Stage 3 - Set 6 Answers: Empirical formulas

1.

$$n(CO_2) = \frac{0.531}{44.01}$$
$$= 1.21 \times 10^{-2} \text{ mol}$$
$$= n(CO_3^{2-})$$
$$m(CO_3^{2-}) = 60.01 \times (1.21 \times 10^{-2})$$
$$= 0.724 \text{ g}$$
$$n(H_2O) = \frac{0.219}{18.016}$$
$$= 1.21 \times 10^{-2} \text{ mol}$$
$$= n(OH^-)$$
$$m(OH^-) = (1.21 \times 10^{-2}) \times 17.008$$
$$= 0.2067 \text{ g}$$
$$m(Cu) = 2.088 - (0.724 + 0.2067)$$
$$= 1.157 \text{ g}$$
$$n(Cu) = \frac{1.157}{63.55}$$
$$= 1.82 \times 10^{-2} \text{ mol}$$

	Cu	CO_3	OH
n	1.82×10^{-2}	1.21×10^{-2}	1.21×10^{-2}
Ratio	$\frac{1.82 \times 10^{-2}}{1.21 \times 10^{-2}}$	$\frac{1.21 \times 10^{-2}}{1.21 \times 10^{-2}}$	$\frac{1.21 \times 10^{-2}}{1.21 \times 10^{-2}}$
	1.5	1	1
x 2	3	2	2

E.F. = $Cu_3(CO_3)_2(OH)_2$

2. a)

	C	H
m in 100 g	85.7	14.3
n	$\frac{85.7}{12.01}$ $= 7.14$	$\frac{14.3}{1.008}$ $= 14.18$
Ratio	$\frac{7.14}{7.14}$ $= 1$	$\frac{14.18}{7.14}$ $= 2$

E.F. = CH_2

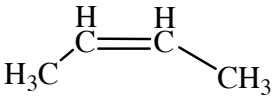
b)

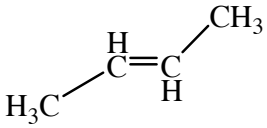
$$n = \frac{1.18x105}{298x8.315}$$
$$= 5.00x10^{-2} \text{ mol}$$

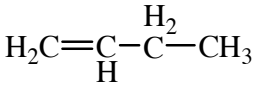
$$M = \frac{2.80}{5.00x10^{-2}}$$
$$= 56.00 \text{ g mol}^{-1}$$

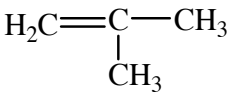
$$MF = \frac{56.00}{14.00}$$
$$= 4$$

MF = C_4H_8

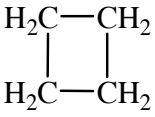




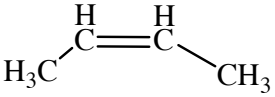


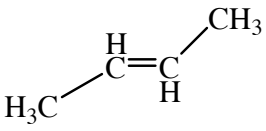


c)



d)





3.

$$\%Pb = \frac{2.93}{3.41} x100$$
$$= 85.9\ \%$$

$$n(AgCl) = \frac{1.16}{107.9 + 35.45}$$
$$= 8.09 \times 10^{-3}\ mol$$
$$= n(Cl^-)$$

$$M(C\ell) = (8.09 \times 10\text{-}3) \times 35.45$$
$$= 0.287\ g$$

$$\%Cl = \frac{0.287}{2.93} x100$$
$$= 9.79\ \%$$

$$\%O = 100 - (85.9 + 9.79)$$
$$= 4.31\ \%$$

	Pb	$C\ell$	O
M in 100 g	85.9	9.79	4.31
N	$\frac{85.9}{207.2}$ $= 0.415\ mol$	$\frac{9.79}{35.45}$ $= 0.276\ mol$	$\frac{4.31}{16.00}$ $= 0.269$
ratio	$\frac{0.415}{0.269}$ $= 1.5$	$\frac{0.276}{0.269}$ ≈ 1	1

EF = $Pb_3C\ell_2O_2$

4. a)

$$n(CO_2) = \frac{6.60}{44.01}$$
$$= 0.150\ mol$$
$$= n(C)$$

$$m(C) = 0.150 \times 12.01$$
$$= 1.80\ g$$

$$n(H_2O) = \frac{4.05}{18.016}$$
$$= 0.224\ mol$$

$$n(H) = 2x0.224$$
$$= 0.450\ mol$$

$$m(H) = 0.450 \times 1.008$$
$$= 0.453\ g$$

$$m(O) = 3.45 - (1.80 + 0.453)$$
$$= 1.197\ g$$

$$n(O) = \frac{1.197}{16.0}$$
$$= 0.0750\ mol$$

	C	H	O
n	0.150	0.450	0.0750
ratio	$\frac{0.150}{0.0750}$	$\frac{0.450}{0.0750}$	$\frac{0.0750}{0.0750}$
	2	6	1

E.F. = C_2H_6O

b)

$$n = \frac{0.950 \times 98}{373 \times 8.315}$$

$$= 3.00 \times 10^{-2} \text{ mol}$$

$$M = \frac{1.38}{3.00 \times 10^{-2}}$$

$$= 46.0 \text{ g mol}^{-1}$$

EFM=MFM

MF = C_2H_6O

c) CH_3CH_2OH

5.

$$n(CoCO_3) = \frac{0.849}{58.93 + 12.01 + 48.00}$$

$$= 7.14 \times 10^{-3} \text{ mol}$$

M(Co) = (7.14 x 10-3) x 58.93

= 0.421 g

$$\%Co = \frac{0.421}{1.22} \times 100$$

= 34.5 %

$$n(C) = \frac{3.43}{44.01}$$

$$= 7.79 \times 10^{-3} \text{ mol}$$

M(C) = (7.79 x 10-3)) x 12.01

= 0.936 g

$$\%C = \frac{0.936}{3.33} \times 100$$

= 28.1 %

%O = 100 –(34.5 + 28.1)

= 37.4 %

	Co	C	O
M in 100 g	34.5	28.1	37.4
N	$\frac{34.5}{58.93}$ = 0.585 mol	$\frac{28.1}{12.01}$ 2.34 mol	$\frac{37.4}{16.00}$ = 2.34 mol
Ratio	1	$\frac{2.34}{0.585}$ = 4	$\frac{2.34}{0.585}$ = 4

EF = CoC_4O_4

b) EFM = 58.93 + (4 x 12.01) + (4 x 16.00)
= 170.93

$$\text{Ratio} = \frac{341.9}{120.93}$$

$= 2$

MF = 2 x EF
$= Co_2C_8O_8$

6. a)

	C	H	N
n	$\frac{2.64}{44.01}$ $= 6.00 \times 10^{-2}$ mol	$\frac{1.62}{18.016} \times 2$ $= 0.1798$ mol	$\frac{0.236 \times 105}{298 \times 8.315} \times 2$ $= 2.00 \times 10^{-2}$ mol
ratio	$\frac{6.00 \times 10^{-2}}{2.00 \times 10^{-2}}$ $= 3$	$\frac{0.1798}{2.00 \times 10^{-2}}$ $= 9$	1

EF = C_3H_9N

b)

$$n = \frac{0.254 \times 95.5}{(19 + 273) \times 8.315}$$

$= 9.99 \times 10^{-3}$ mol

$$M = \frac{0.5896}{9.99 \times 10^{-3}}$$

$= 59.0$ g

EFM = (3 x 12.01) + (9 x 1.008) + 14.01
= 59.1 g

EFM = MFM

MF = C_3H_9N

7. a)

	C	Cℓ	H
	$\frac{1.189}{44.01} \times 12.01$ $= 0.3245$g	$\frac{1.292}{143.35} \times 35.45$ $= 0.3195$g	0.662- (0.3245+0.3195) =0.0180 g
n	$\frac{0.3245}{12.01}$ $= 0.0271$ mol	$\frac{0.3195}{35.45}$ $= 9.01 \times 10^{-3}$ mol	$\frac{0.0180}{1.008}$ $= 0.0179$ mol
Ratio	$\frac{0.0271}{9.01 \times 10^{-3}}$ $= 3$	1	$\frac{0.0179}{9.01 \times 10^{-3}}$ $= 2$

EF = $C_3H_2C\ell$

b) EFM = (3 x 12.01) + (2 x 1.008) + 35.45
= 73.5

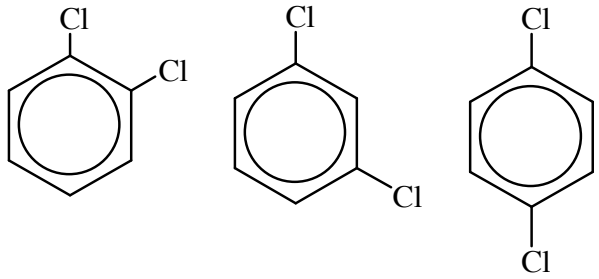
$$\text{Ratio} = \frac{147}{73.5}$$

= 2

MF = 2 x EF

= $C_6H_4C\ell_2$

c)



8.

	C	H	N
	$\frac{1.76}{44.01}$ x12.01 = 0.480g	$\frac{0.420}{18.016}$ x2x1.008 = 0.0470g	$\frac{0.0295x101.3}{(15+273)x8.315}$ x2x14. = 0.0350g
% (m in 100 g)	$\frac{0.480}{0.620}$ x100 = 77.4%	$\frac{0.0470}{0.620}$ x100 = 7.58%	$\frac{0.0350}{0.232}$ = 15.1%
N	$\frac{77.29}{12.01}$ = 6.44	$\frac{7.52}{1.008}$ = 7.52	$\frac{15.1}{14.01}$ = 1.08
ratio	$\frac{6.44}{1.08}$ = 6	$\frac{7.52}{1.08}$ = 7	1

EF = C_6H_7N

b) $n = \frac{1.00x101.3}{(100+273)x8.315}$

$= 3.27x10^{-2}$ mol

$M = \frac{3.04}{3.27x10^{-2}}$

$= 93.1\ g\ mol^{-1}$

EFM = (6 x 12.01) + (7 x 1.008) + 14.01

= 93

MF = EF

= C_6H_7N

9.

$$\%H_2O = \frac{5.43 - 4.88}{5.43} x100$$
$$= 10.4\%$$

$$m(Ni) = \frac{0.578}{58.69 + 32.06} x58.69$$
$$= 0.374\,g$$

$$\%Ni = \frac{0.374}{\frac{2,00}{4.88} x5.43} x100$$
$$= 16.8\%$$

$$\%C_2O_4 = \frac{1.62}{\frac{2.88}{4.88} x5.43} x100$$
$$= 50.5\%$$

$$\%K = 100 - (10.4 + 16.8 + 50.5)$$
$$= 22.3\ \%$$

	K	Ni	C_2O_4	H_2O
% (m in 100g)	22.3	16.8	50.5	10.4
n	$\frac{22.3}{39.1}$ $= 0.570$mol	$\frac{16.8}{58.69}$ $= 0.286$mol	$\frac{50.5}{88.02}$ 0.574mol	$\frac{10.4}{18.016}$ 0.577mol
ratio	$\frac{0.570}{0.286}$ $= 2$	1	$\frac{0.574}{0.286}$ $= 2$	$\frac{0.577}{0.286}$ $= 2$

$EF = K_2Ni(C_2O_4)_2.2.H_2O$

10.

$$n(BaSO_4) = \frac{0.4671}{137.3 + 32.06 + 64.00}$$
$$= 2.00 \times 10^{-3}\ mol$$
$$= n(S)$$

$$m(S) = (2.00 \times 10^{-3}) \times 32.06$$
$$= 6.42 \times 10^{-2}\ g$$

$$n(OH^-) = 0.250 \times 0.024$$
$$= 6.00 \times 10^{-3}\ mol$$

$$n(HC\ell) = n(NaOH) - 2n(H_2SO_4)$$
$$n(C\ell^-) = n(OH^-) - 2n(S)$$
$$= 6.00 \times 10^{-3} - 4.00 \times 10^{-3}$$
$$= 2.00 \times 10^{-3}\ mol$$
$$m(C\ell^-) = 35.45 \times (2.00 \times 10^{-3})$$
$$= 0.0709\ g$$

	S	Cℓ	O
% (m in 100 g)	$\frac{6.42\text{x}10^{-2}}{0.2702}$ x100 = 23.7%	$\frac{0.0709}{0.2702}$ x100 = 26.2%	100 –(23.7+26.2) =50.1 %
n	$\frac{23.7}{32.06}$ = 0.739 mol	$\frac{26.2}{35.45}$ = 0.739 mol	$\frac{50.1}{16.00}$ = 3.13 mol
ratio	1	1	$\frac{3.13}{0.739}$ = 4.25
x4	4	4	17

EF = $S_4C\ell_4O_{17}$