

Topic 5: Forces

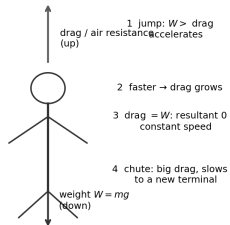
AQA GCSE Physics 8463 · spec 4.5 · sheets 5.1–5.9

Forces run Paper 2

- The largest topic of Paper 2; energy ideas are drawn on.
- Every equation is on the enclosed sheet.
- Physics-only and Higher-Tier parts are marked.

Scalars have size; vectors have direction

free-body diagram: only forces ON the skydiver
terminal velocity story



- Scalar: distance, speed, mass. Vector: displacement, velocity, force.
- An arrow: length = magnitude, direction = direction.
- Contact forces touch; non-contact forces act at a distance.

Weight acts at the centre of mass

- $W = mg$, with g given for the place.
- Weight acts at a single point: the centre of mass.
- Weight is proportional to mass; newtonmeter measures it.

Resultant forces change motion

- Collinear: add or subtract.
- (HT) Free-body diagram: only forces ON the object.
- Zero resultant: balanced.

Your turn: two forces

- 45 N east and 30 N east; then 45 N east and 30 N west.
- Find both resultants.

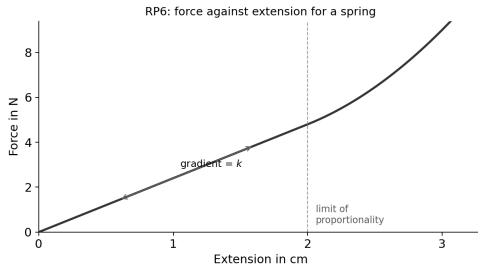
Two forces worked

- 1 **Add** $R = 45 + 30 = 75$ N east.
- 2 **Subtract** $R = 45 - 30 = 15$ N east.

Work: force along the line of action

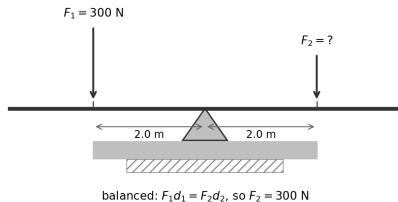
- $W = Fs$ with s along the force's line of action.
- $1 \text{ J} = 1 \text{ N}\cdot\text{m}$.
- Work against friction raises temperature.

Springs: linear, then not



- $F = ke$ below the limit of proportionality.
- $E_e = \frac{1}{2}ke^2$ for the stored energy.
- RP6: gradient of the straight section is k .

Moments: force times perpendicular distance

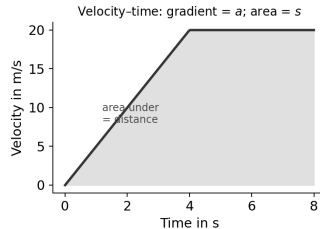
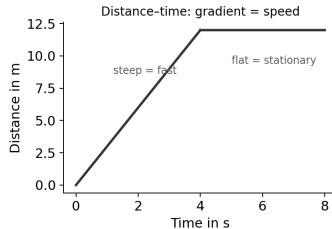


- $M = Fd$, d perpendicular from the pivot.
- Balanced: clockwise = anticlockwise.
- Levers and gears trade force for distance.

Pressure: force spread over area

- $p = F/A$, force normal to the surface.
- (HT) $p = h\rho g$ for a liquid column.
- Upthrust: deeper face feels more pressure.

Distance-time and velocity-time



- d\’t gradient = speed; flat = stationary.
- v\’t gradient = acceleration; (HT) area = distance.
- Typical speeds: walk 1.5, run 3, cycle 6, sound 330 m/s.

Terminal velocity

- Falling: weight $>$ drag, accelerates.
- Drag grows with speed until drag = weight.
- Resultant zero: constant terminal velocity.

Your turn: read the graph

- A v - t graph rises 0 to 20 m/s in 8 s, flat for 12 s.
- Find the acceleration and (HT) the distance.

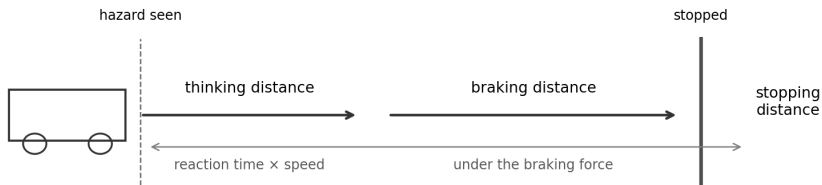
Graph worked

- 1 Gradient** $a = \Delta v / t = 20 / 8 = 2.5 \text{ m/s}^2$.
- 2 Area** $s = \frac{1}{2} \times 8 \times 20 + 12 \times 20 = 320 \text{ m}$.

Three laws, one equation

- First: no resultant force, motion unchanged.
- Second: $F = ma$.
- Third: equal, opposite, on each other.

Stopping distance has two parts



- thinking = reaction time $\times$ speed.
- braking grows with speed, road, tyres.
- Large decelerations overheat brakes.

Your turn: stopping numbers

- At 20 m/s, reaction 0.7 s, braking 12 m.
- Estimate the stopping distance.

Stopping worked

1 Thinking $s = vt = 20 \times 0.7 = 14$ m.

2 Total $14 + 12 = 26$ m.

Momentum and safety (HT)

- $p = mv$; conserved in a closed system.
- $F = m\Delta v/\Delta t$: force = rate of change.
- Air bags and crumple zones lengthen Δt .

Check yourself

- Checklist before you call this topic done.
- Choose the equation from the words; convert units first.
- Graphs: gradient, tangent, area; laws; stopping; momentum.