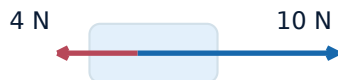


P5 Forces

Physics Paper 2 | AQA Combined Science Trilogy | Key ideas to remember

Forces & energy

1 Forces and weight



Resultant = 6 N right

Scalar: magnitude only (mass, speed). **Vector:** magnitude and direction (force, velocity). Add forces in the same direction; subtract opposing forces.

W = mg: weight W in N, mass m in kg, field strength g in N/kg. Use the given g. Weight acts through the centre of mass; measure it with a newtonmeter.

Contact: friction, tension, normal contact.

Non-contact: gravity, magnetic, electrostatic.

Motion graphs

2 Work, springs and RP18

W = Fs: work (J) = force (N) × distance (m) along the force. 1 J = 1 Nm. Friction transfers energy to thermal stores.

F = ke: force (N), spring constant (N/m), extension (m). Applies up to the limit of proportionality. Extension = loaded – original length.

E_e = ½ke² for a spring obeying F = ke. Example: k = 100 N/m, e = 0.20 m gives E_e = 2 J. Convert cm to m before calculating.

RP18: secure the spring; add known loads. Read length at eye level, calculate extension, repeat and plot F against e. Use a safety tray. **Elastic:** returns to original shape when unloaded.

Newton's laws

3 Motion and graphs

$$\text{speed} = \frac{\text{distance}}{\text{time}} \quad a = \frac{v - u}{t}$$

Speed: m/s. **Acceleration:** m/s². u = initial velocity; v = final velocity; t = time. Distance is total path length; displacement includes direction from start to finish.

v² – u² = 2as for constant acceleration. s is displacement; use consistent directions. Example: u = 0, v = 10 m/s, a = 2 m/s² → s = 25 m.

Distance-time gradient = speed. Horizontal means stationary. **Velocity-time gradient = acceleration.** Horizontal means constant velocity. Slowing means acceleration opposes velocity.

4 Newton's laws and RP19

1: Zero resultant force means constant velocity (including rest). **2:** **F = ma**, using the resultant F. **3:** Interaction forces are equal and opposite, on **different objects**.

Falling: near Earth, free-fall acceleration ≈ 9.8 m/s². As speed rises, drag rises. At terminal velocity, drag = weight: zero resultant and constant velocity.

RP19: use light gates for acceleration. Transfer masses from trolley to hanger: vary force, keep **total moving mass** fixed. Then fix hanger mass and add trolley mass. Repeat; minimise friction; use an end stop and catch tray.

Fixed mass: a ∝ F. Fixed force: a ∝ 1/m.

5 Stopping and reaction time

Thinking

Braking

Stopping distance = thinking + braking

Thinking distance = speed × reaction time. At 20 m/s and 0.6 s: 12 m. Fatigue, distraction, alcohol and some drugs increase reaction time.

Reaction time: often 0.2–0.9 s. Ruler-drop test: repeat from the same start position; compare means. Do not anticipate release.

Braking distance rises with speed, poor brakes, worn tyres and slippery roads. Braking: kinetic → thermal energy. Greater deceleration needs greater force, risking injury.

6 Higher Tier only

Vectors: draw to scale, tip to tail. Resultant: start to final tip. Perpendicular components have the same combined effect.

Graphs: tangent gradient on d-t gives instant speed. Signed v-t area = displacement; absolute areas give distance.

Inertia: resistance to velocity change; inertial mass = F/a. In a circle, direction and velocity change.

p = mv (kg m/s). Total momentum is conserved in a closed system. Choose a positive direction. Joined objects: v = total p / total mass.

Braking: a = (v – u)/t, then F = ma. Same car, constant braking force: distance ∝ speed².