Questions

Q1.

What is the number of ions in 9.53 g of magnesium chloride, $MgCl_2$?

[Avogadro constant = 6.02×10^{23} mol^{-1}]

(1)

- ☒ **A** 6.02×10^{22}
- ☒ **B** 1.20×10^{23}
- ☒ **C** 1.81×10^{23}
- ☒ **D** 6.02×10^{23}

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

The equation for the complete combustion of butane is

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

What is the minimum volume of oxygen, at room temperature and pressure (r.t.p.), needed for the complete combustion of 0.200 mol of butane?

[Molar volume of a gas at r.t.p. = 24.0 dm^3 mol^{-1}]

(1)

- ☒ **A** 4.8 dm^3
- ☒ **B** 9.6 dm^3
- ☒ **C** 31.2 dm^3
- ☒ **D** 62.4 dm^3

(Total for question = 1 mark)

Q3.

The reaction of sulfuric acid with potassium hydroxide is a neutralisation. The equation for this reaction is

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

A titration was carried out using the following method.

- Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
- 25.0 cm^3 of sulfuric acid solution, concentration 0.0800 mol dm^{-3}, was transferred to a conical flask.
- Three drops of phenolphthalein indicator were added to the sulfuric acid.
- Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
- Repeat titrations were carried out until concordant titres were obtained.

What is the colour of the solution when neutralisation has just occurred?

(1)

- ☐ **A** colourless
- ☐ **B** orange
- ☐ **C** pale pink
- ☐ **D** red

(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

The nitrates of lithium, rubidium and strontium are all white solids. The compounds are held together by ionic bonds.

What is the percentage by mass of strontium in strontium nitrate?

(1)

- ☐ **A** 38.0 %
- ☐ **B** 41.4 %
- ☐ **C** 58.6 %
- ☐ **D** 74.5 %

(Total for question = 1 mark)

Q5.

This is a question about catalytic converters in car exhaust systems.

In the UK, the exhaust emissions of a petrol-fuelled vehicle must be less than 1.00 g of carbon monoxide per kilometre.

What is the maximum number of carbon monoxide molecules that can be emitted per kilometre for a vehicle to meet this regulation?

(1)

- ☒ **A** 1.37×10^{22}
- ☒ **B** 2.15×10^{22}
- ☒ **C** 6.02×10^{23}
- ☒ **D** 1.69×10^{25}

(Total for question = 1 mark)

Q6.

Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water. It is difficult to dissolve a known amount of hydrogen chloride, so the exact concentration of such solutions is uncertain. A solution of hydrochloric acid of concentration between 0.095 mol dm^{-3} and 0.105 mol dm^{-3} was prepared.

Before a class attempted a practical using this solution, a technician standardised the hydrochloric acid with sodium carbonate solution. The technician dissolved 1.30 g of anhydrous sodium carbonate in water and made up the solution to 100 cm^3.

The equation for the reaction which occurs is shown.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A 10.0 cm^3 portion of the sodium carbonate solution was transferred to a conical flask. Three drops of methyl orange indicator were added and the solution titrated with hydrochloric acid. The results for the experiment are shown.

Titration	1	2	3	4	5
Final burette reading / cm^3	26.00	34.00	36.10	24.15	48.20
Initial burette reading / cm^3	0.00	10.00	11.00	0.05	24.15
Titre / cm^3					
Concordant results (✓)					

The colour change at the end-point when methyl orange is used as an indicator for this titration is from

(1)

☒ **A** orange to yellow

☒ **B** red to orange

☒ **C** yellow to orange

☒ **D** yellow to red

(Total for question = 1 mark)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

How many **ions** are present in 306 g of aluminium oxide, Al_2O_3 ?

[Avogadro constant = 6.02×10^{23} mol^{-1} Molar mass of Al_2O_3 = 102 g mol^{-1}]

- ☐ **A** 6.02×10^{23}
- ☐ **B** 1.81×10^{24}
- ☐ **C** 3.01×10^{24}
- ☐ **D** 9.03×10^{24}

(Total for question = 1 mark)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about compounds with the molecular formula C_4H_8O.

What is the percentage by mass of each element in C_4H_8O?

(1)

	Percentage carbon	Percentage hydrogen	Percentage oxygen
☐ **A**	66.67	11.11	22.22
☐ **B**	60.00	20.00	20.00
☐ **C**	41.38	3.45	55.17
☐ **D**	30.77	61.54	7.69

(Total for question = 1 mark)

Q9.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about iron(II) salts.

What is the percentage by mass of iron in anhydrous iron(II) sulfate, $FeSO_4$, to 3 significant figures?

(1)

- ☐ **A** 21.3%
- ☐ **B** 35.1%
- ☐ **C** 36.7%
- ☐ **D** 53.8%

(Total for question = 1 mark)

Q10.

The reaction of sulfuric acid with potassium hydroxide is a neutralisation. The equation for this reaction is

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

A titration was carried out using the following method.

- Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
- 25.0 cm^3 of sulfuric acid solution, concentration 0.0800 mol dm^{-3}, was transferred to a conical flask.
- Three drops of phenolphthalein indicator were added to the sulfuric acid.
- Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
- Repeat titrations were carried out until concordant titres were obtained.

Select the most appropriate piece of apparatus to measure the 25.0 cm^3 of sulfuric acid.

(1)

- ☐ **A** burette
- ☐ **B** measuring cylinder
- ☐ **C** pipette
- ☐ **D** volumetric flask

(Total for question = 1 mark)

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about iron(II) salts.

Mohr's salt is another compound containing iron(II) ions.

It has the formula $(NH_4)_2Fe(SO_4)_2 . 6H_2O$.

What is the molar mass, in g mol^{-1}, of Mohr's salt?

(1)

- ☐ **A** 392.0
- ☐ **B** 312.0
- ☐ **C** 302.0
- ☐ **D** 284.0

(Total for question = 1 mark)

Q12.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Malachite is a green mineral with the formula $Cu_2CO_3(OH)_2$. It has a molar mass of 221 g mol^{-1}.

What is the percentage by mass of copper in pure malachite?

(1)

- ☐ **A** 40.3%
- ☐ **B** 51.4%
- ☐ **C** 57.5%
- ☐ **D** 67.9%

(Total for question = 1 mark)

Q13.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

What is the total number of **ions** in 26.4 g of ammonium sulfate, $(NH_4)_2SO_4$?

[Molar mass of $(NH_4)_2SO_4$ = 132 g mol^{-1} Avogadro constant = 6.0×10^{23} mol^{-1}]

☐ **A** 4.0×10^{22}

☐ **B** 1.2×10^{23}

☐ **C** 2.4×10^{23}

☐ **D** 3.6×10^{23}

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Mark
	C (1.81×10^{23})	**(1)**

Q2.

Question Number	Answer	Mark
	The only correct answer is C ($31.2\ dm^3$) **A** *is not correct because the answer assumes a 1:1 ratio of butane to oxygen* **B** *is not correct because the answer assumes a 1:2 ratio of butane to oxygen* **D** *is not correct because the answer assumes a 1:13 ratio of butane to oxygen*	**(1)**

Q3.

Question Number	Acceptable Answer	Mark
	The only correct answer is C ***A*** *is not correct because this is the appearance of the solution before the potassium hydroxide is added* ***B*** *is not correct because this is the colour that methyl orange would be in neutral solution* ***D*** *is not correct because this is a colour sometimes given for the end-point which is incorrect, and it is the colour of phenolphthalein in acidic solution*	**(1)**

Q4.

Question Number	Answer	Mark
	The only correct answer is **B** (41.4%) ***A*** *is not correct because this uses the atomic number in the calculation instead of the relative atomic mass* ***C*** *is not correct because this assumes the formula of strontium nitrate is* $SrNO_3$ ***D*** *is not correct because this assumes the formula of strontium nitrate is SrNO*	(1)

Q5.

Question Number	Answer	Mark
	The only correct answer is B (2.15×10^{22}) ***A*** *is not correct because the molar mass of carbon dioxide has been used in the calculation instead of that of carbon monoxide* ***C*** *is not correct because this is the number of molecules that are in one mole and not one gram of carbon monoxide* ***D*** *is not correct because this is the result of incorrectly using the molar mass of carbon monoxide rather than the number of moles of carbon monoxide*	**(1)**

Q6.

Question Number	Answer	Mark
	The only correct answer is C ***A*** *is not correct because this is the reverse of the correct colour change* ***B*** *is not correct because this is doing the reverse titration (acid in flask and carbonate in burette)* ***D*** *is not correct because this is going beyond the endpoint to an acidic solution*	**(1)**

Q7.

Question Number	Answer	Mark
	The only correct answer is D (9.03×10^{24}) ***A** is not correct because this is the answer for 1 mol of aluminium oxide as molecules* ***B** is not correct because this is the answer for 3 mol of aluminium oxide as molecules* ***C** is not correct because this is the answer for the ions in 1 mol of aluminium oxide*	**(1)**

Q8.

Question Number	Answer	Mark
	The only correct answer is A (66.67/ 11.11 / 22.22) **B** *is not correct because this calculation uses atomic number not mass* **C** *is not correct because this calculation ignores the number of each type of atom present* **D** *is not correct because this calculation ignores the mass of each atom and only uses the number*	**(1)**

Q9.

Question Number	Answer	Mark
	The only correct answer is C (36.7%) ***A** is not correct because 21.3% is calculated using the atomic number of iron* ***B** is not correct because 35.1% is calculated using all atomic numbers* ***D** is not correct because 53.8% is calculated using the atomic numbers of sulfur and oxygen*	**(1)**

Q10.

Question Number	Acceptable Answer	Mark
	The only correct answer is C ***A*** *is not correct because a burette is used to measure varied volumes* ***B*** *is not correct because a measuring cylinder is less precise* ***D*** *is not correct because a volumetric flask is less precise*	**(1)**

Q11.

Question Number	Answer	Mark
	The only correct answer is A (392.0) *B is not correct because 312.0 is calculated from only 6 multiples of the H_2 of the 6-water* *C is not correct because 302.0 is calculated by not multiplying the water by 6* *D is not correct because 284.0 is calculated by ignoring the 6-water completely*	**(1)**

Q12.

Question Number	Answer	Mark
	The only correct answer is C (57.5%) **A** *is not correct because* 40.3 % *would be the % for* $CuCO_3(OH)_2$ **B** *is not correct because* 51.4 % *would be the % for* $CuCO_3$ **D** *is not correct because* 67.9 % *would be the % for* Cu_2CO_3	**(1)**

Q13.

Question Number	Answer	Mark
	The only correct answer is D (3.6×10^{23}) ***A** is not correct because the number of moles of $(NH_4)_2SO_4$ has been divided by 3, rather than multiplied by 3* ***B** is not correct because it is the number of SO_4^{2-} ions* ***C** is not correct because it is the number of NH_4^+ ions*	**(1)**