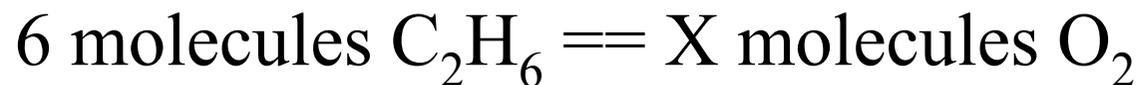
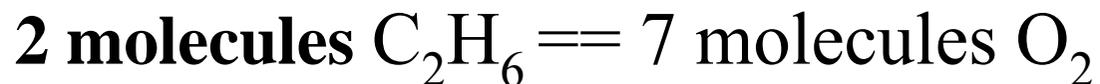


Problem 1

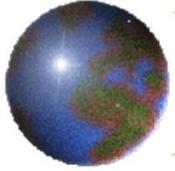
Consider the following reaction:



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



$$X = 6 \times 7 / 2 = 21 \text{ molecules}$$



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

$X = 12 \times 6 / 4 = 18$ molecules



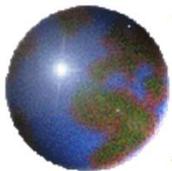
C. If 20.0 mol of oxygen gas react, how many moles of water are produced?



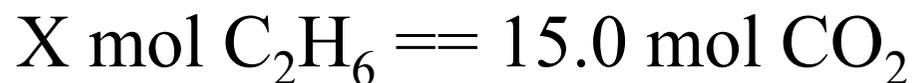
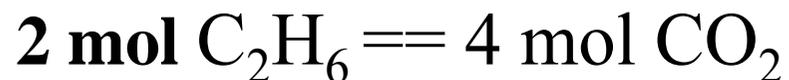
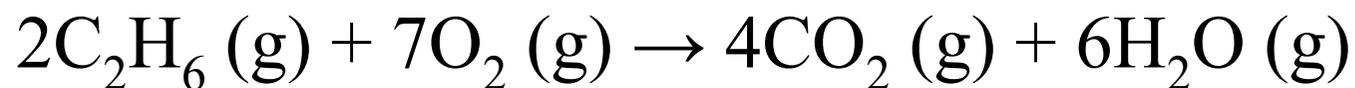
$$7 \text{ mol O}_2 == 6 \text{ mol H}_2\text{O}$$

$$20 \text{ mol O}_2 == X \text{ mol H}_2\text{O}$$

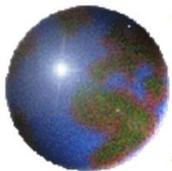
$$X = 20 \times 6 / 7 = 17.14 \text{ mol}$$



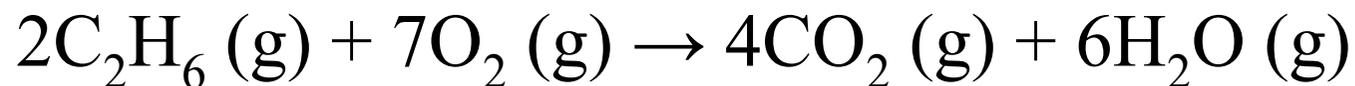
D. If 15.0 mol of CO_2 are produced, how many moles of C_2H_6 react?



$$X = 15.0 \times 2 / 4 = 7.5 \text{ mol}$$



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

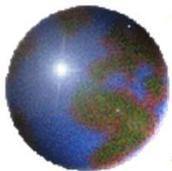


Excess of O_2 : means is the C_2H_6 limiting reagent



$$\frac{90.0}{30} = 3.00 \text{ mol } \text{C}_2\text{H}_6 == X \text{ mol } \text{CO}_2$$

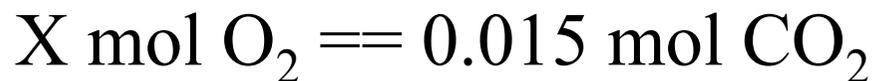
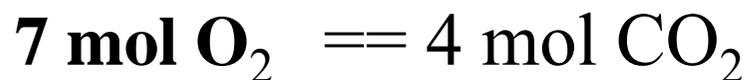
$$\mathbf{X = 3.00 \times 4 / 2 = 6 \text{ mol} \quad \longrightarrow \quad 6 \times 44 = 264 \text{ g}}$$



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 ?

$$9.03 \times 10^{21} \text{ molecules } CO_2 =$$
$$\frac{9.03 \times 10^{21} \text{ molecules}}{6.02 \times 10^{23} \text{ molecules / mol}} = 0.015 \text{ mol}$$



$$X = 0.026 \text{ mol} \rightarrow 0.026 \times 32 = 0.84 \text{ g}$$



H. If 15.0 mol of CO₂ were collected at 300 °C in 5-liter vessel, what is the pressure of CO₂?

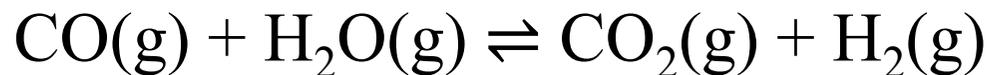
$$PV = nRT$$

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



Problem 2

At a certain temperature the reaction,



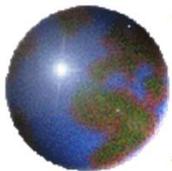
has $K_c = 0.400$

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 K_c ?**

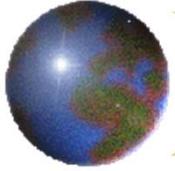
$$1. \quad Q = \frac{1.00 \times 1.00}{1.00 \times 1.00} = 1.00 \quad Q > K_c$$

Right \rightarrow left



2. What were the equilibrium concentrations of each gas?

Concentrations ↓ Initial	$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$			
	0.01M	0.01M	0.01M	0.01M
	<hr/>			
Change	+ X	+ X	- X	- X
<hr/>				
Equilibrium	1+X	1+X	1-X	1-X



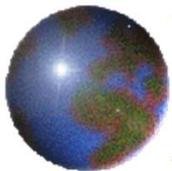
$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} = \frac{(1-X)(1-X)}{(1+X)(1+X)} = 0.400$$

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

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

$$[CO]=[H_2O]= 1.227 \times 10^{-2} \text{ M}$$

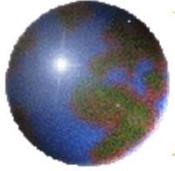
$$[CO_2]=[H_2]= 0.773 \times 10^{-2} \text{ M}$$



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



NO effect



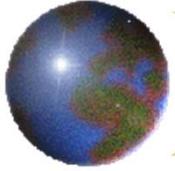
Problem 3

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.

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

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

$$T_2 = 337.3 \text{ K}$$



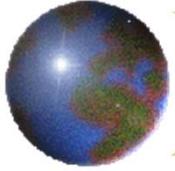
Problem 4

For an alkaline solution of ammonium hydroxide, $[\text{OH}^-] = 1.8 \times 10^{-3}$ 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.

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

$$C_b = 0.18$$



2. Calculate the pH for the solution

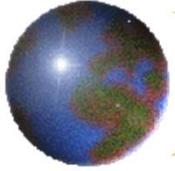
$$[\text{OH}^-] = 1.8 \times 10^{-3}$$

$$\text{pOH} = -\log 1.8 \times 10^{-3}$$

$$\text{pH} = 11.26$$

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

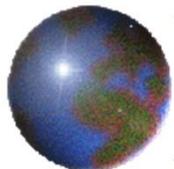




4. Calculate the pH for the mentioned buffer solution if the concentration of ammonium hydroxide is 0.8 mol/L and the concentration of the second component is 0.6 mol/L.

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

$$\mathbf{pH = 9.38}$$



Problem 5

For the ion OF^+

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

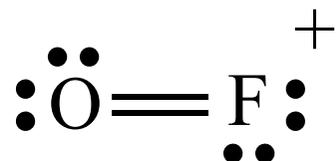
$$\text{(a) Total valence electrons} = 6 + 7 - 1 = 12$$

$$\text{(b) \# electrons required for individual atoms} = 2 \times 8 = 16$$

$$\text{(c) Number of shared electrons} = 16 - 12 = 4$$

$$\text{(d) Number of covalent bonds} = 4/2 = 2 \text{ bonds}$$

$$\text{(e) Number of unshared electrons} = 12 - 4 = 8 \text{ electrons}$$



Two bonds

b) Calculate the formal charge on each atom.

Formal charges:

$$\text{F} = 7 - [2 + 4] = +1$$

$$\text{O} = 6 - [2 + 4] = 0$$

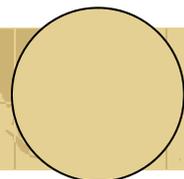
c) Draw a molecular orbital energy-level diagram

d) State the bond order.

e) State the magnetic property.



σ^*2p

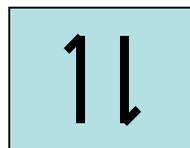


Number of valence electrons:12

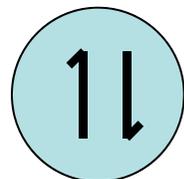
π^*2p



$\pi2p$



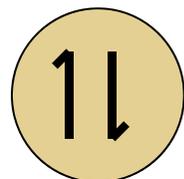
$\sigma2p$



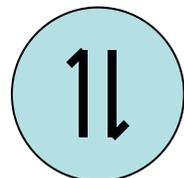
$B.O. = \frac{1}{2} [10 - 6] = 2$

paramagnetic

$\sigma^* 2s$



$\sigma2s$





f) Use the VSEPR theory to predict the geometric shape

Linear

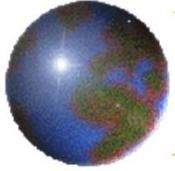
g) What type of hybrid orbitals are employed by oxygen atom in the ion

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

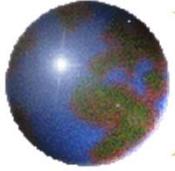
1) ${}_8\text{O}^{2-}$ has ___ protons, ___ electrons, and ___ neutrons

a) 8, 8, 18

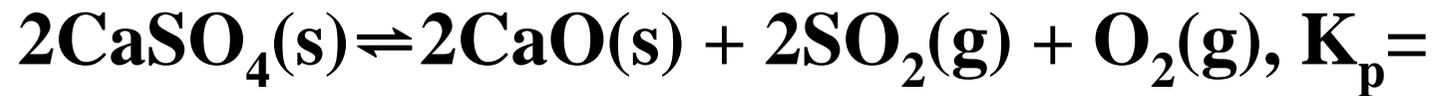
b) 8, 6, 10

c) 8, 10, 6

d) 8, 10, 10



2) For the reaction:



a) K_c

b) $K_c (RT)$

c) $P_{\text{SO}_4} P_{\text{O}_2}$

d) $K_c (RT)^3$



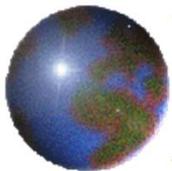
3) A sample of 1.50 moles of CH₄ gas contains how many atoms of hydrogen?

(a) 3.61 x 10²⁴

(b) 2.40 x 10²⁴

(c) 1.20 x 10²⁴

(d) 6.02 x 10²³



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.

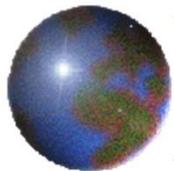
What is the molarity of the AgNO_3 solution?

(a) 0.669 M

(b) 0.309 M

(c) 0.193 M

(d) 0.107 M



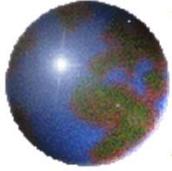
5) How many moles of ions are there per mole of $\text{Al}_2(\text{SO}_4)_3$?

(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