Question Number	Acceptable Answers	Reject	Mark
1(a)	**First mark:** Mass of **an atom**/mass of **an isotope** (of an element) **(1)** IGNORE any references to average or (weighted) mean **Second mark:** relative to 1/12th the mass of a ^{12}C atom **(1)** NOTE: The second mark is awarded for **any mention of ^{12}C** IGNORE throughout the candidate's answer any references to 'moles' or '1 mol' or '12 g' Mark the two points independently	Mass of (all the) isotope**s** /atom**s** 'Mass of an element'	**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	{(35 x 75.53) + (37 x 24.47)} ÷ 100 **(1)** = 35.4894 = 35.49 **(1)** **Answer to 4 s.f. only**. Correct answer no working **(2)** IGNORE units of any kind (e.g. 'g' 'g mol^{-1}' 'amu', etc.)		**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	$^{35}Cl_2^+$ / $(^{35}Cl—^{35}Cl)^+$ **(1)** $^{37}Cl_2^+$ / $(^{37}Cl—^{37}Cl)^+$ **(1)** ALLOW $(^{35}Cl + {}^{35}Cl)^+$ and/or $(^{37}Cl + {}^{37}Cl)^+$ OR $(^{35}Cl^{35}Cl)^+$ and/or $(^{37}Cl^{37}Cl)^+$ OR $(^{35}Cl$ and $^{35}Cl)^+$ and/or $(^{37}Cl$ and $^{37}Cl)^+$ If the 'formal' charge is omitted on either ion (or both the ions), then award **(1)** mark only. NOTE: $^{35}Cl^+$ $^{35}Cl^+$ and $^{37}Cl^+$ $^{37}Cl^+$ scores **(1)** as each ion has an extra + charge. $2^{35}Cl^+$ and $2^{37}Cl^+$ scores **(1)** Accept mass number written as superscript to right of symbol.	$^{70}Cl_2^+$ $^{74}Cl_2^+$ $2^{35}Cl$ and/or $2^{37}Cl$ scores **(0)**	**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	**(1)** $^{35}Cl—^{37}Cl^{(+)}$ **(1)** ALLOW $(^{35}Cl + {}^{37}Cl)^{(+)}$ and/or $(^{37}Cl + {}^{35}Cl)^{(+)}$ OR $(^{37}Cl^{35}Cl)^{(+)}$ and/or $(^{37}Cl^{35}Cl)^{(+)}$ OR $(^{35}Cl$ and $^{37}Cl)^{(+)}$ and/or $(^{37}Cl$ and $^{35}Cl)^{(+)}$ NOTE: The + charge is not needed on **this ion** IGNORE extra + charges, so ALLOW $^{35}Cl^+$ $^{37}Cl^+$ and/or $^{37}Cl^+$ $^{35}Cl^+$		**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)(i)	Amount Na = 1.73 (g) ÷ 23 (g mol^{-1}) = 0.075(22) (mol) Amount O = 1.20 (g) ÷ 16 (g mol^{-1}) = 0.075 (mol) **(1)** IGNORE sf, even if 1 sf NaO **(1)** Correct answer no working **(2)** NOTE: Correct answer can be obtained via incorrect working and all responses should be read carefully e. Amount Na = 23 ÷ 1.73 = 13.3 Amount O = 16 ÷ 1.20 = 13.3 scores second mark only for NaO if obtained by incorrect working OR e. Use of atomic numbers gives the Na : O ratio as 0.157 : 0.150 and an empirical formula of NaO. This scores (1) overall (i.e. the 2nd mark). OR e. Use of atomic number ONLY for Na (i.e. Na = 11) gives the Na : O ratio as 0.157 : 0.075 and an empirical formula of Na_2O. This scores (1) overall (i.e. the 2nd mark). NOTE: Use of **O** = 32 gives Na_2O and scores second mark	Na_2O_2	**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	(NaO = 39 hence molar mass twice that of NaO ∴) so **Na_2O_2**	'2NaO'	**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(iii)	$2Na(s) + O_2(g) \rightarrow Na_2O_2(s)$ All species correct **(1)** State symbols and balancing **(1)** NOTE: 2nd mark is conditional on correct species. NOTE: $2Na(s) + O_2(g) \rightarrow 2NaO(s)$ scores **(1)** $Na(s) + O_2(g) \rightarrow NaO_2(s)$ scores **(1)** $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ scores **(2)**		**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)(iv)	Moles of O_2 = 0.075 ÷ 2 = 0.0375 OR 1.2 ÷ 32 = 0.0375 (mol) **(1)** 0.0375 mol x 24 dm^3 mol^{-1} = 0.9(0) (dm^3) **(1)** ALLOW 900 **cm^3 (units must be present here)** Correct answer no working **(2)** OR Moles of Na = 1.73 ÷ 23 = 0.075217 = moles of O Moles of O_2 = 0.075217 ÷ 2 = 0.0376085 0.0376085 x 24 = 0.903 (dm^3) or 903 **cm^3** IGNORE s.f., including ONE s.f. NOTE: If number of moles x 24 (dm^3 mol^{-1}) is clearly evident and correctly calculated in stated units, award second mark		**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)(v)	0.0375 x 6.02 x 10^{23} (= 2.2575 x 10^{22} (molecules)) = 2.26 x 10^{22} (molecules) IGNORE s.f. unless 1 s.f.		**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)	Sodium might react with nitrogen in the air/sodium forms a nitride/ nitrogen (gas) is present in the air (which reacts with the sodium) OR sodium might form a different oxide (e.g. Na_2O or allow NaO_2) NOTE: If nitrogen / N_2 is mentioned as part of a 'list' of substances that can be present in air, award the mark	**Just** 'very reactive' OR 'very explosive' sodium forms Na_2O_2 alone References to hydrogen in the air **Just** 'reacts with other substances in the air' (as nitrogen not identified Sodium nitrate formation **Just** sodium hydroxide formation	**1**

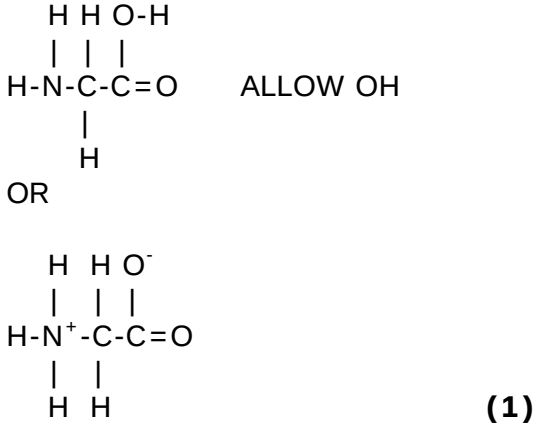
Question Number	Acceptable Answers	Reject	Mark
3(a)	**Route 1 by mol of H, C and N** $\frac{0.072}{18}$ = 0.004 mol water OR 0.008 mol H(atoms) **And** $\frac{0.176}{44}$ = 0.004 mol carbon (dioxide) **(1)** $\frac{24.0}{24000}$ = 0.001 mol nitrogen N_2 OR 0.002 mol N(atoms) **(1)** Mass of H + mass of C + mass of N = 0.008 + 0.004 x 12 + 0.028 **(1)** = 0.084 g mass of oxygen = 0.132 – (0.008 + 0.004 x 12 + 0.028) = 0.048 g amount of oxygen = $\frac{0.048}{16}$ = 0.003 mol **(1)** empirical formula is $C_4H_8O_3N_2$ **(1)** **Route 2 by mass of H, C and O calculated in one step** mass of H = 2/18 x 0.072 = 0.008 g **(1)** mass of C = 12/44 x 0.176 = 0.048 g **(1)** mass of N = 24/24000 x 28 = 0.028 g **(1)** mass of O = 0.132 – (0.008 + 0.048 + 0.028) = 0.048 g moles of O = 0.003 **(1)** moles of H = 0.008		**5**

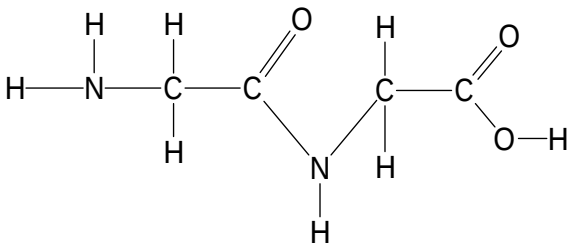
	moles of C = 0.004 moles of N = 0.002 empirical formula is $C_4H_8O_3N_2$ **(1)** **Route 3 Percentage by mass of each element in 0.132 g** First three marks by either method above. Then percentages are: H – 6.06 C – 36.36 N – 21.21 So O is 100 – (6.06 + 36.36 + 21.21) = 100 – 63.63 = 36.37 Mole ratios O – 2.27 – allow = or – 0.02 **(1)** H – 6.06, C – 3.03, N – 1.515 Dividing by smallest gives H – 4, C – 2, N – 1, O – 1.5 empirical formula is $C_4H_8O_3N_2$ **(1)** **The following transferred errors are allowed:** If nitrogen gas taken as N, first two marks can still be awarded for all methods Then mass of nitrogen is 0.014 g This gives mass of oxygen as 0.062 g and amount of oxygen as 0.003875 mol **(1)** now empirical formula is $C_4H_8O_4N$ **(1)** **OR** percentage method: N – 10.61% O – 46.97%		

	Mole ratio N – 0.7575 O – 2.935 **(1)** empirical formula is $C_4H_8O_4N$ **(1)** **Transferred error for hydrogen** Two from first three marks still awarded Then amount of hydrogen is 0.004 mol This gives 0.003125 mol oxygen empirical formula is $C_4H_4O_3N_2$ **(1)** **Both the above nitrogen and hydrogen errors** Award 1 mark for correct mass of carbon or correct moles of carbon Then mass of nitrogen is 0.014 g Then mass of hydrogen is 0.004 g This gives 0.004125 mol oxygen **(1)** Empirical formula is $C_4H_4O_4N$ **(1)**		

Question Number	Acceptable Answers	Reject	Mark
3(b)	**(12 x 4 + 1 x 8 + 16 x 3 + 14 x 2)** n = 132 n = 1 So molecular formula is $C_4H_8O_3N_2$ Some element of working must be shown TE from (a) of nitrogen error can be given **only if**: **(12 x 4 + 1 x 8 + 16 x 4 + 14)** n = 132 n = 0.98 (which is approximately 1) TE from (a) of hydrogen error can be given **only if**: **(12 x 4 + 1 x 4 + 16 x 3 + 14 x 2)** n = 132 n = 1.03 (which is approximately 1) TE from (a) of nitrogen and hydrogen error can be given **only if**: **(12 x 4 + 1 x 4 + 16 x 4 + 14)** n = 132 n = 1.015/1.02 (which is approximately 1)		**1**

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	**Y** reacts with HCl/acid so it is an amine /contains NH_2 /CO_2^- **(1)** It reacts with alkali/NaOH so it is a carboxylic acid/contains CO_2H/NH_3^+ **(1)** It forms a purple colour/reacts with ninhydrin so it is an amino acid **(1)** OR As it is an amine/contains NH_2 /CO_2^- it will react with HCl/acid **(1)** As it is a carboxylic acid/contains CO_2H/NH_3^+ it will react with alkali/NaOH **(1)** As it is an amino acid so it forms a purple colour/reacts with ninhydrin **(1)** Each marking point is independent and requires both the functional group and the test **NOTE:** It is an amino acid so it reacts with acid and alkali (with neither of first two points) **(1)**	Just ... it is a base Just ... it is an acid ...it is amphoteric (alone)	**3**

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	 ALLOW OH OR **(1)** 2-aminoethanoic aci aminoethanoic acid/glycine **(1)** Mark independently	C-H-O if bond is clearly to H **1**- aminoethanoi acid	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (c)(iii)	$H_2NCH_2CONHCH_2CO_2H$ Or $NH_2CH_2CONHCH_2CO_2H$ Or $HOCOCH_2NHOCCH_2NH_2$ ALLOW  Or reversed displayed formula ALLOW ionic formulae with H_3N^+ and CO_2^-		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a)	Do not penalize the use of A_r (Mg) = 24.3 at any stage in this question. Penalize SF errors (1 SF, incorrect SF (eg. 0.02) and incorrect rounding to 2 SF (e.g. 0.016)) only once in parts (a – d) Allow 0.0166 Allow fractions (e.g. 1/60) Amount Mg = (0.4 ÷ 24) = 0.016666 = 0.0167 (mol) Allow Amount Mg = (0.4 ÷ 24.3) = 0.016461 = 0.0165 (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b)	Amount HCl = 1.5 x 22.2/1000 = 0.033333 = 0.0333 (mol) Allow Amount HCl = 2 x answer in (a)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (c)	Amount of H_2 = 400 ÷ 24 000 = 0.016666 = 0.0167 (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (d)	Ratio mol Mg:HCl:H_2 = 0.0167 (0.165) : 0.0333 : 0.0167 = 1:2:1 Allow answers in which the mole ratios of the reactant and products are compared separately	Just stating the molar ratio	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (e)	M_r ($MgCl_2$) = 24 + 2 x 35.5 = 95 **(1)** Mol $MgCl_2$ = (mol Mg) = 0.0166666 (or 0.0167) **(1)** Mass $MgCl_2$ = 95 x 0.0166666 = 1.58 (g) **3 sf (1)** Or 95 x 0.0167 = 1.59 (g) 3sf Or 95.3 x 0.0166666 = 1.59 Or 95 x 0.0165 = 1.58 Or 95.3 x 0.0165 = 1.57 Correct answer with no working scores **(3)** TE on 17(a)		**3**