PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



MARK SCHEME

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 3)

SCORE	PERCENTAGE
/308	%

STEMUP

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(Total for question = 9 marks)

Mark Scheme

Q1.

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)	

Q2.

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

Q3.

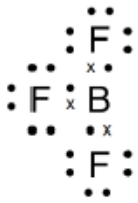
Question number	Answer	Mark
(a)	Fluorine	**1**

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)

Q4.

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

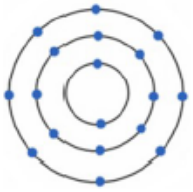
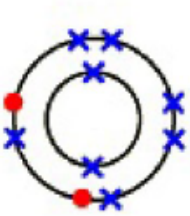
Question number	Answer	Notes	Marks
(c) (i)	Any **one** from:		1
	burette	**ALLOW** measuring cylinder	
	(volumetric) pipette	**REJECT** beaker	
(ii)	Example calculation		3
	M1 moles of coper chloride = (25 x 0.50) ÷ 1000 **OR** 0.0125 moles		
	M2 moles of silver chloride = 0.0250	**ALLOW** answer to 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

Q5.

Question number	Answer	Notes	Marks
(a) (i)	all points plotted correctly to the nearest grid line		1
(ii)	point at 50 °C and 17.5 g circled on grid/in table	**ALLOW** ECF from incorrect plotting	1
(iii)	smooth curve of best fit		1
(b)	Any two from **M1** less than 25 cm^3 of water was used **M2** the temperature was less than 50 °C **M3** not enough potassium nitrate was added **M4** the solution was not stirred	**ALLOW** ECF from incorrect plotting and incorrect point circled for **M1** and **M2** only	2

Question number	Answer	Notes	Marks
(c)	**M1** curve extended to 75 °C **M2** correct mass read from graph to the nearest grid line	expected answer around 39 to 40 g 0 marks if curve not extended	2
(d)	**M1** mass at 25 °C read from graph to nearest grid line **M2** mass from graph multiplied by 4	expected answer around 44 g **ALLOW** ECF from incorrect plotting	2 **Total 9**

Q6.

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

Q7.

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

Q8.

Question number	Answer	Notes	Marks
(a) (i)	(produces) acid rain	**ALLOW** any detrimental effect of acid rain e.g. kills fish, damages limestone buildings	1
(ii)	• M1 find moles of sulfur • M2 multiply moles by 24 • M3 answer in standard form Example calculation **M1** $6.4 \times 10^6 \div 32$ **OR** $2.0 \times 10^5 / 200\,000$ **M2** $2.0 \times 10^5 \times 24$ / 200 000 x 24 / 4 800 000 **M3** 4.8×10^6	**ALLOW** ECF as long as an attempt has been made to calculate moles Correct answer without working scores 3 4 800 000 (dm^3) without working scores 2	3
(b) (i)	An explanation that links the following two points **M1** provides an alternative (reaction) pathway/route **M2** with a lower activation energy OWTTE	**ACCEPT so** more particles/collisions have energy greater than the activation energy **ALLOW** lowers the energy needed to start the reaction	2
(ii)	fewer moles (of gas) on RHS (than on (LHS)	**ALLOW** 3 moles (of gas) on LHS and 2 moles (of) gas on RHS **ALLOW** fewer moles of product/SO_3 (gas) (than of reactants/SO_2 and O_2 (gas)) **ALLOW** molecules in place of moles **IGNORE** references to rate	1
(iii)	as yield is approximately 98% /very high (it is not necessary to increase the pressure) OWTTE	**ALLOW** reference to reaction rate (already high enough) as catalyst used OWTTE	1

Question number	Answer	Notes	Marks
(c)	M1 $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ M2 $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	**ALLOW** multiples	2
(d)	M1 (2 x 14 ÷ 132) x 100 M2 21.21 (%)	**ALLOW** any number of sig figs except 1 **ALLOW** ECF from M1 as long as 132 used correctly Correct answer without working scores 2	2
			Total 12

Q9.

Question number	Answer	Mark
(a)	• (mass of solid) 5.3 (g) (1) • (mass of water) 20.9 (g) (1)	**2**

Question number	Answer	Mark
(b)	• (10.5 ÷ 16.8) × 100 (1) • 62.5 (grams of solid per 100 g of water) (1)	**2**

Question number	Answer	Mark
(c)	An explanation that links together the following three points: • the gas will escape (1) • the mass of solid remaining will be less (than it should be) (1) • the value of the calculated solubility will be lower (than it should be) (1)	3

(Total for question = 7 marks)

Q10.

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:		
	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	3
	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	

Q11.

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	

Q12.

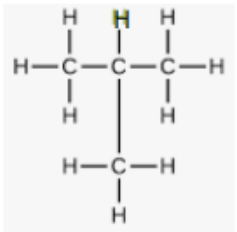
Question number	Answer	Notes	Marks
(a)	**B** filtration is the correct answer because it will enable sand to be separated from salt solution **A** is not correct because crystallisation will not enable sand to be separated from salt solution **C** is not correct because fractional distillation will not enable sand to be separated from salt solution **D** is not correct because simple distillation will not enable sand to be separated from salt solution		1 comp
(b) (i)	X is a thermometer Y is a (Liebig) condenser Z is a beaker		3 clor
(ii)	salt		1 clor
		Total for Q = 5	

Q13.

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

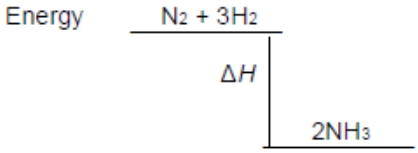
Question number	Answer	Notes	Marks
(c) (i)	brown vapour/gas/fumes (of bromine)	**ALLOW** orange/orange-brown	1
(ii)	An explanation that links the following four points	Penalise incorrect use of ide/ine once only	4
	M1 bromide ions are negatively charged / Br^-	**ALLOW** bromide ions are anions	
	M2 (so 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

Q14.

Question number	Answer	Notes	Marks
(a)	M1 use of amount in moles = $\frac{\text{volume of gas}}{\text{molar volume}}$ M2 correct evaluation Example calculation M1 amount in moles = $\frac{600}{24000}$ M2 = 0.025 (mol)	0.025 with no working scores 2 REJECT 0.03 for M2	2
(b)	M1 statement/use of amount in moles = $\frac{\text{mass}}{Mr}$ M2 substitution and correct evaluation: $Mr = \frac{1.45}{0.025} = 58$		2
(c)	molecular formula = C_4H_{10} = (4 x 12) + (10 x 1) = 58 OR alkane general formula = C_nH_{2n+2} so M1 (nx12) + (2n+2)x1 = 58 so 14n = 56 M2 n =4 so C_4H_{10}		1
(d)			1
		(Total for Question = 6)	

Q15.

Question number	Answer	Notes	Marks
(a) (i)	reversible (reaction) / reaction that goes both ways OWTTE	IGNORE references to equilibrium	1
(ii)	increases the rate of reaction /speeds up the reaction	REJECT to increase yield ALLOW to reach equilibrium faster IGNORE provides an alternative pathway with lower activation energy	1
(b) (i)	**M1** yield decreases **M2** (forward) reaction is exothermic/ backward reaction is endothermic	IGNORE references to rate and Le Chatelier throughout ACCEPT (when temperature increased equilibrium shifts in) endothermic direction which is (from right) to left **M2** DEP **M1** correct or missing	2 2
(ii)	**M1** yield increases **M2** there are fewer moles (of gas) on the right-hand side/product side / there are more moles (of gas) on the left-hand side/there are 4 moles of reactants and 2 moles of product/ OWTTE	ALLOW molecules for moles **M2** DEP **M1** correct or missing	

(c)	 **M1** horizontal line labelled with $N_2 + 3H_2$ **M2** horizontal line showing $2NH_3$ in correct position **M3** vertical line in correct position and labelled ΔH /-92 (kJ/mol)	IGNORE any horizontal axis/labels IGNORE any attempts at including activation energy ALLOW nitrogen and hydrogen ALLOW ammonia If not balanced or words reactants and products on horizontal lines in correct position scores 1 out of 2 ACCEPT double headed arrow or arrow pointing from reactants level to products level REJECT arrow pointing from products level to reactants level If endothermic reaction can score M1 and M3	3

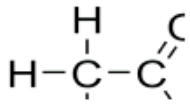
(d)	(i)	**M1** amount of nitrogen = (48 ÷ 24 =) 2 (mol) **M2** amount of hydrogen = (120 ÷ 24 =) 5 (mol) **M3** 2.5 mol of hydrogen to 1 mol of nitrogen (which is less than 3 so nitrogen is in excess) **OR** 2 mol of nitrogen needs 6 mol of hydrogen (so not enough hydrogen to react with the nitrogen)	ACCEPT alternative methods	3
	(ii)	**M1** 5 mol of hydrogen gives 3.33 mol of ammonia **M2** volume of ammonia (if 100% conversion) = 3.33 x 24 **OR** 80 (dm^3) **M3** (volume of ammonia if 20% conversion) = $\frac{(20 \times 80)}{100}$ = 16.0 (dm^3)	correct answer without working scores 3 ALLOW ECF from (i) ALLOW 3.3 use of 3.3 gives 79.2 use of 79.2 gives 15.84 ALLOW ECF from **M2** ACCEPT 120 dm^3 of hydrogen gives 2 x 120 ÷ 3 **OR** 80 (dm^3 of ammonia) for M1 and M2 ALLOW max 2 for use of 48 dm^3 of nitrogen giving 96 dm^3 of ammonia and final answer of 19.2 (dm^3)	3
				Total 15

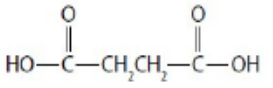
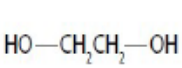
Q16.

Question number	Answer	Notes	Marks
(a)	M1 crude oil is heated / vapourised M2 vapours / gases / compounds / hydrocarbons rise up the column M3 the column is hotter at the bottom than the top M4 vapours / compounds / hydrocarbons condense at their boiling point	**ALLOW** boiled **ALLOW** temperature gradient of the column **ALLOW** vapours / compounds / hydrocarbons / condense at different heights **ALLOW** the vapours / compounds / hydrocarbons / fractions have different boiling points.	4
(b)	M1 temperature of 600°C - 700°C M2 catalyst of silica / alumina	**ALLOW** aluminosilicates / zeolites / silicon dioxide / aluminium oxide **IGNORE** references to pressure	2

Question number	Answer	Notes	Marks
(c) (i)	M1 nitrogen (from the air) reacts / combines with oxygen (from the air) M2 at high temperatures (in the car engine)	**REJECT** any implication that oxygen or nitrogen come from the fuel.	2
(ii)	Any one from: acid rain respiratory problems		1
(iii)	Example calculation M1 volume of carbon dioxide = 206 000 cm^3 / 2.06×10^5 cm^3 / 206 dm^3 M2 volume of carbon dioxide per km = 51 500 cm^3/ 5.15×10^4 cm^3 / 51.5 dm^3 M3 (51 500 ÷ 24 000) = 2.15 moles M4 M_r of carbon dioxide is 44 M5 mass of carbon dioxide per Km = 94.4 g	Division by 4 can happen in M1, M2, M3 or M5 **ALLOW** M1 ÷ 4 **ALLOW** M2 or M1 ÷ 24 000 **ALLOW** 94 – 95 g **ALLOW** ecf from incorrect M_r Correct answer of 94 – 95 g scores 5 marks.	5
			14 marks

Q17.

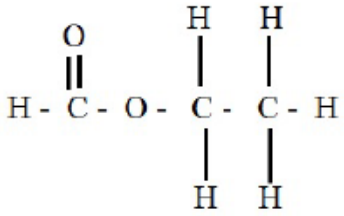
Question number	Answer	Notes	Marks
(a) (i)	**M1** $\frac{40.0}{12}$ $\frac{6.7}{1}$ $\frac{53.3}{16}$	0 marks for division by atomic numbers or upside-down calculation	2
	M2 3.33 6.7 3.33 **AND** 1 2 1	**ALLOW** any number of sig figs except 1 **ACCEPT** alternative methods	
(ii)	CH_3COOH **OR** 	**ACCEPT** $HCOOCH_3$ **OR** 	1
(b) (i)	$2HCOOH + Na_2CO_3 \rightarrow 2HCOONa + CO_2 + H_2O$		2
	M1 $CO_2 + H_2O$	**IGNORE** numbers in front of CO_2 and/or H_2O if only M1 scored	
	M2 HCOONa **and** equation correctly balanced	**REJECT** NaCOOH **ALLOW** NaHCOO	
(ii)	bubbles/ fizzing/ effervescence	**IGNORE** gas given off **ALLOW** sodium carbonate disappears/dissolves	1

(c)	(i)	propyl methanoate	spelling must be correct **ALLOW** propyl formate	1
	(ii)	reversible reaction	**ALLOW** reaction which goes both ways **IGNORE** equilibrium	1
	(iii)	forward and backward reactions occur at the same rate OWTTE **OR** concentrations of reactants and products remain constant/stay the same/do not change	 **ALLOW** amounts/moles/ratios of reactants and products remain constant **REJECT** concentrations of reactants and products are equal/the same	1
(d)	(i)	condensation (polymerisation)		1
	(ii)	**M1**  **M2** 	**ALLOW** $HOOCCH_2CH_2COOH$ for **M1** **ALLOW** $HOCH_2CH_2OH$ for **M2** **REJECT** OH—C once only	2
				Total 12

Q18.

Question number		Answer	Notes	Marks
(a)	(i)	sulfuric acid	**IGNORE** references to concentration **ALLOW** H_2SO_4 **REJECT** sulfurous acid	1 Grad
	(ii)	**D** orange to green A is incorrect as the solution is not colourless at the start of the reaction B is incorrect as the solution is not green at the start or orange at the end of the reaction C is incorrect as the solution is not colourless at the end of the reaction		1 Comp

(b)	(i)	• show the expression for the sum of the bond energies for the breaking of bonds • evaluation to give answer in kJ Example calculation **M1** ∑ C-C + 5C-H + C-O + O-H + 3O=O **OR** ∑ 346 + (5 x 412) + 358 + 463 + (3 x 496) **M2** 4715 (kJ)	correct answer without working scores 2 - 1 mark for each error	2 Exp
	(ii)	• show the expression for the sum of the bond energies for the forming of bonds • evaluation to give answer in kJ Example calculation **M1** ∑ 4C=O + 6O-H **OR** ∑ (4 x 743) + (6 x 463) **M2** 5750 (kJ)	correct answer without working scores 2 - 1 mark for each error **IGNORE** any signs in (i) and (ii)	2 Exp
	(iii)	(4715 – 5750 =) – 1035 (kJ/mol)	minus sign must be included **ACCEPT** – 1040 (kJ/mol) **ALLOW** ecf on answers to (i) and (ii) If answers to (i) and (ii) are reversed allow max 3 and ecf on (iii)	1 Exp

Question number	Answer	Notes	Marks
(c) (i)	ethyl methanoate	**ALLOW** ethyl formate **ALLOW** words written without gap	1 Grad
(ii)	**M1** ester linkage  **M2** rest of molecule correct  Structural formula of ethyl formate or ethyl methanoate	 **M2** dep on **M1**	2 Exp
(iii)	**M1** forward and reverse reactions occur at the same rate OWTTE **M2** concentrations of reactants and products remain constant		2 Exp

(d)	• calculate amount in moles of HCOOH • use equation to find amount in moles of CO_2 • multiply amount in moles of CO_2 by molar volume • evaluation of answer in cm^3 Example calculation **M1** n(HCOOH) = 2.3 ÷ 46 **or** 0.05(0) **M2** $n(CO_2)$ = 0.05(0) ÷ 2 **or** 0.025 **M3** (volume of CO_2) = 0.025 x 24 **or** 0.025 x 24000 **M4** 600 (cm^3)	correct answer without working scores 4 No ecf from **M1** and **M2** if mass or M_r multiplied by 24 /24000 **ALLOW** ecf from **M3** 0.6, 1200 and 2400 score 3 1.2 and 2.4 score 2	4 Exp **Total 16**

Q19.

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**

Q20.

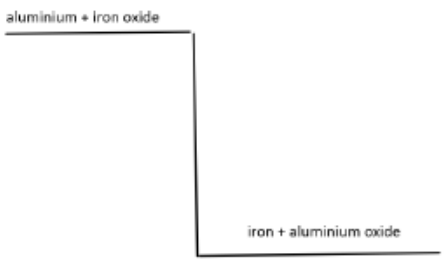
Question number	Answer	Notes	Marks
(a) (i)	$NH_4Cl + NaOH \rightarrow NaCl + NH_3 + H_2O$		1
(ii)	M1 moist/damp red litmus paper M2 turns blue	ALLOW moist/damp universal indicator paper	2

(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)	

Q21.

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

Q22.

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

Q23.

Question number	Answer	Mark
(a)	A	1

Question number	Answer	Mark
(b)	C	1

Question number	Answer	Mark
(c)	B	1

Question number	Answer	Mark
(d)	A	1

(Total for question = 4 marks)

Q24.

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

Q25.

Question number	Answer	Notes	Marks
(a)	calculation with following steps M1 calculation of $n(K_2CO_3)$ M2 deduction of $n(CO_2)$ and $vol(CO_2)$ by multiplying by 24 (dm^3) M3 correct evaluation of volume in cm^3 Example calculation M1 $n(K_2CO_3) = 6.9 \div 138$ OR 0.05 M2 $vol(CO_2) = 0.05 \times 24$ (dm^3) M3 1200 (cm^3)	 Mark ECF from M1 correct answer with no working scores 3 1.2 scores 2 marks	3 Exp
(b) (i)	M1 higher yield of CO M2 because (equilibrium shifts to the right as the forward) reaction is endothermic	ACCEPT more CO is produced IGNORE references to Le Chatelier's Principle eg increasing temperature favours the forward reaction M2 DEP M1 correct or missing	2 Exp
(ii)	M1 no effect (on yield) OWTTE M2 because equal numbers of moles/molecules (of gas) on both sides	 M2 DEP M1 correct or missing	2 Exp
			Total for Q = 7

Q26.

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

Q27.

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)

Q28.

Question number	Answer	Notes	Marks
(a)	Explanation containing following ideas (A saturated solution is one which contains) M1 as much solute as possible in (a certain volume of) the solvent OWTTE M2 at a particular / given / constant temperature OWTTE		2
(b) (i)	(volumetric) pipette/burette		1
(ii)	(water / solution) would be heated too quickly OR (water / solution) might spit out or be lost OWTTE	ALLOW (water / solution) might boil or evaporate	1
(iii)	repeat (and find the mean temperature)		1
(iv)	M1 4.5 (g solid in 10 g water) M2 (so solubility = 4.5 x 10) = 45 (g per 100 g of water)	ALLOW M1×10 45 with no working scores 2	2

Question number	Answer	Notes	Marks
(c) (i)	71 (°C)	ALLOW 70-72(°C)	1
(ii)	M1 (from curve) 124 g of solid B dissolves in 100 g water M2 (so 124 x 2.5) = 310 (g dissolves in 250 g water)	ALLOW 123-125 g ALLOW ecf from M1 307.5-312.5 with no working scores 2 marks ALLOW M1×2.5 If solid A used 1 mark for correct answer of 262-268g	2
(iii)	some water may have been lost/evaporated OWTTE		1
		Total marks for Question = 11	

Q29.

Question number	Answer	Notes	Marks
(a)	fractional distillation	**ACCEPT** fractionation/fractionating **IGNORE** distillation alone	1 1
(b)	aircraft fuel/jet fuel/paraffin or fuel for lamps/ heaters	**ALLOW** heating oil **ALLOW** cooking fuel	
(c) (i)	butane	Spelling must be correct	1
(ii)	(M_r = 4 x 12 + 10 x 1 =) 58		1
(d) (i)	C_7H_{16}		1
(ii)	C_nH_{2n+2}	**ACCEPT** different letters to n / uppercase	1

Question number	Answer	Notes	Marks
(e) (i)	alumina / silica	**ACCEPT** aluminium oxide / silicon dioxide / Al_2O_3 / SiO_2 / zeolite(s) / aluminosilicate(s)	1
(ii)	An explanation that links the following two points		2
	M1 greater demand for short chain alkanes (than long chain alkanes)	**ALLOW** short chain alkanes are more useful (than long chain alkanes) **ALLOW** short chain alkanes needed for specific uses e.g. petrol	
	M2 more long-chain alkanes than are needed / too great a supply of /surplus of long-chain alkanes **OR** not enough short chain alkanes to meet demands		
(f)	$(C_{11}H_{24} \rightarrow C_5H_{12}) + C_2H_4 + C_4H_8$	alkenes can be in either order	2
	M1 C_2H_4		
	M2 C_4H_8	**ALLOW** 1 mark for C_8H_{12} / $2C_3H_6$ / $C_3H_6 + C_3H_6$ **ALLOW** correct displayed formulae	
			Total 11

Q30.

Question number	Answer	Notes	Marks
(a) (i)	M1 working shown on graph		2
	M2 56 (°C)	ALLOW any value between 56 and 57 inclusive.	
(ii)	M1 31-13		2
	M2 18 (g)	ALLOW ecf if one incorrect reading in M1 correct answer of 18g with or without working scores 2	
(b) (i)	5.1 (g)		1
(ii)	15 (g)		1
(iii)	M1 5.1÷15 **OR** 0.34 (g) **OR** answer to (i) ÷ answer to (ii)		2
	M2 34 (g) **OR** answer to M1 × 100	correct answer of 34 (g) with or without working scores 2	
(iv)	Any one from		1
	M1 (hydrated) copper(II) sulfate would become anhydrous copper sulfate	ALLOW the (hydrated) crystals would decompose	
	M2 (hydrated) copper(II) sulfate would lose water		
			Total for question = 9