Test 1 Chemical Industry and Mole Calculations

Multiple Choice (10 marks - 1 for each question)

1. Which compound is not a raw material in the chemical industry?
   A  Benzene
   B  Water
   C  Iron oxide
   D  Sodium chloride

2. Which of the following is produced by a batch process?
   A  Sulphuric acid from sulphur and oxygen
   B  Aspirin from salicylic acid
   C  Iron from iron ore
   D  Ammonia from nitrogen and hydrogen

3. The costs involved in the industrial production of a chemical are made up of fixed costs and variable costs.

   Which of the following is most likely to be classified as a variable cost?
   A  The cost of land rental
   B  The cost of plant construction
   C  The cost of labour
   D  The cost of raw materials

4. Which compound is a raw material in the chemical industry?
   A  Ethene
   B  Ammonia
   C  Sodium chloride
   D  Sulphuric acid
5. Which of the following gases has the same volume as 128.2 g of sulphur dioxide gas? 
   (All volumes are measured under the same conditions of temperature and pressure).
   A  2.0g of hydrogen
   B  8.0g of helium
   C  32.0g of oxygen
   D  80.8g of neon

6. What volume of oxygen, in litres, is required for the complete combustion of 1 litre of butane gas? 
   (All volumes are measured under the same conditions of temperature and pressure).
   A  1
   B  4
   C  6.5
   D  13

7. \[3\text{CuO} + 2\text{NH}_3 \rightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}\]
   What volume of gas, in cm\(^3\), would be obtained by reaction between 100 cm\(^3\) of ammonia gas and excess copper (II) oxide? 
   (All volumes are measured at atmospheric pressure and 20\(^\circ\)C)
   A  50
   B  100
   C  200
   D  400

8. In which reaction is the volume of products less than the volume of reactants.
   A  \[\text{CH}_4 (g) + 2\text{O}_2 (g) \rightarrow \text{CO}_2 (g) + 2\text{H}_2\text{O} (g)\]
   B  \[2\text{NH}_3 (g) \rightarrow \text{N}_2 (g) + 3\text{H}_2 (g)\]
   C  \[\text{H}_2 (g) + \text{Cl}_2 (g) \rightarrow 2\text{HCl} (g)\]
   D  \[2\text{CO} (g) + \text{O}_2 (g) \rightarrow 2 \text{CO}_2 (g)\]
9. A mixture of sodium bromide and sodium sulphate is known to contain 5 moles of sodium and 2 moles of bromide ions. How many moles of sulphate ions are present?

A  1.5  
B  2.0  
C  2.5  
D  3.0

10. How many moles of oxygen atoms are in 0.5 mol of carbon dioxide?

A  0.25  
B  0.5  
C  1  
D  2

**Written Part (20 marks)**

11. The following flow diagram outlines the manufacture of sodium carbonate by the Solvay Process.

(a) Name the reactants in the reaction taking place in the Solvay Tower.
(b) Using the information in the flow diagram, give two different features of the Solvay Process that make it economical.
12. Salpherite is an impure zinc sulphide ore, containing traces of other metal compounds. The flow diagram for the extraction of zinc from this ore is shown below.

(a) Name gas A

(b) Name the type of reaction taking place in reaction vessel B.

(c) It is economical to make use of the sulphuric acid produced. Where would you put an arrow on the flow diagram to show how the sulphuric acid could be used in this extraction?
13. Copper reacts with hot, concentrated sulphuric acid to produce sulphur dioxide gas.

\[ \text{Cu} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O} \]

Calculate the volume, in litres, of sulphur dioxide gas that would be produced when 10g of copper reacts with excess concentrated sulphuric acid. (Take the molar volume of sulphur dioxide to be 24 litres mol\(^{-1}\) )

14. A student added 50cm\(^3\) of 4.0 moll\(^{-1}\) hydrochloric acid to 4.0g of magnesium ribbon.

The balanced equation for the reaction is:

\[ \text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g}) \]

Show by calculation which reactant is in excess.

15. Aspirin, a common painkiller, can be made by the reaction of salicylic acid with ethanoic anhydride.

\[
\begin{align*}
\text{C}_7\text{H}_6\text{O}_3 & \quad \text{C}_4\text{H}_6\text{O}_3 & \quad \text{C}_9\text{H}_8\text{O}_4 & \quad \text{C}_2\text{H}_4\text{O}_2 \\
\text{salicylic acid} & \quad \text{ethanoic anhydride} & \quad \text{aspirin} & \quad \text{ethanoic acid} \\
\text{mass of one mole} & \quad \text{mass of one mole} & \quad \text{mass of one mole} & \quad \text{mass of one mole} \\
\text{= 138 g} & \quad \text{= 102 g} & \quad \text{= 180 g} & \quad \text{= 60 g}
\end{align*}
\]

(a) Calculate the atom economy for the formation of aspirin using the method.

(b) In a laboratory preparation of aspirin, 5.02g of salicylic acid produced 2.62g of aspirin. Calculate the % yield of aspirin.
16. A student bubbled 240 cm$^3$ of carbon dioxide into 400 cm$^3$ of 0.1 mol l$^{-1}$ lithium hydroxide solution

The equation for the reaction is:

$$2\text{LiOH(aq)} + \text{CO}_2(g) \rightarrow \text{Li}_2\text{CO}_3(aq) + \text{H}_2\text{O(l)}$$

Calculate the number of moles of lithium hydroxide that would not have reacted. (Take the molar volume of carbon dioxide to be 24 litres mol$^{-1}$) 3

17. When a mixture of solid sodium hydroxide and sodium ethanoate is heated, methane gas and solid sodium carbonate are produced.

$$\text{NaOH (s)} + \text{CH}_3\text{COONa (s)} \rightarrow \text{CH}_4 (g) + \text{Na}_2\text{CO}_3 (s)$$

Draw a diagram of the apparatus which could be used for this reaction showing how the methane gas can be collected and its volume measured. 2

End of Question Paper 30
Marking Scheme

1. A
2. B
3. D
4. C
5. B
6. C
7. A
8. B
9. A
10. C

11. (a) Ammonia, seawater and carbon dioxide (all 3 for 1 mark) 1
    (b) Recycling materials, cheap raw materials 2

12. (a) Sulphur dioxide 1
    (b) Displacement/ redox 1
    (c) In the reaction with zinc oxide to produce zinc sulphate 1

13. 3.78 litres (units not required) 3
     1 mark is awarded for a correct strategy to work out number of moles of copper
     1 mark is awarded for correct strategy work out moles of sulfur dioxide gas using
     balanced equation.
     1 mark for the correct volume of sulfur dioxide.

14. Moles of Mg = 0.165 Moles of HCl= 0.2 (1 mark) 2
     Zinc is in excess (1 mark)

15. (a) 75 %
     Total mass of reactants = 240 g (1 mark)
     \[ \text{Atom Economy} = \frac{180}{240} \times 100\% = 75\% \] (1 mark)
     (Accept 0·75 also, this would be atom economy as a fraction) 2
    (b) 40 %
     1 mark is given for either calculating the theoretical yield, or for working out the
     numbers of moles of reactant and product formed.
     eg 6•55(g) or both 0•0364 and 0•0146
     1 mark is given for calculating the % yield; either using the actual and theoretical
     masses, or using the actual number of moles of products and actual number of
     moles of reactant. 2

16. 0.02 moles of LiOH excess 3
    Correct moles of LiOH and CO₂ (1 mark)
    Correct mole of LiOH needed from equation (1 mark)
    Li OH in excess by (1 mark)

17. Correct apparatus labelled and methane collected over water with a measuring cylinder. Or with a syringe. 2