Problem 1

Consider the following reaction:

$2C_2H_6\ (g) + 7O_2\ (g) \rightarrow 4CO_2\ (g) + 6H_2O\ (g)$

A. How many molecules of oxygen are required to react with 6 molecules of C_2H_6?

2 molecules C_2H_6 == 7 molecules O_2

6 molecules C_2H_6 == X molecules O_2

X = 6 x 7 /2 =21 molecules

B. How many molecules of water are produced when 12 molecules of CO_2 are produced?

4 molecules CO_2 == 6 molecules H_2O

12 molecules CO_2 == X molecules H_2O

X = 12 x 6 /4 =18 molecules

C. If 20.0 mol of oxygen gas react, how many moles of water are produced?

$$2C_2H_6\,(g) + 7O_2\,(g) \rightarrow 4CO_2\,(g) + 6H_2O\,(g)$$

7 mol O_2 == 6 mol H_2O

20 mol O_2 == X mol H_2O

X = 20 x 6 /7 =17.14 mol

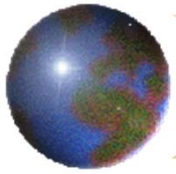
D. If 15.0 mol of CO_2 are produced, how many moles of C_2H_6 react?

$$2C_2H_6\,(g) + 7O_2\,(g) \rightarrow 4CO_2\,(g) + 6H_2O\,(g)$$

2 mol C_2H_6 == 4 mol CO_2

X mol C_2H_6 == 15.0 mol CO_2

X = 15.0 x 2 /4 =7.5 mol



E. How many grams of CO_2 are formed when 90.0 g of C_2H_6 react with an excess of oxygen?

$$2C_2H_6\,(g) + 7O_2\,(g) \rightarrow 4CO_2\,(g) + 6H_2O\,(g)$$

Excess of O_2 : means is the C_2H_6 limiting reagent

2 mol C_2H_6 == 4 mol CO_2

$$\frac{90.0}{30} = 3.00 \text{ mol } C_2H_6 == X \text{ mol } CO_2$$

X = 3.00 x 4 / 2 = 6 mol ⟶ 6 x 44 = 264 g

F. How many grams of O_2 are needed to burn 90.0 g of C_2H_6?

G. How many grams of O_2 are necessary to produce 9.03×10^{21} molecules of CO_2?

$$9.03\times10^{21}\ molecules\ \ CO_2 =$$

$$\frac{9.03\times10^{21}\ molecules}{6.02\times10^{23}\ molecules/mol} = 0.015 mol$$

7 mol O_2 == 4 mol CO_2

X mol O_2 == 0.015 mol CO_2

X = 0.026 mol → 0.026x32 = 0.84 g

H. If 15.0 mol of CO_2 were collected at 300 ºC in 5-litter vessel, what is the pressure of CO_2?

PV = nRT

$$P = \frac{nRT}{V} = \frac{15 \times 0.082 \times 573}{5} = 141 atm.$$

Problem 2

At a certain temperature the reaction,

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

has Kc = 0.400

Exactly 1.00 mol of each gas was placed in a 100-liter vessel and allowed to react.

1. What was the direction of the reaction immediately after the gases were mixed?

2. What were the equilibrium concentrations of each gas?

3. What is the effect of pressure increase on Kc?

1. $$Q = \frac{1.00 \times 1.00}{1.00 \times 1.00} = 1.00$$ **$Q > K_c$**

Right → left

2. What were the equilibrium concentrations of each gas?

Concentrations ↓

	$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$			
Initial	**0.01M**	**0.01M**	**0.01M**	**0.01M**
Change	**+ X**	**+ X**	**- X**	**- X**
Equilibrium	**1+X**	**1+X**	**1-X**	**1-X**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} = \frac{(1-X)(1-X)}{(1+X)(1+X)} = 0.400$$

$$K_c = \frac{(1-X)^2}{(1+X)^2} = 0.400$$

$$\left(\frac{(1-X)}{(1+X)}\right)^2 = 0.400$$

$[CO]=[H_2O]= 1.227x10^{-2}$ M

$[CO_2]=[H_2]= 0.773x10^{-2}$ M

3. What is the effect of pressure increase on K_c?

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

NO effect

Problem 3

An automobile tire is inflated with air at 22°C to a pressure of 1.8 atm. After the car is driven for several hours, the volume of the tire increases from 7.2 L to 7.8 L and the pressure increases to 1.9 atm. Calculate the temperature of the air inside the tire.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{1.8 \times 7.2}{(22 + 273)} = \frac{1.9 \times 7.8}{T_2}$$

T_2 = 337.3 K

Problem 4

For an alkaline solution of ammonium hydroxide,$[OH^-]=1.8x10^{-3}$ M, and $K_b = 1.8 \times 10^{-5}$, answer the following questions:

1. Calculate the concentration of ammonium hydroxide (NH_4OH)
2. Calculate the pH for the solution
3. If ammonium hydroxide was one of the components of a buffer solution, write a possible chemical formula for the second component.
4. Calculate the pH for the mentioned buffer solution if the concentration of ammonium hydroxide is 0.8 mol/L and the concentration of the second component is 0.6 mol/L.

$$[OH^-] = \sqrt{K_b C_b}$$

C_b = 0.18

2. Calculate the pH for the solution

$[OH^-]=1.8x10^{-3}$

$pOH = -\log 1.8x10^{-3}$

pH = 11.26

3. If ammonium hydroxide was one of the components of a buffer solution, write a possible chemical formula for the second component.

NH_4Cl

4. Calculate the pH for the mentioned buffer solution if the concentration of ammonium hydroxide is 0.8 mol/L and the concentration of the second component is 0.6 mol/L.

$$pOH = pK_b + \log\frac{[salt]}{[base]}$$

pH = 9.38

Problem 5

For the ion OF^+

a)Determine the number of bonds between the two atoms.

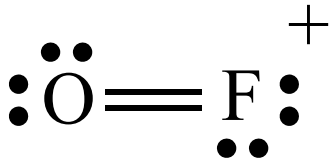
(a) Total valence electrons = 6 + 7 -1 =12

(b) # electrons required for individual atoms 2 × 8 = 16

(c) Number of shared electrons = 16 – 12 = 4

(d) Number of covalent bonds = 4/2 = 2 bonds

(e) Number of unshared electrons = 12 – 4 = 8 electrons



Two bonds

b) Calculate the formal charge on each atom.

Formal charges:

F = 7 – [2+4]=+1

O = 6 – [2+4] = 0

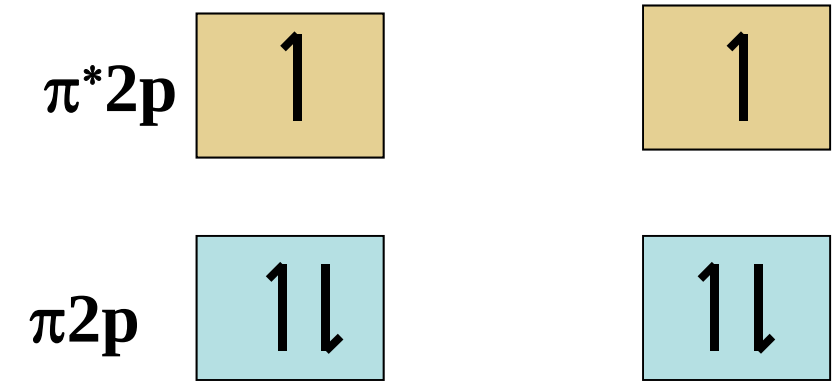
c) Draw a molecular orbital energy-level diagram

d) State the bond order.

e) State the magnetic property.

σ*2p

Number of valence electrons:12



B.O. = ½ [10 - 6] = 2

paramagnetic

f) Use the VSEPR theory to predict the geometric shape

Linear

g) What type of hybrid orbitals are employed by oxygen atom in the ion

sp2

h) Compare between the two atoms in terms of ionization energy and atomic volume (>, =, <)

Atomic volume: F<O

Ionization E : F>O

Multiple choice questions

1) $_{8}O^{2-}$ has ___ protons, ____ electrons, and ____ neutrons

a) 8, 8, 18

b) 8, 6, 10

c) 8, 10, 6

d) 8, 10, 10

2) For the reaction:

$$2CaSO_4(s) \rightleftharpoons 2CaO(s) + 2SO_2(g) + O_2(g),\ K_p =$$

a) K_c

b) $K_c\,(RT)$

c) $P_{SO_4}\ P_{O_2}$

d) $K_c\,(RT)^3$

3) A sample of 1.50 moles of CH_4 gas contains how many atoms of hydrogen?

(a) 3.61×10^{24} **(b) 2.40×10^{24}**

(c) 1.20×10^{24} **(d) 6.02×10^{23}**

4) 9.10 g of $AgNO_3$ is dissolved in water and the solution is diluted to the 500 mL mark in a volumetric flask. What is the molarity of the $AgNO_3$ solution?

(a) 0.669 M **(b) 0.309 M**

(c) 0.193 M **(d) 0.107 M**

5) How many moles of ions are there per mole of $Al_2(SO_4)_3$?

(a) 6 **(b) 5**

(c) 3 **(d) 1**

8) What is the volume of 1.00 mole of an ideal gas at 25°C and one atmosphere pressure?

(a) 0.0409 L

(b) 2.05 L

(c) 22.4 L

(d) 24.4 L