Unit 1
Mechanics and radioactivity

An understanding of the principles in this unit and in the general requirements is expected in familiar and unfamiliar situations. In examination questions where the context is beyond the content of the specification it will be fully described.

Rectilinear motion

Unit	Topic	Content
1.1	• Distance, displacement, speed, velocity and acceleration. • Equations for uniformly accelerated motion in one dimension.	• Experimental study of uniformly accelerated motion, based on laboratory measurements of displacement and speed. • Measurement of the acceleration of free fall. A method involving a body in free fall is expected.
1.2	Displacement/time and velocity/time graphs and their interpretation, for motion with uniform and non–uniform acceleration.	Identify and use the physical quantities derived from the gradient and area of velocity/time graphs and the gradient of displacement/time graphs.
1.3	Projectiles.	• The independence of vertical and horizontal motion should be understood. • Numerical problems will involve either vertical or horizontal projection.

Forces and moments

Unit	Topic	Content
1.4	• Force interpreted as a push or a pull and identified as the push or pull of A on B. • Weight	• Familiarity with gravitational, electric, magnetic and nuclear forces; normal and frictional contact forces; viscous and drag forces; tension. • The gravitational pull of the Earth (or Moon, etc.) on an object. Weight = mg
1.5	Free-body force diagrams.	Use of free-body force diagrams to represent forces on a particle or on an extended but rigid body. Centre of gravity.
1.6	Newton's first law.	Bodies in equilibrium. Vector forces on body sum to zero.
1.7	Newton's third law.	Force pairs. A statement that the push or pull of A on B is always equal and opposite to the push or pull of B on A.
1.8	Moment of a force.	• Principle of moments. • Moment of F about O = F x (perpendicular distance from F to O). • For a rigid body in equilibrium, sum of clockwise moments about any point = sum of anticlockwise moments about that point. • Problems will only be set involving sets of parallel forces.
1.9	Density.	Typical values for solids, liquids and gases. Measurement of the density of solids, liquids and gases is expected. Application of p = m/V

Dynamics

Unit	Topic	Content
1.10	• Linear momentum. • Principle of the conservation of linear momentum.	• Momentum defined as $p = m \times v$ • Experimental study of conservation of linear momentum for collisions in one dimension only.
1.11	Newton's second law.	• Force and rate of change of momentum. • Resultant force as rate of change of momentum $F = \Delta p/\Delta t$ • Calculations will only be set in situations where mass is constant. • Impulse = change of momentum.
1.12	Acceleration, mass and force.	• Applications of $\Delta F = m \times a$ • Experimental investigation of uniformly accelerated motion where mass is constant.

Mechanical energy

Unit	Topic	Content
1.13	Work done and energy transfer	Work done = average applied force multiplied by the distance moved in the direction of the force. $\Delta W = F\Delta x$ Calculation of work done when force is not along the line of motion. Energy transfer when work is done.
1.14	• Kinetic energy. • Gravitational potential energy.	$k.e. = 1/2\ m \times v^2$ • Changes in gravitational potential energy close to the Earth's surface. $\Delta g.p.e. = m \times g \times \Delta h$
1.15	Principle of the conservation of energy.	Qualitative study and quantitative application of conservation of energy, including use of work done, gravitational potential energy and kinetic energy.
1.16	Power.	• Rate of energy transfer (or of work done). • $P = \Delta W/\Delta t$ • $P = F \times v$

Radioactive decay and the nuclear atom

Unit	Topic	Content
1.17	The existence and nature of radioactive emissions.	Sources of background radiation
1.18	Properties of alpha, beta (+ and -) and gamma radiation and corresponding disintegration processes.	Ionising properties of radiations linked to penetration and range. Experiments with sealed alpha and beta sources are expected
1.19	Stable and unstable nuclei.	• Nucleon number and proton number. • The balancing of nuclear equations. • Isotopes.
1.20	• Radioactivity as a random process. • Exponential decay: decay constant and half-life.	• Activity and the becquerel. • Activity = λN • The constant ratio property of exponential curves. • The use of e^x and loge x are not required. • $\lambda t_{1/2} = 0.69$ • The experimental determination or modelling of half-life.
1.21	• The nuclear atom. Evidence for the existence and size of nuclei. • Elastic scattering. • Deep inelastic scattering.	• Size of atoms. Relative size of nuclei. • Scattering as a means of probing matter. • Alpha particle scattering experiment in broad outline. • The use of electrons of high energy to reveal the structure of protons and neutrons. • A qualitative discussion of the processing and interpretation of data will be required.