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CHEMISTRY

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Paper 4 Extended Theory

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MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)(i)	B	1
1(a)(ii)	A	1
1(a)(iii)	C	1
1(a)(iv)	E	1
1(b)	O^{2-} M1 O M2 $^{2-}$	2

Question	Answer	Marks
2(a)(i)	S	1
2(a)(ii)	S	1
2(a)(iii)	V	1
2(b)	any value in the range 130–145 °C	1
2(c)	sublimation	1
2(d)(i)	Brownian motion	1
2(d)(ii)	nitrogen / oxygen / carbon dioxide / air molecules hit / bombard the smoke particles	1
	(the bombarding particles) move randomly	1

Question	Answer	Marks
3(a)(i)	brown / orange solid (forms / is made) OR solution becomes paler / colourless	1
3(a)(ii)	magnesium is oxidised AND copper ions are reduced OR magnesium loses electrons AND copper ions gain electrons OR magnesium increases in oxidation number AND copper decreases in oxidation number	1
3(a)(iii)	Cu ²⁺ OR copper(II) ions OR copper ions	1
	gains electrons	1
3(a)(iv)	3Mg + Fe ₂ O ₃ → 3MgO + 2Fe M1 Fe ₂ O ₃ AND MgO M2 fully correct	2
3(b)(i)	prevents air / oxygen AND water from reaching the steel	1
3(b)(ii)	magnesium is more reactive than iron / steel	1
	the magnesium corrodes (before the iron / steel) OR the magnesium corrodes preferentially	1
3(b)(iii)	copper is less reactive than iron / steel	1

Question	Answer	Marks
4(a)(i)	$\rightarrow 2(\text{C}_2\text{H}_5\text{OH}) + 2\text{CO}_2$ M1 carbon dioxide made as product M2 balanced	2
4(a)(ii)	any 2 from: • 37 °C • anaerobic • glucose is aqueous • yeast	2
4(b)(i)	(concentrated) phosphoric acid	1
4(b)(ii)	92 If full credit is not awarded, allow 1 mark for M_r of ethene = 28	2
4(c)(i)	(acidified) potassium manganate(VII) OR potassium (di)chromate(VI)	1
4(c)(ii)	M1 all shared pairs of electrons correct for single bonds M2 2 shared pairs of electrons for the C=O bond M3 total of 8 electrons on each O including 4 non-bonding electrons and no additional non-bonding electrons	3
4(d)(i)	partially ionised / dissociated	1

Question	Answer	Marks
4(d)(ii)	M1 (acids) have same concentration	1
	M2: measure pH OR describe how to measure pH (such as use Universal Indicator) M3: lower pH corresponds to the stronger acid / hydrochloric acid OR M2: add calcium / magnesium / zinc / iron M3: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid OR M2: rate of reaction with (metal) carbonate M3: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid OR M2: rate of reaction with (named) metal oxide M3: dissolves faster means that reaction is with the stronger acid / hydrochloric acid OR M2: electrical conductivity M3: greater conductivity corresponds to the stronger acid / hydrochloric acid OR M2: add sodium hydroxide (or other named alkali) M3: greater temperature change corresponds to the stronger acid / hydrochloric acid	2
4(e)	structure of propanoic acid	1
	propanoic acid	1
	structure of butan-1-ol	1
	butan-1-ol	1

Question	Answer	Marks
5(a)(i)	<i>start colour:</i> green <i>end colour:</i> black	1
5(a)(ii)	$\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$	1
5(b)(i)	(<i>copper(II) ions</i>) add sodium hydroxide (solution)	1
	(<i>copper(II) ions</i>) blue ppt.	1
	(<i>nitrate ions</i>) add aluminium AND aqueous sodium hydroxide AND warm	1
	ammonia given off / gas turns damp (red) litmus blue	1
5(b)(ii)	2 / 2 / 4 / 1	1
5(c)(i)	becomes paler	1
	equilibrium moves right	1
	(because) fewer moles (of gas) on right	1
5(c)(ii)	equilibrium moved right / more N_2O_4 / less NO_2	1
	(forward) reaction exothermic	1

Question	Answer	Marks
6(a)	aluminium is more reactive than carbon	1
6(b)(i)	oxide ion has an outer shell with six <u>dots</u> and two <u>crosses</u>	1
	oxide ion has a charge of 2^-	1

Question	Answer	Marks
6(b)(ii)	(electrostatic) forces of attraction between ions	1
	(are) strong OR require lots of energy to overcome	1
6(c)(i)	<i>the wires</i> : electrons	1
	<i>the electrolyte</i> : ions	1
6(c)(ii)	any 2 from: - increases conductivity - as a solvent - lowers the operating temperature	2
6(c)(iii)	$Al^{3+} + 3e^{-} \rightarrow Al$	1
6(c)(iv)	oxygen is made at the anode	1
	the anodes are made of carbon	1
	oxygen (made) reacts with carbon	1
6(d)	aluminium coated with layer of (unreactive) aluminium oxide	1

Question	Answer	Marks
7(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	1
	more collisions per second / unit time OR greater collision rate	1

Question	Answer	Marks
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	1
7(b)(i)	0.075 If full credit is not awarded, allow 1 mark for M_r of CuO = 80	2
7(b)(ii)	0.05	1
7(b)(iii)	4 (g) M1 moles copper(II) oxide that reacted = $(0.05 / 2) = 0.025$ mol M2 mass copper(II) oxide = $((0.075 - 0.025) \times 80) = 4$ g	2
7(c)	$C_2CuH_4O_2$ M1 41.52 / 35.5; 37.43 / 64; 2.34 / 1; 18.71 / 16 OR 1.17 : 0.58 : 2.34 : 1.17 M2 appropriate scaling to give whole number ratios	2