SCH3U Practice Exam

Part A: Multiple Choice (25 mks) *Chose the best response in each case.*

1. The particle that has the smallest mass is the
   a. electron
   b. proton
   c. neutron
   d. nucleus
   e. ion

2. The chemical family known as the halogens are the elements in Group
   a. 1
   b. 2
   c. 5
   d. 17
   e. 18

3. Electronegativity is derived from
   a. ionization energies
   b. electron affinity
   c. reactivity
   d. all of the above
   e. none of the above

4. According to the Lewis model of the atom, the number of bonding electrons in a nitrogen atom is
   a. 1
   b. 2
   c. 3
   d. 5
   e. 7

5. Classify the following chemical reaction: $2AsCl_3 + 3H_2S \rightarrow As_2S_3 + 6HCl$
   a. combustion
   b. synthesis
   c. decomposition
   d. single displacement
   e. double displacement

6. Gold and fluorine are able to combine to form two compounds of different combining proportions. Resulting formulas of these compounds include
   a. AuF_3 and AuF_2
   b. Au_3F and AuF
   c. Au_2F and AuF_3
   d. AuF and AuF_3
   e. AuF and AuF_2

7. A possible molecular formula for the compound CH_2O is
   a. $C_2H_4O_2$
   b. $C_3H_6O_3$
   c. $C_4H_8O_4$
   d. $C_{10}H_{20}O_{10}$
   e. all of the above

8. The percentage composition of chlorine, by mass, in the compound K_2PtCl_4 is
   a. 47.0%
   b. 34.2%
   c. 18.9%
   d. 15.3%
   e. 11.3%

9. If the molar mass of a hydrocarbon is 26.0 g/mol, and its empirical formula is CH, its molecular formula is
   a. CH
   b. C_2H_2
   d. C_4H_4
   e. C_5H_5

c. C_3H_3

10. Which of the following is not an electrolyte?
    a. sugar dissolved in water
    b. salt dissolved in water
    c. an acid solution
    d. a basic solution
    e. Gatorade (sport drink)

11. The parts of a water molecule that surround the sodium ions when salt dissolves are the
    a. positive hydrogen ends
    b. negative hydrogen ends
    c. negative oxygen ends
    d. positive oxygen ends
    e. chloride ions

12. Cola soft drinks have a sucrose concentration of 11g/100mL. What mass of sucrose is present in a 355-mL can of cola?
    a. 11g
    b. 39 g
    c. 30 g
    d. 22 g
    e. 0.11 g

13. Which piece of lab equipment is used for measuring a precise volume of the final solution?
    a. Erlenmeyer flask
    b. beaker
    c. volumetric flask
    d. test tube
    e. graduated cylinder

14. Which of the following statements are true?
    (i) As temperature goes down, molecules move more rapidly.
    (ii) If the volume is constant, an increase in pressure may be a result of an increase in the number of molecules in the container.
    (iii) The molecules of a gas are in constant, random, and nonlinear motion.
    (iv) The volume of a given mass of gas varies directly with its absolute temperature when the pressure remains constant.
    a. (i) and (ii)
    b. (ii) and (iii)
    c. (iii) and (iv)
    d. (i) and (iii)
    e. (ii) and (iv)

15. The vapour pressure of water at 292 K is 2.200 kPa. Some oxygen gas is collected by the downward displacement of water at 292 K and the total pressure of the gas is 101.1 kPa. The partial pressure attributed to the oxygen is
    a. 103.3 kPa
    b. 101.325 kPa
    c. 101.1 kPa
    d. 99.9 kPa
    e. 98.9 kPa

16. The general formula for a cycloalkane is
    a. C_nH_n
    b. C_nH_{2n}
    c. C_nH_{2n+2}
    d. $C_{2n}H_{n+1}$
    e. none of the above

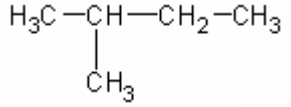
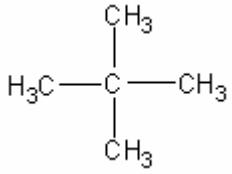
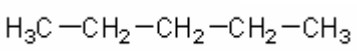
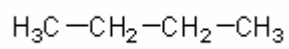
17. When baking soda is heated, sodium carbonate, water, and carbon dioxide gas are formed. This reaction can be classified as
    a. synthesis
    b. combustion
    d. single displacement
    e. double displacement

c. decomposition

18. The substance that would be expected to form a precipitate as a product of a chemical reaction is
    a. silver hydroxide
    b. calcium sulfide
    c. sodium phosphate
    d. lithium chloride
    e. chromium(III) sulfate

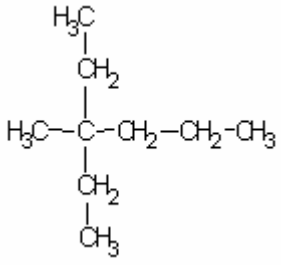
19. Classify the following chemical reaction: $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$
    a. combustion
    b. synthesis
    c. decomposition
    d. single displacement
    e. double displacement

20. The kinetic molecular theory includes all of the following <u>except</u>
    a. molecules attract one another
    b. particles are small compared to the volume they occupy
    c. molecules move in straight line motion
    d. molecules collide elastically with one another
    e. molecules collide elastically with surrounding objects

21. Which of the following is not a structural isomer of pentane?
    a. 
    b. 
    c. 
    d. 
    e. none of the above

22. The alkyl group that contains four carbons is known as
    a. butanyl
    b. butyl
    c. propyl
    d. propanyl
    e. pentyl

23. The IUPAC name for the following molecule is



    a. 2,2-diethylpentane
    b. 3-methyl-2-ethylpentane
    c. 3-methyl-2-ethylhexane
    d. 3-methyl-3-propylpentane
    e. 3-ethyl-3-methylhexane

24. Blackberries have a $[H^+_{(aq)}] = 4.0 \times 10^{-4}$ mol/L. What is their pH?

a. 3.4
b. 4.0
c. 2.0
d. 8.0
e. 5.0

25. Which statement about 0.1 mol/L acetic acid and 0.1 mol/L hydrochloric acid solutions is true?
a. HCl produces almost 100% $H_3O^+_{(aq)}$ ions.
b. $HC_2H_3O_2$ produces 1.3% $H_3O^+_{(aq)}$ ions.
c. There is no difference in pH.
d. both a and b
e. none of the above

Part B: Short Answer

Elements A, B, and C are in the same chemical family. Element A bursts into pink flames when it dissolves in water. Element B sizzles slightly when it dissolves in water. Element C sizzles and sometimes burns when it dissolves in water. How would A, B, and C be arranged in the periodic table? Of the three, which would most likely be highest in the group? Which would most likely be lowest?

Determine the molar mass of mercury(II) sulfide.

Briefly state the difference between empirical and molecular formulas and provide an example of each.

3. Balance the following equation:
$Al_2(SO_4)_3 + NH_3 + H_2O \rightarrow Al(OH)_3 + (NH_4)_2SO_4$

Use the kinetic molecular theory to explain why the pressure increases in a tire when it has been driven for a long period of time on a hot afternoon.

6. State the level of saturation of a solution at the following points on a typical solubility curve:
a) point above the curve
b) point below the curve
point directly on the curve

7. Consider the following reaction: Barium chloride solution is mixed with potassium sulphate solution to produce a solid precipitate barium sulphate and a solution of potassium chloride.

8. For this reaction, write
a) a balanced chemical equation
b) a total ionic equation
a net ionic equation

How does dilution affect the pH of basic solutions?

Write the balanced chemical equation for the neutralization of aqueous phosphoric acid by potassium hydroxide.

If the absolute temperature of a gas is doubled and the pressure is tripled, what happens to the volume of the gas? Assume ideal gas behaviour.

Propane is used as the fuel for barbeques. What volume of oxygen would be required to completely burn 2 L of propane, C_3H_8, and produce CO_2 and H_2O?

13. Using the solubility table in the reference sction, state whether the following ionic compounds are soluble or insoluble in water.

14. Compound	15. **Soluble or insoluble**
16. (a) PbI_2	17.
18. (b) $KClO_3$	19.
20. (c) $CaCO_3$	21.
22. (d) $BaSO_4$	23.

Part C: Problem solving

Convert a mass of 1.2 kg of iron(III) chloride to an amount in moles.

Experimental analysis of an alcohol shows it to consist of 59.97% C, 13.35% H, and 26.68% oxygen by mass. Determine the empirical formula of the alcohol.

27. Sodium chloride is produced when sodium metal combines with chlorine gas as shown in the following balanced equation: $2\ Na + Cl_2 \rightarrow 2\ NaCl$
In an experiment, 36.9 g of sodium chloride is produced when 15.9 g of Na and 27.4 g of chlorine are combined. Determine the percentage yield of the product.

Cameco in Port Hope, Ontario uses hydrofluoric acid to make an uranium hexafluoride product which is used a fuel for nuclear reactors. A waste drum containing 85.0 L of 6.0 mol/L hydrofluoric acid needs to be neutralized so that it isn't hazardous. Calculate the mass of potassium hydroxide pellets that would be required to completely neutralize the acid.

30. Magnesium was added to hydrochloric acid, HCl, and produced 5.25 L of H_2 gas at a temperature of 325 K and a pressure of 100 kPa. What mass of Mg was used in this single displacement reaction?

SCH3U Practice Exam
Answer Section

MULTIPLE CHOICE

1.	A	6.	D	11.	C	16.	B	21.	D
2.	D	7.	E	12.	B	17.	C	22.	B
3.	D	8.	B	13.	C	18.	A	23.	E
4.	C	9.	B	14.	E	19.	E	24.	A
5.	E	10.	A	15.	E	20.	C	25.	D

SHORT ANSWER

1. Element B would be highest and element A would be lowest. Element C would lie in between.
2. $M_{HgS} = (1 \times 200.6) + (1 \times 32.06)$

   $= 232.66$ g/mol
3. A molecular formula shows the actual number of atoms of each element in a molecule of a compound. ($C_6H_{12}O_6$)
   An empirical formula is the simplest formula and shows only the relative number of moles of each type of atom in a compound. (CH_2O)
4. $Al_2(SO_4)_3 + 6NH_3 + 6H_2O \rightarrow 2Al(OH)_3 + 3(NH_4)_2SO_4$
5. As temperature rises, the particles move more rapidly and this increases the number of collisions with the sides of the tire. Greater force per unit area increases the pressure.
6. (a) supersaturated
   (b) unsaturated
   (c) saturated
7. (a) $BaCl_{2(aq)} + K_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2KCl_{(aq)}$
   (b) $Ba^{2+}_{(aq)} + \cancel{2Cl^-_{(aq)}} + \cancel{2K^+_{(aq)}} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4\,(s)} + \cancel{2K^+_{(aq)}} + \cancel{2Cl^-_{(aq)}}$
   (c) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$
8. (a) Diluting acidic solutions decreases the hydrogen ion concentration. This increases the pH and makes these solutions less acidic.
   (b) Diluting basic solutions decreases the pH and makes these solutions less basic.
9. $H_3PO_{4(aq)} + 3KOH_{(aq)} \rightarrow K_3PO_{4(aq)} + 3H_2O_{(l)}$
10. $P_2 = 3P_1$
    $T_2 = 2T_1$
    $V_2 = xV_1$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1}$$

$$= \frac{P_1 V_1 (2T_1)}{3P_1 (T_1)}$$

$$= \frac{2V_1}{3}$$

The final volume will be $\frac{2}{3}$ that of the initial volume.

11. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

$$\text{volume of } O_2 = 2 \text{ L } C_3H_8 \times \frac{5\ O_2}{1\ C_3H_8}$$

$$= 10 \text{ L of oxygen are required.}$$

12.

Compound	Soluble or insoluble
(a) PbI_2	insoluble
(b) $KClO_3$	soluble
(c) $CaCO_3$	insoluble
(d) $BaSO_4$	insoluble

PROBLEM

1. $m = 1.2$ kg
   $M = (1 \times 55.8) + (3 \times 35.5)$
   $M = 162.3$ g/mol

$$n = 1.2 \text{ kg} \times \frac{1 \text{ mol}}{162.3 \text{ g}}$$

$$= 1\ 200 \text{ g} \times \frac{1 \text{ mol}}{162.3 \text{ g}}$$

$$= 7.4 \text{ mol}$$

A mass of 1.2 kg of iron(III) chloride is equivalent to 7.4 mol of iron(III) chloride.

2.

$m_C = 59.97\% \times 100.0 \text{ g C} = 59.97 \text{ g}$ $\quad M_C = 12.01$ g/mol
$m_H = 13.35\% \times 100.0 \text{ g H} = 13.35 \text{ g}$ $\quad M_H = 1.01$ g/mol
$m_O = 26.68\% \times 100.0 \text{ g O} = 26.68 \text{ g}$ $\quad M_O = 16.00$ g/mol

$$n_C = 59.97\ \text{g} \times \frac{1\ \text{mol}}{12.01\ \text{g}} \qquad n_H = 13.35\ \text{g} \times \frac{1\ \text{mol}}{1.01\ \text{g}} \qquad n_O = 26.68\ \text{g} \times \frac{1\ \text{mol}}{16.00\ \text{g}}$$

$$= 4.99\ \text{mol} \qquad = 13.2\ \text{mol} \qquad = 1.67\ \text{mol}$$

The molar ratio for C:H:O is 4.99:13.2:1.67. Dividing by 1.67 to obtain the lowest ratio, we obtain the molar ratio of C:H:O to be 3:8:1.

The empirical formula of the compound is C_3H_8O.

3. We can determine the number of moles of chlorine needed to react completely with 15.9 g of Na.

$$n_{Na} = 15.9\ \text{g} \times \frac{1\ \text{mol}}{22.99\ \text{g}}$$

$$= 0.692\ \text{mol}$$

Mole ratio: $Na:Cl_2 = 2:1$

$$n_{Cl_2}\ \text{needed} = 0.692\ \text{mol Na} \times \frac{1\ \text{mol}\ Cl_2}{2\ \text{mol Na}}$$

$$= 0.346\ \text{mol}$$

$$n_{Cl_2}\ \text{available} = 27.4\ \text{g} \times \frac{1\ \text{mol}}{70.90\ \text{g}}$$

$$= 0.386\ \text{mol}$$

More chlorine is available than is required, therefore, chlorine is in excess. The sodium is the limiting reagent.

$$n_{Na} = 0.692\ \text{mol}$$

mole ratio: Na:NaCl = 1:1

$$n_{NaCl} = n_{Na}$$

$$= 0.692\ \text{mol}$$

$$m_{NaCl} = 0.692\ \text{mol} \times \frac{58.44\ \text{g}}{1\ \text{mol}}$$

$$= 40.4\ \text{g}$$

The theoretical yield of the NaCl is 40.4 g.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

$$= \frac{36.9\ \text{g}}{40.4\ \text{g}} \times 100\%$$

$$= 91.3\%$$

The percentage yield is 91.3%.

4. $HF_{(aq)} + KOH_{(aq)} \rightarrow KF_{(aq)} + H_2O_{(l)}$

85.0L m

6.0 mol/L 56.11 g/mol

$$n_{HF} = 85.0\ \text{L} \times 6.0\ \text{mol/L}$$
$$= 510\ \text{mol}$$

$$n_{KOH} = 510\ \text{mol} \times \frac{1}{1}$$
$$= 510\ \text{mol}$$

$$m_{KOH} = 510\ \text{mol} \times \frac{56.11\ \text{g}}{1\ \text{mol}}$$
$$= 28\ 614\ \text{g}$$
$$= 29\ \text{kg}$$

A 29 kg mass of potassium hydroxide pellets would neutralize the acid.

5. $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + H_{2\,(g)}$

$P = 100$ kPa
$V = 5.25$ L
$R = 8.31$ kPa L/mol K
$T = 325$ K
$n_{H2} = ?$

$$PV = nRT$$
$$n = \frac{PV}{RT}$$
$$= \frac{100\ \text{kPa} \times 5.25\ \text{L}}{8.31\ \text{kPa L/mol K} \times 325\ \text{K}}$$
$$= 0.194\ \text{mol of } H_2$$

$$\text{number of moles of Mg} = 0.194\ \text{mol } H_2 \times \frac{1\ \text{mol Mg}}{1\ \text{mol } H_2}$$
$$= 0.194\ \text{mol of Mg}$$

$$\text{mass of Mg} = 0.194\ \text{mol Mg} \times \frac{24.31\ \text{g}}{1\ \text{mol Mg}}$$
$$= 4.72\ \text{g}$$

Therefore, 4.72 g of Mg was added to the HCl to form 5.25 L of H_2.