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CHEMISTRY

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Paper 4 Theory (Extended)

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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><tr><td></td><td>carbon</td><td>silicon</td><td></td></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>		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
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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

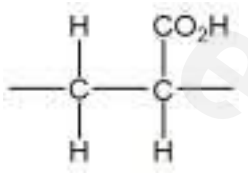
Question	Answer	Marks
3(a)(i)	450 °C	1
	200 atmospheres	1
3(a)(ii)	iron	1
3(b)(i)	4(NO)	1
	5(O ₂) AND 6(H ₂ O)	1
3(b)(ii)	lower yield of NO / lower yield of nitric acid / lower yield of product / equilibrium shifts to left (at higher temperatures) / backward reaction favoured (at higher temperatures) 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: 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"><thead><tr><td></td><td>aqueous potassium chloride</td><td>aqueous potassium bromide</td><td>aqueous potassium iodide</td></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>					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 cells completed correctly = [3] 3 or 4 cells completed correctly = [2] 2 cells completed correctly = [1]																					
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																	
	VC l_2			1																	

Question	Answer	Marks
5(c)(i)	solid	1
5(c)(ii)	$2\text{Na} + \text{At}_2 \rightarrow 2\text{NaAt}$ 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