# A-Level Physics



*Every error below cost marks that the candidate had already earned by understanding the physics. They come from Cambridge's own examiner reports, ordered by how often the examiners raise them. The × line is what candidates write; the ✓ line is what scores. ,× ,✓ General exam technique is in the Exam Technique guide; this booklet is Physics.*

## Across every paper

✗ Finishing a calculation with a bare number, or writing the number in the answer box with no unit.

✓ **Every final answer carries its unit: 4.5 N,** $2.0 \times 10^3$ **J,** 6.7 **m s**$^{-1}$**.**

A correct number with no unit routinely loses the final mark, however good the working above it.

ER 12 sessions P4

✗ Starting a calculation by substituting numbers straight into a rearranged expression.

✓ **Write the symbol equation first, state its subject, then substitute –** $E_k = \frac{1}{2}mv^2$**, so** $v = \sqrt{2E_k/m}$**.**

Credit is often available for a correct equation alone, so working that shows one survives an arithmetic slip. An unsupported wrong answer scores nothing.

ER 12 sessions P4

✗ Rounding an intermediate value to two significant figures and carrying it into the next step.

✓ **Keep the full value in the calculator and round once, at the very end.**

Premature rounding changes the final digit, and the final answer is then simply wrong. Carry at least one extra figure through any intermediate step.

ER 8 sessions P4

✗ Copying ten figures off the calculator, or cutting a final answer to one significant figure.

✓ **Match the least precise data in the question – usually two or three significant figures.**

The data given in the question is the guide. Too many figures and too few are both penalised.

ER 12 sessions P4

✗ Writing the answer to a question that was asked in a recent past paper rather than this one.

✓ **Read the question twice, and answer the quantity it actually names.**

Examiners report this every session. Memorised mark schemes are the commonest way a well-prepared candidate loses marks on extended writing.

ER 12 sessions P4

✗ Giving two alternative answers to a definition, hoping the examiner takes the right one.

✓ **Commit to one answer. A definition has exactly one.**

Where two answers are offered and one is wrong, the mark is not awarded – the wrong one cancels the right one.

ER Jun23 P41

✗ Defining a quantity in words that are not dimensionally correct – 'power is energy'.

✓ **Use 'per unit' for a ratio and 'product' for a multiplication: power is energy transferred per unit time.**

A definition that does not balance dimensionally is marked wrong even when the idea behind it is right. Symbols only count if every symbol is defined.

"…"

ER 12 sessions P4

✗ Using an everyday word where the syllabus has a technical one – atom for molecule, nucleus for nuclide, force for field.

✓ **Use the syllabus term, and use it consistently through the answer.**

One inaccurate word can make a whole response technically incorrect, and full credit is then unavailable.

ER 12 sessions P4

✗ Leaving a question part blank because an earlier part failed.

✓ **Attempt every part. Later parts are marked on correct use of YOUR earlier value.**

A blank can never earn anything; a partial calculation often can. Examiners record significant numbers of unattempted parts every session.

ER 6 sessions P4

✗ Accepting an answer of $3 \times 10^7$ m s$^{-1}$ for the speed of a car without a second glance.

✓ **Check the magnitude is plausible before moving on.**

A power-of-ten slip is the commonest arithmetic error in this subject, and a two-second sanity check catches almost all of them.

ER 5 sessions P1

■ Repeating the question in your first sentence. It uses answer space and time, and earns nothing.

ER Nov23 P41

## 1 · Physical quantities and units

✗ Substituting 5 cm as 5, 20 g as 20, or 12 kΩ as 12.

✓ **Convert the prefix first: 0.05 m, 0.020 kg,** $1.2 \times 10^4$ **Ω.**

Prefix errors put an answer out by a factor of a hundred or a thousand and are the single most common source of power-of-ten mistakes.

ER 3 sessions P4; EX P4

✗ Giving the percentage uncertainty in $T^2$ as the same as the percentage uncertainty in $T$.

✓ **Squaring doubles the percentage uncertainty; a square root halves it.**

Examiners name this specifically: candidates forget to double the percentage uncertainty in the period when the quantity used is $T^2$.

→

EX P2

✗ Treating percentage uncertainty and fractional uncertainty as the same number.

✓ **Fractional uncertainty** ×100 **is the percentage; absolute uncertainty is the fraction** × **the**

**value.**

Confusing the two introduces a factor-of-100 error into the absolute uncertainty, which examiners see repeatedly.

$\neq$ EX P2

✗ Quoting the uncertainty in a measurement as the smallest division on the instrument, whatever the measurement was.

✓ **Judge it from how hard the reading actually was – several mm when the edge itself is hard to identify.**

The uncertainty is rarely the smallest reading possible. Where judgement is involved, the honest uncertainty is larger.

ER Nov22 P51; EX P5

■ Ringing or ticking where the question says underline. Follow the instruction given, exactly.

EX P2

## 2 · Kinematics

✗ Saying the heavier ball hits the ground first, or faster, when air resistance is ignored.

✓ **Both fall with the same acceleration and hit the ground at the same speed.**

Named by the examiners as a common misconception. Mass cancels: $a = g$ regardless of $m$.

EX P2

✗ Taking the gradient of a $v$–$t$ graph when the question wants the area, or the area when it wants the gradient.

✓ **Gradient is acceleration; area under the line is displacement.**

Both are one-mark reads, and the wrong one is a confident zero.

, ER Jun24 P12

✗ Drawing a curve on a $v$–$t$ graph for a body under constant acceleration.

✓ **Constant acceleration means a straight line of constant gradient; only the sign of $v$ changes on the bounce.**

Less successful responses curve the line, which contradicts the constant acceleration the question stated.

→ EX P2

## 3 · Dynamics

✗ 'The forces are balanced' or 'the forces cancel out'.

✓ **'The resultant force on the object is zero.'**

Only the second is the physics statement the scheme credits; the first is an everyday paraphrase.

"" ER 12 sessions P4

✗ Adding both speeds in a head-on collision because momentum is 'total'.

✓ **Choose a positive direction, give the opposing velocity a minus sign, then add.**

Momentum is a vector. Without signs, a collision problem gives a plausible number that is simply wrong.

ER Nov24 P21

✗ Calculating kinetic energy from the components of the velocities along one line.

✓ **Kinetic energy uses the FULL speed of each body, not a component of it.**

Named as a common mistake in an oblique-collision question: energy is a scalar and has no direction to resolve along.

EX P2

✗ Calling the centripetal force an extra force and adding it to the free-body diagram.

✓ **It IS the resultant of the forces already there – tension, friction, gravity.**

Drawing it as an additional arrow double-counts a force that is already on the diagram.

ER Jun22 P41

## 4 · Forces, density and pressure

✗ Resolving with $\cos\theta$ where the geometry needs $\sin\theta$.

✓ **Draw the triangle and check which side the angle is next to before choosing.**

Examiners call out $\cos 68°$ used for $\sin 68°$, and omitting the trig factor altogether, as common mistakes.

EX P2

✗ Substituting the weight of a sphere where the question is about the upthrust on it.

✓ **Upthrust is the weight of the fluid displaced, $\rho V g$ – not the weight of the object.**

A common mistake in a sinking-sphere question: the correct formula was recalled and then the wrong force put into it.

EX P2

## 5 · Work, energy and power

✗ Giving the change in height as the final answer to a change-in-energy question.

✓ **Finish the calculation: $\Delta E_p = mg\Delta h$.**

Examiners note that less successful responses stop at $\Delta h$. The question asked for an energy, so an answer in metres cannot score.

EX P2

✗ Using the distance along a slope as the height in $mg\Delta h$, or using mass where weight is needed.

✓ **Use the VERTICAL height gained, and check whether the quantity wanted is $m$ in kg or $W$ in N.**

Examiners record candidates confusing the weight of a sphere with its mass in this exact calculation.

EX P2

## 6 · Deformation of solids

✗ Saying that doubling the extension of a wire doubles its elastic potential energy.

✓ **It QUADRUPLES it: $E_p = \frac{1}{2}kx^2$, so $E_p \propto x^2$.**

The examiners trace this to reading $E_p = \frac{1}{2}Fx$ as if $F$ were constant. $F$ rises with $x$ too.

$\propto$ EX P2

✗ Using $F = kx$ beyond the limit of proportionality because the question gives an extension.

✓ **Check the loading is still in the proportional region before using Hooke's law.**

Past the limit the relation is no longer linear, so every value calculated from it is wrong.

ER Jun23 P21

## 8 · Superposition

✗ Answering 'the slit separation decreases' when the command word is EXPLAIN.

✓ **State the change AND its cause: blue light has a shorter wavelength, so for the same fringe separation the slits must be closer.**

Examiners record candidates giving the change with no supporting explanation. Half the marks, every time.

"" EX P4

✗ Answering $9.9 \times 10^{-7}$ m when the question asked for the path difference in nm.

✓ **Convert to the unit the question names: 990 nm.**

The instruction to use a particular unit is part of the question, and an answer in another unit is marked wrong.

EX P4

✗ Calling two sources coherent because they have the same amplitude or the same intensity.

✓ **Coherent means the same frequency and a constant phase difference.**

Amplitude is irrelevant to coherence, and this definition is bookwork that examiners expect verbatim.

: ER Nov23 P21

## 9 · Electricity

✗ Substituting resistances in kΩ into an equation that returns an answer in amperes.

✓ **Convert to Ω first, or track the power of ten explicitly.**

Examiners name this conversion as the cause of a power-of-ten error in a potential-divider question.

kΩ Ω EX P4

✗ Writing 'the resistance increases' in a thermistor circuit without saying which resistance.

✓ **Name it: the resistance OF THE THERMISTOR increases, so the p.d. across it increases.**

In a circuit with three resistances, an unqualified 'resistance' is ambiguous, and an ambiguous answer is not credited.

EX P4

✗ Saying a filament lamp obeys Ohm's law because it has a resistance.

✓ **Ohm's law holds only where the $I$–$V$ graph is a straight line through the origin.**

A filament lamp's graph curves, so it does not obey Ohm's law – a standard multiple-choice trap.

ER Jun24 P11

## 10 · D.C. circuits

✗ Treating e.m.f. and terminal p.d. as the same quantity.

✓ **They differ by the p.d. lost across the internal resistance: $E = V + Ir$.**

That difference is the whole point of the topic; examiners report confusion about the effect of internal resistance on terminal p.d.

$\neq$ ER Jun24 P11

✗ Adding resistances in parallel directly, or using the two-resistor product-over-sum formula for three resistors.

✓ **Reciprocals add. Check the answer is smaller than the smallest resistance in the combination.**

Examiners record candidates applying the two-resistor formula to a larger network. The smaller-than-the-smallest check catches it instantly.

: EX P4

■ Saying current is 'used up' round a circuit. Current is the same everywhere in a series loop; it is energy that is transferred.

ER Nov22 P12

## 11 · Particle physics

✗ Saying that both the positron and the electron are antiparticles.

✓ **The positron is the antiparticle; the electron is the particle.**

Named by the examiners as a common misconception in a pair-annihilation question.

EX P4

✗ Describing what a meson and a baryon are without saying which of the two groups in the question is which.

✓ **Name the group AND justify it: Y is a baryon because it contains three quarks.**

Examiners record general descriptions that never answer the question asked. The identification is where the mark is.

EX P4

✗ Writing quark charges as whole numbers, or with the wrong sign.

✓ **$u$ has charge $+\frac{2}{3}e$ and $d$ has charge $-\frac{1}{3}e$.**

In a 'show that' question the charges must be substituted explicitly, so a sign slip is visible and costs the mark.

EX P4

## 13 · Gravitational fields

✗ Explaining what a gravitational field IS when the question says 'define gravitational field strength'.

✓ **Force per unit mass acting on a small test mass placed at that point.**

Examiners report that only a minority gave the syllabus bookwork; the rest answered a different question.

= ER Jun24 P41

✗ Saying the change in potential energy must be a decrease because potential energy is negative.

✓ **Decide the direction of the change from the motion, not from the sign convention.**

The change is the same whatever arbitrary zero is chosen, and examiners name this reasoning as a misunderstanding.

EX P4

✗ Substituting a speed in km $s^{-1}$ into an energy equation.

✓ **Convert to m $s^{-1}$ first, and convert back only if the answer is asked for in km $s^{-1}$.**

Examiners list this conversion, and omitting the comet's initial kinetic energy, as the common errors in that question.

km/s m/s EX P4

## 15 · Ideal gases

✗ Putting a Celsius temperature into $pV = nRT$.

✓ **Every gas equation takes kelvin: $T/\mathbf{K} = \theta/°\mathbf{C} + 273$.**

A 27 °C substituted as 27 instead of 300 K gives an answer out by a factor of eleven.

ER Jun23 P41

✗ In a 'show that' question, writing down the number of moles without showing where it came from.

✓ **Show every interim step, including the substitution that produced $n$.**

In a 'show that' the working IS the answer – the final value is already printed in the question.

"" EX P4

## 16 · Thermodynamics

✗ Saying temperature is a measure of the heat in a body.

✓ **Temperature measures the average kinetic energy of the molecules; heat is energy transferred because of a temperature difference.**

Examiners flag force/field and similar word pairs; this is the thermal one, and the wrong word makes the answer incorrect.

ER Nov24 P41

✗ Saying internal energy is only kinetic, so melting at constant temperature needs no energy.

✓ **Internal energy is the sum of the random kinetic AND potential energies of the molecules.**

The potential term is exactly what melting changes, which is why it takes energy at constant temperature.

ER Jun22 P41

## 19 · Capacitance

✗ Putting the total p.d. across the whole combination into the discharge equation for one capacitor.

✓ **Use the initial and final p.d. across THAT capacitor.**

Examiners record candidates comparing the 6.0 V across the capacitor with the 12 V across the circuit – the equation needs one of them, consistently.

EX P4

## 20 · Magnetic fields

✗ Giving as a condition something the question already stated – 'the wire must be in a magnetic field'.

✓ **Give the condition the question has NOT given: the wire must be at right angles to the field.**

Examiners note candidates offering facts from the stem, and facts so obvious they carry no credit.

EX P4

✗ Comparing field strength at two points without referring to the spacing of the field lines.

✓ **Read the diagram: the closer the lines, the stronger the field.**

Examiners report that many candidates found applying this to the diagram difficult, often because they compared the wrong pair of points.

, EX P4

■ Using the left hand for induction. Left hand is the motor effect; the right hand is the generator effect.

, ER Jun23 P42

## 22 · Quantum physics

✗ Saying that brighter light gives photoelectrons more kinetic energy.

✓ **Intensity increases the NUMBER of photoelectrons; only frequency increases their energy.**

This is the standard photoelectric distinction and a recurring multiple-choice discriminator.

, ER Jun24 P12

## 23 · Nuclear physics

✗ Balancing a decay equation by nucleon number alone and leaving the proton number to chance.

✓ **Balance BOTH: nucleon number and proton number, on each side.**

Examiners note that nucleon number is usually conserved correctly while the second number defeats weaker candidates.

EX P4

✗ Reading a half-life off a decay curve once and moving on.

✓ **Check a second halving gives the same time – that constancy is the evidence for exponential decay.**

A single read can come from a curve that is not exponential at all, so the check is where the reasoning mark sits.

ER Nov23 P42

## 25 · Astronomy and cosmology

✗ Describing the redshift as the wavelength 'of the star' increasing.

✓ **It is the wavelength of a line in the light received from the star that is longer than the laboratory value.**

Examiners record this loose wording specifically, along with the idea that the wavelength increases continuously.

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EX P4

## The practical papers – Paper 3 and Paper 5

✗ Writing 'measurements were difficult' or 'use more precise instruments' as a limitation.

✓ **Name the measurement and say why it was hard: the angle is hard to read because of parallax against the scale.**

The single most repeated point in the practical reports. A general limitation that would fit any experiment earns nothing.

ER 8 sessions P5

✗ Justifying significant figures with the phrase 'the raw data'.

✓ **Name the raw quantities: $k$ is given to two figures because $T$, $W$ and $L$ were each read to two.**

Examiners state repeatedly that 'raw readings' without saying which readings does not earn the mark.

ER 6 sessions P5

✗ Choosing an awkward scale so the plotted points fill the grid.

✓ **Use a sensible scale that still spreads the points over at least six squares vertically and four horizontally.**

Awkward scales earn no credit of their own and cause further plotting and read-off errors.

ER 3 sessions P5

✗ Forcing the line of best fit through the origin, or through the highest and lowest points.

✓ **Draw it to balance the points either side, wherever that puts it.**

Examiners name both habits. The line must follow the data, not a relationship you expected.

ER 5 sessions P5

✗ Reading a point off the graph to the nearest whole square when calculating a gradient.

✓ **Read to the nearest half small square, mark both points used, and draw the triangle.**

The gradient marks depend on read-offs that the examiner can check, so the construction has to be visible.

ER 5 sessions P5

✗ Ignoring an anomalous point silently when drawing the line.

✓ **Circle or label it, and ignore at most one.**

There is no credit for identifying an anomaly, but ignoring one without marking it makes the line look wrong.

ER 3 sessions P5

✗ Comparing two values of a constant and concluding 'they are close, so the relation is supported'.

✓ **Calculate the percentage difference and test it against the criterion the question gives.**

The conclusion mark depends on the number, not on the impression. Examiners record omitted percentage differences every session.

ER 3 sessions P5

■ In a table, calculate each row to the significant figures of the least precise raw reading in it. Forcing every row to the same number of figures is often wrong.

ER 7 sessions P5