PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



MARK SCHEME

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 8)

SCORE	PERCENTAGE
/234	%

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Mark Scheme

Q1.

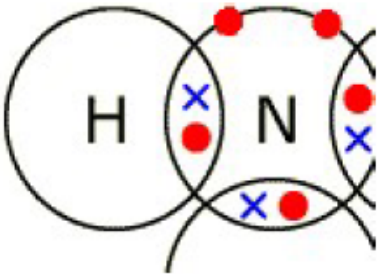
Question number	Answer	Notes	Marks
(a) (i)	neutralisation	ALLOW acid - base	1
(ii)	acid donates proton(s)/base accepts proton(s)	ALLOW metal oxide for base	1
(b) (i)	description including M1 appropriate use of at least three named pieces of apparatus AND any four of the following points M2 add copper(II) carbonate to (dilute sulfuric) acid (a spatula/little at a time and stir after each addition) M3 until no more effervescence M4 filter (to remove excess copper(II) carbonate/to obtain (copper(II) sulfate) solution) M5 heat/warm filtrate/(copper(II) sulfate) solution until crystals start to appear (solution saturated) OWTTE M6 filter to obtain (the saturated) solution	ALLOW until no more reacts/dissolves ALLOW until in excess IGNORE if continue and prepare crystals instead of saturated solution	5
(b) (ii)	M1 calculation of actual mass of crystals obtained M2 division by expected mass of crystals (6.4) and multiplication by 100 to convert to percentage M3 correct to 1 dp Example calculation M1 (6.40 – 1.80 =) 4.6(0) M2 (% yield =) $\frac{4.6}{6.4}$ x100 OR 71.875 (%) M3 = 71.9 (%)	M2 ECF M1 M3 DEP M2	3

Question number	Answer	Notes	Marks
(c) (i)	M1 find percentage of water M2 divide each percentage by Mr to find number of moles M3 divide each answer by smallest to find ratio and value of x Expected calculation: M1 (79%) $CaSO_4$ 21% H_2O M2 $\frac{79}{136}$ (= 0.58) $\frac{21}{18}$ (= 1.17) M3 $\frac{0.58}{0.58}$ $\frac{1.17}{0.58}$ = 1 : 2 so x = 2	correct answer without working scores 3	3
(ii)	description including M1 do a flame test M2 orange-red flame	ALLOW description of flame test	2
		(Total for Question = 15)	

Q2.

Question number	Answer	Notes	Marks
(a) (i)	$N_2 + O_2 \rightarrow 2NO$	**ALLOW** fractions and multiples **IGNORE** state symbols, even if incorrect	1
(ii)	the reaction has a high activation energy / E_a	**ACCEPT** to give the reactants enough energy to react **ACCEPT** a lot of energy is required to break the bonds in the reactants **ALLOW** nitrogen is unreactive	1
(iii)	acid rain	**ACCEPT** references to respiratory problems **ALLOW** a specific harmful effect of acid rain **ALLOW** references to smog **ALLOW** references to greenhouse gases / global warming / climate change **ALLOW** toxic	1

(b)	(i)	M1 catalyst provides an alternative reaction route/ pathway M2 with lower activation energy		2
	(ii)	M1 particles / molecules are closer together M2 therefore more collisions M3 per unit time	**ACCEPT** more particles in a smaller volume /space more frequent collisions scores M2 and M3 any reference to increasing energy max = 1	3

(c)	(i)	M1 one pair of electrons between the nitrogen and each hydrogen M2 two non-bonding electrons on the nitrogen  	 M2 dep on M1	2 2
	(ii)	M1 (electrostatic) attraction between nuclei M2 and shared pair(s) of electrons OR M1 (electrostatic) attraction between shared pair(s) of electrons M2 and nuclei (of both atoms)	nuclei must be plural **ALLOW** bonding pair(s) of electrons **ALLOW** bonding pair(s) of electrons nuclei must be plural	2
	(iii)	M1 forces between molecules/intermolecular forces (of attraction) are weak M2 and therefore require little energy to overcome	**ALLOW** intermolecular bonds are weak **IGNORE** less energy Mention of breaking covalent bonds = 0	
				14

Q3.

Question number	Answer	Notes	Marks
(a)	shared pair(s) of electrons (between two atoms)	**REJECT** if between molecules	1
(b) (i)	$N_2 + 2O_2 \rightarrow 2NO_2$	**ALLOW** multiples and fractions	1
(ii)	acid rain	**ACCEPT** breathing problems/ asthma **ALLOW** an effect of acid rain e.g. kills fish	1
(c)	An explanation that links the following six points **M1** nitrogen dioxide has a simple molecular structure **M2** silicon dioxide has a giant (covalent) structure **M3** many/strong (covalent) bonds in silicon dioxide (need to be broken) **M4** intermolecular forces in nitrogen dioxide **M5** are weak **M6** more energy needed to break the bonds in silicon dioxide than to overcome the (intermolecular) forces in nitrogen dioxide	 **REJECT** ionic or metallic structure/ bonds for **M2** and **M3** **REJECT** mention of intermolecular forces for **M3** **REJECT** covalent bonds are weak for **M4** and **M5** **REJECT** reference to breaking of covalent bonds in nitrogen dioxide	6 Total 9

Q4.

Question number	Answer	Additional guidance	Marks
(a) (i)	red	**REJECT** brick-red / orange-red and all other colours	1
(ii)	Li^+	**IGNORE** name even if incorrect	1
(iii)	An explanation that links the following two points **M1 (**litmus turns) blue **M2** (because) hydroxide (ion) / OH^- forms / solution is alkaline / an alkali	 **REJECT** purple	2
(b) (i)	Any two from: **M1** forms a ball **M2** disappears / gets smaller **M3** forms a white trail **M4** bubbles/fizzes/effervescence	 **ALLOW** melts **ALLOW** dissolves **IGNORE** hydrogen or gas given off/evolved/formed/ produced	2
(ii)	$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + (1)\,H_2$	**ACCEPT** multiples and fractions **IGNORE** state symbols, even if incorrect	1

Question number			
(c) (i)	Any one from: **M1** burns / catches fire / (lilac/purple) flame produced **M2** moves (around the surface) more quickly	 **REJECT** any incorrect flame colour **ALLOW** reacts more vigorously	 1
(ii)	Any number or range of numbers between 8 and 14 inclusive		1
(d)	An explanation that links together the following two points: **M1** rubidium/it is below potassium (in Group 1) **M2** and the reactivity (of the elements/metals) increases down the group/as the group is descended/as atomic number/ atomic mass increases	 **ACCEPT** rubidium/it is lower down in the Periodic Table **ACCEPT** rubidium/it has bigger atoms/more shells (of electrons)/more shielding **ACCEPT** rubidium (atom)/it loses electrons more easily/readily **ACCEPT** correct reverse argument	 2
		Total	**11**

Q5.

Question number	Answer	Notes	Marks
(a) (i)	Y		1
(ii)	V		1
(iii)	W		1
(iv)	X		1
(v)	displayed formula of but-1-ene or methylpropene		1
(vi)	Any two from		2
	M1 same general formula	**ALLOW** same empirical formula	
	M2 similar chemical properties	**ALLOW** they react in a similar way/same chemical properties	
	M3 trend in physical properties	**ACCEPT** named physical property e.g. trend in boiling points	
	M4 each consecutive member differs by a CH_2 group		

(b)	(i)	M1 $\frac{38.7}{12}$ $\frac{9.7}{1}$ $\frac{51.6}{16}$ **OR** 3.225 9.7 3.225 M2 (divide by smallest) 1 3 1	0 marks if upside down calculation or use of atomic numbers	2
	(ii)	M1 Mr of CH_3O = 31 M2 (62 ÷ 31 = 2 so molecular formula is) $C_2H_6O_2$	$C_2H_6O_2$ without working scores 2	2
				11

Q6.

Question number	Answer	Notes	Marks
(a) (i)	A description including any three of the following **M1** pour some solvent into a beaker /chromatography tank **M2** place the paper in the solvent so that the food colourings are above the level of the solvent **M3** leave the paper until the solvent reaches the level shown in the diagram/ has moved to near the top of the paper OWTTE **M4** take the paper out and leave to dry	**M1** and **M2** can be scored from a labelled diagram **ALLOW** any named solvent	3
(ii)	one/1		1
(iii)	(F/it is) insoluble (in the solvent)/ does not dissolve (in the solvent)		1
(iv)	**M1** E and H **M2** they contain a dye that moved the furthest (distance up the paper)/ is closest to the solvent front / has the greatest R_f value	**M2** dep on **M1**	2
(b)	**M1** distance moved by solvent = 59-61mm **and** distance moved by the dye = 37-41mm **M2** distance moved by the dye ÷ distance moved by the solvent ≈ 0.67 **M3** (the dye in food colouring) G	**ALLOW** distances in cm e.g. 6cm and 4cm If paper has been printed on A4 distances will be 51-53mm and 33-37mm **ALLOW** alternative methods	3 **Total 10**

Q7.

Question number	Answer	Notes	Marks
(a) (i)	V is insoluble (in the solvent)/ does not dissolve (in the solvent)		1
(ii)	M1 X and Z M2 because the top spots are/dye is closest to the solvent front **OR** the dye/the top spots moved the furthest distance (from the start line) OWTTE	 M2 dep on M1	2
(b)	M1 distance from start line to spot to nearest mm 17 to 20 mm M2 distance from start line to solvent front to nearest mm 56 mm M3 answer to M1 ÷ answer to M2 = R_f value between 0.30 and 0.36	**ACCEPT** answers in cm **ALLOW** 55 - 57mm **ACCEPT** any number of sig figs except 1 **ALLOW** ECF on incorrect measurements for M1 and/or M2	3
			Total 6

Q8.

Question number	Answer	Notes	Marks
(a) (i)	potassium hydroxide + hydrochloric acid → potassium chloride + water	**ALLOW** correctly balanced chemical equation	1
(ii)	**M1** to mix (the two solutions more thoroughly)		2
	M2 (so that) more reactant particles come into contact with each other OWTTE	ALLOW references to increasing rate of reaction	
	M3 so that the heat energy is given out more quickly OWTTE		
	M4 so that the mixture is the same temperature throughout OWTTE		
(b)	Correct answer with or without working scores 2 • setting out of calculation • evaluation Example calculation **M1** $\frac{17.8 + 18.4}{2}$ **M2** 18.1		2

Question number	Answer	Notes	Marks
(c) (i)	Mean temperature at start in °C 17.2 Temperature at end in °C 22.4 Temperature rise in °C 5.2		2
(ii)	• calculation of volume/mass of mixture • substitution of values into $Q = mc\Delta T$ • evaluation Example calculation **M1** (volume/mass =) 25 + 25 **OR** 50 (cm^3) , (g) **M2** (Q =) 50 x 4.2 x 5.2 **M3** (Q =) 1092	**ALLOW** ecf if 25 used in calculation 1092 without working scores 3 marks	3

(iii)	• division of *Q* by moles of KOH • conversion of J to kJ • answer with correct sign Example calculation M1 $\frac{1092}{0.02}$ **OR** 54600 M2 conversion from J to kJ OR 54.6(00) M3 (ΔH =) − 54.6 (kJ/mol)	**ALLOW** ecf from answer to (ii) **ALLOW** any number of sig figs greater than 1 throughout **ACCEPT** 1092 or 1100 used in calculation **ALLOW** ecf from M1 Minus sign must be present **ALLOW** ecf from M2 **ACCEPT** any value between 54.5 and 55 **M3** dep on division of Q by moles Correct answer with correct sign and without working scores 3 Correct answer without sign or with incorrect sign and without working scores 2.	3 **Total 13**

Q9.

Question number	Answer	Notes	Marks
(a)	M1 (propane/it) contains hydrogen and carbon (atoms) M2 only	REJECT carbon and hydrogen molecules M2 is dependent on mention of just carbon and hydrogen in M1	2
(b) (i)	carbon monoxide	ALLOW CO	1
(ii)	it decreases the capacity of the blood to transport oxygen OWTTE	ALLOW carbon monoxide binds to haemoglobin	1
(c)	M1 (strong electrostatic) attraction between (bonding) pair of electrons M2 (and) nuclei (of both atoms) OR M1 (bonding) pair of electrons M2 attracted to nuclei	 REJECT nucleus REJECT nucleus 0 marks if reference to intermolecular forces between atoms	2
(d)	An explanation that links the following three points M1 (crude oil) produces more long chain hydrocarbons than can be used directly OWTTE M2 shorter chain alkanes are more flammable /more useful as fuels M3 alkenes are used to make polymers / plastics	 ALLOW less demand for long chain hydrocarbons ALLOW shorter chain alkanes/hydrocarbons are more useful	3
(e) (i)	M1 C_3H_7Br M2 HBr	 ALLOW polysubstituted product if correct balancing number in front of Br_2 and HBr	2
(ii)	substitution		1

12 marks

Q10.

Question number	Answer	Notes	Marks
(a) (i)	14		1
(ii)	2.5	**REJECT** any charge shown **IGNORE** brackets	1
(iii)	**M1** same number of protons **M2** different numbers of neutrons	**IGNORE** references to numbers of electrons	2
(iv)	**M1** (three) more electrons than protons **M2** electrons have a negative charge and protons have a positive charge	**REJECT** incorrect numbers of electrons	2
(b)	**M1** $(98.930 \times 12) + (1.070 \times 13) \div 100$ **M2** 12.01	**ALLOW** 1 mark for 1201.07 if not divided by 100 as long as given to 2dp correct answer to 2 decimal places with or without working scores 2 marks.	2
			8

Q11.

Question number	Answer	Notes	Marks
(a)	$Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$ all state symbols correct		1
all clip with graph (b) (i)	all points correctly plotted (within +/- half a square)		1
(ii)	circle around point at 6 min		1
(iii)	smooth curve of best fit		1
(iv)	student took reading too soon/before 6 min		1
(v)	mass from graph at 6 min	IGNORE UNITS	1
(c) (i)	**M1** curve becomes less steep /gradient decreases (as time increases) **M2** so rate of reaction decreases	 M2 DEP M1	2
(ii)	the (sulfuric) acid was in excess OWTTE	**ALLOW** not all (sulfuric) acid reacted **ALLOW** zinc was limiting reagent **ALLOW** zinc was not in excess	1

Question number	Answer	Notes	Marks
(d)	**M1** magnesium (more reactive than zinc so) would make reaction faster/increase the rate **M2** less concentrated acid would make reaction slower/decrease the rate **M3** (so) difficult/impossible to know whether rate will increase or decrease overall OWTTE	**REJECT** reference to different surface area **REJECT** references to differences in energy/speed of particles **ALLOW** difficult/impossible to know which change has greater effect OWTTE **ALLOW** idea of difficult/impossible to predict (overall) effect of changing two factors at same time OWTTE **ALLOW** idea of difficult/impossible to know if changes cancel each other out OWTTE	3
(e)	**M1** at higher temperature particles have more (kinetic) energy **M2** more (successful) collisions per unit time **M3** rate of reaction increases	**ACCEPT** more particles have the required activation energy **ALLOW** particles move faster **ALLOW** more frequent (successful) collisions	3

Q12.

Question number	Answer	Notes	Marks
(a)	M1 to prevent acid splashing out OR so only (carbon dioxide) gas leaves the flask M2 so the decrease in mass is close to the actual value OR so that the decrease in mass is only due to the gas	IGNORE solid leaving the flask REJECT prevents gas escaping	2
(b)	M1 $CaCO_3(s) + 2HCl(aq)$ M2 $H_2O(l) + CO_2(g)$		2
(c) (i)	the hydrochloric acid has all reacted		1
(ii)	mass stays the same / stops decreasing	ALLOW effervescence / fizzing stops ALLOW the curve levels off	1
(iii)	M1 0.98 M2 (0.98÷44) = 0.022	ALLOW any number of significant figures REJECT incorrect rounding ALLOW M1÷44 Correct answer of 0.022 moles with or without working scores 2 marks	2
(iv)	M1 tangent shown on graph M2 method of calculating gradient (change in y ÷ change in x) M3 rate of reaction in g/s	 ALLOW ECF from M2 Answer of 0.005 - 0.006 with a tangent shown on the graph scores 3 with or without other working.	3

		Answer of 0.015g/s (the average rate of reaction for the first 60s scores 1)	
(d) (i)	M1 the rate of reaction increases as the percentage concentration increases M2 the rate of reaction is (directly) proportional to the percentage concentration	 M2 subsumes M1	2
(ii)	M1 change in number of particles (per unit volume) M2 change in collisions per unit time	ALLOW particles are closer together or further apart ALLOW change in frequency of collisions REJECT increased / changed energy / speed	2
			Total for question = 15 marks

Q13.

Question number	Answer	Notes	Marks
(a) (i)	$Mg + 2HCl \rightarrow MgCl_2 + H_2$	**IGNORE** state symbols even if incorrect	1
(ii)	(squeaky) pop with lighted splint		1
(iii)	**M1** amount of magnesium = 0.090 ÷ 24 **OR** 0.00375 (mol) **M2** amount of HCl needed = 2 × 0.00375 = 0.0075 (mol) (which is less than 0.025) **OR** **M1** amount of magnesium needed = 0.025÷2 **OR** 0.0125 (mol) **M2** mass of magnesium needed = 0.0125 × 24 = 0.3(g) (there is less magnesium than needed)	 **ALLOW** any number of significant figures	2

(b)	(i)	all points plotted correctly to the nearest grid line		1
	(ii)	best fit curve starting at 0 and levelling off at 88 cm^3		1
	(iii)	**M1** vertical line on grid from 10 seconds to curve	**ALLOW** any mark at correct position on curve / either axis	2
		M2 volume correctly read from their graph to the nearest grid line	expected value 25 to 30 cm^3	
	(iv)	An explanation that links the following two points		2
		M1 concentration (of HCl) is greatest (at the start)	**REJECT** incorrect references to energy **ALLOW** more particles (of HCl / more H^+ ions) **ALLOW** more HCl molecules / greater surface area of Mg **IGNORE** greater mass /more Mg **IGNORE** references to the graph	
		M2 more collisions per unit time / more frequent collisions		

(c)	(i)	**M1** curve starting at 0 and steeper than original curve	**ALLOW** a curve starting within 1 small square of the original	2
		M2 curve levelling off at same volume as original curve		
	(ii)	An explanation that links the following three points		3
		M1 particles gain more (kinetic) energy	**ALLOW** particles move faster	
		M2 more collisions have energy greater than the activation energy	**ACCEPT** more collisions are successful	
		M3 collision frequency increases **OR** rate of reaction increases	**ACCEPT** more (successful) collisions per unit time	
				Total 15

Q14.

Question number	Answer	Notes	Marks
(a) (i)	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$		2
	M1 all symbols and formulae correct		
	M2 correctly balanced	M2 DEP M1	
(ii)	lighted splint (produces squeaky) pop		1
(b) (i)	52 (cm^3)	ALLOW 51.5-52.5	1
(ii)	M1 vertical line from 15 cm^3 acid to graph line	ALLOW extra point drawn at 15 cm^3	2
	M2 volume hydrogen from graph multiplied by 2	ALLOW 68-70	
	OR		
	M1 vertical line from 30 cm^3 acid to graph line	ALLOW extra point drawn at 30 cm^3	
	M2 volume hydrogen from graph	ALLOW 68-70	
(c)	explanation linking		3
	M1 more (acid) particles/(hydrogen) ions/H^+ in same volume	REJECT molecules once only ALLOW particles are closer together	
	M2 more (successful) collisions per second/unit time	ACCEPT more frequent collisions IGNORE more chance/probability of collision	
	M3 rate increases	ALLOW reaction is faster /speeds up MAX 1 if refer to particles moving faster/having more energy	

(d)	explanation including M1 (increase/decrease) surface area M2 increase surface area by using smaller pieces of zinc M3 more (successful) collisions per second/unit time (so rate increases)	 ACCEPT more frequent collisions IGNORE more chance/probability of collision M2 M3 ACCEPT reverse arguments	3
		(Total for Question = 12)	

Q15.

Question number	Answer	Notes	Marks
(a) (i)	$Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$	**ACCEPT** upper case letters	1
(ii)	effervescence/bubbles/fizzing	**ACCEPT** zinc gets smaller or disappears **IGNORE** hydrogen / gas produced / given off	1
(b) (i)	An explanation that links the following two points **M1** to make sure all of the acid reacts **M2** (so that) a pure zinc sulfate solution is obtained/pure zinc sulfate crystals are obtained OWTTE		2
(ii)	**M1** filter funnel containing filter paper **M2** suitable container to collect filtrate e.g. beaker, conical flask, evaporating basin	**M2** dep on a filter funnel in **M1**	2

Question number	Answer	Notes	Marks
(c) (i)	• setting out of calculation • evaluation Example calculation M1 65 + 32 + (4 x 16) + (7 x 18) M2 287	correct answer without working scores 2	2
(ii)	• multiply moles by M_r • evaluation Example calculation M1 (mass of $ZnSO_4.7H_2O$ =) 287 x 0.02(00) M2 (mass of $ZnSO_4.7H_2O$ =) 5.74 (g)	correct answer (5.74) without working scores 2 **ALLOW** ecf from (i)	2
(iii)	M1 4.28÷5.74 OR 0.7456 M2 0.7456 × 100 M3 74.6	correct answer to 3 sig figs without working scores 3 **ALLOW** ecf from (ii) **ALLOW** use of 6g **ALLOW** any number of sig fig greater than 1 **ALLOW** use of 6g giving answer of 71.3 Must be 3 sig figs to score M3	3
			Total 13

Q16.

Question number	Answer	Notes	Marks
(a)	(thermal) decomposition (1)		1
(b)	any two of the following: M1 (use the same) amount of metal carbonate M2 (use the same) sized pieces/surface area M3 (use the same) volume of limewater M4 (use same) size flame / distance of flame from boiling tube OWTTE	 ALLOW mass ALLOW amount	2
(c)	bubbles are air (from tube) / caused by air (expanding on heating)	ALLOW gas in tube expands (on heating)	1
(d)	explanation including M1 (when limewater turns milky/cloudy it) shows carbon dioxide produced M2 showing metal carbonate has reacted/decomposed	 ALLOW carbon dioxide comes from carbonate (reacting/decomposing)	2
(e) (i)	M1 (from) green M2 (to) black	IGNORE qualifiers eg light	2
(ii)	$CuCO_3 \rightarrow CuO + CO_2$	ALLOW products in either order	1

Question number	Answer	Notes	Marks
(f) (i)	M1 the lower the metal is (in the reactivity series) M2 the more easily the (metal) carbonate reacts/decomposes	ALLOW the less reactive a metal is ALLOW the more easily the (metal) carbonate produces carbon dioxide ALLOW references to the less time the (metal) carbonate takes to react/decompose ALLOW references to the faster the (metal) carbonate reacts/decomposes ACCEPT reverse arguments	2
(ii)	repeat (the investigation) using different / other / more (metal) carbonates		1
		(Total for Question = 12)	

Q17.

Question number	Answer	Notes	Marks
(a) (i)	**M1** white flame/light **M2** white powder/solid (formed)	 **ALLOW** white smoke **ALLOW** white ash **REJECT** white precipitate	2
(ii)	magnesium gains oxygen	**ACCEPT** magnesium loses electrons/ oxidation state (of Mg) increases / goes from / changes from 0 to +2	1
(b) (i)	gives out/releases heat (energy)/thermal energy	**IGNORE** energy alone	1
(ii)	$2Mg + CO_2 \rightarrow 2MgO + C$	**ALLOW** multiples and fractions	1
(iii)	Any one from the fire would keep burning OR the carbon dioxide would not put out the fire OR a large amount of heat/thermal energy would be released	 **ALLOW** Any other sensible suggestion	1

Question number	Answer	Notes	Marks
(c)	An explanation giving two linked changes **M1** (the student should) lift and replace the lid **M2** (to allow) oxygen/air to enter the crucible (to react with the magnesium) AND **M3** reheat and reweigh / heat to constant mass **M4** to make sure that all the magnesium has reacted		4 **Total 10**

Q18.

Question number	Answer	Notes	Marks
(a) (i)	glowing splint relights	**REJECT** burning splint	1
(ii)	A description that refers to the following three points M1 filter out manganese(IV) oxide / solid M2 leave to dry M3 same mass/ 1g of manganese(IV) oxide / solid		3
(b) (i)	M1 280 ÷ 120 M2 2.33	 **ALLOW** ecf from M1 **ALLOW** any number of significant figures except 1	2
(ii)	An explanation that links the following three points M1 the concentration of hydrochloric acid is greatest M2 therefore there are more collisions M3 per unit time	 **ALLOW** the surface area of zinc is greatest **ALLOW** greatest number of/more particles (of hydrochloric acid/ zinc) More frequent collisions scores M2 and M3 Max 1 if incorrect reference to energy	3 2
(iii)	M1 curve above original and starts at 0 M2 curve goes flat at same volume (410cm^3)		

(iv)	M1 greater surface area M2 more collisions per unit time / more frequent collisions		2
(c)	M1 8.46×10^{-3} mol of zinc M2 therefore 1.69×10^{-2} mol hydrochloric acid needed (which is less than 2.50×10^{-2} mol) **OR** M1 1.25×10^{-2} mol of zinc are needed M2 therefore 0.8(13) g of zinc is needed (and there is only 0.55g)	**ALLOW** any number of sig figs including one e.g. 0.008 moles of zinc, therefore 0.016 moles of acid needed scores M1 and M2	2
			15 marks

Q19.

Question number	Answer	Notes	Marks
(a)	<table><tr><th></th><th>Proton</th><th>Electron</th></tr><tr><td>Relative mass</td><td>1</td><td>1/1700 to 1/2000 (or 0.0005 to 0.0006)</td></tr><tr><td>Relative charge</td><td>(+)1</td><td>-1</td></tr></table>	all 4 correct = 2 marks 2 or 3 correct = 1 mark 0 or 1 correct = 0 marks **ALLOW** +1 for relative mass of proton but **REJECT** -1	2
(b) (i)	<table><tr><td>Atomic number of atom</td><td>7</td></tr><tr><td>Mass number of atom</td><td>15</td></tr><tr><td>Group number of element in Periodic Table</td><td>5</td></tr></table>	1 mark for each correct row	3
(ii)	nitrogen		1
(iii)	3-	**ACCEPT** –3, N^{3-}, N^{-3}	1
		Total for question	= 7 marks

Q20.

Question number	Answer	Notes	Marks
(a) (i)	relative mass proton 1 relative mass neutron 1 relative charge proton +1 relative charge neutron 0	All 4 correct scores 2 2 or 3 correct scores 1	2
(b) (i)	M1 atoms (of the same element) with the same number of protons M2 but different numbers of neutrons	ALLOW atoms with the same atomic number ALLOW atoms with the same number of electrons ALLOW but different mass numbers	2
(ii)	M1 number of protons and electrons = 12 M2 number of neutrons = 14		2
(iii)	$\frac{(24 \times 79) + (25 \times 10) + (26 \times 11)}{100}$ scores 2 marks M1 multiplies each mass number by the percentages M2 adds multiples together and divides by 100	(24 x 0.79) + (25 x 0.10) + (26 x 0.11) scores both marks	2
(iv)	M1 $24.32 \div (6.022 \times 10^{23})$ M2 4.039×10^{-23}	(24 x 0.79) + (25 x 0.10) + (26 x 0.11) scores both marks ALLOW ecf from M1 as long as answer is given to 4 sig figs Correct answer of 4.039×10^{-23} g to 4 sig sigs scores 2 with or without working	2
(c)	(moles of MgO) = 0.40		1
			Total for question = 11