UNIT 1 Chemistry Sample **NAME:**_____

REACTIONS & STOICHIOMETRY: **Answer all questions**

PART A: MULTIPLE CHOICE QUESTIONS. (10 marks)

Q1. Which one of the following is an example of a chemical reaction?

A. Combustion of petrol.
B. Addition of sodium chloride to water.
C. Melting candle wax.
D. Solidification of molten lead.

Q2. The mole is a particle counting unit. One mole of any substance contains 6.02×10^{23} (Avogadro's Number) discrete units of that substance.
How many atoms of oxygen are there in 882.6 g of $K_2Cr_2O_7$?

A. 6.02×10^{23} B. 1.81×10^{24}
C. 4.96×10^{24} D. 6.32×10^{24}

Q3. Sodium hydroxide (NaOH) is a well known base (alkali).
An amount of 39.998 g of NaOH is its:

A. formula mass
B. molecular mass
C. molar mass
D. none of these

Q4. The relative masses of molecules can be determined by adding the relative atomic masses of all atoms present in the molecule.
Which of the four molecules whose formulae are given below has the greatest mass?

A. Propane, C_3H_8
B. Ethylamine, $C_2H_5NH_2$
C. Ethanol, C_2H_5OH
D. Dimethylamine, $(CH_3)_2NH$

Q5. The equations below represent the basic reactions that occur in the manufacture of nitric acid from ammonia.

$$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$$

$$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$$

$$3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$$

The number of moles of nitric acid which can be produced from 1 mole of ammonia is:

A. 1/2 B. 2/1 C. 3/2 D. 2/3

Q6. One of the following substances is observed to react with dilute hydrochloric acid. This substance is most likely to be:

A. $NaCl$ B. $CaSO_4$

C. $CaCO_3$ D. SiO_2

Q7. Which of the following compounds contain the **highest** percentage of sulphur by mass?

A. $Na_2S_2O_3$
B. SO_2
C. Na_2S
D. $H_2S_2O_8$

Q8. An organic substance consists of 54.5% Carbon, 9.1% Hydrogen and 36.4% Oxygen by mass. The empirical formula of the substance is

A. C_2H_4O B. CHO

C. C_2H_3O D. $C_4H_8O_2$

Q9. Hydrocarbons (compounds of carbon and hydrogen only) are used in many countries as fuels, and this contributes to the greenhouse effect (i.e. global warming) by releasing carbon dioxide into the atmosphere.

When one mole of a gaseous hydrocarbon is combusted (burned in oxygen), three moles of carbon dioxide and four moles of water were formed. The molecular formula for the hydrocarbon was:

A. C_4H_{10} B. C_3H_8 C. C_3H_6 D. C_3H_4

Q10. The chemical equation

$$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$$

tells you that:

A. the reaction is very rapid.
B. the reaction does not go to completion.
C. the reaction occurs in a complicated way.
D. the silver ions and chloride ions react in a 1:1 mole ratio.

END OF PART A

PART B: SHORT ANSWER QUESTIONS (10 marks)

This section has five **(5)** questions. Attempt **ALL** questions in the spaces provided.

Question 1 (4 marks)

Phosphoric acid (H_3PO_4) can be generated by the oxidation of phosphorus with nitric acid according to the equation:

$$P(s) + 5HNO_3(aq) \longrightarrow H_3PO_4(aq) + H_2O(l) + 5NO_2(g)$$

If sufficient reactants are employed to produce 1.00 kg of phosphoric acid, what volume, measured at STP, of nitrogen dioxide will also be generated in the reaction?

Question 2 (6 marks)

Oxy-acetylene welding involves the burning of acetylene (ethyne) C_2H_2 in the presence of oxygen to produce carbon dioxide and water. The heat (energy) produced is used to effect the welding process.

A. Write a balanced chemical equation for this reaction.

B. If 15.6 g of ethyne (C_2H_2) reacts with excess oxygen, calculate the mass in grams of carbon dioxide in A. above,

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C. If 15.6 g of ethyne (C_2H_2) reacts with excess oxygen Calculate the mass in grams of water formed in A. above,

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PART C: EXTENDED ANSWER SECTION (15 marks)

This section has three **(3)** questions. Attempt **ALL** questions in the spaces provided.

Question 1 (4 marks)

Chromium(III) oxide reacts with hydrogen sulfide (H_2S) gas to form chromium(III) sulfide and water:

$$Cr_2O_{3(s)} + 3H_2S_{(g)} \rightarrow Cr_2S_{3(s)} + 3H_2O_{(l)}$$

What is the percentage yield if 63.9 g of hydrogen sulfide are consumed to give 105.0 g of chromium(III) sulfide?

Question 2 (6 marks)

Aluminium metal reacts with hydrochloric acid.

A. Write a balanced equation using formula units to represent this reaction.

(1 mark)

B. What mass of gaseous product forms when 5.40 g of aluminium reacts completely with hydrochloric acid?

(2 marks)

D. Describe a test you would use to confirm the identity of the gas produced in the above reaction. Record all observations and write a balanced chemical equation to represent the test.

Test:

Observations:

Equation:

(2 marks)

C. When the reaction is complete the resultant solution is heated and a white solid is produced. Draw a Lewis (electron dot) diagram, showing all valence electrons, to represent this white compound.

(1 mark)

Question 3 (5 marks)

Ammonium nitrate is often used as an explosive in fireworks and mining.
Nitrogen, oxygen and water vapour are formed when it undergoes explosive decomposition.
How many grams of **each** of these gases are produced and how many grams **in total**, would be formed by the explosive decomposition of 12.0 g ammonium nitrate?

END OF TEST

UNIT2ACHE SOLUTIONS

STOICHIOMETRY AND KINETIC THEORY: Answer all questions

PART A: MULTIPLE CHOICE QUESTIONS (10 marks)

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

PART B: SHORT ANSWER QUESTIONS (10 marks)

Q1.

$n(H_3PO_4) = \frac{m}{M} = \frac{1000}{97.994} = 10.20$ mol

$n(NO_2) = \frac{5}{1} \times n(H_3PO_4) = 5 \times 10.20 = 51.02$ mol

$\therefore V(NO_2) = n \times 22.41 = 51.02 \times 22.41 = 1140$ L

Q2.

A. $C_2H_2 + O_2 = CO_2 + H_2O$; now balance the equation

$2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O$

B.

$n(C_2H_2)$ = $m(C_2H_2) \div M(C_2H_2) = 15.6 \div [2(12.01) + 2(1.008)]$

= $15.6 \div 26.036 = 0.5991$ mol

$n(CO_2)$ = $4/2 \times n(C_2H_2) = 4/2 \times 0.5991 = 1.198$ mol

$m(CO_2)$ = $n(CO_2) \times M(CO_2) = 1.198 \times [12.01 + 2(16)]$

= 1.198×44.01 g = 52.7 g

C.

$n(C_2H_2)$ worked in B. above

$n(H_2O)$ = $n(C_2H_2) = 0.5991 = 0.5991$ mol

$m(H_2O)$ = $n(H_2O) \times M(H_2O) = 0.5991 \times [2(1.008) + 1)]$

= $0.5991 \times 18.016.01$ g = 10.8 g

PART C: EXTENDED ANSWER SECTION

Q1. $n(H_2S)$ $= m(H_2S) \div M(H_2S) = 63.9 \div [2(1.008) + 32.06] = 63.9 \div 34.076$
$= 1.875$ mol

$n(Cr_2S_3)$ $= 1/3 \times n(H_2S) = 1/3 \times 1.875 = 0.6250$ mol

$m(Cr_2S_3)$ $= n(Cr_2S_3) \times M(Cr_2S_3) = 0.6250 \times [2(52) + 3(32.06)]$
$= 0.6250 \times 200.18 = 125.11$ g

% Yield $=$ Actual Yield $\div$ Theoretical Yield $\times 100$
$= 105.0 \div 125.11 \times 100 = 83.9$ %

Q2.

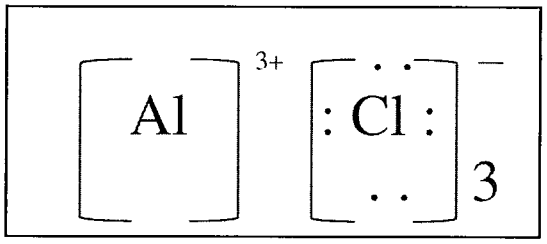
A. $2Al_{(s)} + 6HCl_{(aq)} = 2AlCl_{3(aq)} + 3H_{2(g)}$

B. $n(Al) = m(Al) \div M(Al) = 5.4 \div 26.98 = 0.2001$ mol

$n(H_2) = 3/2 \times n(A) = 3/2 \times 0.2001 = 0.3002$ mol

$m(H_2) = n(H_2) \times M(H_2) = 0.3002 \times 2(1.008) = 0.605$ g

C. Test with a lighted taper (naked flame)
The colourless gas burns with a POP!; a colourless liquid is produced
$2H_{2(g)} + O_{2(g)} = 2H_2O_{(l)}$



PART C: SHORT ANSWER QUESTIONS (15 marks)

Q3.

$NH_4NO_{3(s)}$ $=$ $N_{2\,(g)} + O_{2\,(g)} + H_2O_{(g)}$; now balance the equation

$2NH_4NO_{3(s)} = 2N_{2\,(g)} + O_{2\,(g)} + 4H_2O_{(g)}$

$n(NH_4NO_3) = m(NH_4NO_3) \div M(NH_4NO_3) = 12.0 \div [2(14.01) + 4(1.008) + 3(16)]$
$= 12.0 \div 80.052 = 0.1499$ mol

$n(N_2) = n(NH_4NO_3) = 0.1499$ mol

$m(N_2) = n(N_2) \times M(N_2) = 0.1499 \times 2(14.01)$ g $= 4.2$ g

$n(O_2) = 1/2 \times n(NH_4NO_3) = 1/2 \times 0.1499 = 0.07495$ mol

$m(O_2) = n(O_2) \times M(O_2) = 0.07495 \times 2(16)$ g $= 2.4$ g

$n(H_2O) = 2 \times n(NH_4NO_3) = 2 \times 0.1499 = 0.2998$ mol

$m(H_2O) = n(H_2O) \times M(H_2O) = 0.2998 \times [2(1.008) + 16]$ g $= 5.4$ g

Total $= 4.2 + 2.4 + 5.4 = 12$ g

[Since matter cannot be created nor destroyed in a system of constant mass (Law of Conservation of Matter), total mass of reactants = total mass of products i.e. 12 g of reactants decomposes to give 12 g of products]