

# Cambridge IGCSE™

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**CO-ORDINATED SCIENCES****0654/42**

Paper 4 Theory (Extended)

**May/June 2025****MARK SCHEME**Maximum Mark: 120

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**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 May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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This document consists of **17** printed pages.

**PUBLISHED****Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

**GENERIC MARKING PRINCIPLE 1:**

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

**GENERIC MARKING PRINCIPLE 2:**

Marks awarded are always **whole marks** (not half marks, or other fractions).

**GENERIC MARKING PRINCIPLE 3:**

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

**GENERIC MARKING PRINCIPLE 4:**

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

**GENERIC MARKING PRINCIPLE 5:**

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

**GENERIC MARKING PRINCIPLE 6:**

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

**Science-Specific Marking Principles**

1 Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.

2 The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.

3 Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).

4 The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.

5 'List rule' guidance

For questions that require ***n*** responses (e.g. State **two** reasons ...):

- The response should be read as continuous prose, even when numbered answer spaces are provided.
- Any response marked *ignore* in the mark scheme should not count towards ***n***.
- Incorrect responses should not be awarded credit but will still count towards ***n***.
- Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.
- Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

**6** Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g.  $a \times 10^n$ ) in which the convention of restricting the value of the coefficient ( $a$ ) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

**7** Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

**Annotations guidance for centres**

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

**Annotations**

| <b>Annotation</b>                                                                   | <b>Meaning</b>                                                                                                                 |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|    | correct point or mark awarded                                                                                                  |
|    | incorrect point or mark not awarded                                                                                            |
|    | benefit of the doubt given                                                                                                     |
|    | follow through                                                                                                                 |
|  | benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied. |
|  | response is too vague or there is insufficient detail in response                                                              |
|  | error carried forward applied                                                                                                  |
|  | information missing or insufficient for credit                                                                                 |
|  | unclear response                                                                                                               |
|  | incorrect or insufficient point ignored while marking the rest of the response                                                 |

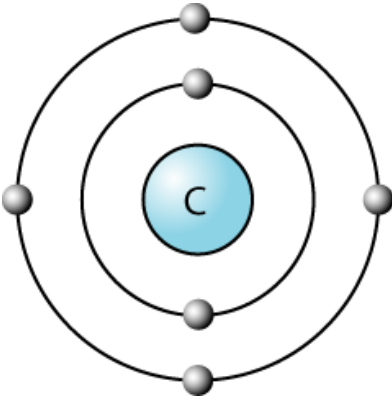
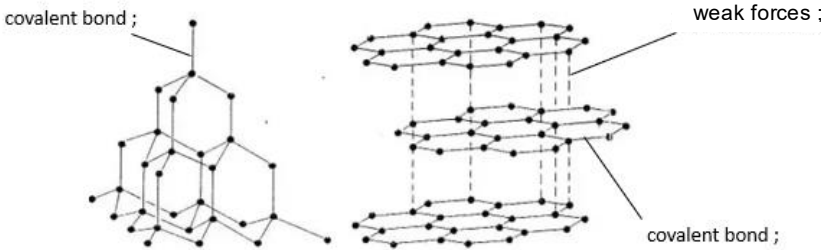
| <b>Annotation</b>                                                                 | <b>Meaning</b>                                                                                                             |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
|  | incorrect point or mark not awarded                                                                                        |
|  | two statements are linked                                                                                                  |
|  | point has been noted, but no credit has been given or blank page seen                                                      |
|  | key point attempted / working towards marking point / incomplete answer / response seen but not credited / blank page seen |
|  | blank page                                                                                                                 |

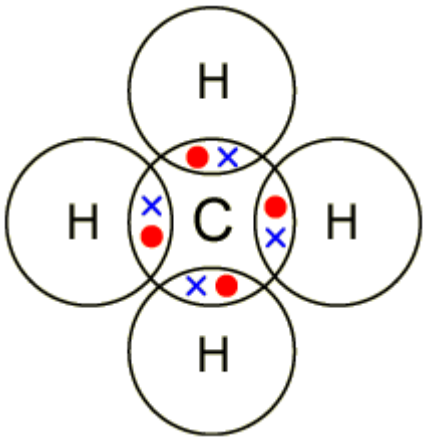
| Question     | Answer                                                                                                                                                                                                                                                                                              | Marks                                      |                      |              |       |         |                                            |              |                  |                      |          |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------------|--------------|-------|---------|--------------------------------------------|--------------|------------------|----------------------|----------|
| 1(a)         | <b>D ;</b><br><b>A ;</b>                                                                                                                                                                                                                                                                            | <b>2</b>                                   |                      |              |       |         |                                            |              |                  |                      |          |
| 1(b)         | translocation ;                                                                                                                                                                                                                                                                                     | <b>1</b>                                   |                      |              |       |         |                                            |              |                  |                      |          |
| 1(c)         | <table border="1"> <tr> <td>substance</td><td>method of absorption</td><td>use in plant</td></tr> <tr> <td>water</td><td>osmosis</td><td>support / photosynthesis / prevent wilting</td></tr> <tr> <td>nitrate ions</td><td>active transport</td><td>(making) amino acids</td></tr> </table><br>; ; | substance                                  | method of absorption | use in plant | water | osmosis | support / photosynthesis / prevent wilting | nitrate ions | active transport | (making) amino acids | <b>2</b> |
| substance    | method of absorption                                                                                                                                                                                                                                                                                | use in plant                               |                      |              |       |         |                                            |              |                  |                      |          |
| water        | osmosis                                                                                                                                                                                                                                                                                             | support / photosynthesis / prevent wilting |                      |              |       |         |                                            |              |                  |                      |          |
| nitrate ions | active transport                                                                                                                                                                                                                                                                                    | (making) amino acids                       |                      |              |       |         |                                            |              |                  |                      |          |
| 1(d)         | cell membrane plasmolysed ;<br>smaller vacuole ;                                                                                                                                                                                                                                                    | <b>2</b>                                   |                      |              |       |         |                                            |              |                  |                      |          |
| 1(e)         | <i>any <b>three</b> from:</i><br>increases transpiration rate ;<br>wind blows water (vapour) away from leaf (surface) ;<br>increases concentration gradient (from inside the leaf to the air) ;<br>increases (rate of) / faster, evaporation / diffusion ;                                          | <b>3</b>                                   |                      |              |       |         |                                            |              |                  |                      |          |

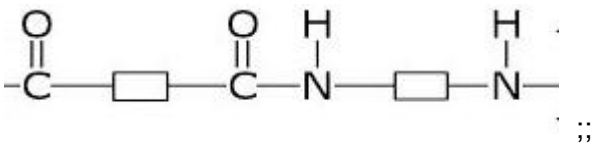
| Question | Answer                                                                                                                                                                                                                                                                                                          | Marks    |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 2(a)     | <b>B ;</b><br><b>D ;</b>                                                                                                                                                                                                                                                                                        | <b>2</b> |
| 2(b)     | any <b>two</b> from:<br><br>large surface area ;<br><br>thin (surface / membrane / wall) ;<br><br>good blood supply ;<br><br>good ventilation (with air) ;<br><br>AVP ;;                                                                                                                                        | <b>2</b> |
| 2(c)(i)  | 3.96 ;                                                                                                                                                                                                                                                                                                          | <b>1</b> |
| 2(c)(ii) | oxygen used in (aerobic) respiration ;<br>carbon dioxide produced in (aerobic) respiration ;<br>water <u>evaporates</u> from, alveoli / cells ;                                                                                                                                                                 | <b>3</b> |
| 2(d)     | <i>any <b>four</b> from:</i><br><i>ref to</i> anaerobic respiration (in muscles) ;<br>production / build up, of lactic acid ;<br><br><i>ref to</i> oxygen debt ;<br>(extra) <u>oxygen</u> required to, break down / remove, lactic acid ;<br>(lactic acid removed) by <u>aerobic</u> respiration in the liver ; | <b>4</b> |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                 | Marks |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 3(a)(i)  | 120.0 – 7.0 ;<br>113 $\mu\text{m}$ ;                                                                                                                                                                                                                                                                                                                                                                   | 2     |
| 3(a)(ii) | red blood cell ;                                                                                                                                                                                                                                                                                                                                                                                       | 1     |
| 3(b)     | antibodies ;<br>phagocytes ;<br>active ;                                                                                                                                                                                                                                                                                                                                                               | 3     |
| 3(c)     | <i>any <b>three</b> from:</i><br><i>idea that weakened / dead, pathogens / virus OR antigens, given ;</i><br><i><u>antigens</u> stimulate an <u>immune response</u> ;</i><br><i>lymphocytes produce antibodies ;</i><br><i>correct ref to memory cells / ref to long-term OR active, immunity ;</i><br><i>idea of antibodies destroy, (flu) virus or (flu) pathogens in <u>future infections</u> ;</i> | 3     |
| 3(d)     | ref to changes in (shape of) <u>antigen</u> (of flu virus) ;<br><i>idea of new antibodies are required (to match antigen) ;</i>                                                                                                                                                                                                                                                                        | 2     |

| Question | Answer                                                                                                                                                                                                                                                                                 | Marks |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4(a)     | energy store ;<br>jelly coat (which changes when egg is fertilised) ;<br>AVP ;                                                                                                                                                                                                         | 2     |
| 4(b)(i)  | tertiary consumer ;                                                                                                                                                                                                                                                                    | 1     |
| 4(b)(ii) | arrow from herring pointing to a label for humans ;                                                                                                                                                                                                                                    | 1     |
| 4(c)     | any <b>three</b> from:<br>toxins / poisons / chemicals (kills orcas / stops orcas breeding) ;<br><i>idea that</i> orca is (physically) harmed by, nets / rubbish / plastic ;<br>(over)fishing of (Orca) prey ;<br>boats / noise, disturbs migration ;<br>hunting ;<br>climate change ; | 3     |

| Question | Answer                                                                                                                                                                                                                | Marks |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 5(a)     |  ;                                                                                                                                   | 1     |
| 5(b)     | 12 ;                                                                                                                                                                                                                  | 1     |
| 5(c)     | $6.02 \times 10^{23}$ ;                                                                                                                                                                                               | 1     |
| 5(d)(i)  |                                                                                                                                    | 3     |
| 5(d)(ii) | (diamond is) <u>hard</u> ;<br><br>(because)<br>each carbon (atom) is bonded to four other carbon (atoms) / tetrahedral arrangement of carbon atoms / there are many strong covalent bonds / it is a giant structure ; | 2     |

| Question | Answer                                                                            | Marks |
|----------|-----------------------------------------------------------------------------------|-------|
| 5(e)     |  | 2     |

| Question | Answer                                                                                                                | Marks |
|----------|-----------------------------------------------------------------------------------------------------------------------|-------|
| 6(a)(i)  | $\text{C}_6\text{H}_{16}\text{N}_2$ ;                                                                                 | 1     |
| 6(a)(ii) | <i>idea that</i> (molecule <b>X</b> ) does not contain only carbon and hydrogen (atoms) / contains nitrogen (atoms) ; | 1     |
| 6(b)     |                                     | 2     |

| Question                                                                | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks                   |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------|-----------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------|----------------------------------|-------------------------|--------------------------|---|
| 6(c)                                                                    | <p>Any <b>two</b> rows from:</p> <table><tr><td>addition polymerisation</td><td>condensation polymerisation</td></tr><tr><td>requires, unsaturated monomers / monomers with a C=C bond</td><td>does not require, unsaturated monomers / monomers with a C=C bond</td></tr><tr><td>forms polymer (molecule) only / no (additional) small molecule produced</td><td>forms (polymer molecule and) one small (additional) molecule</td></tr><tr><td>(requires) one functional group (only)</td><td>(requires) two functional groups</td></tr><tr><td>many identical monomers</td><td>two (different) monomers</td></tr></table> <p>;;</p> | addition polymerisation | condensation polymerisation | requires, unsaturated monomers / monomers with a C=C bond | does not require, unsaturated monomers / monomers with a C=C bond | forms polymer (molecule) only / no (additional) small molecule produced | forms (polymer molecule and) one small (additional) molecule | (requires) one functional group (only) | (requires) two functional groups | many identical monomers | two (different) monomers | 2 |
| addition polymerisation                                                 | condensation polymerisation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| requires, unsaturated monomers / monomers with a C=C bond               | does not require, unsaturated monomers / monomers with a C=C bond                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| forms polymer (molecule) only / no (additional) small molecule produced | forms (polymer molecule and) one small (additional) molecule                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                         |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| (requires) one functional group (only)                                  | (requires) two functional groups                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| many identical monomers                                                 | two (different) monomers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| 6(d)                                                                    | <p>test – limewater ;</p> <p>result – turns milky / turns cloudy ;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2                       |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |
| 6(e)                                                                    | <p>good electrical conductivity when molten</p> <p>high boiling point</p> <p>low melting point ✓ ;</p> <p>malleable</p> <p>poor electrical conductivity when solid ✓;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2                       |                             |                                                           |                                                                   |                                                                         |                                                              |                                        |                                  |                         |                          |   |

| Question | Answer                                                                                                       | Marks |
|----------|--------------------------------------------------------------------------------------------------------------|-------|
| 7(a)     | $\text{Na}_2\text{SO}_4$ ;                                                                                   | 1     |
| 7(b)     | anode dissolves / anode gets smaller ;                                                                       | 1     |
| 7(c)(i)  | $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ ;;                                                      | 2     |
| 7(c)(ii) | oxidation<br><b>and</b><br>loss of electrons ;                                                               | 1     |
| 7(d)(i)  | magnesium<br>zinc<br>iron<br>copper ;;                                                                       | 2     |
| 7(d)(ii) | $\text{Mg} + \text{ZnSO}_4 \rightarrow \text{Zn} + \text{MgSO}_4$ ;;                                         | 2     |
| 7(e)     | different sized atoms in, (the alloy / brass) ;<br><br>mean the layers can no longer slide over each other ; | 2     |

| Question | Answer                                                                                                                                            | Marks |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 8(a)     | $2\text{HCl}(\text{aq}) + \text{CaCO}_3(\text{s}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ ;; | 2     |
| 8(b)(i)  | 4.8 (minutes) ;                                                                                                                                   | 1     |
| 8(b)(ii) | curve drawn with less steep gradient ;                                                                                                            | 1     |
| 8(c)     | more molecules (of acid) per unit volume ;<br><br>increased frequency of collisions (of molecules) / AW ;                                         | 2     |

| Question | Answer                                                                                                                                                       | Marks |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 8(d)     | moles of $\text{CaCl}_2 = 0.2 \div 2 = 0.1$ ;<br>relative molecular mass of $\text{CaCl}_2 = 111$ ;<br>mass of $\text{CaCl}_2 = 0.1 \times 111 = 11.1$ (g) ; | 3     |

| Question  | Answer                                                                           | Marks |
|-----------|----------------------------------------------------------------------------------|-------|
| 9(a)(i)   | chemical ;                                                                       | 1     |
| 9(a)(ii)  | (chemical $\rightarrow$ ) electrical ;                                           | 1     |
| 9(a)(iii) | (electrical $\rightarrow$ ) light / thermal / EM waves / (EM) radiation ;        | 1     |
| 9(b)(i)   | evidence of $E=mgh$ or $70 \times 9.8 \times 5.0$ ;<br>3400 (J) ;                | 2     |
| 9(b)(ii)  | KE = their 9(b)(i) ;                                                             | 1     |
| 9(b)(iii) | evidence of $KE = 0.5 mv^2$ or $0.5 \times 70 \times v^2$ ;<br>$v = 9.9$ m / s ; | 2     |

| Question  | Answer                                                                                          | Marks |
|-----------|-------------------------------------------------------------------------------------------------|-------|
| 10(a)(i)  | perpendicular / at right angles / at $90^\circ$ ;                                               | 1     |
| 10(a)(ii) | visible light, water, ultraviolet ;;<br>2 correct = 1 mark, 3 correct = 2 marks                 | 2     |
| 10(b)(i)  | first (correctly) reflected ray ;<br>second reflected ray ;<br>Y labelled in correct position ; | 3     |

| Question  | Answer                                                                                                                | Marks |
|-----------|-----------------------------------------------------------------------------------------------------------------------|-------|
| 10(b)(ii) | upright ;<br>virtual ;                                                                                                | 2     |
| 10(c)     | evidence of $\lambda = v / f$ or $3.0 \times 10^8 / 6.6 \times 10^{14}$ ;<br>$4.5 \times 10^{-7}$ (m) ;               | 2     |
| 10(d)     | different, colours have different frequencies ;<br>the higher the frequency the greater the <u>refraction</u> / ORA ; | 2     |

| Question  | Answer                                                                                                        | Marks |
|-----------|---------------------------------------------------------------------------------------------------------------|-------|
| 11(a)     | ref to, nucleus / nuclei ;<br>nucleus splits ;                                                                | 2     |
| 11(b)(i)  | 92 ;                                                                                                          | 1     |
| 11(b)(ii) | 143 ;                                                                                                         | 1     |
| 11(c)(i)  | increases (pd) ;                                                                                              | 1     |
| 11(c)(ii) | (step-up transformer) increases voltage ;<br>reduces current ;<br>less, power / energy, loss (through heat) ; | 3     |
| 11(d)     | evidence of $V_p / V_s = N_p / N_s$ or $30\,000 / V_s = 25\,000 / 90$ ;<br>110 (V) ;                          | 2     |

| Question   | Answer                                                                                                         | Marks |
|------------|----------------------------------------------------------------------------------------------------------------|-------|
| 12(a)      | star / planet / protostars ;                                                                                   | 1     |
| 12(b)(i)   | ref to nuclear reaction / nuclear fusion ;<br>fusion of hydrogen nuclei ;<br>formation of helium (nuclei) ;    | 3     |
| 12(b)(ii)  | hot <del>gas</del> is less dense and rises ;<br><del>gas</del> cools (becomes more dense) and, sinks / falls ; | 2     |
| 12(b)(iii) | shiny / smooth ;<br>white / silver ;                                                                           | 2     |
| 12(c)      | density / temperature ;<br>13.8 billion ;                                                                      | 2     |