Question Number	Answer	Mark
13	**The only correct answer is A** (BF_3) ***B*** *is incorrect because there are four bonding pairs of electrons which repel equally* ***C*** *is incorrect because there are two bonding pairs of electrons which repel less strongly than the two lone pairs* ***D*** *is incorrect because there are three bonding pairs of electrons which repel less strongly than the lone pair*	**(1)** **Computer**

Question Number	Answer	Mark
3	**The only correct answer is A** (a molecule of ethene, $^{12}C_2\ ^{1}H_4$) ***B*** *is incorrect because it contains 16 neutrons* ***C*** *is incorrect because it contains 16 neutrons* ***D*** *is incorrect because it contains 16 neutrons*	**(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
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
6	**The only correct answer is B**(NO_2) ***A*** *is incorrect because it contains 47% N* ***C*** *is incorrect because it contains 64% N* ***D*** *is incorrect because it contains 37% N*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is A** (small large) ***B*** *is incorrect because the ion needs a large charge* ***C*** *is incorrect because the ion needs a small radius and a large charge* ***D*** *is incorrect because the ion needs a small radius*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** (2.107×10^{24}) ***A*** *is incorrect because moles of methane correctly calculated multiplied by L* ***B*** *is incorrect because moles of methane incorrectly calculated and then multiplied by L* ***D*** *is incorrect because moles of methane incorrectly calculated and then multiplied by 4 and L*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is A** (ionic soluble high poor) ***B*** *is incorrect because ionic compounds usually have high melting temperatures and do not conduct as a solid* ***C*** *is incorrect because metallic structures are insoluble in water and usually have high melting temperatures* ***D*** *is incorrect because metallic stuctures have good electrical conductivity*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is C** (0.0060 mol) ***A*** *is incorrect because this is the number of moles of magnesium nitrate in the solution* ***B*** *is incorrect because this would be correct if the formula of magnesium nitrate was* $MgNO_3$ ***D*** *is incorrect because this is the number of ions that would be present if there were two magnesium ions and two nitrate ions in each magnesium nitrate*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is A** (111 neutrons 77 electrons) ***B*** *is not correct because the atom has lost two electrons, not gained two electrons* ***C*** *is not correct because the number of neutrons is 111 and the atom has lost two electrons* ***D*** *is not correct because the number of neutrons is 111*	**(1)**

Question Number	Answer	Mark
1(a)	**The only correct answer is B** (element Q, 1521) ***A** is incorrect because it has 7 electrons in its outer shell* ***C** is incorrect because it has 1 electron in its outer shell* ***D** is incorrect because it has 2 electrons in its outer shell*	**(1)**

Question Number	Answer	Mark
1(b)	**The only correct answer is A** (element P, 1251) ***B** is incorrect because it would not form a compound as it is an inert gas.* ***C** is incorrect because it would not form a covalent compound* ***D** is incorrect because it would not form a covalent compound*	**(1)**

Question Number	Answer	Mark
1(c)	**The only correct answer is D** (element S, 590) ***A** is incorrect because it would form a covalent compound* ***B** is incorrect because it would not form a compound as it is an inert gas.* ***C** is incorrect because it would from a compound with the formula YF*	**(1)**

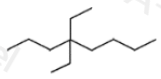
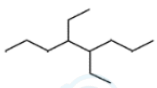
Question Number	Answer	Mark
1(d)	**The only correct answer is C** (element R, 419) ***A** is incorrect because it has a smaller atomic radius* ***B** is incorrect because it has a smaller atomic radius* ***D** is incorrect because it has a smaller atomic radius*	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)	Method • convert °C to K **(1)** • kPa to Pa **and** 415 cm^3 to m^3 **(1)** • substitution into $pV = nRT$ **and** rearrangement **(1)** • evaluation **(1)**	Example of calculation 20 + 273 = 293 101 x 1000 = 101000 **and** 415 ÷ 1000000 = 415 x 10^{-6} / 4.15 x 10^{-4} n = 101000 × 415 x 10^{-6} ÷ 8.31 × 293 n = 0.0172 mol Ignore SF except 1 SF TE on M1 and M2 but no TE from M3 to M4 Correct answer with no working scores (4)	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following point: • (burned / reacted) in sufficient / excess **oxygen**	Allow a reaction in which all of the atoms in the fuel are fully oxidised. Ignore any reference to carbon dioxide and water	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	An answer that makes reference to the following point: • correctly balanced equation **(1)** • state symbols correct **(1)**	$C_{12}H_{26}(l) + 18.5O_2(g) \rightarrow 12CO_2(g) + 13H_2O(l)$ Accept $13H_2O(g)$ Allow multiples	**(2)**

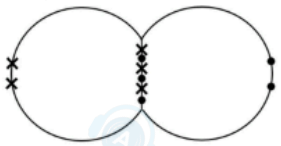
Question Number	Answer	Additional Guidance	Mark
20(b)(iii)	Method • calculation of litres of fuel used **(1)** • calculation of mass of fuel used **(1)** • calculation of mol of fuel used **(1)** • calculation of mol of carbon dioxide **(1)** • calculation of mass of carbon dioxide **(1)** • calculation of mass (kg) of carbon dioxide/passenger **(1)** **and** to 3SF	Example of calculation (11400) × **9.25** = 105 450 (1.0545 × 10^5) (105 450) × **0.749** (× 1000) = 78 982 000 (7.8982 × 10^7)(g) (78 982 000) ÷ **170** = 464 600 (4.6460 × 10^5) (mol) (464 600) × **12** = 5 575 200 (5.5752 × 10^6) (mol) (*check mole ratio from 20bii*) (5 575 200) × **44** = 245 310 000 (2.4531 × 10^8) (g) (245 310 000) ÷ **800** (÷ 1000)= (306 640 (3.0664 × 10^5) (g) 307 (kg) Allow 306 (kg) Allow 307000 / 306000 **g** If all six operations have **not** been carried out ignore SF Allow TE throughout	**(6)**

Question Number	Answer	Additional Guidance	Mark
20(b)(iv)	•  **(1)** •  **(1)**	Ignore any names even if incorrect Allow 1 mark for two correct non skeletal formulae	**(2)**

(Total for Question 20 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)	• a suitable suggestion	the oil must be heated until it is a gas / the air must be cooled/compressed until it becomes a liquid Allow air must be liquefied first Allow air (distils at a) lower temperature / oil (distils at a) higher temperature Ignore different temperatures Do not award temperature alone Ignore comments about elements/compounds Ignore comments about numbers of fractions Ignore references to energy/cost	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	• volume of oxygen needed per breath **(1)** • volume of air required **(1)**	Example of a calculation: $90 \times 500 \div 100 = 450$ (cm^3) Accept 0.45 (dm^3) $450 \times 100 \div 21 = 2142.9$ **cm^3** / 2.1429 (dm^3) Ignore SF except 1 SF Alternative calculation: Passing over zeolite reduces $100cm^3$ to $(21 \times 10/9)$ $cm^3 = 23.333cm^3$ (M1) So 1 breath requires $500 \times 100/23.333 = 2143$ **cm^3** $= 2.14(dm^3)$ (M2) Other alternate M1: $(500 \times 100) \div 21 =$ 2380 **cm^3**/2.38 dm^3 Correct answer (2.14) scores 2 The expression $\frac{90 \times 500}{21}$ scores 1 Answer in **cm^3** must contain units for two marks	**(2)**

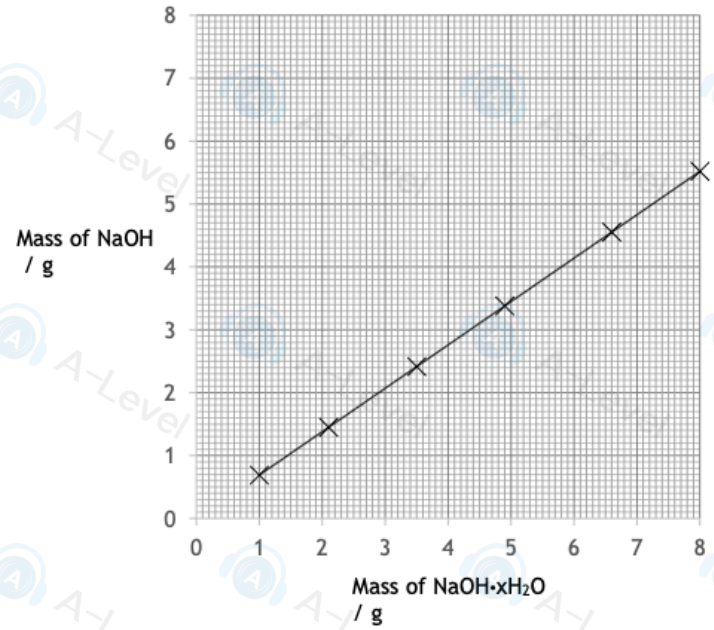
Question Number	Answer	Additional Guidance	Mark
23(b)(ii)	• three pairs of shared electrons between two atoms **(1)** • a lone pair on each atom **(1)**	Example of a diagram:  Circles are not required Allow any representation of electrons Allow lone pairs to be two individual electrons Ignore inner shells of electrons Ignore lines representing bonds	**(2)**

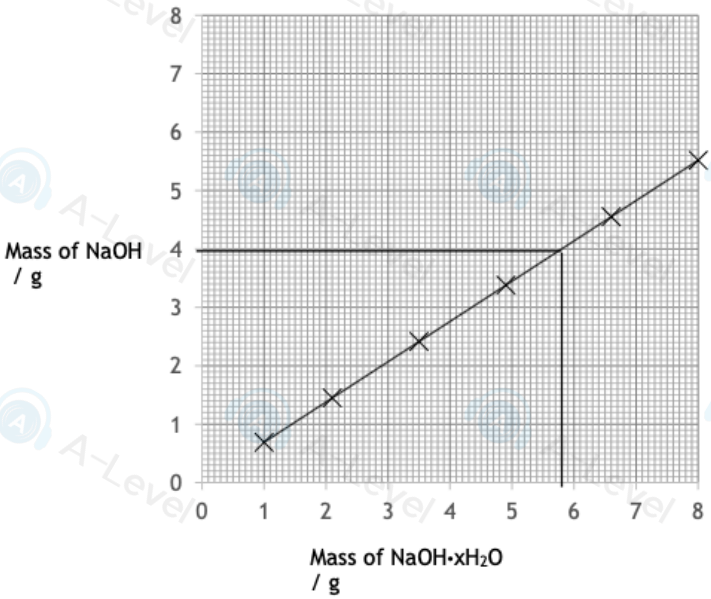
Question Number	Answer	Additional Guidance	Mark
23(c)(i)	• calculation of mass of oxygen **(1)** • number of moles **(1)** • volume in dm^3 **(1)** • conversion to m^3 **(1)** **Common incorrect answer:** $23.77(m^3)/23.8(m^3)$ = 3 marks (divide by 16 instead of M_r 32)	Example of a calculation: $13.9 \times 1140 = 15846$ (g) $15846 \div 32.0 = 495.19$ (mol) $495.19 \times 24.0 = 11884.5$ (dm^3) $11884.5 \div 1000 = 11.88 / 11.9$ (m^3) Incorrect rounding e.g. 11.8 loses M4 Ignore SF except 1 SF Correct answer with some working scores (4) TE throughout Allow 12.14 or 12.26(m^3) if calculated with $pV=nRT$ for 4 marks TE on pV=nRT using moles from M2, so answer worked through would score 2 marks e.g. when using 0.579 mol (from 13.9÷24) the answer is $0.0142m^3$.	**(4)**

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	• mass of bottle stated to 2 or 3SF	Example of calculation: $80.0 - 15.846 = 64.154$ = 64 / 64.2 (kg) Allow answers in grams to 2 or 3SF TE on mass calculated in (c)(i) provided it gives a positive mass If no mass calculated in kg (c)(i) then allow the subtraction of a mass calculated in (c)(ii) if answer is positive and given to 2 or 3SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(c)(iii)	An explanation that makes reference to: • the container has to have **thick** walls **(1)** • so that it will withstand the high **pressure** **(1)**	Allow "container is **thick**" Allow discussion of density of the material making the container Ignore references to density of the oxygen Ignore insulation Allow great/extreme **pressure** Ignore "needs to be strong" Ignore explosion Do not award M2 for flammability of oxygen	**(2)**

(Total for Question 23 = 12 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)