H2 Physics Mechanics: Final Quick Cheat Sheet

Quantities & Measurement • Kinematics • Dynamics • Equilibrium • Energy Updated 2026-05-21

0. Exam Algorithm

Pick model first: measurement/uncertainty? → Q&M. Motion only? → kinematics. Forces causing acceleration? → dynamics. Pivot/balance? → moments/equilibrium. Height/speed/spring/loss/power? → energy. Collision/impact/force-time? → impulse/momentum.
Then: draw diagram/FBD → define positive direction/pivot → write law in words → equation → units/signs/s.f.

1. Quantities & Measurement

Units you must know

- $N = kg\,m\,s^{-2}$
- $J = N\,m = kg\,m^2\,s^{-2}$
- $W = J\,s^{-1}$

Uncertainty rules

- $+$ or $-$: add **absolute** uncertainties.
- $\times$ or $\div$: add **fractional/percentage** uncertainties.
- Power: multiply percentage uncertainty by power, e.g. $x^2 \Rightarrow 2\Delta x/x$.

Trap: Do not add percentage uncertainties for addition/subtraction.

Errors

- Accuracy = close to true value.
- Precision = repeated readings close.
- Random error = scatter; reduce by repeat + average.
- Systematic error = same-direction bias; fix calibration/zero error.

Vectors

- Scalars: mass, time, distance, speed, energy, work, power.
- Vectors: displacement, velocity, acceleration, force, momentum, impulse.
- Components: if angle is from horizontal, $A_x = A\cos\theta$, $A_y = A\sin\theta$.

Trap: If angle is from vertical, sine/cosine swap.

2. Kinematics

SUVAT: constant acceleration only

$$v = u + at \qquad s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as \qquad s = \tfrac{1}{2}(u+v)t$$

Method: choose positive direction → list u, v, a, s, t → pick equation missing unwanted variable. **Trap:** At highest point, $v = 0$ but acceleration is still g downward.

Graphs

- s-t gradient = velocity.
- v-t gradient = acceleration.
- v-t area = displacement.
- a-t area = change in velocity.
- Area below axis is negative; distance uses absolute areas.

Trap: Graph shape is not the physical path shape.

Free fall

- No air resistance ⇒ constant acceleration g downward.
- Up positive: $a = -g$. Down positive: $a = +g$.

Projectiles

- Split into independent horizontal + vertical motion.
- Horizontal: $a_x = 0$, constant v_x.
- Vertical: $a_y = \pm g$.
- Same time t in both directions.
- Resolve first: $u_x = u\cos\theta$, $u_y = u\sin\theta$.

Trap: Never use total launch speed in vertical SUVAT.

Terminal velocity answer chain

Weight downward. As speed rises, drag rises. Resultant downward force falls, so acceleration falls. At terminal velocity, drag/upthrust balances weight, resultant force is zero, acceleration is zero.
Trap: Terminal velocity is constant velocity, not zero velocity.

3. Dynamics

FBD discipline

1. Isolate one object/system.
2. Draw only real forces: weight, normal, tension, friction, drag, upthrust, spring, applied.
3. Choose axes, usually along/perpendicular to motion.
4. Resolve, then apply $\sum F = ma$.

Trap: No "force of motion". No acceleration arrow as a force.

Newton's laws

- 1st: zero resultant force ⇒ constant velocity/rest.
- 2nd: resultant force = rate of change of momentum; constant mass: $\sum F = ma$.
- 3rd: equal/opposite same-type forces on **different bodies**.

Trap: 3rd-law pairs do not cancel on one FBD.

Slopes

- Down-slope weight component: $mg\sin\theta$.
- Into-slope component: $mg\cos\theta$.
- If no acceleration perpendicular to slope: $N = mg\cos\theta$.

Trap: $mg\sin\theta$ and $mg\cos\theta$ are components, not extra forces if full mg is drawn.

Lifts

Upward positive:

- Accelerating up: $R - mg = ma$, so $R > mg$.
- Accelerating down: $mg - R = ma$, so $R < mg$.
- Rest/constant velocity: $R = mg$.

Trap: Velocity direction does not tell you apparent weight; acceleration does.

4. Momentum & Impulse

Core formulae

$$p = mv \qquad J = \Delta p = F\Delta t$$

Force-time graph area = impulse = change in momentum.
Trap: Momentum and impulse are vectors. Signs matter, especially rebound.

Collisions

Trigger: collision, explosion, rebound, short impact, two bodies.

- Closed system: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$.
- Always write a signed equation.
- Stock sentence: "During the short collision, external impulse is negligible, so total momentum is conserved."

Trap: Momentum conserved does **not** imply kinetic energy conserved. KE conserved only if elastic. Perfectly inelastic = stick together.

5. Equilibrium

Conditions

- Translational equilibrium: $\sum F = 0$.
- Rotational equilibrium: $\sum \tau = 0$.

Trap: Zero resultant force alone may still allow rotation.

Moments

- Moment = Fd.
- d = perpendicular distance from pivot to line of action.
- Equilibrium: clockwise moments = anticlockwise moments.
- Best trick: choose pivot through unknown force to remove it.

Trap: Distance along rod works only if force is perpendicular to rod.

Couple

Two equal opposite parallel forces separated by distance. Couple torque = one force × perpendicular separation. Resultant force zero, turning effect non-zero.

Hooke/upthrust

- Hooke: $F = kx$, before proportional limit.
- Elastic energy: $E = \tfrac{1}{2}kx^2$.
- Floating equilibrium: upthrust = weight.

Trap: x is extension/compression, not total length.

6. Energy

Core formulae

$$W = Fs\cos\theta \qquad E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_p = mg\Delta h \qquad E_e = \tfrac{1}{2}kx^2$$
$$P = E/t \qquad P = Fv$$
$$\eta = \frac{\text{useful output}}{\text{total input}} \times 100\%$$

Force-displacement graph area = work done.

Energy template

Initial stores + work input = final stores + losses.

- No friction/drag: mechanical energy conserved.
- Friction/drag present: include energy lost/work done against resistance.

Trap: Total energy is always conserved; mechanical energy may not be.

Use energy when

Height ↔ speed, spring compression, variable force, friction losses, power/efficiency, or only initial/final states matter.
Trap: Use dynamics, not energy, if the question asks for acceleration/-time/force details.

7. Pattern Recognition

Units	replace quantities with SI base units.
Uncertainty	abs for +/−; percentage for ×/÷; power multiplies.
Motion graph	gradient = rate; area = accumulated quantity.
SUVAT	constant acceleration, list u, v, a, s, t.
Projectile	resolve first; vertical gives time; horizontal gives range.
Terminal v	drag rises → resultant falls → acceleration falls.
FBD/Newton	isolate, real forces, resolve, $\sum F = ma$.
Impulse	F-t area = Δp.
Collision	signed momentum before = after.
Moments	choose pivot; cw = acw.
Energy	stores + input = stores + losses.

8. Final 30-Second Check

- SI units? cm→m, g→kg, min→s, kW→W.
- Direction/sign stated for vectors?
- SUVAT only if constant acceleration?
- FBD has real forces only?
- Did you double-count mg and components?
- Momentum signs correct after rebound/collision?
- Moment arm is perpendicular distance?
- Friction/drag losses included in energy?
- Efficiency $\leq 100\%$?
- Final answer has unit + sensible s.f.?

Last-minute priority

1. Uncertainty rules. 2. Graph gradients/areas. 3. SUVAT signs. 4. Projectile split. 5. Terminal velocity explanation. 6. Slopes/lifts FBDs. 7. Impulse + momentum signs. 8. Moments pivots. 9. Energy with losses. 10. Power/efficiency.