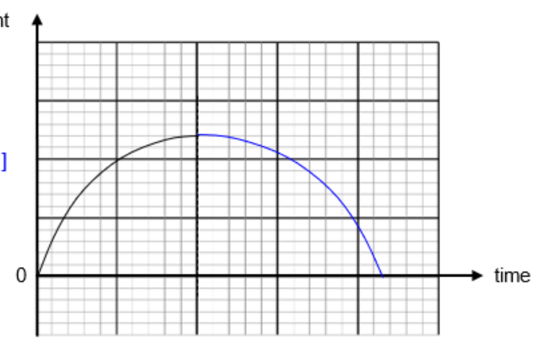
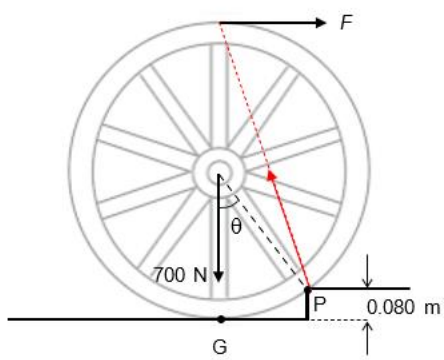
2025 H2 Physics P2 Suggested Solution

1(a)(i)	From energy conservation, gain in g.p.e. = loss in k.e. $mg(10.0) = \frac{1}{2}mu^2 - \frac{1}{2}m(5.00)^2$ $u = 14.87 \approx 14.9$ m s^{-1}.	M1
(a)(ii)	$14.873\, cos\, cos\, \theta \ = 5.00$ $\theta = 70.4°$ Or Vertical motion: $u_y = 14.9\, sin\, sin\, q\ \uparrow,\ a_y = 9.81 \downarrow,\ s_y = 10.0 \uparrow,\ v_y = 0$ From $v^2 = u^2 + 2as$ taking ↑ +ve: $0 = u_y^2 + 2(-9.81)(10.0)$ $u_y = \sqrt{196.2} = 14.873\, sin\, sin\, \theta$ $\theta = 70.4°$	M1 A1 M1 A1
(a)(iii)	Consider vertical motion: $u_y = 14.873\, sin\, sin\, 70.4°\ \uparrow,\ a_y = 9.81 \downarrow,\ s_y = 0,$ $t = ?$ From $s_y = u_y t + \frac{1}{2}a_y t^2$ and taking ↑+ve: $0 = (14.873\, sin\, sin\, 70.4°\,)t + \frac{1}{2}(-9.81)t^2$ $0 = \left\{(14.873\, sin\, sin\, 70.4°\,) + \frac{1}{2}(-9.81)t\right\}(t)$ $t = 0$ (reject) or $t = \frac{2(14.873 sinsin\ 70.4°\,)}{9.81} = 2.86$ s or $0 = (14.873\, sin\, sin\, 70.4°\,) - 9.81t'$ $t = 2t' = 2.86$ s	M1 A1
(a)(iv)	Rate of change of momentum = resultant force = weight = mg = 8.00 x 10^{-3} x 9.81 = 0.0785 N	A1
(b)	Correct shape [B1] Time of descent > time of ascent [B1]  	

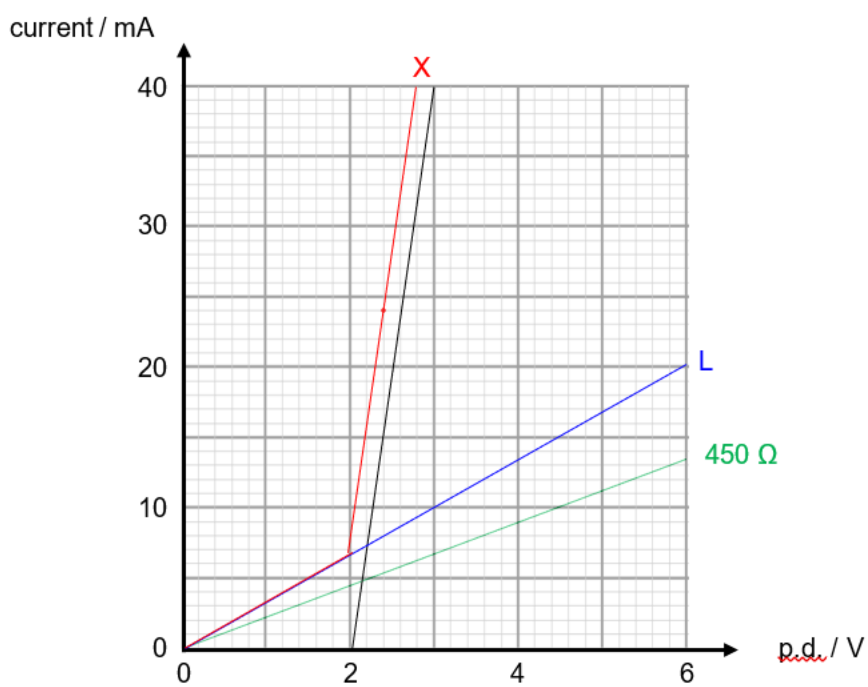
2(a)	No resultant external force acting on the two colliding / interacting objects.	B1
(b)(i)	Force on B = rate of change of momentum of B $= \frac{(24-20)\times 10^3}{3.0-1.5}$ = 2667 ≈ 2700 N	M1 A1
(b)(ii)	Gradient is equal to the rate of change of momentum of the truck and this is also equal to the impact force exerted on the trucks according to Newton's 2nd law Since the impact forces between the two trucks are an action-reaction pair and and are of equal magnitude but acts in opposite directions, the gradients have the same magnitude but opposite signs.	B1 B1
(b)(iii)	Impulse acting on each truck (during the collision) is equal to the change in momentum of the truck. Since the impulse on the two trucks are equal and opposite, it follows that the gain in momentum of one truck must be equal to the lost in momentum of the other truck. Hence total momentum is conserved.	B1 B1
(b)(iv)	Total kinetic energy of the two trucks before collision $= \frac{(20{,}000)^2}{2\times 4000} + \frac{(16{,}000)^2}{2\times 2000} = 114$ kJ Total kinetic energy after collision $= \frac{(24{,}000)^2}{2\times 4000} + \frac{(12{,}000)^2}{2\times 2000} = 108$ kJ [C1- for calculation of KE before and after collision] Change in kinetic energy = - 6000 J (Perfectly) Inelastic collision	 A1 B1

3(a)	$cos\ cos\ \theta\ = \frac{0.60-0.08}{0.60}$ $\theta = 29.93 \approx 30°$	M1
(b)	 	B1
(c)	Using principle of moments and taking moments about P: $700 \times 0.60\ sin\ sin\ 30\ = F(1.20 - 0.08)$ $F = 187.5 \approx 188$ N = 190 N	M1
(d)	Sum forces vertically: $R_y = 700$ N Sum forces horizontally: $R_x = 188$ N $R = \sqrt{700^2 + 190^2}$ = 725 = 730 N (Accept between 725 to 730)	C1 C1 A1

4(i)	They are an action-reaction pair or they are equal in magnitude and opposite in direction.	B1
(ii)	$Mr_1\left(\frac{2\pi}{T}\right)^2 = 2Mr_2\left(\frac{2\pi}{T}\right)^2$ $\frac{r_1}{r_2} = \frac{2M}{M} = 2$	B1
(iii)	Since $\frac{r_1}{r_2} = 2$ and $r_1 + r_2 = 3.0 \times 10^{12}$ $r_1 = \frac{2}{1+2} \times 3.0 \times 10^{12} = 2.0 \times 10^{12}$ m	C1 A1
(iv)	Consider forces acting on *M*. From Newton's 2nd law and Newton's law of universal gravitation, $$\frac{G(2M)(M)}{(3.0 \times 10^{12})^2} = M(2.0 \times 10^{12})\left(\frac{2\pi}{T}\right)^2$$ $$T^2 = \frac{(4\pi^2)(2.0 \times 10^{12})(3.0 \times 10^{12})^2}{(6.67 \times 10^{-11})(2 \times 2.0 \times 10^{30})} = 2.6635 \times 10^{18}$$ $T = 1.63 \times 10^9$ s	M1 A1

5(a)	Any two of the following: ● Energy is transferred along the direction of propagation of progressive waves while there is no propagation of energy in a stationary wave. ● There is a propagation of the waveform (the crests/troughs/compressions/rarefactions of the waves) in a progressive wave but the waveform of a stationary wave does not move but instead undergoes changes in shape. ● All particles within an internodal segment are in phase in a stationary wave while the phase difference of particles in progressive waves is proportional to their distance apart. ● Amplitudes of vibrations of particles in a stationary wave vary from a minimum at the nodes to a maximum at the antinodes while the amplitude of a progressive wave (propagating in a plane) remains the same.	B2
(b)(i)	A (micro)wave (from the transmitter) is incident on the sheet and reflects at Y The incident and reflected waves overlap and superpose to form stationary wave.	B1 B1
(b)(ii)	Distance between PY = 50 x (0.5 λ) 1.5 = 50 x (0.5 λ) λ = 0.060 m	M1 A1
(b)(iii)(1)	wavelength decreases, distance between maxima/minima decreases Number of maximum amplitude increases	M1 A1
(b)(iii)(2)	wavelength is unchanged so (PQ is) the same (as QR). Distance between maxima/minima remains the same. Number maximum amplitude remains unchanged	M1 A1

6(a)	The magnetic flux density at a point in space is the magnetic force per unit length per unit current acting on a long straight conductor carrying current and placed at right angle to the field at that point. 1 marks for any 2 underlined phrases 2 marks for 3 underlined phrases	B2
(b)	Spacing between **circles** increases with distance from wire (at least three circles needed) Arrows showing direction of field is clockwise	B1 B1
(c)(i)	(each) wire lies/sits in the (magnetic) field generated/created by the other OR magnetic fields generated/created by the wires interact with each other. current (in one wire) is **perpendicular** (or not parallel) to (magnetic) field (due to other wire) so (magnetic) force acts (on wire)	B1 B1
(c)(ii)	Arrow drawn to the left of X, labelled F	B1
(c)(iii)	B-field on X due to Y = $\frac{\mu_o I}{2\pi d}$ = $\frac{4\pi x10^{-7}(3)}{2\pi(0.12)}$ = 5.0 x 10^{-6} T Force on X per unit length, F = BIL $\frac{F}{L}$ = 5 x 10^{-6} (2) = 10 x 10^{-6}	C1 A1
(c)(iv)	Magnetic field acting on Y by X is parallel to the wire Y. No magnetic force acts on Y.	A1

7(a)	300 Ω	A1
(b)(i)	$\frac{R}{300} = \frac{6.0-2.4}{2.4}$ or any other method *R* = 450 Ω	C1 A1
(b)(ii)	Resistance of the LDR increases Since current drop, pd across fixed resistor drops, OR using potential divider, potential difference across the LDR increases [B1]	B1 B1
(c)	R = V/I = 3.0 / 40 × 10^{-3} = 75 Ω	A1 A1
(d)(1)(2)	 Fig. 7.4	B1 A1

	L: straight line passing through (0,0) and (6,20) Note: The LDR follows Ohm's Law and has a resistance of 300 Ω X: same as L between pd = 0 V and 2 V, parallel to LED graph above 2 V Component X will not allow current in the LED branch but will allow the same current in the LDR branch below 2 V. Above 2 V, current in component X = sum of current in LDR and LED (accurately, we should have a curve that starts parallel to LED graph but eventually curve away from it, but this effect is not significant over this range.)	
d)(1)(2)	9.0 ± 0.5 mA 9 ± 1 mA Find the current where the pd across X and fixed resistor (450 Ω) sums to 6 V. (Note: In a series circuit, the two components in series will have the same current flowing through them.) You will need to draw the line for 450 Ω resistance first though. Pro-tip: Place a ruler parallel to x-axis and shift it up/down.	A2 A1

8(a)	energy gained by an electron with charge 1.6×10^{-19} C when accelerated / moved <u>through a p.d. of one volt</u>	B1 B1
(b)(i)	energy of photon = $(60 \times 10^3) \times (1.6 \times 10^{-19})$ wavelength = $(6.63 \times 10^{-34}) \times (3.0 \times 10^8) / 9.6 \times 10^{-15}$ = 2.1×10^{-11} or 2.07×10^{-11} m	C1 C1 A1
(b)(ii)	(incident) electrons encountering target (anode) lose energy to give several X-ray photons of lower energy / higher wavelength than **(b)(i)**.	B1
(c)(i)	energy = $10^{4.84} - 10^{4.06}$ = 57700 eV = 57.7 keV	C1 A1
(c)(ii)	Use either the proportionality constant from the Moseley for each element or compare the ratios of Z and $\sqrt{E}$. Ratios involve at least 3 elements Conclusion with valid reason	M1 M1 A1
(c)(iii)	K_β photon is created by an energy drop that is larger than the K_α photon	B1
(d)	energy is produced as heat in the target tungsten has a high melting point (so will not melt) **OR** tungsten has a high proton number greater probability of collisions between electrons and the large nucleus	B1 B1 B1 B1
(e)(i)(1)	penetrating power = ln 2 / 0.528 = 1.31 cm	C1
(e)(i)(2)	$I/I_0 = 0.40 = e^{-0.528x}$ x = 1.74 cm	M1 A1

(e)(ii)	$0.60 = e^{-\mu(3.87)}$ gives $\mu = 0.132\ cm^{-1}$	A1
(e)(iii)	Different coefficient for different body material Coefficient affects brightness / intensity of parts	B1 B1