Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2017**

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 will not enter into discussions about these mark schemes.

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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**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="2">2(a)</td><td>atoms of the same element / atoms with the same proton number / atoms with the same atomic number</td><td>1</td></tr>
<tr><td>different neutron number / different nucleon number / different mass number</td><td>1</td></tr>
<tr><td>2(b)</td><td>
<table>
<tr><th></th><th>carbon</th><th>silicon</th><th></th></tr>
<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>
</table>
</td><td>3</td></tr>
<tr><td>2(c)(i)</td><td>covalent</td><td>1</td></tr>
<tr><td rowspan="6">2(c)(ii)</td><td>award 1 mark for each correct property and one mark for each correct matching reason.</td><td>4</td></tr>
<tr><td>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</td><td></td></tr>
<tr><td>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</td><td></td></tr>
<tr><td>property: hard
reason: bonds between atoms are strong OR covalent bonds are strong</td><td></td></tr>
<tr><td>property: brittle
reason: bonds between atoms are strong OR covalent bonds are strong / bonds are directional</td><td></td></tr>
<tr><td>property: insoluble
reason: does not form hydrogen bonds with water / no ions that can be hydrated</td><td></td></tr>
<tr><td rowspan="2">2(d)(i)</td><td>incomplete combustion / incomplete burning / combustion in insufficient air / oxygen</td><td>1</td></tr>
<tr><td>of fossil fuels / named fossil fuel / named petroleum fraction / name or formula of a type of substance containing carbon</td><td>1</td></tr>
<tr><td>2(d)(ii)</td><td>toxic / poisonous / combines with or binds to haemoglobin</td><td>1</td></tr>
</table>

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)	$2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$ **IF** full credit is not awarded, allow 1 mark for Na_2SiO_3 **OR** $2OH^- + SiO_2 \rightarrow SiO_3^{2-} + H_2O$ **M1** species correct **M2** balancing	**2**

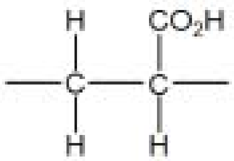
Question	Answer	Marks
3(a)(i)	450 °C	**1**
	200 atmospheres	**1**
3(a)(ii)	iron	**1**
3(b)(i)	4(NO)	**1**
	5(O_2) **AND** 6(H_2O)	**1**
3(b)(ii)	lower yield of NO / lower yield of nitric acid / lower yield of product / equilibrium shifts to left (at higher temperatures) / backward reaction favoured(at higher temperatures) **ORA**	**1**
3(b)(iii)	too slow / rate decreases **ORA**	**1**
3(c)	$4NO + 3O_2 + 2H_2O \rightarrow 4HNO_3$ **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: $CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$	**1**

Question	Answer	Marks
4(a)	any 3 from: • 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)	$Zn \rightarrow Zn^{2+} + 2e / 2e^-$ **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**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)(i)</td><td>
<table>
<tr><th></th><th>aqueous potassium chloride</th><th>aqueous potassium bromide</th><th>aqueous potassium iodide</th></tr>
<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>
</table>
5 cells completed correctly = [3]
3 or 4 cells completed correctly = [2]
2 cells completed correctly = [1]</td><td>3</td></tr>
<tr><td>5(a)(ii)</td><td>$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$
OR
$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$</td><td>1</td></tr>
<tr><td>5(b)(i)</td><td>white</td><td>1</td></tr>
<tr><td>5(b)(ii)</td><td>0.02 (mol)</td><td>1</td></tr>
<tr><td>5(b)(iii)</td><td>0.02 (mol)</td><td>1</td></tr>
<tr><td>5(b)(iv)</td><td>1:2</td><td>1</td></tr>
<tr><td></td><td>VCl_2</td><td>1</td></tr>
</table>

Question	Answer	Marks
5(c)(i)	solid	**1**
5(c)(ii)	$2Na + At_2 \rightarrow 2NaAt$ **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: • same / similar chemical properties • (same) general formula • (consecutive members) differ by CH_2 • 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**
	 repeat unit	**1**
	continuation bonds at both ends	**1**