PROBLEMAS RESUELTOS DE CÁLCULOS QUÍMICOS

(1) $M = 2 \cdot 14 + 8 \cdot 1 + 2 \cdot 52 + 7 \cdot 16 = 252 \ \frac{g}{mol}$

a)

$$n = \frac{m}{M} = \frac{378}{252} = \boxed{1'5 \text{ mol}}$$

b) N: $1'5 \cdot 2 = \boxed{3 \text{ mol}}$

H: $1'5 \cdot 8 = \boxed{12 \text{ mol}}$

Cr: $1'5 \cdot 2 = \boxed{3 \text{ mol}}$

O: $1'5 \cdot 7 = \boxed{10'5 \text{ mol}}$

c) N: $3 \cdot 14 = \boxed{42 \text{ g}}$

H: $12 \cdot 1 = \boxed{12 \text{ g}}$

Cr: $3 \cdot 52 = \boxed{156 \text{ g}}$

O: $10'5 \cdot 16 = \boxed{168 \text{ g}}$

d) $N = n \cdot N_A = 1'5 \cdot 6'022 \cdot 10^{23} = \boxed{9'03 \cdot 10^{23} \text{ moléculas}}$

e) N: $3 \cdot 6'022 \cdot 10^{23} = \boxed{1'81 \cdot 10^{24} \text{ átomos}}$

H: $12 \cdot 6'022 \cdot 10^{23} = \boxed{7'23 \cdot 10^{24}}$ "

Cr: $3 \cdot 6'022 \cdot 10^{23} = \boxed{1'81 \cdot 10^{24}}$ "

O: $10'5 \cdot 6'022 \cdot 10^{23} = \boxed{6'32 \cdot 10^{24}}$ "

(2) $M = 2 \cdot 55'85 + 3 \cdot 16 = 159'7 \ \frac{g}{mol}$

$m_{Fe} = 150 \ \cancel{g \ oligisto} \cdot \frac{75 \ \cancel{g \ Fe_2O_3}}{100 \ \cancel{g \ oligisto}} \cdot$

$\cdot \frac{2 \cdot 55'85 \ g \ Fe}{159'7 \ \cancel{g \ Fe_2O_3}} = \boxed{78'7 \ g \ Fe}$

(3) $m_{N_2} = 28 \ \frac{g}{\cancel{mol}} \cdot \frac{1 \ \cancel{mol}}{6'022 \cdot 10^{23} \ moléculas} = \boxed{4'65 \cdot 10^{-23} \ \frac{g}{molécula}}$

$m_H = 1 \ \frac{g}{\cancel{mol}} \cdot \frac{1 \ \cancel{mol}}{6'022 \cdot 10^{23} \ átomos} = \boxed{1'66 \cdot 10^{-24} \ \frac{g}{átomo}}$

(4) $M = 4 \cdot 12 + 10 \cdot 1 + 16 = 74 \ \frac{g}{mol}$

$m = d \cdot V = 0'713 \ \frac{g}{\cancel{cm^3}} \cdot 250 \ \cancel{cm^3} = \boxed{178 \ g}$

$n = \frac{m}{M} = \frac{178}{74} = \boxed{2'41 \ mol}$

$N = n \cdot N_A = 2'41 \cdot 6'022 \cdot 10^{23} = \boxed{1'45 \cdot 10^{24} \ moléculas}$

(5) $M = 2 \cdot 27 + 3 \cdot 16 = 102 \frac{g}{mol}$

a) $n_{Al} = 1 \text{ ton mineral} \cdot \frac{10^6 \text{ g mineral}}{1 \text{ ton mineral}} \cdot \frac{60 \text{ g } Al_2O_3}{100 \text{ g mineral}} \cdot \frac{1 \text{ mol } Al_2O_3}{102 \text{ g } Al_2O_3} \cdot \frac{2 \text{ mol } Al}{1 \text{ mol } Al_2O_3} =$

$= \boxed{1'18 \cdot 10^4 \text{ mol } Al}$

b) $m = n \cdot M = 1'18 \cdot 10^4 \cdot 27 = \boxed{3'18 \cdot 10^5 \text{ g } Al}$

c) $N = n \cdot N_A = 1'18 \cdot 10^4 \cdot 6'022 \cdot 10^{23} = \boxed{7'11 \cdot 10^{27} \text{ átomos } Al}$

(6) $M = 3 \cdot 55'85 + 2 \cdot 31 + 8 \cdot 16 = 357'6 \ \frac{g}{mol}$

a) $n = \frac{m}{M} = \frac{80}{357'6} = \boxed{0'224 \ mol}$

b) $N = n \cdot N_A = 0'224 \cdot 6'022 \cdot 10^{23} = \boxed{1'35 \cdot 10^{23} \text{ moléculas}}$

c) Fe: $0'224 \cdot 3 = \boxed{0'672 \ mol}$

P: $0'224 \cdot 2 = \boxed{0'448 \ mol}$

O: $0'224 \cdot 8 = \boxed{1'79 \ mol}$

d) Fe: $0'672 \cdot 55'85 = \boxed{37'5 \ g}$

P: $0'448 \cdot 31 = \boxed{13'9 \ g}$

O: $1'79 \cdot 16 = \boxed{28'6 \ g}$

e) Fe: $0'672 \cdot 6'022 \cdot 10^{23} = \boxed{4'05 \cdot 10^{23} \text{ átomos}}$

P: $0'448 \cdot 6'022 \cdot 10^{23} = \boxed{2'70 \cdot 10^{23} \text{ "}}$

O: $1'79 \cdot 6'022 \cdot 10^{23} = \boxed{1'08 \cdot 10^{24} \text{ "}}$

(7) $m_O = 1'07 - 0'36 - 0'16 = 0'55$ g O

Cu: $\frac{0'36}{63'54} = 5'67 \cdot 10^{-3} \rightarrow \frac{5'67 \cdot 10^{-3}}{5'67 \cdot 10^{-3}} = 1$

N: $\frac{0'16}{14} = 0'0114 \rightarrow \frac{0'0114}{5'67 \cdot 10^{-3}} \simeq 2$

O: $\frac{0'55}{16} = 0'0344 \rightarrow \frac{0'0344}{5'67 \cdot 10^{-3}} \simeq 6$

Fórmula: $\boxed{Cu\,N_2\,O_6}$

(8) H: $\frac{0'8}{1} = 0'8 \rightarrow \frac{0'8}{0'793} \simeq 1$

Na: $\frac{36'5}{23} = 1'58 \rightarrow \frac{1'58}{0'793} \simeq 2$

P: $\frac{24'6}{31} = 0'793 \rightarrow \frac{0'793}{0'793} = 1$

O: $\frac{38'1}{16} = 2'38 \rightarrow \frac{2'38}{0'793} \simeq 3$

Fórmula: $\boxed{Na_2\,H\,P\,O_3}$

(9) Fórmula semidesarrollada:

$CHO-CH_2-CO-CHNH_2-CHNH_2-COOH$

Fórmula molecular: $C_6H_{10}O_4N_2$

Fórmula empírica: $C_3H_5O_2N$

(10) Sb: $\frac{25'4}{121'76} = 0'209 \rightarrow \frac{0'209}{0'209} = 1 \xrightarrow{\times 2} 2$

Se: $\frac{41'2}{78'96} = 0'522 \rightarrow \frac{0'522}{0'209} \simeq 2'5 \xrightarrow{\times 2} 5$

O: $\frac{33'4}{16} = 2'09 \rightarrow \frac{2'09}{0'209} = 10 \xrightarrow{\times 2} 20$

Fórmula: $Sb_2Se_5O_{20}$

(11) $M = 3 \cdot 112'41 + 2 \cdot 31 + 8 \cdot 16 = 527'2 \frac{g}{mol}$

Cd: $\frac{3 \cdot 112'41 \cdot 100}{527'2} =$ 64 %

P: $\frac{2 \cdot 31 \cdot 100}{527'2} =$ 11'8 %

O: $100 - 64 - 11'8 =$ 24'2 %

(12) $M = 2 \cdot 58'69 + 3 \cdot 12 + 9 \cdot 16 = 297'4 \frac{g}{mol}$

Ni: $\frac{2 \cdot 58'69 \cdot 100}{297'4} = \boxed{39'5\ \%}$

C: $\frac{3 \cdot 12 \cdot 100}{297'4} = \boxed{12'1\ \%}$

O: $100 - 39'5 - 12'1 = \boxed{48'4\ \%}$

(13) Como no hay ningún dato de masa ni de volumen, hay que suponerlo:

$40\ \% \longrightarrow \begin{cases} 40\ g\ HClO_4 \\ 100\ g\ \text{disolución} \end{cases}$

$M = 1 + 35'5 + 16 \cdot 4 = 100'5 \frac{g}{mol}$

$n_s = \frac{m}{M} = \frac{40}{100'5} = 0'398\ mol$; $V_D = \frac{m_D}{d_D} = \frac{100}{1'2} = 83'3\ mL$

a) $c_M = \frac{n_s}{V_D} = \frac{0'398\ mol}{0'0833\ L} = \boxed{4'78\ M}$

b) $c = \frac{m_s}{V_D} = \frac{40\ g}{0'0833\ L} = \boxed{480\ \frac{g}{L}}$

(14) Como no hay ningún dato de masa ni de volumen, hay que suponerlo:

$$28\ \% \longrightarrow \begin{cases} 28\ g\ H_2SO_4 \\ 100\ g\ \text{disolución} \end{cases}$$

$$M = 2\cdot 1 + 32 + 4\cdot 16 = 98\ \frac{g}{mol}\ ;\quad n_s = \frac{m_s}{M_s} = \frac{28}{98} = 0'286\ mol$$

$$V_D = \frac{m_D}{d_D} = \frac{100}{1'25} = 80\ mL = 0'080\ L$$

a) $$c_M = \frac{n_s}{V_D} = \frac{0'286\ mol}{0'080\ L} = \boxed{3'57\ M}$$

b) $$c = \frac{m_s}{V_D} = \frac{28\ g}{0'080\ L} = \boxed{350\ \frac{g}{L}}$$

(15) a) $$m_s = n_s \cdot M_s = 0'5 \cdot 98 = 49\ g\ H_2SO_4$$

$$m_D = \frac{m_s \cdot 100}{\text{Porc.}} = \frac{49\cdot 100}{53} = 92'4\ g$$

$$V_D = \frac{m_D}{d_D} = \frac{92'4\ \cancel{g}}{1'1\ g/cm^3} = \boxed{84\ cm^3}$$

b) $$m_D = d_D \cdot V_D = 1'1\ \frac{g}{\cancel{cm^3}} \cdot 40\ \cancel{mL} = 44\ g\ \text{disolución}$$

$$m_s = \frac{\text{Porc.}\cdot m_D}{100} = \frac{53\cdot 44}{100} = \boxed{23'3\ g\ \text{soluto}}$$

(16) $m_D = m_s + m_d = 40 + 80 = 120\ g$ disolución

$$V_D = \frac{m_D}{d_D} = \frac{120\ g}{1'12\ g/mL} = 107\ mL = 0'107\ L$$

$$V_d = \frac{m_d}{d_d} = \frac{80\ g}{1\ g/mL} = 80\ mL$$

$$V_s = V_D - V_d = 107 - 80 = 27\ mL$$

$$M_s = 23 + 35'5 = 58'5\ \frac{g}{mol}$$

$$n_s = \frac{m_s}{M_s} = \frac{40\ g}{58'5\ \frac{g}{mol}} = 0'684\ mol$$

* Porcentaje en masa:

$$\text{Porc. masa} = \frac{m_s \cdot 100}{m_D} = \frac{40 \cdot 100}{120} = \boxed{33'3\ \%}$$

* Masa por unidad de volumen:

$$c = \frac{m_s}{V_D} = \frac{40\ g}{0'107\ L} = \boxed{373\ \frac{g}{L}}$$

* Porcentaje en volumen:

$$\text{Porc. volumen} = \frac{V_s \cdot 100}{V_D} = \frac{27 \cdot 100}{107} = \boxed{25'2\ \%}$$

* Molaridad:

$$c_M = \frac{n_s}{V_D} = \frac{0'684\ mol}{0'107\ L} = \boxed{6'38\ M}$$

(17) Como no tenemos datos de masa ni de volumen, hay que suponerlo:

$$2\,M \longrightarrow \begin{cases} n_S = 2\ mol\ H_2SO_4 \\ V_D = 1\ L\ disolución \end{cases}$$

$$M_S = 2\cdot 1 + 32 + 4\cdot 64 = 98\ \frac{g}{mol}$$

$$m_S = n_S \cdot M_S = 2\ \cancel{mol}\cdot 98\ \frac{g}{\cancel{mol}} = 196\ g$$

$$m_D = d_D \cdot V_D = 1'3\ \frac{kg}{L}\cdot 1\ L = 1'3\ kg = 1300\ g\ disolución$$

* Porcentaje en masa:

$$Porc.\ masa = \frac{m_S \cdot 100}{m_D} = \frac{196\cdot 100}{1300} = \boxed{15'1\ \%}$$

* Masa por unidad de volumen:

$$c = \frac{m_S}{V_D} = \frac{196\ g}{1\ L} = \boxed{196\ \frac{g}{L}}$$

(18) * Masa de disolución:

$$m_D = \frac{m_S \cdot 100}{\text{Porc.}} = \frac{50 \cdot 100}{60} = 83'3 \text{ g disolución}$$

* Volumen de disolución:

$$V_D = \frac{m_D}{d_D} = \frac{83'3 \text{ g}}{1'3 \frac{\text{g}}{\text{cm}^3}} = \boxed{64'1 \text{ cm}^3}$$

$1'3 \frac{\text{kg}}{\text{L}}$ es lo mismo que $1'3 \frac{\text{g}}{\text{cm}^3}$

(19) * Número de moles del gas:

$$n = 0'175 \text{ L} \cdot \frac{1 \text{ mol}}{22'4 \text{ L}} = 7'81 \cdot 10^{-3} \text{ mol}$$

* Masa molecular del gas:

$$n = \frac{m}{M} \Rightarrow M = \frac{m}{n} = \frac{0'625 \text{ g}}{7'81 \cdot 10^{-3} \text{ mol}} = \boxed{80 \frac{\text{g}}{\text{mol}}}$$

(20) $\frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$; $T = \text{cte} \Rightarrow T_1 = T_2 \Rightarrow P_1 \cdot V_1 = P_2 \cdot V_2 \Rightarrow$

$$\Rightarrow V_2 = \frac{P_1 \cdot V_1}{P_2} = \frac{1 \cdot 60}{5} = \boxed{12 \text{ L}}$$

(21) $P \cdot V = n \cdot R \cdot T \Rightarrow V = \dfrac{n \cdot R \cdot T}{P}$

$n = \dfrac{m}{M} = \dfrac{50}{32} = 1'56 \text{ mol}$; $T_K = T_c + 273 =$
$= -30 + 273 = 243 K$

$V = \dfrac{n \cdot R \cdot T}{P} = \dfrac{1'56 \cdot 0'082 \cdot 243}{2} = \boxed{156 \text{ L}}$

(22) $\dfrac{P_1 \cdot V_1}{T_1} = \dfrac{P_2 \cdot V_2}{T_2} \Rightarrow V_2 = \dfrac{P_1 \cdot V_1 \cdot T_2}{P_2 \cdot T_1} =$

$= \dfrac{3 \cdot 20 \cdot (273+40)}{1 \cdot (273+25)} = \dfrac{60 \cdot 313}{298} = \boxed{63 \text{ L}}$

(23) a)

$1s^2 2s^2 2p^6 = [He] 2p^6$

b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} = [Ar] 4s^2 3d^{10}$

c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$
$6s^2 4f^{14} 5d^{10} 5p^6 7s^2 5f^{12} = [Xe] 7s^2 5f^{12}$

(24) a) Rb b) Al c) As

d) Te e) Ar

(25) H–O–H Cl–Be–Cl

H–N(H)–H O=C=O N≡N

O=O H–N⁺(H)–H O=S=O

Cl–N(Cl)–Cl

(26) $T_K = T_C + 273 = 20 + 273 = 293\ K$

$P = \frac{300}{760} = 0'395\ atm$

* Número de moles:

$n = \frac{P \cdot V}{R \cdot T} = \frac{0'395 \cdot 5}{0'082 \cdot 293} = 0'0822\ mol\ O_2$

* Número de moléculas de O_2:

$N = n \cdot N_A = 0'0822 \cdot 6'022 \cdot 10^{23} = 4'95 \cdot 10^{22}$ moléculas O_2

* Número de átomos de O:

$N = 4'95 \cdot 10^{22}$ ~~moléculas O_2~~ $\cdot \frac{2\ \text{átomos O}}{1\ \text{~~molécula~~} O_2} =$

$= \boxed{9'9 \cdot 10^{22}\ \text{átomos O}}$

(27) * Número de moles del compuesto:

$$n = \frac{P \cdot V}{R \cdot T} = \frac{1'5 \cdot 40}{0'082 \cdot 293} = 2'5 \text{ mol}$$

* Masa molecular:

$$n = \frac{m}{M} \Rightarrow M_{molecular} = \frac{m}{n} = \frac{345 \text{ g}}{2'5 \text{ mol}} = 138 \frac{\text{g}}{\text{mol}}$$

* Masa de la fórmula empírica:

$$M_{empírica} = 2 \cdot 12 + 6 + 16 = 46 \frac{\text{g}}{\text{mol}}$$

* Coeficiente por el que hay que multiplicar la fórmula empírica:

$$x = \frac{M_{molecular}}{M_{empírica}} = \frac{138}{46} = 3$$

Fórmula molecular: $\boxed{C_6 H_{18} O_3}$

(28) * Masas moleculares:

$M_{NaNO_3} = 23 + 14 + 16 \cdot 3 = 85 \frac{g}{mol}$

$M_{KNO_3} = 39'1 + 14 + 16 \cdot 3 = 101'1 \frac{g}{mol}$

* Porcentajes de N:

En el $NaNO_3$: $\frac{14 \cdot 100}{85} = 16'5\%$

En el KNO_3: $\frac{14 \cdot 100}{101'1} = 13'8\%$

Solución: $\boxed{NaNO_3}$