

IB Physics HL — Paper 1A TZ C — Mark Scheme

28 April 2026 | 40 questions | 40 marks | Calculator required

Q	Answer	Explanation	Marks
1	B	Car starts from rest; $v = at$ so displacement $s = \frac{1}{2}at^2 = vt/2$.	1
2	A	Rock (no air resistance): faster vertical fall, lands first. Constant horizontal speed \rightarrow larger range. Ball slowed by air resistance in both directions.	1
3	A	Terminal velocity: Buoyancy = Weight + Drag = $(3+2) \times 10^{-8}$ N. $\rho_{\text{oil}}/\rho_{\text{water}} = \text{Weight}/\text{Buoyancy} = 3/5$.	1
4	B	Impulse = change in momentum = $12 \text{ kg m s}^{-1} = 12 \text{ N s}$.	1
5	D	Constant speed \rightarrow work by gravity = work by friction. $F_{\text{friction}} \times 30 = 1.5 \times 14 \rightarrow F = 1.5 \times 14/30 \text{ kN}$.	1
6	D	Constant velocity \rightarrow net force = 0. GPE rate = Weight $\times v = 2F \cos\theta \times v = 2Fv \cos\theta$.	1
7	C	Angular momentum conserved. $\Delta E \propto r^2/(I_{\text{disc}} + mr^2)$, which increases monotonically from 0 at $r=0$ to a maximum at $r=R$.	1
8	C	Constant net torque \rightarrow constant angular acceleration \rightarrow angular momentum $L = I\omega = Iat$ increases linearly with time.	1
9	D	Proper time is measured by a clock present at both events. The spaceship clock is present at both departure (E) and arrival (F).	1
10	C	$P = \epsilon\sigma AT^4$. $P_2 = \epsilon \cdot \sigma \cdot (A/4) \cdot (2T)^4 = \epsilon \cdot \sigma \cdot (A/4) \cdot 16T^4 = 4\epsilon\sigma AT^4 = 4\epsilon \cdot P_1$. So $P_2/P_1 = 4\epsilon$.	1
11	A	Equal heat flow through both bars: $k_1 (T_1 - T_M) = k_2 (T_M - T_2) \rightarrow T_M = (k_1 T_1 + k_2 T_2)/(k_1 + k_2)$.	1
12	C	Without atmosphere: no greenhouse effect \rightarrow cooler surface (III smaller) \rightarrow less thermal radiation (II smaller). Solar intensity at Earth's orbit is unchanged (I same).	1
13	C	Gradient $q = PV$ (isothermal, so $PV = \text{constant} = q$). Internal energy of monatomic ideal gas = $(3/2)nRT = (3/2)PV = 3q/2$.	1
14	B	Isothermal compression (left along gentle curve) \rightarrow adiabatic expansion (right along steeper curve to larger V) \rightarrow isovolumetric heating (vertical line up). Matches diagram B.	1
15	D	$W = q\Delta V = 2 \text{ J}$, $\Delta V = 2 \text{ V}$. A charge of -1 C moving from Y to X (from low to high potential): $W = (-1)(V_Y - V_X) = (-1)(-2) = +2 \text{ J}$ ✓	1
16	B	Two R in parallel: $R_{\text{total}} = R/2$. Power $P = \epsilon^2/R_{\text{total}} = \epsilon^2/(R/2) = 2\epsilon^2/R$.	1
17	D	$a = d^2x/dt^2 = -\omega^2x = -(5^2)(0.04 \sin(5t+0.1)) = -\sin(5t+0.1)$.	1
18	B	E is upward (\hat{j}). For propagation to the right (\hat{i}): $E \times B$ must point right $\rightarrow \hat{j} \times \hat{k} = \hat{i}$ ✓. So B is out of the page.	1
19	D	Angles with normal: $\theta_1 = 90^\circ - 60^\circ = 30^\circ$, $\theta_2 = 90^\circ - 50^\circ = 40^\circ$. Snell's law: $n_2 = n_1 \sin\theta_1 / \sin\theta_2 = 1.5 \sin 30^\circ / \sin 40^\circ$.	1
20	B	The 4th double-slit fringe coincides with the 1st diffraction minimum, so $d/a = 4$, giving slit width/slit separation = $a/d = 1/4$.	1
21	C	Closed-open pipe: only odd harmonics. Fundamental $\lambda = 60 \text{ cm} \rightarrow L = 15 \text{ cm}$. Next allowed: $\lambda = 4L/3 = 20 \text{ cm}$.	1
22	B	Galaxy moving away \rightarrow redshift \rightarrow spectral lines shifted toward longer wavelengths (red end of spectrum).	1

Q	Answer	Explanation	Marks
23	A	Moving source approaching: $\lambda_{\text{obs}} = \lambda(v-v_s)/v = \lambda(v-v/5)/v = \lambda(4/5) = 4\lambda/5$.	1
24	A	$g = (4/3)\pi G\rho R$. Same density, $R'=R/2 \rightarrow g' = g/2 = 10/2 = 5 \text{ m s}^{-2}$.	1
25	C	Field zero at Z: $Gm/r^2 = 4Gm/(d-r)^2 \rightarrow d = 3r$. Potential: $V = -Gm/r - 4Gm/2r = -3Gm/r$.	1
26	B	Charges Q and -2Q touch \rightarrow total = -Q, each gets -Q/2. New force $F' = k(Q/2)^2/r^2 = kQ^2/(4r^2) = F/8$. Both negative \rightarrow repulsive (away).	1
27	D	Three positive charges share connected equipotentials; the one negative charge has separate concentric equipotentials. A zero-potential surface separates the two groups.	1
28	A	Uniform E field \rightarrow constant force \rightarrow constant acceleration. Electron moving along field: straight line (I). Entering perpendicular: parabolic (II). Circular path impossible in uniform E alone.	1
29	C	The magnetic field from vertical wire Y acts on horizontal wire X. Net force on X is non-zero (directed upward/downward). Torque about X's midpoint is zero by symmetry.	1
30	A	Rod moves right, B out of page. Magnetic force on electrons: $F_m = (-e)(v \times B) =$ upward. At equilibrium, electric force $F_e =$ downward.	1
31	D	Max EMF = $NBA\omega$. Decreasing period of rotation increases $\omega \rightarrow$ increases max EMF.	1
32	D	Rutherford experiment: most alpha particles passed through undeflected \rightarrow most of the atom is empty space, with a tiny dense nucleus.	1
33	D	Transition 4 (-1.90 \rightarrow -4.06 eV): $\Delta E = 2.16 \text{ eV} \rightarrow$ visible light. Transition 3 (-0.016 \rightarrow -4.06 eV): $\Delta E = 4.04 \text{ eV} \rightarrow$ UV ($> 3.1 \text{ eV}$).	1
34	D	$\Delta\lambda = h/(m_e c)$ corresponds to 90° Compton scatter. Diagram D shows incident photon, target electron, scattered photon at $\sim 90^\circ$, recoil electron forward.	1
35	B	$\lambda = h/p = h/\sqrt{(2mK)} \propto 1/\sqrt{K}$.	1
36	D	Alpha decay: ${}^{225}_{87}\text{Ac} \rightarrow {}^4_2\text{He} + \text{X}$. X has $A=221, Z=87$. Neutrons = $221-87 = 134$.	1
37	B	β^+ decay: proton converts to neutron: $p^+ \rightarrow n + e^+ + \nu$.	1
38	C	Decay constant $\lambda = \ln 2/t_{1/2} = \ln 2/(28 \times 3600) \text{ s}^{-1}$. Probability $\approx \lambda \times \Delta t = \ln 2/(28 \times 3600)$ for $\Delta t = 1 \text{ s}$.	1
39	A	Moderator slows neutrons by elastic collisions. Most effective with similar mass to neutron \rightarrow small nucleon number. Must be stable (not absorb neutrons).	1
40	A	Parallax angle p is the angle at Earth (θ) using 1 AU baseline. Distance $d = 1/\theta$ parsecs.	1