PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



MARK SCHEME

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 2)

SCORE	PERCENTAGE
/195	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a) (i)	B		1
(ii)	A and B		1
(iii)	M1 2 and 8 M2 0.25	0.25 without working scores 2 **ALLOW** M1 for 1.8-2.2 and 8 and **ALLOW** M2 ECF as long as correctly evaluated to at least 2 SF (Special case if used ruler and then) 1.4-1.7 and 5.9-6.2 used no M1 but ALLOW M2 ECF as long as correctly evaluated to at least 2 SF	2
(iv)	the dye is the most soluble (in the solvent/water)		1
(b)	Any four from M1 draw start line in pencil M2 use same food colourings/use same solvent/use same (type of chromatography) paper M3 place (spots/samples of) A, B, C, D/food colourings on the start line OWTTE M4 (place paper in beaker) with start line above solvent OWTTE M5 (remove paper/stop experiment) when solvent almost reaches top of paper / when spots stop moving OWTTE M6 mark solvent front (on paper) M7 (remove paper from beaker and) allow to dry	**ALLOW** water for solvent throughout **ALLOW** dye for food colouring throughout **IGNORE** length of paper	4
		Total for question	= 9 marks

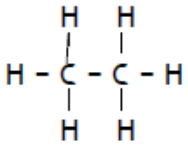
Q2.

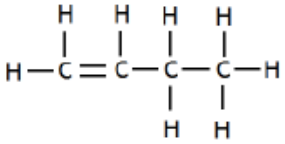
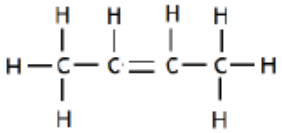
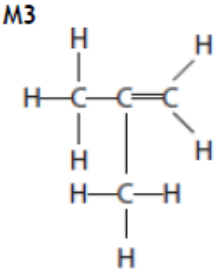
Question number	Answer	Notes	Marks
(a)	**C** red is correct because litmus indicator in an acidic solution is red **A** is incorrect because litmus indicator in an acidic solution is not blue **B** is incorrect because litmus indicator in an acidic solution is not orange **D** is incorrect because litmus indicator in an acidic solution is not yellow		1
(b)	**C** 7 is correct because the pH value of a neutral solution is 7 **A** is incorrect because the pH value of a neutral solution is not 0 **B** is incorrect because the pH value of a neutral solution is not 4 **D** is incorrect because the pH value of a neutral solution is not 14		1

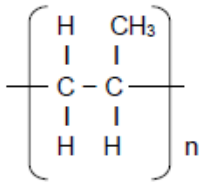
Question number	Answer	Notes	Marks
(c)	**D** is correct because a solution with a pH value of 9 is weakly alkaline **A** is incorrect because a solution with a pH value of 9 is not strongly acidic **B** is incorrect because a solution with a pH value of 9 is not strongly alkaline C is incorrect because a solution with a pH value of 9 is not weakly acidic		1
(d)	**A** is correct because HNO_3 is the chemical formula of an acid **B** is incorrect because H_2O is not the chemical formula of an acid **C** is incorrect because NaCl is not the chemical formula of an acid **D** is incorrect because NaOH is not the chemical formula of an acid		1

Question number	Answer	Notes	Marks
(e)	neutralisation	**ALLOW** exothermic	1
(f)	M1 potassium chloride M2 water	**ACCEPT** in either order **ALLOW** correct chemical formulae	2

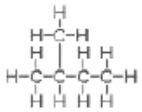
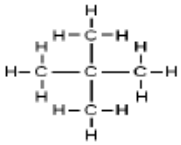
Q3.

Question number	Answer	Notes	Marks
(a) (i)	<table><tr><td>molecular formula</td><td>C_2H_6</td></tr><tr><td>name</td><td>**ethane**</td></tr><tr><td>empirical formula</td><td>CH_3</td></tr><tr><td>displayed formula</td><td></td></tr></table>	Penalise incorrect use of case, superscripts	3
(ii)	**2**C_2H_6 + **7**O_2 → **4**CO_2 + **6**H_2O	**ACCEPT** multiples and fractions	1
(iii)	Any two from **M1** carbon monoxide/CO **M2** carbon/C **M3** water (vapour)/steam/H_2O	 **ALLOW** soot **IGNORE** carbon dioxide	2

(b)	(i)	A addition B is incorrect as it is not a decomposition reaction C is incorrect as no solid precipitate is produced D is incorrect as it is not a substitution reaction		1
	(ii)	Any two from M1  M2  M3 	Do not accept displayed formulae of cyclic alkanes **ALLOW** cis-trans (E/Z) isomers of but-2-ene for both marks	2
	(iii)	isomers	**ALLOW** isomerism	1

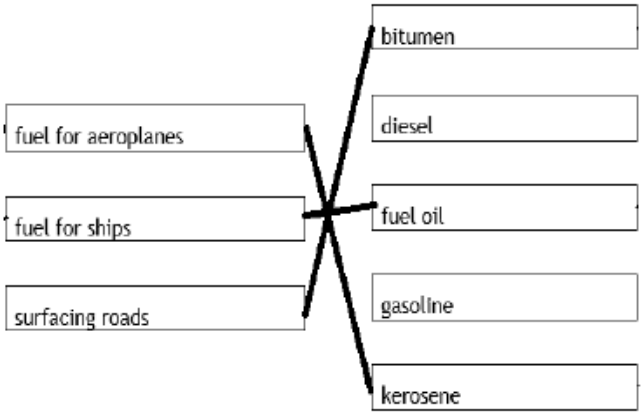
Question number	Answer	Notes	Marks
(c) (i)	 **M1** correct repeat unit **M2** extension bonds, brackets and n after brackets	If double bond between carbon atoms scores 0	2
(ii)	A discussion which refers to the following points **M1** polymers/poly(propene) will remain in landfill indefinitely OWTTE **M2** (as they) are inert /unreactive/do not biodegrade **M3** burning produces toxic gases	**ALLOW** burning produces greenhouse gases	3
			Total 15

Q4.

Question number	Answer	Notes	Marks
(a) (i)	**M1** (compounds with) same molecular formula	**ALLOW** same number of carbons and hydrogens / atoms of each element	2
	M2 different structural / displayed formulae	**ALLOW** different structures / arrangement of atoms	1
(ii)	(5 x 12 + 12 x1 =) 72		1
(iii)	pentane	spelling must be correct	1
(iv)	**M1** 	either order	2
	M2 		

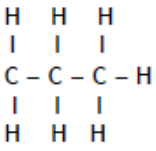
(b)	A description that refers to any five of the following points:	**IGNORE** any colour changes given	5
	M1 ethane needs UV (radiation) to react	**IGNORE** UV for ethene	
	M2 ethane produces bromoethane	**IGNORE** any references to temperature and pressure	
	M3 ethane produces hydrogen bromide / HBr	**ALLOW** formulae	
	M4 reaction with ethane involves breaking C-H bond / reaction with ethene involves breaking C=C bond		
	M5 ethane reaction is substitution		
	M6 ethene produces dibromoethane		
	M7 ethene reaction is addition		
		ALLOW formula	
		M1, M2, M3 and **M6** can be scored from word or chemical equations	
			Total 11

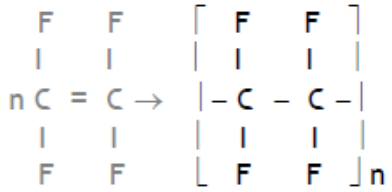
Q5.

Question number	Answer	Notes	Marks
(a)	alkanes		1
(b) (i)	**A** boiling point is the correct answer because fractional distillation depends on differences in boiling point **B** is not correct because fractional distillation does not depend on differences in density **C** is not correct because fractional distillation does not depend on differences in melting point **D** is not correct because fractional distillation does not depend on differences in solubility		1
(b) (ii)	 1 mark for each correct line from boxes on left	If more than one line from a box on left do not award mark for that box	3
(c)	explanation including the following points: M1 (common impurity in fuels is) sulfur M2 sulfur burns/combusts/reacts (in air/oxygen) to form sulfur dioxide/SO_2 M3 sulfur dioxide/SO_2 dissolves in/reacts with rain/water to form acid rain	If M2 M3 not scored ALLOW 1 mark for reference to sulphur dioxide/SO_2 and acid rain	3

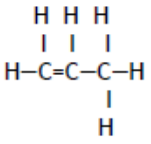
Question number	Answer	Notes	Marks
(d) (i)	cracking		1
(ii)	M1 (catalyst) silica/alumina	ALLOW silicon dioxide/aluminium oxide ALLOW formulae	2
	M2 (temperature) 600-700 (°C)	ALLOW zeolite	
(iii)	$C_{13}H_{28} \rightarrow C_8H_{18}$ +		
	M1 C_3H_6 +	in either order ALLOW structural formulae	2
	M2 C_2H_4		
		ALLOW 1 mark for single product C_5H_{10}	
		(Total for Question = 13)	

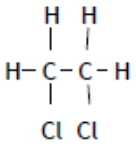
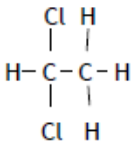
Q6.

Question number	Answer	Notes	Marks
(a) (i)	propane	spelling must be correct	1
(ii)			1
(iii)	C_nH_{2n+2}	**ALLOW** upper case N or different letter e.g. x	1
(b) (i)	shared pair of electrons (between two atoms)	**REJECT** if between molecules	1
(ii)	An explanation that links the following three points		3
	M1 C_4H_{10} has larger molecules/longer chain ORA	**ALLOW** C_4H_{10} has more carbon (and hydrogen) atoms	
	M2 C_4H_{10} has stronger intermolecular forces ORA	**ACCEPT** forces between molecules **ALLOW** intermolecular bonds	
	M3 more energy needed to separate the molecules /overcome the forces in C_4H_{10} ORA	No **M2** or **M3** if implied that covalent bonds break	

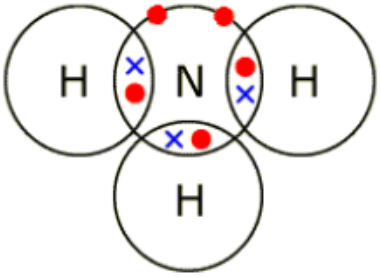
(c) (i)	 M1 correct repeat unit M2 extension bonds brackets and n	**REJECT** double bond between carbons for both marks n must be on RHS of bracket and extension bonds do not have to go through brackets	2
(ii)	Any one from M1 food will not bind to/ bond with the coating M2 hard/tough /long lasting coating M3 resistant to heat/ will not melt M4 inert/ unreactive	**ALLOW** coating will not react with the food/ non-toxic/ not poisonous **ALLOW** high melting point	1
			Total 10

Q7.

Question number	Answer	Notes	Marks
(a)	molecular formula: C_3H_6 name of this alkene: propene empirical formula: CH_2 general formula: C_nH_{2n} displayed formula:  1 mark for each correct answer	**ACCEPT** propylene **ACCEPT** N or other letters e.g. x	4
b) i)	(contains a carbon carbon) double bond	**ACCEPT multiple bond**	1
ii)	M1 add bromine water M2 decolourises/changes to colourless	**REJECT bromine** **REJECT bromide** **ALLOW** turns colourless **IGNORE** clear M2 dep M1 or near miss	2

(c)	(i)	$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$	**ACCEPT** multiples	1
	(ii)	**D** Substitution A is incorrect as it is not an addition reaction B is incorrect as it is not a decomposition reaction C is incorrect as it is not a neutralisation reaction		1
	(iii)	Ultraviolet radiation/light	**ACCEPT** UV/ultraviolet rays	1
(d)	(i)	**M1** (isomers have) the same molecular formula **M2** (but) different structural/displayed formulae	 **ALLOW** different structures **ALLOW** different arrangement of atoms	2
	(ii)	**M1**  **M2** 		2
				Total 14

Q8.

Question number	Answer	Notes	Marks
(a)	 M1 3 bonding pairs M2 rest of molecule fully correct	M2 dep on M1 **ALLOW** any combination of dots and crosses	2
(b) (i)	<table><tr><td>M1 ammonium chloride</td><td>ammonium carbonate</td></tr><tr><td>NH_4Cl</td><td>M2 $(NH_4)_2CO_3$</td></tr></table>		2
(ii)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	**ALLOW** multiples **IGNORE** state symbols even if incorrect	1
(iii)	M1 add sodium hydroxide (solution) M2 test (gas / ammonia) with (damp) red litmus paper / (damp) universal indicator paper M3 (red litmus) turns blue / universal indicator) turns blue / purple	**REJECT** if solution / ammonium (sulfate) tested with litmus / universal indicator paper	3

(c)	(i)	**M1** 2 x 14 ÷ 80 **OR** 0.35	correct answer without working scores 2	2
		M2 (0.35 x 100 =) 35 (%)	**ALLOW** 1 mark for 17 / 17.5 / 18 (%)	
	(ii)	An answer that links any 4 points:		4
		M1 (NH_3) higher % of N **OR** (($NH_4)_2SO_4$) lower % of N		
		M2 ($NH_4)_2SO_4$ easy to use (to soil) / easy for the plants to absorb / less wastage **OR** (NH_3) difficult to use (to soil) / difficult for the plants to absorb / more wastage / has to be dissolved (in water) first		
		M3 ($NH_4)_2SO_4$ pH close to that of (rain) water / will not alter the pH (of the soil/water)	**REJECT** NH_3 has a pH close to rainwater	
		M4 NH_3 will cause (the soil/water) to become alkaline / will raise the pH (of the soil/water) / neutralise (the water / soil) / may stunt growth of plants / may damage / kill plants	**REJECT** ammonia causes the soil / water to become acidic	
		M5 NH_3 and or ($NH_4)_2SO_4$ soluble so runoff / wastage of fertiliser / water pollution / eutrophication / leaching		
				Total 14

Q9.

Question number	Answer	Notes	Marks
(a)	nucleus	**ACCEPT** nuclei	1
(b)	11 / eleven		1
(c)	1 / one / group 1		1
(d)	3 / three / period 3		1
(e)	+1 / 1+	**ACCEPT** + / Na^+ / positive 1 **IGNORE** positive alone	1
			Total 5

Q10.

Question number	Answer	Notes	Marks
(a)	Atomic number of this atom **4** Mass number of this atom **9** Period number of this element **2** Number of electrons in the 2+ ion formed from this atom **2**	1 mark each correct answer	4
(b)	Similarity = number of protons Difference = number of neutrons	**ALLOW** both isotopes have 4 protons **ALLOW** references to electrons **ALLOW** stated examples eg one isotope has 5 neutrons, the other has 6 neutrons If similarity: same atomic number and difference: different mass number **ALLOW** 1 mark	2
		Total for question = 6 marks	

Q11.

Question number	Answer	Mark
(a)	An explanation that makes reference to the following points: • (all) contain carbon and hydrogen (1) • only/but no other elements (1)	**2**

Question number	Answer	Mark
(b)	(The only one that shows) all atoms and all bonds	**1**

Question number	Answer	Mark
(c)	A, C, D and F	**1**

Question number	Answer	Mark
(d)(i)	(C_3H_8 + $5O_2$ →) $3CO_2$ + $4H_2O$ • 1 mark for both product formulae correct (1) • 1 mark for balancing (1)	2

Question number	Answer	Additional guidance	Mark
(d)(ii)	An explanation that makes reference to the following points: • sulfur dioxide reacts with water (1) • to form an acid (1)	accept sulfuric or sulfurous	2

Q12.

Question number	Answer	Additional guidance	Mark
(a)	Equal numbers of + and – charges/equal numbers of protons and electrons	accept 5 in place of equal	1

Question number	Answer	Mark
(b)	An explanation that makes reference to the following two points: • same number of protons (1) • different numbers of neutrons (1)	2

Question number	Answer	Mark
(c)	• (Atom 1 mass number) 10 (1) • (Atom 2 atomic number) 5 (1)	2

Question number	Answer	Mark
(d)	• Setting out of calculation • Evaluation ((6 x 7.0) + (7 x 93.0) ÷ 100) (1) = 6.9 (1)	2

Q13.

Question number	Answer	Notes	Marks
(a)	<table><tr><th>Apparatus</th><th>Unit</th></tr><tr><td>(gas) syringe</td><td>cm^3</td></tr><tr><td>(top pan) balance **OR** (weighing) scales</td><td>g **OR** mg</td></tr></table>	**ALLOW** ml **ALLOW** words e.g.grams **ALLOW** weighing machine **ALLOW** kg 1 mark each correct row/column Mark horizontally or vertically (whichever benefits the candidate)	2
(b) (i)	M1 to cool (the water vapour/steam) M2 so the water vapour/steam condenses	**ALLOW** to keep condenser cool **ALLOW** so the water vapour/steam becomes liquid	2
(ii)	**M1** add silver nitrate/$AgNO_3$ (solution) **M2** white precipitate	**IGNORE** addition of nitric acid but **REJECT** addition of hydrochloric/sulfuric acid for M1 M2 dep on use of silver nitrate	2
(iii)	**M1** measure its boiling point **M2** (boiling point is) 100°C OR **M1** measure its freezing point **M2** (freezing point is) 0°C	**ALLOW** boil it **ALLOW** freeze it	2
		Total for question	= 8 marks

Q14.

Question number	Answer	Notes	Marks
(a)	number of protons (in nucleus of atom)	**IGNORE** references to electrons	1
(b) (i)	**D** 29 is correct because mass number = total number of protons and neutrons = 14 + 15 = 29 **A** is incorrect because 14 is the number of protons **B** is incorrect because 15 is the number of neutrons **C** is incorrect because 28 is the number of protons + the number of electrons		1
(b) (ii)	**M1** (group) 4 **M2** because 4 electrons in outer shell	 **ALLOW** electronic configuration is 2.8.4	2

Question number	Answer	Notes	Marks
(c)	**M1** $\frac{(32 \times 95.0) + (33 \times 0.75) + (34 \times 4.25)}{100}$ OR $\frac{(3040) + (24.75) + (144.5)}{100}$ **M2** = 32.0925 **M3** = 32.1 (1 dp)	 32.09(25) with no working scores 2 **ALLOW** 1 mark for 3209.25 **ALLOW** M2 ECF M1 if minor error in calculation using all 3 isotopes correct answer to 1 dp with or without working scores 3 **ALLOW M3** ECF **M2** (must be correct to 1 dp)	3

Q15.

Question number	Answer	Mark
(a)	Nucleus	1

Question number	Answer	Mark
(b)	Proton	1

Question number	Answer	Additional guidance	Mark
(c)	Equal numbers of protons and electrons	accept equal numbers of positive and negative particles/charges	1

Question number	Answer	Mark
(d)	5	1

Question number	Answer	Mark
(e)	Lithium	1

(Total for question = 5 marks)

Q16.

Question number		Answer	Notes	Marks
(a)	(i)	3/three		1
	(ii)	nucleus	ALLOW nuclei	1
	(iii)	1/one	ALLOW alkali metals	1
	(iv)	2/two		
	(v)	lithium	IGNORE Li	1
	(vi)	+1/1+	ALLOW +/plus/positive	1

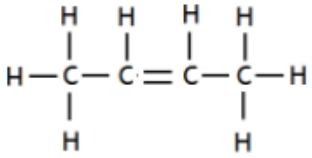
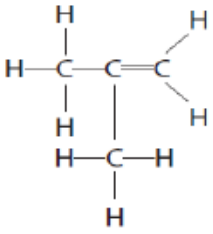
(b) (i)	M1 atoms (of the same element) with same atomic number/ same number of protons **M2 but** different mass numbers/different number of neutrons	**REJECT** molecules/ compound once only	2
(ii)	M1 (6 x 7.8) + (7 x 92.2) **OR** 692.2 M2 692.2 ÷ 100 = 6.9 **OR** answer to M1 ÷ 100	**ACCEPT** 6.92/6.922 An answer of 7 with working scores 1 An answer of 7 without any working scores 0.	2 Total 10

Q17.

Question number	Answer	Notes	Marks
(a) (i)	curve of best fit	**REJECT** dot to dot line	1
(ii)	M1 lines shown on graph	**ALLOW** extra point on curve at 7 carbon atoms	2
	M2 value correctly read from graph (expected value between 97 and 103°C)	**ACCEPT** value to ± 1°C	
(iii)	An explanation that links the following three points		3
	M1 the boiling point increases as the number of carbons / the chain length increases	**ALLOW** boiling point increases as the M_r increases	
	M2 because the intermolecular forces (of attraction) get stronger	**REJECT** directly proportional	
	M3 and therefore take more energy to overcome / break	M3 dep on M2 Any mention of breaking covalent bonds does not score M2 or M3	
(b)	M1 same **molecular** formula		2
	M2 different **displayed** / **structural** formulae	**ALLOW** different structures/ different arrangement of atoms	
(c) (i)	M1 82.8 ÷ 12 **or** 6.9 17.2 ÷ 1 **or** 17.2	0 marks if upside down calculation or use of atomic numbers	2
	M2 (divide by smallest to give) 1:2.5 which is 2:5	**ACCEPT** alternative methods	
(ii)	C_4H_{10}		1
(d)	M1 moles of CO_2 = 7 **or** X = 7		3
	M2 moles of H_2O = 8 **or** Y = 8		
	M3 balancing number = 11 **or** Z = 11	**ALLOW** ecf from incorrect values of X and Y	
			14 marks

Q18.

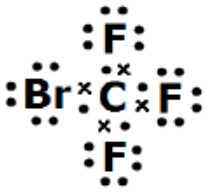
Question number	Answer	Notes	Marks
(a) (i)	S		1
(ii)	T and U		1
(iii)	U		1
(b)	A description that makes reference to the following three points **M1** (add) bromine water **M2** no change / stays orange **M3** (bromine water) decolourised / changes (from orange) to colourless	 **ACCEPT** Br_2 (aq) **ALLOW** no reaction If initial colour of bromine water is given in M2 or M3 it must be correct -ALLOW any combination of orange/yellow/brown - but penalise once only If bromine given for M1 then in M2 and M3 allow any combination of red/orange/brown/yellow **M2** and **M3** dep on bromine water/bromine in **M1** If no reagent and correct M2 and M3 - score 1 if incorrect reagent and correct M2 and M3 score 0 **IGNORE** clear **REJECT** discoloured **ALLOW M1** acidified potassium manganate(VII) **M2** no change/stays purple **M3** decolourised / goes colourless	3

Question number	Answer	Notes	Marks
(c)	Any **two** of the following points **M1** (can be represented by a) general formula **M2** each member differs from the next by a CH_2 group OWTTE **M3** (each member has) same functional group **M4** (each member has) similar/same chemical properties / similar/same (chemical) reactions **M5** trend in physical properties (between successive members)	**ACCEPT** react in similar/same way **ACCEPT** named physical property, e.g. boiling point **REJECT** similar/same physical properties	2
(d) (i)	but-1-ene	**ALLOW** 1-butene	1
(ii)	**Either**  **Or** 	**ACCEPT** cis or trans isomer **REJECT** displayed formulae of cyclic alkanes	1

Question number	Answer	Notes	Marks
(e) (i)	• Divide percentages by relative atomic masses • Divide results by smallest value to obtain ratio Example calculation **M1** C: $\frac{36.36}{12}$ H: $\frac{6.06}{1}$ F: $\frac{57.58}{19}$ **M2** $\frac{3.03}{3.03}$ $\frac{6.06}{3.03}$ $\frac{3.03}{3.03}$ **OR** 1 2 1	0 marks if division by atomic numbers or upside down calculation	2
(ii)	• divide relative molecular mass by empirical formula mass • correct molecular formula Example calculation **M1** $\frac{66}{12 + 2 + 19}$ **OR** $\frac{66}{33}$ OR 2 **M2** $C_2H_4F_2$	**ACCEPT** symbols in any order correct answer without working scores 2 marks. $2CH_2F$ scores 1	2
			Total 14

Q19.

Question number	Answer	Notes	Marks
a	**M1** C 8.05 ÷ 12 **OR** 0.671 **and** Br 53.69 ÷ 80 **OR** 0.671 **and** F 38.26 ÷ 19 **OR** 2.01 **M2** divide all numbers by 0.671 (to obtain ratio 1 : 1 : 3)	 **ALLOW** ECF from **M1** If division by atomic numbers or numerators and denominators reversed 0 marks **Alternative method** **M1** M_r (of $CBrF_3$) = 149 **M2** $\frac{12}{149} \times 100 = 8.05$ (%) **and** $\frac{80}{149} \times 100 = 53.69$ (%) **and** $\frac{57}{149} \times 100 = 38.26$ (%)	**2**

b	 **M1** all four bonding pairs correct **M2** rest of electrons correct	**ACCEPT** any combination of dots and crosses **IGNORE** inner shell electrons even if incorrect **M2** DEP on **M1**	**2**

Question number	Answer	Notes	Marks
c	An explanation that links together the following two points: **M1** the intermolecular forces (of attraction) are weak **M2** therefore little energy is required to overcome the forces	**ACCEPT** London forces/dispersion forces/dipole-dipole forces **ALLOW** intermolecular bonds **ALLOW** little energy is required to separate the molecules **ALLOW** little energy is required to break the bonds as long as it is clear that the bonds are between molecules **IGNORE** less energy Any mention of covalent bonds/ionic bonds/metallic bonds breaking scores 0 out of 2	**2**

Q20.

Question number	Answer	Notes	Marks
(a) (i)	$4NH_3 + 5O_2 \rightleftharpoons 4NO + 6H_2O$	**ACCEPT** multiples and fractions	1
(ii)	reversible (reaction)	**ACCEPT** reaction that goes both ways / both forwards and backwards reactions occur **IGNORE** references to equilibrium	1
(iii)	to increase the rate of the reaction / to speed up the reaction OWTTE	**IGNORE** references to lowering the activation energy	1
(b)	$2NO + O_2 \rightarrow 2NO_2$	**ACCEPT** multiples and fractions	1

(c)	(i)	• calculate M_r of NO_2 and HNO_3 • calculate the amount, in moles, of NO_2 • calculate the amount, in moles, of HNO_3 • calculate the mass in tonnes of HNO_3 Example calculation **M1** M_r of NO_2 = 46 M_r of HNO_3 = 63 **M2** $n(NO_2)$ = 11.5 x 10^6 ÷ 46 **OR** 250 000 (mol) **M3** $n(HNO_3) = \frac{2 \times 250000}{3}$ **OR** 167 000 / 170 000 **M4** (167 000 x 63 g) = 10.5 (tonnes)	**ALLOW** working in megamoles i.e. 11.5 ÷ 46 **OR** 0.25 **ALLOW** ECF from incorrect Mr of NO_2 calculator answer 166666.66 **ALLOW** working in megamoles i.e. $\frac{2 \times 0.25}{3}$ **OR** 0.167 / 0.17 **ALLOW** ECF from M2 10.5 (tonnes) with no working scores 4 **ACCEPT** 10.7 (if 170 000 used) **ALLOW** ECF from M3 **ALLOW** ECF from incorrect M_r of HNO_3	4
	(ii)	can be (re)used in stage 2 / to make more nitrogen dioxide (in stage 2) / can be used to make more nitric acid	**IGNORE** can be recycled/reused unless qualified	1

Question number	Answer	Notes	Marks
(d)	• calculate the amount, in moles, of copper(II) nitrate • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the percentage yield Example calculation **M1** nCu$(NO_3)_2$ formed = 15.3 ÷ 187.5 **OR** 0.0816 **M2** theoretical nCu$(NO_3)_2$ = 0.200 ÷ 2 **OR** 0.100 **M3** (% yield) = $\frac{(0.0816 \times 100)}{(0.100)}$ = 81.6 (%) Alternative method • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the theoretical mass of copper nitrate that should be formed • calculate the percentage yield	**ALLOW** 0.082 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2	3

	Example calculation **M1** theoretical $n\text{Cu(NO}_3)_2 = 0.200 \div 2$ **OR** 0.100 **M2** theoretical mass of copper nitrate = 0.1 x 187.5 = 18.75 **M3** (% yield) = $\frac{15.3}{18.75}$ x 100 = 81.6 (%)	**ALLOW** 18.8 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2 81.6(%) with no working scores 3 marks	**Total 12**