Unit M1 Mechanics 1

GCE AS and GCE Mathematics, GCE AS and GCE Further Mathematics and GCE AS and GCE Further Mathematics (Additional) AS optional unit

M1.1 Unit description

Mathematical models in mechanics; vectors in mechanics; kinematics of a particle moving in a straight line; dynamics of a particle moving in a straight line or plane; statics of a particle; moments.

M1.2 Assessment information

Prerequisites	Students are expected to have a knowledge of C1, its preambles and associated formulae and of vectors in two dimensions.
Examination	The examination will consist of one 1½ hour paper. It will contain about seven questions with varying mark allocations per question which will be stated on the paper. All questions may be attempted.
Calculators	Students are expected to have available a calculator with at least the following keys: $+, -, \times, \div, \pi, x^2, \sqrt{x}, \frac{1}{x}, x^y, \ln x, e^x$, sine, cosine and tangent and their inverses in degrees and decimals of a degree, and in radians; memory. Calculators with a facility for symbolic algebra, differentiation and/or integration are not permitted.

Formulae

Students are expected to know any other formulae which might be required by the specification and which are not included in the booklet, *Mathematical Formulae including Statistical Formulae and Tables*, which will be provided for use with the paper. Questions will be set in SI units and other units in common usage.

Students will be expected to know and be able to recall and use the following formulae:

Momentum = mv

Impulse = $mv - mu$

For constant acceleration:

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$s = vt - \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

1 Mathematical Models in Mechanics

What students need to learn:

The basic ideas of mathematical modelling as applied in Mechanics.	Students should be familiar with the terms: particle, lamina, rigid body, rod (light, uniform, non-uniform), inextensible string, smooth and rough surface, light smooth pulley, bead, wire, peg. Students should be familiar with the assumptions made in using these models.

2 Vectors in Mechanics

What students need to learn:

Magnitude and direction of a vector. Resultant of vectors may also be required.	Students may be required to resolve a vector into two components or use a vector diagram. Questions may be set involving the unit vectors **i** and **j**.
Application of vectors to displacements, velocities, accelerations and forces in a plane.	Use of $\text{velocity} = \frac{\text{change of displacement}}{\text{time}}$ in the case of constant velocity, and of $\text{acceleration} = \frac{\text{change of velocity}}{\text{time}}$ in the case of constant acceleration, will be required.

3 Kinematics of a particle moving in a straight line

What students need to learn:

Motion in a straight line with constant acceleration.	Graphical solutions may be required, including displacement-time, velocity-time, speed-time and acceleration-time graphs. Knowledge and use of formulae for constant acceleration will be required.

4 Dynamics of a particle moving in a straight line or plane

What students need to learn:

The concept of a force. Newton's laws of motion.	Simple problems involving constant acceleration in scalar form or as a vector of the form $a\mathbf{i} + b\mathbf{j}$.
Simple applications including the motion of two connected particles.	Problems may include (i) the motion of two connected particles moving in a straight line or under gravity when the forces on each particle are constant; problems involving smooth fixed pulleys and/or pegs may be set; (ii) motion under a force which changes from one fixed value to another, eg a particle hitting the ground; (iii) motion directly up or down a smooth or rough inclined plane.
Momentum and impulse. The impulse-momentum principle. The principle of conservation of momentum applied to two particles colliding directly.	Knowledge of Newton's law of restitution is not required. Problems will be confined to those of a one-dimensional nature.
Coefficient of friction.	An understanding of $F = \mu R$ when a particle is moving.

