Paper 2

Section A : Astronomy and Space Science

1. B(78%)	**2. D(43%)**	**3. A(44%)**	**4. D(33%)**
5. A(43%)	**6. B(56%)**	**7. C(61%)**	**8. C(46%)**

Marks

1. (a) Satellites will be directly above a certain location on the equator of the Earth, with period = 24 hrs same as that of the Earth, 1A
thus enables easy transmitting / receiving signals from the Earth / no altering of aerial for tracking the satellite is required. 1A 2

(b) $\frac{mv^2}{r} = \frac{GMm}{r^2}$ 1M

$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{4.0\times10^{14}}{(6.4\times10^6 + 0.3\times10^6)}}$

$= 7727 \text{ m s}^{-1}$ 1A 2

(c) (i) Total energy $= \frac{1}{2}mv^2 + (\frac{-GMm}{r})$ 1M

$= \frac{GMm}{2r} + (\frac{-GMm}{r}) = \frac{-GMm}{2r}$ $(\frac{mv^2}{r} = \frac{GMm}{r^2}$ i.e. $\frac{mv^2}{2} = \frac{GMm}{2r})$ 1M 2

(ii)

$\Delta E = \frac{-GMm}{2}(\frac{1}{r_B} - \frac{1}{r_A}) = \frac{1}{2}(4.0\times10^{14})(2000)(\frac{1}{6700} - \frac{1}{42400})\times10^{-3}$ 1M

$= 5.03 \times 10^{10}$ J 1A 2

(iii) Kepler's third law for elliptical orbit $T^2 = \frac{4\pi^2 a^3}{GM}$

$a = [r_A + r_B] \div 2$

$= \frac{6.7\times10^6 + 42.4\times10^6}{2}$ m

$= 2.455 \times 10^7$ m 1M

Time from A to B $= \frac{T}{2} = \frac{1}{2}\sqrt{\frac{4\pi^2 a^3}{GM}} = \frac{2\pi}{2}\sqrt{\frac{a^3}{GM}} = \pi\sqrt{\frac{(2.455\times10^7)^3}{4.0\times10^{14}}}$

$=19107$ s $= 318.5$ min / 5.3 hrs 1A 2

{Or : $T^2 \propto a^3$

$(\frac{T}{24})^2 = [\frac{(6700 + 42400) \div 2}{42400}]^3$

$T = 10.6$ hrs $\Rightarrow t = 5.3$ hrs}

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Section B : Atomic World

1. D(50%)	**2. C(42%)**	**3. C(49%)**	**4. D(44%)**
5. A(64%)	**6. B(73%)**	**7. B(22%)**	**8. A(44%)**

Marks

2. (a) (i) $E = hf$ = work function + KE_{max} 1A 1
= 2.30 eV + 0.81 eV = 3.11 (eV)

(ii) Only those conduction / free electrons at the surface can have the maximum kinetic energy. 1A
Or The work function of a metal is only the minimum energy required to eject an electron.
Or The conduction / free electrons in metal have different energies.
Or Less energetic electrons are tightly bound to the nuclei and require more energy to break free of its attraction to the nuclei.
Or Some electrons are not at the surface of metal so don't have maximum kinetic energy. 1

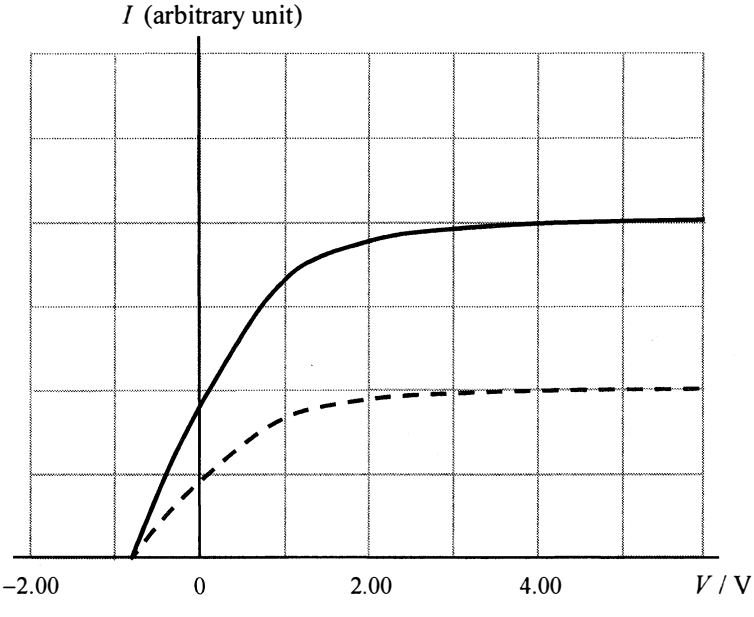
(b) (i) Energy absorbed by an atom = work function
$(0.01\ W\ m^{-2}) \times [0.01 \times (10^{-9})^2\ m^2] \times t\ s = 2.30 \times (1.60 \times 10^{-19})\ J$ 1M
$t = 3680\ s = 61.3\ min.$ 1A 2

(ii) If a single photon has sufficient energy to knock out an electron, the electron gains enough energy in just one collision. 1A
Or It is a one-to-one process / an electron can be ejected instantaneously if it accepts a photon of energy larger than the work function of the metal. 1

(c) $(0.01\ W\ m^{-2}) \times (4.00 \times 10^{-4}\ m^2) \div [3.11 \times (1.60 \times 10^{-19})\ J]$
$= 8.04 \times 10^{12}$ (photons per second) 1A

$(8.04 \times 10^{12}) \times 0.1 \times (1.60 \times 10^{-19})\ A$ 1M
$= 1.29 \times 10^{-7}\ A = 0.13\ \mu A$ 1A 3

(d)



2A 2

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Section C : Energy and Use of Energy

1. A(55%)	**2. B(75%)**	**3. C(78%)**	**4. D(56%)**
5. B(59%)	**6. D(30%)**	**7. A(71%)**	**8. C(55%)**

Marks

3. (a) $2000\left[\frac{1}{4\pi(3.4)^2}\cos^3(\tan^{-1}(\frac{1.2}{3.4}))\right]$ 1M

$= 11.5$ (lm m^{-2}) 1A 2

(b) Rough surface should be used such that 1A
reflection becomes diffuse to reduce glare. 1A 2

(c) (i) $14.5\text{ kW} + 15 \times 0.1\text{ kW} + 6 \times 0.08\text{ kW}$ 1M
$= 16.48$ (kW) (accept 16.48 kW or 16.5 kW) 1A 2

(ii) $(6 \times 0.1\text{ kW} + 16.48\text{ kW} \times 50\%)$ 1M
$\times 8 \times 20 \times 1.0$ 1M
= \$ 1414.4 (accept \$ 1414.4 or \$1416) 1A 3

(iii) Windows with low-e coating. 1A
Or Thicker walls.
Or Replace light bulb by fluorescent lamp.
Or Replace air-conditioner with higher cooling capacity / COP. 1

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Section D : Medical Physics

1. A(47%)	**2. C(59%)**	**3. C(38%)**	**4. A(41%)**
5. D(37%)	**6. B(36%)**	**7. B(53%)**	**8. D(77%)**

Marks

4. (a) (i) 2.25 cm — 1A — 1

(ii) $x_{1/2} = \dfrac{\ln 2}{\mu}$ (or $0.5I_0 = I_0 e^{-\mu x_{1/2}}$) — 1M

$0.0225 = \dfrac{\ln 2}{\mu}$

$\mu = 30.8\ m^{-1}$ (accept $30.8\ m^{-1}$ and $31.0\ m^{-1}$) — 1A — 2

(iii) Medium Q: lower density — 1A — 1

(b) (i) Intensity of X-rays is attenuated / absorbed when they pass through a medium. — 1A

The attenuation / absorption in bone is greater than that in soft tissue. Therefore the film appears lighter under bone / darker under soft tissue. — 1A — 2

(ii) The X-ray tube and detectors rotate round the patient to take multiple X-ray projections / images. — 1A

The projections are used to reconstruct /compute / make back projection /combine to form tomographs which contain more information of the body. — 1A — 2

(iii) - radiation exposure or dosage is much higher for CT scan (8.0 mSv Vs 0.01 mSv for X-ray imaging) — 1A

- not as mobile or easily accessible as X-ray imaging — 1A — 2

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