PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



MARK SCHEME

SECTION 2: INORGANIC CHEMISTRY (PACK 3)

SCORE	PERCENTAGE
/116	%

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	M1 oxygen M2 water / water vapour	ALLOW air ALLOW moisture ALLOW answers in either order	2
(b) (i)	iodine		1
(ii)	methane		1
(iii)	gold		1
			Total 5

Q2.

Question number	Answer	Notes	Marks
(a) (i)	$2H_2S$ (g) + SO_2 (g) → 3 S (s) + 2 H_2O (l) M1 all state symbols correct M2 balancing correct	ALLOW upper case ALLOW multiples/fractions	2
(ii)	(sulfur dioxide is reduced because it) loses oxygen	IGNORE references to electrons	1
(b) (i)	Explanation linking following points M1 sulfur/(pale yellow) solid forms nearer to sulfur dioxide side/closer to left OWTTE ORA M2 so hydrogen sulfide particles moved / diffused further (in same time) OWTTE ORA		2
(ii)	M1 M_r of H_2S = (1 + 1 + 32) = 34 M2 M_r of SO_2 = (32 +16 + 16) = 64 M3 statement of relationship eg the higher the Mr the slower the gas diffuses	ACCEPT reverse argument	3
		Total marks for Question	= 8

Q3.

Question number	Answer	Additional guidance	Mark
(a)(i)	Graph A An explanation that links the following two points: • the backward/reverse reaction is endothermic (1) • so an increase in temperature shifts the equilibrium to the left (hence the percentage of NO decreases) (1) Graph B An explanation that links the following two points: • there are fewer molecules/moles of gas on the left (1) • so an increase in pressure shifts the equilibrium to the left (hence the percentage of NO decreases) (1)	ignore any references to or arguments based on Le Chatelier's principle accept the (forward) reaction is exothermic	4

Question number	Answer	Additional guidance	Mark
(a)(ii)	• (The catalyst/it) increases the rate of both the forward and reverse reactions (1) • To the same extent (1)	second mark is dependent on the first	2

Question number	Answer	Mark
(b)(i)	Because a proton is transferred from HNO_3 to NH_3	1

Question number	Answer	Mark
(b)(ii)	• Calculate the amount of nitric acid • Calculate the volume of aqueous ammonia Example calculation: $n(HNO_3)$ = 15.8 × 150 mol (= 2370 mol) (1) vol(NH_3) required = (2370 ÷ 14.8) = 160(dm^3) (1)	2

(Total for question = 9 marks)

Q4.

Question number	Answer	Notes	Marks
(a)	nitrogen	ALLOW N/N_2	1
(b)	silicon/Si or phosphorus/P or sulfur/S		1
(c)	bromine		1
(d)	73		1
(e)	The only correct answer is D as francium is the most reactive element in Group 1 and fluorine is the most reactive element in Group 7 A is not correct because lithium is not the most reactive element in Group 1 B is not correct because astatine is not the most reactive element in Group 7 C is not correct because lithium is not the most reactive element in Group 1 and astatine is not the most reactive element in Group 7		1
		Total marks for Question	= 5

Q5.

Question number	Answer	Notes	Marks
(a)	An explanation of properties that includes five of the following points	reason must be linked to correct property IGNORE references to cost/reactivity/hardness/ strength/shiny	5
	M1 conducts electricity		
	M2 (because the) delocalised electrons can move/flow (through structure)	If any mention of ions/atoms moving cannot score M2	
	M3 malleable/ductile	ALLOW explanations of malleable/ductile	
	M4 (because) layers of cations/atoms	ALLOW sheets/rows	
	M5 layers/cations/atoms can slide/slip/move over each other		
	M6 high melting point	IGNORE high boiling point	
	M7 (because) strong (electrostatic) attraction between cations and delocalised electrons	ALLOW giant metallic lattice/strong bonds between cations and delocalised electrons /strong metallic bonds **Max 4** if any mention of intermolecular forces/covalent/ionic bonding	

(b)	(i)	copper ion Cu^{2+} sulfate ion SO_4^{2-}	ALLOW Cu^{+2} SO_4^{-2}	1
	(ii)	effervescence/bubbles/fizzing	IGNORE oxygen/gas	1
	(iii)	relights a glowing splint		1
	(iv)	$2H_2O \rightarrow O_2 + 4H^+ + 4e^{(-)}$ OR $4OH^- \rightarrow O_2 + 2H_2O + 4e^{(-)}$ **M1** all formulae correct **M2** balancing of correct formulae		2
	(v)	(OH^- ions/they) are present in/come from water OWTTE	ACCEPT (some) water molecules dissociate to give OH^- ions OWTTE ALLOW because copper sulfate solution/it contains water/is aqueous REJECT because copper sulfate/solution is alkaline	1 **Total 11**

Q6.

Question number	Answer	Notes	Marks
(a)	**M1** (moles of TiO_2 =) $\frac{20 \times 10^6}{80}$ **OR** 2.5×10^5 (mol) **M2** (moles of Cl_2 =) 2.5×10^5 x 2 **OR** 5.0×10^5 (mol) **M3** (vol of Cl_2 =) $5.0 \times 10^5 \times 24$ **OR** 12 000 000 (dm^3) **M4** 1.2×10^7 (dm^3)	correct answer with or without working scores 4 **ACCEPT** 250 000 (mol) **ACCEPT** 500 000 (mol) **ALLOW** ecf on **M2** and **M3** 6×10^6 scores 3 3×10^6 scores 3 6 000 000 scores 2 3 000 000 scores 2 2.083×10^4 scores 3	4
(b)	An explanation that links the following two points **M1** argon is unreactive/inert **M2** (so argon) will not react with/oxidise the magnesium **OR** oxygen (in air) will react with/oxidise the magnesium	 **ALLOW** argon will not react with/oxidise titanium **OR** oxygen (in air) will react with/oxidise the titanium	2
(c)	An explanation that links the following three points **M1** in pure titanium all atoms are the same size **OR** layers/atoms can slide over each other (making it soft /malleable) **M2** the alloy has atoms of different sizes **M3** (which disrupts the structure so that) atoms/layers do not/harder to slide over each other (making it stronger) OWTTE	all marks can be awarded from labelled diagrams **ALLOW** cations/ions /particles in place of atoms throughout **REJECT** mention of molecules once only	3
			Total 9

Q7.

Question number	Answer	Notes	Marks
(a)	(results that are) within 0.2(0) (cm^3) of each other	ACCEPT other values if less than 0.2	1
(b)	An explanation that links two of the following pairs of points **M1** a pipette should have been used instead of measuring cylinder/to measure the sodium hydroxide solution **M2** a pipette is more precise/a measuring cylinder is less precise **M3** methyl orange/phenolphthalein/litmus should have been used instead of universal indicator **M4** methyl orange/phenolphthalein/litmus would give a clear/sharp colour change/end-point /universal indicator would not give a clear/sharp colour change/end-point **M5** use white tile (under conical flask) **M6** easier to see colour change (at end point) OWTTE	ALLOW a pipette is more accurate/ a measuring cylinder is less accurate ALLOW pipette would give exactly 25 cm^3 ALLOW universal indicator would give a range of colours ALLOW methyl orange/ phenolphthalein/litmus only have two colours/ are one colour in acid and one in alkali (colours given for a named indicator do not need to be correct) ALLOW easier to see colour change with methyl orange/ phenolphthalein/litmus	4

(c)	**M1** amount of NaOH = $\frac{25.0 \times 1.50}{1000}$ **OR** 0.0375 (mol) **M2** amount of H_2SO_4 = $\frac{0.0375}{2}$ **OR** 0.01875 (mol) **M3** volume of H_2SO_4 = $\frac{(0.01875 \times 1000)}{(0.600)}$ = 31.25 (cm^3)	correct answer without working scores 3 ALLOW ECF throughout ALLOW 2, 3 or 4 sig figs throughout Penalise use of 1 sig fig once only 62.5/125 scores 2 ACCEPT alternative methods	3

(d)	A description that refers to four of the following **M1** heat the solution **M2** to evaporate some of the water/ to form a saturated solution/ to crystallisation point **M3** leave the solution to cool / leave the solution for (more) crystals to form **M4** filter off the crystals **M5** suitable method of drying the crystals	 ALLOW boil Max 1 mark if solution evaporated to dryness If solution left to partially evaporate without heating only **M4** and **M5** can be awarded leave solution to cool and (then) filter off crystals scores **M3** and **M4** ALLOW decant off solution **IGNORE** references to washing e.g. dry between filter papers/dry in a warm oven/ leave to dry **REJECT** hot oven or direct heating with Bunsen burner **M5** DEP on crystals having been formed No **M5** if crystals are washed after drying	4 **Total 12**

Q8.

Question number	Answer	Notes	Marks
(a)	**M1** X conical flask **M2** Y pipette **M3** Z burette		3
(b)	**B** colourless A is not correct as the colour of phenolphthalein in phosphoric acid is not blue C is not correct as phenolphthalein is pink in alkali not in acid D is not correct as the colour of phenolphthalein in phosphoric acid is not red		1

Question number	Answer	Notes	Marks
(c) (i)	ticks in boxes 1, 2 and 4		1
(ii)	**M1** $\frac{30.35 + 30.25 + 30.30}{3}$		
	M2 30.30	30.30 without working scores 2 30.3 without working scores 1 If no results ticked then only use of 2 or 3 concordant titres can score both marks in (ii) If only one result ticked then **M2** can be scored for averaging two or more titre values correctly **M1** CQ on results ticked **M2** CQ on correct calculation from **M1** Answer to **M2** must be correct to 2dp	

(d)	(i)	**M1** $\frac{30.40 \times 0.525}{1000}$ **M2** 0.01596 (mol)	If no division by 1000 giving an answer of 15.96 award 1 mark correct answer without working scores 2	2
	(ii)	(0.01596 ÷ 3) = 0.00532 (mol)	**OR** answer to (i) ÷ 3	1
	(iii)	**M1** $\frac{0.00532 \times 1000}{25.0}$ **M2** 0.2128 (mol/dm^3)	**OR** $\frac{\text{answer to (ii)} \times 1000}{25.0}$ **OR** answer to **M1** evaluated correctly correct answer without working scores 2 **ACCEPT** answers to any number of sig figs except 1 throughout (d) If no division by 1000 in (i) and no multiplication by 1000 in (iii) do not penalise twice	2
				Total 12

Q9.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a) (i)</td><td>pipette</td><td>ALLOW graduated pipette</td><td>1</td></tr>
<tr><td>(ii)</td><td>The correct answer is D yellow because methyl orange is yellow in alkaline solution
A is incorrect because methyl orange is not blue in alkaline solution
B is incorrect because methyl orange is not orange in alkaline solution
C is incorrect because methyl orange is not red in alkaline solution</td><td></td><td>1</td></tr>
<tr><td>(b) (i)</td><td>ticks under titration numbers 1, 2 and 4
<table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>20.65</td><td>20.60</td><td>20.90</td><td>20.55</td></tr><tr><td>✓</td><td>✓</td><td></td><td>✓</td></tr></table></td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>M1 $\frac{(20.65 + 20.60 + 20.55)}{3}$ =
M2 20.60</td><td>M1 CSQ on results ticked
M2 CSQ on correct calculation from M1

Answer to M2 must be correct to 2dp

20.60 without working scores 2
20.6 with or without working scores 1

If no ticks then only use of 2 or 3 concordant titres can score M1 and M2 in (ii)

If only one tick then M2 can be scored for averaging two or more titre values correctly</td><td>2</td></tr>
</table>

Question number	Answer	Notes	Marks
(c) (i)	M1 mol (KOH) = $\frac{0.0370 \times 25}{1000}$		2
	M2 = 9.25×10^{-4} / 0.000925	ALLOW any number of sig fig except one If no division by 1000 giving answer of 0.925 award 1 mark correct answer with no working scores 2	
(ii)	M2 from (i) divided by 2 expected answer 4.625×10^{-4} / 0.0004625	ALLOW any number of sig fig except one	1
(iii)	M1 answer to $\frac{\text{(ii)} \times 1000}{21.20}$		2
	M2 correctly evaluated expected answer if (i) and (ii) correct 0.0218	ACCEPT any number of sig fig except one (unless ECF answer is exactly 1 sig fig) correct answer with no working scores 2	
		(Total for Question	**= 10)**

Q10.

Question number	Answer	Notes	Marks
(a) (i)	pipette		1 CI
(b) (i)	**M1** (colour in NaOH) pink **M2** (colour in HCl) colourless/no colour	**ACCEPT** magenta **ALLOW** red **IGNORE** clear 1 mark for two correct colours in the wrong order	2 Grad
(ii)	There is no clear (colour change at the) end point/ difficult to determine which shade of green is pH 7 OWTTE	**ALLOW** it has a range of colours	1 Exp

Question number	Answer	Notes	Marks
(c) (i)	A description that makes reference to the following two points **M1** add 21.5 cm^3 of hydrochloric acid **M2** to 25 cm^3 of sodium hydroxide solution	0 marks if mention of adding indicator **ALLOW** repeat the titration without indicator for 1 mark **ALLOW** the following alternative method **M1** add activated charcoal (to absorb the indicator) **M2** filter (to remove the activated charcoal and indicator) **M2** dep on **M1**	2 Exp
(ii)	A description that makes reference to the following four points **M1** heat the solution to evaporate some of the water/ to form a saturated solution/ to crystallisation point **M2** leave the solution to cool /leave the solution for (more) crystals to form **M3** filter off the crystals **M4** suitable method of drying the crystals	Max 1 mark if solution evaporated to dryness If solution left to partially evaporate without heating only **M3** and **M4** can be awarded **IGNORE** references to washing e.g. dry between filter papers/dry in a warm oven/ leave to dry **REJECT** hot oven or direct heating with Bunsen burner No **M4** if crystals are washed after drying	4 Exp

(d)	• calculate the amount, in moles, of NaOH • divide amount in moles by volume in dm3 • evaluation to obtain correct answer	correct answer without working scores 3 marks	3 Exp
	Example calculation **M1** n(NaOH) = 0.0250 x 0.800 or 0.02(00) **M2** conc = (0.02 ÷ 0.0215) **M3** 0.930	answer to **M1** ÷ 0.0215 **ALLOW** any number of sig fig except 1	
		ALLOW ecf on **M2**	
			Total 13

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Q11.

Question number	Answer	Notes	Marks
(a)	A description that includes six of the following points **M1** use the pipette to add (25 cm^3 of) potassium hydroxide (solution) to the (conical) flask **M2** add a few drops of methyl orange (to the flask) **M3** add sulfuric acid to the burette and record the initial burette reading **M4** add sulfuric acid (from the burette) to the flask, swirling (continuously) **M5** until the (methyl orange) indicator turns red/orange **M6** take the final burette reading and find volume of acid added (by finding difference between initial and final burette readings) **M7** repeat (the titration) adding the acid dropwise near the end-point / repeat (the titration) to obtain concordant results	ALLOW fill burette with sulfuric acid to "0" mark ALLOW shaking (gently) / stirring **ALLOW** take final burette reading only if previously filled burette to "0" mark **ACCEPT** repeat (the titration) to obtain results within 0.2 cm^3 of each other	6

(b)	(i)	**M1** 0.0250×0.240 **OR** $\frac{25.0 \times 0.240}{1000}$	correct answer without working scores 2	2
		M2 0.006(00)	If no division by 1000 giving an answer of 6 award 1 mark	
	(ii)	(0.006 ÷ 2 =) 0.003	**ALLOW** ECF from (i)	1
	(iii)	**M1** $\frac{0.003(00) \times 1000}{15.00}$		2
		M2 0.2(00)	**ALLOW** ECF from (ii) correct answer without working scores 2 answer to (ii) ÷ 15.00 scores 1 do not penalise not multiplying by 1000 in (iii) if they have not divided by 1000 in (i)	
				Total 11

Q12.

Question number	Answer	Notes	Marks
(a) (i)	zinc would react with sulfuric acid/solution X	IGNORE zinc is too reactive	1 grad
(ii)	bubbles	ALLOW fizzing / effervescence IGNORE gas evolved IGNORE incorrectly named gas	1 grad
(iii)	**B** a burning splint gives a squeaky pop is correct because this is the test for hydrogen **A** is incorrect because a glowing splint relights is not the test for hydrogen **C** is incorrect because a burning splint goes out is not the test for hydrogen **D** is incorrect because limewater turns cloudy is not the test for hydrogen		1 comp
(b)	description including M1 add barium chloride/$BaCl_2$	ACCEPT barium nitrate/$Ba(NO_3)_2$ IGNORE references to adding (dilute) HCl/HNO_3 REJECT add H_2SO_4	2 Grad
	M2 white ppt forms	M2 DEP M1	
(c) (i)	(graduated) pipette	ALLOW burette	1 Cler
(ii)	calculation with following steps M1 setting out of how to calculate n(KOH) M2 evaluation Example calculation M1 n(KOH) = 0.125 x 25 ÷ 1000 M2 = 0.003125 / 3.125 $x10^{-3}$	ALLOW any number of sig figs except one If no division by 1000 giving answer of 3.125 award 1 mark correct answer with no working scores 2	2 Exp

(iii)	calculation with following steps M1 calculate n (H_2SO_4) = M2 from (i) ÷ 2 M2 calculate vol H_2SO_4 = (M1 x 1000) ÷ 0.10 M3 evaluation of volume Example calculation M1 0.003125 ÷ 2 = 0.0015625 / 1.5625×10^{-3} M2 0.0015625 x 1000 ÷ 0.10 M3 = 15.625/15.63/15.6 /16 (cm^3)	 Mark ECF from M1 Mark ECF from M2 ALLOW any number of sig figs except one correct answer with no working scores 3 Do not penalise not multiplying by 1000 in (iii) if they have not divided by 1000 in (ii) 31.25/31.3/31 scores 2 62.5/63 scores 2	3 Exp
		Total for Q	= 11