PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



MARK SCHEME

SECTION 2: INORGANIC CHEMISTRY (PACK 1)

SCORE	PERCENTAGE
/282	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	M1 dissolving M2 diffusion	Answers can be in either order IGNORE dilution	2
(b) (i)	A 3 B is incorrect as there are not 4 different types of atoms in $KMnO_4$ C is incorrect as there are not 6 different types of atoms in $KMnO_4$ D is incorrect as there are not 7 different types of atoms in $KMnO_4$		1
(ii)	(M_r = 39 + 55 + 16 x 4 =) 158		1
(c)	(something that) gives oxygen (to another substance)/takes/gains electrons (from another substance) OWTTE	ALLOW oxygen donor ALLOW electron acceptor ALLOW (something that) causes another substance to be oxidised/to lose electrons OWTTE ALLOW (something that) is reduced (in a reaction) ALLOW increases the oxidation number (of another species) OWTTE	1 **Total 5**

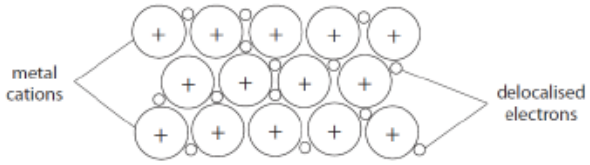
Q2.

Question number	Answer	Notes	Marks
(a)	Any two of the following observations. **M1** (sodium) floats/moves on surface (of water) **M2** (sodium) melts/forms a ball **M3** (sodium) gets smaller/disappears **M4** (sodium forms) white trail	 **ALLOW** dissolves **IGNORE** references to flame/heat released /temperature increases **IGNORE** fizzing /effervescence	2 Exp

(b)	(i)	$2Li + F_2 \rightarrow 2LiF$	**ALLOW** multiples or fractions **IGNORE** state symbols even if incorrect	1 Exp
	(ii)	**M1** flame test	**ALLOW** description of flame test	2 Exp
		M2 red (flame)	**ALLOW** crimson /scarlet **REJECT** orange-red/ brick red	
	(iii)	**M1** correct electron arrangement of lithium ion  lithium ion Li^+ $[2]^+$	**ACCEPT** any combination of dots and crosses **IGNORE** empty second shell	3 Exp
		M2 correct electron arrangement of fluoride ion  fluoride ion F^- [2,8]$^-$	Inner electron shell required to score M2	
		M3 correct charges on both ions (with or without brackets)	**M3** not dep on **M1** and **M2** correct	

Question number	Answer	Notes	Marks
(c)	An explanation that links three of the following four points **M1** the outer electron is further from the nucleus in potassium / potassium has more shells/ potassium has larger atomic radius ORA **M2** there is more shielding (by the inner shells) in potassium ORA **M3** there is less attraction between the outer electron and the nucleus in potassium ORA **M4** (so outer) electron (in potassium) more easily lost ORA	 **ALLOW** potassium atom is bigger than a sodium atom outer electron needs to be mentioned at least once in the answer for full marks Max 2 if no mention of outer electron in the answer	3 Exp **Total 11**

Q3.

Question number	Answer	Notes	Marks
(a) (i)	A labelled diagram showing **M1** at least three rows of at least three cations/atoms in a regular arrangement **M2** surrounded by (delocalised) electrons Example of diagram  	Max 1 if no labels Minimum requirement for 2 marks is + signs on atoms and electrons labelled or shown as e^-	2 Exp
(ii)	An explanation that links the following two points **M1** delocalised electrons **M2** flow/are mobile/move/are free to move	**IGNORE** free electrons/ sea of electrons **M2** dep on mention of electrons Any mention of ions/atoms moving scores 0	2 Exp

(b)	Any two of the following properties **M1** low density **M2** does not react with drink **M3** malleable	**ALLOW** lightweight **IGNORE** light **IGNORE** less dense **ALLOW** does not corrode/non-toxic **IGNORE** does not rust **ALLOW** easy to bend/ easy to shape **IGNORE** references to cost **IGNORE** can be recycled **IGNORE** any irrelevant properties e.g. high melting/boiling point/ good conductor/ductile	2 Exp

Question number	Answer	Notes	Marks
(c) (i)	aluminium/it is more reactive/higher in the reactivity series than carbon ORA	**ALLOW** aluminium is too reactive/too high in the reactivity series	1 Grad
(ii)	electrons are gained (by aluminium ion/Al^{3+})	**ACCEPT** oxidation state of aluminium/Al is decreased/ changes from +3 to 0 **REJECT** aluminium/Al gains electrons **IGNORE** references to loss of oxygen	1 Exp
(iii)	$2O^{2-} \rightarrow O_2 + 4e^{(-)}$ **M1** correct formulae of products **M2** balancing of correct formulae	**ACCEPT** multiples and fractions **M2** dep on **M1**	2 Exp **Total 10**

Q4.

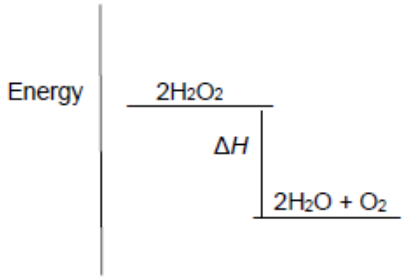
Question number	Answer	Notes	Marks
(a) (i)	M1 (X) measuring cylinder M2 (Y) pipette	 **ALLOW** graduated pipette	2
(ii)	(volume measurement with Y is) more precise ORA	**ALLOW** (volume measurement with Y is) more accurate ORA **ALLOW** (Y gives) a (more) exact volume /exactly 25 cm^3	1
(b) (i)	yellow		1
(ii)	there is no clear end point/ colour change is gradual (at the end point)/no sharp colour change OWTTE	**ALLOW** it has a range of colours	1

(c)	M1 moles of $HNO_3 = \frac{21.5 \times 0.6(00)}{1000}$ **OR** 0.0129 M2 moles of $Ba(OH)_2 = 0.0129 \div 2$ **OR** 0.00645 M3 conc. of $Ba(OH)_2 = \frac{0.00645 \times 1000}{25} = 0.258$ (mol/dm^3)	correct answer with or without working scores 3 **ALLOW** ecf on **M2** **ACCEPT** alternative methods 0.516 scores 2 1.032 scores 2 **ALLOW** 2 sig figs correctly rounded throughout Penalise rounding to 1 sig fig once only	3
(d)	barium sulfate is insoluble /does not dissolve /forms a precipitate		1
			Total 9

Q5.

Question number	Answer	Notes	Marks
(a)	**B** it relights a glowing splint A is incorrect as this is the test for hydrogen C is incorrect as oxygen is not an acidic gas D is incorrect as this is the test for carbon dioxide		1
(b)	An explanation that links the following two points **M1** provides an alternative pathway OWTTE **M2** with a lower activation energy OWTTE	**ACCEPT** more collisions with energy greater than the activation energy **ALLOW** lowers the energy needed to start the reaction	2

Question number	Answer	Notes	Marks
(c) (i)	• find energy needed to break bonds • find energy released when bonds form • correct subtraction to find ΔH Example calculation **M1** (4 x 463) + (2 x 143) **OR** 2138 (kJ) **M2** (4 x 463) + 498 **OR** 2350 (kJ) **M3** — 212 (kJ) **OR M1 – M2** correctly evaluated	**ACCEPT** (2 x 143)/286 for **M1** and 498 for **M2** **IGNORE** any signs in **M1** and **M2** — 212 with or without working scores 3 (+) 212 with or without working scores 2	3

(ii)	 **M1** horizontal line to show products in correct position and correctly labelled **M2** vertical line in correct position and labelled ΔH	Mark CQ on sign in (i) **ACCEPT** double headed arrow or arrow pointing from reactants level to products level **REJECT** arrow pointing from products level to reactants level **IGNORE** any attempts at including activation energy	2 **Total 8**

Q6.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to the following six points: Test for cation: • do a flame test (1) • if flame is yellow then cation is sodium (1) • if flame is lilac then cation is potassium (1) Test for anion: • dissolve solid in water (1) **EITHER** • add (dilute nitric acid and) aqueous silver nitrate (1) • if (white) precipitate forms the anion is chloride/if no precipitate forms then anion is sulfate (1) **OR** • add (dilute hydrochloric acid and) aqueous barium chloride (1) • if (white) precipitate forms the anion is sulfate/if no precipitate forms then anion is chloride (1)	accept any combination of hydrochloric acid/nitric acid and barium chloride/barium nitrate	**6**

(Total for question = 6 marks)

Q7.

Question number	Answer	Additional guidance	Marks
(a)	<table><tr><th>Name of halogen</th><th>Physical state at room temperature</th><th>Colour</th></tr><tr><td>chlorine</td><td>gas</td><td>pale green</td></tr><tr><td>bromine</td><td>liquid</td><td>red-brown</td></tr><tr><td>iodine</td><td>solid</td><td>(dark) grey</td></tr></table>	**ALLOW** black **ALLOW** any combination of grey and black eg grey-black	2
(b)	**M1** (35 × 77.78) + (37 × 22.22) **OR** 3544.44 **M2** 3544.44 ÷ 100 **OR** 35.4444 OR **M1** ÷ 100 **M3** 35.4	(35 × 0.7778) + (37 × 0.2222) **OR** 35.4444/35.444/35.44 with no working scores 2 35.4 with no working scores 3 M3 can be ECF from an incorrect M2	3
(c)	An explanation that links together the following four points: **M1** add chlorine (solution) to potassium bromide (solution) **M2** (solution) turns orange **M3** bromine/Br_2 is displaced **M4** (therefore) chlorine is more reactive (than bromine)	 **ACCEPT** mix the two solutions **ALLOW** any combination of orange/yellow/brown **IGNORE** other observations eg bubbles **ALLOW** bromine/Br_2 is produced/formed **IGNORE** state of bromine **REJECT** bromide **IGNORE** a displacement reaction occurs **M3** can be scored by Br_2 as a product in an equation **ACCEPT** reverse argument "If a reaction occurs then chlorine is more reactive than bromine" scores **M4**	4

Q8.

Question number	Answer	Notes	Marks
(a)	**M1** (from) yellow **M2** (to) orange	 **ACCEPT** red **ALLOW** pink 1 mark for two correct colours in the wrong order	2
(b)	A description that makes reference to any **four** of the following points **M1** he should not rinse flask with sodium hydroxide solution **or** he should rinse flask with water **M2** he should use a pipette to measure out the sodium hydroxide solution **M3** he should not rinse the burette with water **or** he should rinse the burette with sulfuric acid **M4** he should record the initial burette reading **M5** he should place a white tile under the flask **M6** he should swirl the flask whilst adding the acid **M7** he should add the acid dropwise near the end-point **M8** repeat the titration (to obtain an average/ concordant results)	 **ACCEPT** he should use a pipette instead of a measuring cylinder **ALLOW** white paper **IGNORE** stir	4

Question number	Answer	Notes	Marks
(c)	• calculate the amount, in moles, of sodium hydroxide • calculate the amount, in moles, of sulfuric acid • calculate the concentration of sulfuric acid Example calculation **M1** $n(NaOH) = 0.0250 \times 0.200$ **or** 0.005 (mol) **M2** $n(H_2SO_4) = 0.005 \div 2$ **or** 0.0025 (mol) **M3** conc^n = (0.0025 ÷ 0.0167) = 0.150 (mol/dm^3)	 answer to **M1** ÷ 2 answer to **M2**÷0.0167 **ALLOW** 0.1497 or any number of sig fig except one Correct answer without working scores 3 **ACCEPT** alternative methods	3 **Total 9**

Q9.

Question number	Answer	Notes	Marks
(a)	potassium	ALLOW K	1
(b)	(paper) chromatography		1
			1
(c) (i)	sodium chloride	ALLOW NaCl	1
(ii)	air		1
(iii)	sulfur	ALLOW S	
			Total 5

Q10.

Question number	Answer	Notes	Marks
(a) (i)	D nitrogen D is the only correct answer as nitrogen is the most abundant gas in unpolluted air. A is not correct as there are only trace amounts of hydrogen in unpolluted air. B is not correct as there are only trace amounts of methane in unpolluted air. C is not correct as there are only trace amounts of neon in unpolluted air.		1
(ii)	C 21% C is the only correct answer as the percentage of oxygen in the air is 21% A is not the correct answer as the percentage of oxygen in the air is not 0.04% B is not the correct answer as the percentage of oxygen in the air is not 0.9% D is not the correct answer as the percentage of oxygen in the air is not 35%		1
(b) (i)	cracking an alkane: ; complete combustion of an alkane: ✔ ; reaction between magnesium and hydrochloric acid: ; rusting of iron: ; thermal decomposition of copper(II) carbonate: ✔		2
(ii)	Any one from: M1 global warming M2 climate change	ALLOW greenhouse effect ALLOW an effect of global warming/climate change e.g. wildfires/ melting of polar ice caps/flooding	1
(iii)	argon		1

(c)	(i)	nitric acid	ALLOW HNO_3/ nitrous acid /HNO_2	1
	(ii)	sulfur dioxide	ALLOW SO_2 ALLOW other oxides of nitrogen	1
				Total for question = 8

Q11.

Question number	Answer	Notes	Marks
(a) (i)	argon	**ALLOW** Ar	1
(ii)	nitrogen	**ALLOW** N_2/N	1
(iii)	hydrogen	**ALLOW** H_2/H	1
(b)	climate change/global warming /oceans becoming more acidic	**ALLOW** greenhouse effect **ALLOW** effects of global warming e.g. melting of polar ice caps/flooding/wild fires **IGNORE** acid rain **REJECT** references to ozone layer	1
(c)	M1 bubble/pass/add the gas/carbon dioxide into limewater M2 (limewater) turns cloudy/milky	 **ALLOW** white precipitate M2 dep on mention of limewater **REJECT** addition of extra reagents for both marks	2
			Total 6

Q12.

Question number	Answer	Notes	Marks
(a) (i)	nitrogen	**ALLOW** N_2/N	1
(ii)	carbon dioxide	**ALLOW** CO_2	1
(iii)	argon	**ALLOW** Ar	1
(iv)	carbon dioxide	**ALLOW** CO_2	1
(b)	lighted splint (produces squeaky) pop		1
			5 marks

Q13.

Question number	Answer	Notes	Marks
(a) (i)	calcium + water → calcium hydroxide + hydrogen	**ACCEPT** fully correct balanced chemical equation. $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ **IGNORE** state symbols even if incorrect	1
(ii)	Any two from **M1** effervescence/fizzing/bubbles **M2** calcium/metal/solid disappears/becomes smaller OWTTE **M3** test tube/beaker feels warm/hot	 **IGNORE** gas given off **ALLOW** calcium/metal /solid dissolves **ALLOW** heat produced /temperature increases	2

(b) (i)	A description that makes reference to the following five points **M1** dissolve each of the solids in water/make a solution of each of the solids **M2** mix/add (the two solutions together) **M3** filter (the mixture) **M4** wash the precipitate/solid/barium sulfate /salt/residue (with water) **M5** suitable method of drying the solid	 **ALLOW M1** and **M2** if just one of the solids is dissolved in water and then the other solid is added to it. **M2** dep on **M1** or on reference to the **solutions** being mixed If implication is that filtering is to obtain crystals from the solution no **M3** e.g. dry in a (warm) oven/dry between filter papers **ALLOW** leave to dry **REJECT** hot oven or direct heating (with Bunsen burner) If evaporation of solution to form crystals do not award **M4** but allow **M5** for suitable drying method	5

(ii)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **M1** all formulae correct **M2** state symbols correct	If formulae incorrect or full equation given (even if incorrect) **M2** can still be awarded for correct state symbols. If NaCl in equation must be (aq).	2

Question number	Answer	Notes	Marks
(c) (i)	**C** decomposition A is incorrect as it is not an addition reaction B is incorrect as oxygen is not a reactant D is incorrect as nothing is neutralised here		1
(ii)	• calculate the amount, in moles, of magnesium nitrate • use the equation to find the total amount, in moles, of gas produced • multiply this amount by 24 • answer given to two significant figures Example calculation **M1** *n*(magnesium nitrate) = 7.7 ÷ 148 **or** 0.052 (mol) **M2** *n*(gas) = 5 x 0.052 ÷ 2 **or** 0.13 (mol) **M3** Total volume of gas = 0.13 x 24 **or** 3.12 **M4** 3.1(dm^3)	5 x answer to **M1** ÷2 answer to **M2** x 24 answer to **M3** to 2 sig fig Allow any number of sig fig for **M1**, **M2** and **M3** 3.1 without working scores 4 3.12 without working scores 3	4
			Total 15

Q14.

Question number	Answer	Notes	Marks
(a) (i)	(pale/light) yellow		1
(ii)	The correct answer is **B** 1 as bromine is the only liquid at room temperature (20 °C) **A** 0 is incorrect because bromine is a liquid at room temperature (20 °C) **C** 2 is incorrect because bromine is the only liquid at room temperature (20 °C) **D** 3 is incorrect because bromine is the only liquid at room temperature (20 °C)		1
(iii)	At_2		1
(b) (i)	explanation including M1 oxidising agent is chlorine/Cl_2 M2 because chlorine/Cl_2 gains electron(s)/is reduced	ACCEPT because bromide ions/Br^- lose electrons/are oxidised REJECT bromine ions M2 DEP M1 correct or missing	2

Question number	Answer	Notes	Marks
(b) (ii)	explanation containing three of following points M1 bromine and chlorine react by gaining electron/forming 1- or negative ion M2 bromine atom larger (than chlorine atom) M3 bromine (atom) has smaller/weaker attraction (from nucleus) for (outer shell) electrons (than chlorine) OWTTE M4 so (bromine has) less tendency to gain electron/form negative ion (so less reactive than chlorine) OWTTE	ALLOW bromine has larger atomic radius ALLOW bromine outer (electron) shell further from nucleus ALLOW bromine atom has more (electron) shells (than chlorine) ALLOW reverse argument for chlorine in M2 M3 M4	3

(c)	The correct answer is **D** K^+ and Cl^- because both have electronic configuration of 2.8.8 A is not correct because Li^+ does not have electronic configuration of 2.8.8 B is not correct because F^- does not have electronic configuration of 2.8.8 C is not correct because neither Li^+ nor F^- have electronic configuration of 2.8.8		1
		(Total for Question = 9)	

Q15.

Question number	Answer	Notes	Marks
(a)	**C** fluorine A is incorrect as astatine is black B is incorrect as bromine is brown D is incorrect as iodine is dark grey		1
(b)	**A** astatine B is incorrect as bromine is a liquid C is incorrect as chlorine is a gas D is incorrect as fluorine is a gas		1
(c)	An explanation that links the following four points **M1** fluorine is more reactive than chlorine ORA **M2** the outer shell is closer to the nucleus in fluorine / fluorine has fewer shells / fluorine has a smaller atomic radius ORA **M3** there is a stronger attraction to the nucleus for an electron in fluorine ORA **M4** so fluorine accepts an electron more readily ORA	**ALLOW** reactivity decreases down the group ORA **ALLOW** a fluorine atom is smaller than a chlorine atom ORA **ALLOW** there is less shielding in fluorine ORA	4

(d)	(i)	$2Li + Cl_2 \rightarrow 2LiCl$	**ALLOW** multiples or fractions **IGNORE** state symbols even if incorrect **ACCEPT** $2Li^+Cl^-$ **REJECT** any charges on Li or Cl_2	1
	(ii)	A description that refers to the following five points Test for lithium ions **M1** flame test **M2** red (flame) Test for chloride ions **M3** add nitric acid **M4** add silver nitrate (solution) **M5** white precipitate	 **ACCEPT** description of flame test **ALLOW** crimson/scarlet **REJECT** brick red/orange red **M2** dep on **M1** **REJECT** incorrect acid e.g. HCl or H_2SO_4 for **M3** only **ALLOW** acidified silver nitrate for **M3** and **M4** **M5** dep on addition of silver nitrate	5
				Total 12

Q16.

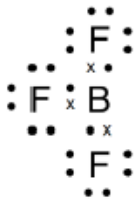
Question number	Answer	Mark
(a)	Fluorine	**1**

Question number	Answer	Mark
(b)	Iodine OR astatine	**1**

Question number	Answer	Mark
(c)(i)	$Cl_2 + 2Br^- \rightarrow 2Cl^- + 2Br$	**1**

Question number	Answer	Additional guidance	Mark
(c)(ii)	(they are) Losing electrons	accept oxidation number (of bromine) increases accept oxidation number (of bromine) changes from −1 to 0	1

Question number	Answer	Additional guidance	Mark
(c)(iii)	$2Br \rightarrow Br_2$	accept $Br + Br = Br_2$	1

Question number	Answer	Mark
(d)	A diagram that shows: • all three bonding pairs correct (1) • all non-bonding pairs (1) Example 	2

(Total for question = 7 marks)

Q17.

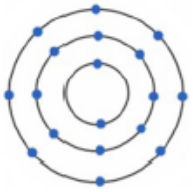
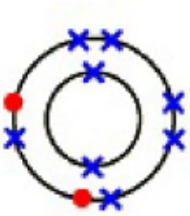
Question number	Answer	Notes	Marks
(a)	M1 mix / stir / add (silver nitrate and copper (II) chloride) M2 filter (the silver chloride) M3 wash with (deionised / distilled) water M4 dry in a warm oven **or** dry with filter paper **or** leave / allow to dry (on a windowsill) **or** dry in a desiccator	**IGNORE** references to heating If evaporation is mentioned to form crystals max = 1	4
(b) (i)	M1 and M2 all points correctly plotted to ± half a square	Deduct 1 mark for every incorrect point.	2
(ii)	M3 two straight lines of best fit which must meet at 3 cm and 6 cm^3		1
(iii)	Any **one** from: the precipitate wasn't left to settle (for long enough) the tube was on a slant not enough / less than 3.0 cm^3 of silver nitrate added	 **ALLOW** measured the height too early **IGNORE** references to human error unqualified	1
(iv)	all the copper [(II)] chloride has reacted	**ALLOW** the silver nitrate is in excess / not all the silver nitrate has reacted	1

Question number	Answer	Notes	Marks
(c) (i)	Any **one** from:		1
	burette	**ALLOW** measuring cylinder	
	(volumetric) pipette	**REJECT** beaker	
(ii)	Example calculation		3
	M1 moles of coper chloride = (25 x 0.50) ÷ 1000 **OR** 0.0125 moles		
	M2 moles of silver chloride = 0.0250	**ALLOW** answer to M1 x 2	
	M3 mass of silver chloride = 3.59 g	**ALLOW** answer to M1 or M2 × 143.5 **ALLOW** 2 or more significant figures Correct answer of 3.59 g scores 3 marks	
(iii)	M1 (0.744 ÷ 0.850) × 100		2
	M2 87.5(%)	**ALLOW** 2 or more significant figures	
			15 marks

Q18.

Question number	Answer	Notes	Marks
(a) (i)	red-brown (coating on nail)	**ACCEPT** orange-brown / brown **ALLOW** orange **IGNORE** rust colour **IGNORE** red alone	1
(ii)	(hydrated) iron(III) oxide/ferric oxide	**ACCEPT** (hydrated) iron oxide **REJECT** iron oxide with incorrect oxidation state	1
(b)	An explanation that links 4 of the following 5 points tube 1 **M1** air/oxygen is needed for rusting **M2** boiled water does not contain air/oxygen **M3** oil keeps air/oxygen out tube 2 **M4** water/moisture is needed for rusting **M5** drying agent keeps water/moisture out	 **ALLOW** 1 mark for no air/oxygen present as an alternative to **M1** and **M2** **ALLOW** 1 mark for no water/moisture present as an alternative to **M4** and **M5**	4 **Total 6**

Q19.

Question number	Answer	Notes	Marks
(a)	M1 (cation) Mg^{2+} M2 (anion) SO_4^{2-}	ALLOW 1 mark if formulae correct but in wrong order	2
(b)	M1 potassium ion  M2 oxide ion  M3 $(K)^+$ and $(O)^{2-}$	ALLOW any combination of dots and crosses If only outer shells shows - max 2	3

Question number	Answer	Notes	Marks
(c) (i)	hydroxide/OH^-	ALLOW HO^-	1
(ii)	$K_2O + H_2O \rightarrow 2KOH$	ALLOW multiples	1
(d)	M1 (when molten or in aqueous solution) ions can move M2 (in solid) ions cannot move		2
(e)	M1 X is chlorine / Cl_2	ALLOW oxygen / O_2	4
	M2 Y is hydrogen / H_2	If both given but wrong way round or unclear which is which allow 1 mark from M1 and M2	
	M3 $2Cl^- \rightarrow Cl_2 + 2e^{(-)}$	$2H_2O \rightarrow O_2 + 4H^+ + 4e^{(-)}$ or $4OH^- \rightarrow O_2 + 2H_2O + 4e^{(-)}$	
	M4 $2H^+ + 2e^{(-)} \rightarrow H_2$		
		Total marks for Question	= 13

Q20.

Question number	Answer	Notes	Marks
(a)	**M1** bright/white light **OR** bright/white flame **M2** white powder/solid/ash	 **ALLOW** white smoke **ALLOW** grey powder /solid/ash **REJECT** white precipitate	2
(b)	A description that refers to the following two points **M1** magnesium/Mg loses two electrons/becomes 2.8 **M2** oxygen/O gains two electrons/becomes 2.8	 **ACCEPT** magnesium gives two electrons to oxygen for **M1** and **M2** Both marks can be scored from diagrams showing correct electronic configurations of the ions.	2
(c) (i)	magnesium is more reactive/higher in the reactivity series (than carbon)/magnesium is a better reducing agent (than carbon) ORA	**ALLOW** carbon cannot displace magnesium	1
(ii)	An explanation that links the following four points **M1** (magnesium) has delocalised electrons **M2** electrons can move **M3** (magnesium chloride) can only conduct when molten/in solution **OR** (magnesium chloride) cannot conduct when solid **M4** ions are free to move	 **REJECT** reference to ions or atoms moving for **M2** ions are free to move when (magnesium chloride) is molten/in solution scores **M3** and **M4** **REJECT** reference to electrons moving for **M4**	4

(d)	(i)	magnesium ions/ Mg^{2+} gains electrons	**ALLOW** electrons are gained **REJECT** magnesium /Mg gains electrons **REJECT** reference to loss or gain of oxygen	1
	(ii)	$2Cl^- \rightarrow Cl_2 + 2e^{(-)}$	**ALLOW** $2Cl^- - 2e^{(-)} \rightarrow Cl_2$ **ALLOW** multiples or fractions **IGNORE** state symbols even if incorrect	1
				Total 11

Q21.

Question number	Answer	Additional guidance	Marks
(a)	**C** (electrostatic attraction between positively charged particles and delocalised electrons) is correct as it describes metallic bonding A is incorrect since it describes ionic bonding not metallic bonding B is incorrect since it describes covalent bonding not metallic bonding D is incorrect since it describes interatomic or intermolecular forces not metallic bonding		1
(b)	Any two from the following: **M1** good conductor of heat/thermal energy **M2** does not react with food/affect flavour of food **M3** resistant to corrosion **M4** high melting point **M5** low density/lightweight/strong	 **IGNORE** non-toxic **ALLOW** does not corrode/rust **IGNORE** unreactive/inert **IGNORE** references to recycling **IGNORE** light	2

Question number		Answer	Additional guidance	Marks
(c)	(i)	a mixture of (two or more) elements, one of which is a metal	**ACCEPT** a mixture of (two or more) metals **ALLOW** combination for mixture **REJECT** compound or references to chemical bonding	1
	(ii)	An explanation that links together the following three points:		3
		M1 the regular arrangement of atoms is distorted/disrupted OWTTE	**ALLOW** lattice/layers/rows of atoms are disrupted/distorted **ALLOW** lattice/layers/rows of atoms less regular	
		M2 because magnesium atoms are larger than aluminium atoms	**ALLOW** magnesium and aluminium atoms are of different sizes	
		M3 and therefore it is more difficult for the layers to slide over one another	**ALLOW** layers cannot (as easily) slide over one another **IGNORE** references to strength of metallic bonds	

Q22.

Question number	Answer	Notes	Marks
(a) (i)	ore(s)	IGNORE minerals	1
(ii)	gold/platinum	ALLOW silver/copper ALLOW symbols	1
(b) (i)	(calcium from calcium chloride) M1 electrolysis M2 (because) calcium is more reactive than carbon **OR** carbon cannot displace calcium	 ALLOW reverse argument M2 dep on M1	2
(ii)	(lead from lead oxide) M1 carbon extraction M2 (because) carbon is more reactive than lead **OR** carbon can displace lead	 ALLOW reverse argument M2 dep on M1	2

Question number	Answer	Notes	Marks
(c)	M1 2-D diagram showing at least two layers of particles M2 particles labelled atoms or (positive) ions (malleable because) M3 layers can slide over each other		3
(d)	M1 calculation of M_r of Al_2O_3 M2 moles of Al_2O_3 M3 calculation of mass of aluminium exemplar M1 102 M2 1275÷102 OR 12.5(moles) M3 (12.5×2×27) = 675g	 ALLOW M1×2 ALLOW ecf from M1 ALLOW ecf from M2 675g without working scores 3 0.675 without working scores 2 337.5 without working scores 2 1350 without working scores 2	3
		Total marks for Question = 12	

Q23.

Question number	$_3$Answer	Notes	Marks
(a)	A description that refers to the following three points **M1** filter **M2** wash the precipitate/solid/lead(II) bromide /residue (with distilled water) **M3** dry with filter paper/in a (warm) oven	 **ALLOW** leave to dry or any other suitable method **REJECT** direct heating e.g. with a Bunsen burner If description relates to preparation of a soluble salt allow 1 mark only for **M3** for a suitable method of drying the solid	3
(b)	**M1** solid lead(II) bromide does not conduct electricity **M2** because ions cannot move/are in fixed positions	**ALLOW** lead(II) bromide only conducts when molten **ALLOW** when lead(II) bromide is solid no electricity/current flow(s) through the circuit/lamp **REJECT** reference to (delocalised) electrons /atoms cannot move in solid	2

Question number	Answer	Notes	Marks
(c) (i)	brown vapour/gas/fumes (of bromine)	**ALLOW** orange/orange-brown	1
(ii)	An explanation that links the following four points	Penalise incorrect use of ide/ine once only	4
	M1 bromide ions are negatively charged / Br^-	**ALLOW** bromide ions are anions	
	M2 (so bromide ions/they) are attracted to the positive electrode	**ALLOW** anode	
	M3 (at the positive electrode) bromide ions/they lose/give up electron(s) (to form bromine atoms)	**ALLOW** bromide ions are oxidised **ALLOW** $Br^- \rightarrow Br + e^{(-)}$	
	M4 (bromine atoms) join in pairs to form bromine molecules/Br_2 OWTTE	**ALLOW** $Br + Br \rightarrow Br_2$ $2Br^- \rightarrow Br_2 + 2e^{(-)}$ scores **M1 M3** and **M4**	
(d)	$Pb^{2+}(l) + 2e^{(-)} \rightarrow Pb(s)$	**ALLOW** Pb(l)	2
	M1 formulae and balancing correct	**ALLOW** multiples and fractions	
	M2 both state symbols correct	**ALLOW M2** ECF if charge on lead ion and/or balancing are incorrect	
			Total 12

Q24.

Question number	Answer	Notes	Marks
(a) (i)	(squeaky) pop with lighted splint		1
(ii)	M1 (damp) litmus paper/ universal indicator M2 bleached	 **ACCEPT** turns white OR decolourised **ACCEPT** (damp) blue litmus turns red and is bleached scores M1 and M2	2
(b) (i)	chloride ions/Cl^- lose electrons /electrons are lost	**ALLOW** oxidation state of chlorine increases /changes from -1 to 0 **REJECT** chlorine loses electrons **REJECT** reference to gain of oxygen	1
(ii)	$2H^+ + 2e^{(-)} \rightarrow H_2$		1
(iii)	chlorine is toxic/poisonous		1
(iv)	(some) chlorine dissolves (in the solution)	**ALLOW** chlorine dissolves in water	1

Question number	Answer	Notes	Marks
(c) (i)	An explanation that links two of the following points **M1** in solid sodium chloride the ions are not free to move/are in fixed positions **M2** in molten sodium chloride the ions are mobile **M3** ions/charged particles need to move for current (to flow) / to conduct electricity	 No **marks** if reference to mobile electrons	2
(ii)	• calculate the amount, in moles, of NaCl • determine the amount, in moles, of Cl_2 • calculate the volume of Cl_2 • give the final answer in standard form		4

	Example calculation **M1** $\frac{23\,400\,000}{58.5}$ **OR** 400 000 **M2** $\frac{400\,000}{2}$ **OR** 200 000 **M3** 200 000 x 24 **OR** 4 800 000 (dm^3) **M4** 4.8 x 10^6 (dm^3)	**OR** $\frac{\text{answer to M1}}{2}$ **OR** answer to **M2** x 24 **OR** answer to **M3** in standard form correct answer in standard form without working scores 4 4 800 000 without working scores 3 9.6 x 10^6 and 1.92 x 10^7 score 3 9 600 000 and 19 200 000 score 2 **M4** can be awarded for an answer in standard form as long as some working is shown	**Total 13**

Q25.

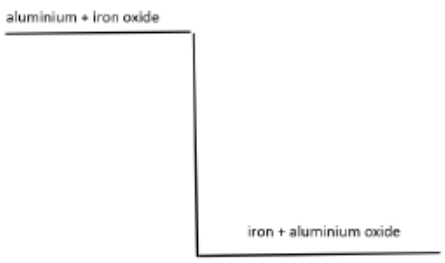
Question number	Answer	Notes	Marks
(a) (i)	$NH_4Cl + NaOH \rightarrow NaCl + NH_3 + H_2O$		1
(ii)	M1 moist/damp red litmus paper M2 turns blue	ALLOW moist/damp universal indicator paper	2

(b)	an explanation linking following two points: M1 forward and backward/reverse reactions are taking place at same rate M2 the concentrations of reactants and products remain constant	 ACCEPT reaction is taking place in both directions at same rate REJECT concentrations of the reactants and products are equal/the same	2
(c)	an explanation linking following two points: M1 as temperature decreases yield of ammonia (formed in forward reaction) increases M2 so forward reaction is exothermic	 ALLOW as temperature decreases equilibrium position shifts in forward direction/(from left) to right (producing more ammonia) IGNORE references to pressure ALLOW reverse arguments IGNORE references to Le Chatelier's Principle M2 DEP M1	2
		(Total for Question = 7)	

Q26.

Question number	Answer	Notes	Marks
(a) (i)	M1 layers / rows (of atoms / ions) M2 can slide over one another	 M2 is dependent on mention of layers / rows in M1	2
(ii)	M1 delocalised electrons M2 can move / can flow / are free to move (throughout the structure)	 **IGNORE** references to charge or current **IGNORE** free electrons M2 dependent on mention of electrons in M1	2

(b)		aluminium is more reactive than carbon	**ALLOW** references to position in reactivity series e.g. aluminium is higher in reactivity series than carbon. **ALLOW** carbon is less reactive than aluminium	1
(c)	(i)	M1 aluminium / Al^{3+} ions are attracted to the negative electrode / cathode (because they are positively charged) M2 where they gain electrons (forming aluminium)	**ALLOW** $Al^{3+} + 3e^- \rightarrow Al$ **IGNORE** references to reduction	2
	(ii)	$2O^{2-} \rightarrow O_2 + 4e^-$	**ALLOW** $2O^{2-} - 4e^- \rightarrow O_2$	1
	(iii)	M1 electrodes are made of carbon M2 which reacts with / burns in oxygen		2

(d)	(i)	iron oxide loses oxygen	**IGNORE** references to electrons	1
	(ii)	 M1 right hand line below left hand line M2 correct name / formula of **both** reactants M3 correct name / formula of **both** products	**IGNORE** horizontal axis drawn **IGNORE** activation energy if shown If only use words *reactants* (on left) and *products* (on right) award 1 mark from M2 and M3 M2 and M3 can be scored from an endothermic diagram	3
				14 marks

Q27.

Question number	Answer	Notes	Marks
(a) (i)	magnesium	ALLOW Mg	1 clər
(ii)	explanation including the following points M1 silver		2 grad
	M2 because it is the least reactive (of the metals)	ALLOW it is very unreactive	
(b)	explanation including the following points: M1 Method 1/ heating the metal oxide/lead(II) oxide with carbon		3 exp
	M2 (because) lead is less reactive than iron (and iron is obtained from iron oxide by carbon extraction)	ALLOW carbon is more reactive than lead ACCEPT reverse arguments	
	M3 $2PbO + C \rightarrow 2Pb + CO_2$	ALLOW $PbO + CO \rightarrow Pb + CO_2$ ALLOW $PbO + C \rightarrow Pb + CO$	

Question number	Answer	Notes	Marks
(c)	Explanation containing the following points Pure metal: M1 (particles/ions/atoms are same size in a regular arrangement so) layers can easily slide over each other Alloy: M2 diagram of alloy structure showing minimum of three layers with at least one different sized circle M3 (having different sized particles/ions/atoms) disrupts/breaks up regular arrangement OWTTE M4 so hard(er) for layers to slide over each other	REJECT molecules once only ALLOW disrupts the lattice / layers / rows (of particles/ions /atoms) ALLOW layers cannot slide over each other IGNORE references to strength/breaking of forces/(metallic) bonds	4 exp
			Total for Q3 = 10

Q28.

Question number	Answer	Notes	Marks
(a) (i)	$2\ Na(s) + 2\ H_2O(l) \rightarrow 2\ NaOH(aq) + H_2(g)$ M1 correct balancing numbers M2 (s) and (aq) for state symbols	**ALLOW** multiples or fractions.	2
(ii)	hydroxide or OH^-	**REJECT** OH	1
(iii)	Any **three** from: M1 the sodium moves (on the surface) M2 effervescence or bubbles (of gas) M3 (indicator or phenolphthalein or water) turns pink M4 the sodium gets smaller M5 the sodium melts or turns into a ball	**ALLOW** sodium floats **IGNORE** gas or hydrogen produced **IGNORE** initial colour of indicator **ALLOW** the sodium disappears / (appears to) dissolve	3

(b)	M1 electron configuration of sodium is 2,8,1 and electron configuration of potassium is 2,8,8,1 M2 outer electron less attracted (to the nucleus of potassium) M3 therefore (outer shell electron) is more easily lost	**ALLOW** the outer shell is further from the nucleus **ALLOW** potassium has more shells **ALLOW** larger atom / larger atomic radius **ALLOW** reverse argument for sodium	3
			9 marks

Q29.

Question number	Answer	Notes	Marks
(a) (i)	Any two from: M1 sodium moves (on the surface) M2 sodium turns into a sphere/ball M3 effervescence M4 sodium gets smaller M5 white trail seen	 ALLOW sodium melts ALLOW fizzing / bubbles ALLOW sodium disappears / dissolves IGNORE references to a flame	2
(ii)	blue / purple	IGNORE qualifiers ALLOW violet/lilac	1
(b) (i)	same number of electrons/one electron in the outer shell.	ALLOW same number of valence electrons/one valence electron	1
(ii)	M1 lithium (atom) has a smaller atomic radius M2 the outer shell electron is more strongly attracted to the nucleus OWTTE M3 so is less easily lost	ALLOW lithium is smaller (atom)/lithium (atom) has fewer shells /energy levels ALLOW outer electron in lithium (atom) is closer to the nucleus ALLOW reverse argument for sodium	3

(c)	M1 amount lithium = 0.150 ÷ 7 **OR** 0.0214 mol M2 amount hydrogen = 0.0107 mol M3 254 ÷ 0.0107 M4 23,738	penalise 1 sig fig in M1 ALLOW M1÷2 ALLOW 2 or more sig figs in answers to M1 and M2 ALLOW 2 or more sig figs if all working shown correct answers in the range 23,707 to 24,910 cm^3 to 3 or more significant figures, without working scores 4 marks.	4
			Total for question = 11

Q30.

Question number	Answer	Mark
(a)	Zinc has displaced cadmium	1

Question number	Answer	Mark
(b)(i)	$Zn^{2+} + 2e^{(-)} \rightarrow Zn$ (1)	1

Question number	Answer	Mark
(b)(ii)	$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$	1

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that links the following two points: • pH decreases • hydrogen ion/H^+ (ion) concentration increases	accept hydrogen ions are formed	2

Question number	Answer	Additional guidance	Mark
(c)	An explanation that links three of the following points: • the ions of (pure) copper are the same size (1) • the layers (of ions) can easily slide over one another (1) • the ions of zinc and copper have different sizes (1) • this disrupts the layers/structure/arrangement of the copper ions (1) • hence it is more difficult for the layers (of ions) to slide over one another (1)	accept atoms/particles for ions reject molecules once only	3

(Total for question = 8 marks)