JOHN XXIII
SEEK JUSTICE

Test 3 2015
The mole
Question/Answer Booklet

CHEMISTRY
ATAR

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
   b) 32g of oxygen gas
   c) 9g of water
   d) 55g of hydrochloric acid

2. The number of atoms of carbon in one mole of ethanol, C_2H_5OH, 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 $(NH_4)_2SO_4$.

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

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

   a) 1g of H_2
   b) 2g of N_2
   c) 4g of O_2
   d) 8g of O_3

5. What is the percentage by mass of Iron in Fe_2O_3?

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

$M(Fe_2O_3) = 159.7\ g\ mol^{-1}$

$\%\ Fe = \frac{m(Fe)}{M(Fe_2O_3)} \times 100$

$= \frac{111.7}{159.7} \times 100 = 69.9\ \%$

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

$2\ NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + H_2O\ (g) + CO_2$

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

$n(NaHCO_3) = 2 \times n(CO_2)$
$= 2 \times 0.2$
$= 0.4\ mol$

$m(NaHCO_3) = n \times M$
$= 0.4 \times 84.008$
$= 33.6\ g$

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

$C_2H_5OH\ (g) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (g)$

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

$n(CO_2) = 2 \times n(C_2H_5OH)$
$= 2 \times 0.5$
$= 1\ mol$

$m(CO_2) = n \times M$
$= 1 \times 44.01$
$= 44.01\ g$

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

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

$PV = nRT$

$P \propto T$

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:

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

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

$n(H_2O) = m/M$

$= \frac{18}{18.016}$

$= 0.999\ mol$

$n(O_2) = \frac{n(H_2O)}{2}$

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

$V(O_2) = n \times 22.7 l$

$= 0.499 \times 22.7$

$= 11.35\ L$

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?

$\%N = \frac{m(N)}{M(NH_4Cl)} \times 100$

$= \frac{14.01}{53.492} \times 100 = 26.2\%$ ..... (2)

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

$n(NH_4Cl) = m/M$

$= \frac{6}{53.492} = 0.112\ mol$ ..... (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.

$$Fe + 2\,HCl \rightarrow FeCl_2 + H_2$$

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

$n(H_2) = \frac{V}{22.71}$

$= \frac{3.02}{22.71} = 0.133$ mol

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

$n(Fe) = 1 \times n(H_2)$

$= 0.133$ mol

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

$m(Fe) = n \times M$

$= 0.133 \times 55.85$

$= 7.43$ g

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

% Fe in steel $= \frac{m(Fe)}{m(steel)} \times 100$

$= \frac{7.43}{15.3} \times 100$

$= 48.5\%$

Question 4. Balance the following chemical equations: **(3 marks)**

(a) __ $Pb(CO_3)_{2\,(s)}$ + 4 $HNO_{3\,(aq)}$ → ___ $Pb(NO_3)_{4\,(aq}$ + 2 $H_2O_{\,(l)}$ + 2 $CO_{2\,(g)}$

(b) 2 $Cr_{\,(s)}$ + 6 $HCl(aq)$ → 2 $CrCl_{3\,(aq)}$ + 3 $H_{2\,(g)}$

(c) 3 $NH_4OH_{\,(aq)}$ + ___ $H_3PO_{4\,(aq)}$ → ___ $(NH_4)_3PO_{4\,(aq)}$ + 3 $H_2O_{\,(l)}$

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)

$HNO_{3\,(aq)} + KHCO_{3\,(aq)} \longrightarrow CO_{2\,(g)} + H_2O_{(l)} + KNO_{3\,(aq)}$

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

$MgCO_{3\,(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$

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.

$$Cu_2O + H_2SO_4 \rightarrow Cu_2SO_4 + H_2$$

(a) What was the mass of the copper (I) oxide sample?
(4 marks) **Use appropriate number of significant figures.**

$n(Cu_2SO_4) = m/M$

$= \frac{3.14}{223.17}$

$= 0.01407 \text{ mol}$

$n(Cu_2O) = 1 \times n(Cu_2SO_4)$

$= 1 \times 0.01407$

$= 0.01407 \text{ mol}$

$m(Cu_2O) = n \times M$

$= 0.01407 \times 143.1$

$= 2.01 \text{ g}$

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.**

$4Fe_{(s)} + 3O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$

$n(Fe_2O_3) = \frac{m}{M}$

$= \frac{4.95}{159.7}$

$= 0.03099 \text{ mol}$

$n(Fe) = \frac{4}{2} \times n(Fe_2O_3)$

$= 2 \times 0.03099$

$= 0.06199 \text{ mol}$

$m(Fe) = n \times M$

$= 0.06199 \times 55.85$

$= 3.46 \text{ g}$

% Fe in steel wire

$= \frac{m(Fe)}{m(steel)} \times 100$

$= \frac{3.46}{4.15} \times 100$

$= 83.4\%$

END OF TEST