INTRODUCTION TO NATURAL SCIENC

CHEMISTRY HW - FALL 2006 - WEEK 4

Chapter 3

(28) (a) dinitrogen pentoxide
(b) tetraphosphorus trisulfide
(c) oxygen difluoride
(d) xenon tetrafluoride

(29) (a) SCl_2 (b) N_2O_5 (c) $SiCl_4$ (d) B_2O_3

(32) (a) $Fe(C_6H_{11}O_7)_2$

			g/mol
Fe	= 55.845 g/mol	=	55.845
C x 12	= 12.011 g/mol x 12	=	144.132
H x 22	= 1.008 g/mol x 22	=	22.176
O x 14	= 15.999 g/mol x 14	=	223.986
			446.139 g/mol

(b) $CH_3CH_2CH_2CH_2SH$

			g/mol
C x 4	= 12.011 g/mol x 4	=	48.044
H x 10	= 1.008 g/mol x 10	=	10.08
S x 1	= 32.066 g/mol x 1	=	32.066
			90.199 g/mol

C x 20	=	12.011 g/mol x 20	= 240.22
H x 24	=	1.008 g/mol x 24	= 24.192
N x 2	=	14.007 g/mol x 2	= 28.014
O x 2	=	15.99 g/mol x 2	= 31.98
			324.406 g/mol

(35) (a) molar mass of C_3H_7OH

3 x C	=	12.011 g/mol x 3	= 36.033
8 x H	=	8 x 1.008 g/mol	= 8.064
1 x O	=	15.99 g/mol x 1	= 15.99
			60.087 g/mol

$$0.0255 \text{ mol } C_3H_7OH \times \frac{60.087 \text{ g}}{1 \text{ mol}} = 1.53 \text{ g}$$

(b) $C_{11}H_{16}O_2$ molar mass calculation

11 x C	=	11 x 12.011 g/mol	= 132.121
16 x H	=	16 x 1.008 g/mol	= 6.048
2 x O	=	2 x 15.99 g/mol	= 31.98
			170.149 g/mol

$$0.0255 \text{ mol } C_{11}H_{16}O_2 \times \frac{170.149 \text{ g}}{1 \text{ mol}} = 4.34 \text{ g}$$

(c) $C_9H_8O_4$ (aspirin)

$9 \times C = 9 \times 12.011\ g/mol = 108.099$

$8 \times H = 8 \times 1.008\ g/mol = 8.064$

$4 \times O = 4 \times 15.99\ g/mol = 63.96$

$180.123\ g/mol$

$0.0255\ mol\ C_9H_8O_4 \times \frac{180.123\ g}{1\ mol} = 4.59\ g$

(40) $324\ mg \times \frac{1\ g}{1000\ mg} \times \frac{1\ mol\ aspirin}{180.123\ g} = 1.79 \times 10^{-3}\ mol$ aspirin

$NaHCO_3$ molar mass

$1 \times Na = 22.9899\ g/mol = 22.989$

$1 \times H = 1.008\ g/mol = 1.008$

$1 \times C = 12.011\ g/mol = 12.011$

$3 \times O = 3 \times 15.99\ g/mol = 47.97$

$83.978\ g/mol$

$1904\ mg \times \frac{1\ g}{1000\ mg} \times \frac{1\ mol\ NaHCO_3}{83.978\ g} = 2.267 \times 10^{-2}\ mol$ $NaHCO_3$

Citric acid molar mass

$H_3C_6H_5O_7$

		g/mol
$8 \times H$	$= 8 \times 1.008$	$= 8.064$
$6 \times C$	$= 6 \times 12.011$	$= 72.066$
$7 \times O$	$= 7 \times 15.99$	$= 111.93$
		$192.069\ g/mol$

$1000\,mg \times \frac{1\,g}{1000\,mg} \times \frac{1\,mol}{192.069\,g}$ citric acid $= 5 \times 10^{-3}$ mol citric acid

(6) 1.79×10^{-3} mol aspirin per tablet $\times \frac{6.02 \times 10^{23}}{1\,mol}$ molecules

$= 1.08 \times 10^{21}$ aspirin molecules

(42) (a) Caffein molar mass $C_8H_{10}N_2O_2$

		g/mol		g/mol
$8 \times C$	=	8×12.011	=	96.088
$10 \times H$	=	10×1.008	=	10.08
$2 \times N$	=	2×14.007	=	28.014
$2 \times O$	=	2×15.99	=	31.98
				166.1629 g/mol

% of C $= \frac{96.0889\,g}{166.162\,g} \times 100\% = 57.83\%$

% of H $= \frac{10.089\,g}{166.162\,g} \times 100\% = 6.07\%$

% of N $= \frac{28.014\,g}{166.162\,g} \times 100\% = 16.86\%$

% of O $= \frac{31.98\,g}{166.162\,g} \times 100\% = 19.25\%$

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(b) menthol ($C_{10}H_{20}O$) molar mass

$10 \times C$	$= 10 \times 12.0119\ g/mol =$		$120.11\ g$
$20 \times H$	$= 20 \times 1.008\ g/mol =$		20.16
$1 \times O$	$= 1 \times 15.99\ g/mol =$		15.99
			$156.26\ g/mol$

mass % of C $= \frac{120.11\ g}{156.26\ g} \times 100\% = 76.87\ \%$

mass % of H $= \frac{20.16\ g}{156.26\ g} \times 100\% = 12.90\ \%$

mass % of O $= \frac{15.999\ g}{156.26\ g} \times 100\% = 10.23\ \%$

(c) $CoCl_2 \cdot 6H_2O$ molar mass

			g/mol
$1 \times Co$	$= 58.93 \times 1$	$=$	58.93
$2 \times Cl$	$= 2 \times 35.45$	$=$	70.90
$12 \times H$	$= 12 \times 1.008$	$=$	12.096
$6 \times O$	$= 6 \times 15.99$	$=$	95.94
			$237.866\ g/mol$

mass % of Co $= \frac{58.93\ g}{237.866\ g} \times 100\% = 24.77\%$

mass % of Cl $= \frac{70.90\ g}{237.866\ g} \times 100\% = 29.81\%$

mass % of H $= \frac{12.096\ g}{237.866\ g} \times 100\% = 5.09\%$

$$\text{mass \% of O} = \frac{95.94\ g}{237.866\ g} \times 100\% = \underline{40.33\%}$$

(45) CuS molar mass

$$Cu \times 1 = 63.5\ g/mol$$

$$S \times 1 = 32.066\ g/mol$$

$$\underline{95.566\ g/mol}$$

$$\text{mass \% of Cu} = \frac{63.5\ g}{95.566\ g} \times 100\% = \underline{66.45\%}$$

$$\text{mass \% of S} = \frac{32.066\ g}{95.566\ g} \times 100\% = \underline{33.55\%}$$

$$10.0\ g \text{ of Cu} \times \boxed{\frac{100\ g \text{ of CuS}}{66.45\ g\ Cu}} = \underline{15.05\ g\ CuS}$$

(50) [illegible]

(a) $C_2H_3O_3$

empirical formula mass

		g
$2 \times C$	$= 2 \times 12.011\ g/mol$	$= 24.022$
$3 \times O$	$= 3 \times 15.99\ g/mol$	$= 47.97$
$3 \times H$	$= 3 \times 1.008\ g/mol$	$= 3.024$
		$\underline{75.016\ g}$

Molar mass = 150.0 g/mol

$$\left.\begin{array}{l}\#\text{ of empirical formula units} \\ \text{in molecular formula}\end{array}\right\} = \frac{150.0\ g}{75.016\ g} \approx 2$$

(b) C_3H_8 empirical formula mass

		g
$3 \times C$	$= 3 \times 12.011$ g/mol	$= 36.033$
$8 \times H$	$= 8 \times 1.008$ g/mol	$= 8.064$
		44.097 g

Molar mass = empirical formula mass

∴ Molecular formula = C_3H_8

(c) B_4H_{10} molecular formula

Molar mass

$4 \times B$	$= 4 \times 10.811$ g/mol	$= 43.244$
$10 \times H$	$= 10 \times 1.008$ g/mol	$= 10.08$
		53.3249 g/mol

empirical formula = B_2H_5 (simplest ratio)

(51)

	C	H
In 100 g of acetylene we get	92.26 g	7.74 g
moles	$\frac{92.26\text{ g}}{12.011\text{ g/mol}} = 7.6813$ mol	$\frac{7.749}{1.008\text{ g/mol}} = 7.6786$ mol
molar ratios	$\frac{7.6813\text{ mol}}{7.6786\text{ mol}} = 1$	$\frac{7.6786\text{ mol}}{7.6786\text{ mol}} = 1$
		1 : 1

empirical formula CH

empirical formula mass $= 1 \times C + 1 \times H$

$= (1 \times 12.011 + 1 \times 1.008)\ g$

$= 13.019\ g$

Molar mass $= 26.02\ g/mol$

$$\left.\begin{array}{l}\#\text{ of empirical formula}\\ \text{units in one molecular formula}\end{array}\right\} = \frac{26.02\ g}{13.019\ g} = 2$$

$\therefore$ Molecular formula $= \underline{\underline{C_2H_2}}$

(53) Since cumene is a hydrocarbon, it is made of C and H only.

mass % of C $= 89.94\%$

$\therefore$ mass % of H $= (100 - 89.94)\% = 10.06\%$

	C	H
in 100 g of cumene	89.94 g	10.06 g
# of moles	$89.94\ g \times \frac{mol}{12.011\ g}$	$10.06\ g \times \frac{mol}{1.008\ g}$
	$= 7.488\ mol$	$= 9.980\ mol$
molar ratio	$\frac{7.488\ mol}{7.488\ mol} = 1$	$\frac{9.980\ mol}{7.488\ mol} = 1.33$

$1 : 1.33$

$3 : 3.99 \approx 4$

empirical formula mass = $(3 \times 12.011 + 4 \times 1.008)$

$= 40.065\,g$

Molar mass $= 120.2\,g/mol$

∴ It takes 3 empirical formula units to make one molecular formula.

Molecular formula of cumene $= \underline{\underline{C_9H_{12}}}$

(59) Xe + Fluorine ⟶ new compound

0.526g 0.678g

Mass of fluorine in new compound $= 0.678g - 0.526g$

$= 0.152g$

	Xe	F
masses	0.526 g	0.152 g
moles	$0.5269 \times \frac{mol}{131.299}$	$0.152g \times \boxed{\frac{mol}{18.998g}}$
	$= 4.0064 \times 10^{-3}\,mol$	$= 8.0008 \times 10^{-3}\,mol$
Molar ratios	$\frac{4.0064 \times 10^{-3}\,mol}{4.0064 \times 10^{-3}\,mol} = 1$	$\frac{8.0008 \times 10^{-3}\,mol}{4.0064 \times 10^{-3}\,mol} = 2$

1 : 2

The empirical formula = XeF_2

(60)

$$S + F_2 \longrightarrow SF_x$$

1.256 g 5.722 g

amount of F in SF_x = (5.722 − 1.256) g
= 4.466 g

	S	F
masses that combine	1.256 g	4.466 g
moles	$1.256\text{ g} \times \frac{\text{mol}}{32.066\text{ g}}$	$4.466\text{ g} \times \frac{\text{mol}}{18.998\text{ g}}$
	$= 3.917 \times 10^{-2}$ mol	0.2352 mol
molar ratios	$\frac{3.917 \times 10^{-2}\text{ mol}}{3.917 \times 10^{-2}\text{ mol}} = 1$	$\frac{0.2352\text{ mol}}{3.917 \times 10^{-2}\text{ mol}} = 6$

1 : 6

empirical formula of SF_x = SF_6

$x = 6$

③ (a) $2\,Cr(s) + \frac{3}{2}O_2(g) \longrightarrow Cr_2O_3(s)$

OR

$4\,Cr(s) + 3\,O_2(g) \longrightarrow 2\,Cr_2O_3(s)$

(b) $Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$

(c) $C_6H_5CH_3(\ell) + 9\,O_2(g) \rightarrow 4\,H_2O(\ell) + 7\,CO_2(g)$

④ (a) $2\,Cr(s) + 3\,Cl_2(g) \longrightarrow 2\,CrCl_3(s)$

(b) $SiO_2(s) + 2\,C(s) \longrightarrow Si(s) + 2\,CO(g)$

(c) $3\,Fe(s) + 4\,H_2O(g) \longrightarrow Fe_3O_4(s) + 4\,H_2(g)$