1 Complete combustion of 50 cm^3 of a hydrocarbon vapour gave 350 cm^3 of carbon dioxide, both gas volumes being measured at the same temperature and pressure. The formula of the hydrocarbon could be

☒ **A** C_8H_{18}

☒ **B** C_7H_{16}

☒ **C** C_6H_{14}

☒ **D** C_5H_{12}

(Total for Question 1 mark)

2 Which of the following statements is true? The Avogadro constant is the number of

☒ **A** grams of any element which contains 6.02×10^{23} atoms of that element.

☒ **B** atoms contained in one mole of any element.

☒ **C** atoms contained in one mole of any monatomic element.

☒ **D** particles (atoms, molecules or ions) required to make one gram of a substance.

(Total for Question 1 mark)

3 A compound **Z** contains, by mass, 26.7% carbon, 2.2% hydrogen, and 71.1% oxygen. The empirical formula of **Z** is

☒ **A** CHO_2

☒ **B** $C_2H_2O_4$

☒ **C** CHO

☒ **D** $C_2H_2O_2$

(Total for Question 1 mark)

4 An important reaction which occurs in the catalytic converter of a car is

$$2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$$

In this reaction, when 500 cm^3 of CO reacts with 500 cm^3 of NO at 650 °C (the operating temperature of the catalyst) and at 1 atm, the **total** volume of gases produced at the same temperature and pressure is

☒ **A** 500 cm^3

☒ **B** 750 cm^3

☒ **C** 1000 cm^3

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

(Total for Question 1 mark)

5 Ethanol (molar mass 46 g mol^{-1}) is manufactured by the hydration of ethene (molar mass 28 g mol^{-1}):

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

In a typical process 28 tonnes of ethene produces 43.7 tonnes of ethanol. The percentage yield of ethanol in this process is

☒ **A** 64%

☒ **B** 95%

☒ **C** 100%

☒ **D** 156%

(Total for Question 1 mark)

6 The following reactions have been used in the chemical industry to make liquid and solid products, allowing any gaseous products to escape into the atmosphere:

A $CH_3OH(g) + CO(g) \rightarrow CH_3COOH(l)$

B $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

C $CH_4(g) + 3C_2(g) \rightarrow CHCl_3(l) + 3HCl(g)$

D $CH_2CH_2(g) + Cl_2(g) \rightarrow CH_2ClCH_2Cl(l)$

(a) Which reaction has an atom economy by mass of 56%?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which reaction causes the most immediate damage to the environment?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which reaction is an electrophilic addition?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 marks)

7 The enthalpy change of neutralization of an acid by an alkali is measured by adding 10.0 cm^3 of hydrochloric acid to 10.0 cm^3 of sodium hydroxide. 10.0 cm^3 pipettes with an accuracy of ±0.04 cm^3 are used to measure out both solutions.

The overall percentage error in measuring the total volume of the reaction mixture is

☒ **A** ±0.04%

☒ **B** ±0.08%

☒ **C** ±0.4%

☒ **D** ±4.0%

(Total for Question 1 mark)

8 A sample of gas was prepared for use in helium-neon lasers. It contained 4 g of helium and 4 g of neon. What is the ratio of helium atoms to neon atoms in the sample?

☒ **A** 1 : 1

☒ **B** 2.5 :

☒ **C** 1 : 5

☒ **D** 5 : 1

(Total for Question = 1 mark)

9 The overall equation for the reaction between sulfur and oxygen to form sulfur trioxide is shown below.

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$$

0.9 mol of $O_2(g)$ reacted completely with excess sulfur. What volume, in dm^3, of sulfur trioxide would form?

[Assume the molar gas volume = 24 dm^3 mol^{-1}]

☒ **A** $(0.9 \times 3/2) \times 24$

☒ **B** $(0.9 \times 3/2) \div 24$

☒ **C** $(0.9 \times 2/3) \times 24$

☒ **D** $(0.9 \times 2/3) \div 24$

(Total for Question = 1 mark)

10 Which of these solutions does **not** contain the same total number of ions as the others?

☒ **A** 10.00 cm^3 of 0.100 mol dm^{-3} NaCl(aq)

☒ **B** 20.00 cm^3 of 0.050 mol dm^{-3} NaCl(aq)

☒ **C** 20.00 cm^3 of 0.050 mol dm^{-3} $MgCl_2$(aq)

☒ **D** 13.33 cm^3 of 0.050 mol dm^{-3} $MgCl_2$(aq)

(Total for Question = 1 mark)

11 Calculate the volume of dilute sulfuric acid, concentration 0.500 mol dm^{-3}, required to neutralize 20.0 cm^3 aqueous sodium hydroxide, concentration 0.100 mol dm^{-3}.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

☒ **A** 2.0 cm^3

☒ **B** 4.0 cm^3

☒ **C** 8.0 cm^3

☒ **D** 20.0 cm^3

(Total for Question = 1 mark)

12 A compound was analysed and found to contain

1.45 g carbon 0.482 g hydrogen 1.69 g nitrogen

[Relative atomic masses: C = 12; H = 1; N = 14]

The empirical formula of the compound is

☒ **A** CH_3N

☒ **B** CH_4N

☒ **C** CH_5N

☒ **D** C_2H_4N

(Total for Question = 1 mark)

13 17.1 g of aluminium sulfate, $Al_2(SO_4)_3$, was dissolved in water.

Calculate the number of sulfate ions, SO_4^{2-}, present in the solution formed.

[Assume the molar mass of $Al_2(SO_4)_3$ is 342 g mol^{-1} and the Avogadro Constant is 6×10^{23} mol^{-1}.]

☒ **A** 3×10^{21}

☒ **B** 1×10^{22}

☒ **C** 3×10^{22}

☒ **D** 9×10^{22}

(Total for Question = 1 mark)

14 Calculate the mass of calcium hydroxide, $Ca(OH)_2$, present in 100 cm^3 of a 0.100 mol dm^{-3} solution.

[Assume the molar mass of $Ca(OH)_2$ is 74.0 g mol^{-1}.]

☒ **A** 0.570 g

☒ **B** 0.740 g

☒ **C** 1.85 g

☒ **D** 3.70 g

(Total for Question = 1 mark)

15 Sodium hydrogensulfate, $NaHSO_4$, reacts with sodium hydroxide, NaOH, as shown below.

$$NaHSO_4(aq) + NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$$

0.0100 mol of sodium hydrogensulfate is neutralized with dilute sodium hydroxide, concentration 0.200 mol dm^{-3}.

Calculate the volume of sodium hydroxide required.

☒ **A** 20.0 cm^3

☒ **B** 50.0 cm^3

☒ **C** 100 cm^3

☒ **D** 500 cm^3

(Total for Question = 1 mark)

16 Which of the following gas samples occupies the greatest volume at the same temperature and pressure?

[Relative atomic masses: H = 1; C = 12; O = 16; F = 19; Ne = 20]

☒ **A** 1 gram of ethane

☒ **B** 1 gram of oxygen

☒ **C** 1 gram of fluorine

☒ **D** 1 gram of neon

(Total for Question = 1 mark)

17 Which of the following processes has the highest atom economy?

☒ **A** Making poly(ethene) from ethene.

☒ **B** Making ethene from eicosane, $C_{20}H_{42}$.

☒ **C** Making chloromethane from methane.

☒ **D** Making magnesium chloride from magnesium and hydrochloric acid.

(Total for Question = 1 mark)

18 How many molecules are present in 16 g of oxygen gas, $O_2(g)$?

[Avogadro constant = 6×10^{23} mol^{-1}]

☒ **A** 96 ^{23}

☒ **B** $12 \times$ ^{23}

☒ **C** 6×10^{23}

☒ **D** $3 \times$ ^{23}

(Total for Question = 1 mark)

19 Nickel(II) sulfate is prepared by adding an excess of nickel(II) carbonate to 0.010 mol of dilute sulfuric acid.

$$NiCO_3(s) + H_2SO_4(aq) \rightarrow NiSO_4(aq) + H_2O(l) + CO_2(g)$$

Solid nickel(II) sulfate crystals are produced with a 20% yield. How many moles of nickel(II) sulfate crystals are obtained?

☒ **A** 0.001

☒ **B** 0.002

☒ **C** 0.010

☒ **D** 0.050

(Total for Question = 1 mark)

20 Calculate the volume of dilute hydrochloric acid, concentration 0.200 mol dm^{-3}, needed to neutralize 20 cm^3 of aqueous calcium hydroxide, concentration 0.100 mol dm^{-3}.

$$2HCl(aq) + Ca(OH)_2(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

☒ **A** 10 cm^3

☒ **B** 20 cm^3

☒ **C** 40 cm^3

☒ **D** 80 cm^3

(Total for Question = 1 mark)

21 The concentration of blood glucose is usually given in millimoles per dm^3 or mmol dm^{-3}. A reading of 5.0 mmol dm^{-3} is within the normal range. Glucose has a molar mass of 180 g mol^{-1}. What mass of glucose dissolved in 1 dm^3 of blood would give this normal reading?

☒ **A** 0.090 g

☒ **B** 0.18 g

☒ **C** 0.90 g

☒ **D** 9.0 g

(Total for Question 1 mark)

22 Oxygen can be prepared using several different reactions. Which of those given below has the highest atom economy by mass?

☒ **A** $NaNO_3 \rightarrow NaNO_2 + ½O_2$

☒ **B** $H_2O_2 \rightarrow H_2O + ½O_2$

☒ **C** $Cl_2 + H_2O \rightarrow 2HCl + ½O_2$

☒ **D** $PbO_2 \rightarrow PbO + ½O_2$

(Total for Question 1 mark)

23 During a titration, when the solution in a pipette is transferred to a conical flask, a small amount of liquid remains in the tip of the pipette. This situation should be dealt with by

☒ **A** leaving the liquid in the pipette which is calibrated to allow for it.

☒ **B** slightly over-filling the pipette to compensate for the additional volume.

☒ **C** carefully blowing the liquid out of the pipette to ensure that it is empty.

☒ **D** repeating the titration.

(Total for Question 1 mark)

24 The tolerance of a 25 cm^3 pipette is ±0.06 cm^3. The percentage error in the measurement of 25 cm^3 using this pipette is

☒ **A** ±0.06%

☒ **B** ±0.12%

☒ **C** ±0.24%

☒ **D** ±0.48%

(Total for Question 1 mark)

25 A series of titrations is carried out using the same conical flask. Before carrying out each titration, the conical flask **must** be

☒ **A** rinsed with ethanol.

☒ **B** rinsed with distilled or deionised water.

☒ **C** rinsed with the solution that it will contain.

☒ **D** dried to remove all traces of liquid.

(Total for Question 1 mark)

26 The Avogadro constant is 6.0×10^{23} mol ^{1}. Therefore the number of **atoms** in 1 mol of carbon dioxide is

☒ **A** 2.0×10^{23}

☒ **B** 6.0×10^{23}

☒ **C** 1.2×10^{24}

☒ **D** 1.8×10^{24}

(Total for Question 1 mark)

27 The equation for the complete combustion of octane is

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(a) The mass of 10 mol of octane is

(1)

☒ **A** 0.66 kg

☒ **B** 1.14 kg

☒ **C** 2.10 kg

☒ **D** 2.28 kg

(b) The volume of 1 mol of any gas (measured at room temperature and pressure) is 24 dm^3. Hence the volume of oxygen (measured at room temperature and pressure) required for the complete combustion of 10 mol of octane is

(1)

☒ **A** 240 dm^3

☒ **B** 300 dm^3

☒ **C** 3000 dm^3

☒ **D** 6000 dm^3

(Total for Question 2 marks)

28 In 2006, the concentration of carbon dioxide in the atmosphere was 382 ppm. This is equivalent to

☒ **A** 0.00382%

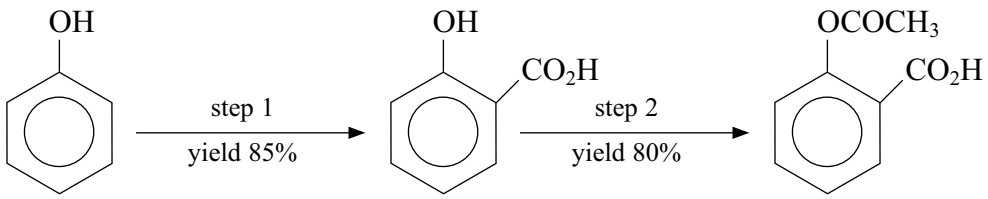
☒ **B** 0.0382%

☒ **C** 0.382%

☒ **D** 3.82%

(Total for Question 1 mark)

29 Consider the reaction scheme below and calculate the mass of aspirin you would expect to form if you started with 47 g of phenol.



phenol, M_r 94 aspirin, M_r 180

☒ **A** 31.96 g

☒ **B** 61.20 g

☒ **C** 74.25 g

☒ **D** 90.00 g

(Total for Question 1 mark)

30 The human body contains around 0.025 g of iodine molecules, I_2. Which of the following shows the number of iodine **atoms** in 0.025 g of I_2?

The Avogadro constant is $6.02 \times 10^{23}\,\text{mol}^{-1}$.

☒ **A** $\dfrac{0.025}{126.9} \times 6.02 \times 10^{23}$

☒ **B** $\dfrac{0.025}{253.8} \times 6.02 \times 10^{23}$

☒ **C** $\dfrac{253.8}{0.025} \times 6.02 \times 10^{23}$

☒ **D** $\dfrac{126.9}{0.025} \times 6.02 \times 10^{23}$

(Total for Question = 1 mark)

31 20 cm^3 of sulfuric acid, concentration 0.25 mol dm^{-3}, was neutralized in a titration with barium hydroxide, concentration 0.50 mol dm^{-3}. The equation for the reaction is

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

(a) The volume of barium hydroxide required was

(1)

☒ **A** 10 cm^3

☒ **B** 20 cm^3

☒ **C** 25 cm^3

☒ **D** 40 cm^3

(b) During the titration, the barium hydroxide was added until it was present in excess. The electrical conductivity of the titration mixture

(1)

☒ **A** increased steadily.

☒ **B** decreased steadily.

☒ **C** increased and then decreased.

☒ **D** decreased and then increased.

(Total for Question = 2 marks)

32 Why does phenolphthalein, which is colourless in acidic solutions, turn pink in alkaline solutions?

☒ **A** It is oxidized to a pink compound by hydroxide ions.

☒ **B** It forms a pink anion by loss of H^+ ions.

☒ **C** It forms a pink anion by gain of H^+ ions.

☒ **D** It forms a pink cation by gain of H^+ ions.

(Total for Question = 1 mark)