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Paper 4 Extended Theory

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MARK SCHEME

Maximum Mark: 80

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This document consists of **7** printed pages.

Question	Answer	Marks
1(a)(i)	Brownian (motion)	1
1(a)(ii)	molecules	1
	nitrogen / N ₂ / N OR oxygen / O ₂ / O	1
1(a)(iii)	nitrogen OR oxygen (particles) collide with / bombard / hit the dust (particles)	1
	(the bombarding particles) move randomly	1
1(b)(i)	diffusion	1
1(b)(ii)	Br ₂ has an <i>M_r</i> of 160 AND Cl ₂ has an <i>M_r</i> of 71 / bromine has an <i>A_r</i> of 80 AND chlorine has an <i>A_r</i> of 35.5	1
	(heavier) bromine (molecules / particles) diffuses more slowly	1
1(b)(iii)	particles have more energy / move faster	1

Question	Answer	Marks
2(a)	Si: 2: 8 : 4	1
	Ca ²⁺ : 2 : 8: 8	1
	N ³⁻ : 2 : 8	1
2(b)	Ca ₃ N ₂	1
2(c)	Li shown as having one shell with 2 electrons OR no electrons OR no outer shell	1
	Cl shown as having an outer shell of 7 electrons of one type, plus one different electron which matches Li electrons	1
	'+' charge on Li AND '-' charge on Cl	1

Question	Answer	Marks
2(d)	two shared pairs of electrons	1
	both Cl with complete outer shells	1
	S with complete outer shell	1
2(e)	SCl ₂ has intermolecular forces (of attraction)	1
	LiCl has (electrostatic) forces (of attraction) between ions	1
	intermolecular forces are weaker / less energy is needed to break intermolecular forces	1
2(f)	silicon(IV) oxide	1

Question	Answer	Marks
3(a)	<i>exothermic mark</i> : horizontal line representing the energy of the products below the energy of the reactants	1
	<i>label of products mark</i> : product line labelled with 2CO ₂ + 3H ₂ O	1
	<i>correct direction of vertical heat of reaction arrow</i> : arrow starts level with reactant energy and finishes level with product energy AND has (only) one arrow head	1
3(b)	activation energy / E _a	1

Question	Answer	Marks
3(c)	<p>–650 kJ / mol</p> <p>M1 bonds broken</p> $2 \times ((3 \times 410) + 360 + 460) + (3 \times 500)$ $2 \times (1230 + 360 + 460) + 1500$ $2 \times 2050 + 1500$ $4100 + 1500 = 5600$ <p>M2 bonds formed</p> $(2 \times (2 \times 805)) + (4 \times (2 \times 460))$ $2 \times 1610 + 4 \times 920$ $3220 + 3680 = 6900$ <p>M3 = M1 – M2</p> <p>energy change of reaction = 5600 – 6900 = –1300</p> <p>M4 = M3 / 2</p>	4
3(d)(i)	cracking	1
3(d)(ii)	$\text{C}_{12}\text{H}_{26} \rightarrow 3\text{C}_2\text{H}_4 + \text{C}_6\text{H}_{14}$ <p>M1 $\text{C}_{12}\text{H}_{26}$</p> <p>M2 rest of equation</p>	2
3(d)(iii)	phosphoric acid	1
	heat	1
3(d)(iv)	addition / hydration	1
3(d)(v)	measure its boiling temperature	1
	compare to (known) data	1
3(e)(i)	<p>any 2 from:</p> <ul style="list-style-type: none"> • 37 °C • anaerobic • glucose is aqueous • yeast 	2

Question	Answer	Marks
3(e)(ii)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ M1 CO ₂ as a product M2 Rest of equation	2
3(e)(iii)	yeast is killed by the ethanol	1
3(e)(v)	slow rate of reaction	1
3(e)(v)	uses renewable resources / does not use a finite resource	1
3(e)(vi)	fractional distillation	1
3(f)(i)	CH ₃ O	1
3(f)(ii)	no (C=C) double bonds	1
3(f)(iii)	at least two alternating rectangles with attempted linking	1
	one displayed ester link (all atoms and all bonds)	1
	fully correct structure with at least one repeat unit including continuation bonds from correct atom or rectangle	1
3(f)(iv)	polyester	1

Question	Answer	Marks
4(a)	the breakdown (into elements)	1
	of an (ionic) compound by (the passage of) electricity	1
4(b)(i)	oxygen	1
4(b)(ii)	glowing splint	1
	relights	1

Question	Answer	Marks
4(b)(iii)	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ M1 gain of electrons by H^+ M2 rest of equation	2
4(c)	<i>the wires:</i> electrons	1
	<i>the electrolyte:</i> ions	1
4(d)	any 2 from: <ul style="list-style-type: none"> • green gas at positive electrode • bulb is brighter • rate of bubbles increases 	2
4(e)(i)	<i>anode made of:</i> impure copper	1
	<i>cathode made of:</i> (pure) copper	1
	<i>electrolyte of:</i> (aqueous) copper sulfate	1
4(e)(ii)	silver (impurities) fall to the bottom of the cell	1
	zinc (impurities) (dissolve) into solution (as ions)	1
	because zinc is more reactive than copper AND silver is less reactive than copper	1

Question	Answer	Marks
5(a)	both colours referred to correctly as observations in both parts of the answer	1
	(if sulfuric acid is added to solution Y,) equilibrium moves to the right-hand side	1
	because the concentration of acid has increased	1
	(if sodium hydroxide is added to solution Y,) equilibrium moves to the left-hand side	1
	because sodium hydroxide reacts with / neutralises sulfuric acid	1
5(b)(i)	210 cm ³ M1 expected volume of hydrogen = 300 cm ³ M2 70% of M1	2
5(b)(ii)	fewer moles / molecules / particles (of gas) on the left-hand side	1
5(b)(iii)	endothermic	1
5(b)(iv)	increases rate (of reaction)	1