1. Write the formulas of the following:

a. **Sulfur trioxide** SO_3

b. **Potassium hydrogen sulfite** $KHSO_3$

c. **Chromium (III) carbonate** $Cr_2(CO_3)_3$

d. **Ammonium hydrogen carbonate** NH_4HCO_3

e. **Sodium hydride** NaH

f. **Hydrobromic acid** HBr

2. Write the name for the following:

a. **P_4S_{10}** Tetraphosphorus decasulfide

b. **HNO_2** nitrous Acid

c. **$Ca_3(PO_4)_2$** Calcium phosphate

d. **$Fe_2(CO_3)_3$** IRON (III) carbonate

e. **NCl_3** nitrogen trichloride

f. **Al_2O_3** Aluminum oxide

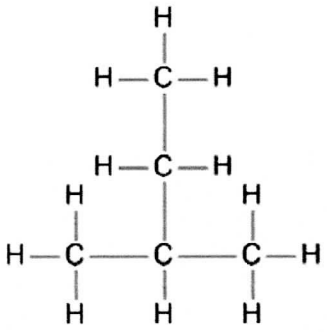
3. Write the net ionic equation for the reaction between sodium chloride and mercury (I) nitrate.

$2NaCl(aq) + Hg_2(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + Hg_2Cl_2(s)$

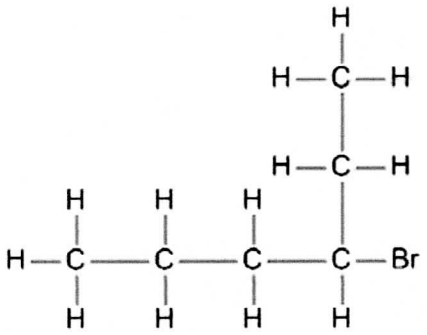
Net ionic $Hg_2^{2+} + 2Cl^-_{(aq)} \longrightarrow Hg_2Cl_2(s)$

$2Na^+_{(aq)} + 2Cl^-_{(aq)} + Hg_2^{2+}{}_{(aq)} + 2NO_3^-{}_{(aq)} \longrightarrow 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)} + Hg_2Cl_2(s)$

4. Give the correct name for the following molecules:

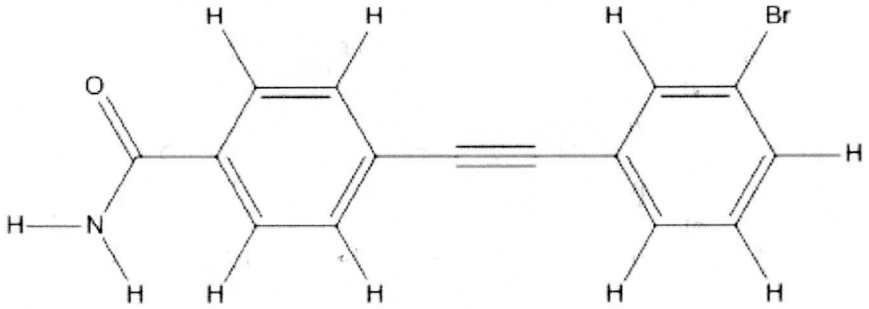


Name 2-methylbutane



Name 3-BromohexANE

5. How many pi and sigma bonds are there in the following molecule:

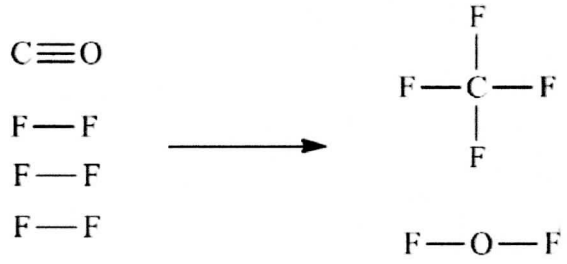


Pi bonds 9

Sigma Bonds 29

6. **Using the average bond enthalpies from Table 8.6 below to estimate ΔH_{rxn} for the following reaction:**

$$CO(g) + 3F_2(g) \rightarrow CF_4(g) + OF_2(g)$$



Setup:

Solution:

$$\begin{aligned}\Delta H_{rxn} &= BE(C \equiv O) + 3BE(F\text{–}F) - \left[4BE(C\text{–}F) + 2BE(O\text{–}F)\right] \\ &= 1070\ \text{kJ/mol} + (3)(156.9\ \text{kJ/mol}) - \left[(4)(453\ \text{kJ/mol}) + (2)(190\ \text{kJ/mol})\right] \\ &= \mathbf{-651\ kJ\ /\ mol}\end{aligned}$$

TABLE 8.6 Bond Enthalpies

Bond	Bond Enthalpy (kJ/mol)	Bond	Bond Enthalpy (kJ/mol)	Bond	Bond Enthalpy (kJ/mol)
H–H*	436.4	C≡O	1070	O–O	142
H–N	393	C–P	263	O=O	498.7
H–O	460	C–S	255	O–P	502
H–S	368	C=S	477	O=S	469
H–P	326	C–F	453	O–F	190
H–F	568.2	C–Cl	339	O–Cl	203
H–Cl	431.9	C–Br	276	O–Br	234
H–Br	366.1	C–I	216	O–I	234
H–I	298.3	N–N	193	P–P	197
C–H	414	N=N	418	P=P	489
C–C	347	N≡N	941.4	S–S	268
C=C	620	N–O	176	S=S	352
C≡C	812	N=O	607	F–F	156.9
C–N	276	N–F	272	Cl–Cl	242.7
C=N	615	N–Cl	200	Cl–F	193
C≡N	891	N–Br	243	Br–Br	192.5
C–O	351	N–I	159	I–I	151.0
C=O	799				

7. The combustion of a 28.1 g sample of ascorbic acid (vitamin C) produces 42.1g CO_2 and 11.5g H_2O. Determine the empirical and molecular formulas of ascorbic acid. The molar mass of ascorbic acid is approximately 176 g/mol and the molecule consists of only carbon, hydrogen, and oxygen.

Calculate the mass of carbon and Hydrogen in the original sample:

MASS of Carbon: $42.1\text{g } CO_2 \times \frac{1\text{mol } CO_2}{44.01\text{g } CO_2} \times \frac{1\text{mol C}}{1\text{mol } CO_2} \times \frac{12.01\text{g C}}{1\text{mol C}} = 11.49\text{g C}$

MASS of Hydrogen: $11.5\text{g } H_2O \times \frac{1\text{mol } H_2O}{18.02\text{g } H_2O} \times \frac{2\text{mol H}}{1\text{mol } H_2O} \times \frac{1.008\text{g H}}{1\text{mol H}} = 1.287\text{g H}$

MASS of oxygen: $28.1\text{g} - (11.49\text{g} + 1.287\text{g}) = 15.32\text{g O}$

total Weight − (C + H) = weight of Oxygen

$11.49\text{g C} \times \frac{1\text{mol C}}{12.01\text{g C}} = 0.957\text{mol C}$

$1.287\text{g H} \times \frac{1\text{mol H}}{1.008\text{g H}} = 1.277\text{mol H}$

$15.32\text{g O} \times \frac{1\text{mol O}}{16.00\text{g O}} = 0.958\text{mol O}$

$\frac{C_{0.957}}{0.957}\ \frac{H_{1.277}}{0.957}\ \frac{O_{0.958}}{0.957}$

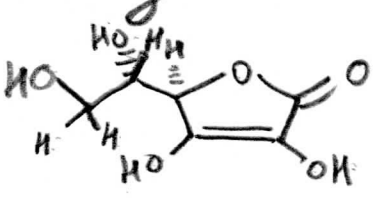
$C_1\ H_{1.33}\ O_1$ or

$C_3\ H_4\ O_3$ = Empirical formula

MASS of Empirical Formula = $3(12.01) + 4(1.008\text{g}) + 3(16.00\text{g}) = 88.06\text{ g}$

Molecular MASS of Ascorbic Acid = 176 g/mol. $\frac{176}{88.06\text{g}} = 2.0$

Molecular Formula = $C_6H_8O_6$



8. What is the molar mass of a diprotic acid if 30.5 mL of 0.1112 M NaOH is required to neutralize a 0.1365 g sample?

$$30.5\ mL \times \frac{0.1112\ mmol\ NaOH}{1\ mL} = 3.3916\ mmol\ NaOH$$

$$3.3916\ mmol\ NaOH \times \frac{1\ mmol\ acid}{2\ mmol\ NaOH} = 1.696\ mmol\ acid$$

$$\frac{0.1365\ g}{0.001696\ mol} = \boxed{80.5\ g/mol}$$

9. What volume of 0.144 M H_2SO_4 is required to neutralize 25.0 mL of 0.0415 M $Ba(OH)_2$?

$$25.0\ mL \times \frac{0.0415\ mmol\ Ba(OH)_2}{1\ mL} = 1.0375\ mmol\ Ba(OH)_2$$

$$1.0375\ mmol\ Ba(OH)_2 \times \frac{1\ mmol\ H_2SO_4}{1\ mmol\ Ba(OH)_2} = 1.0375\ mmol\ H_2SO_4$$

$$1.0375\ mmol\ H_2SO_4 \times \frac{1\ mL\ H_2SO_4}{0.144\ mmol\ H_2SO_4} = \boxed{7.20\ mL\ H_2SO_4}$$

10. A serving of Grape Nuts cereal (5.80g) is burned in a bomb calorimeter with a heat capacity of 43.7 kJ/°C. During the combustion, the temperature of the water in calorimeter increased by 1.92 °C. Calculate the energy content (in kJ/g) of Grape Nuts.

$q_{RXN} = -C_{cal}\Delta T = -(43.7\,kJ/°C)(1.92°C)$

$= -83.9\,KJ$

(83.9 kJ is released)

$\frac{83.9\,kJ}{5.80\,g} =$ 14.5 KJ/g is the energy contained in Grape Nuts.

11. Given the thermochemical equation:

$2Cu_2O(s) \rightarrow 4\,Cu(s) + O_2(g) \quad \Delta H = +333.8$ kJ/mol

Calculate the mass of copper produced when

1.47×10^4kJ is consumed in this reaction.

$1.47 \times 10^4\,KJ \times \frac{4\,mol\,Cu}{333.8\,kJ} \times \frac{63.55\,g\,Cu}{1\,mol\,Cu} = 11195\,g$

$11195\,g \times \frac{1\,kg}{1000\,g} =$ 11.2 kg Cu

12. The average distance between Mars and Earth is about 1.3 X 10^8 miles. How long would it take video images transmitted from the Mars Spirit rover on Mars' surface to reach Earth (1 mile = 1.61 km)?

$$1.3\times10^{8}\ \text{mile} \times \frac{1.61\ \text{km}}{1\ \text{mile}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{s}}{3.00\times10^{8}\ \text{m}} = 7.0\times10^{2}\ \text{s}$$

13. Protons can be accelerated to speeds near that of light in particle accelerators. Estimate the wavelength (in nm) of such a proton moving at 2.90 X 10^8 m/s. The mass of a proton is 1.673 X 10^{-27} kg.)

$$\lambda = \frac{h}{m_p} = \frac{6.63\times10^{-34}\ \text{kg}\cdot\text{m}^2/\text{s}}{(1.673\times10^{-27}\ \text{kg})(2.90\times10^{8}\ \text{m/s})}$$

$$= 1.37\times10^{-15}\ \text{m} \times \frac{10^{9}\ \text{nm}}{1\ \text{m}} =$$

$$1.37\times10^{-6}\ \text{nm}$$

14. The volume of a sample of pure HCl gas was 189 mL at 25 °C and 108 mmHg. It was completely dissolved in about 60 mL of water and titrated with a NaOH solution. 15.7 mL of the NaOH solution was required to neutralize the HCl. Calculate the molarity of the NaOH solution.

To calculate the molarity of NaOH, we need moles of NaOH and volume of the NaOH solution. The volume is given in the problem; therefore, we need to calculate the moles of NaOH. The moles of NaOH can be calculated from the reaction of NaOH with HCl. The balanced equation is:

$$NaOH(aq) + HCl(aq) \longrightarrow H_2O(l) + NaCl(aq)$$

The number of moles of HCl gas is found from the ideal gas equation. $V = 0.189$ L, $T = 25°C + 273$ K $= 298$

and $P = 108 \text{ mmHg} \times \dfrac{1 \text{ atm}}{760 \text{ mmHg}} = 0.142 \text{ atm}$.

$$n_{HCl} = \frac{PV_{HCl}}{RT} = \frac{(0.142 \text{ atm})(0.189 \text{ L})}{\left(0.0821 \dfrac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}\right)(298 \text{ K})} = 1.10 \times 10^{-3} \text{ mol HCl}$$

The moles of NaOH can be calculated using the mole ratio from the balanced equation.

$$(1.10 \times 10^{-3} \text{ mol HCl}) \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HCl}} = 1.10 \times 10^{-3} \text{ mol NaOH}$$

The molarity of the NaOH solution is:

$$M = \frac{\text{mol NaOH}}{\text{L of soln}} = \frac{1.10 \times 10^{-3} \text{ mol NaOH}}{0.0157 \text{ L soln}} = 0.0701 \text{ mol/L} = \mathbf{0.0701\ M}$$

15. Calculate the density of hydrogen bromide (HBr) gas in g/L at 733 mmHg and 46 °C.

$$d = \frac{PM}{RT}$$

$HBr = 80.91\ g/mol$

$T = 46°C + 273.15 = 319.15K$

$$P = 733\ mmHg \times \frac{1\ atm}{760\ mmHg} =$$

$0.964\ atm$

$$d = \frac{(0.964\ atm)(80.91\ g/mol)}{\left(0.0821\ \frac{L \cdot atm}{mol \cdot K}\right)(319.15K)} = 2.98\ g/L$$