
CHEMISTRY**0620/42**

Paper 4 Theory (Extended)

May/June 2017

MARK SCHEME

Maximum Mark: 80

Published

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This document consists of **9** printed pages.

| Question | Answer | Marks |
|-----------------|--|--------------|
| 1(a)(i) | fractional distillation | 1 |
| 1(a)(ii) | chromatography | 1 |
| 1(a)(iii) | fermentation / ferment | 1 |
| 1(a)(iv) | (simple) distillation / distil | 1 |
| 1(a)(v) | filtration / decantation / centrifugation | 1 |
| 1(b)(i) | (substance that) cannot be split up / broken down into (two or more) simpler substances by chemical means OR (substance) made of atoms with the same atomic number / number of protons / proton number | 1 |
| 1(b)(ii) | (two or more) elements joined or combined or bonded (together) | 1 |
| 1(b)(iii) | (particle) containing different numbers of protons and electrons OR atom or group of atoms that has gained or lost an electron / electrons | 1 |

| Question | Answer | Marks | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|---|--------|-----------|-----------|--|---------------|---|----|-----------|----------------------|-----|-------|-----------|----------------|----|----|--|--------------------------------|---|----|-----------|---|
| 2(a) | <u>atoms</u> of the same element/ <u>atoms</u> with the same proton number/ <u>atoms</u> with the same atomic number | 1 | | | | | | | | | | | | | | | | | | | | |
| | different neutron number / different nucleon number / different mass number | 1 | | | | | | | | | | | | | | | | | | | | |
| 2(b) | <table border="1"> <thead> <tr> <th></th> <th>carbon</th> <th>silicon</th> <th></th> </tr> </thead> <tbody> <tr> <td>proton number</td> <td>6</td> <td>14</td> <td>M1</td> </tr> <tr> <td>electronic structure</td> <td>2,4</td> <td>2,8,4</td> <td>M2</td> </tr> <tr> <td>nucleon number</td> <td>12</td> <td>28</td> <td></td> </tr> <tr> <td>number of neutrons in one atom</td> <td>6</td> <td>14</td> <td>M3</td> </tr> </tbody> </table> | | carbon | silicon | | proton number | 6 | 14 | M1 | electronic structure | 2,4 | 2,8,4 | M2 | nucleon number | 12 | 28 | | number of neutrons in one atom | 6 | 14 | M3 | 3 |
| | | carbon | silicon | | | | | | | | | | | | | | | | | | | |
| | proton number | 6 | 14 | M1 | | | | | | | | | | | | | | | | | | |
| | electronic structure | 2,4 | 2,8,4 | M2 | | | | | | | | | | | | | | | | | | |
| | nucleon number | 12 | 28 | | | | | | | | | | | | | | | | | | | |
| number of neutrons in one atom | 6 | 14 | M3 | | | | | | | | | | | | | | | | | | | |
| 2(c)(i) | covalent | 1 | | | | | | | | | | | | | | | | | | | | |
| 2(c)(ii) | award 1 mark for each correct property and one mark for each correct matching reason. | 4 | | | | | | | | | | | | | | | | | | | | |
| | property: high melting point/ high boiling point reason: bonds between atoms are strong OR covalent bonds are strong/ bonds need large amount of energy to break | | | | | | | | | | | | | | | | | | | | | |
| | property: non-conductor/ poor conductor(of electricity)/ insulator reason: no moving charged particles/ no moving ions/ no moving electrons/ all (outer shell) electrons used in bonding | | | | | | | | | | | | | | | | | | | | | |
| | property: hard reason: bonds between atoms are strong OR covalent bonds are strong | | | | | | | | | | | | | | | | | | | | | |
| | property: brittle reason: bonds between atoms are strong OR covalent bonds are strong/ bonds are directional | | | | | | | | | | | | | | | | | | | | | |
| | property: insoluble reason: does not form hydrogen bonds with water/ no ions that can be hydrated | | | | | | | | | | | | | | | | | | | | | |
| 2(d)(i) | incomplete combustion/ incomplete burning/ combustion in insufficient air/ oxygen | 1 | | | | | | | | | | | | | | | | | | | | |
| | of fossil fuels/ named fossil fuel/ named petroleum fraction/ name or formula of a type of substance containing carbon | 1 | | | | | | | | | | | | | | | | | | | | |
| 2(d)(ii) | toxic/ poisonous/ combines with or binds to haemoglobin | 1 | | | | | | | | | | | | | | | | | | | | |

| Question | Answer | Marks |
|----------|---|-------|
| 2(e)(i) | carbon dioxide: (simple) molecular / simple covalent | 1 |
| | silicon(IV) dioxide: macromolecular / giant molecular / giant covalent / giant atomic | 1 |
| 2(e)(ii) | carbon dioxide: weak (force of) attraction between molecules / weak intermolecular forces / weak van der Waals' forces / weak dispersion forces / weak London forces | 1 |
| | silicon(IV) dioxide: covalent bonds are strong / force of attraction between atoms is strong / no weak bonds (are present) / all bonds are strong | 1 |
| | (weak) forces of attraction in carbon dioxide need small amounts of energy or heat to break / less energy or heat needed to break forces of attraction in carbon dioxide OR (strong) bonds in silicon(IV) dioxide need large amounts of energy or heat to break / more energy or heat needed to break bonds in silicon(IV) dioxide | 1 |
| 2(f) | $2\text{NaOH} + \text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$ IF full credit is not awarded, allow 1 mark for Na_2SiO_3 OR $2\text{OH}^- + \text{SiO}_2 \rightarrow \text{SiO}_3^{2-} + \text{H}_2\text{O}$ M1 species correct M2 balancing | 2 |

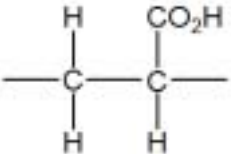
| Question | Answer | Marks |
|-----------|--|-------|
| 3(a)(i) | 450 °C | 1 |
| | 200 atmospheres | 1 |
| 3(a)(ii) | iron | 1 |
| 3(b)(i) | 4(NO) | 1 |
| | 5(O ₂) AND 6(H ₂ O) | 1 |
| 3(b)(ii) | lower yield of NO/lower yield of nitric acid/lower yield of product/equilibrium shifts to left (at higher temperatures)/backward reaction favoured(at higher temperatures) ORA | 1 |
| 3(b)(iii) | too slow / rate decreases ORA | 1 |
| 3(c) | 4NO + 3O ₂ + 2H ₂ O → 4HNO ₃ M1 all formulae correct M2 balancing | 2 |
| 3(d) | add copper(II) carbonate (to acid) until it stops dissolving or no more effervescence / bubbling / fizzing | 1 |
| | filter (to remove copper(II) carbonate) | 1 |
| | evaporate / heat / warm / boil / leave in sun AND until most of the water has gone / some water is left / evaporate some of the water / until it is concentrated / saturation (point) / crystallisation point / crystals form on glass rod or microscope slide / crystals start to form | 1 |
| | (for any solution) leave / allow to cool / allow to crystallise OR (for any crystals) filter / wash / dry with filter paper / dry in warm place / dry in a (low) oven / leave to dry | 1 |
| | formula of Cu(NO ₃) ₂ | 1 |
| | equation: CuCO ₃ + 2HNO ₃ → Cu(NO ₃) ₂ + CO ₂ + H ₂ O | 1 |

| Question | Answer | Marks |
|-----------|--|----------|
| 4(a) | any 3 from: <ul style="list-style-type: none"> • catalyst • more than one/variable oxidation state/oxidation number/valency • form coloured compounds/coloured ions • forms complex ions/complexes | 3 |
| 4(b) | add sodium hydroxide (solution)/NaOH/potassium hydroxide (solution)/KOH | 1 |
| | zinc oxide dissolves/reacts OR copper(II) oxide does not dissolve/react | 1 |
| | filter/decant/centrifuge (copper(II) oxide) | 1 |
| 4(c)(i) | $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^- / 2\text{e}^-$ M1 formula of Zn^{2+} on the right-hand side M2 equation fully correct | 2 |
| 4(c)(ii) | zinc/Zn nickel/Ni copper/Cu | 1 |
| 4(c)(iii) | copper (+) and nickel (–) | 1 |
| | 0.59 V | 1 |

| Question | Answer | | | Marks | | | | | | | | | | | | | | | | |
|-----------|---|---------------------------|--------------------------|-------|----------------------------|---------------------------|--------------------------|----------|--|--|---|---------|---|--|---|--------|---|---|--|---|
| 5(a)(i) | <table border="1" data-bbox="349 236 1357 483"> <thead> <tr> <th></th> <th>aqueous potassium chloride</th> <th>aqueous potassium bromide</th> <th>aqueous potassium iodide</th> </tr> </thead> <tbody> <tr> <td>chlorine</td> <td></td> <td></td> <td>✓</td> </tr> <tr> <td>bromine</td> <td>✗</td> <td></td> <td>✓</td> </tr> <tr> <td>iodine</td> <td>✗</td> <td>✗</td> <td></td> </tr> </tbody> </table> <p data-bbox="349 523 819 619">5 cells completed correctly = [3] 3 or 4 cells completed correctly = [2] 2 cells completed correctly = [1]</p> | | | | aqueous potassium chloride | aqueous potassium bromide | aqueous potassium iodide | chlorine | | | ✓ | bromine | ✗ | | ✓ | iodine | ✗ | ✗ | | 3 |
| | aqueous potassium chloride | aqueous potassium bromide | aqueous potassium iodide | | | | | | | | | | | | | | | | | |
| chlorine | | | ✓ | | | | | | | | | | | | | | | | | |
| bromine | ✗ | | ✓ | | | | | | | | | | | | | | | | | |
| iodine | ✗ | ✗ | | | | | | | | | | | | | | | | | | |
| 5(a)(ii) | $\text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2$ OR $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$ | | | 1 | | | | | | | | | | | | | | | | |
| 5(b)(i) | white | | | 1 | | | | | | | | | | | | | | | | |
| 5(b)(ii) | 0.02 (mol) | | | 1 | | | | | | | | | | | | | | | | |
| 5(b)(iii) | 0.02 (mol) | | | 1 | | | | | | | | | | | | | | | | |
| 5(b)(iv) | 1:2 | | | 1 | | | | | | | | | | | | | | | | |
| | VCl_2 | | | 1 | | | | | | | | | | | | | | | | |

| Question | Answer | Marks |
|-----------|--|-------|
| 5(c)(i) | solid | 1 |
| 5(c)(ii) | 2Na + At ₂ → 2NaAt M1 formula of NaAt M2 equation fully correct | 2 |
| 5(d)(i) | 393 (kJ) | 1 |
| 5(d)(ii) | 416 (kJ) | 1 |
| 5(d)(iii) | –23 (kJ/mol) | 1 |

| Question | Answer | Marks |
|----------|--|-------|
| 6(a)(i) | alkene | 1 |
| | carboxylic acid | 1 |
| 6(a)(ii) | any 2 from: <ul style="list-style-type: none"> • same / similar chemical properties • (same) general formula • (consecutive members) differ by CH₂ • same functional group • common (allow similar) methods of preparation • physical properties vary in predictable manner / show trends / gradually change / example of a physical property variation | 2 |
| 6(b) | carboxylic acid / aldehyde | 1 |
| | ester | 1 |
| 6(c)(i) | colourless / decolourised | 1 |
| | bubbles / fizzing / effervescence | 1 |

| Question | Answer | Marks |
|----------|--|-------|
| 6(c)(ii) | addition | 1 |
| |  <p>repeat unit</p> | 1 |
| | continuation bonds at both ends | 1 |