Paper 2

Section A : Astronomy and Space Science

1. B (71%)	2.C (49%)	3.A (54%)	4.C (57%)
5. D (69%)	6.B (53%)	7.A (38%)	8.D (38%)

Solution	Marks	Remarks
1. (a) *Apparent magnitude* is a measure of brightness and it depends on (star's) *luminosity* and distance from the Earth.	1A	brightness = power per unit area at the observer = luminosity / $(4\pi D^2)$
When distance D is fixed (at 10 pc), it is called *absolute magnitude* which then depends only on *luminosity*.	1A	
	2	
(b) (i) $L = 4\pi R^2 \sigma T^4$ $L_S = 4\pi R_S^2 \sigma T_S^4$	1M	
Assume that the Sun and the star are black bodies.	1A	
	2	
(ii) $\frac{R}{R_S} = \left(\frac{L}{L_S}\right)^{1/2} \left(\frac{T_S}{T}\right)^2$		
$\frac{R}{R_S} = (126000)^{1/2} \times \left(\frac{5840}{6100}\right)^2$	1M	
$R = 325.350364\ R_S \approx 325\ R_S$	1A	
Star X - (super)giant	1A	
	3	
(c) (i) $\log\left(\frac{L}{L_S}\right) = 4\log T + 2\log\left(\frac{R}{R_S}\right) - 4\log T_S$ $y = \log\frac{L}{L_S}$, $x = \log T$ Accept $x = \log(\frac{T}{T_S})$		
It takes the form of a straight line $y = mx + c$ (with $m = 4$)	1A	
and the y-intercept c is determined by the star radius R [Note: $c = +2\log\left(\frac{R}{R_S}\right) - 4\log T_S$, R_S & T_S are constants]	1A	
	2	
(ii) B (largest)	1A	
	1	

Section B : Atomic World

1. C (34%)	2. D (50%)	3. C (57%)	4. B (56%)
5. B (46%)	6. D (52%)	7. A (49%)	8. A (32%)

Solution	Marks	Remarks
2. (a) (i) All photoelectrons emitted (from X) can reach Y.	1A	
Or Maximum number of photoelectrons emitted is limited by intensity of light.	1A	
Or Limited number of photoelectrons is produced in each second.	1A	
	1	
(ii) Maximum k.e. reaching anode $Y = (0.8 + 1.0)$ eV	1M	
$= 1.8$ (eV)	1A	
	2	
(b) (i) $3.4 = \Phi + 0.8 \Rightarrow \Phi = 2.6$ (eV)	1A	
$\frac{hc}{\lambda} = \Phi \Rightarrow \lambda = \frac{(6.63\times10^{-34})(3.0\times10^{8})}{(2.6)(1.60\times10^{-19})}$	1M	
$\lambda = 4.78125 \times 10^{-7}$ m ≈ 478 nm	1A	
	3	
(ii) No, as	1A	
λ_{yellow}=576 nm (≈2.16 eV) > 478 nm (≈2.6 eV) or threshold.	1M	
Or $f_{yellow} = 5.20833 \times 10^{14}$ Hz $< f = 6.27451 \times 10^{14}$ Hz	1M	
Or $E_{yellow} = 3.45312 \times 10^{-19}$ J $< E = 4.16000 \times 10^{-19}$ J	1M	
	2	
(c) This light beam is more intense but with	1A	
the same frequency as the original one.	1A	
	2	

Section C : Energy and Use of Energy

1. B (59%)	2. A (26%)	3. C (76%)	4. B (48%)
5. A (41%)	6. D (53%)	7. C (61%)	8. C (46%)

Solution	Marks	Remarks
3. (a) (i) (I) Friction between contact surfaces is too large which cannot be overcome by the wind at such speed.	1A	
(II) The turbine is automatically locked and stopped, otherwise the strong wind may damage the blades.	1A	
	2	
(ii) $P = \frac{1}{2}\rho A v^3 \times \eta$	1M	
$1600 \times 10^3\ \text{W} = \frac{1}{2} \times 1.23\ \text{kg m}^{-3} \times \pi (30\ \text{m})^2 \times (15\ \text{m s}^{-1})^3 \times \eta$		
$\eta = 27.3\ \%$	1A	
	2	
(b) (i) Power required from one turbine $= \dfrac{40 \times 10^6}{50} = 0.8\ \text{MW}$ or $800\ \text{kW}$	1M/1A	Note: Due to wind direction and the orientation of wind turbines, the power output of each turbine would be different in real situations.
From the graph, wind speed needed is $10\ \text{m s}^{-1}$.	1A	
	2	
(ii) (I) $1600\ \text{kW} \times 50 = 80000\ \text{kW}$ or $80\ \text{MW}$	1M/1A	
From the graph (>80 MW), 15:00 – 21:00 (i.e. 6 hours)	1A	
	2	
(II) $(80 - 40) \times 10^6\ \text{W} \times 80\ \% = m \times 9.81\ \text{m s}^{-2} \times 120\ \text{m}$	1M	
$m = 2.7183 \times 10^4\ (\text{kg s}^{-1})$	1A	For $g = 10\ \text{m s}^{-2}$, $m = 26667\ (\text{kg s}^{-1})$
	2	

Section D : Medical Physics

1. A (48%)	2. A (46%)	3. D (55%)	4. C (66%)
5. B (49%)	6. B (45%)	7. D (49%)	8. D (53%)

Solution	Marks	Remarks
4. (a) (i) *B*	1A	
A radioactive / radiopharmaceutical substance is injected to / inhaled by the patient and	1A	
is transported in the blood stream to the rest of the body, the (radioactive) substance accumulates in particular organs.	1A	
Gamma rays emitted by the radioisotope are detected by gamma cameras.	1A	
	4	
(ii) Advantage: A hot spot (above normal uptake) or a cold spot (below normal uptake) can infer some problem with the organ, i.e. functional diagnosis.	1A	
	1	
(b) (i) $T_{phy} = 4$ days	1A	
	1	
(ii) Period of time required to reduce the amount of 'tracer' in the body / organ to one-half of its original value due to biological process (such as elimination / excretion / metabolism).	1A	
	1	
(iii) $\frac{1}{T_{eff}} = \frac{1}{T_{phy}} + \frac{1}{T_{bio}} = \frac{1}{2} + \frac{1}{4}$ $T_{eff} = 1.33$ days	1M	
$N = N_0 e^{-kt}$, $k = \frac{\ln 2}{T_{eff}}$ or $\frac{N}{N_0} = (\frac{1}{2})^n$, $t = nT_{eff}$	1M	
$t = \frac{-T_{eff}}{\ln 2}\ln(\frac{10}{50})$ or $10 = 50(\frac{1}{2})^{t/T_{eff}}$ $t = \frac{-1.33}{\ln 2}\ln(\frac{10}{50})$ or $10 = 50(\frac{1}{2})^{t/1.33}$		
≈ 3.096 days	1A	Or 74.3 hours, 2.67×10^5 s
	3	