Question Number	Answer	Mark
1	**The only correct answer is A** ($C_{10}H_8$) ***B*** *is incorrect because there are only 8 hydrogens, one on each of the carbons which are not linking the two rings* ***C*** *is incorrect because there are only 10 carbons and 8 hydrogen atoms* ***D*** *is incorrect because there are only 10 carbons and 8 hydrogen atoms*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** (1 kg of urea) ***A*** *is incorrect because 2 kg of sodium nitrate contains 329.4 g of nitrogen* ***C*** *is incorrect because 1 kg of ammonium nitrate contains 350 g of nitrogen* ***D*** *is incorrect because 1 kg of ammonium sulphate contains 212 g of nitrogen*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** ($x = 2$, $y = 7$, $z = 4$) ***A*** *is incorrect because x must be 2 to match the 4 P in* P_4O_{10} ***B*** *is incorrect because z must be 4 to give 8 H to match the H in* $2P_2H_4$ ***D*** *is incorrect because x must be 2 to match the 4 P in* P_4O_{10}	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is C** (3.00 dm^3) ***A*** *is incorrect because this is the volume if oxygen were the only gas produced* ***B*** *is incorrect because this is the volume if oxygen were the only gas and 1 mol of calcium nitrate gave 1 mol of oxygen* ***D*** *is incorrect because this is the volume of gas if 1 mol of calcium nitrate gave 5 mol of gas*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is C** (13 900 Pa) ***A*** *is not correct because the volume is converted into* dm^3 ***B*** *is not correct because the temperature has been converted into degrees Celsius* ***D*** *is not correct because the nRT has been multiplied by the volume instead of divided*	**(1)**

Question Number	Answer	Mark
1	**The only correct answer is B** (3.6×10^{23}) ***A*** *is incorrect because this is the number of molecules of carbon dioxide in 8.8 g* ***C*** *is incorrect because this is the number of molecules of carbon dioxide in 88 g* ***D*** *is incorrect because this is the number of atoms of carbon dioxide in 88 g*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is C** (2.408×10^{22}) ***A*** *is incorrect because this is the number of* H_2SO_4 *molecules in 0.0100 mol* ***B*** *is incorrect because this is the number of oxygen molecules required to give this many oxygen atoms* ***D*** *is incorrect because this is the number of atoms in 0.0100 mol of* H_2SO_4	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is C** (between 20 g and 40 g) ***A*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***B*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***D*** *is incorrect because the atomic mass of silver is less than twice that of copper so less than 40 g will be formed*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is D** (0.2335 mol dm^{-3}) ***A*** *is not correct because this is the number of moles of barium hydroxide in 250* cm^3 ***B*** *is not correct because this is the number of moles of hydroxide ions in 250* cm^3 ***C*** *is not correct because the stoichiometry has not been taken into account*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is B** (92) ***A*** *is incorrect because this is the molecular mass of* NO_4 *which has 82.05% oxygen* ***C*** *is incorrect because this is the molecular mass of* N_3O_4 *which has 60.38% oxygen* ***D*** *is incorrect because this is* $69.57 \div 64 \times 100$ *instead of* $64 \div (69.57 \div 100)$	**(1)**

Question Number	Answer	Mark
7(a)	**The only correct answer is B** (64) ***A*** *is incorrect because the mass of bromide has been converted into moles* ***C*** *is incorrect because the mass of bromide in mg has been divided by the A_r of bromine before conversion to ppm* ***D*** *is incorrect because the mass of bromide ions has been taken as 64 g rather than 64 mg*	**(1)** **Computer**

Question Number	Answer	Mark
7(b)	**The only correct answer is A** (2.4×10^{20}) ***B*** *is incorrect because the mass of solution has not been divided by 2* ***C*** *is incorrect because the mass of the ions has not been divided by the A_r of bromine* ***D*** *is incorrect because the mass of the ions has not been divided by the A_r of bromine and the mass of solution has not been divided by 2*	**(1)** **Computer**

Question Number	Answer	Mark
5	**The only correct answer is C** (10.0 cm^3 of 0.90 mol dm^{-3} magnesium chloride solution) ***A*** *is incorrect because this solution contains 0.012 mol of chloride ions* ***B*** *is incorrect because this solution contains 0.012 mol of chloride ions* ***D*** *is incorrect because this solution contains 0.012 mol of chloride ions*	**(1)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>21(a)</td><td>

- M1 % (of hydrogen) **(1)**
- M2 calculation of moles **(1)**
- M3 divide by the lowest number of moles to get empirical formula **(1)**
- M4 calculation of M_r of empirical formula **(1)**

- M1 % (of hydrogen) **(1)**
- M2 multiplication of % by M_r (row 2) **(1)**
- M3 calculation of ratio number (row 3) **(1)**
- M4 divide by the lowest number to get empirical formula (row 4) **(1)**

</td><td>

<u>Example of calculation</u>

100 − 17.48 – 77.67 = 4.85 (%)

B	O	H
17.48/10.8	77.67/16	4.85/1
1.6185	4.854	4.85
1.6185/1.6185 = 1	4.85/1.6185 = 2.996	4.85/1.6185 = 2.996

1 x 10.8 + 3 x 16 + 3 x 1 = 61.8 (g mol^{-1})

If they only use 2 elements, they can score one mark for M2 and M3 being correct for both B and O

Or

B	O	H
17.48 × 61.8/100	77.67 × 61.8/100	4.85 × 61.8/100
= 10.8	= 48	= 3
10.8/10.8 = 1	48/16 = 3	3/1 = 3

</td><td>(4)</td></tr>
</table>

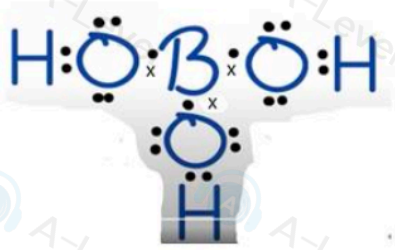
<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>21(b)(i)</td><td>

An answer that makes reference to the following points:

- correct electrons around B **(1)**
- correct electrons around the oxygens **(1)**
- correct electrons round the hydrogens **(1)**

</td><td>

Example of diagram
Allow any combination of dots and crosses or just dots or just crosses.



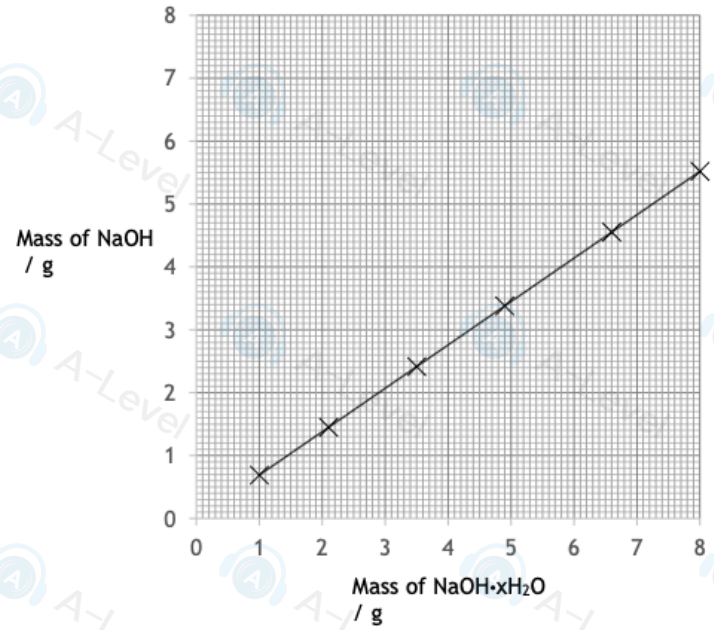
Ignore how the lone pair electrons are arranged in oxygen.
The marks are only awarded if the bond and number of bonds is correct between the correct two atoms.

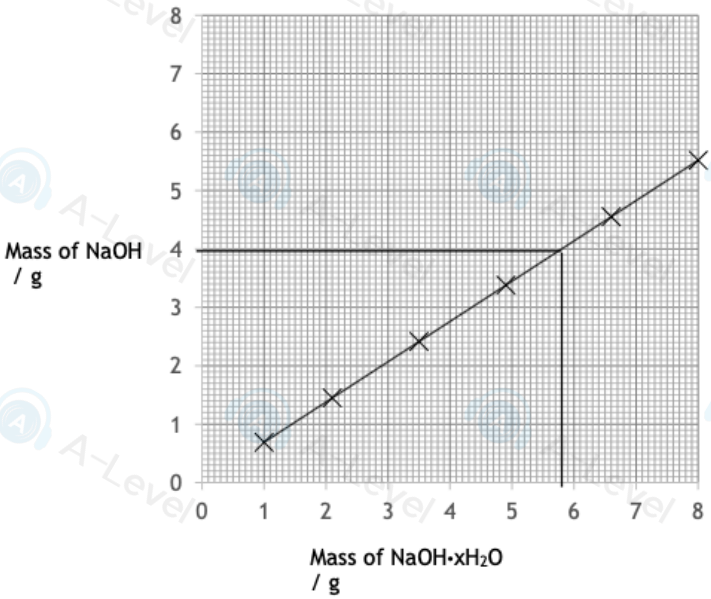
Anything ionic score 0

</td><td>(3)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following points: • bond angle 120° **(1)** • 3 (bonding) pairs of electrons (round B) adopt a position of minimum repulsion **(1)**	Ignore trigonal planar/any shape even if incorrect Allow maximum separation of 3 electron pairs No TE on incorrect bond angle for M2 Do not award bonds for electrons Ignore electron pairs have equal repulsion Allow TE on structure in (b)(i) If structure in (b)(i) has 3 bonding and 1 lone pair of electrons M1 bond angle of 107° (allow 106-108) M2 lone pairs repel more than bonding pairs (and adopt a position of minimum repulsion/maximum separation) Any ionic structure from (b)(i) will score 0	**(2)**

(Total for Question 21 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
17(a)(i)	• six points plotted correctly within a square **(1)** • axes labelled including units **(1)** • straight line passing through all points **(1)**	Example of graph  Allow line of best fit going through 0,0 Allow axes reversed. Allow "(g)" instead of "/ g" for units	**(3)**

Question Number	Answer	Additional Guidance	Mark
17(a)(ii)	An answer that makes reference to the following point: • mass of NaOH·xH₂O read from the graph (using a line on the graph)	 Expected value is 5.8 g (± 0.1) but value should be from the graph. Allow TE on the line of best fit Allow correct reading of value from graph with axes reversed.	**(1)**

Question Number	Answer	Additional Guidance	Mark
17(a)(iii)	EITHER • calculation of moles of NaOH in 4 g **(1)** • calculation of molecular mass of $NaOH \cdot xH_2O$ **(1)** • calculation of x **(1)** OR • a subtraction either Mr or mass **(1)** • two mole calculations **(1)** • mole ratio and final answer must be a whole number **(1)**	Example of calculation $4.0 \div 40 = 0.1$ (mol) $5.8 \div 0.1 = 58$ (g mol^{-1}) $58 - 40 = 18$ Therefore x = 1 Allow calculation from any other point on the graph max (2) Allow TE on (a)(ii) Correct answer with no working 1 mark only	**(3)**

Question Number	Answer	Additional Guidance	Mark
17(b)	• calculation of molar mass $NaOH \cdot 7H_2O$ • calculation of mass of 0.150 mol of $NaOH \cdot 7H_2O$ • calculation of mass needed for 250 cm^3 OR • calculation of moles in 250cm^3 • calculation of molar mass • calculation of mass	Example of calculation $23 + 16 + 1 + (7 \times 18) = 166$ (g mol^{-1}) $0.150 \times 166 = 24.9$ (g) $24.9 \div 4 = 6.225/6.23$ (g) Ignore SF except 1 SF Correct answer without working scores 2 0.15 x 0.250 = 0.0375 $23 + 16 + 1 + (7 \times 18) = 166$ (g mol^{-1}) 0.0375 x 166 = 6.225 / 6.23	**(2)**

(Total for Question 17 = 9 marks)

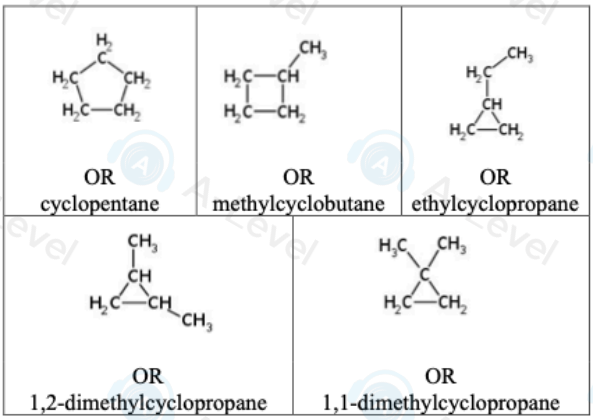
Question Number	Answer	Additional Guidance	Mark
24(a)(i) Clip all	• rearrangement of $pV = nRT$ **(1)** • conversion of dm^3 to m^3 **(1)** • substitution in correctly rearranged expression **(1)** • calculation of value of n **(1)**	Example of calculation $n = pV \div RT$ $V = 0.00179 / 1.79 \times 10^{-3}$ $n = (110\,000 \times 0.00179) \div (8.31 \times 473)$ Allow TE in M3 from incorrect conversion from dm^3 to m^3 $n = 0.0501$ (mol) / 5.01×10^{-2} (mol) / 0.050094 (mol) / 5.0094×10^{-2} (mol) / 0.05 (mol) / 5×10^{-2} (mol) Allow TE for M4 from incorrect values shown in a correctly rearranged expression Ignore SF throughout Correct answer with some working scores 4	**(4)**

Question Number	Answer	Additional Guidance	Mark
24(a)(ii)	• calculation of M_r of X	Example of calculation $M_r = 3.5 \div 0.0500 = 70$ Accept 69.869 Allow TE on incorrect moles in (a)(i) provided answer >1	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(a)(iii)	• calculation of moles of carbon **and** moles of hydrogen **(1)** • calculation of ratio **and** gives empirical formula **(1)**	Example of calculation 85.7 ÷ 12 = 7.1417 **and** 14.3 ÷ 1 = 14.3 14.3 ÷ 7.1417 = 2.0023 CH_2 Ignore SF throughout Correct answer with no working scores (2)	**(2)**

Question Number	Answer	Additional Guidance	Mark
24(a)(iv)	• molecular formula	Example of calculation ans(a)(ii) ÷ ans(a)(iii) 70 ÷ 14 = 5 C_5H_{10} Allow TE on (a)(ii) and (a)(iii) Answer with no working scores 1	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(b)	An answer that makes reference to the following point: • no (C=C) double bonds are present / molecule is not unsaturated / molecule is not an alkene / only single bonds are present / molecule is saturated / molecule is an alkane	Allow it is a cycloalkane Ignore it does not contain oxygen	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(c)	An answer that makes reference to the following points: • one possible structural isomer **(1)** • a second structural isomer **(1)**	 OR cyclopentane OR methylcyclobutane OR ethylcyclopropane OR 1,2-dimethylcyclopropane OR 1,1-dimethylcyclopropane Allow any type of displayed or skeletal formulae Allow 1-methylcyclobutane and 1-ethylcyclopropane If name and formula are given, both must be correct Allow TE on formula from (a)(iv) If answer in (b) is alkene, then allow 1 mark for two correct alkenes using formula in (a)(iv)	**(2)**

(Total for Question 24 = 11 marks)