



CHEMISTRY ATAR

Test 3 2015 The mole Question/Answer Booklet

Student Name	
Class (Teacher)	

Section	Mark
One	/20
Two	/32
Total	/52
%	

Time allowed for this paper

Working time for paper: 50 minutes

Material required/recommended for this paper

To be provided by the supervisor

This Question/Answer booklet
Multiple-choice Answer sheet
Chemistry Data sheet

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in the WACE examinations

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Section One: Multiple-choice

(20 marks)

This section has 10 questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided.

1. Which of the following describes the mass of Avogadro's number of particles (6.022×10^{23})?

- a) 10g of sodium hydroxide \times
- ☒ b) 32g of oxygen gas \checkmark
- c) 9g of water \times
- d) 55g of hydrochloric acid \times

2. The number of atoms of carbon in one mole of ethanol, $\text{C}_2\text{H}_5\text{OH}$, is:

- a) 6.022
- b) 6.022×10^{23}
- c) 1.204×10^{23}
- ☒ d) 1.204×10^{24}

3. Calculate the **mass** of hydrogen atoms in 0.132 g of $(\text{NH}_4)_2\text{SO}_4$.

$$m(\text{H}) = n \times M$$

$$= 7.92 \times 10^{-3}$$

$$\times 1.008$$

$$= 7.98 \times 10^{-3}$$

- a) 4.03×10^{-4} g
- ☒ b) 8.05×10^{-3} g
- c) 8.05×10^{-4} g
- d) 4.03×10^{-3} g

$$n((\text{NH}_4)_2\text{SO}_4) = m/M$$

$$= \frac{0.132}{132.154}$$

$$= 9.9 \times 10^{-4} \text{ mol}$$

$$n(\text{H}) = 8 \times n((\text{NH}_4)_2\text{SO}_4)$$

$$= 8 \times 9.9 \times 10^{-4} =$$

$$7.92 \times 10^{-3} \text{ g}$$

4. Which of the following contains the least number of molecules?

- a) 1g of H_2 $n = 0.496 \text{ mol}$
- ☒ b) 2g of N_2 $n = 0.07 \text{ mol}$
- c) 4g of O_2 $n = 0.125 \text{ mol}$
- d) 8g of O_3 $n = 0.167 \text{ mol}$

5. What is the percentage by mass of Iron in Fe_2O_3 ? $M(\text{Fe}_2\text{O}_3) = 159.7 \text{ g mol}^{-1}$

- a) 35 %
- b) 50 %
- c) 60 %
- ☒ d) 70 %

$$\begin{aligned} \% \text{ Fe} &= \frac{m(\text{Fe})}{M(\text{Fe}_2\text{O}_3)} \times 100 \\ &= \frac{111.7}{159.7} \times 100 = 69.9\% \end{aligned}$$

6. Sodium hydrogen carbonate decomposes on heating as in the equation:



If 0.2000 mole of Carbon Dioxide is produced, what mass of sodium hydrogen carbonate has reacted?

- a) 84.01 g
- b) 67.21 g
- c) 16.80 g
- ☒ d) 33.61 g

$$\begin{aligned} n(\text{NaHCO}_3) &= 2 \times n(\text{CO}_2) \\ &= 2 \times 0.2 \\ &= 0.4 \text{ mol} \\ m(\text{NaHCO}_3) &= n \times M \\ &= 0.4 \times 84.008 \\ &= 33.6 \text{ g} \end{aligned}$$

7. Once vaporised and ignited, ethanol burns readily according to the following equation:



What mass of carbon dioxide is produced when 0.5 mole of ethanol is completely burnt?

- a) 2 g
- ☒ b) 44 g
- c) 88 g
- d) 66 g

$$\begin{aligned} n(\text{CO}_2) &= 2 \times n(\text{C}_2\text{H}_5\text{OH}) \\ &= 2 \times 0.5 \\ &= 1 \text{ mol} \\ m(\text{CO}_2) &= n \times M \\ &= 1 \times 44.01 \\ &= 44.01 \text{ g} \end{aligned}$$

8. Which of the following contains the greatest number of molecules at STP?

- a) 16 g of oxygen gas $n = 0.5 \text{ mol}$
- b) 4 g of helium gas $n = 1 \text{ mol}$
- ☒ c) 40 L of hydrogen gas $n = \frac{V}{22.71} = \frac{40}{22.71} = 1.76 \text{ mol}$
- d) 1.5 moles of carbon dioxide gas $n = 1.5 \text{ mol}$

$$PV = nRT$$

$$P \propto T$$

9. A gas is stored in a rigid container. If the temperature of the container is reduced, what will happen to the pressure of the gas in the container?

- a) The pressure will remain unchanged.
- ☒ b) The pressure will decrease.
- c) The pressure will increase.
- d) The pressure cannot be determined without knowing the number of moles of gas.

10. According to the equation:



What volume of oxygen (at STP) is required to react to produce 18 g of water?

- ☒ a) 11.4 L
- b) 22.7 L
- c) 44.9 L
- d) 67.2 L

$$n(\text{H}_2\text{O}) = m/M$$

$$= \frac{18}{18.016}$$

$$= 0.999 \text{ mol}$$

$$n(\text{O}_2) = \frac{n(\text{H}_2\text{O})}{2}$$

$$= \frac{0.999}{2} = 0.499 \text{ mol}$$

$$V(\text{O}_2) = n \times 22.7 \text{ L}$$

$$= 0.499 \times 22.7$$

$$= \underline{\underline{11.35 \text{ L}}}$$

END OF PART A – PLEASE TURN OVER

PART B: EXTENDED ANSWER AND CALCULATIONS

(32 MARKS)

Question 1

4 Marks

A student was given a sample of 6.00g of NH_4Cl

a) What is the chemical name of this compound?

..... ammonium chloride (1)

b) What is the percentage of nitrogen by mass, in this compound?

$$\begin{aligned} \% \text{N} &= \frac{m(\text{N})}{M(\text{NH}_4\text{Cl})} \times 100 \\ &= \frac{14.01}{53.492} \times 100 = 26.2\% \end{aligned} \quad (2)$$

c) How many moles of the compound are in this sample?

$$\begin{aligned} n(\text{NH}_4\text{Cl}) &= \frac{m}{M} \\ &= \frac{6}{53.492} = 0.112 \text{ mol} \end{aligned} \quad (1)$$

Question 2

4 Marks

With one or more of the postulates of the Kinetic Theory of Gases explain why;

a) Gases are easily compressed.

..... large distance between them
..... when pressure is exerted space between
..... particles is reduced.
..... volume of particles is negligible (2)

b) Heating a gas causes an increase in the pressure exerted by the gas.

..... kinetic energy of the particles increases
..... as temperature increases.
..... Particles collide more frequently & exert
..... pressure on walls of container. (2)

Question 3

5 marks

A 15.3 g piece of steel, containing only iron and carbon, was treated with an excess of hot hydrochloric acid to form 3.02 L of hydrogen at STP.



- a) Work out the number of moles of Hydrogen gas (H_2) produced. (1)

$$\begin{aligned} n(\text{H}_2) &= \frac{V}{22.71} \\ &= \frac{3.02}{22.71} = 0.133 \text{ mol} \end{aligned}$$

- b) Work out the number of moles of iron used up in this reaction. (1)

$$\begin{aligned} n(\text{Fe}) &= 1 \times n(\text{H}_2) \\ &= 0.133 \text{ mol} \end{aligned}$$

- c) Work out the mass of iron used up. (1)

$$\begin{aligned} m(\text{Fe}) &= n \times M \\ &= 0.133 \times 55.85 \\ &= 7.43 \text{ g} \end{aligned}$$

- d) Calculate the percentage of iron in the steel. (2)
Use appropriate number of significant figures.

$$\begin{aligned} \% \text{ Fe in steel} &= \frac{m(\text{Fe})}{m(\text{steel})} \times 100 \\ &= \frac{7.43}{15.3} \times 100 \\ &= 48.5\% \end{aligned}$$

Question 4. Balance the following chemical equations:

(3 marks)

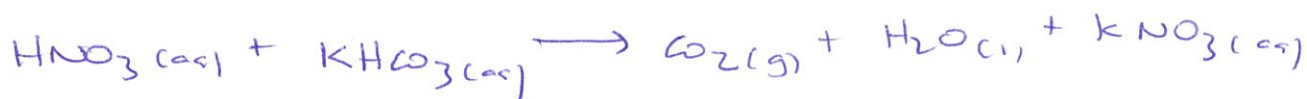


Question 5

(6 marks)

Write balanced chemical equations (including states of matter for each species) of the following reactions:

- (a) The production of carbon dioxide gas, water and potassium nitrate upon the addition of nitric acid to potassium hydrogen carbonate solution.
(3 marks)



- (b) The reaction of magnesium carbonate and hydrochloric acid to produce magnesium chloride, water and carbon dioxide.
(3 marks)



Question 6**(4 marks)**

A sample of copper (I) oxide was dissolved in sulfuric acid and the solution evaporated to dryness to yield 3.14 g of Cu_2SO_4 .



(a) What was the mass of the copper (I) oxide sample?

(4 marks) **Use appropriate number of significant figures.**

$$\begin{aligned} n(\text{Cu}_2\text{SO}_4) &= \frac{m}{M} \\ &= \frac{3.14}{223.17} \\ &= 0.01407 \text{ mol} \end{aligned}$$

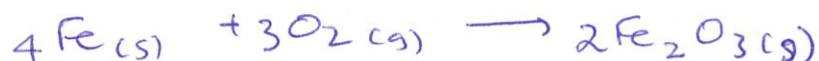
$$\begin{aligned} m(\text{Cu}_2\text{O}) &= n \times M \\ &= 0.01407 \times 143.1 \\ &= 2.01 \text{ g} \end{aligned}$$

$$\begin{aligned} n(\text{Cu}_2\text{O}) &= 1 \times n(\text{Cu}_2\text{SO}_4) \\ &= 1 \times 0.01407 \\ &= 0.01407 \text{ mol} \end{aligned}$$

Question 7.**(6 marks)**

A 4.15 g sample of steel wire is oxidized to form iron (III) oxide when reacted with oxygen. If the mass of iron (III) oxide produced was 4.95 g what was the percentage of iron in the steel wire?

Use appropriate number of significant figures.



$$\begin{aligned} n(\text{Fe}_2\text{O}_3) &= \frac{m}{M} \\ &= \frac{4.95}{159.7} \\ &= 0.03099 \text{ mol} \end{aligned}$$

$$\begin{aligned} n(\text{Fe}) &= \frac{4}{2} \times n(\text{Fe}_2\text{O}_3) \\ &= 2 \times 0.03099 \\ &= 0.06199 \text{ mol} \end{aligned}$$

$$\begin{aligned} m(\text{Fe}) &= n \times M \\ &= 0.06199 \times 55.85 \\ &= 3.46 \text{ g} \end{aligned}$$

$$\begin{aligned} \% \text{ Fe in steel wire} &= \frac{m(\text{Fe})}{m(\text{steel})} \times 100 \\ &= \frac{3.46}{4.15} \times 100 \\ &= 83.4\% \end{aligned}$$

END OF TEST