General Chemistry (Chem1101) Worksheet I

General Chemistry worksheet for pre-engineering

1. If 9 moles of NH_3 react with 13 moles of oxygen, a) identify the limiting and excess reactants, b) find the number of moles of NO and H_2O produced, c) Find the number of moles of excess reagent leftover, d) If 13 moles of H_2O is actually produced, what is the percent yield of the reaction?

2. 0.240 mole of tungsten (W) are mixed with 3.84g of sulphur. The mixture is heated so that a compound, tungsten sulphide (WS3), is formed. What mass of this compound is formed?

3. 1.15889 g of a certain element, chemical symbol X, displaced 2.5826g of gold from a gold bromide solution. The equation for the reaction is: $3X(s) + 2Au^{3+}(aq) \rightarrow 3X^{2+}(aq) + 2Au(s)$. If the relative atomic mass of gold is 197.0, find the relative atomic mass of X.

4. Analysis of a hydrocarbon showed that 7.8 g of the hydrocarbon contained 0.6 g of hydrogen and that the relative molecular mass was 78. Find the molecular formula of the hydrocarbon.

5. 3.36 g of iron join with 1.44 g of oxygen in an oxide of iron. What is the empirical formula of the oxide?

6. Caffeine has the following percent composition: carbon 49.48%, hydrogen 5.19%, oxygen 16.48% and nitrogen 28.85%. Its molecular weight is 194.19 g/mol. What is its molecular formula?

7. 0.487 grams of sample (molar mass = 324 g/mol) is combusted and found to produce 1.321 g CO_2, 0.325 g H_2O and 0.0421 g nitrogen. Determine the empirical and molecular formulas.

8. 95.6 mg of menthol (molar mass = 156 g/mol) are burned in oxygen gas to give 269 mg CO_2 and 110 mg H_2O. What is menthol's empirical formula?

9. Calculate the percentage composition for each of the following compounds (three significant figures)

a. $Co(NO_3)_2$ **b**. CO_2 **c**. NaH_2PO_4

10. One of the additives in unleaded gasoline that replaced tetraethyl lead in leaded gasoline is called MTBE. When 15.078 g MTBE is burned with oxygen completely, 37.640 g CO_2 and 18.489 g H_2O form. In a separate experiment the molecular mass of MTBE is found to be 88.150. What is the molecular formula for MTBE?

11. Quinone, which is used in the dye industry and in photography, is an organic compound containing only C, H, and O. What is the empirical formula of the compound if you find that 0.105 g of the compound gives 0.257 g of CO_2 and 0.0350 g of H_2O when burned

completely? Given a molecular weight of approximately 108 g/mol, what is its molecular formula?

12. An alkaloid derived from tobacco was found to have a relative molecular mass of 162. When a 0.395 g sample was burned 1.072 g of carbon dioxide, 0.307 g of water, and 0.068 g of nitrogen were produced. What are the empirical and molecular formulae of the alkaloid, given that it contained carbon, hydrogen and nitrogen only?

13. If a patient's blood is too acidic, doctors often use sodium hydrogen carbonate to raise the pH to a normal level. Given:

$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + Na^+$ How many grams of sodium hydrogen carbonate

should be administered to eliminate 0.50 grams of excess acid (H^+)?

Given: $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

a. How many moles of oxygen are needed to completely burn 3.0 moles of ammonia (NH3?

b. How many grams of NO will form for every 3 moles of oxygen that react?

c. How many moles of water will accompany the formation of 2.8 g of NO?

d. What mass of oxygen reacted if 90 g of water were formed?

14. One of the fastest baseballs ever pitched traveled at a speed of 46.0 m/s. If the average baseball has a mass of 0.145 kg, what is the baseball's wavelength?

15. Stock cars typically race at around a speed of 77.0 m/s. If the average stock car has a mass of 1,312 kg, what is the stock car's wavelength?

16. What is the wavelength of an electron traveling at 1.25×10^5 m/s if the mass of the electron is 9.11×10^{-31} kg?

17. Calculate (a) the de Broglie wavelength of an electron moving with a velocity of 5.0×10^5 ms^{-1} and (b) relative de Broglie wavelength of an atom of hydrogen and atom of oxygen moving with the same velocity ($h = 6.63 \times 10^{-34}$ kg m^2 s^{-1})

18. The energy of electron in the second and third Bohr orbit of the hydrogen atom is -5.42×10^{-12} erg and -2.41×10^{-12}erg, respectively. Calculate the wavelengths of emitted radiation when the electron drops from third to second orbit.

19. A naturally occurring sample was found to contain 25% of X-24 and 75% of X-28. Calculate the relative atomic mass of the element X. Use the periodic table and identify X.

20. If calcium is heated and put into a gas jar of chlorine a violent reaction takes place and solid calcium chloride is formed. The reaction proceeds due to the transfer of electrons.

(i) Use the electron arrangements and the idea of electron transfer to explain how the reaction between atoms of calcium and chlorine takes place.

(ii) Write down the formulae of the ions that calcium and chlorine form during the reaction.

(iii) Write down the formula of calcium chloride

(iv) Calcium chloride is a solid at room temperature and has a high melting point. Explain why calcium chloride has a high melting point

21. Use electronegativity value to arrange the following bonds in order of increasing polarity:-

P---H, H—O, C---Cl.

22. What is the bond order of the He^{+2} ion? Would you expect this ion to be stable relative to the separated He atom and He^{+} ion?

23. Draw Lewis structures and show formal charges for the following species:

(a) CO, (b) NO^{+}, (c) CN^{-}, (d) O_2^{2-} (e) CNO^{-}

24. Calculate the heat of formation of hypothetical ionic solid $Ne^{+}Cl^{-}$ (neon monochloride) Given:

U_o = -840 KJ / mol D (Cl_2) = 226 KJ / mol

IE = 2080 KJ / mol EA (Cl^{-}) = -351 KJ / mol

25. Combustion of 6. 38mg of ethylene glycol gives 9.06mg CO_2 and 5.58mg H_2O. The compound contains only C, H, and O. What is the percentage of each element s in ethylene glycol?

26. In an experiment, 15.0 g of methanol and 10.0 g of carbon monoxide were placed in a reaction vessel.

a) Determine the limiting reactant and excess reactant.

b) What is the theoretical yield of acetic acid?

c) If the actual yield is 19.1 g, what is the percentage yield?

27. Acetyl chloride (CH_3COCl) has the connectivity shown:

a. Draw the best Lewis structure for acetyl chloride.

b. Indicate the molecular geometry at each central atom.

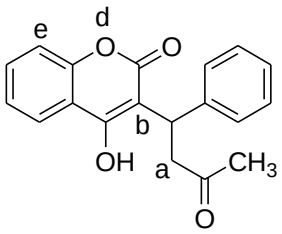
c. What is the hybridization of the two central carbons when VB theory is applied to acetyl chloride?

d. How many sigma bonds are there in one molecule of acetyl chloride?

e. How many pi bonds are there in one molecule of acetyl chloride?

28. The starship Enterprise is powered by dilithium (Li_2). Based on molecular orbital theory, should Li_2 be a stable molecule? Justify your answer with a MO diagram.

29. Answer the following regarding warfarin, an anticoagulant also known as coumadin. Note: the two unshared electron pairs on each oxygen have been omitted for clarity



a. Circle and name three functional groups in the compound
b. What is the molecular formula for warfarin?
c. How many sigma and pie bonds are there in warfarin
d. Identify the hybridization of each of the atoms noted below:

Carbon *a*: _____

Carbon *b*: _____

Oxygen *d*: _____

Carbon *e*: _____

30. Balance the following equations

a. $Cr_2O_7^{2-} + C_2H_6O \rightarrow Cr^{3+} + C_2H_4O$ (Acidic)
b. $Cr(OH)_3(s) + ClO_3^-(aq) \rightarrow CrO_4^{2-}(aq) + Cl^-(aq)$ (basic)
c. $Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) \rightarrow Fe^{3+}(aq) + Cr^{3+}(aq)$
d. $MnO_4^-(aq) + Br^-(aq) \rightarrow MnO_2(s) + BrO_3^-(aq)$

31. An electron in the hydrogen atom in the level n=5 under-goes a transition to level n = 3. What is the frequency of the emitted radiation?

32. For the principal quantum number n = 5?

(a) What are the possible values of *l* and m_l ?
(b) What is the total number of orbitals associated in this quantum numbers?
(c) What is the maximum number of electrons?

33. Draw Lewis structures, name shapes and indicate polar or non-polar for the following molecules:

a) CS_2 b) NCl_3 c) CCl_2F_2 d) CF_2H_2 f) CH_2O g) CHN h) PI_3 i) N_2O j) SO_2 k) C_2H_2

34. What is the wave length of neutron traveling at a speed of 4.15 Km/s? (Neutron of this speed is obtained from a nuclear pile.)

35. Use the VSEPR model to predict the geometry of the following molecules and ions:

a) SO_2, b) NH_3, c) $BeCl_2$, d) NH_4^+

36. Predict the following properties of O_2^{2-}

(a) Electron configuration

(b) Bond order

(c) Magnetic property

37. Write the condensed electronic configuration of $_{50}Sn^{4+}$, $_{50}Sn^{2+}$, $_{24}Cr$, $_{49}In^{3+}$, and $_{49}In^{+}$