



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**CHEMISTRY**

**0620/42**

Paper 4 Extended Theory

**October/November 2016**

MARK SCHEME

Maximum Mark: 80

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**Published**

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| Question | Answer                                                                                                                                                                                                             |         |         |  | Mark  |          |         |         |        |  |  |  |     |              |        |        |   |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|--|-------|----------|---------|---------|--------|--|--|--|-----|--------------|--------|--------|---|
| 1(a)     | fixed volume <b>AND</b> take the shape of the container                                                                                                                                                            |         |         |  | 1     |          |         |         |        |  |  |  |     |              |        |        |   |
| 1(b)     | <table><tr><td>solid</td><td>touching</td><td>regular</td><td>vibrate</td></tr><tr><td>liquid</td><td></td><td></td><td></td></tr><tr><td>gas</td><td>not touching</td><td>random</td><td>random</td></tr></table> |         |         |  | solid | touching | regular | vibrate | liquid |  |  |  | gas | not touching | random | random | 6 |
| solid    | touching                                                                                                                                                                                                           | regular | vibrate |  |       |          |         |         |        |  |  |  |     |              |        |        |   |
| liquid   |                                                                                                                                                                                                                    |         |         |  |       |          |         |         |        |  |  |  |     |              |        |        |   |
| gas      | not touching                                                                                                                                                                                                       | random  | random  |  |       |          |         |         |        |  |  |  |     |              |        |        |   |
| 1(c)(i)  | melting                                                                                                                                                                                                            |         |         |  | 1     |          |         |         |        |  |  |  |     |              |        |        |   |
| 1(c)(ii) | sublimation                                                                                                                                                                                                        |         |         |  | 1     |          |         |         |        |  |  |  |     |              |        |        |   |

| <b>Question</b> | <b>Answer</b>                                                                                                        | <b>Mark</b> |
|-----------------|----------------------------------------------------------------------------------------------------------------------|-------------|
| 2(a)            | (total) number of protons and neutrons in a nucleus (of an atom)                                                     | <b>2</b>    |
| 2(b)            | Na     2 : 8 : 1<br>P <sup>3-</sup> 2 : 8 : 8                                                                        | <b>2</b>    |
| 2(c)            | radiotherapy <b>OR</b> treatment of cancer                                                                           | <b>1</b>    |
| 2(d)            | <u>average</u> mass of (naturally occurring) <u>atom(s)</u> (of an element) (compared to an atom of) <sup>12</sup> C | <b>2</b>    |

|               |                                                |                 |              |
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| <b>Question</b> | <b>Answer</b>                                                                                                                                                   | <b>Mark</b> |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 2(e)            | chlorine must have more than one isotope<br>the masses of these isotopes / (any given) mass numbers are averaged                                                | <b>2</b>    |
| 2(f)            | lattice of labelled $Al^{3+}$ ions<br>electrons seen on the diagram between the ions<br>attraction between (positive) ions and (sea of / delocalised) electrons | <b>3</b>    |

| <b>Question</b> | <b>Answer</b>                                                                                                                                                                                                                                                                                                         | <b>Mark</b> |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 3(a)            | nitrogen (78%) <b>AND</b> oxygen (21%)<br>noble gases <b>OR</b> argon (1%)                                                                                                                                                                                                                                            | <b>2</b>    |
| 3(b)            | nitrogen <b>AND</b> oxygen (from the air) react<br>(in the) high temperatures of a car engine<br>$NO_x$ / oxides of nitrogen react with or dissolve in water (to form an acid)                                                                                                                                        | <b>3</b>    |
| 3(c)            | any 2 from:<br>(named) ruminant animal / cattle / (anaerobic) digestion / flatulence (in animals) / animal waste / (animal) dung<br>decomposing vegetation / animals / organisms / decaying (organic) matter /<br>(fractional distillation / cracking of) petroleum / crude oil / hydrocarbons / natural gas / coal / | <b>2</b>    |
| 3(d)            | photosynthesis                                                                                                                                                                                                                                                                                                        | <b>1</b>    |

|        |                                         |          |       |
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| Question | Answer                                                                                          | Mark |
|----------|-------------------------------------------------------------------------------------------------|------|
| 4(a)     | <i>copper(II) carbonate</i><br>fizzes / bubbles / effervescence<br>dissolves / disappears       | 2    |
|          | <i>copper(II) oxide</i><br>dissolves / disappears<br>blue (solution formed)                     | 2    |
| 4(b)(i)  | $\text{Cu}(\text{NO}_3)_2$<br><u>3</u> Cu <b>AND</b> <u>3</u> Cu(NO <sub>3</sub> ) <sub>2</sub> | 2    |
| 4(b)(ii) | hydrogen (gas) is not produced (when copper reacts with nitric acid)                            | 1    |

| Question | Answer                                                                                                                                                                                                                                                                              | Mark |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 5(a)     | 20 cm <sup>3</sup><br><b>M1</b> $M_r$ of MnO <sub>2</sub> : 87<br><b>M2</b> moles of MnO <sub>2</sub> used: $3.48 / 87 = 0.04$<br><b>M3</b> moles of HCl needed: $0.04 \times 4 = 0.16$<br><b>M4</b> volume of HCl needed: $(0.16 / 8.0) \times 1000$ <b>AND</b> 20 cm <sup>3</sup> | 4    |
| 5(b)(i)  | from colourless<br>to yellow / orange / brown                                                                                                                                                                                                                                       | 2    |
| 5(b)(ii) | $\text{Cl}_2(\text{g}) + 2\text{Br}^-(\text{aq}) \rightarrow \text{Br}_2(\text{aq}) + 2\text{Cl}^-(\text{aq})$<br><br><b>M1</b> (aq) as state symbols for the two products given<br><b>M2</b> correct products<br><b>M3</b> balancing                                               | 3    |

|               |                                                |                 |              |
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| <b>Question</b> | <b>Answer</b>                                                                                                                                                                       | <b>Mark</b> |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 5(c)(i)         | the (C=C) double bond                                                                                                                                                               | <b>1</b>    |
| 5(c)(ii)        | addition <b>OR</b> bromination                                                                                                                                                      | <b>1</b>    |
| 5(d)(i)         | substitution                                                                                                                                                                        | <b>1</b>    |
| 5(d)(ii)        | (compounds with the) same molecular formula<br>different structural formulae or structures                                                                                          | <b>2</b>    |
| 5(d)(iii)       | structure of 1–chloropropane<br>structure of 2–chloropropane                                                                                                                        | <b>2</b>    |
| 5(e)(i)         | I <sub>2</sub> O <sub>5</sub><br><b>M1</b> 76.0 / 127 <b>AND</b> 24.0 / 16.0<br><b>M2</b> 0.59 <b>AND</b> 1.5 <b>OR</b> 1 <b>AND</b> 2.5<br><b>M3</b> I <sub>2</sub> O <sub>5</sub> | <b>3</b>    |
| 5(e)(ii)        | (turns) red / pink / orange / yellow<br>iodine is a non-metal                                                                                                                       | <b>2</b>    |

| <b>Question</b> | <b>Answer</b>                                                                                                                                                                                                                                                                                | <b>Mark</b> |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 6(a)            | bauxite/Alumina is dissolved in <u>molten</u> cryolite<br>cryolite lowers the melting temperature<br>molten aluminium forms<br><i>anode reaction:</i> $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$<br><i>cathode reaction:</i> $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$ | <b>5</b>    |

|               |                                                |                 |              |
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| <b>Question</b> | <b>Answer</b>                                                                                                                                                                   | <b>Mark</b> |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 6(b)            | carbon or graphite<br>electrode reacts with oxygen / burns (in oxygen) / combusts                                                                                               | <b>2</b>    |
| 6(c)            | <i>use 1</i> : manufacture of aircraft<br><i>reason 1</i> : low density<br><i>use 2</i> : food containers <b>OR</b> cooking foil<br><i>reason 2</i> : Al resistant to corrosion | <b>4</b>    |

| <b>Question</b> | <b>Answer</b>                                                                                                                                                                                 | <b>Mark</b> |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 7(a)            | large / big molecule<br>made from (many) monomers (joined together)                                                                                                                           | <b>2</b>    |
| 7(b)(i)         | hydrolysis                                                                                                                                                                                    | <b>1</b>    |
| 7(b)(ii)        | acid (conditions) / enzyme                                                                                                                                                                    | <b>1</b>    |
| 7(c)(i)         | $\frac{\text{distance moved by substance}}{\text{distance moved by solvent (front)}}$                                                                                                         | <b>1</b>    |
| 7(c)(ii)        | circle around top spot                                                                                                                                                                        | <b>1</b>    |
| 7(c)(iii)       | mixture of amino acids is placed as a spot onto a (pencil) baseline<br>placed into a (suitable) solvent / water<br>a locating agent is added to the (finished) chromatogram (to reveal spots) |             |

|               |                                                |                 |              |
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| <b>Question</b> | <b>Answer</b>                                                                                                                                                                                                                                                                                                                                                             | <b>Mark</b> |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 7(d)            | <p>fully displayed amide link between any two 'blocks'</p> <p>dipeptide 1: amino acid <b>A</b> on left-hand side and amino acid <b>B</b> on right-hand side</p> <p><b>AND</b></p> <p>dipeptide 2: amino acid <b>B</b> on left-hand side and amino acid <b>A</b> on right-hand side</p> <p>correct terminal amine and carboxylic acid group on both correct dipeptides</p> | <b>3</b>    |