

# Cambridge IGCSE™

---

**COMBINED SCIENCE****0653/43**

Paper 4 Theory (Extended)

**October/November 2024****MARK SCHEME**Maximum Mark: 80

---

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

| Question  | Answer                                                                                                                                                                                                                                 | Marks |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1(a)(i)   | grasshopper / rabbit / caterpillar ;                                                                                                                                                                                                   | 1     |
| 1(a)(ii)  | hawk AND owl ;                                                                                                                                                                                                                         | 1     |
| 1(a)(iii) | snake AND hawk AND (blue) jay ;                                                                                                                                                                                                        | 1     |
| 1(b)      | energy is lost at each trophic level ;<br>named example of energy loss, e.g. heat / respiration / excretion / protein synthesis / metabolism / not all organism is eaten ;<br>not enough energy left (to support trophic level five) ; | 3     |

| Question  | Answer                                                                                                                                                           | Marks |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 2(a)(i)   | $\text{Zn(s)} + \dots 2\text{HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \dots \text{H}_2\text{(g)}$<br>2 added for balancing ;<br>$\text{H}_2$ as product ; | 2     |
| 2(a)(ii)  | <i>any two from:</i><br>solid zinc reduces in size / AW ;<br>fizzing / bubbles (of gas) ;<br>AVP ;                                                               | 2     |
| 2(a)(iii) | by filtration ;                                                                                                                                                  | 1     |
| 2(a)(iv)  | heat ;<br>evaporate / remove <b>water</b> ;                                                                                                                      | 2     |
| 2(b)      | sodium has a +1 charge AND zinc has a +2 charge ;<br>chloride ions have a -1 charge AND idea that charges must balance ;                                         | 2     |

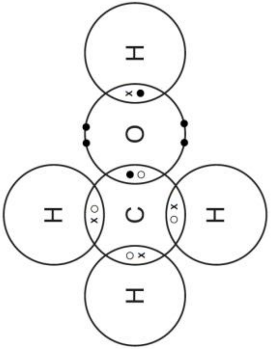
| Question                                       | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks                                                  |                                    |                                        |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------------------------------|----------------------------------------|----------------------|-----------------------|------------------------------|---------------------|--------------------------------------------------------|--|----------------------------------------|---------------------------------|--|-------------------------------------------------------|------------------------------|-----------------------------------|------------------------------------------------|-------------|-----------------------------------------------------|------------------------------------|---------------------------------|---|
| 3(a)                                           | vibrating ;<br>20 ;<br>gases ;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3                                                      |                                    |                                        |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| 3(b)                                           | (because of its) change in speed / different speeds ;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1                                                      |                                    |                                        |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| 3(c)                                           | <table><tr><th>volume and shape</th><th>fluidity</th><th>molecular motion</th><th>molecular separation</th><th>intermolecular forces</th></tr><tr><td>fixed volume,<br/>fixed shape</td><td><div>can flow</div></td><td>molecules move only by vibrating about fixed positions</td><td></td><td><div>no forces between molecules</div></td></tr><tr><td>fixed volume,<br/>no fixed shape</td><td></td><td>molecules move around while still touching each other</td><td>molecules are close together</td><td>moderate forces between molecules</td></tr><tr><td><div>no fixed volume,<br/>no fixed shape</div></td><td>cannot flow</td><td><div>molecules move quickly in all directions</div></td><td><div>molecules are far apart</div></td><td>strong forces between molecules</td></tr></table> <p>two columns correct ;<br/>four columns correct ;</p> | volume and shape                                       | fluidity                           | molecular motion                       | molecular separation | intermolecular forces | fixed volume,<br>fixed shape | <div>can flow</div> | molecules move only by vibrating about fixed positions |  | <div>no forces between molecules</div> | fixed volume,<br>no fixed shape |  | molecules move around while still touching each other | molecules are close together | moderate forces between molecules | <div>no fixed volume,<br/>no fixed shape</div> | cannot flow | <div>molecules move quickly in all directions</div> | <div>molecules are far apart</div> | strong forces between molecules | 2 |
| volume and shape                               | fluidity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | molecular motion                                       | molecular separation               | intermolecular forces                  |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| fixed volume,<br>fixed shape                   | <div>can flow</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | molecules move only by vibrating about fixed positions |                                    | <div>no forces between molecules</div> |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| fixed volume,<br>no fixed shape                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | molecules move around while still touching each other  | molecules are close together       | moderate forces between molecules      |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| <div>no fixed volume,<br/>no fixed shape</div> | cannot flow                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <div>molecules move quickly in all directions</div>    | <div>molecules are far apart</div> | strong forces between molecules        |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |
| 3(d)                                           | evidence of, $v = f\lambda / 3.0 \times 10^8 \div 1.2 \times 10^7$ ;<br>25 (m) ;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2                                                      |                                    |                                        |                      |                       |                              |                     |                                                        |  |                                        |                                 |  |                                                       |                              |                                   |                                                |             |                                                     |                                    |                                 |   |

| Question  | Answer                                                                                                                                                                                                    | Marks |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4(a)(i)   | (most) enzyme denatured;<br><u>active site</u> changes shape / substrate no longer fits <u>active site</u> ;<br>rate of photosynthesis decreases (so fewer bubbles) ;                                     | 3     |
| 4(a)(ii)  | gas exchange takes place through stomata / carbon dioxide enters through stomata / oxygen exits through stomata ;<br>carbon dioxide is needed for photosynthesis / oxygen is produced in photosynthesis ; | 2     |
| 4(a)(iii) | iodine (solution) ;<br>colour changes (from brown) to blue-black ;                                                                                                                                        | 2     |
| 4(b)      | amylase ;<br>(simpler) sugars ;<br>salivary ;<br>pancreas ;                                                                                                                                               | 4     |

| Question | Answer                                                                          | Marks |
|----------|---------------------------------------------------------------------------------|-------|
| 5(a)     | compound ;<br>electricity ;                                                     | 2     |
| 5(b)     | $2e^-$ ;<br>$H_2$ ;                                                             | 2     |
| 5(c)     | (hydroxide ions) lose electrons / ions are discharged;<br>water (also) formed ; | 2     |
| 5(d)     | acid remains / acid is not used up / only water is electrolysed ;               | 1     |

| Question  | Answer                                                                                                                    | Marks |
|-----------|---------------------------------------------------------------------------------------------------------------------------|-------|
| 6(a)(i)   | 0.40 (m / s) ;                                                                                                            | 1     |
| 6(a)(ii)  | (calculation of any relevant area) 160 / 1280 ;<br>(all three relevant areas) 160 + 1280 + 160 / 1600 (m) ;<br>1.6 (km) ; | 3     |
| 6(b)(i)   | evidence of, $W = Fd / 462\,000 \div 1100$ ;<br>420 (m) ;                                                                 | 2     |
| 6(b)(ii)  | idea that some energy is also transferred to the surroundings ;<br>as, thermal / sound / AVP ;                            | 2     |
| 6(b)(iii) | evidence of, $P = W \div t / 792\,000 \div 330$ ;<br>2400 ;<br>$W / \text{watt(s)}$ ;                                     | 3     |

| Question  | Answer                                                                                                                                                                                                                                                                                        | Marks    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 7(a)(i)   | <b>A</b> pulmonary artery ;<br><b>B</b> vena cava ;                                                                                                                                                                                                                                           | <b>2</b> |
| 7(a)(ii)  | left atrium labelled ;                                                                                                                                                                                                                                                                        | <b>1</b> |
| 7(a)(iii) | reference to contraction ;<br>(muscles of) ventricles (contract) ;                                                                                                                                                                                                                            | <b>2</b> |
| 7(b)(i)   | <i>any two from:</i><br>diet ;<br>stress ;<br>smoking ;<br>genetic predisposition ;<br>age ;<br>AVP ;                                                                                                                                                                                         | <b>2</b> |
| 7(b)(ii)  | <i>any two from:</i><br>both / male / female / number of people increasing AND then decreasing ;<br>males higher (than females) ORA ;<br>AVP ;<br><br><i>plus one for:</i><br>correct use of supporting data, e.g. both graphs reach peak in 2004 / 10 000 females and 22 000 males in 1978 ; | <b>3</b> |

| Question                                                                                                  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks                               |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|------|-------|-----------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------|--------------------------|-------------------------------------|---------------------------------------------------------------------|--------------------------|-------------------------------------|---|
| 8(a)                                                                                                      |  <p>four pairs bonding electrons around carbon correct ;<br/> one bonding pair between oxygen and hydrogen (O-H bond) correct ;<br/> four non-bonding electrons on oxygen shell AND no extra electrons (on hydrogen) ;</p>                                                                                                                                                                                                                                                                                                                                                                                                                         | 3                                   |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| 8(b)(i)                                                                                                   | <p>ethene, has a double bond / shares 4 electrons OR<br/> ethane, has <b>only</b> single bonds / has single bond between carbons / shares 2 electrons ;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                                   |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| 8(b)(ii)                                                                                                  | <table border="0"> <thead> <tr> <th></th><th>true</th><th>false</th></tr> </thead> <tbody> <tr> <td>One molecule of ethene produces the same number of molecules of carbon dioxide as one molecule of ethane.</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr> <td>One molecule of ethene produces the same number of molecules of water as one molecule of ethane.</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> <tr> <td>The combustion reactions of ethene and ethane are both endothermic.</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> </tbody> </table> <p>two correct ;<br/> three correct ;</p> |                                     | true | false | One molecule of ethene produces the same number of molecules of carbon dioxide as one molecule of ethane. | <input checked="" type="checkbox"/> | <input type="checkbox"/> | One molecule of ethene produces the same number of molecules of water as one molecule of ethane. | <input type="checkbox"/> | <input checked="" type="checkbox"/> | The combustion reactions of ethene and ethane are both endothermic. | <input type="checkbox"/> | <input checked="" type="checkbox"/> | 2 |
|                                                                                                           | true                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | false                               |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| One molecule of ethene produces the same number of molecules of carbon dioxide as one molecule of ethane. | <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <input type="checkbox"/>            |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| One molecule of ethene produces the same number of molecules of water as one molecule of ethane.          | <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <input checked="" type="checkbox"/> |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| The combustion reactions of ethene and ethane are both endothermic.                                       | <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <input checked="" type="checkbox"/> |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| 8(c)                                                                                                      | <p><i>alkene</i> C<sub>5</sub>H<sub>10</sub> ;<br/> <i>alkane</i> C<sub>4</sub>H<sub>10</sub> ;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2                                   |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |
| 8(d)                                                                                                      | <p><i>alkene</i> no colour / colourless ;<br/> <i>alkane</i> orange ;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2                                   |      |       |                                                                                                           |                                     |                          |                                                                                                  |                          |                                     |                                                                     |                          |                                     |   |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 9(a)     | fuse ;                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1     |
| 9(b)(i)  | (current in headlight branch = $11.0 - 1.0 \Rightarrow 10.0$ (A) ;                                                                                                                                                                                                                                                                                                                                                                                                    | 1     |
| 9(b)(ii) | <p>(current in one headlight = <math>\frac{1}{2} \times 10.0</math>) = 5.0 (A) ;<br/> evidence of, <math>R = V \div I / 12 \div 5.0</math> ;<br/> 2.4 (<math>\Omega</math>) ;</p> <p><i>alternative method:</i><br/> evidence of, <math>R = V \div I</math> or <math>12 \div 10.0</math> or 1.2(<math>\Omega</math>) ;<br/> (resistance of parallel arrangement) <math>1.2 \times 2</math> OR double the calculated resistance ;<br/> 2.4 (<math>\Omega</math>) ;</p> | 3     |
| 9(c)     | <p>resistance of wire proportional to length / <math>3 \times</math> longer gives <math>3 \times</math> resistance / <math>3 \times 3</math> or 9 ;<br/> resistance of wire inversely proportional to cross-sectional area / half cross-sectional area gives <math>2 \times</math> resistance / <math>2 \times 3</math> or 6 ;<br/> (resistance of rear lamp is <math>6 \times</math> resistance of headlamp <math>\Rightarrow</math>) 18 (<math>\Omega</math>) ;</p> | 3     |





# Cambridge IGCSE™

---

**COMBINED SCIENCE****0653/04**

Paper 4 Theory (Extended)

**For examination from 2025**

MARK SCHEME

Maximum Mark: 80

---

**Specimen**

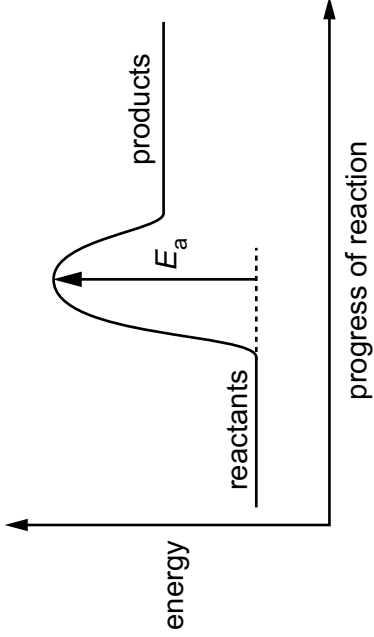
---

This document has **10** pages.

| Question | Answer                                                                                                                                                                                                                                                                                                                    | Marks    | Guidance                                                                                                        |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------|
| 1(a)     | any <b>two</b> from:<br>pathogens spread diseases ;<br>idea of good personal hygiene ;<br>stops the spread of pathogens ;                                                                                                                                                                                                 | <b>2</b> | <b>A</b> named pathogen<br><b>A</b> removes pathogens from hands<br><b>A</b> stops pathogens getting on to food |
| 1(b)(i)  | any <b>two</b> from:<br>initial vaccination – fewer antibodies produced ;<br>initial vaccination – number of antibodies increases more slowly ;<br>initial vaccination – antibodies decrease to a lower number (after the peak) ;<br>initial vaccination – number of antibodies decreases more rapidly (after the peak) ; | <b>2</b> | <b>ORA</b>                                                                                                      |
| 1(b)(ii) | phagocytosis <input type="checkbox"/><br><br>assimilation <input type="checkbox"/><br><br>active immunity <input checked="" type="checkbox"/> ;<br><br>transmissible disease <input type="checkbox"/>                                                                                                                     | <b>1</b> |                                                                                                                 |
| 1(c)     | help form a clot ;<br>idea that blood clot, seals wound / prevents entry of pathogens ;                                                                                                                                                                                                                                   | <b>2</b> | <b>I</b> produces antibodies                                                                                    |
| 1(d)(i)  | coronary ;                                                                                                                                                                                                                                                                                                                | <b>1</b> |                                                                                                                 |
| 1(d)(ii) | red blood cell(s) ;                                                                                                                                                                                                                                                                                                       | <b>1</b> |                                                                                                                 |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                          | Marks    | Guidance                                                                                                |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------|
| 2(a)(i)  | sucrose <b>AND</b> amino acids ;                                                                                                                                                                                                                                                                                                                                | <b>1</b> | more than <b>two</b> circled = 0 marks                                                                  |
| 2(a)(ii) | support ;                                                                                                                                                                                                                                                                                                                                                       | <b>1</b> |                                                                                                         |
| 2(b)     | $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow$ ;<br>$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ ;                                                                                                                                                                                                                                                       | <b>2</b> | <b>A</b> reactants any order<br><b>A</b> products any order<br><b>I</b> anything written over the arrow |
| 2(c)     | test-tube <b>A</b><br>high concentration of carbon dioxide because:<br>carbon dioxide produced in respiration ;<br>no photosynthesis / light is needed for photosynthesis ;<br><br>test-tube <b>C</b><br>low concentration of carbon dioxide because:<br>carbon dioxide used in photosynthesis ;<br>rate of photosynthesis is higher than rate of respiration ; | <b>4</b> |                                                                                                         |
| 2(d)     | reduces biodiversity because:<br><br>any <b>two</b> from:<br>less food available for consumers ;<br>some species become extinct ;<br>removes habitat / shelter ;                                                                                                                                                                                                | <b>2</b> |                                                                                                         |

| Question | Answer                                                                                                                                                                                                                               | Marks | Guidance              |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------|
| 3(a)(i)  | egestion ;                                                                                                                                                                                                                           | 1     |                       |
| 3(a)(ii) | pancreas ;<br>lipase ;<br>fatty acids <b>AND</b> glycerol ;                                                                                                                                                                          | 3     | <b>A</b> either order |
| 3(b)(i)  | stomach contents, are acidic / have a lower pH ;<br>active site changes shape ;<br>substrate no longer fits into the active site / substrate no longer complementary to the active site / enzyme-substrate complex no longer forms ; | 3     |                       |
| 3(b)(ii) | bell-shaped curve with optimum pH 1–3 ;                                                                                                                                                                                              | 1     |                       |

| Question | Answer                                                                                                                                  | Marks | Guidance |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------|-------|----------|
| 4(a)(i)  | the minimum energy that colliding particles must have to react ;                                                                        | 1     |          |
| 4(a)(ii) | arrow to show $E_a$ ;<br>                           | 1     |          |
| 4(b)     | temperature decreases <b>AND</b> reaction is endothermic / takes in thermal energy / the products have more energy than the reactants ; | 1     |          |
| 4(c)(i)  | carbon dioxide ;<br>water ;                                                                                                             | 2     |          |

| Question | Answer                                                                                                                                                                             | Marks | Guidance |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|
| 4(c)(ii) | frequency of collisions increases ;<br>more particles have kinetic energy greater than the activation energy /<br>collisions are more energetic / more collisions are successful ; | 2     |          |

| Question  | Answer                                                                                                                                                                                                                                                                | Marks        | Guidance                                             |              |           |  |   |        |   |  |      |   |  |   |  |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------|--------------|-----------|--|---|--------|---|--|------|---|--|---|--|
| 5(a)(i)   | both have high electrical conductivity ;                                                                                                                                                                                                                              | 1            |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(a)(ii)  | aluminium, has low density / is light in weight / is lightweight ;                                                                                                                                                                                                    | 1            |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(a)(iii) | some copper compounds are toxic ;                                                                                                                                                                                                                                     | 1            | A aluminium is preferred because it does not corrode |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(b)(i)   | mixture of a metal with (one or more) other elements ;                                                                                                                                                                                                                | 1            |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(b)(ii)  | steel contains particles of different sizes ;<br>which stop layers of atoms from sliding over each other ;                                                                                                                                                            | 2            |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(b)(iii) | stainless steel is, hard / resistant to rusting ;                                                                                                                                                                                                                     | 1            | A stainless steel does not corrode                   |              |           |  |   |        |   |  |      |   |  |   |  |
| 5(c)      | <table><tr><td>metal</td><td>heating with carbon</td><td>electrolysis</td></tr><tr><td>aluminium</td><td></td><td>✓</td></tr><tr><td>copper</td><td>✓</td><td></td></tr><tr><td>iron</td><td>✓</td><td></td></tr></table><br>any two correct ;<br>all three correct ; | metal        | heating with carbon                                  | electrolysis | aluminium |  | ✓ | copper | ✓ |  | iron | ✓ |  | 2 |  |
| metal     | heating with carbon                                                                                                                                                                                                                                                   | electrolysis |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| aluminium |                                                                                                                                                                                                                                                                       | ✓            |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| copper    | ✓                                                                                                                                                                                                                                                                     |              |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |
| iron      | ✓                                                                                                                                                                                                                                                                     |              |                                                      |              |           |  |   |        |   |  |      |   |  |   |  |

| Question | Answer                                                                                                                                         | Marks    | Guidance                                                                                                 |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------|
| 6(a)     | carbon monoxide <b>AND</b> carbon particulates by incomplete combustion ;<br>carbon dioxide by complete combustion ;                           | <b>2</b> | <b>A</b> max 1 for identification of combustion alone                                                    |
| 6(b)     | CO <sub>2</sub> (g) <b>AND</b> CO(g) ;<br>C(s) <b>AND</b> C <sub>8</sub> H <sub>18</sub> (l) ;                                                 | <b>2</b> |                                                                                                          |
| 6(c)(i)  | idea that, the double bonds are not between two carbon atoms ;                                                                                 | <b>1</b> |                                                                                                          |
| 6(c)(ii) | any <b>two</b> from:<br>reduce deforestation ;<br>decrease the use of fossil fuels ;<br>increase the use of, renewable energy / wind / solar ; | <b>2</b> | <b>A</b> reduce livestock farming<br><b>A</b> other examples of suitable energy sources<br>e.g. hydrogen |
| 6(d)(i)  | 2CO + 2NO → 2CO <sub>2</sub> + N <sub>2</sub>                                                                                                  | <b>1</b> |                                                                                                          |
| 6(d)(ii) | acid rain ;<br>because oxides of nitrogen are removed ;                                                                                        | <b>2</b> | <b>A</b> NO for oxides of nitrogen                                                                       |

| Question  | Answer                                                                                                                                             | Marks    | Guidance                                              |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------|
| 7(a)(i)   | 40 (s) ;                                                                                                                                           | <b>1</b> |                                                       |
| 7(a)(ii)  | <b>X</b> marked on graph line at any point between 100 s and 120 s ;                                                                               | <b>1</b> |                                                       |
| 7(a)(iii) | use of, graph data between 40 s and 100 s / speed 1.5 m / s ;<br>distance = speed × time / use of graph to calculate area / 1.5 × 60 ;<br>90 (m) ; | <b>3</b> | in that order                                         |
| 7(b)      | $\Delta E_p = mgh / 55 \times 9.8 \times 0.15$ ;<br>81 ;<br>J / joules ;                                                                           | <b>3</b> | <b>A</b> formula in any form<br><b>A</b> 80.9 / 80.85 |

| Question | Answer                                                                                                                                                                                 | Marks | Guidance                     |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------|
| 8(a)(i)  | infrared ;                                                                                                                                                                             | 1     |                              |
| 8(a)(ii) | absorbed <b>AND</b> greater than <b>AND</b> emitted ;                                                                                                                                  | 1     | in that order                |
| 8(b)(i)  | sound ;                                                                                                                                                                                | 1     |                              |
| 8(b)(ii) | transverse waves: direction of vibration at right angles to direction of propagation ;<br>longitudinal waves: direction of vibration parallel to direction of propagation ;            | 2     |                              |
| 8(c)     | conversion of days to hours / $365.25 \times 24$ / 8766 hours ;<br>orbital speed $v = \frac{2\pi r}{T} / \frac{2\pi \times 1.51 \times 10^8}{8766}$ ;<br>$1.08 \times 10^5$ (km / h) ; | 3     | <b>A</b> formula in any form |
| 8(d)(i)  | red giant ;                                                                                                                                                                            | 1     |                              |
| 8(d)(ii) | (the Sun) does not have enough <u>mass</u> / Sun is a small <u>mass</u> star / (only) very large <u>mass</u> stars become black holes ;                                                | 1     |                              |

| Question  | Answer                                                                                                                                                                                                           | Marks | Guidance                                                                                                                                                                                                         |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9(a)(i)   | $(5.4 + 3.5 =) 8.9$ ( $\Omega$ ) ;                                                                                                                                                                               | 1     |                                                                                                                                                                                                                  |
| 9(a)(ii)  | <b>(S =)</b> 0.2 (A) ;<br><b>(U =)</b> 2.5 (A) ;                                                                                                                                                                 | 2     |                                                                                                                                                                                                                  |
| 9(a)(iii) | LED / light-emitting diode ;                                                                                                                                                                                     | 1     |                                                                                                                                                                                                                  |
| 9(b)(i)   | chemical ;<br>kinetic ;                                                                                                                                                                                          | 2     | in that order                                                                                                                                                                                                    |
| 9(b)(ii)  | useful power output = $\frac{\text{energy}}{\text{time}} / \frac{32}{10}$ ;<br>efficiency = $\frac{\text{useful power output}}{\text{total power input}} \times 100\% / \frac{3.2}{3.6} \times 100$ ;<br>88.9% ; | 3     | <b>A</b> alternative approach of converting input power to energy, then using energy efficiency formula<br><b>A</b> formula in any form<br>calculation shown with final answer to at least 3 significant figures |