## Marking Scheme

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

## General Marking Instruction

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates may have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct answer merits ***the answer mark*** allocated to that part, unless a particular method has been specified in the question.

   In the marking scheme, alternative answers and marking guidelines are in | rectangles |.

2. In the marking scheme, answer marks or 'A' marks are awarded for a correct numerical answer with a unit. If the answer should be in km, then cm and m are considered to be wrong units.

3. In a question consisting of several parts each depending on the previous parts, method marks or 'M' marks are awarded to steps/methods or substitutions correctly deduced from previous answers.

4. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

**DSE Paper 1 Section A**

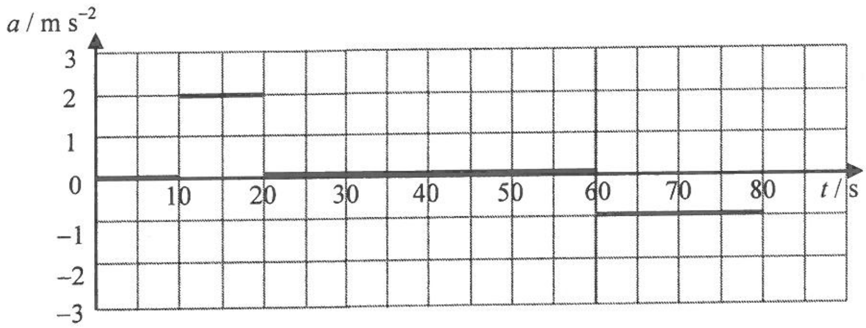
| Question No. | Key | Question No. | Key |
|---|---|---|---|
| 1. | D (83) | 26. | A (58) |
| 2. | A (55) | 27. | D (22) |
| 3. | C (75) | 28. | D (68) |
| 4. | A (54) | 29. | B (28) |
| 5. | B (37) | 30. | B (57) |
| 6. | D (45) | 31. | D (54) |
| 7. | C (26) | 32. | A (61) |
| 8. | C (54) | 33. | C (56) |
| 9. | B (91) | | |
| 10. | B (66) | | |
| 11. | B (29) | | |
| 12. | B (58) | | |
| 13. | B (74) | | |
| 14. | A (80) | | |
| 15. | C (78) | | |
| 16. | A (76) | | |
| 17. | B (53) | | |
| 18. | C (41) | | |
| 19. | A (76) | | |
| 20. | C (44) | | |
| 21. | D (43) | | |
| 22. | D (61) | | |
| 23. | B (53) | | |
| 24. | C (20) | | |
| 25. | D (48) | | |

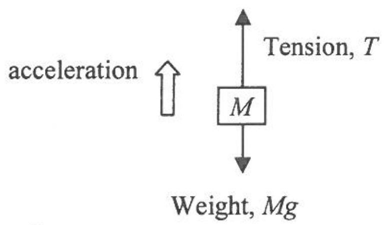
*Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.*

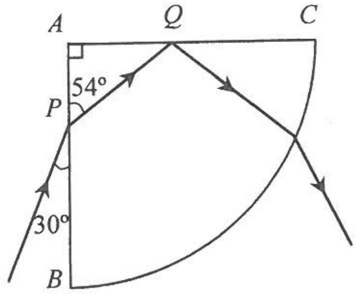
**Paper 1 Section B**

| Solution | Marks | Remarks |
|---|---|---|
| 1. (a) 5 min. (or 300 s) | 1A | |
| | 1 | |
| (b) When the heater is switched off, its temperature is higher than the metal. | 1A | |
| Or Heat continues to conduct to the metal until the same temperature is attained. | 1A | |
| Or It takes time for them to attain the same temperature. | 1A | |
| | 1 | |
| (c) (i) $mc\Delta T = IVt$ | 1M | |
| $(0.80)\,c\,(45-20) = (4.0)(12)(5\times 60)$ | | |
| $c = 720\ \text{J kg}^{-1}\ {}^\circ\text{C}^{-1}$ | 1A | |
| | 2 | |
| (ii) Experimental result is higher than the actual value. | 1A | |
| Not all the energy supplied by the heater goes to the metal. | 1A | |
| Or Some energy is absorbed by the heater itself and / or by the thermometer. | 1A | |
| Or Heat loss to the surroundings. | 1A | |
| | 2 | |
| (d) Glass is not a good conductor of heat. | 1A | |
| Or Prolonged time is required for the whole glass block to attain uniform temperature. | 1A | |
| Or No insulating material is perfect, so heat loss is appreciable. | 1A | |
| | 1 | |

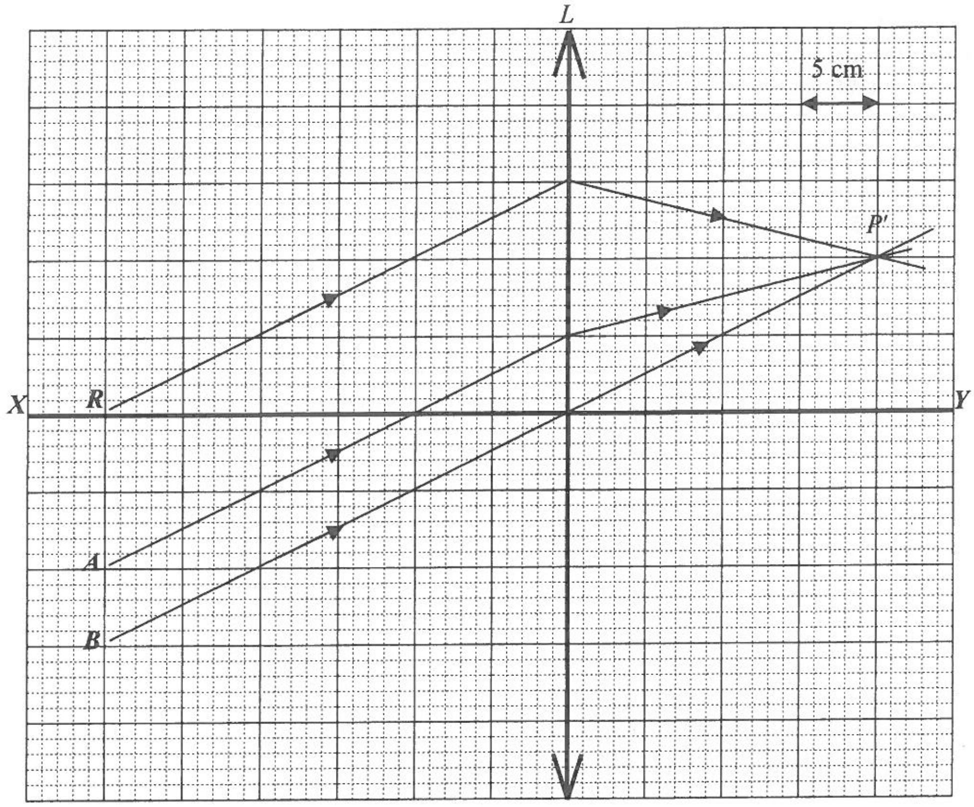
| Solution | Marks | Remarks |
|---|---|---|
| 2. (a) (i) $V_0$ = total volume of air required at $P_0$, including the residual air in the ball | | |
| $P_1V_1 = P_0V_0$ | 1M | |
| (156 kPa) (6000 cm$^3$) = (100 kPa) ($V_0$) | | |
| $V_0$ = 9360 cm$^3$ | 1A | |
| ∴ volume of air = $V_0$ − volume of the basketball | 1M | |
| = 9360 cm$^3$ − 6000 cm$^3$ | | |
| = 3360 cm$^3$ | | |
| *Alternatively:* | | |
| $\because n = \frac{PV}{RT}$ | | |
| $\frac{156V}{RT} - \frac{100V}{RT} = n'$ | 1M | |
| $\therefore V' = \frac{56V}{RT} \bullet \frac{RT}{100} = 3360\text{cm}^3$ | 1M + 1A | |
| | 3 | |
| (ii) Number of strokes required = 3360 cm$^3$ ÷ 120 cm$^3$ | | |
| = 28 | 1A | |
| | 1 | |
| (b) Using kinetic theory, the pressure $p$ is given by | | |
| $pV = \frac{Nm\overline{c^2}}{3} = \frac{2N}{3} \bullet \frac{m\overline{c^2}}{2}$ | | |
| As the volume and the temperature (∝ kinetic energy of the air molecules) remain unchanged, | 1A | |
| the increase in pressure is due to the increase of number of air molecules hitting the wall of the container per unit time. | 1A | |
| Or Frequency of collision with the wall of container increases. | 1A | |
| | 2 | |

| Solution | Marks | Remarks |
|---|---|---|
| 3. (a) 0 – 10 s: constant / uniform acceleration<br>10 – 80 s: constant velocity / uniform motion | 1A<br>1A<br>2 | |
| (b) (i) Car $B$.<br>It is represented by the steepest slope between 10 s and 20 s for $B$.<br>$a = \frac{20-0}{20-10} = 2 \text{ m s}^{-2}$ | 1A<br><br>1A<br>2 | |
| (ii)  | | |
| Uniform acceleration between 10 s and 20 s & uniform deceleration between 60 s and 80 s.<br>Or Either acceleration or deceleration correct.<br>All correct. | 1A<br>1A<br>1A<br>2 | |
| (c) (i) Total area of $A$ by 20 s = $\frac{(10+20)}{2} \times 15 = 225$ m<br>Total area of $B$ by 20 s = $\frac{(10 \times 20)}{2} = 100$ m<br>Separation of $A$ & $B$, $s_{AB} = 225 \text{ m} - 100 \text{ m} = 125$ m | 1M<br><br>1A<br>2 | |
| (ii) Let $B$ meet $A$ at time $(20 + T)$ s,<br>$(v_B - v_A) \times T = s_{AB}$<br>$(20 \text{ m s}^{-1} - 15 \text{ m s}^{-1}) \times T = 125$ m<br>$T = 25$ s<br>$\therefore B$ catches up with $A$ at $t = (20 + 25)$ s = 45 s.<br>Or $s_A + v_A \times T = s_B + v_B \times T$<br>$225 \text{ m} + 15 \text{ m s}^{-1} \times T = 100 \text{ m} + 20 \text{ m s}^{-1} \times T$<br>Or Accept using graphical method and read the answer from the graph | 1M<br><br><br>1A<br><br>1M<br><br>1M<br>1A<br>2 | |
| (d) Let $F_A$ and $F_B$ be the driving forces developed by the engines of $A$ and $B$ respectively.<br>Ratio of power developed by cars $A$ and $B$,<br>$P_A : P_B = F_A \times v_A : F_B \times v_B$<br>$= v_A^2 \times v_A : v_B^2 \times v_B$<br>$= 3^3 : 4^3 = 27 : 64$ | <br><br>1M<br><br>1A<br>2 | |

| Solution | Marks | Remarks |
|---|---|---|
| 4. (a) Arrows correct | 1A | |
| Labels (tension / $T$, weight / $Mg$) | 1A | |
| Or Either force correct and with label | 1A | |
| All correct. | 1A | |
|  | | |
| As $M$ accelerates upward, | | |
| $T - Mg = Ma$ | 1M | |
| i.e. $T = Mg + Ma$ | | |
| Greater tension needed ($T >$ original tension $= Mg$) and thus the spring extends further. | 1A | |
| i.e. $M$ is closer to the bottom, smaller $h$ in Figure 4.2 | | |
| | 4 | |
| (b) Change in tension / reading = $2\text{ N cm}^{-1} \times 0.5\text{ cm} = 1\text{ N}$ | | |
| $\therefore\ T - Mg = 1\text{ N}$ i.e. $T = 6\text{ N}$ | 1A | |
| $T - Mg = Ma$ | | |
| $1\text{ N} = \dfrac{5\text{N}}{g}\ a$ (accept $M = 0.5\text{ kg}$) | 1M | |
| $a = \dfrac{1}{5}g$ or $0.2\,g$ (upward) (or $\dfrac{g}{5} = 2\text{ m s}^{-2}$ or $1.96\text{ m s}^{-2}$) | 1A | |
| | 3 | |
| (c) $a_Y = -0.5g = -g\cos\theta$ | 1M | |
| $\therefore\ \theta = 60° > 45°$, 'Landscape display' results. | 1A | |
| Or When the phone is rotated 45° clockwise, | | |
| $a_Y = -g\cos 45°$ or $-g\sin 45°$ | 1M | |
| $= -\dfrac{g}{\sqrt{2}} = -0.71\,g$ or $-6.94\text{ m s}^{-2}$ (or $-7.07\text{ m s}^{-2}$) | | |
| 'Landscape display' results as $a_Y = -0.5\,g > -0.71\,g$. | 1A | |
| Or 'Landscape display' results as magnitude of $a_Y <$ that at 45° | 1A | |
| | 2 | |

| Solution | Marks | Remarks |
|---|---|---|
| 5. (a) $n = \frac{\sin i}{\sin r}$ (or $n_1 \sin\theta_1 = n_2 \sin\theta_2$) | 1M | |
| $= \frac{\sin(90° - 30°)}{\sin(90° - 54°)} = \frac{\sin 60°}{\sin 36°}$ | | |
| $= 1.47$ | 1A | Accept 1.47 to 1.50 |
| | 2 | |
| (b) $\sin c = \frac{1}{n} = \frac{1}{1.47}$ | 1M | |
| $c = 42.7°$ (for $n = 1.50$, $c = 41.8°$) | | |
| Because incident angle at face $AC$ (= 54°) > $c$ (= 42.7°). | 1M | |
| | 2 | |
| (c)  | | |
| Reflected ray correct, $i = r$ | 1A | |
| Emergent ray away from normal. | 1A | |
| | 2 | |
| (d) A spectrum is seen. | 1A | |
| Or splitting into different colours occurs. | 1A | |
| | 1 | |

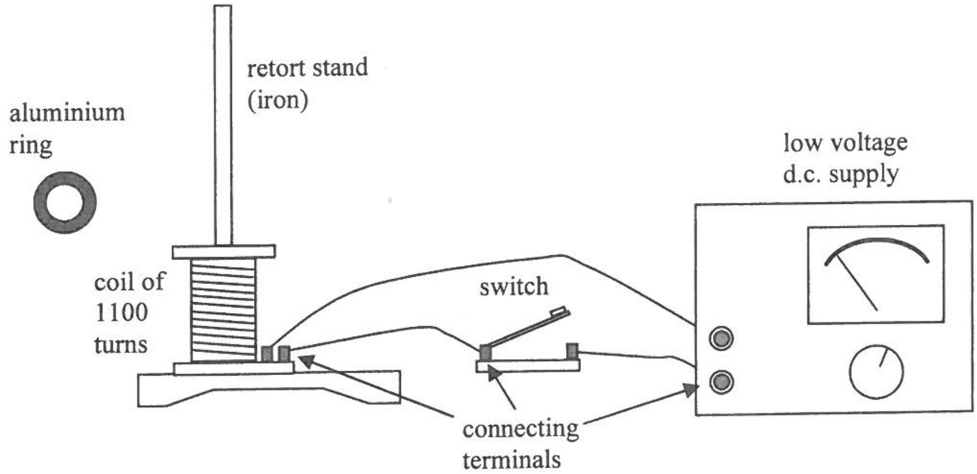
| Solution | Marks | Remarks |
|---|---|---|
| 6. (a) Convex lens / Converging lens. | 1A | |
| Refracted ray of $A$ after passing through $L$ bends towards the principal axis (or optical centre) / converges / bends inward / bends downward. | 1A | |
| Or A real / an inverted image can be formed. | 1A | |
| Or The object and the image are on opposite sides of the lens. | 1A | |
| | 2 | |
| (b) (i) | | |




| Solution | Marks | Remarks |
|---|---|---|
| Rays $A$ and $B$ correctly completed. | 1M | |
| $P'$ correctly located. | 1M | |
| | 2 | |
| (ii) $f = 20$ cm | 1A | Accept 19 - 21 cm |
| | 1 | |
| (c) Ray $R$ correctly completed. | 1M | |
| | 1 | |
| (d) Use a screen to capture a/the (sharp) image (of a distant object). | 1A | |
| The distance between the screen and the lens is $f$. | 1A | |
| | 2 | |

| Solution | Marks | Remarks |
|---|---|---|
| 7. (a) (i) $\tan\theta = 0.38$ | | |
| $\theta = 20.8°$ | 1A | Accept 20.8° to 21° |
| | 1 | |
| (ii) $d\sin\theta = n\lambda$ | | |
| As $d = (\frac{1}{300}\times 10^{-3})$, | 1M | |
| $(\frac{1}{300}\times 10^{-3})\times\sin 20.8° = 2\lambda$ | 1M | |
| $\lambda = 5.92\times 10^{-7}$ m (or 592 nm) | 1A | Accept $5.90\times 10^{-7}$ m to $5.97\times 10^{-7}$ m |
| | 3 | |
| (iii) Smaller percentage error in $x$ / the diffraction angle $\theta$. | 1A | |
| Or Larger $x$, percentage error decreases. | 1A | |
| | 1 | |
| (b) Repeat the procedures with the pin on the left-hand side / the other side of the observer. | 1A | |
| Take the average value of $x$ obtained from both sides to calculate $\lambda$. | 1A | |
| | 2 | |

| Solution | Marks | Remarks |
|---|---|---|
| 8. (a) $P = \frac{V^2}{R}$ <br> $500 = \frac{220^2}{R}$ <br> $R = 96.8\ \Omega$ | 1A | Accept 97 Ω |
| | 1 | |
| (b) As the total resistance of the circuit for mode $X$ is doubled, | 1M | |
| total power dissipation $= \frac{V^2}{2R}$ <br> $= \frac{220^2}{2 \times 96.8} = 250$ W | 1A | Accept 249 W for 97 Ω |
| *Alternative method*: <br> As the voltage across each heating element (1 and 2) is halved, power dissipated in each of the heating element <br> $P_1$ or $P_2 = \frac{500}{4} = 125$ W (since $P \propto V^2$) | 1M | |
| Or $P_1$ or $P_2 = \frac{V'^2}{R} = \frac{110^2}{96.8} = 125$ W | 1M | |
| Or $i = \frac{V}{R_1 + R_2} = \frac{220}{2 \times 96.8} = 1.14$ A <br> $P_1$ or $P_2 = i^2R = 1.14^2 \times 96.8 = 125$ W | 1M | |
| Total power dissipation = 2 × 125 W = 250 W | 1A | |
| | 2 | |
| (c) In mode $Z$, the equivalent resistance of the heating elements is the least as they are connected in parallel, | 1A | |
| hence, under the same voltage, the total power dissipation is the largest since $P = \frac{V^2}{R}$. | 1A | |
| | 2 | |
| (d) (i) For mode $Z$, <br> the total power dissipated = 500 + 500 = 1000 W <br> $I_z = \frac{P}{V} = \frac{1000}{220} = 4.55$ A | 1M+1M | |
| *Alternative method*: <br> $R_{eq} = \frac{96.8}{2}\ \Omega = 48.4\ \Omega$ <br> $I = \frac{220\ \text{V}}{48.4\ \Omega} = 4.55$ A | 1M+1M | |
| Most suitable value of fuse = 5 A | 1A | |
| | 3 | |
| (ii) Although the heater still works in either connection, it is dangerous for switch $S$ to be fitted in wire $B$ (neutral) as the heater / cable would still be live even when the switch was turned off. | 1A <br> 1A (1+1) | |
| | 2 | |
| (iii) Wire $C$ (Earth). | 1A | |
| Current would be conducted from the case through this wire to the Earth. | 1A | |
| | 2 | |

<table>
<tr><th>Solution</th><th>Marks</th><th>Remarks</th></tr>
<tr><td>9. (a) Connect the coil to the terminals of the d.c. supply via the switch (diagram).</td><td>1A</td><td></td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td>Put the aluminum ring on the top of the coil through the rod of the retort stand.</td><td>1A</td><td></td></tr>
<tr><td>When closing the switch, the ring would shoot up the rod once,</td><td>1A</td><td></td></tr>
<tr><td>as the aluminum ring experiences a changing magnetic field produced by the coil at the start,</td><td>1A</td><td></td></tr>
<tr><td>According to Lenz's Law, eddy currents flow in the ring to oppose the change.</td><td>1A</td><td></td></tr>
<tr><td><u>Or</u> A magnetic field in the opposite direction generated by the eddy currents repels the magnetic field produced by the coil.</td><td>1A</td><td></td></tr>
<tr><td>However, when the current and thus the resulting magnetic field are constant, the ring would fall back to the coil as eddy currents no longer flow.</td><td>1A</td><td></td></tr>
<tr><td></td><td>6</td><td></td></tr>
<tr><td>(b) (i) The aluminum ring would float in the air.</td><td>1A</td><td></td></tr>
<tr><td></td><td>1</td><td></td></tr>
<tr><td>(ii) The aluminum ring with a slit would remain stationary.</td><td>1A</td><td></td></tr>
<tr><td></td><td>1</td><td></td></tr>
</table>

| Solution | Marks | Remarks |
|---|---|---|
| 10. (a) Alpha particles emitted can be stopped by the (thin) metallic casing. | 1A | |
| Or Shorter range / Lower penetrating power. | 1A | |
| | 1 | |
| (b) (i) $k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{87.74 \times 3.16 \times 10^7}$ | 1M | |
| $= 2.5 \times 10^{-10} s^{-1}$ or $7.9 \times 10^{-3}$ year$^{-1}$ | | |
| Activity $A = kN$ | | |
| $= \frac{\ln 2}{87.74 \times 3.16 \times 10^7}(3.2 \times 10^{25})$ | 1M | |
| $= 8.000 \times 10^{15}$ (Bq) | 1A | |
| | 3 | |
| (ii) Power = Energy per decay × Activity | | |
| $= 5.5$ MeV $\times 8.000 \times 10^{15}$ Bq | 1M | |
| $= 5.5 \times 10^6 \times 1.60 \times 10^{-19} \times 8.000 \times 10^{15}$ | | |
| $= 7040$ W or 7.040 (kW) | 1A | |
| | 2 | |
| (iii) Power $\propto$ Activity | | |
| Activity $\propto N$ | | |
| $\therefore$ Percentage of power left $= (\frac{1}{2})^{t/t_{1/2}} \times 100\%$ | | |
| $= (\frac{1}{2})^{36/87.74} \times 100\%$ | 1M | |
| $= 75.25\% \approx 75\%$ | 1A | |
| Or Percentage / fraction of power left = 3/4 | | |
| *Alternatively:* $N = N_0 e^{-kt}$ | | |
| $\therefore$ Percentage of power left $= e^{-kt} \times 100\%$ | 1M | |
| $= e^{-(\ln 2 \div 87.74) \times 36} \times 100\%$ | | |
| $= e^{-0.2844} \times 100\%$ | | |
| $= 75.25\% \approx 75\%$ | 1A | |
| | 2 | |

**Paper 2**

**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> $= \dfrac{L}{4\pi d^2} = \dfrac{R^2}{d^2}\sigma T_s^4$ | 1M | |
| Power absorbed $= \pi r^2 \times \dfrac{R^2}{d^2}\sigma T_s^4$ | 1M | |
| | 2 | |
| (ii) At equilibrium, power absorbed = power radiated <br> $\dfrac{R^2}{d^2}\pi r^2 \sigma T_s^4 = 4\pi r^2 \sigma T_p^4$ | 1M | |
| $\dfrac{R^2}{d^2} T_s^4 = 4 T_p^4$ | 1+1 | |
| $T_p^4 = \dfrac{R^2}{4d^2} T_s^4$ <br> $T_p = \sqrt{\dfrac{R}{2d}}\, T_s$ | 1M | |
| | 2 | |
| (b) (i) $T_p = \sqrt{\dfrac{R}{2d}}\, T_s$ <br> $= \sqrt{\dfrac{6.82\times10^8}{2\times(0.84\times1.50\times10^{11})}}\, 5518$ | 1M | |
| $= 287$ K (or 14 °C) | 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 | |
| | 2 | |
| (b) (i) K.E. = energy gain of the electron<br>$\frac{1}{2}mv^2 = eV$ | 1M | |
| $(mv)^2 = 2meV$<br>$p = mv = \sqrt{2meV}$ | 1M | |
| $\therefore \lambda = \frac{h}{\sqrt{2meV}}$ | | |
| | 2 | |
| (ii) $\lambda = \frac{h}{\sqrt{2meV}}$<br>$= \frac{6.63 \times 10^{-34}}{\sqrt{2(9.11 \times 10^{-31})(1.60 \times 10^{-19})(10 \times 10^3)}}$ | 1M | |
| $\lambda = 1.2279 \times 10^{-11}$ m (= 0.012 nm) | 1A | $1.20 \times 10^{-11} \sim 1.23 \times 10^{-11}$ m |
| | 2 | |
| (iii) Since the wavelength of the electron beam ($\sim 10^{-11}$ m) is smaller / shorter than that of visible light ($\sim 10^{-7}$ m), | 1A | |
| resolving power of a microscope, $\theta = \frac{1.22\lambda}{d}$, is greater with shorter wavelength (or less diffraction with shorter wavelength ). | 1A | |
| | 2 | |
| (c) TEM. | 1A | |
| STM only reveals surface structure of specimen. | 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>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 or Motor | 1A | |
| During braking, some of the kinetic energy of the wheels / vehicle is converted by the motor / generator / component $X$ to electrical energy. | 1A | |
| The electrical energy is then stored in / used to charge the rechargeable battery. | 1A<br>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>1A<br>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>Accept same effect 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. | 1A | |
| Or The mechanical braking system can lock the vehicle in position. | 1A | |
| Or The regenerative braking system will not work when the battery is fully charged. | 1A<br>1 | |
| (c) Mode 2<br>(overall efficiency = 45% × 60% = 27% > 20% or 21% of the other two modes) | 1A | |
| No. Mode 3 practically has little or no emission of air pollutants. | 1A<br>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; | 1A | |
| 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 | |
| | 2 | |
| (ii) Advantage : better resolution / clearer | 1A | |
| Disadvantage: greater attenuation / penetrate less | 1A | |
| | 2 | |
| (b) (i) $P = \frac{1}{u} + \frac{1}{v}$ or $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ | | |
| $59 = \frac{1}{\infty} + \frac{1}{v}$ | 1M | |
| $v = 0.01695$ m (or 1.695 cm) $\approx$ 17 mm | 1A | Accept 16.9 ~ 17.0 mm |
| | 2 | |
| (ii) $\theta = \frac{1.22\,\lambda}{d}$ | | |
| $\theta = \frac{1.22 \times 5.35 \times 10^{-7}}{4.0 \times 10^{-3}}$ | 1M | |
| $= 1.63175 \times 10^{-4}$ (rad) $\approx 1.63 \times 10^{-4}$ (rad) | 1A | Accept 0.0093° |
| | 2 | |
| (iii) $\theta = \frac{r}{L}$ for small $\theta$ in radians | 1M | Accept $\tan\theta = \frac{r}{L}$ |
| $r = 1.632 \times 10^{-4} \times 0.30$ m | | |
| $= 4.89525 \times 10^{-5}$ m (or 0.0489525 mm) $\approx 49.0\ \mu$m | 1A | Accept 48.9 ~ 49.0 μm |
| | 2 | |