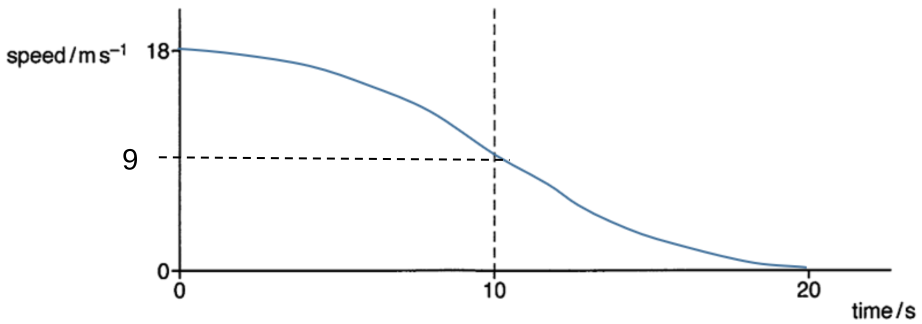
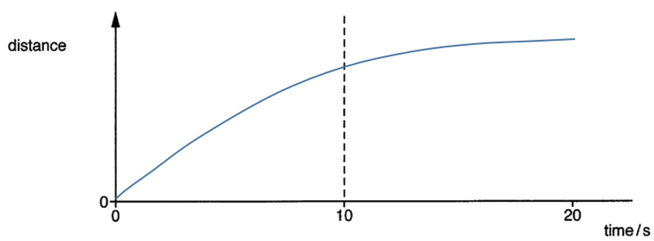
JC2 Prelim (H2 Physics) Paper 2 Solutions

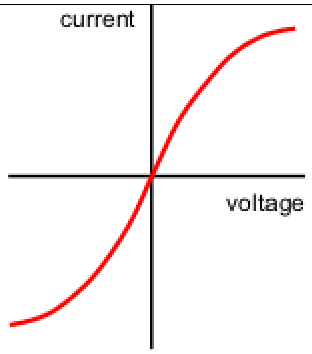
1(a)(i)	a = dv/dt ⊗v = + a dt = area enclosed by a-t graph ⊗ v = area enclosed by F-t graph / m (as F = ma) = [½ (1980)(10)] /1100 = 9.0 m s^{-1} v = v_i - ⊗v = 18.0 – 9.0 = 9.0 m s^{-1}	[1 – for ⊗p or ⊗v using area under graph] [1]
(ii)	The net force is the braking force	[1]
(b)	 A downward slope with speed starting from 18 m s^{-1} and end at 0 Gradient of curve starts from 0 at t=0 and increases to a max gradient at 10 s. Gradient of curve decreases gradually from max at 10 s to 0 at t=20 s	[1] [1] [1]
(c)	 Gradient of the curve decreases non-linearly from a max at t= 0 to 0 at t=20 s. Distance is 0 at t=0 and max at t=20	[1] [1]
2(a)	sum / total momentum before (interaction) = sum / total momentum after **or** sum / total momentum (of a system of interacting objects) is constant	[1]
	if no resultant force / for an isolated system	[1]

(b)(i)	$3m \times 4 = m \times v \sin\Theta$ ($v \sin\Theta = 12$) $2m \times 6 = m \times v \cos\Theta$ ($v \cos\Theta = 12$) therefore, $\sin\Theta = \cos\Theta$ **or** $\tan\Theta = 1$ $\Theta = 45°$ or a method using close triangle of the momentum vectors and trigo	[1] [1] [1]
(b)(ii)	$mv \times \cos 45° = 12m$ **or** $mv \times \sin 45° = 12m$ **or** $(mv)^2 = (3m \times 4)^2 + (2m \times 6)^2$ $v = 17$ m s^{-1} or use pyth theorem for momentum	[1-ecf] [1-ecf]
(c)	Chemical energy = ½ mv^2 (By conservation of energy) Chemical energy = 0.0050 x 700 or 5.0 x 0.700 = 3.5 $3.5 = (0.5 \times 3m \times 4^2) + (0.5 \times 2m \times 6^2) + (0.5 \times m \times 17^2)$ 0.0050 x 700 or 5.0 x 0.700 = 3.5 = 204m m = 0.017 kg	 [1] [1-ecf] [1-ecf]

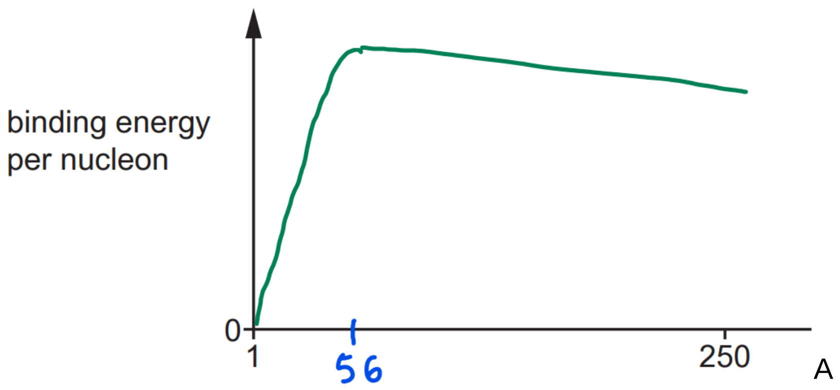
3(a)	$F = \rho g V$ $V = 4 / 3 \times \pi \times (2.1 \times 10^{-3})^3 = 3.88 \times 10^{-8}$ m^3 $\rho = 4.8 \times 10^{-4} / 9.81 \times V = 1300$ kg m^{-3}	 [1] [1]
(b)(i)	W downwards > U upwards > F_v upwards. total length up = total length down	[1]
(ii)	$F_V = 7.2 \times 10^{-4} - 4.8 \times 10^{-4} = 2.4 \times 10^{-4}$ (N) velocity = $2.4 \times 10^{-4} / (17 \times 2.1 \times 10^{-3}) = 6.7 \times 10^{-3}$ m s^{-1}	[1] [1]

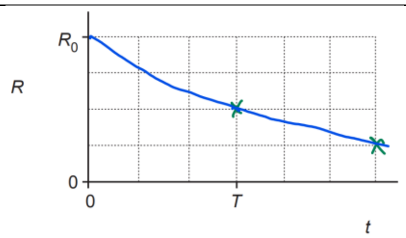
4 (a)	From infinity to Mars, |KE gain| = |GPE loss| Thus, $\| \frac{1}{2} mv^2 – 0 \| = \| m)_{surface} - m) \|$ $= \| (-\frac{GMm}{R}) – zero \|$ □speed of rock v = $\frac{2GM}{\frac{D}{2}}$ where M = 6.4×10^{23} kg, D = 6.8×10^6 m = 5.0×10^3 m s^{-1}	[1] [1]
(b)(i)	½ m $<c^2>$ = 3/2 kT □ temperature T = $\frac{m<c^2>}{3k}$ where mass of 1 atom, m = $\frac{4x10^{-3}kg}{N_A}$, $<c^2>$ = [Ans in (a) $]^2$ = 2.5×10^7 m^2s^{-2} = 4.0×10^3 K ● [1 m] for mass of 1 atom, m = $\frac{4x10^{-3}kg}{N_A}$ ● [1 m, ecf v & m] for correct caln of T	 [1] [1]
(ii)	1. The speed in (a) is the escape speed fr surface of Mars. 2. Since surface temperature of Mars is (much) lower than the temperature in (b) (i), 3. rms speed of He-4 is (much) lower than the escape speed. Thus, helium-4 gas is found on surface of Mars.	[1] [1]

5(a)	Progressive: all particles have the same amplitude Stationary: maximum to minimum/zero amplitude Progressive: adjacent particles within one wavelength are not in phase Stationary: waves particles are in phase between adjacent nodes and/or wave particles between adjacent nodes are in antiphase to wave particles in the next adjacent nodes.	[1] [1]
(b)(i)	wavelength = 1.2 m(zero displacement at 0. 0.60 m, 1.2 m, 1.8 m, 2.4 m) either peaks at 0.30 m and 1.5 m and troughs at 0.90 m and 2.1 m or vice versa (but not both) maximum amplitude 5.0 mm	[1] [1]
(ii)	180° or □ rad	[1]
(iii)	t = 0, particles has KE as particle is moving t = 5.0 ms, particle has no KE as particle is stationary so decrease in KE between t = 0 to 5.0 ms.	[1] [1]

6(a)(i)	$R = \rho L / A$ $P = I^2 R$ Therefore rate of heat loss, $P \quad \rho L / A$ $P_X / P_Y = (〉_x/〉_y)$ x (L_x/L_Y) x (A_Y / A_X) = (1/1.58) (1/1.50) (1.50) = 0.633	 [1] [1]
(ii)	Wire X because there is lower rate of energy loss as thermal energy in the wire.	[1]
(iii)1.	The cable is made up of 5 thin wires in parallel. Let resistance of a single thin wire be R. 1 / 0.0458 = 5 (1 / R) R = 0.229 Ω	 [1] [1]
2.	Any one: Several thin wires are more flexible than a single thick wire Thin wires have more surface area and thus dissipate heat more effectively/better dissipate the heat (Note: both wires have the same heat production but heat dissipation from the wire can be different) Cable remains workable even when one wire is broken	[1]
(b)(i)	 Note: The line must not be horizontal at high voltage. Hence do not overdo the decreasing slope. The graph near the origin should be linear.	[1]
(ii)	With increasing magnitude of V, more heat is dissipated and temperature of filament rises, Lattice metal ions vibration amplitude increase, Collision frequency between metal ions and electrons increase, Resistance increases (and the current increases at a decreasing rate.)	 [1] [1] [1]

(iii)	No, the equation is only true where the I-V graph is a straight line passing through origin (ohmic conductor) but this I-V graph is not. OR No, as the resistance is represented by the inverse of the gradient of a line connecting that point to the origin. It is not the inverse of the tangent at that point because the resistance is the ratio of the potential difference to the current.	[1]

7(a)(i)	Nuclear fusion is the process where two light/small nuclei are combined to produce a heavier/large nucleus with the release of energy.	[1]
(ii)	 line with a peak at A≈56 line with steep initial positive gradient on the left of peak and gentler negative gradient at all points to the right of peak and line does not return to 0 binding energy	[1]
(iii)1.	X shown at value of A to the right of the peak	[1]
(iii)2.	Y shown at value of A close to 1	[1]
(iv)	energy from 1 nucleus = $(1.77 \cdot 10^{13}) / (6.02 \cdot 10^{23}) = 2.94 \cdot 10^{-11}$ J nucleon number of Z = 93 + 139 + 2 – 1 = 233 Energy Released = Total Binding Energy Final – Total Binding Energy Initial $2.94 \cdot 10^{-11}$ J = $[(1.25 + 1.81) \cdot 10^{-10}]$ - binding energy of Z binding energy of Z = $[(1.25 + 1.81) \cdot 10^{-10}] – 2.94 \cdot 10^{-11}$ $= 2.77 \cdot 10^{-10}$ J binding energy per nucleon $= (2.77 \cdot 10^{-10}) / (233 \cdot 1.60 \cdot 10^{-13}) = 7.43$ MeV	[1] [1 – equation to for energy released] [1 – J to MeV]

(b)(i)	$A = \lambda N$ and $\lambda = \ln 2 / T$ Since the number of moles of fluorine-18 is n, the initial number of fluorine-18 nuclei: $N = n \cdot N_A$ $A_0 = \lambda N_0$ 2 photons produced from each decay, so $R_0 = 2\ A_0$ $= 2\ \lambda N_0$ $= 2 \cdot \lambda \cdot n \cdot N_A$ $= (2 \ln 2)\ nN_A / T$	[1] [1]
(ii)	 exponential decay curve from $t = 0$ to $t = 2T$, starting at $(0, R_0)$ and with a negative gradient of continuously decreasing magnitude line with negative gradient passing through $(T, R_0 / 2)$ and $(2T, R_0 / 4)$	[1] [1]

8(a)(i)	1. Solar energy can be affected by cloud cover, OR is only present in the day. 2. Wind speeds can vary for wind power 3. It is difficult to efficiently store excess energy generated for use at a later timing when the supply of energy falls. (any 2 of the above)	[2]
(ii)	γ-radiation is high energy/high frequency/short wavelength electromagnetic radiation / photons	[1] [1]
(iii)	γ-radiation can penetrate the skin/go through human/has high penetrating power ionizing powers can cause damage to DNA / cells / organs /tissue or cause cancer or death	[1] [1]
(iv)	To ensure that all γ-radiation would travel the same distance x through the absorber.	[1]
(v)	The curve reaches an asymptote at the x-axis. OR The (ratio of the) count rate does not go to 0.	[1]
(b)(i)	$C_X / C_0 = e^{-\mu x}$, Taking ln on both sides, $\ln (C_X / C_0) = -\mu x$	 [1] [1]

	As Fig. 8.3 is a graph of ln (C_X / C_0) against x with a straight line/constant gradient, passing through the origin, it indicates a relationship $C_X / C_0 = e^{-\mu x}$.	[1]
(ii)	gradient = $-\mu$ gradient = -4.5 / 10 = -0.45 Hence, μ = 0.45 cm^{-1}	 [1] [1]
(c)(i)	units of μ_m = units of μ / units of ρ = cm^{-1} / g cm^{-3} = g^{-1} cm^{2}	 [1]
(ii)	For lead, μ = 0.45 cm^{-1} $\mu_m = \mu/\rho$ = 0.45 / 11.3 = 0.0398 = 0.040 cm^2 g^{-1}	 [1]
(d)(i)	average μ_m = (0.035 + 0.037 + 0.040) /3 = 0.037 cm^2 g^{-1} For concrete, $\mu = \mu_m \rho$ = 0.037 × 2.4 = 0.037 × 2.4 × 10^3 × 10^3 / 100^3 = 0.0888 = 0.09 cm^{-1}	[1] [1] [1] [0]
(ii)	$C_X / C_0 = e^{-\mu x}$, For same shielding effect, value of C_X / C_0 is the same. Hence, value of μx must be the same. $(\mu x)_{concrete} = (\mu x)_{lead}$ (0.09) x = (0.45) (4.0) x = 20 cm OR From Fig. 8.2, when x = 4.0 cm, C_X / C_0 = 0.16 Using $C_X / C_0 = e^{-\mu x}$, ln (C_X / C_0) = $-\mu x$ ln 0.16 = -0.09 x x = 20 cm	 [1] [1] [1] [1]
(iii)	1. Concrete is cheaper OR more available than lead. 2. Concrete is a stronger material than lead 3. Concrete can be easily used in building compared to lead as it can mould into various shapes and forms 4. Lead is toxic compared to concrete. (any 2 of the above)	[2]

End of solutions