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**CHEMISTRY****0620/42**

Paper 4 Theory (Extended)

**May/June 2017**

MARK SCHEME

Maximum Mark: 80

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**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 <b>OR</b> (substance) made of <b>atoms</b> with the same atomic number / number of protons / proton number	1
1(b)(ii)	(two or more) <b>elements</b> joined or combined or bonded (together)	1
1(b)(iii)	(particle) containing different numbers of protons and electrons <b>OR</b> 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 <b>number</b> / different nucleon <b>number</b> / 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><b>M1</b></td> </tr> <tr> <td>electronic structure</td> <td>2,4</td> <td>2,8,4</td> <td><b>M2</b></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><b>M3</b></td> </tr> </tbody> </table>		carbon	silicon		proton number	6	14	<b>M1</b>	electronic structure	2,4	2,8,4	<b>M2</b>	nucleon number	12	28		number of neutrons in one atom	6	14	<b>M3</b>	3
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number of neutrons in one atom	6	14	<b>M3</b>																			
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 <b>OR</b> covalent bonds are strong/ <b>bonds</b> 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 <b>OR</b> covalent bonds are strong																					
	property: brittle reason: bonds between atoms are strong <b>OR</b> 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 <b>fossil</b> 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: <b>weak (force of) attraction</b> between molecules / <b>weak</b> intermolecular forces / <b>weak</b> van der Waals' forces / <b>weak</b> dispersion forces / <b>weak</b> London forces	1
	silicon(IV) dioxide: covalent bonds are <b>strong</b> / force of attraction between atoms is <b>strong</b> / no weak bonds (are present) / <b>all</b> bonds are <b>strong</b>	1
	(weak) <b>forces of attraction</b> in carbon dioxide need small amounts of <b>energy</b> or heat to break / <b>less energy</b> or heat needed to break <b>forces of attraction</b> in carbon dioxide <b>OR</b> (strong) <b>bonds</b> in silicon(IV) dioxide need large amounts of <b>energy</b> or heat to break / <b>more energy</b> or heat needed to break <b>bonds</b> in silicon(IV) dioxide	1
2(f)	$2\text{NaOH} + \text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$ <b>IF</b> full credit is not awarded, allow 1 mark for $\text{Na}_2\text{SiO}_3$ <b>OR</b> $2\text{OH}^- + \text{SiO}_2 \rightarrow \text{SiO}_3^{2-} + \text{H}_2\text{O}$ <b>M1</b> species correct <b>M2</b> 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 <sub>2</sub> ) <b>AND</b> 6(H <sub>2</sub> 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) <b>ORA</b>	1
3(b)(iii)	too slow / rate decreases <b>ORA</b>	1
3(c)	4NO + 3O <sub>2</sub> + 2H <sub>2</sub> O → 4HNO <sub>3</sub> <b>M1</b> all formulae correct <b>M2</b> 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 <b>AND</b> until most of the water has gone / some water is left / evaporate <b>some</b> of the water / until it is concentrated / saturation (point) / crystallisation point / crystals form on glass rod or microscope slide / crystals <b>start</b> to form	1
	(for any solution) leave / allow to cool / allow to crystallise <b>OR</b> (for any crystals) filter / wash / dry with filter paper / dry in warm place / dry in a ( <b>low</b> ) oven / leave to dry	1
	formula of Cu(NO <sub>3</sub> ) <sub>2</sub>	1
	equation: CuCO <sub>3</sub> + 2HNO <sub>3</sub> → Cu(NO <sub>3</sub> ) <sub>2</sub> + CO <sub>2</sub> + H <sub>2</sub> O	1

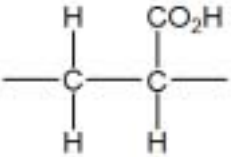
Question	Answer	Marks
4(a)	any 3 from: <ul style="list-style-type: none"> <li>• catalyst</li> <li>• more than one/variable oxidation state/oxidation number/valency</li> <li>• form coloured <b>compounds</b>/coloured <b>ions</b></li> <li>• forms complex ions/complexes</li> </ul>	<b>3</b>
4(b)	add sodium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

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>x</td> <td></td> <td>✓</td> </tr> <tr> <td>iodine</td> <td>x</td> <td>x</td> <td></td> </tr> </tbody> </table> <p data-bbox="349 523 819 622">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	x		✓	iodine	x	x		3
	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide																	
chlorine			✓																	
bromine	x		✓																	
iodine	x	x																		
5(a)(ii)	$\text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2$ <p><b>OR</b></p> $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$			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																
	$\text{VCl}_2$			1																

Question	Answer	Marks
5(c)(i)	solid	1
5(c)(ii)	2Na + At <sub>2</sub> → 2NaAt <b>M1</b> formula of NaAt <b>M2</b> 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"> <li>• same / similar chemical properties</li> <li>• (same) general formula</li> <li>• (consecutive members) differ by CH<sub>2</sub></li> <li>• same functional group</li> <li>• common (allow similar) methods of preparation</li> <li>• physical properties vary in predictable manner / show trends / gradually change / example of a physical property variation</li> </ul>	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