5.8 AS MODULE 4728: MECHANICS 1 (M1)

Preamble

Knowledge of the specification content of Modules *C1* and *C2* is assumed, and candidates may be required to demonstrate such knowledge in answering questions in Unit *M1*.

Candidates should know the following formulae, none of which is included in the List of Formulae made available for use in the examination.

Forces and Equilibrium

Weight and mass: $\text{Weight} = \text{mass} \times g$

Limiting friction: $F = \mu R$

Newton's second law: $F = ma$

Kinematics

For linear motion with constant acceleration:

$$v = u + at$$

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

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

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

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

For general linear motion: $v = \dfrac{\mathrm{d}s}{\mathrm{d}t}$, $a = \dfrac{\mathrm{d}v}{\mathrm{d}t}$

Linear Momentum

Momentum of a particle: mv

Force as a Vector

Candidates should be able to:

(a) understand the vector nature of force, and use directed line segments to represent forces (acting in at most two dimensions);

(b) understand the term ‘resultant’ as applied to two or more forces acting at a point, and use vector addition in solving problems involving resultants and components of forces (solutions involving calculation, rather than scale drawing, will be expected);

(c) find and use perpendicular components of a force, e.g. in finding the resultant of a system of forces, or to calculate the magnitude and direction of a force (knowledge of column vector or **i**, **j** notation is not required, though candidates are free to use any such notation in answering questions if they wish).

Equilibrium of a Particle

C3.1a C3.1b C3.3

Candidates should be able to:

(a) identify the forces acting in a given situation, and use the relationship between mass and weight;

(b) understand and use the principle that a particle is in equilibrium if and only if the vector sum of the forces acting is zero, or equivalently if and only if the sum of the resolved parts in any given direction is zero (problems may involve resolution of forces in direction(s) to be chosen by the candidate, or the use of a ‘triangle of forces’);

(c) use the model of a ‘smooth’ contact and understand the limitations of the model;

(d) represent the contact force between two rough surfaces by two components, the ‘normal force’ and the ‘frictional force’, understand the concept of limiting friction and limiting equilibrium, recall the definition of coefficient of friction, and use the relationship $F \leq \mu R$ or $F = \mu R$ as appropriate;

(e) use Newton’s third law.

Kinematics of Motion in a Straight Line

Candidates should be able to:

(a) understand the concepts of distance and speed as scalar quantities, and of displacement, velocity and acceleration as vector quantities (in one dimension only);

(b) sketch and interpret (t, x) and (t, v) graphs, and in particular understand and use the facts that

 (i) the area under a (t, v) graph represents displacement,

 (ii) the gradient of a (t, x) graph represents velocity,

 (iii) the gradient of a (t, v) graph represents acceleration;

(c) use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration;

(d) use appropriate formulae for motion with constant acceleration.

Newton's Laws of Motion

Candidates should be able to:

(a) apply Newton's laws of motion to the linear motion of bodies of constant mass moving under the action of constant forces (which may include friction); for example, a car pulling a caravan;

(b) model, in suitable circumstances, the motion of a body moving vertically or on an inclined plane, as motion with constant acceleration and understand any limitations of this model;

(c) solve simple problems which may be modelled as the motion of two particles, connected by a light inextensible string which may pass over a fixed smooth peg or light pulley (including, for example, situations in which a pulley is placed at the top of an inclined plane).

Linear Momentum

Candidates should be able to:

(a) recall and use the definition of linear momentum and show understanding of its vector nature (in one dimension only);

(b) understand and use conservation of linear momentum in simple applications involving the direct collision of two bodies moving in the same straight line before and after impact, including the case where the bodies coalesce (knowledge of impulse and of the coefficient of restitution is not required).