Motion, forces and energy

Cambridge IGCSE Physics

The syllabus introduces every one with the words “recall and use”, and 0625 provides no formula sheet in any paper. Compiled by GioPhysics from the published syllabus. This is an independent study aid, not a Cambridge document; the official syllabus is the authority.

1.1 Physical quantities and measurement techniques

SUPP. **Resultant of two vectors at right angles**

$$R = \sqrt{x^2 + y^2}$$

R — resultant of the two vectors
x, y — the two perpendicular components

Forces or velocities only. A scale drawing is an accepted method — the syllabus asks for the resultant by calculation or graphically.

1.2 Motion

CORE **Speed**

$$v = s / t$$

$s = vt$ · $t = s / v$

v — speed (m/s)
s — distance travelled (m)
t — time taken (s)

CORE **Average speed**

average speed = total distance travelled / total time taken

distance — the whole journey (m)
time — the whole journey (s)

CORE **Speed from a distance-time graph**

speed = gradient of a distance–time graph

gradient — rise ÷ run of a straight-line section

CORE **Distance from a speed-time graph**

distance travelled = area under a speed–time graph

area — of the region between the line and the time axis

For motion at constant speed or constant acceleration.

SUPP. **Acceleration**

$$a = \Delta v / t$$

$\Delta v = at$

a — acceleration (m/s²)
Δv — change in velocity (m/s)
t — time taken (s)

A deceleration is a negative acceleration, and is used as such in calculations.

SUPP. **Acceleration from a speed-time graph**

acceleration = gradient of a speed–time graph

gradient — rise ÷ run

1.3 Mass and weight

CORE

Gravitational field strength

$$g = W / m$$

$W = mg$ · $m = W / g$

- g — gravitational field strength (N/kg)
- W — weight (N)
- m — mass (kg)

The syllabus asks you to know that g is equivalent to the acceleration of free fall.

1.4 Density

CORE

Density

$$\rho = m / V$$

$m = \rho V$ · $V = m / \rho$

- ρ — density (g/cm^3, kg/m^3)
- m — mass (kg, g)
- V — volume (m^3, cm^3)

1.5.1 Effects of forces

SUPP.

Resultant force and acceleration

$$F = ma$$

$a = F / m$ · $m = F / a$

- F — resultant force (N)
- m — mass (kg)
- a — acceleration (m/s^2)

The force and the acceleration are in the same direction. $F = mv^2/r$ is explicitly not required at 0625.

SUPP.

Spring constant

$$k = F / x$$

$F = kx$ · $x = F / k$

- k — spring constant (N/m, N/cm)
- F — force (load) (N)
- x — extension (m, cm)

Valid up to the limit of proportionality. An understanding of the elastic limit is not required.

1.5.2 Turning effect of forces

CORE

Moment of a force

$$\text{moment} = F \times d$$

- F — force (N)
- d — perpendicular distance from the pivot (m)
- moment — turning effect (N m)

CORE

Principle of moments

$$\text{sum of clockwise moments} = \text{sum of anticlockwise moments}$$

- about — the same pivot, for an object in equilibrium

Core covers one force each side of the pivot; Supplement extends it to more than one force each side.

1.5.3 Centre of gravity

No equations. This point is examined through experiment and qualitative reasoning about stability.

1.6 Momentum

SUPP.

Momentum

$$p = mv$$

$m = p / v$ · $v = p / m$

- p — momentum (kg m/s, N s)
- m — mass (kg)
- v — velocity (m/s)

SUPP.

Impulse

$$\text{impulse} = F\Delta t = \Delta(mv)$$

- F — force (N)
- Δt — time for which the force acts (s)
- Δ(mv) — change in momentum (kg m/s, N s)

SUPP.

Resultant force from momentum

$$F = \Delta p / \Delta t$$

- F — resultant force (N)
- Δp — change in momentum (kg m/s)
- Δt — time taken (s)

SUPP.

Conservation of momentum

total momentum before = total momentum after

- p — summed for every object, with direction

Simple problems in one dimension only.

1.7.1 Energy

SUPP.

Kinetic energy

$$E_k = \tfrac{1}{2}mv^2$$

$v = \sqrt{(2E_k / m)}$

- Ek — kinetic energy (J)
- m — mass (kg)
- v — speed (m/s)

SUPP.

Change in gravitational potential energy

$$\Delta E_p = mg\Delta h$$

- ΔEp — change in g.p.e. (J)
- m — mass (kg)
- g — gravitational field strength (N/kg)
- Δh — change in height (m)

CORE

Conservation of energy

total energy before = total energy after

- stores — kinetic, gravitational potential, chemical, elastic, nuclear, electrostatic, internal

Core applies this to simple flow diagrams; Supplement to multi-stage examples and Sankey diagrams.

1.7.2 Work

CORE

Mechanical work done

$$W = Fd = \Delta E$$

$F = W / d$ · $d = W / F$

- W — work done (J)
- F — force (N)
- d — distance moved in the direction of the force (m)
- ΔE — energy transferred (J)

1.7.3 Energy resources

SUPP.

Efficiency, by energy

$$\text{efficiency} = \text{useful energy output} / \text{total energy input}$$

- energy — both terms in the same unit (J)

Multiply by 100% for a percentage. Core needs the idea of efficiency qualitatively; the equation is Supplement.

SUPP.

Efficiency, by power

$$\text{efficiency} = \text{useful power output} / \text{total power input}$$

- power — both terms in the same unit (W)

Multiply by 100% for a percentage.

1.7.4 Power

CORE

Power from work done

$$P = W / t$$

$W = Pt$ · $t = W / P$

- P — power (W, kW, MW)
- W — work done (J)
- t — time taken (s)

CORE

Power from energy transferred

$$P = \Delta E / t$$

- P — power (W)
- ΔE — energy transferred (J)
- t — time taken (s)

1.8 Pressure

CORE

Pressure

$$p = F / A$$

$F = pA$ · $A = F / p$

- p — pressure (N/m^2, Pa)
- F — force normal to the surface (N)
- A — area (m^2, cm^2)

SUPP.

Change in pressure beneath a liquid surface

$$\Delta p = \rho g \Delta h$$

- Δp — change in pressure (Pa)
- ρ — density of the liquid (kg/m^3)
- g — gravitational field strength (N/kg)
- Δh — change in depth (m)