1 The mass of magnesium ions in 1 kg of sea water is 1.3 g.
The concentration in parts per million (ppm) is

☒ **A** 1.3×10^{6}

☒ **B** 1.3×10^{3}

☒ **C** 1.3×10^{-3}

☒ **D** 1.3×10^{-6}

(Total for Question = 1 mark)

2 Calculate the total number of **ions** in 7.41 g of calcium hydroxide, $Ca(OH)_2$.

The molar mass of calcium hydroxide is 74.1 g mol^{-1}.

The Avogadro constant is 6.0×10^{23} mol^{-1}.

☒ **A** 6.0×10^{22}

☒ **B** 1.2×10^{23}

☒ **C** 1.8×10^{23}

☒ **D** 3.0×10^{23}

(Total for Question = 1 mark)

3 100 cm^3 of hydrogen is mixed with 25 cm^3 of oxygen at a temperature of 150 °C.
The gases react as shown in the equation below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

The total volume of gas present at the end of the reaction is

☒ **A** 50 cm^3

☒ **B** 100 cm^3

☒ **C** 125 cm^3

☒ **D** 150 cm^3

(Total for Question = 1 mark)

4 Sodium nitrate decomposes on heating.

$$2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$$

What is the maximum volume of oxygen, measured in dm^3 at room temperature and pressure, which could be obtained by heating 0.50 mol of sodium nitrate?

[Molar volume of a gas = 24 dm^3 mol^{-1} at room temperature and pressure]

☒ **A** 3

☒ **B** 6

☒ **C** 12

☒ **D** 24

(Total for Question = 1 mark)

5 An excess of copper(II) oxide is mixed with 40.0 cm^3 of 2.50 mol dm^{-3} hydrochloric acid.

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

(a) If the mass of copper(II) chloride produced is 5.50 g, what is the percentage yield of copper(II) chloride?

[Molar mass of copper(II) chloride = 134.4 g mol^{-1}]

(1)

☒ **A** 81.8%

☒ **B** 67.2%

☒ **C** 40.9%

☒ **D** 20.4%

(b) The ionic equation for the reaction is

(1)

☒ **A** $Cu^{2+}(s) + 2Cl^-(aq) \rightarrow CuCl_2(aq)$

☒ **B** $CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$

☒ **C** $CuO(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Cu^{2+}(Cl^-)_2(aq) + H_2O(l)$

☒ **D** $CuO(s) + 2Cl^-(aq) \rightarrow CuCl_2(aq) + O^{2-}(l)$

(c) Some facts about copper(II) chloride are given below.

Which of these gives the **best** evidence that the bonding in copper(II) chloride is ionic?

(1)

☒ **A** It has a melting temperature of 620 °C.

☒ **B** It does not conduct electricity as a solid.

☒ **C** It decomposes before it reaches its boiling temperature.

☒ **D** In the electron density map, there are no contour lines around more than one nucleus.

(Total for Question = 3 marks)

6 A compound has the composition 62.1% C, 10.3% H and 27.6% O.

What is its empirical formula?

☒ **A** CH_2O

☒ **B** C_6H_2O

☒ **C** C_6H_3O

☒ **D** C_3H_6O

(Total for Question = 1 mark)

7 25.00 cm^3 of 1.00 mol dm^{-3} sulfuric acid is fully neutralized by 50.00 cm^3 of 1.00 mol dm^{-3} sodium hydroxide.

(a) What is the concentration of sodium sulfate solution produced by the reaction, in mol dm^{-3}?

(1)

☒ **A** 1.00

☒ **B** 0.67

☒ **C** 0.50

☒ **D** 0.33

(b) The volumes are measured using burettes, with each burette reading having an uncertainty of ±0.05 cm^3.

The percentage error in measuring the 25.00 cm^3 of the acid is

(1)

☒ **A** ±0.05%

☒ **B** ±0.10%

☒ **C** ±0.20%

☒ **D** ±0.40%

(Total for Question = 2 marks)

8 Complete combustion of a hydrocarbon produced 0.66 g of carbon dioxide and 0.225 g of water.

Which of the following molecular formulae is consistent with these data?

☒ **A** C_3H_6.

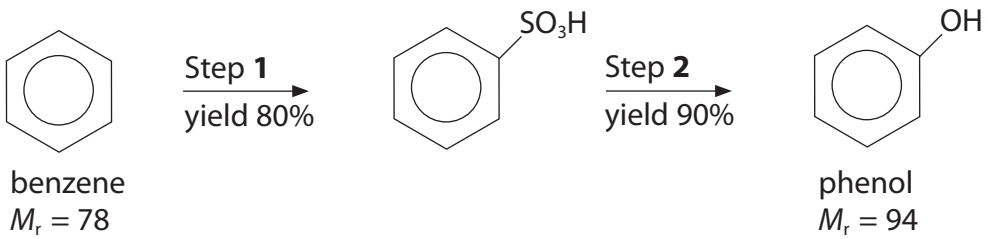
☒ **B** C_3H_8.

☒ **C** C_6H_6.

☒ **D** C_6H_{10}.

(Total for Question = 1 mark)

9 Phenol can be produced from benzene as shown in the reaction sequence below.



benzene
$M_r = 78$

phenol
$M_r = 94$

The mass of phenol, to 2 decimal places, produced from 3.90 g of benzene is

☒ **A** 3.38 g.

☒ **B** 3.76 g.

☒ **C** 4.23 g.

☒ **D** 4.70 g.

(Total for Question = 1 mark)

10 Lithium reacts with water to produce hydrogen.

$$Li(s) + H_2O(l) \rightarrow LiOH(aq) + \tfrac{1}{2}H_2(g)$$

(a) In an experiment, 0.069 g (0.01 mol) of lithium produced 90 cm^3 of hydrogen at room temperature and pressure. What is the percentage yield of hydrogen?

[1 mol of any gas occupies 24 dm^3 at room temperature and pressure.]

(1)

☒ **A** 45%

☒ **B** 60%

☒ **C** 75%

☒ **D** 90%

(b) Which of the following is **not** a possible reason for the yield being less than 100%?

(1)

☒ **A** Some oil remained on the surface of the lithium.

☒ **B** Hydrogen gas is very soluble in water.

☒ **C** A layer of oxide was present on the surface of the lithium.

☒ **D** Some of the hydrogen gas escaped collection.

(Total for Question = 2 marks)

11 How many moles of **atoms** are present in 240 cm^3 of carbon dioxide at room temperature and pressure?

[1 mol of any gas occupies 24 dm^3 at room temperature and pressure.]

☒ **A** 0.010

☒ **B** 0.020

☒ **C** 0.024

☒ **D** 0.030

(Total for Question = 1 mark)

12 What is the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3?

[Molar masses/g mol^{-1}: N = 14.0; H = 1.0; O = 16.0]

☒ **A** 14.0%

☒ **B** 17.5%

☒ **C** 28.0%

☒ **D** 35.0%

(Total for Question = 1 mark)

13 A compound of nitrogen and hydrogen only is analyzed and found to contain 97.7% by mass of nitrogen. What is the empirical formula of the compound?

Molar masses /g mol^{-1}: H = 1; N = 14

☒ **A** NH_3

☒ **B** NH_2

☒ **C** N_3H_5

☒ **D** N_3H

(Total for Question = 1 mark)

14 Which of the following can be determined, for an unknown alkene, using **only** percentage composition by mass data?

☒ **A** Molecular formula

☒ **B** Empirical (simplest) formula

☒ **C** Both the molecular formula and the empirical (simplest) formula

☒ **D** Structural formula

(Total for Question = 1 mark)

15 1.12 g of iron reacts with oxygen to form 1.60 g of an oxide of iron.
Use relative atomic masses: Fe = 56, O = 16.

What is the formula of this oxide of iron?

☒ **A** FeO_5

☒ **B** Fe_2O_{10}

☒ **C** Fe_3O_2

☒ **D** Fe_2O_3

(Total for Question = 1 mark)

16 In an experiment, 1.226 g of potassium chlorate(V), $KClO_3$, was heated. A mass of 0.320 g of oxygen gas, O_2, was collected.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

Use the molar mass of $KClO_3$ = 122.6 g mol^{-1} and relative atomic mass O = 16.

The percentage yield of oxygen in this experiment is

☒ **A** 17.4%

☒ **B** 26.1%

☒ **C** 66.7%

☒ **D** 100%

(Total for Question = 1 mark)

17 Oxygen gas, O_2, can be converted into ozone, O_3, by passing it through an electric discharge.

$$3O_2(g) \rightarrow 2O_3(g)$$

In an experiment, a volume of 300 cm^3 of oxygen was used but only 10% of the oxygen was converted into ozone. All volumes were measured at the same temperature and pressure.

The **total** volume of gas present at the end of the experiment, in cm^3, was

☒ **A** 200

☒ **B** 210

☒ **C** 290

☒ **D** 300

(Total for Question = 1 mark)

18 1.40 g of an alkene gave 3.77 g of a dichloroalkane on reaction with chlorine.

What is the molecular formula of the alkene?

☒ **A** C_2H_4

☒ **B** C_3H_6

☒ **C** C_4H_8

☒ **D** C_6H_{12}

(Total for Question = 1 mark)

19 The recommended limit for safe exposure to sulfur dioxide in the air is 0.000025 %. What is this concentration in parts per million, ppm?

☒ **A** 25

☒ **B** 0.25

☒ **C** 0.025

☒ **D** 0.0025

(Total for Question = 1 mark)

20 What is the number of **atoms** in 2.8 g of ethene, C_2H_4?

DATA

- The molar mass of C_2H_4 is 28 g mol^{-1}
- The Avogadro constant is 6.0×10^{23} mol^{-1}

☒ **A** 1.0 ^{22}

☒ **B** 6.0 ^{22}

☒ **C** 1.2 ^{23}

☒ **D** 3.6 ^{23}

(Total for Question = 1 mark)

21 A compound has the following percentage composition by mass.

C 61.0% H 15.3% N 23.7%

The empirical formula of the compound is

☒ **A** CH_3N

☒ **B** C_3H_9N

☒ **C** $C_6H_9N_2$

☒ **D** $C_8H_2N_3$

(Total for Question = 1 mark)

22 Carbon monoxide and oxygen react together as follows.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

If all volumes of gas are measured at the same temperature and pressure, the volume of carbon dioxide produced after 50 cm^3 of carbon monoxide react with 25 cm^3 of oxygen is

☒ **A** 100 cm^3

☒ **B** 75 cm^3

☒ **C** 50 cm^3

☒ **D** 25 cm^3

(Total for Question = 1 mark)

23 Potassium chlorate(V), $KClO_3$, decomposes on heating as follows.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

What is the maximum volume of oxygen, measured in dm^3 at room temperature and pressure, which could be obtained by heating 0.50 mol potassium chlorate(V)?

[Molar volume of a gas = 24 $dm^3\,mol^{-1}$ at room temperature and pressure.]

☒ **A** 8

☒ **B** 18

☒ **C** 36

☒ **D** 72

(Total for Question = 1 mark)

24 One definition of the term 'carbon footprint' is

'the amount of carbon dioxide produced when a fuel is burned.'

Fuel	Energy density / MJ l^{-1}	CO_2 produced on combustion / g l^{-1}
Paraffin	46	2580

Given the information above, what is the carbon footprint for paraffin in terms of grams of CO_2 produced per MJ of energy?

☒ **A** 46

☒ **B** 56.09

☒ **C** 2580

☒ **D** 118 680

(Total for Question = 1 mark)

25 Sodium thiosulfate was used to determine the concentration of iodine by titration.

(a) The sodium thiosulfate solution was prepared by dissolving 4.5 g of sodium thiosulfate in water and making the solution up to 250 cm^3 in a volumetric flask. The volumetric flask is accurate to ± 0.3 cm^3 so, to match this accuracy, the mass of the sodium thiosulfate should be accurate to at least

(1)

☒ **A** ± 0.5 g

☒ **B** ± 0.05 g

☒ **C** ± 0.005 g

☒ **D** ± 0.0005 g

(b) With the sodium thiosulfate in the burette, what is the colour of the solution in the conical flask at the end-point of the reaction?

(1)

☒ **A** Blue-black

☒ **B** Colourless

☒ **C** Red-brown

☒ **D** Yellow

(Total for Question = 2 marks)

26 15 cm^3 of a gaseous hydrocarbon requires 90 cm^3 of oxygen for complete combustion, both volumes being measured at 15 °C and 1 atm. The formula of the hydrocarbon is

☒ **A** C_4H_6

☒ **B** C_4H_8

☒ **C** C_4H_{10}

☒ **D** impossible to calculate without knowing the molar volume of gases under these conditions.

(Total for Question = 1 mark)

27 A drop of sodium manganate(VII) solution is placed at the centre of a piece of moist filter paper on a microscope slide. The ends of the paper are clipped to a 30 V DC power supply. After a few minutes,

☒ **A** a purple colour has moved towards the positive terminal.

☒ **B** a purple colour has moved towards the negative terminal.

☒ **C** an orange colour has moved towards the positive terminal.

☒ **D** an orange colour has moved towards the negative terminal.

(Total for Question = 1 mark)

28 How many moles of **ions** are present in 20 cm^3 of 0.050 mol dm^{-3} calcium chloride solution, $CaCl_2(aq)$?

☒ **A** 0.0050

☒ **B** 0.0030

☒ **C** 0.0020

☒ **D** 0.0010

(Total for Question = 1 mark)

29 The Avogadro constant is 6.0×10^{23} mol^{-1}. The number of **atoms** in 1 mol of dinitrogen tetroxide, N_2O_4, is

☒ **A** 3.6 ^{24}

☒ **B** 1.8 ^{24}

☒ **C** 6.0 ^{23}

☒ **D** 1.0 ^{23}

(Total for Question = 1 mark)

30 The equation for the complete combustion of ethane is

$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$$

What volume of oxygen, measured at room temperature and pressure, is needed to completely burn 0.1 mol of ethane?

[The volume of 1 mol of any gas measured at room temperature and pressure is 24 dm^3]

☒ **A** 2.4 dm^3

☒ **B** 4.8 dm^3

☒ **C** 8.4 dm^3

☒ **D** 16.8 dm^3

(Total for Question = 1 mark)

31 A sample of swimming pool water contains 0.482 parts per million (ppm) of chlorine. This is equal to a percentage of

☒ **A** 0.000482

☒ **B** 0.0000482

☒ **C** 0.00000482

☒ **D** 0.000000482

(Total for Question = 1 mark)

32 A compound was found to contain 2.8 g of nitrogen and 8.0 g of oxygen.

What is the empirical formula of the compound?

Use the Periodic Table as a source of data.

☒ **A** NO

☒ **B** NO_2

☒ **C** N_2O_3

☒ **D** N_2O_5

(Total for Question = 1 mark)

33 What is the total number of **atoms** in 1.8 g of water, H_2O?

DATA
- The molar mass of H_2O is 18 g mol^{-1}
- The Avogadro Constant is 6.0×10^{23} mol^{-1}

☒ **A** 6.0×10^{22}

☒ **B** 6.0×10^{23}

☒ **C** 1.8×10^{23}

☒ **D** 1.8×10^{24}

(Total for Question = 1 mark)

34 Phosphorus(V) chloride, PCl_5, reacts with water according to the equation

$$PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$$

If 1.04 g of phosphorus pentachloride (molar mass = 208 g mol^{-1}) is reacted completely with water and the solution made up to 1 dm^3, the concentration of the hydrochloric acid in mol dm^{-3} is

☒ **A** 0.001

☒ **B** 0.005

☒ **C** 0.025

☒ **D** 0.250

(Total for Question = 1 mark)

35 A sample of sodium chlorate(V), $NaClO_3$, was heated and 120 cm^3 of oxygen gas was collected.

$$2NaClO_3(s) \rightarrow 2NaCl(s) + 3O_2(g)$$

Calculate the number of moles of sodium chlorate(V) that were decomposed in the above reaction.

[Molar volume of a gas under the conditions of the experiment = 24000 $cm^3\ mol^{-1}$]

☒ **A** 2.50×10^{-3}

☒ **B** 3.33×10^{-3}

☒ **C** 5.00×10^{-3}

☒ **D** 7.50×10^{-3}

(Total for Question = 1 mark)

36 3.0 dm^3 of sulfur dioxide reacts with 1.5 dm^3 of oxygen, under suitable conditions, according to the equation below.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

What is the maximum volume of sulfur trioxide that can be formed in the above reaction?

[The volumes of the gases are measured at the same temperature and pressure.]

☒ **A** 6.0 dm^3

☒ **B** 4.5 dm^3

☒ **C** 3.0 dm^3

☒ **D** 1.5 dm^3

(Total for Question = 1 mark)

37 Hydrochloric acid and sodium carbonate solution react as shown below.

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Which sample of sodium carbonate solution will be neutralized by 20 cm^3 of 0.05 mol dm^{-3} hydrochloric acid?

	Volume of sodium carbonate/ cm^3	Concentration of sodium carbonate/ mol dm^{-3}
☒ **A**	10	0.05
☒ **B**	40	0.05
☒ **C**	40	0.10
☒ **D**	10	0.10

(Total for Question = 1 mark)

38 The concentration of a solution of potassium iodate(V) can be determined by the liberation of iodine, followed by titration with sodium thiosulfate.

A suitable indicator is

☒ **A** methyl orange.

☒ **B** phenolphthalein.

☒ **C** starch.

☒ **D** universal indicator.

(Total for Question = 1 mark)

39 A 50 cm^3 sample of a gaseous hydrocarbon required exactly 250 cm^3 of oxygen for complete combustion. A volume of 150 cm^3 of carbon dioxide was produced.

[All volume measurements were made at the same temperature and pressure.]

Which of the following is the correct formula of the hydrocarbon?

☒ **A** C_3H_4

☒ **B** C_3H_8

☒ **C** C_5H_{10}

☒ **D** C_5H_{12}

(Total for Question = 1 mark)

40 A solution contains 66 ppm of a solute. The mass of the solute dissolved in 1 kg of this solution is

☒ **A** 66 g

☒ **B** 0.66 g

☒ **C** 0.066 g

☒ **D** 0.000066 g

(Total for Question 1 mark)