Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 9_Thermodynamics

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Name of the Student:____

Max. Marks : 24 Marks **Time : 24 Minutes**

Mark Schemes

Q1.

Question Number	Answer		Mark
(a)(i)	$$N + \alpha \rightarrow {}^{17}_{8}O + {}_{1}p$$ All values correct	(1)	1
(a)(ii)	In nuclear fission a chain reaction can be set up **Or** in a chain reaction the (total) energy released can be very large **Or** heavier/larger nuclei release much more energy **Or** a very high reaction rate releases much more energy	(1)	1
(b)	Attempt at mass deficit calculation Use of $\Delta E = c^2 \Delta m$ (Allow use of 1 u = 1.66×10^{-27} kg) Use of 1 MeV = 1.6×10^{-13} J (Allow use of 1u = 931.5 MeV/c^2) ΔE = 174 MeV Example of calculation $\Delta m = (390.29989 - 233.99404 - 152.64708 - (2 \times 1.67493)) \times 10^{-27}\,\text{kg}$ $\Delta m = 3.0891 \times 10^{-28}\,\text{kg}$ $\Delta E = (3.00 \times 10^{8}\,\text{m s}^{-1})^2 \times 3.0891 \times 10^{-28}\,\text{kg} = 2.780 \times 10^{-11}\,\text{J}$ $\Delta E = \dfrac{2.780 \times 10^{-11}\,\text{J}}{1.60 \times 10^{-13}\,\text{J MeV}^{-1}} = 173.8\,\text{MeV}$	(1) (1) (1) (1)	4
(c)(i)	Same number of protons [do not accept atomic/proton number]. Different numbers of neutrons [do not accept mass/nucleon/neutron number]	(1) (1)	2
(c)(ii)	Correct calculation for ω [see 6283 or 2000π or $\frac{60\,000 \times 2\pi}{60}$] a = (-) 5.9×10^{6} m s^{-2} Example of calculation $a = -\left(\dfrac{60000 \times 2\pi}{60\,\text{s}}\right)^2 \times 15 \times 10^{-2}\,\text{m} = 5.92 \times 10^{6}\,\text{m s}^{-2}$	(1) (1)	2
(c)(iii)	**Max 2** Stiff/stiffness Strong/strength Low density	 (1) (1) (1)	2

(d)	Use of $\Delta E = mc\Delta\theta$ Rate at which energy is removed = 3.1×10^9 (W) Use of the efficiency equation [must have 2.2×10^9 (W) on top line] Efficiency = 42% [accept 0.42] Example of calculation $\Delta E = 70000\text{ kg} \times 3990\text{ J kg}^{-1}\text{ K}^{-1} \times 11\text{K} = 3.07 \times 10^9\text{J}$ $\%\,\text{efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100 = \dfrac{2.2 \times 10^9\text{ W}}{(2.2+3.1) \times 10^9\text{ W}} \times 100 = 41.5\%$	(1) (1) (1) (1)	4

Q2.

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• Use total mass / mass of D ion • Use of $pV = NkT$ • $p = 2.8 \times 10^4$ Pa	(1) (1) (1)	Example of calculation $N = 5.0 \times 10^{-6}$ kg / 3.3×10^{-27} kg = 1.5×10^{21} $p = 1.5 \times 10^{21} \times 1.38 \times 10^{-23}$ J K^{-1} × 130 000 000 K / 98 m^3 = 2.77×10^4 Pa	3
(ii)	• Use of $\frac{1}{2} m \langle c^2 \rangle = 3/2\, kT$ **Or** $pV = 1/3\,(Nm\langle c^2 \rangle)$ (ecf for N and p from (i)) • $\sqrt{\langle c^2 \rangle} = 1.3 \times 10^6$ m s^{-1}	(1) (1)	Example of calculation $\frac{1}{2} m \langle c^2 \rangle = 3/2\, kT$ $\frac{1}{2} \times (3.3 \times 10^{-27}$ kg$) \times \langle c^2 \rangle = 3/2 \times 1.38 \times 10^{-23}$ J K^{-1} × 130 000 000 K $\langle c^2 \rangle = 1.6 \times 10^{12}$ m^2 s^{-2} $\sqrt{\langle c^2 \rangle} = 1.28 \times 10^6$ m s^{-1}	2
(iii)	• Use of $\Delta\lambda / \lambda = v/c$ to determine $\Delta\lambda$ • Adds shift to original wavelength • 1.075×10^{-6} m	(1) (1) (1)	Example of calculation $\Delta\lambda / 1.064 \times 10^{-6}$ m = 15×10^6 m s^{-1}/3.00×10^8 m s^{-1} $\Delta\lambda = 5.3 \times 10^{-9}$ m $\lambda + 2\Delta\lambda = 1.075 \times 10^{-6}$ m	3