

IB Standards of Physics Required

TOPIC	LEARNING OUTCOMES
Measurements	<ul style="list-style-type: none"> Describe the use of rules and measuring cylinders to determine a length or a volume Describe the use of clocks and devices for measuring an interval of time. Describe the use of a mechanical method for the measurement of a small distance measure and describe how to measure a short interval of time (including the period of a pendulum).
Distance, speed and acceleration	<ul style="list-style-type: none"> Define speed and calculate speed from $\frac{\text{total distance}}{\text{total time}}$ Plot and interpret a speed/time graph Recognise from the shape of a speed/time graph when a body is (a) at rest, (b) moving with constant speed, (c) moving with changing speed Calculate the area under a speed/time graph to determine the distance travelled for motion with constant acceleration Understand that acceleration is related to changing speed State that the acceleration of free fall for a body near to the Earth is constant Distinguish between speed and velocity Recognise linear motion for which the acceleration is constant and calculate the acceleration Recognise motion for which the acceleration is not constant Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity).
Forces	<ul style="list-style-type: none"> State that a force may produce a change in size and shape of a body. Plot extension/load graphs and describe the associated experimental procedure. Describe the ways in which a force may change the motion of a body. Find the resultant of two or more forces acting along the same line. State Hooke's Law and recall and use the expression $F = kx$. Interpret extension/load graphs. Recognise the significance of the term 'limit of proportionality' for an extension/load graph. Recall and use the relation between force, mass and acceleration (including the direction). Describe, qualitatively, motion in a curved path due to a perpendicular force ($F = mv^2/r$ is <i>not</i> required).
Turning Forces	<ul style="list-style-type: none"> Describe the moment of a force as a measure of its turning effect and recognise everyday examples Describe, qualitatively, the balancing of a beam about a pivot.

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	<ul style="list-style-type: none"> Describe an experiment (involving vertical forces) to verify that there is no net moment on a body in equilibrium. Apply the idea of opposing moments to simple systems in equilibrium. State that, when there is no resultant force and no resultant turning effect, a system is in equilibrium. Describe an experiment to determine the position of the centre of mass of a plane lamina. Describe qualitatively the effect of the position of the centre of mass on the stability of simple objects.
Vectors and Scalars	<ul style="list-style-type: none"> Demonstrate an understanding of the difference between scalars and vectors and give common examples. Add vectors by graphical representation to determine a resultant. Determine graphically a resultant of two vectors. Relate work done to the magnitude of a force and distance moved. Demonstrate an understanding that an object may have energy due to its motion or its position, and that energy may be transferred and stored. Give examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, internal, electrical, light and sound. Use the terms kinetic and potential energy in context. Recall and use the expressions $k.e. = \frac{1}{2}mv^2$ and $p.e. = mgh$. Apply the principle of energy conservation to simple examples. Recall and use work done = Fd = energy transformed. Describe energy changes in terms of work done. Relate power to work done and time taken. Recall and use the equation $P = E/t$ in simple systems. Describe how electricity or other useful forms of energy may be obtained from chemical energy stored in fuel, water, including the energy stored in waves, in tides and in water behind hydroelectric dams, geothermal resources
Reflection of light	<ul style="list-style-type: none"> Describe the formation, and give the characteristics, of an optical image by a plane mirror. Use the law angle of incidence = angle of reflection. Draw simple ray diagrams
Refraction of at plane surfaces	<ul style="list-style-type: none"> Describe an experimental demonstration of the refraction of light. Use the terminology for the angle of incidence i and angle of refraction r Describe the passage of light through parallel-sided transparent material Recall and use definition of refractive index n in terms of speed.

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	<ul style="list-style-type: none"> Recall and use the equation $\sin i / \sin r = n$. Describe internal and total internal reflection. Understand the meaning of critical angle. Describe the action of optical fibres.
Refraction in Converging Lenses	<ul style="list-style-type: none"> Describe the action of a thin converging lens on a beam of light. Use the terms principal focus and focal length. Draw ray diagrams to illustrate the formation of a real image by a single lens. Draw ray diagrams to illustrate the formation of a virtual image by a single lens. Use and describe the use of a single lens as a magnifying glass.
Dispersion of light	<ul style="list-style-type: none"> Describe the action on light of a glass prism. Give a qualitative account of the dispersion of light by a glass prism.
Kinetic theory of gases	<ul style="list-style-type: none"> State the distinguishing properties of solids, liquids and gases. Describe qualitatively the molecular structure of solids, liquids and gases. Relate the properties of solids, liquids and gases to the forces and distances between molecules and to the motion of the molecules. Interpret the temperature of a gas in terms of the motion of its molecules. Describe qualitatively the pressure of a gas in terms of the motion of its molecules. Describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume. Relate the change in volume of a gas to change in pressure applied to the gas at constant temperature. Recall and use the equation $pV = \text{constant}$ at constant temperature. Show an understanding of the random motion of particles in a suspension as evidence for the kinetic molecular model of matter. Describe this motion (sometimes known as Brownian motion) in terms of random molecular bombardment. Show an appreciation that massive particles may be moved by light, fast-moving molecules.
Evaporation	<ul style="list-style-type: none"> Describe evaporation in terms of the escape of more-energetic molecules from the surface of a liquid. Relate evaporation and the consequent cooling. Demonstrate an understanding of how temperature, surface area and draught over a surface influence evaporation.

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Expansion of solids, liquids and gases	<ul style="list-style-type: none"> Describe qualitatively the thermal expansion of solids, liquids and gases. Identify and explain some of the everyday applications and consequences of thermal expansion. Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure. Show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases.
Thermometers	<ul style="list-style-type: none"> Appreciate how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties. Recognise the need for and identify fixed points. Describe the structure and action of liquid-in-glass thermometers. Demonstrate understanding of sensitivity, range and linearity. Describe the structure of a thermocouple and show understanding of its use for measuring high temperatures and those which vary rapidly.
Thermal capacity and change of state	<ul style="list-style-type: none"> Relate a rise in temperature of a body to an increase in internal energy. Show an understanding of the term thermal capacity. Describe an experiment to measure the specific heat capacity of a substance. Describe melting and boiling in terms of energy input without a change in temperature. State the meaning of melting point and boiling point. Describe condensation and solidification. Distinguish between boiling and evaporation Use the term latent heat and give a molecular interpretation of latent heat. Describe an experiment to measure specific latent heats for steam and for ice.
Transfer of heat	<ul style="list-style-type: none"> Describe experiments to demonstrate the properties of good and bad conductors of heat. Give a simple molecular account of the heat transfer in solids. Relate convection in fluids to density changes and describe experiments to illustrate convection. Identify infra-red radiation as part of the electromagnetic spectrum. Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation. Identify and explain some of the everyday applications and consequences of conduction, convection and

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	radiation.
Wave properties	<ul style="list-style-type: none"> Describe what is meant by wave motion as illustrated by vibration in ropes, springs and by experiments using water waves. Use the term wavefront. Give the meaning of speed, frequency, wavelength and amplitude. Distinguish between transverse and longitudinal waves and give suitable examples. Describe the use of water waves to show <ol style="list-style-type: none"> reflection at a plane surface refraction due to a change of speed diffraction produced by wide and narrow gaps Give the meaning of the term wavefront. Recall and use the equation $v = f \times \lambda$. Interpret reflection, refraction and diffraction using wave theory.
Electromagnetic Waves	<ul style="list-style-type: none"> Describe the main features of the electromagnetic spectrum and state that all e-m waves travel with the same high speed <i>in vacuo</i>. State the approximate value of the speed of electromagnetic waves.
Sound	<ul style="list-style-type: none"> Describe the production of sound by vibrating sources. Describe the longitudinal nature of sound waves. State the approximate range of audible frequencies. Show an understanding that a medium is required in order to transmit sound waves. Relate the loudness and pitch of sound waves to amplitude and frequency. Describe how the reflection of sound may produce an echo. Describe compression and rarefaction. State the order of magnitude of the speed of sound in air, liquids and solids.
Electrostatics	<ul style="list-style-type: none"> Describe simple experiments to show the production and detection of electrostatic charges. State that there are positive and negative charges. State that unlike charges attract and that like charges repel. Describe an electric field as a region in which an electric charge experiences a force. Distinguish between electrical conductors and insulators and give typical examples. State that charge is measured in coulombs. State the direction of lines of force and describe simple field patterns.

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	<ul style="list-style-type: none"> • Give an account of charging by induction. • Recall and use the simple electron model to distinguish between conductors and insulators. • State that current is related to the flow of charge. • Use and describe the use of an ammeter. • Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q/t$. • Distinguish between the direction of flow of electrons and conventional current. • State that the e.m.f. of a source of electrical energy is measured in volts. • Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit. • State that the potential difference across a circuit component is measured in volts. • Use and describe the use of a voltmeter. • State that resistance = pd/current and understand qualitatively how changes in p.d. or resistance affect current. • Recall and use the equation $R = V/I$. • Describe an experiment to determine resistance using a voltmeter and an ammeter. • Relate (without calculation) the resistance of a wire to its length and to its diameter. • Recall and use quantitatively the proportionality between resistance and the length and the inverse proportionality between resistance and cross-sectional area of a wire. • Recall and use the equation $P = IV$ and $E = Ivt$.
Current electricity	<ul style="list-style-type: none"> • Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters, voltmeters, magnetising coils, transformers, bells, fuses, relays. • Understand that the current at every point in a series circuit is the same. • Give the combined resistance of two or more resistors in series. • State that, for a parallel circuit, the current from the source is larger than the current in each branch. • State that the combined resistance of two resistors in parallel is less than that of either resistor by itself. • Draw and interpret circuit diagrams containing diodes and transistors. • Recall and use the fact that the sum of the p.d.s. across the components in a series circuit is equal to the total p.d.s. across the supply. • Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit.

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	<ul style="list-style-type: none"> Calculate the effective resistance of two resistors in parallel. State the hazards of <ol style="list-style-type: none"> damaged insulation overheating of cables damp conditions Show an understanding of the use of fuses and/or circuit-breakers.
Magnets and electromagnetism	<ul style="list-style-type: none"> State the properties of magnets. Give an account of induced magnetism. Distinguish between ferrous and non-ferrous materials. Describe methods of magnetisation and of demagnetisation. Describe an experiment to identify the pattern of field lines round a bar magnet. Distinguish between the magnetic properties of iron and steel. Distinguish between the design and use of permanent magnets and electromagnets. Describe the pattern of the magnetic field due to currents in straight wires and in solenoids. State the qualitative variation of the strength of the magnetic field over salient parts of the pattern. Describe the effect on the magnetic field of changing the magnitude and direction of the current. Describe applications of the magnetic effect of current, including the action of a relay.
Atomic physics	<ul style="list-style-type: none"> Show awareness of the existence of background radioactivity. Describe the detection of alpha-particles, beta-particles and gamma-rays. State that radioactive emissions occur randomly over space and time. State, for radioactive emissions: <ol style="list-style-type: none"> their nature their relative ionising effects their relative penetrating abilities. Describe their deflection in electric fields and magnetic fields. Interpret their relative ionising effects State the meaning of radioactive decay, using equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted. Use the term half-life in simple calculations which might involve information in tables or decay curves.

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	<ul style="list-style-type: none"> Describe how radioactive materials are handled, used and stored in a safe way. Describe the structure of an atom in terms of a nucleus and electrons Describe how the scattering of alpha- particles by thin metal foils provides evidence for the nuclear atom. Describe the composition of the nucleus in terms of protons and neutrons. Use the term proton number (= atomic number), z, use the term nucleon number (= mass number), A, use the term nuclide and nuclide notation ${}_Z^AX$ <ul style="list-style-type: none"> Use the term isotope