INTUITION EDUCATION

HSC 2026 · PREDICTED PRACTICE PAPER

2026 HSC Physics

Answers & marking notes

Paper total: 100 marks

Sit the paper first. These are worked answers with the marking notes behind them — what earns the mark, and the traps the marking centre has flagged in past years. Where a note names a band, it describes what a top-band response does, not a guaranteed mark.

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Answers & marking notes

Section I — answer key

Q	Answer	Note
1	B	Time of flight is set by the vertical motion only; t = 2u_y/g
2	C	$F = 4\pi^2mr/T^2$; halving T quadruples F
3	B	$v = \sqrt{(GM/r)}$: smaller r is faster; $E = -GMm/2r$: larger r is less negative (greater)
4	D	$v_{esc} = \sqrt{(2GM/r)}$; ×2 mass and ×½ radius gives $\sqrt{4} = 2$ times 11.2 = 22.4 km s^{-1}
5	B	Anti-parallel currents repel; magnitude unchanged ($F/l = \mu_0 I_1 I_2/2\pi r$)
6	C	$\omega = 0 \Rightarrow$ back emf = 0 $\Rightarrow$ current rises to V/R (the standing 2025 MC11 idea, written large)
7	C	$\varepsilon_0 \propto$ rate of flux change $\propto \omega$, and $f \propto \omega$: both double
8	C	Magnetic force ($\propto v$) doubles; electric force (qE) is unchanged
9	B	First filter halves unpolarised light; then $I = (I_0/2)\cos^2 45° = I_0/4$
10	A	The speed of light is invariant for all inertial observers
11	B	$p = mv/\sqrt{(1-v^2/c^2)}$ grows without bound as $v \to c$
12	D	Cooler body: lower curve everywhere with λ_{max} shifted to longer wavelength (Wien)
13	C	Maxwell predicted a whole EM spectrum, all propagating at c, E ⊥ B
14	B	Hubble's law: $v \propto d$ is the expansion signature
15	B	udd → uud requires d → u (with e^- and antineutrino emitted)
16	C	Undeflected passage $\Rightarrow$ mostly empty space (backscatter $\Rightarrow$ dense positive nucleus)
17	D	Smallest $\lambda \Rightarrow$ longest half-life $\Rightarrow$ flattest activity curve
18	B	Main-sequence Sun fuses H via the proton–proton chain
19	A	3→2 is a smaller energy gap than 4→2 $\Rightarrow$ lower-energy photon $\Rightarrow$ longer wavelength
20	B	$\Delta m/\Delta t = P/c^2 = 3.8 \times 10^{26} / 9.0 \times 10^{16} = 4.2 \times 10^9$ kg s^{-1}

Section II — marking notes

Q21 (a). $\Delta\Phi$ per turn = $BA = 0.25 \times (0.040)^2 = 4.0 \times 10^{-4}$ Wb; $\varepsilon = N\Delta\Phi/\Delta t = 50 \times 4.0 \times 10^{-4} / 0.20 =$ **0.10 V**.

(b). Flux into the bench is decreasing, so the induced current acts to maintain it: **clockwise viewed from above** (right-hand grip: clockwise current produces flux into the bench through the coil). The mark is for the Lenz reasoning, not the bare direction.

Q22 (a). $\tau = nBIA = 20 \times 0.30 \times 1.5 \times (0.050 \times 0.080) = 20 \times 0.30 \times 1.5 \times 4.0 \times 10^{-3} =$ **3.6×10^{-2} N m**. (Trap: cm → m before computing A — the flagged 2025 Q23 error.)

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(b). |sin θ| shape: maximum 3.6×10^{-2} N m at 0° (plane parallel to B), zero at 90° (plane perpendicular to B), maximum again at 180°. One mark for the correct shape, one for the labelled zero/maximum angles.

Q23 (a). $u_y = 20 \sin 30° = +10$ m s^{-1} (up), $\Delta y = -25$ m: $-25 = 10t - 4.9t^2 \Rightarrow 4.9t^2 - 10t - 25 = 0 \Rightarrow t = [10 + \sqrt{(100 + 490)}]/9.8 = [10 + 24.3]/9.8 =$ **3.5 s**. Full marks require the sign convention stated and the quadratic (or an explicit two-stage up-then-down calculation) — a symmetric-flight calculation ($t = 2u_y/g \approx 2.0$ s) scores at most 1.

(b). $u_x = 20 \cos 30° = 17.3$ m s^{-1}; range $= 17.3 \times 3.5 =$ **61 m**.

(c). $v_y = 10 - 9.8 \times 3.5 = -24.3$ m s^{-1}; $v = \sqrt{(17.3^2 + 24.3^2)} = \sqrt{890} \approx$ **30 m s^{-1} at 55° below the horizontal** (consistency check: $v^2 = u^2 + 2g\Delta h = 400 + 490 = 890$ ✓).

Q24 (a). $GMm/r^2 = 4\pi^2 mr/T^2$ (gravitational force supplies the centripetal force); cancel m, rearrange: $r^3/T^2 = GM/4\pi^2$. Both force expressions and the cancellation must be shown.

(b). $T = 2.0 \times 24 \times 3600 = 1.728 \times 10^5$ s (the days-to-seconds conversion is the first mark). $M = 4\pi^2 r^3/(GT^2) = 39.48 \times (3.8 \times 10^8)^3 / (6.67 \times 10^{-11} \times (1.728 \times 10^5)^2) = 2.17 \times 10^{27} / 1.99 =$ **1.1×10^{27} kg**.

Q25 (a). $E_{photon} = hf = 6.626 \times 10^{-34} \times 6.5 \times 10^{14} = 4.31 \times 10^{-19}$ J = 2.69 eV. 2.69 eV > 2.1 eV (caesium emits); 2.69 eV < 4.3 eV (zinc does not). Both comparisons required.

(b). Kmax = 2.69 − 2.1 = 0.59 eV = $0.59 \times 1.602 \times 10^{-19} =$ **9.4×10^{-20} J**.

(c). Doubling intensity doubles the number of photons per second, each of unchanged energy hf; one photon releases one electron, so the number emitted per second doubles but Kmax = hf − φ is unchanged. "Brighter light gives faster electrons" is the target misconception.

Q26 (a). $\lambda = d \sin \theta / m = 2.5 \times 10^{-5} \times \sin 3.0° / 2 = 2.5 \times 10^{-5} \times 0.0523 / 2 =$ **6.5×10^{-7} m (654 nm)**.

(b). $\sin \theta = m\lambda/d$: λ falls from 654 nm to 450 nm, so sin θ (and θ) decreases in proportion — every maximum moves closer to the central maximum. The proportionality must be used, not just "the pattern shrinks".

(c). Decrease the slit separation d in the same proportion ($\sin \theta = m\lambda/d$ restored), or increase the slit-to-screen distance L (fringe spacing on the screen $\approx \lambda L/d$ restored). Justification via the relevant relationship for one of the two.

Q27 (a). $t = 1.5 \times 10^4 / (0.995 \times 3.0 \times 10^8) =$ **5.0×10^{-5} s (50 μs)**.

(b). $t = \gamma t_0 = 10.0 \times 2.2$ μs = **22 μs**. The proper lifetime is the muon's own 2.2 μs — swapping t and t_0 (giving 0.22 μs) is the flagged error.

(c). In the muons' frame the atmosphere is length-contracted: L = 15 km / 10.0 = **1.5 km**, so the journey takes $1.5 \times 10^3 / (2.985 \times 10^8) \approx 5.0$ μs ≈ 2.3 proper lifetimes — a substantial fraction survives, whereas the classical 50 μs ≈ 23 lifetimes would leave essentially none. Both frames predict the same survival; the mark is for a single-frame, internally consistent account with the calculation.

Q28 (a). $qE = qvB \Rightarrow v = E/B = 4.0 \times 10^4 / 0.20 =$ **2.0×10^5 m s^{-1}**.

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(b). r = mv/qB = $1.673 \times 10^{-27} \times 2.0 \times 10^{5} / (1.602 \times 10^{-19} \times 0.20)$ = **1.0×10^{-2} m (1.0 cm)**.

Q29 (a). qV = ½mv² ⇒ v = √(2qV/m) = √(2 × 1.602 × 10^{-19} × 500 / 9.109 × 10^{-31}) = √(1.76 × 10^{14}) = **1.33×10^{7} m s^{-1}**. (Trap: uppercase V is voltage, lowercase v speed.)

(b). r = mv/qB = $9.109 \times 10^{-31} \times 1.33 \times 10^{7} / (1.602 \times 10^{-19} \times 1.5 \times 10^{-3})$ = **5.0×10^{-2} m (5.0 cm)**.

(c). r ∝ m/q at fixed v and B: the proton's radius is ≈ 1836 times larger (≈ 92 m), and its path curves in the opposite sense because its charge is opposite.

Q30 (a). Vs = 240/20 = **12 V**; Pin = Pout = 24 W ⇒ Ip = 24/240 = **0.10 A**.

(b). Secondary power doubles to 48 W; for an ideal transformer Pin must equal Pout, so with Vp fixed at 240 V the primary current doubles to 0.20 A. The mark is for invoking conservation of energy to carry the change from secondary to primary — describing only the secondary caps at 1.

Q31 (a). T = b/λmax = $2.898 \times 10^{-3} / 5.80 \times 10^{-7}$ = **5.0×10^{3} K**. (λmax in metres; answer in kelvin.)

(b). The line is shifted to a longer wavelength (redshift), so star Q is **receding** from Earth.

(c). As the star rotates, one limb approaches (its absorption blueshifted) while the other recedes (redshifted); light from the whole disc is received together, so each line is smeared over a range of wavelengths — broadened symmetrically. Faster rotation gives broader lines. (Rotation about the star's own axis, not orbital revolution — the flagged 2023 error.)

Q32 (a). Y: **red giant** (post-main-sequence); Z: **white dwarf** (final stage for a Sun-like star, fusion ceased).

(b). X is on the main sequence fusing hydrogen to helium in its core via the proton–proton chain (Sun-like core temperature). Y has exhausted core hydrogen: it fuses helium (to carbon/oxygen) in its core and/or hydrogen in a surrounding shell, at a higher core temperature. Both stars named, both processes distinguished.

(c). Luminosity depends on both temperature and surface area ($L \propto R^2T^4$): Z's radius is tiny, so despite the higher surface temperature its radiating area — and hence luminosity — is far smaller.

Q33 (a). Mass halves every **8.0 days** (100 → 50 g at 8.0 d; 50 → 25 g at 16 d). The value must be read from the graph.

(b). λ = ln 2 / t½ = 0.693 / (8.0 × 24 × 3600 s) = 0.693 / 6.91×10^{5} = **1.0×10^{-6} s^{-1}**. (Days-to-seconds conversion is the second mark.)

(c). 5.0 = 100 e^(−λt) ⇒ t = ln(20)/λ = 3.00 / 0.0866 day^{-1} = **35 days** (equivalently 3.00 / 1.0×10^{-6} s^{-1} ≈ 3.0×10^{6} s). Requires solving with natural logarithms, not stepping half-lives (4.32 half-lives is not an integer count).

Q34 (a). Δm = 209.98286 − (205.97446 + 4.00260) = 209.98286 − 209.97706 = 0.00580 u. E = 0.00580 × 931.5 = **5.40 MeV** = $5.40 \times 10^{6} \times 1.602 \times 10^{-19}$ = **8.7×10^{-13} J**. (Traps: early rounding of the masses; MeV–joule conversion.)

(b)(i). The nucleus is initially at rest, so total momentum is zero: the alpha particle and lead nucleus recoil with equal and opposite momenta. For equal momentum magnitudes, KE = $p^2/2m$ — the lighter particle carries the larger share of the kinetic energy, so the alpha (4 u vs 206 u) takes almost all of it.

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(b)(ii). KE_α = E × m_Pb/(m_Pb + m_α) = 5.40 × 205.97/209.98 = **5.30 MeV** (≈ 98% of the released energy; KE_Pb ≈ 0.10 MeV).

Q35 (a). $E = -GMm/2r = -(6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 800)/(2 \times 7.0 \times 10^{6}) = -3.20 \times 10^{17} / 1.4 \times 10^{7}$ = **-2.3×10^{10} J**. The negative sign is required — it signifies a bound orbit.

(b). $E_2 = -3.20 \times 10^{17} / 2.8 \times 10^{7} = -1.14 \times 10^{10}$ J. Energy supplied = $E_2 - E_1 = -1.14 \times 10^{10} - (-2.29 \times 10^{10})$ = **$+1.1 \times 10^{10}$ J**. (Trap: a less negative total energy is an increase.)

(c). Moving outwards, kinetic energy decreases but potential energy (U = −GMm/r) increases by twice as much; the total mechanical energy therefore rises, and that difference must be supplied by the thrusters. "It slows down so it loses energy" is the target misconception.

Q36 (a). $v = 2\pi rf = 2\pi \times 0.10 \times 12$ = **7.5 m s^{-1}**.

(b). Full chain (one mark per link band): as the disc rotates, the magnetic flux through each region of the disc near the magnet changes → an emf is induced (Faraday) → eddy currents circulate in the conducting disc → by Lenz's law these currents flow so that the magnetic forces on them oppose the relative motion, producing a retarding torque on the disc → the disc's rotational kinetic energy is transformed into heat in the disc's resistance. Answers that say only "Lenz's law opposes the motion" without the intermediate emf/current steps cap at 2.

(c). The gradient of the solid-disc curve decreases in magnitude as the disc slows: the rate of flux change is proportional to the disc's speed, so the induced emf, eddy currents and retarding torque all shrink as it slows — the braking effect weakens, and the disc approaches zero asymptotically rather than stopping abruptly.

(d). The radial slots interrupt the circulating paths of the eddy currents, so only much smaller currents can flow; the opposing forces are correspondingly smaller and the disc keeps most of its kinetic energy over the same interval.

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Prediction provenance

Which consensus prediction each part of this paper realises. Full evidence panels: intuitioneducation.com.au/hsc-2026

Paper item	Prediction	Agreement
Section I Q1	`topic-level consensus`	0.55 (grok) · 2 (grok, deepseek)
Section I Q2	`topic-level consensus`	0.80 (opus) · 2 (opus, gemini-3.1-pro)
Section I Q3	`watch list`	0.85 (opus), 0.55 (gpt-5.6-sol), 0.50 (grok) · 3
Section I Q4	`watch list`	0.42 (grok) · 1
Section I Q5	`watch list`	0.45 (deepseek), 0.38 (gpt-5.6-sol) · 2
Section I Q6	`watch list`	0.50 (grok), 0.50 (deepseek), 0.45 (fable) · 4
Section I Q7	`watch list`	0.55 (deepseek), 0.85 (gemini-3.1-pro as sketch) · 2
Section I Q8	`topic-level consensus`	0.38 (grok) · 2 (grok, opus)
Section I Q9	`watch list`	0.48 (gpt-5.6-sol), 0.45 (grok) · 4
Section I Q10	`watch list`	0.45 (grok) · 1
Section I Q11	`watch list`	0.50 (deepseek) · 2
Section I Q12	`watch list`	0.55 (deepseek), 0.46 (grok as sketch) · 3
Section I Q13	`watch list`	0.43 mean · 5
Section I Q14	`watch list`	0.50 (fable), 0.50 (deepseek), 0.45 (opus) · 3
Section I Q15	`topic-level consensus`	0.55 (deepseek) · 2 (deepseek, gpt-5.6-sol)
Section I Q16	`watch list`	0.50 (deepseek), 0.40 (grok) · 4
Section I Q17	`topic-level consensus`	0.50 (grok) · 2
Section I Q18	`watch list`	0.40 (fable, grok) · 3

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Paper item	Prediction	Agreement
Section I Q19	`watch list`	0.60 (fable), 0.45 (opus, grok) · 3
Section I Q20	`topic-level consensus`	0.50 (fable) · 2
Q21	`watch list`	0.59 mean · 3 (fable, opus, gpt-5.6-sol)
Q22	`phys-q12-motor-torque`	0.55 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q23	`phys-q1-asymmetric-projectile`	0.65 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q24	`phys-q10-kepler-third-law`	0.56 · 4 (fable, opus, gemini-3.1-pro, deepseek)
Q25	`phys-q8-photoelectric`	0.57 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q26	`phys-q9-double-slit`	0.57 · 5 (fable, opus, gemini-3.1-pro, gpt-5.6-sol, grok)
Q27	`phys-q3-time-dilation-length-contraction`	0.61 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q28	`phys-q14-crossed-fields`	0.54 · 5 (fable, opus, gemini-3.1-pro, gpt-5.6-sol, grok)
Q29	`phys-q7-charge-in-magnetic-field`	0.57 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q30	`phys-q13-transformer-transmission`	0.54 · 5 (fable, opus, gemini-3.1-pro, gpt-5.6-sol, grok)
Q31	`phys-q5-stellar-spectrum`	0.59 · 4 (fable, opus, gemini-3.1-pro, deepseek)
Q32	`phys-q2-hr-diagram-fusion`	0.61 · 6 (all)
Q33	`watch list`	0.53 mean · 4 (fable, opus, gpt-5.6-sol, grok)
Q34	`phys-q11-mass-defect-momentum`	0.55 · 5 (fable, opus, gemini-3.1-pro, grok, deepseek)
Q35	`watch list`	0.48 mean · 4 (fable, opus, gpt-5.6-sol, grok)
Q36	`phys-q4-eddy-current-device`	0.60 · 4 (fable, opus, deepseek, grok — fable/opus merged one vote per contamination note)

Built by an AI panel and backtested against the hidden 2025 papers before publication — method at intuitioneducation.com.au/hsc-2026/how-we-did-it. Scored publicly in November 2026. Independent Intuition Education material from publicly available NESA documents; not affiliated with or endorsed by NESA.

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