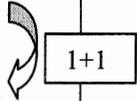


Section A : Astronomy and Space Science

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 1. D(55%) | 2. A(31%) | 3. C(53%) | 4. A(39%) |
| 5. B(58%) | 6. D(50%) | 7. C(30%) | 8. B(36%) |

| Solution   | Marks   | Remarks |
|--|---|---------|
| 1. (a) (i) Luminosity of the star, $L = 4\pi R^2 \sigma T_s^4$<br>Power per unit area at distance $d$ from the star<br>$= \frac{L}{4\pi d^2} = \frac{R^2}{d^2} \sigma T_s^4$<br>Power absorbed = $\pi r^2 \times \frac{R^2}{d^2} \sigma T_s^4$ | 1M<br>1M  |         |
|  | 2   |         |
| (ii) At equilibrium, power absorbed = power radiated<br>$\frac{R^2}{d^2} \pi r^2 \sigma T_s^4 = 4\pi r^2 \sigma T_p^4$<br>$\frac{R^2}{d^2} T_s^4 = 4 T_p^4$<br>$T_p^4 = \frac{R^2}{4d^2} T_s^4$<br>$T_p = \sqrt{\frac{R}{2d}} T_s$             | 1M<br><br>1M |         |
|  | 2   |         |
| (b) (i) $T_p = \sqrt{\frac{R}{2d}} T_s$<br>$= \sqrt{\frac{6.82 \times 10^8}{2 \times (0.84 \times 1.50 \times 10^{11})}} 5518$<br>$= 287 \text{ K (or } 14 \text{ }^\circ\text{C)}$  | 1M<br>1A  |         |
|  | 2   |         |
| (ii) The temperature is between 273 K and 373 K,<br>(liquid) water is likely to exist on the planet.<br>Hence the condition is favourable for life to exist.   | 1A<br>1A  |         |
|  | 2   |         |
| (iii) The equilibrium surface temperature is lower / decreases.<br>A class K star is a cooler star than a class G star.  | 1A<br>1A  |         |
|  | 2   |         |

Section B : Atomic World

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 1. A(71%) | 2. D(45%) | 3. C(57%) | 4. C(49%) |
| 5. D(52%) | 6. B(46%) | 7. A(43%) | 8. B(60%) |

| Solution  | Marks | Remarks   |
|---|-------|---|
| 2. (a) A - (4): anode<br>B - (3): condensing magnetic lens<br>C - (1): objective magnetic lens<br>D - (2): projection magnetic lens   | 2A    | 1.20×10 <sup>-11</sup> ~ 1.23×10 <sup>-11</sup> m |
|   | 2     |   |
| (b) (i) K.E. = energy gain of the electron<br>$\frac{1}{2}mv^2 = eV$<br>$(mv)^2 = 2meV$<br>$p = mv = \sqrt{2meV}$<br>$\therefore \lambda = \frac{h}{\sqrt{2meV}}$   | 1M    |   |
|   | 1M    |   |
|   | 2     |   |
| (ii) $\lambda = \frac{h}{\sqrt{2meV}}$<br>$= \frac{6.63 \times 10^{-34}}{\sqrt{2(9.11 \times 10^{-31})(1.60 \times 10^{-19})(10 \times 10^3)}}$<br>$\lambda = 1.2279 \times 10^{-11} \text{ m } (= 0.012 \text{ nm})$   | 1M    |   |
|   | 1A    |   |
|   | 2     |   |
| (iii) Since the wavelength of the electron beam (~10 <sup>-11</sup> m) is smaller / shorter than that of visible light (~10 <sup>-7</sup> m), resolving power of a microscope, $\theta = \frac{1.22\lambda}{d}$ , is greater with shorter wavelength (or less diffraction with shorter wavelength). | 1A    |   |
|   | 1A    |   |
|   | 2     |   |
| (c) TEM.<br>STM only reveals surface structure of specimen.   | 1A    |   |
|   | 1A    |   |
|   | 2     |   |

Section C : Energy and Use of Energy

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 1. A(53%) | 2. C(72%) | 3. D(47%) | 4. C(61%) |
| 5. B(44%) | 6. D(27%) | 7. B(53%) | 8. A(39%) |

| Solution  | Marks  | Remarks  |   |   |    |
|---|--|--|---|---|----|
| 3. (a) $E = VIt$<br>$23 \times 1000 = 220 \times 13 \times t$<br>$t = 8.04$ (hours)   | 1M<br>1A<br><hr/> 2  | 28951 s or 482.5 minutes   |   |   |    |
| (b) (i) Converting electrical / energy from battery to KE / mechanical energy / force to drive the car / accelerate the car <u>or</u> Motor<br>During braking, some of the kinetic energy of the wheels / vehicle is converted by the motor / generator / component $X$ to electrical energy.<br>The electrical energy is then stored in / used to charge the rechargeable battery. | 1A<br><br>1A<br><br>1A<br><hr/> 3                                  |  |   |   |    |
| (ii) High speed.<br>When braking at high speed, the amount of kinetic energy that can be converted to electrical energy (to recharge the battery) is larger.  | 1A<br><br>1A<br><hr/> 2  | KE of the car = $E$ ;<br>Energy dissipated as heat = $\alpha E$<br>Energy to recharge battery = $(1 - \alpha)E$<br>Fixed $\alpha$ . High speed => More energy $(1 - \alpha)E$ to recharge battery.<br><br>Accept <u>same effect</u> for high speed and low speed only if explanation has the meaning $\frac{E - \alpha E}{E} = (1 - \alpha)$ |   |   |    |
| (iii) The mechanical braking system may come into play when the regenerative braking system fails.<br><table border="1" style="width: 100%;"><tr><td>Or The mechanical braking system can lock the vehicle in position.</td></tr><tr><td>Or The regenerative braking system will not work when the battery is fully charged.</td></tr></table>                                      | Or The mechanical braking system can lock the vehicle in position. |  | Or The regenerative braking system will not work when the battery is fully charged. | 1A<br><table border="1" style="width: 100%;"><tr><td>1A</td></tr><tr><td>1A</td></tr></table> <hr/> 1 | 1A |
| Or The mechanical braking system can lock the vehicle in position.  |  |  |   |   |    |
| Or The regenerative braking system will not work when the battery is fully charged.   |  |  |   |   |    |
| 1A  |  |  |   |   |    |
| 1A  |  |  |   |   |    |
| (c) Mode 2<br>(overall efficiency = $45\% \times 60\% = 27\% > 20\%$ or $21\%$ of the other two modes)<br>No. Mode 3 practically has little or no emission of air pollutants.   | 1A<br><br>1A<br><hr/> 2  |  |   |   |    |

Section D : Medical Physics

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 1. A(48%) | 2. D(46%) | 3. B(54%) | 4. C(63%) |
| 5. C(37%) | 6. D(44%) | 7. B(63%) | 8. A(57%) |

| Solution   | Marks | Remarks  |
|--|-------|--|
| 4. (a) (i) When applying a potential difference across a small block of piezoelectric crystal inside the transducer, the crystal will be distorted; it will return to its original shape if the potential difference is removed, thus ultrasound waves will be generated due to its subsequent oscillations. | 1A    |  |
|  | 1A    |  |
|  | 2     |  |
| (ii) Advantage : better resolution / clearer<br>Disadvantage: greater attenuation / penetrate less   | 1A    |  |
|  | 1A    |  |
|  | 2     |  |
| (b) (i) $P = \frac{1}{u} + \frac{1}{v}$ or $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$<br>$59 = \frac{1}{\infty} + \frac{1}{v}$<br>$v = 0.01695 \text{ m (or } 1.695 \text{ cm)} \approx 17 \text{ mm}$  | 1M    | Accept 16.9 ~ 17.0 mm  |
|  | 1A    |  |
|  | 2     |  |
|  |       |  |
| (ii) $\theta = \frac{1.22 \lambda}{d}$<br>$\theta = \frac{1.22 \times 5.35 \times 10^{-7}}{4.0 \times 10^{-3}}$<br>$= 1.63175 \times 10^{-4} \text{ (rad)} \approx 1.63 \times 10^{-4} \text{ (rad)}$  | 1M    | Accept 0.0093°   |
|  | 1A    |  |
|  | 2     |  |
|  |       |  |
| (iii) $\theta = \frac{r}{L}$ for small $\theta$ in radians<br>$r = 1.632 \times 10^{-4} \times 0.30 \text{ m}$<br>$= 4.89525 \times 10^{-5} \text{ m (or } 0.0489525 \text{ mm)} \approx 49.0 \mu\text{m}$   | 1M    | Accept $\tan \theta = \frac{r}{L}$<br>Accept 48.9 ~ 49.0 $\mu\text{m}$ |
|  | 1A    |  |
|  | 2     |  |
|  |       |  |