object and its distance are given define the power of a lens determine the focal point given the shape of a lens and its refractive index calculate the magnification use the lens formula.
	Optical instruments	At the end of this activity, students should be able to: state the principle of operation of a magnifying glass, a refracting telescope, and a microscope calculate the magnification of a refracting telescope, a microscope and a magnifying glass explain the concept of a prism and its applications explain how light diffraction limits the resolving power of some optical devices.
	An eye	At the end of this activity, students should be able to: explain how images are formed in the eye explain the concept of accommodation, long-sightedness and short-sightedness explain how the sight defects of long-sighted and short-sighted people can be corrected state the definition of colour blindness explain how a moving picture is formed.
XX. Atomic physics	Radiation of objects	At the end of this activity, students should be able to: define a black body state the Stefan-Boltzmann Law state Wien's Law.
	External photoelectric effect	At the end of this activity, students should be able to: describe the photoelectric effect calculate the threshold wavelength determine the work function apply experimental measurement to determine Planck's constant.
	Emission and absorption spectra	At the end of this activity, students should be able to: state Planck's postulates understand the formation of emission and absorption spectra of gases understand the difference between spontaneous and stimulated emission explain the operation of a laser.
	Electron energy levels in an atom	At the end of this activity, students should be able to: describe the atomic models of Thomson, Rutherford and Bohr explain how emission and absorption are related to changes in atomic energy levels describe the band model of a solid body.
	X-rays	At the end of this activity, students should be able to: define X-radiation state the reasons for the occurrence of X -radiation give examples of practical applications of X-radiation explain the causes for the detrimental effect of X-radiation on live organisms describe the application of X-rays in the analysis of crystal structure.
	Waves of matter	At the end of this activity, students should be able to: explain the de Broglie hypothesis state the formula for wavelength related to a material particle describe the operation of an electron microscope.
	The structure of atomic nucleus	At the end of this activity, students should be able to: define an atomic nucleus, a nucleon, a neutron, and an isotope explain the concepts of atomic mass and atomic mass unit explain the concepts of mass number and atomic number describe the composition of a nucleus of any isotope state the forces which are present in a nucleus.
XXI. Nuclear physics	Nuclear radiation	At the end of this activity, students should be able to: describe the phenomenon of radiation describe alpha and beta radiation determine the seed of ? and ? particles describe a radioactive series specify the reasons why nuclear radiation is so harmful.
	Decay law	At the end of this activity, students should be able to:

		describe the decay of radioactive elements explain the concepts of: half-life, decay constant, mean lifetime; and describe the relationship between them state the formula for exponential law of decay explain the concept of the activity, name its units, and state on what its magnitude depends understand the radiocarbon method and scintigraphic examination.
	Stability of the nuclei	At the end of this activity, students should be able to: explain the concept of binding energy and mass defect describe the table of isotopes explain why certain nuclei are characterised by higher stability and others by lower stability explain where unstable isotopes which are heavier than lead are found in nature.
	Nuclear fusion	At the end of this activity, students should be able to: describe a particular reaction of nuclear fusion calculate the energy released during a reaction, given the masses of the substrates and the products explain the operation of the Sun as a thermonuclear reactor describe the operation of a hydrogen bomb.
	Nuclear fission	At the end of this activity, students should be able to: describe a nuclear fission reaction calculate the energy released during a reaction given the mass of the substrates and the products explain the meaning of critical mass describe the operation of a nuclear reactor explain the operation of an atomic bomb.
	Elementary particles	At the end of this activity, students should be able to: describe a lepton, baryon, boson and a fermion explain the concept of particle-antiparticle state what is meant by antimatter explain the concept of a quark, and the fact that nucleons are made of quarks.
XXII. Astrophysics	The Solar System	At the end of this activity, students should be able to: explain the concept of the astronomical unit state the relationship between the size of the Sun and the planets and give the distances between them name the elements of the Solar System and provide a short description of each of them.
	Classification of stars	At the end of this activity, students should be able to: recognise a few of the best-known constellations explain the concept of stellar parallax define the parsec and the light year explain the difference between apparent magnitude and absolute magnitude describe the radiation emitted by stars and explain how it can be used to estimate the surface temperature of a star name the spectral classes of stars describe an H-R diagram.
	Evolution of stars	At the end of this activity, students should be able to: describe the basic stages in the evolution of stars in relation to their initial masses given an H-R diagram, indicate the position of: the main sequence, white and red dwarves, red and blue giants describe the fate of the Sun explain the origin of heavy elements.
	Galaxies	At the end of this activity, students should be able to: explain what is the Milky Way describe the structure of the Galaxy name the different types of galaxies describe the position of the Earth and the Sun in the Universe state Hubble's Law state the basic observations that indicate that the Universe is expanding describe the different cosmological models: close, open and flat.
XIII. Theory of relativity	The speed of light	At the end of this activity, students should be able to: explain how Roemer proved that the speed of light was finite in value describe the measurement of speed as conducted by Fizeau explain the concept of relative motion define inertial and non-inertial frames state Einstein's postulates.
	Time and distance	At the end of this activity, students should be able to: describe the relativity of simultaneity, time dilation and length contraction calculate time dilation and length contraction

		describe the twin paradox and the barn-pole paradox.
	Mass, energy and momentum	At the end of this activity, students should be able to: describe the changes in mass and momentum of an object with increasing velocity calculate the rest energy of an object calculate the total and the kinetic energy of an object state the relativistic relationship between momentum and energy calculate the mass defect and the related energy in nuclear reactions.
	General theory of relativity	At the end of this activity, students should be able to: explain the equivalence principle describe the effects resulting from the general theory of relativity including the deflection of light, the precession of the orbits of planets, the slowing of time and the curvature of space.



CHEMISTRY

CHAPTER	LESSON	DESCRIPTION
I. Atomic structure	The structure of the atom	At the end of this activity, students should be able to: describe the inner structure of the atom define and use atomic number and mass number compare the properties of subatomic particles describe isotopes explain how a mass spectrometer works use the mass spectra of elements to determine the abundance of isotopes define relative atomic mass and relative molecular mass.
	Development of atomic theory. Radioactivity	At the end of this activity, students should be able to: give the main postulates of early atomic theories describe how subatomic particles were discovered explain how the modern atomic model was developer explain the phenomenon of radioactivity discuss the characteristics and origin of alpha, beta and gamma radiation predict the process of radioactive decay indicate the main uses of radioactive isotopes.
	Atomic spectra	At the end of this activity, students should be able to: describe light as a particular kind of electromagnetic radiation explain the wave —like and particle —like nature of light explain the relationships among wavelength, frequency and energy of radiation explain the difference between continuous and line spektra describe Bohr's model of the atom — explain the origin of spectral lines using Bohr's model.
	Electron configuration of atoms	At the end of this activity, students should be able to: define the four quantum numbers describe the structure of energy levels in a many—electron atom define s, p and d orbitals, and describe their shapes describe the rules for assigning electrons to subshells deduce the electron configuration of an atom from its atomic number describe the position of the element in the periodic table based on its electron configuration.
II. Bonding	Types of bonding	At the end of this activity, students should be able to: explain how elements form ions explain the concept of the electrical charge of metal ions explain how the basic types of chemical bond are formed: ionic (electrovalent), covalent, multiple covalent, dative (coordinate) and metallic bonds.
	Electronegativity and polarity	At the end of this activity, students should be able to: define the concept of elektronegativity explain the electronegativity scale describe how electronegativity changes across the periodic table explain how the electronegativities of two elements affect the type of bonding between them describe the variation of chemical bonding in the halides of the third period elements and the second group elements.
	Molecular shapes	At the end of this activity, students should be able to: outline the basis for determining molecular shapes using the VSEPR theory determine the shape of simple molecules, including those containing lone electron pairs.
	Valence bond theory and hybridisation	At the end of this activity, students should be able to: interpret covalent bonds as overlapping of atomic orbitals define the ? bond and the ? bond describe the main types of hybridisation explain shapes of molecules using the concept of hybridisation of atomic orbitals explain the formation of multiple bonds.

III. Phases and phase changes	States of matter	At the end of this activity, students should be able to: describe the macroscopic properties of gases, liquids and solids explain the properties of gases, liquids and solids in terms of the kinetic theory describe the fourth state of matter plasma.
	Phase changes	At the end of this activity, students should be able to: define a phase and a phase change describe and analyse cooling and heating curves explain phase changes in terms of the kinetic theory define melting and boiling points describe melting and freezing processes in terms of dynamic equilibrium explain the process of vaporisation and the existence of vapour pressure tell the difference between vaporisation and boiling explain why boiling point depends on external pressure describe sublimation and deposition.
	Gas laws	At the end of this activity, students should be able to: describe the properties of an ideal gas state Boyle's law, Charles's law and Avogadro's law and use them in calculations use the ideal gas law to calculate the density of a gas and the relative molecular mass of a volatile compound explain under what conditions real gases behave as ideal and how very low temperatures and extremely high pressures affect their behaviour.
	Intermolecular forces	At the end of this activity, students should be able to: decide whether a molecule is polar or non-polar describe dipole dipole interactions describe London (dispersion) forces between induced dipoles describe hydrogen bonding explain the effect of intermolecular interactions on the physical properties of the substance.
	Structure of solids	At the end of this activity, students should be able to: describe the structure and properties of metallic crystals, ionic crystals, molecular crystals, macromolecular crystals and amorphous solids identify the type of structure of a solid based on its properties.
IV. Stoichiometric calculations	Mole	At the end of this activity, students should be able to: define the unit of quantity of matter the mole define Avogadro's number define molar mass calculate the number of moles in a given mass calculate the mass given the number of moles define the molar volume of gases calculate volumes of gas reactants.
	Chemical equations	At the end of this activity, students should be able to: define a chemical equation and describe what it consists of explain the difference between a stoichiometric subscript and a stoichiometric coefficient explain how to balance chemical equations— determine stoichiometric coefficients in chemical reactions obtain information about the qualitative and quantitative composition of a chemical compound from its molecular formula calculate reacting masses on the basis of chemical equations explain the concept of the limiting reactant.
	Practical importance of the mole	At the end of this activity, students should be able to: determine the empirical formula of a chemical compound determine the molecular formula given the empirical formula and molar mass determine the composition of a mixture calculate reaction yields.
	Concentration	At the end of this activity, students should be able to: determine if mixture is homogeneous or heterogeneous define saturated and unsaturated solutions and explain how to recognize the colloid solution calculate molarity and do calculations involving molarity calculate the concentration of ions in a solution prepare a solution of given molarity calculate the molarity of a solution after dilution and calculate the molarity of a solution after mixing two solutions of the same substance explain what titration is and determine the molarity of a solution using titration do calculations of reactant and product quantities for reactions occurring in solution and calculate the mass percent concentration.

V. Periodic table	The periodic table of the elements	At the end of this activity, students should be able to: state the criteria for classifying the elements in the periodic table state the group to which a given element belongs on the basis of its number of valence electrons, and vice versa state the period to which a given element belongs on the basis of its number of electron shells, and vice versa state the block to which a given element belongs s, p, d or f on the basis of its electron configuration give the electron configuration of an element on the basis of its position in the periodic table, and vice versa.
	The trends in the properties of the elements in Period 3	At the end of this activity, students should be able to: know how atomic radius, ionisation energy, electronegativity, conductivity, melting point and boiling point vary across Period 3 be able to explain what factors affect these properties.
	Periodic trends in the chemical properties of elements	At the end of this activity, students should be able to: understand how the electronegativity of elements influences the properties of their compounds understand how the oxides of Period 3 elements form, and what their structure and their properties are understand how the elements of Period 3 behave in the presence of water understand how the chlorides of Period 3 elements form and what their structure is — understand the chemical properties of the chlorides of Period 3 elements.
	s-Block elements	At the end of this activity, students should be able to: write out the electron configurations of the elements in the s—block describe the changes in the atomic radii of the s—block elements within groups and periods describe the changes in the ionic radii of the s—block elements within groups and periods describe the trend in the melting points of the elements in groups 1 and 2 describe the relationship between atomic structure and the physical properties of elements.
	Chemical properties of s-block elements	At the end of this activity, students should be able to: be able to describe the changes in reactivity of s—block metals within groups and periods know what type of bonding occurs in compounds made by the s—block metals with other elements know the reactions between the Group 1 and 2 metals and water know the solubility of the Group 1 and 2 metal hydroxides and sulphates know the reactions of the Group 1 and 2 metals with oxygen know the stability of the Group 1 and 2 metal carbonates know about the unique properties of beryllium.
	Elements of Group 17	At the end of this activity, students should be able to: write the electron configuration of Group 17 elements describe the trends in the size of atomic and ionic radii in elements of Group 17 state the direction of changes in the melting point and the boiling point in Group 17 discuss the relationship between the atomic structure and the physical properties of elements describe the trends in the reactivity of halogens explain why chlorine is more reactive than bromine state whether a reaction occurs between a molecule of a particular halogen and a simple ion of another halogen.
	Reactions of halogens	At the end of this activity, students should be able to: describe the reactions between halogens and metals determine the water solubility of halides describe the reactions between silver halides and ammonia solution define photosensitive substances explain why silver bromide forms a negative image on photographic films describe other uses of the halogens and their compounds describe the reactions between the halogens and concentrated sulphuric acid.
VI. Oxidation and reduction	Oxidation states	At the end of this activity, students should be able to: describe what oxidation—reduction reactions involve calculate oxidation states recognise redox equations give the systematic names of inorganic compounds and polyatomic ions, specifying their oxidation states discuss the oxidative—reductive properties of the s—block metals discuss the oxidative—reductive properties of the elements of Group 17 describe the oxidation states of the p—block elements in their commonest chemical compounds.
	Redox reactions	At the end of this activity, students should be able to: write a redox reaction in the form of half—equations balance redox reactions occurring in acidic solution, using the method of half—equations balance redox reactions occurring in alkaline solution, using the method of half—equations know how to recognise the oxidising agent (reducing agent) in an aqueous solution determine the concentration of a solution using redox titration.

	Extraction of metals. Part I	At the end of this activity, students should be able to: explain and define a mineral and an ore explain the general methods for extracting metals from their ores explain the importance of iron to man describe the operation of a blast furnace and discuss the chemical processes occurring during the extraction of iron explain the basic oxygen process for making steel.
	Extraction of metals. Part II	At the end of this activity, students should be able to: describe the process of electrolysis and discuss its products describe the general properties, uses and extraction methods for aluminium, titanium and copper discuss economic aspects of metal extraction and recycling.
VII. Electrochemistry		At the end of this activity, students should be able to: describe the structure of a voltaic cell discuss the principles of voltaic cells explain what emf is use the conventional notation for cell descriptions and write the half—cell reactions discuss the practical applications of voltaic cells.
	Standard electrochemical potential	At the end of this activity, students should be able to: describe the structure of a standard hydrogen electrode calculate the emf of a cell determine the relative oxidising and reducing ability of a chemical species on the basis of its standard reduction potential identify an equation for a spontaneous reaction discuss the practical applications of the calomel half—cell.
	Electrochemical series	At the end of this activity, students should be able to: estimate the oxidising and reducing properties of chemical elements on the basis of their position in the electrochemical series use the electrochemical series to predict the direction of displacement of metals from solutions of their salts by other metals use the electrochemical series to identify metals that will displace hydrogen from acids estimate the oxidising and reducing properties of chemical species from their position in the electrochemical series estimate the feasibility of a redox reaction using the position of the reactants in the electrochemical series predict whether a particular substance can be used for the oxidation of another substance under standard conditions.
VIII. Thermodynamics	Enthalpy change and calorimetry	At the end of this activity, students should be able to: explain what energy is and classify the various forms of energy distinguish between a system and its surroundings describe the energetic effects that accompany chemical and physical changes classify reactions as exothermic or endothermic explain the concept of enthalpy change write and interpret thermochemical equations define specific heat capacity and use this quantity in calculations explain the concept of calorimetry determine enthalpy changes from calorimetric data.
	Standard enthalpy change. Hess's law	At the end of this activity, students should be able to: define standard conditions, standard state and standard enthalpy change define and use in calculations standard enthalpies of combustion and standard enthalpies of formation explain Hess's law and use it in determining enthalpy changes use standard enthalpies of combustion and standard enthalpies of formation in determining the standard enthalpy change of a reaction.
	Born-Haber cycle	At the end of this activity, students should be able to: describe the formation of an ionic compound as a series of steps explain every step in the formation of an ionic compound and the enthalpy changes involved: enthalpy of atomisation, ionisation enthalpy, electron affinity and lattice formation enthalpy describe a Born—Haber cycle as an energy diagram linking the enthalpy of formation to the enthalpy changes of atomisation, ionisation and crystal lattice formation use a Born—Haber cycle to calculate enthalpy changes and to predict the stability of an ionic compound.
	Enthalpy changes in the solution process	At the end of this activity, students should be able to: explain the properties of water in terms of the structure of the water molecule describe the process of dissolving an ionic solid— define enthalpy of hydration and discuss the factors that affect its value define enthalpy of solution derive the value of enthalpy of solution from lattice formation enthalpy and enthalpy of hydration describe how enthalpy of solution can be measured experimentally.

	Mean bond enthalpies	At the end of this activity, students should be able to: define mean bond enthalpies use mean bond enthalpies to predict enthalpy changes describe the limitations in the use of mean bond enthalpies in thermochemical calculations explain why for certain compounds the predicted values of enthalpy changes do not agree with the experimental values.
	Entropy	At the end of this activity, students should be able to: use the laws of probability to explain the spontaneity of chemical and physical changes explain the concept of entropy as a measure of disorder at the molecular level discuss the entropy changes caused by chemical and physical processes use standard entropy values to calculate standard entropy changes for reactions explain how the entropy change of a system is affected by temperature, phase change or the stoichiometry of gaseous reactions use enthalpy change and temperature to determine the enthalpy change for the surroundings use a calculated total entropy change to predict whether a reaction is spontaneous or not.
	Free energy	At the end of this activity, students should be able to: define free energy change and use it to determine whether a reaction is feasible or not discuss the effect of ?H° and ?S° values on free energy change explain why most exothermic processes are spontaneous but only certain endothermic processes are spontaneous discuss how lattice formation enthalpy, enthalpy of hydration and entropy change affect the solubility of ionic compounds in water correlate the feasibility of a reaction with the temperature explain dynamic equilibrium in terms of free energy change.
IX. Reaction kinetics	Reaction rate	At the end of this activity, students should be able to: explain the importance of the speed at which a chemical reaction occurs define reaction rate as the change in concentration of a reactant or product over time discuss reaction rates qualitatively using graphs describe experimental methods for studying reaction rates: gas volume, gas pressure, mass, conductance, colorimetric, titrimetric.
	Collision theory	At the end of this activity, students should be able to: describe a chemical reaction at the microscopic level as a collision of reactant molecules discuss the factors that govern the effectiveness of collisions explain the course of a reaction in terms of activation energy and an activated complex use energy diagrams to show the course of a reaction define a reaction mechanism give examples of chemical reactions that do not require collisions between molecules to occur.
	Effect of concentration on reaction rates. Rate equation	At the end of this activity, students should be able to: explain how concentration affects reaction rates discuss the effect of concentration in terms of the collision theory explain the effect of pressure on the rate of reactions taking place in the gas phase define the rate equation, rate constant and order of reaction determine a rate equation from the relative rates at various concentrations of reactants use rate equations for predicting relative and actual reaction rates explain why the contact area affects the rate of heterogeneous reactions.
	Effect of concentration on reaction rates. Graphical methods	At the end of this activity, students should be able to: explain what zero—order, first—order and second—order reactions are explain how to express the rate equation for a first—order reaction using natural logarithms explain how the half—life is related to the rate constant for first—order reactions use graphical methods in kinetics.
	Effect of temperature and catalyst on the reaction rates	At the end of this activity, students should be able to: explain how and why reaction rates depend on temperature describe the distribution of molecular energies in gases and liquids discuss why controlling the temperature of chemical reactions is important define a catalyst and inhibitors explain how catalysts work, using the activation energy concept describe the catalytic activity of metals elicit information about reaction rates from potential energy diagrams and the Maxwell—Boltzmann distribution curve.
	Catalysts and enzymes	At the end of this activity, students should be able to: indicate the differences between heterogeneous and homogeneous catalysis describe the course of a reaction in the presence of a solid catalyst explain the concept of autocatalysis explain the active complex theory describe the mechanism of catalyst action give examples of the uses of catalysts explain how enzymes work.

X. Chemical equilibria	Chemical equilibrium and equilibrium constant	At the end of this activity, students should be able to: explain the difference between reversible and irreversible reactions explain the dynamic character of chemical equilibrium write equilibrium constant expressions using the appropriate reaction equations determine the units of Kc discuss the relationship between the magnitude of Kc and the position of chemical equilibrium determine Kc for a reaction, knowing the equilibrium concentration of one of the reagents.
	Factors affecting the chemical equilibrium	At the end of this activity, students should be able to: use the reaction quotient to determine whether a given system is in chemical equilibrium define Le Chatelier's principle predict how the addition or removal of reactants or products will affect an equilibrium describe, in terms of disturbed chemical equilibrium, the formation of stalagmites and stalactites, tooth decay, and the harmful effects of acid rain on trees explain how temperature changes affect chemical equilibrium predict the direction of a net reaction induced by a temperature change explain why catalysts do not affect the position of equilibrium.
	Chemical equilibrium in the gas phase	At the end of this activity, students should be able to: explain why pressure affects reactions involving gases convert between different units of pressure explain how pressure changes affect chemical equilibria define partial pressure and molar fraction write the expression for Kp of a reaction use the Kp constant in calculations of partial pressures at equilibrium explain the importance of reaction conditions for industrial processes discuss the factors that affect the outcome of the Haber process.
XI. Acids, bases and salts	Dissociation of acids, bases and salts	At the end of this activity, students should be able to: define strong and weak electrolytes and non—electrolytes explain why solutions of electrolytes conduct elektricity define acids, bases and salts and describe their general properties explain the dissociation of acids, bases and salts describe the neutralisation reaction discuss the solubility of salts describe the precipitation process.
	Bronsted-Lowry theory of acids and bases. Autoionisation of water	At the end of this activity, students should be able to: define acids and bases in terms of the Br?nsted—Lowry theory identify pairs of conjugated acids—bases in aqueous and non—aqueous media describe the autoionisation of water define the ionic product of water Kw distinguish among neutral, acidic and alkaline solutions calculate concentrations of ions using the ionic product equation.
	pH as the universal acidity measure	At the end of this activity, students should be able to: use logarithms in calculations define pH of a solution explain the relationship between pH and the concentrations of hydrogen and hydroxide ions describe the pH scale determine the pH of strong acids and bases deduce the pH of the solution resulting from mixing an acid and a base.
	Weak acids and weak bases	At the end of this activity, students should be able to: describe the dissociation of weak acids and bases define the acid and base dissociation constants compare the strengths of acids and bases using dissociation constants explain the changes in subsequent dissociation constants for di— and triprotic acids perform pH calculations for solutions of weak acids and bases explain pKa and pKb values and use them to predict the strengths of acids and bases.
	Salts in water solution	At the end of this activity, students should be able to: describe the dissociation of conjugate acids and bases explain the hydrolysis of salts and describe the relation of Ka and Kb in conjugate acid-base pairs decide whether the pH of a salt solution has a neutral, acidic or alkaline value calculate the pH of solutions of the salts of weak acids and strong bases and of the salts of strong acids and weak bases.
	Buffers	At the end of this activity, students should be able to: define acidic and alkaline buffers describe quantitatively how buffers work — calculate the pH of a buffer solution calculate the pH changes resulting from the addition of strong acids/bases to buffer solutions determine the pH range of a buffer based on Ka and Kb constants calculate the amounts of acid/base and salt required to prepare a buffer solution of specified pH.

	Acid-base titration	At the end of this activity, students should be able to: define titration as the volumetric analytical technique describe how to perform an acid—base titration derive the unknown amount of acid/base from the results of an acid—base titration explain the importance of standardisation of titrant solutions.
	Titration curves	At the end of this activity, students should be able to: describe how the pH of a solution changes upon gradual addition of the titrant describe the characteristics of pH curves for strong acid—strong base, weak acid—strong base and weak base—strong acid titrations explain how indicators work choose the appropriate indicator for a given titration discuss qualitatively pH curves with two equivalence points indicate the limitations of acid—base titrations.
XII. Transition metals	Electron configuration and periodic trends of transition elements	At the end of this activity, students should be able to: give a general description of d—block elements relate the properties of transition metals to their electron configurations indicate whether a certain transition metal atom or ion is paramagnetic or not discuss general periodic trends in the d—block explain the reactivity of transition metals in terms of standard reduction potentials.
	Oxidation states of transition elements	At the end of this activity, students should be able to: explain why transition elements exist in many oxidation states in their compounds give the most common oxidation states for the 4th Period transition elements explain the use of manganate(VII) and dichromate(VI) in redox titrations.
	Transition metal complexes	At the end of this activity, students should be able to: describe the structure of complex ions and determine the co—ordination number of the central ion classify ligands as uni— or multitendate determine the charge of a complex ion explain why transition metal complexes are usually coloured, and say what affects their colour describe the reactions of complex ions in terms of ligand Exchange give examples of redox reactions promoted by changing the ligands describe the uses of transition metal complexes, including in analytical tests explain the biological importance of transition metal complexes.
XIII. Reaction of metal ions in water solution	Acid-base reactions of metal ions	At the end of this activity, students should be able to: define acids and bases in terms of the Lewis theory describe the formation of aqua ions in water solution explain the acidity (hydrolysis) reaction of hexaaqua—metal ions define the products of the reactions of metal aqua ions with alkalis, ammonia and carbonates explain the term amphoteric hydroxides use the reactions of aqua complexes for the identification of metal ions.
	Ligand exchange reactions	At the end of this activity, students should be able to: describe the stability of a complex in terms of formation constant explain the reaction of aqua ions with ammonia and describe the structure of the resulting ammine complexes describe metal complexes of chloride ions explain why the complexes with multidentate ligands (chelating agents) are usually more stable than those with unidentate ligands— explain why the formation of complex ions affects the solubility of ionic compounds.
XIV. Hydrocarbons	Petroleum as the source of hydrocarbons	At the end of this activity, students should be able to: understand the origin of fossil fuels recognise the importance of crude oil know the location of the principal deposits of crude oil in the world understand the fractional distillation proces know the basic products from fractional distillation of crude oil and their uses understand the terms ‘cracking’ and ‘reforming’ be able to perform calculations involving the concepts of density and mass percentage.
	Hydrocarbons as fuel	At the end of this activity, students should be able to: understand the importance of energy in modern society understand the difference between total and incomplete combustion of hydrocarbons be able to work with graphs and calculations concerning hydrocarbon oxidation understand the term ‘energetic value’ of a fuel and how to evaluate it know how catalytic converters work.
	Alkanes and cycloalkanes	At the end of this activity, students should be able to: be able to explain the unique properties of the element carbon understand the terms ‘homologous series’ and ‘isomers’ know the basic structural features of alkanes and cycloalkanes know how to name alkanes, alkyl groups and cycloalkanes according to the IUPAC rules and know

		how to draw structural formulas for alkanes and cycloalkanes know the basic physical properties of alkanes and understand the influence of intermolecular forces on the physical properties of alkanes.
	Chemistry of alkanes and cycloalkanes	At the end of this activity, students should be able to: understand why alkanes and cycloalkanes are chemically inert understand the energy profile for the combustion of alkanes know the conditions leading to homolytic fission of the C—C bond understand the mechanism of free—radical substitution know about the influence of the type of halogen on substitution in alkanes know the basic methods for alkane and cycloalkane synthesis.
	Alkenes	At the end of this activity, students should be able to: provide the names and structures of the first members of a homologous series of alkenes state and explain the physical properties of alkenes recall and explain the types of isomerism exhibited by alkenes give examples and systematic names of compounds belonging to the series of alkadienes and cycloalkenes.
	Alkene reactions	At the end of this activity, students should be able to: understand the concept of electrophilic addition understand why alkenes undergo electrophilic addition be able to write molecular and structural equations for reactions involving alkenes understand why addition reactions yield mixtures of isomeric alkanes, and predict their proportion in the mixture understand the importance of addition polymerisation and be able to give examples of this type of reaction.
XV. Haloalkanes, alcohols and epoxides	Haloalkanes	At the end of this activity, students should be able to: define the term 'functional group' build models of, construct formulae for, and correctly name haloalkanes give examples of isomers of haloalkanes describe the physical properties of haloalkanes describe the methods of preparation of haloalkanes and write appropriate reaction equations give examples of the uses of haloalkanes discuss the environmental impact of haloalkanes.
	Reactions of haloalkanes	At the end of this activity, students should be able to: describe the properties of the C—X bond write equations for the reactions of haloalkanes with bases, ammonia and the cyanide ion explain the mechanism of SN1 and SN2 nucleophilic substitution reactions give examples of elimination reactions in haloalkanes and write relevant equations give examples of the applications of haloalkanes in organic synthesis.
	Alcohols	At the end of this activity, students should be able to: describe the structure of alcohol molecule name alcohols and draw their structural formulae explain the phenomenon of isomerism in alcohols explain the concept of primary, secondary and tertiary alcohols describe the physical properties of ethanol describe and explain the changes in the boiling points and solubility of alcohols with increasing molecular size.
	Ethanol	At the end of this activity, students should be able to: investigate the physical properties of ethanol describe the methods for obtaining ethanol explain the most important applications of ethanol assess the effects of alcohol on the human organism.
	Reactions of alcohols	At the end of this activity, students should be able to: describe the acidic properties of the —OH group in alcohols describe and give examples of the elimination reactions of alcohols, the reactions between alcohols and inorganic acids, and reactions involving alcohol oxidation explain how to distinguish primary, secondary and tertiary alcohols explain the concept of monohydric and polyhydric alcohols.
XVI. Compounds with the carbonyl group	Aldehydes and ketones	At the end of this activity, students should be able to: define the carbonyl group, an aldehyde and a ketone and name examples of carbonyl compounds explain the effect of the presence of a carbonyl group on the physical properties of aldehydes and ketones design reactions for obtaining simple aldehydes and ketones describe the occurrence of aldehydes and ketones in nature and give examples of the applications of them.

	Reactions of aldehydes and ketones	At the end of this activity, students should be able to: define a nucleophilic addition reaction and discuss its mechanism write equations for the addition reactions of hydrogen cyanide and hydrogensulphite, and name the products write equations for the reduction of aldehydes and ketones with various reducing agents and name the products of these reactions explain the differences between the behaviour of aldehydes and ketones during oxidation and describe the practical importance of these reactions write equations for the oxidation of aldehydes and ketones using known oxidising agents define Tollens', Fehling's and Brady's reagents and name the reactions used for identification of carbonyl compounds.
	Carboxylic acids	At the end of this activity, students should be able to: describe the general structure of carboxylic acids name carboxylic acids according to the IUPAC rules explain how the physical properties of carboxylic acids are a result of the structure of the carboxyl group explain the acidic properties of carboxylic acids and discuss how the structure of an acid affects its acidic strength describe the properties of the salts of carboxylic acids and the typical reactions of carboxylic acids describe preparative methods for carboxylic acids indicate the natural sources of carboxylic acids.
	Functional derivatives of carboxylic acids	At the end of this activity, students should be able to: describe the general structure of functional derivatives of carboxylic acids explain nucleophilic acyl substitution reactions describe the structure, properties, reactions and preparation of acyl chlorides, acid anhydrides, esters, amides and nitriles explain acylation reactions.
XVII. Aromatic compounds	Benzene	At the end of this activity, students should be able to: describe the inconsistencies arising from the representation of the structure of benzene using C=C double bonds explain the structure of benzene in the light of modern knowledge understand the concepts of delocalisation and resonance and be able to take them into account when writing the structure of an organic compound determine the resonance stabilisation energy for arenes describe the names and structures of some polycyclic aromatic hydrocarbons and alkyl derivatives of benzene explain the aromaticity criteria for organic compounds.
	Electrophilic substitution	At the end of this activity, students should be able to: define an electrophilic substitution reaction of the aromatic ring and describe its mechanism write down the reaction of benzene nitration and name its products give examples of the uses of nitro compounds explain the Friedel—Crafts alkylation and acylation reactions of the benzene ring design synthesis reactions for simple alkyl and acyl derivatives of benzene.
XVIII. Organic compounds of nitrogen	Structure and properties of amines	At the end of this activity, students should be able to: describe amines as functional derivatives of ammonia name and classify amines as primary, secondary or tertiary explain the physical properties of amines as related to their structure explain the properties of amines as bases and discuss their strength as bases explain the effect of a benzene ring on the strength of aromatic amines as bases describe the structure, properties and uses of quaternary ammonium salts.
	Amines and amides: reactions and preparation	At the end of this activity, students should be able to: describe the alkylation of ammonia and amines explain how primary, secondary and tertiary amides are formed by the acylation of amines discuss the physical and acid—base properties of amides describe the hydrolysis and reduction of amides describe the main general preparative routes to aliphatic and aromatic amines and use them to plan syntheses.
	Amino acids	At the end of this activity, students should be able to: explain the structure of amino acids and zwitterions describe the structural features of amino acids found in proteins explain the optical isomerism of amino acids discuss physical properties in terms of zwitterions explain and use the concept of isoelectric point describe the general structure of peptides.
XIX. Biologically important chemical compounds	Fats and sugars	At the end of this activity, students should be able to: describe the structures and physical properties of animal and vegetable fats describe the hydrolysis of fats and the addition reactions of unsaturated fats explain the role of fats in our diet

		explain the washing properties of soaps in terms of their molecular structure describe the structure and physical properties of sugars and explain the reactions of sugars as reactions of the carbonyl and hydroxyl groups describe the general structure and biological function of polysaccharides explain the nutritional importance of sugars.
	Proteins and nucleic acids	At the end of this activity, students should be able to: describe the primary, secondary, tertiary and quaternary structures of proteins explain the nature of the interactions that give proteins a three—dimensional shape explain the relationship between the shape of a protein molecule and its biological function describe the denaturation of proteins name the main building blocks of nucleic acids explain the structure of DNA and how two strands are bonded together explain why the two strands of DNA are complementary.
XX. Polymers	Polymers types. Addition polymers	At the end of this activity, students should be able to: classify polymers and describe their basic types: straight—chain, cross—linked, thermoplastic, thermosetting, elastomers explain the mechanism of the addition reaction leading to polymerisation, using the example of polyethene describe the properties of the most common addition polymers as: polypropene, PVC, polystyrene and Teflon explain how plasticisers work.
	Condensation polymers	At the end of this activity, students should be able to: explain condensation polymerisation reactions describe condensation polymers: polyesters and polyamides and their uses describe composites explain the negative environmental impact of polymers.
XXI. General topics in organic chemistry	Organic molecules	At the end of this activity, students should be able to: explain why carbon has a unique ability to form so many compounds describe the importance of carbon compounds to life on Earth discuss the differences between organic and inorganic chemistry describe the general types of carbon—carbon bond explain how bonding affects the shape of organic molecules derive the empirical formula of an organic compound from experimental data define and use empirical, molecular and general formulae as well as various types of structural formula.
	Naming organic compounds	At the end of this activity, students should be able to: classify organic compounds as aliphatic, alicyclic or aromatic define a homologous series of compounds explain the general approach to naming organic compounds recommended by the IUPAC identify and name parent hydrocarbons for organic molecules build a name for an organic compound using the names of the parent hydrocarbon, alkyl groups and functional groups apply the IUPAC rules in naming organic compounds draw the structure of a molecule using its IUPAC name.
	Isomerism	At the end of this activity, students should be able to: explain the general types of isomerism: structural isomerism (chain, positional, functional group) and stereoisomerism (geometric, optical) identify the type of isomerism in simple organic molecules indicate the differences in physical and chemical properties of enantiomers explain the construction and use of a polarimeter.
	Organic reactions	At the end of this activity, students should be able to: describe homolytic and heterolytic fission of a covalent bond explain free—radical chain reactions discuss the stability of free radicals define electrophiles and nucleophiles describe the formation of carbocations and discuss their stability explain the mechanisms of: electrophilic addition, electrophilic substitution, nucleophilic substitution (SN1 and SN2) , nucleophilic elimination (E1 and E2), nucleophilic addition and nucleophilic addition—elimination describe the most common oxidants and reductants used in organic syntheses, and give examples of specific uses of these reagents.
	Analytical tests in organic chemistry	At the end of this activity, students should be able to: explain what information can be obtained from combustion tests use the results of elementary analysis in the determination of empirical formulae describe the chemical tests for alkenes, haloalkanes (including identification of the halogen), aldehydes, ketones, alcohols (including 1°, 2° and 3° alcohols), carboxylic acids, esters, acid anhydrides, acyl chlorides, amines and amino acids— use the information from analytical tests to identify organic compounds.

XXII. Spectrometric techniques	Infra-red spectrometry. Part I	At the end of this activity, students should be able to: use information from chemical tests to determine the structure of an organic compound describe electromagnetic radiation in terms of wavelength, frequency, energy of photons and wavenumber explain the general concept of spectroscopy define the infra—red region used in spectroscopy explain why organic compounds absorb infra—red radiation state the relationship between the frequency of bond vibration and the frequency of absorbed radiation discuss the factors affecting the frequency of bond vibration and the modes of bond vibration describe recording of an infra—red spectrum, construction of the spectrometer and sample handling.
	Infra-red spectrometry. Part II	At the end of this activity, students should be able to: use a correlation chart for infra—red spektra indicate the most typical absorptions found in the spectra of alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, amines, haloalkanes, aldehydes and ketones, carboxylic acids and their derivatives (esters, amides, nitriles) identify the presence and absence of functional groups using infra—red spektra predict the infra—red absorption regions for molecules of known structure describe the uses and limitations of infra—red spectroscopy.
	Mass spectrometry. Part I	At the end of this activity, students should be able to: discuss the behaviour of charged particles in electric and magnetic fields relate the deflection of a charged particle in a magnetic field to the mass and charge of the particle and the strength of the magnetic field describe how a mass spectrometer works explain what a mass spectrum is explain the terms: base peak, molecular ion, fragmentation ion, relative abundance discuss mass spectra of the elements in terms of the natural abundance of isotopes explain the general features of mass spectra of organic compounds.
	Mass spectrometry. Part II	At the end of this activity, students should be able to: use mass spectra to determine the relative molecular mass of a compound discuss the stability of fragmentation ions predict the most probable fragmentation patterns recognise the spectra of chlorine— and bromine—containing compounds use mass spectra for the identification of organic compounds.
	Nuclear magnetic resonance (NMR) spectroscopy. Part I	At the end of this activity, students should be able to: explain how atomic nuclei behave in an external magnetic field, depending upon whether they posses nuclear spin or not explain why a magnetic field causes the energy levels of nuclei possessing nuclear spin to split explain the nuclear absorption of electromagnetic radiation by nuclei placed in a magnetic field describe the construction and operation of an NMR spectrometer and how an NMR spectrum is recorded explain the term 'chemical shift' and discuss why hydrogen atoms in organic molecules may produce more than one NMR absorption signal explain why TMS has been chosen as a standard in NMR spectroscopy identify equivalent and non—equivalent 1H atoms in the molecule predict the number of absorption signals in low—resolution proton NMR spectra, as well as their relative intensity.
	Nuclear magnetic resonance (NMR) spectroscopy. Part II	At the end of this activity, students should be able to: explain the coupling effect predict the number of components in proton NMR multiplets, given the structural formula of a compound draw conclusions about a molecular structure from the coupling pattern state and use the n + 1 rule and describe the main types of multiplet: singlet, doublet, triplet, quartet explain the types of coupling with non—equivalent 1H atoms explain why there is no coupling with hydrogen atoms bonded to oxygen or nitrogen use a chemical—shift correlation chart to obtain information about molecular structure determine the structure of organic molecules using information provided by proton NMR spectra: the number and intensity of absorption signals, the coupling pattern and chemical shifts.
	Determination of molecular structure	At the end of this activity, students should be able to: calculate and use the hydrogen deficiency index use spectral and analytical data to draw conclusions about the structures of organic compounds.
	Absorption of visible light. Colorimetry	At the end of this activity, students should be able to: explain how the absorption of light produces colour explain the origin of the colours of the inorganic compounds of s, p and d—block metals, as well as of organic compounds describe how absorption spectra are recorded explain the concept of colorimetry define and use the Beer—Lambert law.
XXIII.	Pollution of air	At the end of this activity, students should be able to:

Environmental pollution by chemical products		describe the composition of air and the structure of the atmosphere explain how the contemporary atmosphere evolved explain the carbon cycle and discuss how it is disturbed by human activities explain why the increasing concentration of atmospheric CO2 contributes to global warming, and what the probable results of a prolonged greenhouse effect would be indicate the sources of sulphur dioxide and nitrogen oxides explain the phenomenon of acid rain describe the formation of photochemical smog explain how CFCs disrupt the ozone layer.
	Pollution of water	At the end of this activity, students should be able to: explain the composition and properties of natural water: oxygen content, pH, hardness, content of ionic compounds explain the toxic properties of heavy metals, give examples of poisoning by heavy—metal ions contained in water discuss the positive and negative effects of using pesticides explain the eutrophication of water by excess phosphate describe the purification of tap water and the treatment of sewage.
	Pollution of land	At the end of this activity, students should be able to: explain the composition and disposal of solid commercial and domestic waste discuss the benefits of and problems with the recycling of plastic, paper, glass and metals indicate the sources of dioxins explain the environmental impact of using nuclear energy for the production of electricity.

BIOLOGY

CHAPTER	LESSON	DESCRIPTION
I. Chemistry of organisms	Chemical elements of the cell	At the end of this activity, students should be able to: define biogenic elements and present their basic role in the formation of organic compounds explain the meanings of the terms "macro-elements", "trace elements" and "ultra-trace elements" and present examples of the biological significance of these elements discuss the most important properties of water (from a biological point of view) and their significance in the world of living organisms.
	Carbohydrates: their structure, properties, occurrence and importance	At the end of this activity, students should be able to: define carbohydrates, monosaccharides, disaccharides and polysaccharides and give examples of carbohydrates representing these classes describe the occurrence and functions of the most important carbohydrates describe the characteristic properties of monosaccharides, disaccharides, storage polysaccharides and structural polysaccharides explain the reactions of hydrolysis and condensation of carbohydrates and their importance.
	Lipids: structure, properties, occurrence and importance	At the end of this activity, students should be able to: describe the structure of lipids and their major groups describe the structure of fatty acids and their significance as metabolic fuel and structural components of different groups of lipids describe the structure of a triacylglycerol molecule and the role of triacylglycerols in living organisms understand the bipolar character of the structure of phospholipid molecules and its biological signifikance describe the importance of cholesterol as a component of cell membranes and a substrate for the synthesis of steroid hormones and vitamin D3.
	Proteins	At the end of this activity, students should be able to: present the general structure of amino acids describe the formation of a peptide bond describe four levels of organization of protein molecules and explain how they are formed explain the significance of the primary structure of protein in the configuration of proteins.
	Biochemical tests, chromatography, electrophoresis and separation of tissues	At the end of this activity, students should be able to: know how to detect sugars, reducing sugars, polysaccharides, fats and proteins in biological material define electrophoresis and describe the components of an electrophoresis unit and the principles of electrophoretic separation define chromatography and describe the components of a paper chromatography unit — explain the concept of relative front and its application in chromatography.
II. Basics of cytology	Morphology of prokaryotic and eukaryotic cells as seen under the light microscope	At the end of this activity, students should be able to: describe the differences in the structure of eukaryotic and prokaryotic cells describe the similarities and differences between eukaryotic cells determine the size of objects using the light microscope determine the number of cells using the light microscope explain how the transport of respiratory gases is organized.
	Current techniques in cytology	At the end of this activity, students should be able to: describe the principles of light and electron microscopy and centrifugation give examples of specific areas of biological research in which the above techniques can be applied.
	Cell ultrastructures	At the end of this activity, students should be able to: — describe the structure and functions of the nucleus, cytoplasm and cytosol define the structure and functions of rough endoplasmic reticulum (RER), SER (smooth endoplasmic reticulum), ribosomes, the Golgi body and the cytoskeleton describe the structure and role of cell wall and membrane define the structure and function of the mitochondrion, chloroplast and vacuole describe the structure of the cell and the basic roles of cellular organelles.
	Specialization of cells	At the end of this activity, students should be able to: define the features of stem cells

		explain determination and differentiation of cells and tissues of cells and tissues and name the basic characteristics of such cells name and discuss examples of differentiated cells in animals and plants.
	Transport across membranes	At the end of this activity, students should be able to: describe, compare and contrast the processes of osmosis and diffusion know the principles of Fick's first law explain the importance of passive and active transport and cytosis — explain the following terms: "isotonic", "hypotonic" and "hypertonic", "water potential", "osmotic potential" and "osmotic pressure".
	Cell division — mitosis	At the end of this activity, students should be able to: describe the process of mitosis describe the cell cycle describe changes in chromosome structure during the cell cycle and mitosis explain the importance of mitosis.
III. Taxonomy	Cell division — meiosis (reduction division)	At the end of this activity, students should be able to: describe the process of meiosis describe changes in chromosome structure during the cell cycle and meiosis explain the importance of meiosis explain the differences between mitosis and meiosis.
	Taxonomy	At the end of this activity, students should be able to: prepare a simple classification of species based on their characteristics understand the reasons for the differences between the various systems of classification of living organisms explain the cardiac cycle know the principles of classification of species based on their phenotypical characteristics and the properties of their genome — understand the importance of the degree of kinship and phylogeny in the classification of species.
	Prokaryotes — simple organisms with no nucleus	At the end of this activity, students should be able to: name the basic characteristics of prokaryotes name the basic differences between Archaea and Eubacteria name the basic differences between Gram-positive and Gram-negative bacteria recognise the basic types of bacteria.
	Protista	At the end of this activity, students should be able to: describe the basic characteristics of eukaryotes and protests name the basic differences between protists and tissue organisms differentiate between the groups of protests list the diverse modes of adaptation to environmental conditions developed by protests list the diverse modes of reproduction in protists.
	Fungi	At the end of this activity, students should be able to: describe the basic features of fungi and differentiate between the basic phyla of fungi recognise the different types of adaptations to the environment in fungi recognise the similarities in the methods of reproduction in fungi describe the significance of fungi in nature.
	Plants	At the end of this activity, students should be able to: indicate the basic features of plants distinguish the basic groups of plants recognise the diversity of plant forms recognise the similarities and differences in the life cycles of bryophytes, pteridophytes and seed plants.
	Animals — the invertebrates	At the end of this activity, students should be able to: recognise the variety of adaptations in the invertebrate groups indicate, using selected examples, the characteristic features of each invertebrate group assign animals to a specific invertebrate group recognise the structural and functional similarities and differences in selected examples of the invertebrate groups.
	Animals — the vertebrates	At the end of this activity, students should be able to: recognise the multitude of adaptations of particular vertebrate groups indicate the characteristic features of vertebrate groups using examples place particular animals into the correct vertebrate groups recognise the similarities in structure and function in selected examples of vertebrate groups.
IV. Metabolism	Enzymes as biocatalysts	At the end of this activity, students should be able to: present the components of enzymes explain the catalytic activity of enzymes, and how reaction rate depends on substrate and enzyme

		concentrations explain the substrate specificity of enzymes and the difference between "the lock-and-key" and "induced fit" hypotheses present the effects of temperature and pH on enzyme aktivity present the mechanisms of competitive and non-competitive inhibition of enzyme aktivity present the principles of enzyme classification and name the main classes of enzymes.
	Industrial uses of enzymes	At the end of this activity, students should be able to: present examples of industrial uses of enzymes produce a diagram of the production of an enzymatic protein explain the characteristics of enzymes that make them useful in technology.
	Uses of enzymes in medical laboratories	At the end of this activity, students should be able to: explain why enzymatic methods are better than chemical methods in determining the substances found in body fluids present an enzymatic method for determining glucose concentration explain how a biosensor operates present several uses of the ELISA technique and explain how it functions explain how determining the quantity of certain enzymes in the blood is helpful in diagnosing organ damage and present examples of enzymes used to diagnose diseases.
	Metabolic transformations	At the end of this activity, students should be able to: define metabolism describe the characteristics of catabolism and anabolism define exergonic and endergonic reactions indicate the sites in a cell where the most important metabolic transformations take place describe the role of ATP in cellular metabolism define phosphorylation, present its types and where they occur in a cell explain the role of coenzyme A in cellular metabolism.
	Autotrophic nutrition and photosynthesis	At the end of this activity, students should be able to: define autotrophic and heterotrophic nutrition name photo-autotrophs and chemo-autotrophs explain photosynthesis and chemosynthesis — define the role of pigments in photosynthesis.
	Biochemistry of photosynthesis	At the end of this activity, students should be able to: present the structure of chloroplasts differentiate between light-dependent and light-independent reactions define the sites in the chloroplast at which particular reactions occur explain the light-dependent phase name three phases of the Calvin cycle name the products of photosynthesis.
	Factors affecting photosynthesis	name the factors that affect photosynthesis describe the effects of light intensity on the rate of photosynthesis describe the effects of carbon dioxide concentration on the rate of photosynthesis describe the effects of temperature on the rate of photosynthesis describe the effects of water availability on the rate of photosynthesis.
	Cell respiration	At the end of this activity, students should be able to: explain the concept of cell respiration present the role of ATP in metabolic processes define the respiratory quotient discuss the electron transport chain explain what glycolysis involves and where it occurs present the major stages of glycolysis explain the Krebs cycle explain the process of fermentation and its significance in nature and the human economy.
	Aerobic respiration	At the end of this activity, students should be able to: explain the concept of cell respiration present the role of ATP in metabolic processes define the respiratory quotient discuss the electron transport chain explain what glycolysis involves and where it occurs present the major stages of glycolysis explain the Krebs cycle.
V. Nervous coordination	Excitability of neuronesV	At the end of this activity, students should be able to: describe the structure of a neurone define two functional states of a neurone describe the conduction of a nerve impulse along an axon explain the relationship between the speed of conduction, the presence of a myelin sheath and axon diameter.

Transmission of nerve impulses from cell to cell — synapses	At the end of this activity, students should be able to: describe the function and structure of a chemical synapse define excitatory synapse and inhibitory synapse describe the conduction of a nerve impulse along an axon.
Structure of the human nervous system	At the end of this activity, students should be able to: classify the nervous systém define excitatory and inhibitory synapses describe the structure of the brain, spinal cord and nerves explain the relationship between the central and peripheral nervous systems on the basis of their structure and functions.
Involuntary functioning of the nervous system	At the end of this activity, students should be able to: define and describe the basic characteristics of a reflex arc give examples of the functioning of monosynaptic and polysynaptic reflexes.
Autonomic nervous system	At the end of this activity, students should be able to: define and describe the parts of the ANS show the location of particular types of neurone in the ANS define and describe the functions of the antagonistic divisions of the ANS explain, with examples, the antagonistic effects of the ANS on the body describe the function and effects of acetylcholine and noradrenaline in the ANS describe the 'fight-or-flight' reaction and the nervous and endocrine systems responsible for this.
Receptors	At the end of this activity, students should be able to: define and describe the basic characteristics of receptors (specificity, threshold) describe the process of sensory transduction (receptor and action potentials) describe the functioning of the receptors of touch, pressure, hearing, balance and pain.
The eye	At the end of this activity, students should be able to: define and describe the structure and function of the eye describe the process of impulse generation and transduction in the eye give examples of good habits while reading or writing.
Animal behaviour as a form of adaptation to the environment	At the end of this activity, students should be able to: understand the adaptational role of behaviour understand the role of genetic information in passing on behaviour patterns understand the role of experience in the modification of an individual's behaviour differentiate between the various forms of behaviour understand the association between the evolution of the animal nervous system and the development of controlled behaviour.
Heterotrophic nutrition	At the end of this activity, students should be able to: define heterotrophic nutrition define digestion present the types of digestion present examples of heterotrophic organisms describe saprotrophic nutrition using fungi as an example explain how nutritional requirements in animals change at different stages of development.
Nutrients	At the end of this activity, students should be able to: define the role of proteins, lipids, carbohydrates, vitamins and mineral compounds in human nutrition name foods that are the source of essential chemical compounds vital nutrients.
Nutritional requirements	At the end of this activity, students should be able to: define basal metabolic rate and the conditions under which it should be calculated name the factors affecting the basal and active metabolic rates define the role of carbohydrates and fats in meeting daily energy requirements define complete and incomplete proteins and give examples of products containing such proteins explain what a vegetarian diet involves and present its advantages and disadvantages.
The human alimentary system	At the end of this activity, students should be able to: describe the structure of the alimentary systém define the significance of the glands that empty into the alimentary canal define digestion explain how digestive enzymes work.
Food processing in the alimentary canal	At the end of this activity, students should be able to: describe the digestion of carbohydrates, proteins, fats and nucleic acids describe the nervous and hormonal regulation of the secretion of digestive juices.
Absorption of digestion products	At the end of this activity, students should be able to: present the histology of the wall of the alimentary canal

		define the site of the absorption of digestion products define the mode of absorption of digestion products.
	Digestion of food rich in cellulose	At the end of this activity, students should be able to: name the symbiotic organisms of the digestive systém define the role of symbionts in cellulose digestion present the structure of the ruminant stomach describe the function of the ruminant stomach.
VII. Internal transport	Transport of substances in animals	At the end of this activity, students should be able to: explain the reasons for the development of the circulatory system in animals describe the structure of blood describe the structure and function of blood vessels describe the adaptation of erythrocytes to oxygen transportation explain the significance of tissue fluid and the lymphatic system.
	Structure and functions of the heart	At the end of this activity, students should be able to: outline the structure of the circulatory system in mammals describe the structure of the heart, using a model or an illustration explain the cardiac cycle describe the regulation of heart rate by the nervous and endocrine systems — describe the effect of physical activity on blood flow through the organs during the resting state and during physical effort.
	Transport of substances in plants	At the end of this activity, students should be able to: describe the morphology of vascular tissues the xylem and phloem demonstrate the adaptation of a root for the absorption of water and dissolved mineral salts describe the pathway of water transport in root cells determine the factors that cause flow of water in vessels — explain how transport takes place in phloem
	Physiology of the human respiratory systém	At the end of this activity, students should be able to: describe the anatomy of the respiratory systém explain the functions of the parts of the respiratory systém describe the histological structure of the lung and alveoli explain the mechanisms of pulmonary ventilation give examples of the organism's adaptations to low levels of oxygen.
IX. Physiology of muscles	Physiology of muscle contractions	At the end of this activity, students should be able to: describe the macroscopic and microscopic structure of skeletal muscle describe the principles of the sliding filament theory of contraction compare and contrast slow (red) and fast (white) muscle fibres.
	Chemistry of muscle contraction	At the end of this activity, students should be able to: describe the molecular basis of the sliding theory of contraction describe the transmission of a stimulus from a nerve to a sarcomere explain the principles of aerobic and anaerobic metabolism in skeletal muscles.
X. Reproduction	Physiology of the human reproductive system	At the end of this activity, students should be able to: describe the structure of the male and female reproductive systems differentiate between the tissues of the testes and ovaries describe the process of spermatogenesis in the testes and oogenesis in the ovaries describe the structure of sperm and egg cells.
	Fertilization	At the end of this activity, students should be able to: explain what hormonal regulation of the menstrual cycle involves describe the fusion of the egg and sperm cells describe the development of the blastocyst and its implantation in the uterine wall.
	Development of the human embryo	At the end of this activity, students should be able to: explain how the placenta is formed— define the function of the placenta describe the developmental stages of the human embryo indicate the differences between the circulation in the fetus and after birth describe the physiological changes in the body of a pregnant woman explain how hormones regulate pregnancy, labour and lactation.
	Birth control in humans and animals	At the end of this activity, students should be able to: explain how hormones regulate female fertility describe the oestrous cycle in farm animals list the methods for increasing the reproductive capacity of farm animals describe the influence of bovine somatotropin on the lactation of farm animals.

	Growth and development of the organism	At the end of this activity, students should be able to: define growth and development name the various types of growth of organisms interpret growth curves describe the changes that take place in the female during puberty describe the changes that take place in the male during puberty explain the role of hormones in the growth and development of the organism.
	The ageing process	At the end of this activity, students should be able to: describe the age-related changes in the nervous systém describe the age-related changes in the sensory systems describe age-related changes in the respiratory and circulatory systems explain how ageing affects BMR describe the regression of tissues with reference to bony and cartilaginous tissues describe the hormonal changes during menopause.
	Sexual reproduction in plants	At the end of this activity, students should be able to: describe the flower structure in angiosperms describe the development of a pollen grain and embryo sac define pollination present mechanisms for protection against self-pollination explain what double fertilization involves describe the formation of a seed and a fruit.
XI. Homeostasis	The concept of homeostasis	At the end of this activity, students should be able to: define the internal environment of the human organism define homeostasis name the homeostatic mechanisms describe the mechanisms of negative and positive feedback give examples of the processes regulated by negative and positive feedback.
	Hormonal regulation	At the end of this activity, students should be able to: define a hormone name the main human endocrine glands and the principal hormones secreted by these glands present the difference in the effects of three groups of hormones on cells present the relationship between the hypothalamus, pituitary and the glands controlled by the pituitary present the physiological action of selected hormones describe the hormonal regulation of calcium ion concentration in extracellular fluid describe the role of hormones in the metamorphosis of insects.
	Thermoregulation	At the end of this activity, students should be able to: define homeothermy and the mechanisms of heat exchange between organisms and their environment present the relationship between the metabolic rate and the temperature of the environment in ectotherms and endotherms explain the concept of thermogenesis and its regulation name the elements of the thermoregulatory systém describe the reactions that take place in the thermoregulatory system in response to an increase or decrease n the temperature of the environment define hypothermia, hyperthermia and fever.
	Regulation of glucose level in the blood	At the end of this activity, students should be able to: explain the dangers resulting from excessively high or low glucose levels in the blood present the effects of insulin and glucagon on glucose metabolism present the most important metabolic disorders in diabetes.
	The liver as a homeostatic organ	At the end of this activity, students should be able to: describe the general structure of the liver, its location and vascularization name the major functions of the liver describe the transformations of carbohydrates, proteins and fats that occur in the liver name the major components of bile and discuss the role of bile in metabolism of fats.
	Role of the kidneys in regulating water-electrolyte balance Part 1	At the end of this activity, students should be able to: present the types of nitrogenous waste compounds produced by the catabolism of nitrogenous compounds in different animals according to their environment define filtration, reabsorption and secretion describe the function of the renal tubule and the filtration in the glomerulus describe the structures of the human excretory system and the structure of the nephron explain the mechanism of reabsorption in the proximal tubule of the nephron.
	Role of the kidneys in regulating water-electrolyte balance Part 2	At the end of this activity, students should be able to: describe the structure of the loop of Henle and its role in the concentration of urine explain the principles of the counter-current multiplier system and counter-current Exchange explain the role of ADH and aldosterone in the regulation of the volume and solute concentration of body fluids explain the role of the kidneys in the regulation of blood pH

		describe the regulation of water balance in humans describe the composition of urine and the urination reflex.
	Regulation of water loss in desert animals	At the end of this activity, students should be able to: recognize the different adaptations of animals to life in a water-deficient environment understand the basic mechanisms that limit water loss in desert animals understand the basic principles of water management in desert animals.
XII. Human health	Characteristics of a healthy organism	At the end of this activity, students should be able to: define lifestyle and health describe a balanced diet specify the characteristics of anorexia and bulimia describe the dangers of smoking.
	The concept of disease	At the end of this activity, students should be able to: define disease describe different types of diseases characterise diseases caused by environmental factors.
	Bacterial diseases	At the end of this activity, students should be able to: present examples of the mechanism of bacterial virulence explain Koch's principles name the routes of transmission of salmonellosis, tuberculosis and cholera describe basic antiseptic procedures and the treatment of bacterial infections.
	Parasitic diseases	At the end of this activity, students should be able to: present examples of the mechanisms of parasite pathogenicity discuss the routes of infection and means of preventing parasitic diseases discuss the life cycles of Plasmodium, Ascaris and Schistosoma.
	AIDS — an example of a viral disease	At the end of this activity, students should be able to: define HIV and AIDS discuss the life cycle of the virus present preventive measures against HIV infection.
	Human immunity	At the end of this activity, students should be able to: describe the events that occur during an immune response define antigens and antibodies name the types of immune cells and describe their function compare and contrast innate and acquired responses describe and define the importance of immune memory describe passive and active immunisation with examples.
	Coronary heart disease	At the end of this activity, students should be able to: describe the processes involved in atherosclerosis, coronary heart disease and myocardial infarction define coronary heart disease and ischaemia describe the measures for preventing coronary heart disease and briefly describe the methods of treatment.
	Cancer	At the end of this activity, students should be able to: define malignant and benign neoplasms name and discuss the stages of neoplasm development discuss the factors responsible for neoplasms and give examples of preventive measures we can take to reduce the risk of developing cancer discuss anti-neoplasm mechanisms existing in the organism and methods of cancer treatment.
	Actions of different groups of medicines	At the end of this activity, students should be able to: discuss the action of antibiotics and beta-blockers name the methods for obtaining monoclonal antibodies and give examples of their use as drugs.
XIII. Genetic information	DNA — the carrier of genetic material	At the end of this activity, students should be able to: demonstrate that DNA is the carrier of genetic material located in the cell nukleus present the chemical and spatial structure of DNA — define replication, explain the semi-conservative nature of replication and describe the process of replication.
	Organization of DNA in chromosomes	At the end of this activity, students should be able to: present the levels of DNA organization from double helix to metaphase chromosome explain the role of histones in the spatial structure of DNA present the morphology of metaphase chromosome define homologous chromosomes, autosomes and heterosomes describe a karyotype and the principles of its preparation explain the terms locus, allele, homozygote and heterozygote.

	Cloning of organisms	At the end of this activity, students should be able to: define a clone and explain what cloning involves describe the methods of plant cloning, including micropropagation describe the stages in the cloning of an animal organism explain the concepts of reproductive cloning and therapeutic cloning.
	Genetic code and protein synthesis	At the end of this activity, students should be able to: describe the structure of RNA, its types and the site of location in the cell explain the connection between DNA and proteins explain the notion of translation and describe its course.
	Mutations	At the end of this activity, students should be able to: define a mutation describe the types of gene mutations and their possible consequences describe the effects of certain physical and chemical mutagens on DNA explain the role of suppressor genes and oncogenes in the development of neoplasms.
	Chromosomal mutations	At the end of this activity, students should be able to: define a chromosomal aberration and present the types of chromosomal mutations present examples of the chromosomal aberrations that most often occur in humans.
XIV. Genetic engineering	Genetic engineering techniques	At the end of this activity, students should be able to: define genetic engineering discuss the basic techniques of genetic engineering indicate applications of genetic engineering.
	Medical applications of genetic engineering	At the end of this activity, students should be able to: explain the role of genetic engineering in medicine discuss the basic genetic engineering techniques used in medicine indicate the applications of genetic engineering in forensic medicine and diagnostics.
	Transgenic organisms	At the end of this activity, students should be able to: define a transgenic organism describe the process of creating a transgenic organisms give examples of genetic modifications.
XV. Genetics according to Mendel	Inheritance of a single trait	At the end of this activity, students should be able to: present the importance of Mendel's research for genetics explain Mendel's law of dominance discuss Mendel's first law of segregation define homozygote, heterozygote, phenotype and genotype apply modern knowledge to explain Mendel's first law construct a Punnett square present the mechanism of inheritance of Huntington's chorea and cystic fibrosis.
	Inheritance of two or more traits	At the end of this activity, students should be able to: explain the term co-dominance give examples of co-dominance (inheritance of blood groups and sickle-cell anaemia) demonstrate the functioning of multiple alleles explain the term epistasis draw a genetic diagram for a dihybrid cross quote Mendel's second law.
	Inheritance of sex	At the end of this activity, students should be able to: explain the term sex chromosomes present the mechanism of inheritance of sex hormones in human define linked traits present the mechanism of inheritance of linked traits present the mechanism of inheritance of sex-linked illnesses: haemophilia and colour blindness present the mechanism of inheritance of sex-linked traits explain the cause of baldness.
XVI. Variation in organisms	The nature of variation	At the end of this activity, students should be able to: explain what individual variation involves describe the basic types of distribution of trait variation differentiate between discontinuous variation and continuous variation of traits understand the biological significance of trait variation understand the reasons for the vast range of possible combinations of traits and the uniqueness of individual traits.
	Factors influencing variation	At the end of this activity, students should be able to: name the main factors influencing variation of traits differentiate between inherited variation and non-inherited variation explain the relationship between phenotypic traits, genotype (the genetic record of traits) and the

		modifying effects of environmental factors explain the biological significance of variation explain the reasons for the vast range of possible combinations of traits and the uniqueness of an individual's traits
	Elements of population genetics	At the end of this activity, students should be able to: indicate the main factors that affect the frequency of traits in populations understand the association between the factors that affect a population and evolution explain the reasons for the vast range of possible trait combinations and the uniqueness of individual traits.
	Speciation — the formation of species	At the end of this activity, students should be able to: indicate the main factors that affect the formation of species understand the association between factors that affect a population and the process of speciation understand the processes of reproductive isolation that determine the identity of a species.
	Different modes of speciation	At the end of this activity, students should be able to: indicate the main factors that influence the formation of species understand the range of factors that affect speciation in a population understand the factors that lead to reproductive isolation and determine the formation of species.
XVII. Population	Features of populations	At the end of this activity, students should be able to: name the main features of populations— recognize the changeability of population features understand the reasons for the vast range of possible trait combinations and the uniqueness of population traits.
	Biodiversity	At the end of this activity, students should be able to: recognize the significance of biodiversity for the existence of nature and humankind recognize that human activities can damage biodiversity understand the association between the quality of human life and the degree of biodiversity understand the principle of conserving biodiversity by the protection of entire ecosystems understand the need to protect endangered species.
	The ecosystem — an organized and functional unit of the natural environmental	At the end of this activity, students should be able to: recognize the ecosystem as an organized and functional unit recognize the multiplicity of interactions that constitute an ekosystém understand why ecosystems need to be self-maintaining understand why it is necessary to preserve entire ecosystems in order to maintain the balance of nature.
	Energy flow and the circulation of matter	At the end of this activity, students should be able to: recognize the complex associations between the species in a single ekosystém recognize the multiplicity of pathways of energy flow and matter circulation in an ekosystém understand the one-way nature of energy flow through the environment and the cyclical nature of the flow of matter through the environment understand how the balance of matter and energy in the natural environment can be interpreted in economic terms.
	Ecological succession	At the end of this activity, students should be able to: recognize changes in ecosystems over time recognize the multiplicity of interactions that make up the process of succession assess the effects of human activities on the course of succession in different ecosystems understand the causes of changes that take place in ecosystems over time.
	Effects of human activity on ecosystems	At the end of this activity, students should be able to: recognize the effects of human actions on nature as an organized and functional systém recognize the extent of changes induced by humans in ecosystems understand the association between the quality of human life and the degree of the conservation of nature as an organized and functional systém understand the need for long-term planning and careful management of the exploitation and transformation of ecosystems understand the need for ecosystem conservation and for the restoration of ecosystems destroyed by human actions.
	Agriculture — the conservation of biodiversity	At the end of this activity, students should be able to: recognize the effects of agriculture on environmental resources and the natural environment understand the relationship between agriculture and environmental resources and factors understand why macroeconomic plans and calculations should take into account the effects of agriculture on the natural environment understand the need to conserve biodiversity by agriculture and forestry practices understand the principle of conserving biodiversity by the protection of entire ecosystems.

LOWER SECONDARY

MATHEMATICS

CHAPTER	LESSON	DESCRIPTION
I. Numbers (1)	Integers	At the end of this activity, students should be able to: — understand and use negative integers — order integers — use basic operations on integers — round large integers to the nearest given power of 10.
	Divisibility	At the end of this activity, students should be able to: — understand the division of integers — know the notions of the quotient and the remainder, and how to use them — know how to recognise prime, composite numbers and relatively prime numbers — know how to find the highest common factor of two integers — know how to find the least common multiple of two integers.
	Prime factor decomposition	At the end of this activity, students should be able to: — decompose a positive integer into prime factors — use prime factor decomposition to determine the highest common factor and the least common multiple of two positive integers.
	Fractions	At the end of this activity, students should be able to: — recognise and name fractions — reduce a fraction to lowest terms — compare fractions — find a fraction of a number.
	Operations on fractions	At the end of this activity, students should be able to: — multiply fractions — add and subtract fractions — divide fractions — use the notion of the reciprocal of a rational number — use the properties of operations on rational numbers.
	Decimals	At the end of this activity, students should be able to: — apply arithmetic operations to decimals — round decimals to a given number of significant figures or decimal places.
	Decimals and fractions	At the end of this activity, students should be able to: — recognise terminating, recurring and non-recurring decimals — convert terminating and recurring decimals to fractions — convert a fraction to a decimal.
	General division	At the end of this activity, students should be able to: — divide any two rational numbers — use long division with decimals.
	Powers and roots	At the end of this activity, students should be able to: — represent multiplication as a power — understand and use square and cube roots — apply index laws in calculations (for integer indices).
	Standard index form	At the end of this activity, students should be able to: — represent a number in standard index form — use standard index form in computations.
	Use of a calculator	At the end of this activity, students should be able to: — perform arithmetic operations — apply the division algorithm

		— find the prime factorisation of a natural number — approximate certain irrational numbers — better understand the standard form.
II. Geometry and transformations	Triangles	At the end of this activity, students should be able to: — recognise adjacent, supplementary, vertical, alternate, corresponding, straight and full angles — calculate the measures of the above angles, given one or two of them — use the theorem on the angle sum of a triangle — define an exterior angle in a triangle and compute it — calculate angles in a triangle, given two of its angles, one of its angles etc.
	Congruence of triangles	At the end of this activity, students should be able to: — recognise congruent figures, — understand and use congruence conditions for triangles: SAS, ASA, SSS.
	Quadrilaterals and their properties	At the end of this activity, students should be able to: — understand and be able to precisely describe types of quadrilaterals — know and be able to apply the theorem on the angle sum in a quadrilateral — understand what the exterior angle of a quadrilateral is.
	Polygons and regular polygons	At the end of this activity, students should be able to: — understand what irregular and regular polygons are — calculate the number of diagonals in a polygon — calculate the sum of the angles in a polygon — calculate the sum of the exterior angles of a convex polygon — calculate the central angle in a regular polygon — calculate the interior and the exterior angles of a regular polygon — draw regular n-gons.
	Coordinates	At the end of this activity, students should be able to: — place numbers in their correct places on the number line — understand the coordinates of points on the plane — place points with given coordinates in the correct places on the plane — find equations of horizontal and vertical lines on the plane — understand what the coordinates of a point in 3-dimensional space mean — find equations of planes parallel to the planes x = 0, y = 0 and z = 0.
	Symmetry	At the end of this activity, students should be able to: — find images of figures under reflection — find coordinates of figures under reflection in the axes — find coordinates of figures under reflection in the line x = a and the line y = b.— find coordinates of figures under reflection in the line x = y and the line y = —x, — find images of figures under symmetry — find coordinates of figures under symmetry with respect to the origin.
	Translations, reflections, rotations	At the end of this activity, students should be able to: — draw images of figures under translations, rotations and reflections — find a vector of a translation given in the coordinate systém — know and use properties of translations — know and use properties of rotations — know and use properties of reflections.
	Enlargements	At the end of this activity, students should be able to: — draw images of figures under enlargement with respect to a given point and using a given scale — find the centre point of an enlargement — find the scale of an enlargement — know and use properties of enlargements — know how the area of a given figure is changed after enlargement — know how the volume of a given solid is changed after enlargement.
	Similarity	At the end of this activity, students should be able to: — recognise similar figures — know when two polygons are similar — know when two triangles are similar (SSS, AA, SAS) — know the ratio of the areas of two similar figures.
	Similarity — solving problems	At the end of this activity, students should be able to: — use similarity of triangles in solving problems — recognise proportions when an angle is cut by two parallel lines — find line segments on the arms of an angle cut by two parallel lines.
III. Algebraic	Algebraic expressions	At the end of this activity, students should be able to:

expressions		— form algebraic expressions — calculate their values — simplify like terms — simplify algebraic expressions — name algebraic expressions.
	Multiplying out the brackets	At the end of this activity, students should be able to: — multiply out brackets of the form a(b + c) — multiply out brackets of the form a(b + c + d) — multiply out brackets of the form (a + b)(c + d) — multiply out brackets of the form (a + b)(c + d)(e + f) — deal with the negative sign in expressions.
	Multiplication formulas	At the end of this activity, students should be able to: — use special formulas for squaring binomials — use the formula for the difference of squares — recognise and use the formulas in different calculations.
	Factorisation (by grouping)	At the end of this activity, students should be able to: — reverse the process of multiplying out the brackets — factorise an expression by taking out the common factor — factorise an expression by grouping.
	Factorisation (other methods)	At the end of this activity, students should be able to: — factorise binomials by using the difference of squares — factorise trinomials by algebraic manipulation.
	More factorisation	At the end of this activity, students should be able to: — factorise trinomials by algebraic manipulation.
IV. Algebraic fractions (1)	Solving equations involving algebraic fractions	At the end of this activity, students should be able to: — simplify algebraic fractions — operate on algebraic fractions — solve simple rational equations.
	Changing the subject of the formula	At the end of this activity, students should be able to: — rearrange different formulas — make a variable the subject of the formula.
V. Reasoning	Mathematical statements	At the end of this activity, students should be able to: — recognise mathematical statements in the form of a theorem — recognise the assumption and the claim of a theorem — understand the role of a proof and of a counterexample in mathematical reasoning — construct counterexamples to simple false statements.
	Deductive reasoning	At the end of this activity, students should be able to: — use short deductions to build a proof — verify deductions.
	Understanding the theorem	At the end of this activity, students should be able to: — recognise the difference between a proof and a demonstration — construct a proof based on a demonstration.
	Problem solving	At the end of this activity, students should be able to: — discover a property upon observation and trials — find a (short) proof of a given simple property — recognise incorrect steps in reasoning.B290
	Problem assumptions	At the end of this activity, students should be able to: — understand the significance of theorem assumptions — check the necessity of assumptions.
VI. Sets	Sets	At the end of this activity, students should be able to: — understand the notion of a set — identify particular sets (either by a list of elements or by a formula) — perform operations on sets: sum, intersection and difference — apply the operations to solve simple problems.
VII. Handling Data	Problem specification	At the end of this activity, students should be able to: — identify variables and cases — distinguish different types of data — design experiments.

	Sampling	At the end of this activity, students should be able to: — construct a good questionnaire — identify a source of bias in the data — choose an appropriate sampling method — draw the sampling units using different sampling methods.
	Representing data	At the end of this activity, students should be able to: — draw dot plots — identify categorical, ordinal, discrete and continuous variables — construct stemplots and back-to-back stemplots — join the stems in a stemplot — construct frequency tables — describe class intervals in a frequency table — draw histograms — read the frequencies from a histogram — draw frequency polygons and frequency density polygons — calculate frequency density and frequency density histograms.B343:B344
	Measures of central tendency — the arithmetic mean	At the end of this activity, students should be able to: — understand the mean as an indicator of fair allocation — understand the mean as the 'balancing point' of a data set — calculate the arithmetic mean for raw data — calculate the weighted mean — calculate the arithmetic mean for data in frequency tables — calculate the arithmetic mean for scaled data — calculate the arithmetic mean for combinations of sets of data.
	Measures of central tendency — the mode, the median	At the end of this activity, students should be able to: find the mode of raw data — find the mode of grouped data — check multimodality of data — find the median of raw data — find the median in a stemplot — understand the difference between arithmetic mean and median — find the median in transformed data.
	Measures of variability (1)	At the end of this activity, students should be able to: — use different measures of data variability — calculate the standard deviation and variance.
	Measures of variability (2)	At the end of this activity, students should be able to: — construct the five-number summary — draw a box plot — detect an outlier in data.
	Cumulative frequency curve	At the end of this activity, students should be able to: — draw the cumulative frequency curve (polygon) — draw the cumulative percentage frequency curve (polygon) — estimate the median and the quartiles for grouped data.
	Skewness	At the end of this activity, students should be able to: — investigate skewness of data — calculate different measures of skewness.
	Case study (1)	At the end of this activity, students should be able to: — apply the measures of central tendency in real-life situations.
	Case study (2)	At the end of this activity, students should be able to: — apply statistical tools to real-life data.
VIII. Geometry — Pythagorean theorem	Pythagorean theorem	At the end of this activity, students should be able to: — understand and use the Pythagorean formula for right triangles — calculate the unknown side in a right triangle apply the Pythagorean theorem to real-world problems — recognise Pythagorean triples — use the converse of the Pythagorean theorem to recognise right triangles.
	Application of the Pythagorean theorem in 2-D	At the end of this activity, students should be able to: — find the diagonal of a square — find the height of an equilateral triangle — find the area of an equilateral triangle — find the area of a square, given the diagonal — use the Pythagorean theorem to solve real-world problems — find the radii of inscribed and circumscribed circles about an equilateral triangle

		— find the distance between two points in a coordinate system.
	Application of the Pythagorean theorem in 3-D	At the end of this activity, students should be able to: — find the diagonals of cubes and cuboids — use the Pythagorean theorem to calculate segments in solids — find the distance between points in the 3-dimensional coordinate system.
	Ruler-and-compass constructions, locus (1)	At the end of this activity, students should be able to: — construct a perpendicular bisector of a segment — construct a perpendicular to a given line through a point on the line — construct a perpendicular to a given line through a point off the line — construct a line parallel to a given line — construct the bisector of an angle — use the basic constructions to construct more complex configurations.
	Ruler-and-compass constructions, locus (2)	At the end of this activity, students should be able to: — solve simple problems related to loci and constructions — construct an equilateral triangle, a square, a regular pentagon, a regular hexagon, a regular octagon and decagon — construct some simple loci.
IX. The circle	The circle	At the end of this activity, students should be able to: — recognise parts of a circle: centre, radius, circumference, arc, chord, diameter, sector, segment — calculate the length of an arc — calculate the area of a sector — relate the area of a segment to the area of a sector and of a triangle — understand the notion of tangent and construct a tangent at a given point — understand the notion of a common tangent.
	Circle theorems	At the end of this activity, students should be able to: — solve problems using properties of tangents — solve problems using chord bisection by a perpendicular radius.
	Inscribed and central angles	At the end of this activity, students should be able to: — recognise inscribed and central angles — explain the relation between inscribed and central angles on the same arc — calculate the area of a sector — recognise cyclic quadrilaterals.
	Equation of a circle	At the end of this activity, students should be able to: — write the equation of a circle with centre at the origin and at an arbitrary point — determine the centre and the radius of a circle — solve problems involving the equation of the circle.
	Mutual position of two circles	At the end of this activity, students should be able to: — recognise the mutual position of two circles — find the mutual position of two circles in the coordinate systém — solve problems involving circles.
	Mutual position of a line and a circle	At the end of this activity, students should be able to: — recognise the mutual position of a circle and a line — write an equation of a tangent in simple cases.
	Circles inscribed and circumscribed	At the end of this activity, students should be able to: — understand the notions of inscribed and circumscribed circles — construct a circle inscribed into a triangle or quadrilateral — construct a circle circumscribed about a triangle or quadrilateral — recognise quadrilaterals that have an incircle — recognise cyclic quadrilaterals.
	Solving problems involving circles	At the end of this activity, students should be able to: — solve various problems involving the circle and inscribed and central angles.
X. Percentages	Percentages	At the end of this activity, students should be able to: — change a fraction into a percentage and vice versa — find the percentage of a value — express one number as a percentage of another — find the value, given a percentage of a number.
	Solving problems involving percentages	At the end of this activity, students should be able to: — find the scale factor of increase and decrease

		— find percentage change — find the value after consecutive percentage changes — find the percentage profit.
	Repeated percentage change	At the end of this activity, students should be able to: — find the amount when percentage change is repeated — find the population, given the rate — find the price, given the inflation rate — find the accumulated amount, given the rate — find the equivalent rate and effective rate.
XI. Sequences	Looking for the pattern	At the end of this activity, students should be able to: — recognise patterns in number sequences — name the next term in a given simple sequence.
	Finding the nth term of a sequence	At the end of this activity, students should be able to: — find term-to-term or position-to-term definition for a given sequence — find the nth term of a sequence given by term-to-term or position-to-term definition.
XII. Ratio and proportion	Ratios	At the end of this activity, students should be able to: — understand the ratio of two quantities — understand the ratios of more than two quantities — divide a quantity in the given ratio.
	Proportions	At the end of this activity, students should be able to: — understand the notion of proportion — solve equations in the form of a proportion — solve problems concerning proportion.
	Direct proportion	At the end of this activity, students should be able to: — understand direct proportion — sketch a graph of direct proportion — recognise a problem involving direct proportion and solve it — understand proportionality of one quantity to the square or cube of another.
	Inverse proportion	At the end of this activity, students should be able to: — understand inverse proportion — sketch a graph of inverse proportion — recognise problems involving inverse proportion and solve them — understand that one quantity can be inversely proportional to the square or cube of another.
	Rates of change	At the end of this activity, students should be able to:— understand the rate of change— calculate the average rate of change of various quantities— read the average rate of change from a graph.
XIII. Trigonometry (1)	Trigonometric ratios in a right-angled triangle	At the end of this activity, students should be able to: — use the sine, cosine and tangent ratios to find angles — find the sine, given the cosine (and vice versa) — solve triangles — use exact values for selected angles — use a calculator to find trigonometric ratios — use a calculator to find angles, given trigonometric ratios.
	Solving problems involving trigonometric ratios	At the end of this activity, students should be able to: — use trigonometric ratios to solve miscellaneous problems — solve problems involving angles of depression and elevation — solve problems involving bearings.
	Trigonometry of a general angle	At the end of this activity, students should be able to: — understand and use general angles — use sine, cosine and tangent functions for general angles.
	Properties of trigonometric functions of a general angle (1)	At the end of this activity, students should be able to: — recognise the sign of a trigonometric function of an angle — understand and use the periodicity of trigonometric functions — use the Pythagorean identity.
	Properties of trigonometric functions of a general angle (2)	At the end of this activity, students should be able to: — reduce every angle to the first quadrant — use reduction formulas to find values of trigonometric functions — know the sign of a trigonometric function after changing the sign of an angle.

	Graphs of trigonometric functions	At the end of this activity, students should be able to: — recognise graphs of trigonometric functions — read properties of trigonometric functions from their graphs.
	Use of a calculator	At the end of this activity, students should be able to: — use a calculator to find values of trigonometric functions — use a graphic calculator to investigate trigonometric functions.
XIV. Probability	Random processes	At the end of this activity, students should be able to: — describe events by the outcomes — find the outcomes of combined events — find all equally likely outcomes if it is possible — describe compound experiments — distinguish less or more probable events.
	Counting problems	At the end of this activity, students should be able to: — distinguish different methods of arranging — use combinatorial rules properly.
	Classical concept of probability (1)	At the end of this activity, students should be able to: — understand the notion of relative frequency — understand the notion of probability,use probability measures in simple situations.
	Classical concept of probability (2)	At the end of this activity, students should be able to: — distinguish experimental and subjective probability — understand classical probability — find classical probabilities in different probabilistic situations.
	The set of possible outcomes	At the end of this activity, students should be able to: — represent the possibility space in many several ways — choose equally likely elementary events — write up the outcomes of a compound experiment using a tree diagram and a possibility space diagram.
	Mutually exclusive events	At the end of this activity, students should be able to: — recognise mutually exclusive events — use the sum formula for mutually exclusive events.
	Independent events (1)	At the end of this activity, students should be able to: — recognise independent events.
	Independent events (2)	At the end of this activity, students should be able to: — find the probability of two independent events occurring simultaneously — use the multiplication rule for independent events.
	Solving simple problems in probability	At the end of this activity, students should be able to: — use various methods to solve probabilistic problems.
XV. Graphs of different functions	A function and its graph	At the end of this activity, students should be able to: — plot the graph of a simple function — understand how the graph of a function is constructed.
	Equation of a straight line	At the end of this activity, students should be able to: — plot the graph of a line — find the gradient of a given straight line — find the gradient of a line perpendicular or parallel to a given straight line — read properties of a line from its general equation.
	Linear function	At the end of this activity, students should be able to: — recognise linear functions — understand the role of coefficients of a linear function — construct the graph of a given linear function.
	Quadratic function (1)	At the end of this activity, students should be able to: — recognise the graph of a quadratic function as a parabola — read properties of a quadratic function from its graph.
	Quadratic function (2)	At the end of this activity, students should be able to: — sketch the graph of a given quadratic function — read properties of a quadratic function from its graph.

	Other functions	At the end of this activity, students should be able to: — recognise the graph of a reciprocal function — recognise the graph of the function y=x3 — construct and understand the graph of the function y=a3 for integer x and fixed positive integer a.
	Graphs and real-life situations	At the end of this activity, students should be able to: — understand the behaviour of a function knowing its graph — read basic properties of a function from its graph — predict 'future values' of a function knowing part of its graph.
XVI. Measures on the plane and in space	Measuring (1)	At the end of this activity, students should be able to: — use measures in daily use — use measurements to estimate length, angle and weight — understand and interpret approximate values of measures.
	Measuring (2)	At the end of this activity, students should be able to: — use measures in daily use — use measurements to estimate length, angle, mass and speed — understand and interpret approximate values of measures.
	Areas of plane shapes (1)	At the end of this activity, students should be able to: — find the areas of polygons and other shapes made of triangles on the plane.
	Areas of plane shapes (2)	At the end of this activity, students should be able to: — find the area of shapes bounded by straight lines and arcs on the plane.
	Volume and surface area of prisms	At the end of this activity, students should be able to: — understand the notion of volume — calculate the volume and the surface area of a given prism — apply the formula for the volume of a prism in real-world situations.
	Volume and surface area of pyramids	At the end of this activity, students should be able to: — understand the notion of volume — calculate the volume and the surface area of a given pyramid — apply the formula for the volume of a pyramid in real life.
	Volume and surface area of cylinders and spheres	At the end of this activity, students should be able to: — calculate the volume and the surface area of cylinders and spheres — understand how the formulas for volume and surface area of a sphere were established — apply the formulas for volume and surface area of cylinders and spheres in real-life situations.
	Volume and surface area of cones	At the end of this activity, students should be able to: — calculate the volume and the surface area of cones and frustums — construct a model of a cone and a frustum.
	Volumes of similar solids	At the end of this activity, students should be able to: — recognise similar solids and prove similarity — find the volume of a solid similar to a given solid.
XVII. Solving equations	Linear equations, solving linear equations	At the end of this activity, students should be able to: — understand the notion of a linear equation — solve linear equations in one variable.
	Solving simultaneous linear equations (1)	At the end of this activity, students should be able to: — mark the solution set of an equation on the plane — solve linear equations in two variables — solve simultaneous linear equations in two variables graphically.
	Solving simultaneous linear equations (2)	At the end of this activity, students should be able to: — solve simultaneous linear equations in two variables using graphical and algebraic methods.
	Solving problems involving simultaneous equations	At the end of this activity, students should be able to: — use simultaneous linear equations to solve problems.
	Solving quadratic equations	At the end of this activity, students should be able to: — understand the notion of a quadratic equation — be able to solve quadratic equations.

	The quadratic formula	At the end of this activity, students should be able to: — understand the notion of the discriminant of a quadratic equation — find the number of real solutions of a quadratic equation without solving it — solve a quadratic equation by using the quadratic formula.
	Solving problems involving quadratic equations (1)	At the end of this activity, students should be able to: — apply the quadratic formula in various situations — solve mathematical problems involving quadratic equations.
	Solving problems involving quadratic equations (2)	At the end of this activity, students should be able to: — apply the quadratic formula in different situations — solve real-life problems involving quadratic equations.
	Solving equations by trial and error (1)	At the end of this activity, students should be able to: — recognise polynomial equations — understand the notion of a solution of an arbitrary equation — understand the notion of an approximate solution of an equation.
	Solving equations by trial and error (2)	At the end of this activity, students should be able to: — find approximate solutions of equations — understand the bisection method — approximate roots of an equation up to a given accuracy.
XVIII. Algebraic fractions (2)	Inequalities (1)	At the end of this activity, students should be able to: — understand the notion of inequality — solve linear inequalities in one variable — mark the solution set of an inequality on the number line.
	Inequalities (2)	At the end of this activity, students should be able to: — solve simultaneous linear inequalities in one variable — solve linear inequalities in two variables — solve simultaneous linear inequalities in two variables — mark the solution set on the plane.
XIX. Numbers (2)	Powers, roots and indices	At the end of this activity, students should be able to: — understand and calculate the nth root of a positive number — understand fractional indices — use index laws.
	Irrational numbers	At the end of this activity, students should be able to: — understand and recognise irrational numbers — simplify expressions containing irrational numbers — rationalise denominators — approximate irrational numbers.
XX. Vectors	Vectors	At the end of this activity, students should be able to: — understand the notion of a vector.
	Operations on vectors	At the end of this activity, students should be able to: — add and subtract vectors graphically.
	Scalar multiple	At the end of this activity, students should be able to: — know how to change the magnitude of a vector using a scalar multiple.
	Applications of vectors	At the end of this activity, students should be able to: — understand applications of vectors in science problems — use vectors in simple science problems.
XXI. Correlation and regression	Sampling techniques	At the end of this activity, students should be able to: — use simple, systematic and stratified sampling methods in choosing a random sample from a population.
	Regression line	At the end of this activity, students should be able to: — find the line of best fit for a given set of data— estimate a future value.
	Correlation	At the end of this activity, students should be able to: — understand correlation as a measure of the relationship between two variables — recognise positive, negative and zero correlation — use Pearson's correlation coefficient to measure the strength of linear correlation — use Spearman's rank coefficient to measure correlation between two sets of data.

	Analysing and comparing sets of data	At the end of this activity, students should be able to: — compare two sets of data using measures of central tendency and dispersion of data — compare two sets of data using diagrams.
	Using probability to analyse random events	At the end of this activity, students should be able to: — simulate a random sample for the given frequency — calculate the expectation of a population (population mean) and the population variance — calculate the expectation and variance of the sample mean.
XXII. Trigonometry (2)	Trigonometric equations (1)	At the end of this activity, students should be able to: — solve simple trigonometric equations.
	Trigonometric equations (2)	At the end of this activity, students should be able to: — solve simple trigonometric equations.
	The sine formula for the area of a triangle	At the end of this activity, students should be able to: — use the sine formula for the area of a triangle in various problems.
	Solving problems involving trigonometric equations	At the end of this activity, students should be able to: — solve real-life problems involving trigonometric equations.
	Pythagorean theorem and trigonometry in 3-D	At the end of this activity, students should be able to: — recognise the angles of elevation and depression — find the angle between the line and the plane, and the angle between two planes — apply the Pythagorean theorem and trigonometric ratios to find the volume and surface area of solids — apply the Pythagorean theorem and trigonometric ratios to find the measures of some angles in solids.
XXIII. Transformations of graphs	Transforming graphs of various functions	At the end of this activity, students should be able to: — sketch a graph of a function given by a simple equation (linear or quadratic) involving absolute value — sketch the graph of a function $y = \lvert f(x) \rvert$ or $y = f(\lvert x \rvert)$, knowing the graph of the function $y = f(x)$
	Transforming graphs of trigonometric functions (1)	At the end of this activity, students should be able to: — calculate the periods of modified trigonometric functions — sketch graphs of trigonometric functions with modified periods.
	Transforming graphs of trigonometric functions (2)	At the end of this activity, students should be able to: — draw graphs of trigonometric functions with modified period, amplitude and position — model periodic phenomena using trigonometric functions.
	Using graphs (1)	At the end of this activity, students should be able to: — solve equations graphically — solve systems of equations graphically.
	Using graphs (2)	At the end of this activity, students should be able to: — solve an inequality graphically — solve systems of inequalities graphically.
	Graphs of simple loci	At the end of this activity, students should be able to: — construct graphs of simple loci — derive Cartesian equations of simple loci — find the intersection points of a circle and a straight line graphically and algebraically.
	Area under a curve	At the end of this activity, students should be able to: — understand the relationship between distance and the velocity—time graph — approximate the area under a curve by rectangles — apply the trapezium rule to approximate the area under a curve.
	Tangents to graphs	At the end of this activity, students should be able to: — understand the notion of a tangent to a curve at a point — write the equation of a tangent from a graph — understand the notion of the gradient of a line — find a gradient of a line from a graph — find the equation of a tangent to a circle — estimate the gradient of a curve at a point.

PHYSICS

CHAPTER	LESSON	DESCRIPTION
I. Forces	Forces	At the end of this activity, students should be able to: what a force is the unit of force how to represent a force by means of a vector how to calculate the resultant of forces which are acting along the same line when we encounter forces in equilibrium.
	Addition of forces	At the end of this activity, students should be able to: determine the resultant of any two forces calculate the maximum and the minimum magnitude of the resultant of two forces resolve a force into two component forces.
	Force measurement	At the end of this activity, students should be able to: describe which property of a spring is applied in force gauges explain the difference between weight and mass.
	The moment of a force	At the end of this activity, students should be able to: a force arm the moment of a force the unit of the moment of a force the equilibrium of the moments of forces.
	Equilibrium	At the end of this activity, students should be able to: give an example to explain how to find a centre of gravity give the conditions necessary for a body to remain in equilibrium give examples to show the difference between stable, unstable and neutral equilibrium.
	Levers and pulleys	At the end of this activity, students should be able to: explain how a class one lever operates explain how a class two lever works explain how a stationary pulley and a moving pulley operate give examples of how levers and pulleys are used.
II. Motion	Displacement, distance and velocity	At the end of this activity, students should be able to: explain how to describe the position of a body and define a frame of reference give definitions for: path of motion, distance, and displacement calculate speed and velocity, and determine the differences and similarities between the concepts give examples of units of velocity; note this differs form above (speed) describe average and instantaneous velocities and give examples of each graphically determine the vector of resultant velocity.
	Acceleration	At the end of this activity, students should be able to: specify the types of motion calculate acceleration calculate the speed when the acceleration or the acceleration time relationship is given.
	Graphs of motion	At the end of this activity, students should be able to: represent on a graph, changes and velocity changes in time in uniform motion calculate the speed of a body given a location — time graph calculate distance given a speed — time graph.
	Accelerating motion	At the end of this activity, students should be able to: derive acceleration and distance from the graph v(t) describe how the speed changes in uniformly variable motion and represent it on a graph describe how the distance travelled by a body moving in accelerating motion, in which the initial speed equals zero, changes with every second plot a graph s(t) for uniformly variable motion.

	Curvilinear motion	At the end of this activity, students should be able to: explain the concepts of period and frequency and name their units calculate speed in a circular motion when the radius of the circle and the period or frequency of rotation are given draw a velocity vector at any point of the path in a curvilinear motion calculate the speed of a body during horizontal projection.
III. Forces and motion	Force and acceleration	At the end of this activity, students should be able to: explain the concept of period and frequency and name their units explain how acceleration of a body is affected by the force exerted on the body and the mass of the body state Newton's Second Law of Motion explain the difference between mass and weight calculate force on the basis of Newton's Second Law.
	Momentum	At the end of this activity, students should be able to: give examples to explain the principle of conservation of momentum differentiate between elastic and inelastic collisions explain the relationship between force, the time for which it is applied and change in momentum describe the concept of momentum.
	Inertia	At the end of this activity, students should be able to: describe inertia and explain why Newton's First Law of Motion is called the Inertia Principle give examples to explain that force is required to change the speed and direction of a moving body state and explain Newton's First Law of Motion.
	Friction	At the end of this activity, students should be able to: give examples of static friction and kinetic friction explain what static friction and maximum static friction depend on describe kinetic friction and explain what quantities its magnitude depends on explain the relationship between friction, initial movement, and stopping.
	Air resistance	At the end of this activity, students should be able to: describe the factors on which air resistance depends explain the difference between free fall in vacuum and in the air.
	The force of reaction	At the end of this activity, students should be able to: give examples of pairs of forces of action and reaction explain Newton's Third Law of Motion explain why the forces of action and reaction cannot be in balance.
IV. Energy	Work	At the end of this activity, students should be able to: explain the concept of work calculate the work of a force over a given distance explain when a force performs no work.
	Potential energy	At the end of this activity, students should be able to: give the definition of potential energy and elastic potential energy calculate the magnitude of the potential energy understand that energy can be transferred between bodies and that it can change from one form to another.
	Kinetic energy	At the end of this activity, students should be able to: give the definition of potential energy and elastic potential energy calculate the magnitude of the potential energy understand that energy can be transferred between bodies and that it can change from one form to another.
	Energy conversions	At the end of this activity, students should be able to: know the concept of internal energy, know the concept of mechanical energy know that an increase in temperature corresponds to an increase in internal energy know that energy can be transferred between bodies and can change into a different form of energy know the principle of conservation of energy.
	Power	At the end of this activity, students should be able to: understand the concept of power name the units of power calculate the value of power.
	Efficiency	At the end of this activity, students should be able to: understand the concept of 'energy losses'

		calculate the efficiency of the energy conversion proces calculate the efficiency of a device.
V. Gravitation	Gravitation	At the end of this activity, students should be able to: define the gravitational force state the law of gravitation explain the relationship between the force of gravity and weight explain the difference between weight and mass.
	Free fall	At the end of this activity, students should be able to: state the type of motion represented by free fall explain how the distance travelled by a freely falling body changes in subsequent equal time periods calculate the speed of a falling body at any time calculate the distance travelled by a falling body explain the differences and the similarities between falling bodies on the Earth and on the Moon describe the concept of weightlessness.
	Space flights	At the end of this activity, students should be able to: predict the trajectories of objects launched from the Earth explain the meaning of escape velocities for the Sun and the Earth state how a rocket is provided with a required velocity describe the states of weightlessness and overload.
	Satellites	At the end of this activity, students should be able to: describe the conditions required to place a satellite in a specific orbit explain the quantitative relationships between a satellite's velocity, orbital period and the radius of a satellite's orbit give examples of the application of satellites explain which type of satellite is known as a geostationary satellite.
VI. Matter	Gases, liquids and solids	At the end of this activity, students should be able to: explain the concept of the state of matter explain the concepts of a crystal, a monocrystal, a polycrystal, an amorphous body, allotropy describe the three states of matter.
	Properties of matter	At the end of this activity, students should be able to: explain the concept of elasticity, plasticity, and brittleness understand the concept of wetting, surface tension, and diffusion calculate the extension of a body by applying Hooke's Law.
	Density	At the end of this activity, students should be able to: explain the concepts of density and specific gravity explain how to calculate the density of solids and liquids calculate density, volume, or mass when the other two quantities are given.
	Temperature	At the end of this activity, students should be able to: explain the concepts of heat and temperature understand the temperature scales Celsius, Fahrenheit and Kelvin convert the temperature from one scale into another.
	Thermal expansion	At the end of this activity, students should be able to: explain the concepts of linear and volume expansion understand that the extension of a body depends on the increase in temperature and the initial length calculate the extension of a body due to heating describe the anomalous expansion of water.
	Expansion of gases	At the end of this activity, students should be able to: explain the phenomenon of thermal expansion of gases give examples of the effects of gas expansion use the relationship V/T = const to calculate an increase in the volume of a gas due to an increase in its temperature.
VII. Pressure	Pressure	At the end of this activity, students should be able to: give definitions of pressure and strength calculate any of the quantities p, A, F when the other quantities are given.
	Pressure of a liquid	At the end of this activity, students should be able to: explain the concept of pressure and thrust state Pascal's Principle calculate hydrostatic pressure.

	Air pressure	At the end of this activity, students should be able to: explain the relationship between pressure and altitude explain the concepts of negative pressure and positive pressure calculate the load of the atmosphere on a given surface.
	Gas laws	At the end of this activity, students should be able to: describe gas transformations and the relationship between volume, pressure and temperature calculate volume, pressure or temperature when the two other parameters are given describe the practical application of gas laws.
	Buoyant force	At the end of this activity, students should be able to: understand the concept of buoyant force describe on what buoyant force depends state Archimedes' Principle calculate the buoyant force when the density of a liquid and the volume of an object are given.
	Floating bodies	At the end of this activity, students should be able to: state the conditions under which bodies can float in liquids and gases calculate the part of a homogenous body which is submerged below the surface of a liquid explain why bodies of a particular shape which are made of a substance with a greater density than a liquid, can still float in the liquid explain the difference in the movement of a ship on the surface and a submarine.
VIII. Heat	Specific heat	At the end of this activity, students should be able to: explain the concept of specific heat determine the specific heat of a substance calculate the amount of the heat absorbed and the heat emitted by a body.
	Thermal transfer	At the end of this activity, students should be able to: explain the concept of heat conduction, convection, and radiation calculate the heat penetrating through a partition due to the mechanisms of conduction.
	Melting and freezing	At the end of this activity, students should be able to: explain the concept of melting point of a substance explain the concept of the heat of fusion determine the heat of fusion of a substance calculate the amount of heat absorbed and emitted during melting or freezing.
	Evaporation and condensation	At the end of this activity, students should be able to: state and differentiate between the concepts of evaporation and boiling explain the concept of the heat of vaporisation determine the heat of vaporisation of a substance explain the relationship between the boiling point of water and pressure.
	Sources of heat	At the end of this activity, students should be able to: the concept of the heat of combustion— the concept of a heat engine how to calculate the heat obtained due to combustion the concept of a heat pump.
	Efficiency and economy	At the end of this activity, students should be able to: explain the reasons for heat loss and the methods for limiting the phenomenon explain the consequences of the balance (or lack of balance) between the heat provided and the heat lost, and be able to describe them.
IX. Electrostatics	Charging objects	At the end of this activity, students should be able to: explain the concepts of electron, proton, electric charge and elementary chargé state the methods used to charge objects describe the interaction of charged bodies explain the effect of earthing.
	Conductors and insulators	At the end of this activity, students should be able to: describe the concept of an insulator and a conductor explain the concept of electric field and field lines explain the concept of voltage state the relationship between voltage and the flow of charge across a conductor.
	Capacitors	At the end of this activity, students should be able to: explain the concepts of capacitor, capacitance describe the structure of a capacitor calculate the charge of a capacitor of known capacitance and voltage state the uses of a capacitor.

	Application of static electricity and the threats it poses	At the end of this activity, students should be able to: explain the concept of a spark discharge describe the mechanism of discharging state the reasons for and the results of atmospheric discharges explain the threats posed by static elektricity describe how a photocopier operates.
X. Direct current	Cells and batteries	At the end of this activity, students should be able to: describe a cell and an electrode describe the structure of a cell explain the difference between a capacitor and a cell describe the operation of a battery and an accumulator.
	Electric current	At the end of this activity, students should be able to: explain the concept of electric current apply the relationship between charge, current and time explain how current flows describe the differences in the flow of current through solids and liquids.
	Ohm's Law	At the end of this activity, students should be able to: know how to study the relationship between current and voltage be able to calculate resistance and know the unit of resistence be able to calculate resistance, given the graph I(U) know Ohm's Law.
	Direct current circuit	At the end of this activity, students should be able to: explain the concept of total resistence differentiate between series and parallel connections— state Kirchhoff's Law calculate the voltage and the current in simple electrical circuits.
	Variable resistors and nonlinear resistors	At the end of this activity, students should be able to: explain the concept of a resistance wire and a thermistor describe the way in which a resistor of variable resistance works state how a change in resistance affects the current flowing through a circuit describe the relationship between the resistance and the dimensions of a conductor describe the qualitative relationship between resistance and temperature for different materials.
	Work and power of current	At the end of this activity, students should be able to: explain the concept of work and power of a current calculate the work and power of a current describe the work done by a current explain the concept of the power and efficiency of an electrical device describe energy transformation in an electrical circuit.
	Magnetic field	At the end of this activity, students should be able to: give examples of the application of magnets present methods to demonstrate the presence of magnetic fields describe the shape of a magnetic field around a bar magnet explain the concept of magnetic flux density and name its unit describe the shape of the magnetic field around the Earth.
XI. Magnetism	Electromagnets	At the end of this activity, students should be able to: describe a magnetic field around a rectilinear conductor, a circular loop and a coil give examples of the application of electromagnets.
	Electromagnetic force	At the end of this activity, students should be able to: describe an electromagnetic force determine the direction of operation of an electromagnetic force explain how the position of the conductor in relation to the magnetic field lines affects the magnitude of the electromagnetic force state the relationship between the magnitude of the magnetic force and the flux density, the length of the conductor, and the strength of the field describe the interaction of current-carrying conductors placed close together.
	Electric motor	At the end of this activity, students should be able to: describe the structure of an electric motor name the basic elements of a motor and explain their function give some examples of the application of electric motors.
	CRT and an oscilloscope	At the end of this activity, students should be able to: describe the movement of a charged particle in an electric and a magnetic field determine the direction of the Lorentz force describe the key elements of an oscilloscope and a cathode ray tube (CRT).

XII. Alternating current	Electromagnetic induction	At the end of this activity, students should be able to: explain the phenomenon of electromagnetic induction give an example to explain Lenz's Law describe eddy currents explain the phenomena of mutual induction and self-induction give examples of the application of the phenomenon of induction.
	Alternating current and a generator	At the end of this activity, students should be able to: describe a magnetic field around a rectilinear conductor, a circular loop and a coil give examples of the application of electromagnets.
	Transformer	At the end of this activity, students should be able to: describe the structure and the application of a transformer explain the concept of turns ratio explain how the number of turns in the primary and secondary coils affects the magnitude of the voltage and current in the secondary coil describe the operation of a car ignition system.
	Transfer of electrical energy	At the end of this activity, students should be able to: describe the concept of power demand explain how electricity is transmitted explain the significance of transformers in the transfer of electric energy describe the elements of the National Grid system.
	Current in a household	At the end of this activity, students should be able to: name the parts of a household electric mains systém describe the characteristics of the type of connection used in a household mains systém explain the concepts of overload and short-circuit describe the methods of protection against overload and short-circuit name the conductors that form a household circuit and state the colours with which they are marked.
	Electric energy and methods of energy saving	At the end of this activity, students should be able to: describe the work parameters of an electrical appliance calculate the energy absorbed by a given device when its power and working time are given, and estimate the cost of the energy read and interpret the data displayed by an electricity meter determine the power of a device given the readings of the electricity meter interpret the information on the energy consumption label of a given device.
XIII. Electronics	Diode	At the end of this activity, students should be able to: explain how substances can be divided into conductors, insulators and semiconductors describe the doping of semiconductors explain the difference between n-type and p-type semiconductors describe a p-n junction state the properties of a semiconductor diode.
	Power supply units and rectifiers	At the end of this activity, students should be able to: explain the rectifying operation of a diode state the basic methods of rectifying an alternating current describe the general structure of a DC power supply.
	Light and current	At the end of this activity, students should be able to: describe a light-dependent resistor and give examples of its application describe an LED diode and give examples of its application recognise the symbols for LDR and LED— connect an LED diode in forward bias describe the structure of digital and alphanumeric display devices.
	Transistor	At the end of this activity, students should be able to: explain the operation and application of a transistor describe the ways in which a transistor may be open or closed use the concept of a voltage divider to explain how to control the opening and closing of a transistor give examples of a transistor switch and provide a short description of its operation describe the amplifying property of a transistor and give examples of the application of this feature.
	Logic gates	At the end of this activity, students should be able to: describe the operation of NOT, AND, OR, NAND, and NOR logic gates and prepare truth tables for them explain the operation of a flip-flop.
	Digital systems	At the end of this activity, students should be able to: describe analogue and digital signals, explain the methods of encoding signals— give examples which demonstrate the conversion of an

		analogue signal into a digital one describe different methods of recording and transferring signals.
XIV. Oscillations and mechanical waves	Oscillations	At the end of this activity, students should be able to: explain the concepts of: amplitude, period, frequency, and phase of oscillation describe harmonic oscillations explain the movement of a pendulum state the relationship between the period of oscillation of a pendulum and its length explain the addition of oscillations in two mutually perpendicular directions.
	Resonance	At the end of this activity, students should be able to: describe the conversion of energy during oscillation explain the concepts of free, damped and forced oscillations describe the phenomenon of resonance give examples of the threats related to resonance.
	Mechanical waves	At the end of this activity, students should be able to: explain how waves carry energy explain the concept of a mechanical wave, wavelength, frequency and amplitude calculate the wavelength (of a specific frequency) in a specific medium when the velocity of wave propagation in this medium is given describe the behaviour of a wave when it passes from one medium to another.
	Reflection and refraction of waves	At the end of this activity, students should be able to: explain the phenomena of wave reflection and wave refraction explain the concepts of the angle of incidence and the angle of refraction of a wave state the Laws of Reflection and Refraction of a Wave explain the phenomena of wave absorption and wave dispersion.
	Seismic waves	At the end of this activity, students should be able to: explain the nature of seismic waves define body seismic waves and surface seismic waves describe the propagation of seismic waves inside the Earth describe a tsunami.
	Diffraction and interference of mechanical waves	At the end of this activity, students should be able to: define diffraction and interference xplain the phenomenon of wave diffraction describe a standing wave.
XV. Sounds	Sound	At the end of this activity, students should be able to: define an acoustic wave calculate the wavelength of an acoustic wave given its speed and frequency explain why the speed of sound depends on the medium in which it propagates and understand why, when the medium is air, it also depends on the temperature describe the phenomena of echo, reverberation, and acoustic resonance describe the wavefront of an object moving at supersonic speed.
	Infrasound and ultrasound	At the end of this activity, students should be able to: describe the structure and the functioning of an ear list the properties of infra— and ultrasound state the audibility range of an ear describe the functioning of an ultrasound scanner give examples of the application of ultrasound.
	Interference of sound waves	At the end of this activity, students should be able to: describe the oscillations of a string explain the theory of fundamental frequency and harmonic frequencies explain the concept of the sound spectrum describe and explain the phenomenon of beats.
	Sounds in music	At the end of this activity, students should be able to: explain the structure of a musical scale define an octave, perfect pitch, timbre describe the principle of construction of stringed and wind instruments.
	Sound intensity	At the end of this activity, students should be able to: state the definition of sound intensity define a decibel give examples of the problems caused by noise and the methods of protection against them.
	Doppler effect	At the end of this activity, students should be able to: know on what the Doppler effect depends in the case of acoustic waves

		be able to predict the frequency of the perceived sound in relation to the frequency of emitted sound in a given situation realise that the Doppler effect also occurs with other types of waves.
XVI. Electromagnetic waves	Electromagnetic waves	At the end of this activity, students should be able to: define an electromagnetic wave explain why light is an electromagnetic wave state the relationship between wavelength and wave frequency give the approximate speed of an electromagnetic wave in a vakuum realise that the speed of light is the fastest rate of information transfer.
	Laser	At the end of this activity, students should be able to: define: monochromaticity and coherence state the difference between laser light and light emitted by other sources give examples of laser applications.
	Diffraction and interference	At the end of this activity, students should be able to: recognise and describe the phenomena of the diffraction and interference of light describe interference fringes explain the theory of the interference of light which has passed through a diffraction grating.
	The ranges of electromagnetic waves	At the end of this activity, students should be able to: state the ranges of electromagnetic waves give examples of the different properties of waves from particular ranges give examples of the application of waves from different ranges.
	Threats related to electromagnetic waves	At the end of this activity, students should be able to: understand the concept of an electromagnetic wave know the ranges of electromagnetic waves understand how radiation absorption rate is related to wavelength and the type of materiál know the application of microwaves understand the concept of greenhouse effect and its causes understand the concept of ozone hole understand the concept of ionisation.
	Application of waves for communication	At the end of this activity, students should be able to: explain the concepts of AM and FM modulation give examples of the application of electromagnetic waves in communication
XVII. Light	Reflection of light	At the end of this activity, students should be able to: explain the concept of a ray of light give examples and describe the formation of umbra and penumbra state the Law of Reflection explain how an image is formed in a mirror explain what happens to a ray when it has been reflected at two or three mirrors which are perpendicular to each other.
	Spherical mirrors	At the end of this activity, students should be able to: explain the theory of concave and convex spherical mirrors define principal focus and virtual focus describe the properties of images formed by spherical mirrors produce appropriate drawings.
	Refraction of light	At the end of this activity, students should be able to: describe how speed, wavelength and frequency of light change when light passes from one medium to another explain Fermat's principle calculate the refractive index give examples to explain the Law of Refraction describe the passage of light through a transparent plate list the conditions for total internal refraction and give examples of its application.
	A lens	At the end of this activity, students should be able to: explain the division of lenses describe the properties of the images obtained by means of lenses and make appropriate drawings calculate the enlargement and the optical power of a lens.
	Optical instruments	At the end of this activity, students should be able to: explain the concepts of visual angle, and optimum viewing distance describe the operation of a magnifying glass, a microscope, a camera, refracting telescope, binoculars, and a reflecting telescope.

	The eye	At the end of this activity, students should be able to: describe the structure of the eye and explain the functions of its particular elements define short-sightedness and long-sightedness and explain how these defects can be corrected with glasses.
	Colours	At the end of this activity, students should be able to: name the monochromatic colours explain the process of light mixing and that of mixing paints to obtain a required colour provide a short description of colour blindness and explain the significance of cones for colour perception describe the Purkinje effect.
XVIII. Nuclear physics	Structure of an atom	At the end of this activity, students should be able to: give short descriptions of models of the atom according to Thomson and Rutherford name the components of the nucleus and determine their charges describe spectrum analysis state Bohr's postulates calculate the radius of the n-th orbit in an atom of hydrogen, given the radius of the first orbit calculate the energy (in electronvolts) of an electron located in the n-th orbit and the energy emitted or absorbed when the electron moves from one orbit to another explain the symbolic notation of a nukleus give the definition of an isotope.
	Nuclear radiation	At the end of this activity, students should be able to: describe nuclear radiation provide characteristics of radiation describe radiation explain the concept of a radioactive series.
	Decay Law	At the end of this activity, students should be able to: explain the concept of half-life describe the decay of radioactive isotopes explain the concept of radioactivity, state its unit and state the factors that determine its value.
	Affect of radiation on live organisms	At the end of this activity, students should be able to: describe the operation of a scintillation counter, a Geiger-Müller counter and a Wilson cloud chambre explain the concepts of absorbed dose and dose equivalent and state the units of the two quantities name the main sources of radiation in the surrounding environment give examples of the effects of radiation.
	Application of radioactivity	At the end of this activity, students should be able to: describe the tracer method explain the concepts of: isotope therapy, radiocarbon dating, rock dating, and isotope sterilisation give examples of the application of nuclear radiation in industry.
	Nuclear fission	At the end of this activity, students should be able to: explain the concepts of mass defect and binding energy describe the reaction of fission explain the concepts: fissile material, chain reaction, avalanche reaction, critical mass state the main effects of an atomic explosion.
	Nuclear energy	At the end of this activity, students should be able to: state the conditions that need to be satisfied for a fusion reaction to occur describe the structure and operation of a nuclear reactor explain the advantages and disadvantages of nuclear power engineering in comparison with conventional power engineering.
	Nuclear fusion	At the end of this activity, students should be able to: explain thermonuclear fusion describe a proton cycle describe the construction of an H-bomb explain the methods of conducting a controlled fusion reaction.
XIX. Earth and the Universe	The Solar System	At the end of this activity, students should be able to: name and provide a short description of the main components of the Solar System describe Kepler's Laws.
	The Moon	At the end of this activity, students should be able to: describe the movement of the Moon around the Earth explain the lunar phases describe the structure of the Moon.

	Eclipses	At the end of this activity, students should be able to: describe a lunar eclipse and a solar eclipse name the different types of eclipse describe the course of an eclipse.
	The structure and the evolution of stars	At the end of this activity, students should be able to: describe the structure of the Sun explain the method of division of stars into spectral classes describe an H-R diagram discuss the basic stages in the evolution of stars dependent on their initial mass.
	Galaxies	At the end of this activity, students should be able to: explain the structure of the Galaxy describe the characteristics of star clusters present the classification of galaxies.
	The Universe	At the end of this activity, students should be able to: describe the methods of observation of the Universe state Hubble's Law explain the concept of CMB radiation provide a short characteristic of the Big Bang concept and describe the cosmological models.

CHEMISTRY

CHAPTER	LESSON	DESCRIPTION
I. States of matter	Basic properties of matter	At the end of this activity, students should be able to: — explain what matter is and describe its structure — specify the state of matter for various substances — define density — measure or calculate the volume of solids and liquids — calculate the density of a substance given its mass and volume — name the basic properties of solids, liquids and gases and discuss the differences between them.
	Gases	At the end of this activity, students should be able to: — describe the structure of gases — name the characteristic properties of gases and describe them using the concept of particles (occupying a space of any shape, mixing, compressibility, expansibility, pressure) — explain what influences the pressure of a gas — describe the relationship between the size of gas particles and the density of the gas.
	Liquids	At the end of this activity, students should be able to: — represent the structure of liquids and describe their characteristic properties using the particle concept — explain the importance of the ability of liquids to change shape — explain the purpose of a hydrometer — calculate the density of a liquid after measuring its volume and mass.
	Solids	At the end of this activity, students should be able to: — illustrate the structure of solids and describe their characteristic properties using the concept of particles — determine the hardness of a solid body on the basis of its behaviour in relation to Mohs' hardness scale for minerals — describe the differences in the structure of matter in its different physicalstates (distance between particles, forces of attraction, energy of particles, mobility of particles).
	Changes of state	At the end of this activity, students should be able to: — give definitions of individual changes of state and the temperatures at which they occur — describe the progress of a change of state using the concept of particles — give examples of changes of state that occur in nature and in everyday life.
	Physical changes accompanying heating and cooling	At the end of this activity, students should be able to: — draw the heating curve and cooling curve for a substance and describe them in detail — show the changes in volume and density undergone by most substances during heating or cooling — explain the concept of thermal expansion of bodies and what causes it — describe the changes in the volume and density of water in the three basic states of matter, and explain why ice has a lower density than liquid water — give examples of how the knowledge of thermal expansion of bodies is applied.
	Diffusion and dissolving	At the end of this activity, students should be able to: — describe the phenomenon of diffusion — demonstrate the process of diffusion between substances in different states of matter — name the factors that affect the rate of diffusion and explain the relationship between them — indicate examples of diffusion in the immediate surroundings — describe the process of dissolution and define the terms solvent, solute and solution — name the factors that affect the process of dissolution and describe their effect.
	Gas laws. Part I	At the end of this activity, students should be able to: — name the units used to express gas temperatures and pressures — discuss the relationship between the pressure, temperature and volume of gas — quote Boyle's law and Charles's law — solve calculation problems requiring a knowledge of the gas laws: Boyle's law and Charles's law.

	Gas laws. Part II	At the end of this activity, students should be able to: — discuss the relationship between the volume of a gas and its temperature — quote Gay-Lussac's law — do calculations requiring the application of Gay-Lussac's law — define isobaric, isochoric and isothermal changes and name the gas laws that govern these changes — write the equation describing the relationship among pressure, volume and temperature of a gas — transform the equation of state according to the problem to be solved.
II. Elements, compounds and mixtures	Elements	At the end of this activity, students should be able to: — discuss the different types of matter — explain the difference between a pure substance and a mixture — discuss the different types of pure substance — write the symbols of the most important elements — discuss the properties of metals and non-metals — name the properties of metals that make them different from non-metals — discuss metalloids.
	Chemical compounds	At the end of this activity, students should be able to: — define a chemical compound — define a molecule — define a molecular formula — indicate the difference between a molecular formula and an empirical formula — determine the empirical formula based on the percentage composition of a compound — demonstrate, using an example, that the properties of a chemical compound are different from those of the elements that compose it.
	Mixtures	At the end of this activity, students should be able to: — discuss the different types of mixture — establish whether a mixture is homogeneous or heterogeneous — define a solution— say what decantation and sedimentation involve — say what centrifugation and evaporation involve — say what crystallisation involves — say what chromatography involves — discuss the uses of chromatography.
III. Atomic structure	Early atomic theories	At the end of this activity, students should be able to: — give the main postulates of Dalton's atomic theory — discuss the atomic model proposed by Dalton — discuss the atomic model proposed by Thomson — discuss and interpret the experiment using gold foil — discuss the Rutherford model of the atom — discuss the component particles of the atom (electron, proton, neutron).
	The structure of the atom	At the end of this activity, students should be able to: — say what information can be obtained from the atomic number — determine the number of protons and the total number of electrons in an atom on the basis of the atomic number — determine the composition of atomic nuclei, given the atomic number and the mass number — explain the term isotope — discuss the similarities and differences between hydrogen isotopes — calculate the percentage abundance of a given isotope.
	Relative atomic mass	At the end of this activity, students should be able to: — give a definition of atomic mass unit — explain the terms atomic mass and molecular mass — find atomic masses of elements in the periodic table — calculate the atomic mass of an element taking into account its isotopic composition — calculate the isotopic composition of an element on the basis of its atomic mass — explain why it is useful to know the atomic masses of elements.
	Continuous and line spectra	At the end of this activity, students should be able to: — explain the phenomenon of light — describe and interpret an experiment involving the passing of white light through a prism — discuss the electromagnetic spectrum — describe the atomic spectrum of hydrogen — describe atomic spectra of other elements — discuss the application of flame tests.
	The Bohr model of the atom	At the end of this activity, students should be able to: — discuss the Bohr model of the atom — define atomic energy levels — discuss the ground state and excited states of the hydrogen atom — explain the formation of the spectral lines in the atomic spectrum of hydrogen — discuss the process of ionisation.

	The electron configuration of an atom	At the end of this activity, students should be able to: — state the arrangement of electrons in the individual subshells of an atom — write the electron configuration of an atom, knowing its atomic number — give the principles of the classification of elements in the periodic table — determine which group and period a given element belongs to on the basis of its electron configuration — determine the electron configuration of an element knowing its position in the periodic table — describe the formation of positive and negative ions.
IV. Bonding	Ionic bonding. Part I	At the end of this activity, students should be able to: — explain how ionic compounds are formed using the example of sodium chloride — describe the structure of sodium chloride in the solid state — compare the properties of sodium, chlorine and sodium chloride — solve simple problems concerning ionic bond formation.
	Ionic bonding. Part II	At the end of this activity, students should be able to: — discuss the nature of ionic bonds — predict the type of ion formed by Group 1 and 2 metals and the more important Group 16 and 17 non-metals — describe the structure of an ionic crystal lattice — name the characteristic properties of ionic compounds and explain how they arise.
	Covalent bonding. Part I	At the end of this activity, students should be able to: — discuss the formation of covalent bonds — indicate which elements form covalent bonds — explain the terms: Lewis dot-and-cross diagrams, structural formula and molecular formula — name the non-metals that occur in nature in the form of diatomic molecules — illustrate simple diatomic molecules using molecular formulae, structural formulae and Lewis diagrams — explain how multiple bonds are formed.
	Covalent bonding. Part II	At the end of this activity, students should be able to: — give the definition of valence — write down the formula for a molecule, knowing the valences or ionic charges — give examples of diatomic and polyatomic molecules — know that carbon atoms can form single, double or triple bonds with one another.
	Metallic bonding	At the end of this activity, students should be able to: — identify metals — describe the characteristic physical properties of metals — describe the position of metals in the periodic table and recall their electron configurations — describe the nature of metallic bonding based on the 'electron sea' model — explain how the properties of metals arise from their inner structure.
	Alloys	At the end of this activity, students should be able to: — define alloys — give examples of iron, aluminium, copper and tin alloys — describe some uses of steel, brass, bronze and Duralumin — explain why alloys have different properties from pure metals.
	Simple and giant molecular solids	At the end of this activity, students should be able to: — describe the structure of the crystal lattice of covalent compounds — define the terms simple molecular solid and giant molecular solid — give some examples of simple and giant molecular solids — describe the properties of elements and compounds forming simple molecular solids and giant molecular solid crystals — explain why certain giant molecular solids conduct electricity, and give examples of such solids.
	Allotropes	At the end of this activity, students should be able to: — explain the phenomenon of allotropy — give examples of elements that occur in different allotropic forms — describe the allotropic forms of carbon, oxygen and sulphur — describe the physical properties of diamond and graphite — give examples of the uses of graphite and diamond — discuss the role of ozone in nature.
V. Representing chemical reactions	Chemical and physical change	At the end of this activity, students should be able to: — explain what a physical change and a chemical change involve — give examples of physical changes and chemical changes — discuss the methods for representing a chemical change — define the terms: reagent, reactant and product and identify them in a chemical equation.
	Chemical equations	At the end of this activity, students should be able to:

		— describe how the number of molecules and the number of atoms in a molecule are indicated — write down a simple chemical reaction using symbols for elements and formulae for compounds — balance simple chemical equations using stoichiometric coefficients — explain how the physical states of reactants are indicated in chemical equations — give the definition of a stoichiometric coefficient.
	Reaction types	At the end of this activity, students should be able to: — explain the following reaction types: combination, decomposition, displacement, precipitation, neutralisation, oxidation reaction and reduction reaction, exothermic reaction, endothermic reaction, reversible reaction and irreversible reaction — name the type of reaction, given a chemical equation.
VI. Quantitative aspects of chemical reactions	Atomic and molecular mass	At the end of this activity, students should be able to: — quote the law of conservation of mass and explain it on the basis of the particularity of matter — explain the terms: atomic mass and molecular mass — read the atomic masses of elements from the periodic table — calculate the molecular masses of chemical compounds — obtain information about the quantitative composition of chemical compounds from their molecular formulae — use the different ways of representing the composition of substances.
	The mole	At the end of this activity, students will be able introduced to: — the unit of quantity of matter — the mole — Avogadro's number— the molar mass — calculating the number of moles — interpreting molecular formulae in terms of moles — empirical formulae— calculating the percentage composition of a chemical compound.
	Using the mole concept	At the end of this activity, students should be able to: — write a chemical equation using the molar interpretation — solve simple problems using the mole concept — calculate the mass of products or reactants in a chemical reaction — calculate the volumes of gaseous products — solve simple problems using the concept of molarity — calculate the molarity of an acid or base using acid-base titration.
VII. Acids, bases and salts	Properties of acids	At the end of this activity, students should be able to: — explain the properties of acids — name a few uses of acids — describe the structure of acids — give the definition of dissociation and understand this proces — describe the dissociation of weak and strong acids.
	Properties of bases	At the end of this activity, students should be able to: — give the definition of a hydroxide — describe the properties of bases — describe the uses of bases — determine the structure of bases — give a definition of dissociation — define the terms 'strong' and 'weak' bases and describe their behaviour in water.
	Indicators and pH	At the end of this activity, students should be able to: — state the purpose of indicators — determine the pH of a solution using an indicator — determine the acidity or alkalinity of a solution using the pH scale — indicate the colours corresponding to alkaline, neutral and acidic solutions on the pH scale — identify strong and weak acids and strong and weak alkalis on the basis of the pH value of their solutions — discuss the applications of pH measurements.
	Neutralisation reactions	At the end of this activity, students should be able to: — explain what neutralisation involves and how it is carried out — determine the molecular formula of a salt — name salts — balance equations for neutralisation reactions — discuss the practical applications of neutralisation reactions.
	Salts	At the end of this activity, students should be able to: — give examples of salts occurring in nature — give examples of some uses of salts — discuss the dissociation of salts and specify the types of ion present in a solution of a salt — describe the reaction between a metal and an acid at the macroscopic and microscopic levels — discuss precipitation reactions, using appropriate examples

		— classify some common salts as soluble or insoluble —describe the thermal decomposition of carbonates.
	Reactions of acids and bases	At the end of this activity, students should be able to: — discuss reactions between non-metal oxides and water — discuss reactions between bases and non-metal oxides — discuss reactions between acids and metal oxides — discuss reactions between carbonates or hydrogencarbonates and acids — discuss reactions between acids and a solution of ammonia.
	Acid-base titrations	At the end of this activity, students should be able to: — describe the principles of titration and how it is carried out — discuss the aims of titration — calculate the mass of a solute — determine the concentration of a solution by titration — calculate the mass of solute in a titrated sample.
VIII. Water and water solutions	Properties of water	At the end of this activity, students should be able to: — describe the structure of the water molecule — explain the process of formation of hydrogen bonds — describe the process of dissolution of ionic compounds (electrolytic dissociation) — list methods for detecting the presence of water — explain what distilled water is — discuss the effect of the presence of other substances in water on water's freezing and boiling points.
	Solubility in water	At the end of this activity, students should be able to: — define the terms: saturated solution, solubility, crystallisation, solubility curve — describe the dissolution of gases, liquids and solids in water and discuss the effect of various physical factors on this proces — use a solubility curve to find the number of grams of a solute that will be dissolved at a specific temperature and perform simple calculations using the data obtained from this graph.
	Natural waters	At the end of this activity, students should be able to: — explain what hard water is, the causes and types of water hardness — describe the methods for eliminating temporary and permanent hardness from water — name the main water pollutants and the sources of this pollution — describe methods for removing water pollution caused by petroleum and petroleum products — name the main processes carried out during water treatment — describe the main steps in wastewater purification.
	Colloids. Washing in water	At the end of this activity, students should be able to: — explain what colloids are — name the properties that distinguish colloids from other types of mixture (true solutions and suspensions) — list the types of colloid and give examples of them — explain what emulsifying agents are and what coagulation involves — explain how soap and detergents remove dirt — describe the behaviour of soap and detergents in hard water.
IX. The periodic table and chemical properties of the elements	The periodic table	At the end of this activity, students should be able to: — give the criteria for the classification of the elements in the periodic table — state the group in which a given element occurs on the basis of the number of its valence electrons, and vice versa — state the period in which a given element occurs on the basis of the number of electron shells, and vice versa — determine whether a given element is a metal, a metalloid or a non-metal from its position in the periodic table — give examples of similarities in the properties of elements within a given main group — give examples of periodic changes in the properties of elements that occur in the same period.
	Noble gases	At the end of this activity, students should be able to: — write the electron configuration of the first three elements of Group 18 — describe the trends in the melting points, boiling points and densities in Group 18 — state the relationship between their atomic structure and the properties of the noble gases — account for the chemical inertness of the noble gases — give an example of a compound of a noble gas — give examples of the uses of the noble gases.
	Alkali metals	At the end of this activity, students should be able to: — describe the electron configuration of the alkali metals — describe the trends in the melting points and the boiling points of Group 1 elements — describe the trends in the density of Group 1 elements — explain the relationship between the atomic structure and the properties of the alkali metals

		— describe the trends in the reactivity of the alkali metals — describe the trends in the atomic radii of the Group 1 metals.
	Reactions of alkali metals	At the end of this activity, students should be able to: — describe the electron configuration of alkali metals — write equations for the reactions of alkali metals with water, the halogens and oxygen — know the relationship between the structure of the halides of alkali metals and their properties — know the relationship between the structure of the oxides of alkali metals and their properties — describe the uses of alkali metal compounds.
	Alkaline earth metals. Group 2	At the end of this activity, students should be able to: — describe the electron configuration of Group 2 metals — write equations for the reactions of the alkaline earth metals with water and oxygen — describe the relationship between the structure of the Group 2 elements and their chemical and physical properties — compare the reactivity of the metals of Groups 1 and 2 of the periodic table.
	Halogens. Group 17	At the end of this activity, students should be able to: — represent the electron configuration of the elements of Group 17 — explain the formation of halogen molecules — compare the solubility of halogens in water and in hexane and give reasons for the differences — describe the trends in the melting points and boiling points in Group 17 — describe the relationship between the atomic structure and the physical properties of the elements — mention the uses of halogens and their compounds.
	Reactions of the halogens	At the end of this activity, students should be able to: — account for the high reactivity of the halogens — describe the trend in the reactivity with increasing atomic number of the halogens within the group — explain why chlorine is more reactive than bromine — write equations for reactions of halogens with metals and hydrogen — account for the acidic character of hydrogen halides — mention the most important properties and applications of hydrochloric acid — predict whether a molecule of a given halogen will react with a simple ion of another halogen.
	Electrochemical cells	At the end of this activity, students should be able to: — define a voltaic cell — explain the structure and the principles of a voltaic cell — give an example of a chemical reaction that occurs in a cell — write equations for half-reactions in a voltaic cell — discuss the principles of a fuel cell — discuss the practical applications of voltaic cells and fuel cells.
XI. Electrolysis	Conductivity of chemical substances	At the end of this activity, students should be able to: — know why some substances conduct an electric current in the molten state or in aqueous solutions — know what electrolytes are — explain how to distinguish between an electrolyte and a non-electrolyte — give examples of electrical conductors — determine which ions are present in a molten salt — specify which ions are present in a solution of an electrolyte.
	Electrolysis. Part I	At the end of this activity, students should be able to: — say what electrolysis is and how it is carried out — describe the apparatus for carrying out electrolysis — identify the cathode and anode in an operating elektrolyser — determine the products of electrolysis of typical molten salts and typical aqueous solutions — write equations for the electrode reactions that occur during the electrolysis of typical solutions.
	Electrolysis. Part II	At the end of this activity, students should be able to: — describe how the electrolysis of brine proceeds — explain what electroplating involves — name the uses of electrolysis — calculate the quantity of product prepared by an electrolysis — calculate the time during which electric current must be applied to yield a given amount of a product by electrolysis.
XII. Organic chemistry	Alkanes	At the end of this activity, students should be able to: — indicate which compounds are classed as organic compounds, on the basis of their chemical formulae — explain the terms: hydrocarbons, saturated hydrocarbons, alkanes and homologous series

		— give the names and formulae of the individual members of the homologous series of alkanes containing from 1 to 10 carbon atoms.
	Isomerism of alkanes	At the end of this activity, students should be able to: — define the terms isomerism and isomers — explain what alkyl groups are and give the names of alkyl groups corresponding to individual members of the homologous series of alkanes — name simple isomers of straight chain alkanes that have one substituent or several substituents of the same type, and isomers that have different substituents — explain why straight chain alkanes are characterised by higher boiling and melting points than their branched isomers.
	Alkenes	At the end of this activity, students should be able to: — explain the term unsaturated hydrocarbons or alkenes — give the names and formulae of simple alkenes and isomers that differ in the position of the double bond — describe the addition reactions of bromine and hydrogen to alkenes — discuss the rules of nomenclature for brominated derivatives of alkenes.
	Alcohols	At the end of this activity, students should be able to: — explain what alcohols are — give names and formulae for common monohydric alcohols — describe the methods for obtaining ethanol, and discuss its uses — describe the reaction between ethanol and sodium, and the dehydration reaction — give examples of dihydric and trihydric alcohols.
	Carboxylic acids	At the end of this activity, students should be able to: — explain what carboxylic acids and esters are — give the names and formulae of common carboxylic acids — discuss the chemical properties of carboxylic acids (acidity of aqueous solutions) — write down the reactions of ethanoic or methanoic acid with magnesium, copper(II) oxide and carbonates — give examples of higher fatty acids — discuss the structure of soaps — write down the reaction for esterification and specify the conditions under which it proceeds.
	Exothermic and endothermic reactions	At the end of this activity, students should be able to: — describe the phenomenon of energy transfer in a chemical reaction — define exothermic and endothermic reactions — identify exothermic and endothermic reactions — draw energy diagrams — do simple calculations associated with energy transfer during a chemical reaction.
XIII. Chemical reactions	Reversible reactions and chemical equilibrium	At the end of this activity, students should be able to: — know what irreversible and reversible processes are — give examples of reversible and irreversible processes — explain the state of dynamic equilibrium — know what factors affect equilibrium — apply Le Chatelier's principle in reversible reactions.
	Reaction rate	At the end of this activity, students should be able to: — define reaction rate as the change of concentration of reactants or products with time — give examples of fast and slow reactions — draw a graph showing changes of concentration with time — find reaction rates from given experimental data — describe the basic methods for the determination of reaction rates — describe the economic importance of reaction rates.
	Factors affecting reaction rate	At the end of this activity, students should be able to: — explain the collision theory — give the factors affecting chemical reaction rates — propose methods for increasing a reaction rate — define a catalyst.
	Catalysts	At the end of this activity, students should be able to: — define catalysts — explain the concept of activation energy — explain the mechanism of catalyst action — give examples of applications of catalysts — identify the benefits of using catalysts in industry.
	Enzymes — biological catalysts	At the end of this activity, students should be able to: — explain how to significantly increase the reaction rate — define enzymes and give examples of them

		— describe the action of enzymes and their importance in everyday life — explain the process of fermentation — define biotechnological proces — give an example of biotechnological process.
XIV. Useful products from organic sources	Fossil fuels and crude oil	At the end of this activity, students should be able to: — understand the role of fossil fuels — know the origin of fossil fuels — know the location of the main deposits of fossil fuels in the world — understand the fractional distillation process.
	Cracking and combustion of hydrocarbons	At the end of this activity, students should be able to: — know and understand the cracking proces — understand what octane rating means — know the products from the complete and the incomplete combustion of hydrocarbons.
	Polymers	At the end of this activity, students should be able to: — define the terms: monomer, polymer, polymerisation — describe the structures of polymers and classify them according to the structure of macromolecules — define a copolymer — indicate everyday objects that are made of plastic — mention the basic properties of polymers — explain the terms thermoplastics and thermosetting plastics — describe the uses of at least three different polymers.
	Environmental impact of oil products	At the end of this activity, students should be able to: — know how to identify the products from the complete combustion of hydrocarbons — understand the origin of unwanted industry-related effects in the atmosphere — know what we could do to combat the greenhouse effect, acid rains, increasing amounts of plastic litter — understand the difference between total and incomplete combustion of hydrocarbons.
XV. Useful products from rocks	Metals from metal ores	At the end of this activity, students should be able to: — mention the most important chemical elements which make up the Earth's crust — give the names of minerals that contain iron, aluminium, titanium and copper and write their chemical formulae — predict, on the basis of the reactivity series of the metals, whether a given metal can displace another metal from its compounds — discuss the methods for metal extraction from ores.
	Iron	At the end of this activity, students should be able to: — describe the method for the extraction of iron in a blast furnace — explain the production process for steel — describe the corrosion of iron and steel — describe methods for the protection of iron and steel against corrosion.
	Aluminium	At the end of this activity, students should be able to: — name the ores of aluminium — describe the process of extracting aluminium from bauxite — using aluminium as an example, discuss the phenomenon of passivation — mention the most important uses of aluminium — explain how aluminium is recycled and indicate the benefits of this process.
	Copper and titanium	At the end of this activity, students should be able to: — name the minerals that contain copper and titanium — discuss methods for the extraction and refining of copper — describe the method for the extraction of titanium — explain why titanium and copper do not corrode — state the uses of copper and titanium.
	Industrial uses of limestone	At the end of this activity, students should be able to: — name the types of rock that contain calcium carbonate — describe the reactions that occur in limestone in the presence of carbon dioxide and water — explain what quicklime and slaked lime are and how they are prepared — explain the terms mortar, cement, concrete and glass — describe the methods of preparation and applications of these materials.
	Sulphur and sulphuric(VI) acid	At the end of this activity, students should be able to: — name the principal minerals that contain sulphur — discuss the properties of sulphur — describe the methods for the extraction and the combustion reactions of sulphur — discuss the process for manufacturing and the hygroscopic properties of sulphuric(VI) acid — discuss the uses of sulphur and sulphuric(VI) acid

		— describe the effect of sulphur dioxide on living organisms and on the process of corrosion.
XVI. Useful products from air	Air	At the end of this activity, students should be able to: — name the constituents of clean air — name the pollutants of air, their sources and environmental impact — explain the terms 'acid rain' and 'smog' — discuss the preparation of oxygen and nitrogen from air — describe the properties of oxygen and its applications.
	Ammonia and nitric acid	At the end of this activity, students should be able to: — describe the properties of nitrogen, and its uses — describe the properties of ammonia and the method for its synthesis on an industrial scale — describe the properties of nitric(V) acid and the steps in its preparation from ammonia — give the definition of reaction yield and be able to use it in simple calculations.
	Fertilisers	At the end of this activity, students should be able to: — discuss the structure of soil — name the basic elements essential for plants and discuss their effect on plants — give natural and artificial sources of these elements — describe the processes for preparing basic artificial fertilisers containing nitrogen, phosphorus and potassium — describe the effect of fertilisers on water basins or reservoirs, and ways of preventing the pollution of surface water with fertilisers.
XVII. Food and drugs	Carbohydrates	At the end of this activity, students should be able to: — give the definitions of carbohydrates, mono-, di- and polysaccharides — describe the structures of glucose, fructose, sucrose, starch, cellulose and glycogen — describe the properties of these compounds and give reactions for their identification — discuss the importance of carbohydrates in the diet.
	Proteins	At the end of this activity, students should be able to: — describe what amino acids, polypeptides and proteins are — discuss the spatial structure of proteins — explain the phenomenon of denaturation and name the factors that cause it — describe the colour reactions used for the detection of proteins.
	Fats	At the end of this activity, students should be able to: — describe the structure of a fat molecule — classify fats according to their physical state, origin and structure — describe the reactions of saponification and the hardening of oils — give the uses of fats.
	Food and drugs	At the end of this activity, students should be able to: — explain what vitamins are and classify them as water-soluble or fat-soluble — mention some sources of vitamins — discuss methods for protecting food against the adverse effect of bacteria and oxygen — explain the terms: avitaminosis, hypervitaminosis, antivitamin, functional food, antibiotics.
XVIII. Chemistry and the Earth	The structure of the Earth	At the end of this activity, students should be able to: — define the relative positions of the Earth, Moon and Sun in the Universe — name the layers of the Earth — describe the properties of the main layers within the Earth — compare the abundance of elements in the Earth's crust and in the whole of the Earth — specify the sources of information used to determine the structure of the inner part of the Earth — describe how density, pressure and temperature vary with depth from the surface — specify the position of the magnetic poles of the Earth.
	Tectonic plates	At the end of this activity, students should be able to: — say what tectonic plates are and describe their properties — explain why tectonic plates shift — explain what happens in places where the edges of tectonic plates meet — describe what divergent, convergent and transform boundaries are — give evidence for the expansion of the ocean floor — present the evidence for the changes in the Earth's magnetic field in the past — say how continents move — give the evidence for continental drift.
	Tectonic movements, earthquakes and volcanoes	At the end of this activity, students should be able to: — explain how volcanoes form — explain why earthquakes occur and describe where they occur most often — show the location of volcanoes on the Earth, using a map with the tectonic plates marked on it — show the location of seismic zones on the Earth, using a map with the tectonic plates marked

		on it — describe the effect of the processes involving tectonic plates on the formation of volcanoes and earthquakes — describe the applications of the Richter scale.
	Igneous rocks	At the end of this activity, students should be able to: — explain what minerals are, what rocks are composed of and what is the difference between a rock and a mineral — explain which chemical compounds are the principal components of magma — explain how igneous rocks are formed and classify them according to the form of their crystals — distinguish between intrusive and extrusive rocks — give examples of the most common igneous rocks and explain the differences between them — list the characteristic properties of igneous rocks — know the applications of igneous rocks.
	Sedimentary rocks. Part I	At the end of this activity, students should be able to: — explain what weathering is and list the factors that influence this proces — name and describe the types of rock weathering — give examples of physical, chemical and biological weathering — explain what erosion involves and give examples of different forms of erosion — name the ways in which weathered rocks are transported — discuss rock transportation by water, wind and glaciers — explain the origin of sediments on sea and ocean floors.
	Sedimentary rocks. Part II	At the end of this activity, students should be able to: — explain how sedimentary rocks were formed — account for the order in which rock layers are arranged — explain how fossils were formed — determine the age of rock layers on the basis of the fossils found in them — give examples of the most common sedimentary rocks and explain the differences between them — name the characteristic properties of sedimentary rocks — describe the principal component of limestone rocks.
	Metamorphic rocks and the rock cycle	At the end of this activity, students should be able to: — explain how metamorphic rocks are formed — give examples of the most common metamorphic rocks — mention the characteristic properties of metamorphic rocks — discuss the 'rock cycle' — recognise the basic types of rock on the basis of their characteristic properties.
	The atmosphere	At the end of this activity, students should be able to: — explain how the Earth's atmosphere evolved before reaching its present composition — describe the approximate percentage composition of the atmosphere at present — discuss the structure of the atmosphere — describe the process of formation of radicals by the break-up of a covalent bond — explain how chlorine radicals can deplete the ozone layer — explain the effect of the ozone-hole expansion on human health — explain how the ozone layer is formed — describe the causes of the greenhouse effect, and what impact it could have on the living conditions on Earth.
	Oceans	At the end of this activity, students should be able to: — explain how the oceans were formed — explain the origin of salts in the oceans — list the characteristic properties of sea water — list the most abundant ions in sea water — discuss the concentration of salts in oceans — discuss salinity balance — discuss the role of the oceans in maintaining the composition of the atmosphere — discuss the economic importance of the oceans.
XIX. Laboratory techniques and analytical tests	Handling liquids	At the end of this activity, students should be able to: — explain the purpose of a graduated cylinder, pipette and burette and describe how they are used — describe how to transfer a liquid from a bottle to a beaker — carry out a temperature measurement and determination of the pH and odour of a liquid — determine the age of rock layers on the basis of the fossils found in them — heat a liquid in a test-tube in a safe way.
	Handling solids. Heating	At the end of this activity, students should be able to:

		— describe how solids are stored — give guidelines on how to correctly transfer solids from containers, and how to weigh and crush solids — explain what decantation, filtration and evaporation involve and why these techniques are used — discuss the structure of the Bunsen burner and its safe use.
	Gases: handling and laboratory tests	At the end of this activity, students should be able to: — describe the set-up used for collecting gases — prepare equipment for measuring the volume of gases evolved from various chemical reactions — describe methods for obtaining oxygen, hydrogen and carbon dioxide in a chemistry lab and for the identification of these gases — discuss how to use indicator paper when investigating gases.
	Testing for ions	At the end of this activity, students should be able to: — explain what a flame test involves, give the flame colours characteristic of lithium, sodium, potassium, barium, calcium, copper and lead, and be able to distinguish between these metals on the basis of their flame colours — describe simple methods for detecting ammonium, carbonate, sulphate(VI), sulphate(IV) and halide ions.
XX. Safety in the chemical laboratory	Safety in the chemical laboratory	At the end of this activity, students should be able to: — recognise the types of hazardous substance on the basis of the hazard symbols — read the hazards involved in contact with a given substance and the guidelines for handling on the basis of the R and S symbols — specify appropriate personal protective equipment — discuss the principles for the safe conduct of experiments — describe the procedure in an emergency.

BIOLOGY

CHAPTER	LESSON	DESCRIPTION
I. The cell — the basic unit of living organisms	Structure of plant and animal cells	At the end of this activity, students should be able to: — describe the basic organisation of the cell — compare and contrast animal and plant cells
	Microscopes and the size of cells	At the end of this activity, students should be able to: — describe a light microscope — describe the concept of electron microscope design — compare and contrast light and electron microscopes — define the basic units of measurement applicable to microscopic studies — prepare samples for examination under a light microscope.
	Chemical composition of cells	At the end of this activity, students should be able to: — have a basic understanding of the chemical composition of a cell — know the structure and function of proteins, lipids and carbohydrates — be able to define the role that each of the molecules plays in the metabolic processes within a cell and a multicellular organism.
	The nucleus as a store of genetic material	At the end of this activity, students should be able to: — describe the structure of chromosomes — define haploid and diploid sets of chromosomes — define homologous chromosomes — define changes in the amount of genetic material during cell cycle.
	Cell division	At the end of this activity, students should be able to: — describe and compare mitosis and meiosis — define the importance of mitosis and meiosis.
	Cell specialization	At the end of this activity, students should be able to: — define the levels of organization existing in the living world — associate the components of the cell with their function in particular cells.
	Transport across membranes	At the end of this activity, students should be able to: — define diffusion, osmosis and active transport — compare and contrast diffusion, osmosis and active transport — describe examples of diffusion, osmosis and active transport in animals and plants — discuss the significance of each kind of transport in living organisms.
	Metabolic transformations in a cell	At the end of this activity, students should be able to: — define metabolism — explain the differences between anabolic and catabolic reactions — explain the role of ATP — define the role of enzymes — explain the term "active site" and present a diagram of a reaction with an enzyme — explain the terms "cofactor" and "inhibitor" and their influence on the progress of enzymatic reactions — demonstrate the influence of temperature on the rate of enzymatic reactions.
	Plant tissues	At the end of this activity, students should be able to: — distinguish meristems from true tissues — define the functions and distribution of meristems in plants — define the structure and functions of true primary and true secondary tissues.
	Animal tissues	At the end of this activity, students should be able to: — describe the features of the cells constituting basic animal tissues — define the functions of the main animal tissues.
II. The diversity of living organisms	Classification of organisms	At the end of this activity, students should be able to: — recognize the need for organizing information about species

		— understand the principles of classification of species according to their specific features — understand the reasons for the differences between systems of classification of living creatures.
	Prokaryotes, protists and fungi	At the end of this activity, students should be able to: — name the basic features of prokaryotes and eukaryotes — name the basic features of protists and differentiate between the basic groups of protists — name the basic features of fungi and lichens.
	Plants	At the end of this activity, students should be able to: — name the basic characteristics of plants — distinguish the basic groups of plants — recognise how plants adapt to terrestrial conditions — recognise the diversity of plant forms.
	Invertebrates	At the end of this activity, students should be able to: — recognise the variety of adaptations among the groups of invertebrates — indicate the features that are characteristic for each group of invertebrates — assign animals to a specific group of invertebrates — recognise similarities in structure and function in selected representatives of the groups of invertebrates — recognise the differences in structure and function in selected representatives of the groups of invertebrates.
	Reproduction in invertebrates	At the end of this activity, students should be able to: — describe the diversity of reproductive methods and adaptations in invertebrates — describe the similarities and the differences in the structure and function of the reproductive organs and systems of selected examples from given classes of invertebrates.
	Vertebrates	At the end of this activity, students should be able to: — describe the variety of adaptations among the classes of vertebrates — indicate the features of selected animals that are characteristic of the class of invertebrates to which they belong — describe the similarities and differences in structure and function of selected examples of the classes of vertebrates.
	Reproduction in vertebrates	At the end of this activity, students should be able to: — recognise the different reproductive adaptations among classes of vertebrates — recognise the differences in the structure and function of the egg among classes of vertebrates — recognise the adaptations that enable the embryos of reptiles, birds and mammals to become independent from the aquatic environment — recognise how parents participate in the postembryonic development of their offspring, especially in birds and mammals — recognise the similarities between representatives of classes of vertebrates in regard to the development of the embryo inside the mother's body.
	Viruses	At the end of this activity, students should be able to: — describe the basic characteristics of viruses — describe the main differences between viruses and cell organisms — describe the structure of a virus — name the stages and events in the viral multiplication cycle — recognise human diseases caused by viruses — understand how viruses affect a host cell.
III. Circulation	Blood	At the end of this activity, students should be able to: — describe the structure of blood — describe the chemical composition of plasma — describe the structure and function of blood cells — explain the process of blood clotting — explain how the transport of respiratory gases occurs.
	Blood vessels	At the end of this activity, students should be able to: — describe the structure of arteries, veins and capillaries — define the functions of arteries, veins and capillaries — explain how components are exchanged between blood and tissue fluid.
	Blood groups and the Rhesus factor	At the end of this activity, students should be able to: — determine human blood groups — explain what Rh factor is — present the possibility of transfusion in the ABO and Rh systems — explain what serological incompatibility involves — give examples of medical application of blood.

	The circulatory system	At the end of this activity, students should be able to: — define the location of the heart in the human organism — describe cardiac muscle tissue — discuss the structure of the heart — describe the cardiac cycle — explain the importance of the coronary circulation — describe the pulmonary circulation — describe the systemic circulation.
	Effects of physical effort on the functioning of the circulatory system	At the end of this activity, students should be able to: — the influence of physical effort on blood vessels and the heart — the response of blood vessels and the heart to physical effort the most common ways of prevention of cardiovascular diseases.
	Risk factors for heart attack	At the end of this activity, students should be able to: — define the process of atherosclerosis, arterial hypertension, and the related cardiovascular diseases — describe the most common ways of preventing cardiovascular diseases — describe cardiopulmonary resuscitation.
IV. Nutrition	Nutrients	At the end of this activity, students should be able to: — describe the importance of the organic constituents of food: proteins, fats, carbohydrates, vitamins and fibre — describe the importance of water and mineral ions — indicate the sources of nutrients — explain the factors affecting nutritional requirements — describe the effects of nutrient deficiencies — give examples of the use of preservatives and colourings in foods.
	The human alimentary canal	At the end of this activity, students should be able to: — present the structure of the human alimentary canal — show the relationship between the structure and functions of each section of the alimentary canal — explain the structural and functional connection between the liver and pancreas and the alimentary canal.
	Digestion	At the end of this activity, students should be able to: — define digestion — explain how digestive enzymes work — describe the digestion of carbohydrates, proteins, fats — define the site of the absorption of digestion products — describe the role of bile in lipids digestion — define the role of symbiotic bacteria in vitamins production.
	Absorption	At the end of this activity, students should be able to: — describe the adaptations of the intestine for the absorption of the products of digestion — describe the absorption of the products of protein, carbohydrate and lipid digestion — indicate the association between the circulatory system and alimentary canal — describe the role of the liver in the regulation of glucose levels — describe the role of the liver in detoxification.
V. Respiration	The respiratory system	At the end of this activity, students should be able to: — describe the structure of the respiratory system — explain the mechanism of breathing — compare the composition of inhaled and exhaled air — explain what is involved in gas exchange in the lungs — name the adaptations of the lungs to gas exchange.
	Cellular respiration and energy production	At the end of this activity, students should be able to: — know the structure of the respiratory system — know the course of gas exchange in the lungs. explain that respiration involves the release of energy from organic compounds — differentiate between the two types of respiration: aerobic and anaerobic — indicate the type of respiration that releases the most energy — explain the circumstances in which anaerobic respiration occurs in human beings — explain the meaning of the term "oxygen debt".
VI. Nervous system	The nervous system as a receptor of environmental stimuli	At the end of this activity, students should be able to: — specify the main types of stimuli received by the nervous system — describe a neurone and the basic types of neurones — define the basic elements of the nervous system involved in producing the appropriate response to a stimulus — characterize the structure and function of a synapse — define a neurotransmitter.

	Nervous system	At the end of this activity, students should be able to: — name the parts of the nervous system and their structures — describe the basic functions of particular parts of the nervous system — define the terms "nerve centre" and "nerve" — name the most important structures protecting the nervous system.
	The peripheral nervous system	At the end of this activity, students should be able to: — describe the hierarchy in the peripheral nervous system (PNS) — define and describe the divisions of the autonomic nervous system (ANS) — explain the opposing (antagonistic) actions within the PNS, its motor system and the ANS.
	Reflex responses of the nervous system	At the end of this activity, students should be able to: — differentiate between voluntary and involuntary responses — define conditioned and unconditioned reflexes — describe Pavlov's experiments.
	Sensory organs	At the end of this activity, students should be able to: — describe the three types of receptors — define the role of receptors in the body — describe the structure and function of the organs of taste and smell.
	The eye and the ear	At the end of this activity, students should be able to: — know the tissue structure — know the mechanisms of the generation of nerve impulses and the principles of their operation — know the structure and function of receptors in the nervous system. describe the structure of the eye and ear — the sensory organs of hearing and balance — define the functions of the eye and ear.
VII. Hormones	Hormones and endocrine glands	At the end of this activity, students should be able to: — define a hormone — name the endocrine glands and define their location in the human organism — name the hormones released by certain glands — present examples of hormone activity in the human organism — explain what is involved in the regulation of hormone secretion — define the dominant role of the pituitary gland in the endocrine system.
	Hormonal regulation of metabolic processes	At the end of this activity, students should be able to: — explain how blood sugar level is regulated — describe the action of adrenaline — present the action of growth hormone — explain the role of thyroid hormones.
	Sex hormones	At the end of this activity, students should be able to: — define the effects of sex hormones on the development of the secondary sex characteristics — explain how hormones regulate the menstrual cycle — give examples of the applications of hormones.
VIII. Human locomotion system	The skeletal system	At the end of this activity, students should be able to: — explain what is involved in the process of bone remodelling — describe the morphological structure of a long bone — name the components of the axial and appendicular skeletons — define joint, explain its role and name its main components — name the functions of the human skeletal system.
	Skeletal muscles	At the end of this activity, students should be able to: — describe the external structure of skeletal muscles — describe the structure of the skeletal muscle cell — explain the terms: muscle fibre, myofibril, myofilament, sarcomere and neuromuscular junction — explain the sliding filament theory — explain the antagonistic activity of muscles.
IX. Homeostasis	Homeostasis	At the end of this activity, students should be able to: — explain the terms relating to the internal environment of the organism and homeostasis — explain the roles of the nervous and endocrine systems in homeostasis and the interdependence of these systems, explain the mechanisms of negative and positive feedback — present an example of a homeostatic mechanism (regulation of glucose concentration in the blood).

	Regulation of the amount and composition of systemic fluids by the kidneys	At the end of this activity, students should be able to: — define excretion — discuss the structure of the nephron — describe the stages of urine formation — glomerular filtration, and tubular secretion — explain the role of ADH in the regulation of water excretion — explain how an artificial kidney works and the importance of kidney transplantation to people with renal failure.
	Thermoregulation	At the end of this activity, students should be able to: — distinguish between endothermic and exothermic organisms — define homoiothermy — explain the importance of homoiothermy for the human organism — describe the basic methods used by the organism thermoregulation process — present elements of the thermoregulatory system and indicate the role of the nervous system in thermoregulation — present the mechanism of negative feedback in thermoregulation.
X. Human reproduction	The reproductive system	At the end of this activity, students should be able to: — present the structure of the male reproductive system — define the functions of specific organs of the male reproductive system — present the structure of the female reproductive system — define the functions of specific organs of the female reproductive system — describe spermatogenesis — present the structure of sperm cells — describe oogenesis — present the structure of egg cells.
	Development of the human embryo	At the end of this activity, students should be able to: — explain how fertilization occurs — name the initial stages of embryo development: cleavage and gastrulation — define the role of the placenta — describe the gradual development of the embryo and fetus — present the stages of labour.
XI. Health and diseases	The human immune system	At the end of this activity, students should be able to: — define antigen, antibody, immunity, specific and non-specific immunity, cellular and humoral immunity — name the components of the immune system — describe the role of phagocytes and lymphocytes in the immune response — describe an inflammatory response — characterize primary and secondary immune responses.
	Vaccinations	At the end of this activity, students should be able to: — define the terms "epidemic" and "pandemic" — give examples of epidemic chains and methods of breaking them — describe the significance of the discoveries by Jenner and Pasteur in the development of vaccinations — explain how active immunity is produced by vaccination — state the difference between preventive vaccination and therapeutic vaccination — explain the significance of vaccinations in the fight against infectious diseases — justify the need for the administration of preventive vaccinations.
	Bacterial diseases	At the end of this activity, students should be able to: — describe the most important concepts of medical microbiology — describe how people become infected with the Mycobacterium tuberculosis Salmonella typhi, Vibrio cholerae, Yersinia pestis and Treponema pallidum — describe the most important risks associated with the diseases caused by these bacteria — present the most important methods for avoiding infections with these bacteria — give reasons for the introduction of public health regulations in order to combat infectious diseases.
	Viral diseases	At the end of this activity, students should be able to: — name several viral diseases (influenza, poliomyelitis, rubella, measles, mumps, chickenpox) — explain why one person can contract influenza several times — explain why bird flu viruses are so dangerous to human beings — briefly describe the characteristics of childhood diseases (rubella, measles, mumps, chickenpox) and their complications — describe the possible complications of viral hepatitis B and C — describe the role of vaccinations in the prevention of viral diseases, including poliomyelitis.

	Human immunodeficiency virus (HIV)	At the end of this activity, students should be able to: — explain the abbreviations HIV and AIDS — describe the structure of HIV — describe the life cycle of HIV — explain how HIV affects the functioning of the immune system — describe the process of HIV infection — give examples of high-risk behaviours — explain how HIV can be easily destroyed by means of common disinfectants and high temperature — comprehend that people infected with HIV can lead a normal life in society.
	Antiseptics and antibiotics	At the end of this activity, students should be able to: — give the definitions of antibiotics, antiseptics, antisepsis — describe the action of penicillin — describe the idea and importance of antibiotic resistance in bacteria.
	Parasitic diseases	At the end of this activity, students should be able to: — explain what parasitism involves — present the life cycles of selected human parasites — explain the pathological effect of parasites — present ways to prevent parasitic infections.
	Effects of drugs; cigarettes and alcohol on the organism	At the end of this activity, students should be able to: — define dependence and present its examples — describe the effects of basic drug types on the nervous system — define addiction — give examples of addictions — describe the effects of cigarettes on the organism and name diseases caused by smoking — describe the effects of alcohol on the organism and name diseases caused by drinking.
XII. Plant nutrition	Photosynthesis	At the end of this activity, students should be able to: — write the equation for photosynthesis — describe the course of the light phase and the dark phase of photosynthesis — describe how temperature, light and carbon dioxide levels affect the rate of photosynthesis — describe the relationship between photosynthesis and respiration — explain the importance of photosynthesis.
	Mineral nutrition in plants	At the end of this activity, students should be able to: — define macro-elements, trace elements and ultra-trace elements — describe the importance of macro-elements for optimum plant growth and development — present the importance of inorganic fertilizers.
	Crop production	At the end of this activity, students should be able to: — explain how soil pH affects the growth of plants — name the types of fertilizers — name the methods for combating weeds — describe methods for protecting plants from diseases — present the advantages of greenhouses for plant cultivation — describe the principle of hydroponic cultivation.
	Carnivorous plants	At the end of this activity, students should be able to: — define the significance of carnivorousness — describe how plants capture animals — give named examples of carnivorous plants — indicate the distribution of selected carnivorous plants.
XIII. Plant reproduction	Plant reproduction	At the end of this activity, students should be able to: — describe the mode of reproduction in spore-bearing plants — compare the life cycles of mosses and ferns — describe the life cycle of gymnosperms — describe the reproductive organs and life cycle of angiosperms.
	Seed germination and plant growth	At the end of this activity, students should be able to: — describe the structural components of a seed and their roles — describe the chemical composition of different seeds — describe the process of germination — define the environmental factors necessary for germination.
XIV. Transport in plants and plant movements	Water transport in plants	At the end of this activity, students should be able to: — discuss the structure of xylem — describe the mechanisms of water transport in plants — define transpiration, its types and importance — describe the modes of intake and transport of inorganic ions — define water balance in plants.

	Transport and accumulation of organic substances in plants	At the end of this activity, students should be able to: — discuss the structure of phloem and indicate its location in a plant — name the organic compounds produced during photosynthesis and stored in plants — describe the transport of organic compounds from the leaves to other plant organs — name examples of storage organs in plants.
	Responsiveness and plant movements	At the end of this activity, students should be able to: — define tropisms, nastic movements and taxis — present examples of plant movements — explain mechanisms of tropisms and nastic movements.
XV. Variation in organisms	Variation of organisms	At the end of this activity, students should be able to: — explain what the nature of variation consists in — distinguish between genetic and environmental variation — define phenotype — describe the differences between continuous and discontinuous variation — present examples of both types of variation
	Reproduction and variation	At the end of this activity, students should be able to: — define a clone — explain why simple and mitotic divisions lead to the formation of clones — explain how genetic recombination occurs during meiosis — explain the significance of genetic variation within a species.
	Mutations as a source of variation in organisms	At the end of this activity, students should be able to: — define mutation — present the significance of mutations in somatic and reproductive cells — define mutagens and present examples.
XVI. Heredity	Heredity according to Mendel	At the end of this activity, students should be able to: — define genotype, phenotype, gene, allele –discuss Mendel's first and second laws — use a Punnett square.
	The principles of sex inheritance in humans	At the end of this activity, students should be able to: — discuss sex inheritance — define sex-linked and sex-influenced traits — name the disorders related to abnormalities in the number of sex chromosomes — define karyotype and describe the human karyotype.
	The chromosomal theory of inheritance	At the end of this activity, students should be able to: — discuss chromosomal inheritance — define linked genes — construct a chromosome map.
	Genetic diseases	At the end of this activity, students should be able to: — define mutation — discuss the causes of selected genetic diseases — construct a pedigree chart.
	Inheritance of blood groups in humans	At the end of this activity, students should be able to: — discuss the systems of blood grouping — describe the principles of blood group inheritance.
	Nucleic acids	At the end of this activity, students should be able to: — discuss the structures of DNA and RNA — describe the structure and function of mRNA, tRNA and rRNA.
	The gene as a structural and functional unit of DNA	At the end of this activity, students should be able to: — discuss the processes of transcription and translation — describe the regulation of transcription.
	Mutations as changes in DNA	At the end of this activity, students should be able to: — define point mutations and divide them into different categories — differentiate between point mutations and chromosomal aberrations — present examples of the effects of mutations and the methods by which the organism protects itself against them — describe the mutation occurring in the case of sickle-cell disease and its effects.
XVII. Evolution	The origin of life on Earth	At the end of this activity, students should be able to: — recognise the organic compounds that may arise in an abiotic environment — describe an experiment to confirm the synthesis of organic compounds in an abiotic

		environment — list the characteristics that distinguish living organisms from inanimate matter — describe the differences between the environmental conditions prevailing on Earth 4 billion years ago and now.
	Charles Darwin and the theory of evolution	At the end of this activity, students should be able to: — explain the consequences of the discovery of evolution and its mechanisms — explain how Darwin formulated his theory — explain the significance of Darwin's scientific discoveries.
	Laws of evolution and speciation	At the end of this activity, students should be able to: — describe the basic mechanisms and principles of evolution — describe the process of species formation.
	The history of life on Earth	At the end of this activity, students should be able to: — the evolution of living organisms occurred in changing conditions, usually different from those of the present day — present-day groups of organisms have been evolving for hundreds of millions of years — present-day species have developed over several millions of years.
	Human evolution	At the end of this activity, students should be able to: — indicate the major events in human evolution — indicate the most important achievements of human evolution — understand that human evolution from pre-human forms was a long and complex process — understand that the course of human evolution from pre-human forms has not been fully clarified to date — understand that the present evolution of the Homo sapiens is a cultural evolution.
XVIII. How we combat microorganisms and how we use them	Bacterial growth	At the end of this activity, students should be able to: — explain the concept of doubling time — indicate the factors affecting bacterial growth — define bacterial colony and explain how to estimate the number of bacteria in a culture on the basis of the number of colonies — present a bacterial growth curve for a batch culture — explain the principles of the chemostat.
	Protecting food from spoilage	At the end of this activity, students should be able to: — describe Pasteur's experiment to show the presence of bacteria in the air — name the factors that cause food spoilage — explain what pasteurization involves and give examples of pasteurized products — define sterilization and describe the methods of food sterilization — present some traditional methods for inhibiting the development of bacteria in food.
	Biotechnology past and present	At the end of this activity, students should be able to: — define biotechnology and present examples of past and present biotechnological processes — explain the significance of fermentation as a key biological process in biotechnology — present the main stages in the production of beer, yoghurt and hard cheeses — explain the importance of pasteurization in these processes — present generic names of the microorganisms taking part in these processes — describe single-celled protein and the substrates used in its production — describe the structure of a biofermenter and the differences between batch and continuous cultures.
	Industrial uses of bacteria	At the end of this activity, students should be able to: — explain the principle of the biological treatment of municipal wastewater — explain how wastewater is purified by the activated sludge method and the biofiltration method — define eutrophication and explain the biological method for the removal of nitrogen and phosphorus compounds — explain how biogas is produced — discuss the role of enzymes in biological washing powders — present the main stages of the industrial production of enzymes.
XIX. Genetic engineering	Genetic engineering and its applications in biotechnology	At the end of this activity, students should be able to: — explain the artificial recombination of DNA — demonstrate the significance of restriction enzymes in manipulating DNA — explain the term "vector", give examples and describe its properties from the perspective of genetic engineering — demonstrate the stages of obtaining the product of a given gene in the bacterial cell — give examples of biologically active proteins obtained by genetic engineering techniques — explain the basics of the polymerase chain reaction (PCR).
	Other applications of genetic engineering	At the end of this activity, students should be able to: — explain what the Southern blot technique involves

		— present the principles of operation of genetic probes and examples of their application — explain the term "genetic fingerprint" — explain the goal of the Human Genome Project.
	Genetic modification of organisms	At the end of this activity, students should be able to: — explain what selection involves — give examples of methods for the modification of crops — explain the terms genetically modified organisms, gene therapy, reproductive cloning and therapeutic cloning — describe the principal stages of organism cloning — give examples of the ethical problems arising from genetic modification of organisms.
XX. Living organisms and their environment	The individual and the population	At the end of this activity, students should be able to: — define species, individual and population, population size, range and density, reproduction rate and death rate — interpret a survivorship curve — distinguish between abiotic and biotic factors.
	Competition. Predation	At the end of this activity, students should be able to: — use the term competition — recognize the various results of competition — recognize the variety of relationships possible between competing species — use the term predation — recognize the various results of predation — recognize the variety of predator-prey relationships.
	Symbiosis	At the end of this activity, students should be able to: — use the term "symbiosis" correctly — recognise the different types of symbiotic associations — differentiate between the types of symbiotic associations — recognise the effects of symbiosis and their significance.
	Life on land	At the end of this activity, students should be able to: — notice the many adaptations to terrestrial life — identify the features that enable plants and animals to use the resources of the terrestrial environment.
	Life in water	At the end of this activity, students should be able to: — recognise the many adaptations necessary for life in water — identify features that enable animals to use the resources of the aquatic environment — recognise the similarities and differences in the adaptations of fish and whales to life in water.
	Adaptations of organisms to the environment	At the end of this activity, students should be able to: — describe the dynamic influence of environmental factors on adaptation — describe the range of adaptations and their categories — understand the causes of similar adaptations in unrelated groups of organisms — understand the significance of energy-saving adaptations — understand the adaptational significance of gathering and processing information.
	Different modes of feeding in mammals	At the end of this activity, students should be able to: — recognize the relationships between environmental factors and feeding-related adaptations in mammals — recognize the reasons for the development of different feeding-related adaptations in mammals — recognize the effects of different feeding-related adaptations in mammals — understand the value of feeding-related adaptations in mammals.
	Humans and environment	At the end of this activity, students should be able to: — describe the nature, range and uniqueness of the adaptations of humans to the environment — describe the relationship between the level of human existence and the state of natural resources — describe the effects of human activities on the natural environment — understand the dependency of humans on environmental resources and factors — understand that macroeconomic plans and calculations should take into consideration the effects of human activities on nature — understand the necessity to minimize the negative effects of human activities on nature.
	Environmental pollution	At the end of this activity, students should be able to: — understand the relationship between the introduction of substances, energy and species into the environment by man and the changes that they cause in the environment — understand the adverse effects of pollution on the standard of living of humankind — understand the adverse effects of pollution on all the components of the natural environment and the relationships that exist in it — understand the dependency of humankind on environmental resources and factors

		— understand why it is necessary to include the effects of human activity on nature in macroeconomic planning and accounting — understand why it is necessary to minimise the adverse effects of human activity on the environment.
	The greenhouse effect and the ozone hole	At the end of this activity, students should be able to: — describe how human activities cause global changes in the natural environment — describe the dependency of humans on environmental resources and factors — explain the necessity of taking into account the effects of human activities on the natural environment in macroeconomic plans and calculations — describe the necessity to minimize the adverse effects of humans on the natural environment — explain the difficulties in assessing the proportional effects of human activities and natural processes on the natural environment.
	Conservation of natural resources	At the end of this activity, students should be able to: — determine the range and pace of changes in the natural environment caused by humans — describe the importance of the conservation of natural resources for the continued existence of the natural environment and humankind — describe the measures for nature conservation — understand the relationship between the quality of human life and the degree of conservation of natural resources — understand the principle behind the conservation of natural resources by the protection of entire ecosystems — understand the need for long-term planning in the exploitation and economical use of natural resources.
XXI. The flow of energy and matter, information exchange	Ecosystem	At the end of this activity, students should be able to: — use the concepts of: ecosystem, biocenosis, biotope — recognize the abundance of connections between species inhabiting an ecosystem and their connections with the abiotic environment — recognize the mechanisms functioning within an ecosystem.
	Food chains	At the end of this activity, students should be able to: — use the terms: food chain, trophic level and food web — notice the abundance of potential interdependencies between species inhabiting one ecosystem — notice the abundance of pathways of energy flow and matter circulation in an ecosystem.
	Information in nature	At the end of this activity, students should be able to: — describe the different types of information about the environment that are vital for life — describe the modes of communication between individuals of the same species and different species — understand the significance of information about the environment for the survival and development of individuals (populations, species) — understand the significance of communication for the survival and development of an individual (population, species) — understand the significance of genetic information in nature.
	Biogeochemical cycles	At the end of this activity, students should be able to: — understand the inter-relationships between the elements of the ecosystem that take part in the natural cycles of matter.

UPPER PRIMARY
MATHEMATICS

CHAPTER	LESSON	DESCRIPTION
I. Using and applying Maths (1)	Solving word problems	At the end of this activity, students should be able to: — investigate and solve word problems in a range of contexts.
	Small steps	At the end of this activity, students should be able to: — divisibility — tell the difference in number between A and B — tell both the difference in number between A and B in numbers and in the number of times bigger or smaller — find the time needed to cover a given distance with at a given speed — find the distance if the time and speed are given — find the a percentage of a number.
	Explain and justify	At the end of this activity, students should be able to: — analyse the solution of the problem — on the basis of a given solution, answer any questions connected with it — solve problems connected with a given issue.
II. Numbers and the Number System (1)	Ordering decimals	At the end of this activity, students should be able to: — specify the place value of digits in whole numbers — specify the place value of digits in decimal numbers — compare two numbers — order decimal numbers.
	Fractions, ordering fractions	At the end of this activity, students should be able to: — write parts of a unit using fractions — write quotients using fractions — mark fractions on the number line — mark equivalent fractions on the number line — reduce fractions — extend fractions.
	Changing fractions into decimals and percentages	At the end of this activity, students should be able to: — recognise what a fraction is and what the notation of fractions is — present a part of a unit using fractions — write a quotient using a fraction — mark fractions and equivalent fractions on the number line — reduce and extend fractions.
	Negative numbers	At the end of this activity, students should be able to: — understand why negative numbers are necessary — locate negative numbers on the number line — add and subtract negative numbers on the number line — add and subtract negative numbers in context.
	Multiples, factors and powers	At the end of this activity, students should be able to: — recognise prime numbers and composite numbers — find the least common denominator and the greatest common numerator — reduce a fraction by the highest common factor of the numerator and the denominator.
	Triangular and square numbers	At the end of this activity, students should be able to: — understand what triangular numbers are and know their properties — understand what the square of a number is — understand what a square root is — find square roots.
	Rounding numbers	At the end of this activity, students should be able to: — understand and use the rules of rounding natural numbers — understand and use the rules of rounding decimals.

	Ratio and proportion	At the end of this activity, students should be able to: — write the ratio of two values — understand and use division into two parts in a given ratio — write the ratio of three values — understand and use division into three parts in a given ratio — solve simple problems connected with the ratio of two values — solve simple problems connected with a proportion.
	Written methods	At the end of this activity, students should be able to: — know and use the rules of:— adding and subtracting natural numbers using written methods — adding and subtracting decimals using written methods — multiplying natural numbers using written methods — multiplying decimals using written methods — dividing natural numbers using written methods.
	Calculator methods	At the end of this activity, students should be able to: — find, using a calculator, the results of four arithmetic operations — understand the need for using a calculator.
III. Algebra	Writing algebraic expressions	At the end of this activity, students should be able to: — understand the idea of an algebraic expression — use letters to denote numbers with definite properties — express a simple algebraic expression in words — write down the content of a simple sentence in the form of an algebraic expression.
	Simple operations on algebraic expressions	At the end of this activity, students should be able to: — understand what a monomial is — identify like terms — add like terms — multiply a monomial by a number — understand and apply commutativity of terms addition — understand and apply commutativity of terms multiplication — know what an algebraic sum is.
	Like terms	At the end of this activity, students should be able to: — take a common factor out of the brackets — multiply an algebraic sum by a number and a term — add and subtract algebraic sums — assemble like terms — cancel like terms.
	Simple linear equations	At the end of this activity, students should be able to: — understand what an equation is — form a linear equation with one unknown — solve a linear equation with one unknown — form a linear equation with one unknown for a simple practical problem — solve a simple practical problem using a linear equation with one unknown.
	Substituting into the formulas	At the end of this activity, students should be able to: — understand what a formula is — correctly substitute numbers into the formula — find the required magnitude according to the formula.
	Sequences	At the end of this activity, students should be able to: — recognise sequences that are formed by adding a fixed number, subtract a fixed number, multiply by a fixed number or divide by a fixed number — find consecutive terms of sequences of the above types.
	What a function is?	At the end of this activity, students should be able to: — complete tables of values of functions given in the form of mapping diagrams — draw mapping diagrams of functions given by data in tables — complete tables of values of functions given in the form of mapping diagrams — describe in words functions given in the form of mapping diagrams.
	Graph of a linear function	At the end of this activity, students should be able to: — draw graphs of linear functions y = ax with positive a.— determine the formula of a linear function from its graph.
IV. Space, shape and measures (1)	Lines and angles	At the end of this activity, students should be able to: — understand differences between lines, rays and segments — understand differences between circles and discs — know types of angles (acute, obtuse and reflex) — measure angles by using a protractor — draw angles of given measures

		— draw polygons of given numbers of sides.
	Mutual position of lines and interior angles in a triangle	At the end of this activity, students should be able to: — draw perpendicular lines using a set square — find the shortest path from a point to a line — draw parallel lines using a set square — draw parallel lines using a ruler and a set square — understand the notions of angles around a point and angles on a line— know about vertical angles — know the sum of angles in a triangle and apply this property in simple problems.
	Properties of shapes	At the end of this activity, students should be able to: — recognise and characterise equilateral triangles, isosceles triangles and scalene triangles — recognise and characterise acute triangles, right-angled triangles and obtuse triangles — draw a triangle of given lengths of its sides — recognise and characterise types of quadrilaterals: squares, rectangles, rhombuses, parallelograms, trapeziums and kites — recognise and characterise regular polygons — recognise and draw shapes that have reflection symmetry — recognise and draw shapes that have rotation symmetry of a given order.
	Transformations	At the end of this activity, students should be able to: — find reflection of simple shapes in a given line — rotate simple shapes around a given point using angles 90°, 180°, 270° — find images of figures in a translation by a given vector — find images of figures in a symmetry with respect to a given point.
	Angles in 2-D shapes	At the end of this activity, students should be able to: — know precise definitions of acute, right, obtuse and reflex angles — estimate measures of given angles — construct an exact copy of a given angle — check, using a compass, whether two angles are equal.
	Representations	At the end of this activity, students should be able to: — recognise some basic 3-D shapes such as cubes, cuboids, right prisms, pyramids and spheres — draw simple 3-D objects on triangular dotty paper — understand the meaning of front, side and top views of 3-D objects — reconstruct 3-D objects on the basis of their front, side and top views.
	Angles in 3-D shapes	At the end of this activity, students should be able to: — describe cubes, cuboids, right prisms — recognise parallel faces in cubes, cuboids, right prisms and in their nets — recognise perpendicular faces in cubes, cuboids, right prisms and in their nets — recognise parallel edges in cubes, cuboids, right prisms and in their nets — recognise perpendicular edges in cubes, cuboids, right prisms and in their nets
	Coordinates	At the end of this activity, students should be able to: — find coordinates of points in the coordinate system — mark points of given coordinates in the coordinate system.
	Measurements	At the end of this activity, students should be able to: — choose reasonable units to measure lengths of various objects — convert length expressed in one unit into another.
	Area of rectangles	At the end of this activity, students should be able to: — compute perimeters of squares and rectangles — compute areas of squares and rectangles.
	Surface area	At the end of this activity, students should be able to: — compute the surface area of a cube — compute the surface area of a cuboid.
V. Handling data	Data planning and collecting	At the end of this activity, students should be able to: — understand the need for collecting data — read data from diagrams and tables.
	Data reporting	At the end of this activity, students should be able to: — order data — write down the results of a statistical enquiry.
	Averages	At the end of this activity, students should be able to:

		— point out the mode — find the median — find the arithmetic mean — find the range.
	Comparing data	At the end of this activity, students should be able to: — order integers and decimals — compare integers and decimals — compare the mode and the median — compare the arithmetic mean and the mode — compare the arithmetic mean and the median.
	ITC and data handling	At the end of this activity, students should be able to: — understand the necessity to use ITC while handling data — use ITC while handling data — interpret charts and diagrams.
	Probability scale	At the end of this activity, students should be able to: — write all the results of a random experiment — understand what certain and impossible events are — understand the notion of probability and the probability scale from 0 to 1 — understand what equally probable results are — know the way to find the probability connected with an uncomplicated random experiment whose results are equally probable.
	Probability of events in simple experiments	At the end of this activity, students should be able to: — find probability connected with an uncomplicated random experiment whose outcomes are all equally likely.
VI. Using and applying Maths (2)	Solving word problems	At the end of this activity, students should be able to: — perform the operations in the set of rational numbers — add, subtract, multiply and divide rational numbers — find a percentage of a number — solve slightly more complicated problems.
	Small steps	At the end of this activity, students should be able to: — analyse data — solve complex problems using the method of small steps.
	Using ITC in calculations	At the end of this activity, students should be able to: — understand the need to use the ITC and its benefits while solving complex problems.
VII. Numbers and the Number System (2)	Multiplication and division of integers by fractions	At the end of this activity, students should be able to: — multiply a fraction by an integer — divide an integer by a fraction.
	Ordering decimals on a number line	At the end of this activity, students should be able to: — show a greater or smaller decimal in a pair according to the given examples — mark decimals in the correct order on a number line.
	Rounding numbers	At the end of this activity, students should be able to: — round numbers to any power of 10 — round numbers to the nearest integer — round decimals to 0.1 — round decimals to 0.01.
	Numbers	At the end of this activity, students should be able to: — add integers — subtract integers — multiply integers — divide integers.
	Multiples, factors and powers	At the end of this activity, students should be able to: — indicate prime and composite numbers — factorise composite numbers into prime factors — find the highest common factor — find the least common denominator — write numbers as products of powers.
	Squares and square roots, cubes and cube roots	At the end of this activity, students should be able to: — in simple cases find, mentally, squares and square roots — in simple cases find, mentally, cubes and cube roots

		— be able to determine that a given integer is not a square of another integer; is not a cube of another integer — understand index notation and be able to use it in simple cases.
	Recurring decimals	At the end of this activity, students should be able to: — indicate common fractions that can be changed into terminating decimals — change common fractions into terminating decimals using a calculator — change common fractions into terminating decimals — indicate periods of non-terminating decimals — understand and use the method of changing non-terminating decimals into common fractions.
	Adding and subtracting fractions	At the end of this activity, students should be able to: — write fractions with a common denominator — add fractions and subtract with different denominators — solve simple practical problems connected with adding and subtracting fractions.
	Multiplication and division of integers by fractions	At the end of this activity, students should be able to: — multiply a fraction by an integer — divide an integer by a fraction.
	Percentages	At the end of this activity, students should be able to: — understand what a percentage is — know that a per cent is one hundredth part — be able to calculate what percentage of one number another number is.
	Ratio and proportion	At the end of this activity, students should be able to: — identify quantities of the same kind — write the ratio of two quantities — reduce a proportion to its simplest form — understand the connection between a proportion and a fraction — do more difficult calculations involving proportion, reducing data to common measurements.
	Mental methods	At the end of this activity, students should be able to: — perform simple calculations on fractions, mentally — perform simple calculations on decimals and per cents, mentally.
	Written methods	At the end of this activity, students should be able to: — understand the rules of written addition, subtraction, multiplication and division — use them in practice.
	Calculator methods	At the end of this activity, students should be able to: — know how to use a simple calculator — calculate percentages — calculate the volume of a cuboid.
VIII. Algebra	Letter symbols in formulas	At the end of this activity, students should be able to: — understand the meaning of letters in equations, formulas and functions — see connections between operations on letters and on numbers.
	Transformation of algebraic expressions	At the end of this activity, students should be able to: — find similar terms — factor out the common factor — simplify and transform algebraic expressions.
	Simple linear equations	At the end of this activity, students should be able to: — write simple linear equations with unknowns on both sides of the equation — solve simple linear equations with unknowns on both sides of the equation — solve mentally simple linear equations with unknowns on both sides of the equation.
	Solving equations using graphs	At the end of this activity, students should be able to: — draw graphs of linear equations with two unknowns — find the equation of the given graph.
	Formula based calculations	At the end of this activity, students should be able to: — know how to enter data into formulas — calculate the searched value from the general formula.
	Notation of simple sequences	At the end of this activity, students should be able to: — construct simple sequences of numbers — write simple sequences of numbers.

	Sequences based on rules	At the end of this activity, students should be able to: — write simple sequences of numbers — construct simple sequences term after term — construct simple sequences in a settled order.
	The nth term of a sequence	At the end of this activity, students should be able to: — calculate the nth term of a sequence, according to the given formula — write the formula for the nth term of a sequence.
	Reading graphs of linear functions	At the end of this activity, students should be able to: — draw graphs of linear functions y = ax for any a — draw graphs of linear functions y = ax + b for any a and b — understand the concepts of gradient and intercept.
	Linear functions and their graphs in real life	At the end of this activity, students should be able to: — use linear functions in simple real-life situations — read some realistic information from graphs.
XIX. Space, shape and measures	Angles in triangles and quadrilaterals	At the end of this activity, students should be able to: — recognise vertical, complementary, corresponding and alternate angles — calculate the sizes of different angles — find the sizes of different angles of triangles — find the sizes of different angles of quadrilaterals.
	Angles in simple polygons	At the end of this activity, students should be able to: — attach known measures of angles in a triangle according to the lengths of the sides of the triangle — find measures of angles in a parallelogram — find measures of angles in a trapezoid.
	Symmetry and congruency	At the end of this activity, students should be able to: — use properties of isosceles triangles to solve problems involving angles and sides — recognise congruent triangles by applying properties of congruent figures.
	Representations	At the end of this activity, students should be able to: — draw front and side elevations and plans of simple shapes — construct simple shapes from their front and side elevations and plans.
	Transformations	At the end of this activity, students should be able to: — reflect, rotate and translate 2-D shapes — enlarge 2-D shapes using a whole-number scale factor and centre of enlargement.
	Coordinates of midpoints of line segments	At the end of this activity, students should be able to: — mark points and figures in a coordinate system — mark the sets of points satisfying given conditions in a coordinate system — find the midpoint of a segment, given the end points.
	Properties of 2-D shapes	At the end of this activity, students should be able to: — recognise and name various 2-D shapes — identify simple properties of 2-D shapes.
	Ruler-and-compass constructions	At the end of this activity, students should be able to: — construct an equilateral triangle — construct the perpendicular bisector of a given segment — construct a line perpendicular to a given line through a point on the line — construct a line perpendicular to a given line from a point off the line — construct a line parallel to a given line.
	Drawing simple shapes using ITC	At the end of this activity, students should be able to: — use LOGO programs to draw simple shapes — use graphic calculators to draw and transform shapes.
	Measurements in real life	At the end of this activity, students should be able to: — use metric and basic Imperial units to measure length and area — compare and estimate measures — use the relationship between metric and Imperial measures.
	Areas of polygons	At the end of this activity, students should be able to: — calculate the area of a triangle, a parallelogram and a trapezium

		— calculate the area of a given (simple) polygon as a sum of its parts.
	Surface area and volume of cuboids	At the end of this activity, students should be able to: — understand the notion of volume — calculate the volume of a cuboid — understand the notion of surface area — calculate the surface area of a cuboid.
X. Handling data (2)	Data planning and collecting	At the end of this activity, students should be able to: — plan research and collect data depending on the researched quality — present the collected data as statistical series and frequency tables.
	Data processing	At the end of this activity, students should be able to: — present data as series of individual values — group data — present data as tables of cardinality — present data as frequency tables.
	Using ITC for data presentation	At the end of this activity, students should be able to: — construct on paper and using ITC pie charts, bar charts, simple line graphs and simple scatter diagrams.
	Comparison of two simple data distributions	At the end of this activity, students should be able to: — use one parameter: mean, median, modal value or range to compare two simple distributions — use pairs of parameters: mean, median, modal value or range to compare two simple distributions.
	The vocabulary of probability	At the end of this activity, students should be able to: — know fundamental terms relating to probability — be able to recognise certain and impossible events — understand probability scale
	Probability experiments	At the end of this activity, students should be able to: — understand what a sampling with replacement and sampling without replacement are — calculate the probability of an event in a sampling with replacement experiment — calculate the probability of an event in a sampling without replacement experiment — recognise more, equally and less probable events.
XI. Using and applying Maths (3)	Solving word problems	At the end of this activity, students should be able to: — use simple linear equations to solve word problems — solve problems using proportions and ratios — apply HCF and LCM in complex problems.
	Small steps	At the end of this activity, students should be able to: — solve word problems connected with 2-D geometry — solve word problems connected with 3-D geometry.
	Explain and justify	At the end of this activity, students should be able to: — solve problems involving perimeters and areas using ITC — read information from a graph using ITC.
XII. Numbers and the Number System (3)	Place value	At the end of this activity, students should be able to: — understand what a power of 10 with a natural exponent is — understand what a power of 10 with a negative exponent is — multiply powers of 10 — divide powers of 10 — write a decimal as a power of 10.
	Rounding to decimal places	At the end of this activity, students should be able to: — round a number, accurate to any required decimal place — recognise more and less accurate rounding — find decimals having equal rounding, accurate to any required decimal place.
	Numbers	At the end of this activity, students should be able to: — find square and cube roots by prime factorisation of the radicand — factor out the radical.
	Multiples, factors and powers	At the end of this activity, students should be able to: — find on the graph of the functions x2 and x3 the values of the square and the cube of a number — find on the graph of the functions ?x and 3?x the values of the square root and the cube root of a number

		— find the square and the cube of a given number using a calculator, giving the result rounded to any stated decimal place.
	Squares and square roots, cubes and cube roots	At the end of this activity, students should be able to: — understand the laws of operations on the exponents of powers — understand what a fractional exponent is — use in simple cases the laws of operations on the exponents of powers.
	Working with recurring decimals	At the end of this activity, students should be able to: — recognise recurring decimals — write recurring decimals — change common fractions into recurring and terminating decimals, using a calculator — change common fractions into periodic and terminating decimals, using written methods.
	Operations on fractions	At the end of this activity, students should be able to: — perform operations on expressions containing both fractions and decimals — find the exact values of expressions with common fractions and decimals — solve problems requiring finding values of expressions with common fractions and decimals.
	Percentages	At the end of this activity, students should be able to: — know what percentage increases or decreases are — be able to solve problems relating to percentage changes.
	Ratio and proportion	At the end of this activity, students should be able to: — divide values into a given ratio — apply ratios in calculation of percentages — write and solve equations involving ratio and proportion.
	Mental methods	At the end of this activity, students should be able to: — know the order of operations in an algebraic expression — be able to calculate mentally the value of expression consisting of various operations.
	Written methods	At the end of this activity, students should be able to: — add and subtract decimals using written methods of calculation — multiply and divide decimals by integers using written methodsof calculation — multiply and divide by decimals using written methods of calculation.
	Calculator methods	At the end of this activity, students should be able to: — understand the need for using brackets in calculations on the calculator — use the calculator for more complicated operations.
XIII. Algebra (3)	Letter symbols in equations, formulas and functions	At the end of this activity, students should be able to: — recall and use commutative and distributive properties — transform formulas — convert a linear equation with two unknowns to the form of the equation of a straight line — recognise a quadratic equation — find solutions of simple quadratic equations.
	Simple examples of index laws	At the end of this activity, students should be able to: — understand the rules relating to the exponents of powers whose bases are algebraic expressions and be able to use these rules in practice in simple cases — understand the binomial formula and be able to use it in practice in simple cases.
	Transformation of algebraic equations	At the end of this activity, students should be able to: — multiply linear expressions using different methods — simplify and transform simple quadratic equations — solve simple quadratic equations.
	Composing and solving linear equations	At the end of this activity, students should be able to: — write and solve linear equations with the unknown on one side and on both sides of the equation, with and without brackets — transform equations.
	Simplification of equations	At the end of this activity, students should be able to: — transform linear equations with the unknown on one side and on both sides of the equation, with and without brackets, to the form ax = b or b = ax — solve linear equations efficiently.
	Working with functions	At the end of this activity, students should be able to: — derive a function from observations and equations — understand what changing the subject means and use it to construct new functions from the given ones.

	General term of a sequence	At the end of this activity, students should be able to: — generate terms of simple number sequences defined by a general rule or recursively.
	The expression for the nth term	At the end of this activity, students should be able to: — write the expression for the nth term for simple terms.
	Linear functions	At the end of this activity, students should be able to: — find the inverse function to a given linear function — plot the diagram of the inverse function to a simple linear function.
	Graphs and functions	At the end of this activity, students should be able to: — plot the diagram of a linear function — recognise the type of a linear function from its diagram.
	Graphs	At the end of this activity, students should be able to: — model simple linear real-life phenomena using linear functions.
XIV. Space, shape and measures (3)	Interior and exterior angles in polygons	At the end of this activity, students should be able to: — recognise interior angles of a polygon — recognise exterior angles of a polygon — understand and know the sum of the interior angles in of a polygon — understand and know the sum of the exterior angles of a polygon.
	Problems involving properties of angles and parallel lines	At the end of this activity, students should be able to: — recognise corresponding and alternate angles between two parallel lines intersected by a transversal — use properties of angles to solve problems — infer from properties of angles related to parallel lines.
	Symmetry and congruency	At the end of this activity, students should be able to: — use line symmetry for triangles — understand what point symmetry is — use point symmetry for triangles — understand the term 'congruency of figures'.
	Circle properties	At the end of this activity, students should be able to: — understand what a circle is — understand and be able to use terms relating to a circle — construct simple polygons inscribed in a circle.
	Representations	At the end of this activity, students should be able to: — distinguish between various prisms and their nets — draw a prism on squared paper.
	Transformations	At the end of this activity, students should be able to: — find the image of a shape in two different transformations on the plane — understand combined transformations.
	Enlargements	At the end of this activity, students should be able to: — draw an enlargement of 2-D shapes given a centre of enlargement and a whole-number scale factor.
	Scale drawing	At the end of this activity, students should be able to: — interpret data from maps and plans — calculate distances in accordance with the scale of a map.
	Ruler-and-compass constructions	At the end of this activity, students should be able to: — construct a square and a rectangle — construct a rhombus — construct the centre of a circle — construct an angle bisector — construct a line of symmetry of two given symmetrical shapes — construct a point of symmetry of two given symmetrical shapes.
	The transformed point's image	At the end of this activity, students should be able to: — determine the position of a point that moves according to a simple given rule.
	Changing units	At the end of this activity, students should be able to: — perform calculations relating to the metric unitsof area and volume.

	Areas of rectangles	At the end of this activity, students should be able to: — show on a drawing the relationship between distance, speed and time — use drawings and graphs to solve problems relating to speed, distance and time.
	Circumference of a circle	At the end of this activity, students should be able to: — understand and use the formula for the circumference of a circle — know what the number ? is — perform calculations relating to the circumference of a circle.
	The area of a circle	At the end of this activity, students should be able to: — understand and use the formula for the area of a circle — perform calculations relating to the area and circumference of a circle — write down an exact result.
	Surface area and volume of regular polyhedrons	At the end of this activity, students should be able to: — name a prism — calculate the volume of a prism — calculate the surface area of a prism — apply the volume and surface area formulas to solve problems.
XV. Handling data	Interpretation of collected data	At the end of this activity, students should be able to: — recognise misleading diagrams — read statistics diagrams with caution.
	Usage of secondary data	At the end of this activity, students should be able to: — name different sources of secondary data — recognise advantages and disadvantages of secondary data — use secondary data for investigation.
	Using ITC for comparing data	At the end of this activity, students should be able to: — draw a time series — look for a correlation based on a scatter diagram — recognise basic types of correlation — draw a line of best fit according to the eye.
	Comparing two simple distributions using charts	At the end of this activity, students should be able to: — compare data using measures of central tendency — compare data using their range.
	Presentation and interpretation of a statistical enquiry	At the end of this activity, students should be able to: — conduct a simple statistical investigation — draw conclusions from data.
	An application of the vocabulary of probability	At the end of this activity, students should be able to: — understand and use vocabulary relating to probability.
	Experimental and theoretical probabilities	At the end of this activity, students should be able to: — understand the difference between frequency and probability — calculate probability in random experiments, in which all results are equally probable.

SCIENCE

CHAPTER	LESSON	DESCRIPTION
I. **Life processes and Cell Functions**	Animal and plant cells	At the end of this activity, students should be able to: — know that animal and plant cells form tissues and that tissues form organs — understand the functions of chloroplasts and cell walls in plant cells — understand the functions of the cell membrane, cytoplasm and nucleus in both animal and plant cells.
	Flowering plants organs	At the end of this activity, students should be able to: — understand the functions of the four main plant organs — know that fertilisation in plants is the fusion of a male and a female cell; - be aware of ways in which seeds are dispersed by plants.
	Special cells	At the end of this activity, students should be able to: — understand the ways in which some cells are adapted to their functions — give examples of specialised cells in both animals and plants — know some of the features of ciliated epithelial cells, sperm, ova and root hair cells.
	Human organ systems	At the end of this activity, students should be able to: — explain the functions of human organ systems — know which organs belong to given systems — relate functions to organs and organ systems.
	Life processes	At the end of this activity, students should be able to: — name the seven life processes carried out by all living organisms — relate cells and cell functions to life processes in a variety of organisms.
II. Humans as organisms	Nutrition: a balanced diet	At the end of this activity, students should be able to: — understand what is meant by a balanced diet — know which foods are good sources of carbohydrates, proteins, fats, vitamins, minerals, fibre and water — explain why each of these seven food groups is important for health.
	Respiration	At the end of this activity, students should be able to: — understand that aerobic respiration involves a reaction in cells between oxygen and glucose, in which the glucose is broken down into carbon dioxide and water — summarise aerobic respiration in a word equation — know how the substances involved in respiration are transported through the bloodstream.
	Drugs and health	At the end of this activity, students should be able to: — know the main types of illegal drugs — understand how drug abuse affects health — be aware of the dangers of the most common drugs of abuse.
	Fighting disease	At the end of this activity, students should be able to: — explain how the growth and reproduction of bacteria and the replication of viruses can affect health — understand how the body's natural defences may be enhanced by immunisation and medicines.
	Digestion	At the end of this activity, students should be able to: — understand the principles of digestion, including the role of enzymes in breaking down large molecules into smaller ones — know how food is used as a fuel during respiration to maintain the body's activity and as a raw material for growth and repair — describe the role of the main organs of the human digestive system.
	Absorption and waste	At the end of this activity, students should be able to: — describe how the products of digestion are absorbed into the bloodstream and transported throughout the body

		— understand the role of the kidneys in the removal of waste — explain how egestion takes place in humans.
	The skeleton and movement	At the end of this activity, students should be able to: — describe the role of the skeleton and the joints — understand the principle of antagonistic muscle pairs — know how movement is produced in the body.
	Adolescence	At the end of this activity, students should be able to: — describe the physical changes that happen during puberty — know what changes take place in both girls and boys during adolescence — be aware of the emotional changes that happen during this period of development.
	Human reproduction	At the end of this activity, students should be able to: — describe the male and female reproductive system — understand the menstrual cycle — know how fertilisation takes place in humans.
	Development of the foetus	At the end of this activity, students should be able to: — describe how the foetus develops in the uterus — understand the role of the placenta — know how birth takes place
	Breathing	At the end of this activity, students should be able to: — describe the role of lung structure in gas exchange — understand the mechanism of breathing — know the differences between inhaled and exhaled air.
	Smoking	At the end of this activity, students should be able to: — describe the effects of smoking on the body — know how smoking affects a foetus — know the chemicals found in cigarette smoke and the health problems associated with them.
III. Green Plants as Organisms	Plant nutrition	At the end of this activity, students should be able to: — understand how plants need carbon dioxide, water and light for photosynthesis, and produce biomass and oxygen — summarise photosynthesis in a word equation.
	Factors affecting photosynthesis	At the end of this activity, students should be able to: — know how light, water, temperature and carbon dioxide levels affect photosynthesis — describe how to test for the four factors listed above.
	Plant growth	At the end of this activity, students should be able to: — explain how nitrogen and other elements, as well as carbon, oxygen and hydrogen, are required for plant growth — understand the role of root hairs in absorbing water and minerals from the soil.
	Respiration in plants	At the end of this activity, students should be able to: — explain how plants carry out aerobic respiration — know the word equation for plant respiration.
IV. Variation, Classification and Inheritance	Variation	At the end of this activity, students should be able to: — describe the nature of variation between organisms — know what is meant by continuous and discontinuous variation.
	Causes of variation	At the end of this activity, students should be able to: — be able to describe environmental and inherited causes of variation — know some types of human variation that can be attributed to genetic and environmental factors — be aware of the main causes of variation in plants.
	Classification	At the end of this activity, students should be able to: — classify organisms into the major taxonomic groups — name examples of organisms from each main taxonomic group.
	Inheritance	At the end of this activity, students should be able to: — be able to explain how selective breeding can lead to new varieties of animals and plants — understand what inherited characteristics are — know the role played by genes in inheritance.

V. Living things in their environment	Sustainable development	At the end of this activity, students should be able to: — understand what is meant by sustainable development — know some of the ways in which living organisms and the environment can be protected — be able to describe an example of sustainable development.
	Habitats	At the end of this activity, students should be able to: — know that habitats support a diversity of plants and animals — be able to give examples of the types of organisms that are found in particular habitats — understand the ways in which habitats vary, and the types of features found in them and how these affect organisms.
	Adaptation	At the end of this activity, students should be able to: — describe the ways in which organisms are adapted to survive in their different habitats — explain how plants and animals are adapted to daily changes in their habitats — explain the ways in which organisms are adapted to seasonal changes in their habitats.
	Survival	At the end of this activity, students should be able to: — know how competition affects the size of populations — understand how predation affects the populations of species — understand the relationship between populations of predators and prey.
	Food chains	At the end of this activity, students should be able to: — use the basic terminology associated with food chains — describe how food chains can be quantified using pyramids of numbers — describe how toxic substances can accumulate in food chains.
	Food webs	At the end of this activity, students should be able to: — understand how food webs are composed of several food chains — know how to interpret a food web diagram — understand the terminology of food webs — describe the effect of changes in the population of a single organism in a food web.
VI. Grouping and classifying materials	Solids, liquids and gases	At the end of this activity, students should be able to: — describe the three states of matter — understand the differences between the properties of solids, liquids and gases — explain these differences in terms of particle theory.
	Separating mixtures	At the end of this activity, students should be able to: — explain the ways in which mixtures can be separated into their constituents in a number of ways — explain how distillation, filtration, evaporation and chromatography can be used to separate different types of mixtures.
	Particle theory	At the end of this activity, students should be able to: — describe the particle theory of matter in simple terms — use particle theory to explain the properties of solids, liquids and gases.
	Physical changes	At the end of this activity, students should be able to: — describe what is meant by changes in state — describe how changes in state occur and how they can be reversed — explain gas pressure and diffusion in simple terms.
	Elements	At the end of this activity, students should be able to: — understand the nature of elements — know how elements are shown in the periodic table — understand that elements consist of atoms which can be represented by symbols.
	Properties of metals	At the end of this activity, students should be able to: — describe the appearance, state at room temperature, magnetic properties and thermal and electrical conductivities of metals — describe some of the other properties of metals, such as malleability and density.
	Properties of non-metals	At the end of this activity, students should be able to: — describe the appearance, state at room temperature, magnetic properties and thermal and electrical conductivity of non-metals — describe some of the other properties of non-metals, such as strength and density.
	Compounds	At the end of this activity, students should be able to: — understand how elements combine through chemical reactions to form compounds — give the names of some well known compounds — understand that compounds are not simply mixtures of substances.

	Names of compounds	At the end of this activity, students should be able to: — represent compounds by formulae — understand how chemical reactions can be summarised by word equations.
	Mixtures	At the end of this activity, students should be able to: — explain how mixtures are composed of constituents that are not combined — give the names of some mixtures — describe the properties of mixtures and how mixtures differ from elements and compounds.
VII. Changing metals	Physical changes in materials	At the end of this activity, students should be able to: — explain how mass is conserved when physical changes take place — relate the changes of state to energy transfer.
	Solutions	At the end of this activity, students should be able to: — explain how solubility varies with temperature — define a saturated solution — describe the differences in the solubility of solutes in different solvents.
	Geological changes: weathering	At the end of this activity, students should be able to: — describe three ways in which weathering of rocks takes place — explain how the forces generated by expansion, contraction and the freezing of water can cause weathering — describe some ways in which biological and chemical weathering take place.
	Rock formation	At the end of this activity, students should be able to: — explain the processes of rock formation, which take place over different timescales — explain how the mode of rock formation determines the texture and mineral content of a rock — describe, in simple terms, how igneous rocks, sedimentary rocks, and metamorphic rocks are formed.
	Chemical reactions	At the end of this activity, students should be able to: — understand how mass is conserved when chemical reactions take place — explain that virtually all materials, including those in living systems, are formed by chemical reactions,- recognise the importance of chemical reactions in everyday situations.
	The effects of combustion	At the end of this activity, students should be able to: — explain the effects of burning fossil fuels on the environment — describe how the effects of pollution from combustion can be minimised.
VIII. Patterns of behaviour	The reactivity of metals	At the end of this activity, students should be able to: — describe how metals react with oxygen, water and acids — name the products of these reactions.
	Displacement reactions	At the end of this activity, students should be able to: — explain what is meant by a displacement reaction — give an example of a displacement reaction between a metal and a solution of a salt of another metal — understand the reactivity series.
	Acids and alkalis	At the end of this activity, students should be able to: — describe the properties of acids and alkalis,- use indicators to classify solutions as acids, neutral or alkalis — understand how acidity is measured using the pH scale.
	Acid reactions	At the end of this activity, students should be able to: — describe how acids react with metals, bases and carbonates — name the products of these reactions — explain how acids can corrode metal and cause chemical weathering of rocks.
	Neutralisation	At the end of this activity, students should be able to: — explain the process of neutralization — describe some everyday applications of neutralisation.
IX. Electricity	Electrical circuits	At the end of this activity, students should be able to: — describe an electric circuit — explain how current and voltage are measured — describe how energy is transferred from batteries and other sources to the components in electric circuits.
	Series and parallel circuits	At the end of this activity, students should be able to: — design and construct a parallel and a series circuit

		— explain how current flows in a series and a parallel circuit.
	Electric current	At the end of this activity, students should be able to: — describe how the current in a series circuit depends on the number of cells and the number and nature of other components — explain that current is not 'used up' by components.
	Magnets	At the end of this activity, students should be able to: — explain what is meant by magnetic fields — describe how magnetic materials experience forces in magnetic fields — explain that opposite poles attract and like poles repel.
	Electromagnets	At the end of this activity, students should be able to: — explain how a current in a coil produces a magnetic field pattern — describe how electromagnets are constructed — give some examples of uses of electromagnets.
X. Forces and motion	Speed	At the end of this activity, students should be able to: — determine the speed of a moving object — use the triangular relationship between speed, distance and time.
	Weight	At the end of this activity, students should be able to: — explain how the weight of an object is the result of the gravitational attraction between the mass of the object and the mass of the Earth — explain the difference between weight and mass.
	Balanced and unbalanced forces	At the end of this activity, students should be able to: — explain how unbalanced forces change the speed or direction of movement of objects,-describe how balanced forces produce no change in the movement of an object.
	Friction	At the end of this activity, students should be able to: — explain how frictional forces, including air resistance, affect motion — describe how the balance between frictional forces affects the movement and direction of an object — give examples of the uses of friction ways when driving a vehicle.
	Force and rotation	At the end of this activity, students should be able to: — explain how forces cause objects to turn around a pivot — draw force arrows on diagrams that show levers being used.
	Moment	At the end of this activity, students should be able to: — explain the principle of moment — carry out calculations involving moment.
	Pressure	At the end of this activity, students should be able to: — explain the quantitative relationship between force, area and pressure — give examples of the applications of increased and decreased pressure.
XI. Light and sound	Light	At the end of this activity, students should be able to: — describe how light travels in a straight line at a finite speed in a uniform medium — explain how we see non-luminous objects because light scattered from them enters our eyes.
	Reflection	At the end of this activity, students should be able to: — understand how mirrors work and give examples of the uses of mirrors — describe the paths of reflected light — describe how a periscope works — draw a reflection diagram — describe how light is reflected off different types of surface.
	Refraction	At the end of this activity, students should be able to: — describe how light travels at different speeds in different materials — describe how refraction works — give examples of refraction — draw a refraction diagram.
	Colour	At the end of this activity, students should be able to: — explain how white light can be dispersed to give a range of colours — explain how coloured filters affect white light — describe the appearance of coloured objects in white light and in other colours of light.

	Sound	At the end of this activity, students should be able to: — compare the ways in which sound and light travel, and their speeds — explain the relationship between the loudness of a sound and the amplitude of the vibration causing it — explain the relationship between the pitch of a sound and the frequency of the vibration causing it.
	Hearing	At the end of this activity, students should be able to: — explain how sound travels and how sound is caused by vibration — explain how sound causes the ear drum to vibrate — explain why different people have different audible ranges — describe the effects of loud sounds on the ear.
XII. The Earth and beyond	The movement of the Earth	At the end of this activity, students should be able to: — explain how the movement of the Earth causes the apparent daily movement of the Sun and stars — explain how long it takes the Earth to orbit the Sun — explain the phenomenon of seasons.
	The solar system	At the end of this activity, students should be able to: — describe the relative positions of the Earth, Sun and planets in the solar system — describe the movements of the planets around the Sun and relate these to gravitational forces — explain how the movement of the Earth causes the apparent movement of other bodies.
	The Sun	At the end of this activity, students should be able to: — describe the movement of the planets in the solar system — explain why the Sun and other stars are light sources — explain how the planets and other bodies are seen by reflected light.
	Satellites	At the end of this activity, students should be able to: — describe how the Moon orbits the Earth — explain how artificial satellites and probes observe the Earth and explore the solar system.
XIII. Energy resources and energy transfer	Energy	At the end of this activity, students should be able to: — describe the different forms of energy — describe the variety of energy resources — name examples of non-renewable energy resources — describe examples of renewable energy resources.
	Energy resources	At the end of this activity, students should be able to: — describe the Sun's role as the ultimate source of most of the Earth's energy — explain the Sun's role in the formation of fossil fuels — explain how the Sun's energy is transferred to renewable energy resources.
	Generating electricity	At the end of this activity, students should be able to: — describe how electricity is generated — explain the differences between renewable and non-renewable energy sources in terms of electricity generation.
	Heat and temperature	At the end of this activity, students should be able to: — explain the difference between temperature and heat — describe how differences in temperature can lead to the transfer of energy.
	Transfer of energy	At the end of this activity, students should be able to: — explain how energy can usefully be transferred and stored — describe how heat energy is transferred indirectly by conduction, convection and evaporation — explain how heat energy is transferred directly by radiation.
	Energy conservation	At the end of this activity, students should be able to: — explain what is meant by the conservation of energy — explain how energy is always conserved — describe how energy can be given out as useful energy and wasted energy.