Gas Problems - All Kinds

1)

$$273.15 + 4.0 = \boxed{277.15\ K} = T$$

$$P = \boxed{755.8\ mmHg}$$

$$V = \frac{42{,}000\ ft^3}{1} \times \frac{1728\ in^3}{1\ ft^3} \times \frac{16.4\ cm^3}{1\ in^3} \times \frac{1\ mL}{1\ cm^3} \times \frac{1\ L}{1000\ mL}$$

$$\boxed{1.2 \times 10^6\ L}$$

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(755.8)(1.2 \times 10^6)}{(62.36)(277.15)} = 52000\ moles$$

5.2×10^4 moles

$$\frac{5.2 \times 10^4\ moles}{1} \times \frac{4.00\ g\ He}{1\ mol\ He} = \boxed{2.1 \times 10^5\ g\ He}$$

$$D = \frac{2.1 \times 10^5\ g}{1.2 \times 10^6\ L} = \boxed{.175\ g/L}$$

2)

V = 5.00 L

T = 298 K

P = 3.00 atm

$$\frac{76.0\ g\ C_2Cl_2F_2}{1} \times \frac{1\ mole}{170.92\ g} = .445\ moles$$

leaked out

$$n = \frac{PV}{RT} = \frac{(3.00)(5.00)}{(.08206)(298)} = .613\ moles$$

originally in tank →

$$.613 - .445 = .168\ moles$$

remain

$$P = \frac{nRT}{V} = \frac{(.168)(.08206)(298)}{5.00}$$

$$= \boxed{.822\ atm}$$

3) $\frac{1.4 \times 10^3 \text{ kg}}{\text{m}^3} \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1\text{ m}^3}{1 \times 10^6 \text{ cm}^3} \times \frac{1\text{ cm}^3}{1\text{ mL}} \times \frac{1000\text{ mL}}{1\text{ L}} = 1400\ \text{g/L}$

$$M = \frac{DRT}{P}$$

$$T = \frac{MP}{DR} = \frac{(2.0)(1.3 \times 10^9)}{(1400)(.08206)} = 2.3 \times 10^7 \text{ K}$$

4) $\frac{30.4\text{ g N}}{1} \times \frac{1\text{ mole}}{14.01\text{ g}} = \frac{2.17\text{ mol N}}{2.17} = 1$

$\frac{69.6\text{ g O}}{1} \times \frac{1\text{ mole}}{16.00\text{ g}} = \frac{4.35\text{ mol O}}{2.17} = 2$

Empirical Formula = NO_2 → 46.01 g

$$M = \frac{DRT}{P} = \frac{(11.1)(.08206)(253)}{2.50} = 92.2\ \text{g/mol}$$

$\frac{92.2}{46.01} \approx 2$ Molecular Formula = N_2O_4

5) $\frac{55.8\text{ g C}}{1} \times \frac{1\text{ mol}}{12.01\text{ g}} = \frac{4.65\text{ mol C}}{2.33} \approx 2$

$\frac{7.03\text{ g H}}{1} \times \frac{1\text{ mol}}{1.01\text{ g}} = \frac{6.96\text{ mol H}}{2.33} \approx 3$

$\frac{37.2\text{ g O}}{1} \times \frac{1\text{ mol}}{16.00\text{ g}} = \frac{2.33\text{ mol O}}{2.33} \approx 1$

empirical formula = C_2H_3O → 43.05 g

$$M = \frac{DRT}{P} = \frac{\left(\frac{1.500}{.530}\right)(62.36)(373)}{740} = 89.0\ \text{g/mol}$$

$\frac{89.0}{43.05} \approx 2$ Molecular Formula = $C_4H_6O_2$

6) $T = 300.15K$

$V = 2.00L$

$P_T = 760 \text{ torr}$

$P_{H_2O} = 26.0 \text{ torr}$

$P_{O_2} = 734 \text{ torr}$

(collecting a gas over water)

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(734)(2.00)}{(62.36)(300.15)}$$

$= .0784 \text{ mol } O_2$

$$\frac{.0784 \text{ mol } O_2}{1} \times \frac{2 \text{ mol } KClO_3}{3 \text{ mol } O_2} = \boxed{.0523 \text{ mol } KClO_3}$$

7) mass = 1.00g

$V = .416 L$

$P = 745 \text{ mmHg}$

$T = 348.15 K$

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(745)(.416)}{(62.36)(348.15)}$$

$= .0143 \text{ moles}$

$$MM = \frac{1.00g}{.0143 \text{ mol}} = 69.9 \text{ g/mol}$$

$69.9_g - 32.06_g = 37.81_g$

$SF_x - S = F_x$ ↙

F_2

$\boxed{SF_2}$

8) $$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{5.9}{.55} = \sqrt{\frac{x}{2.02}}$$

$$11^2 = \frac{x}{2.02}$$

$$120 = \frac{x}{2.02}$$

$x = \boxed{240 \text{ g/mol}}$

9) $T = 303.15\,K$

$P = .925\ atm$

$V = ?$

$n = $ → $\frac{1.446\,g\ Sc_2(CO_3)_3}{1} \times \frac{1\ mol\ Sc_2(CO_3)_3}{269.95\,g\ Sc_2(CO_3)_3} \times \frac{3\ mol\ CO_2}{1\ mol\ Sc_2(CO_3)_3}$ $= .01607$ moles CO_2

$$V = \frac{nRT}{P} = \frac{(.01607)(.08206)(303.15)}{.925}$$

$$= \boxed{.432\,L\ CO_2}$$

10) He

$V_1 = 46L$

$T_1 = 298.15K$

$P_1 = 1.0\,atm$

$V_2 = 5.0L$

$P_2 = ?$

$P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1V_1}{V_2} = \frac{(1.0)(46)}{5.0}$$

$P_2 = \boxed{9.2\,atm}$ → partial pressure of He

O_2

$V_1 = 12\,L$

$T_1 = 298.15\,K$

$P_1 = 1.0\,atm$

$V_2 = 5.0\,L$

$P_2 = ?$

$P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1V_1}{V_2} = \frac{(1.0)(12)}{5}$$

$P_2 = \boxed{2.4\,atm}$ → partial pressure of O_2

$$P_{Total} = 9.2 + 2.4$$

$$= \boxed{11.6\,atm}$$

11) KE is directly proportional to Kelvin temperature.

$H_2O > He > N_2$

$KE = \frac{3}{2}RT$

↑ ↑

12) Same Temp then Same KE.

$KE = \frac{1}{2}mv^2$

↓↑

$He > H_2O > N_2$

He ↓ lightest = fastest

N_2 ↓ heaviest = slowest

Some More Gas Law Problems!

1.) $V_{N_2} = 100\,mL \rightarrow$ does not change
$P_{N_2} = 160\,mmHg$
$P_T = 300\,mmHg$

$P_{CO_2} = P_T - P_{N_2}$
$= 300 - 160$
$P_{CO_2} = 140\,mmHg$

Dalton's* Law of Partial Pressure

2.) $V_1 = 225\,L$
$P_1 = .94\,atm$
$T_1 = 25°C = 298\,K$

$V_2 = ?$
$P_2 = .99\,atm$
$T_2 = 0°C = 273\,K$

Combined Gas Law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2}$$

$$= \frac{(.94)(225)(273)}{(298)(.99)}$$

$V_2 = 196\,L$ ~~200 L~~ $2.0 \times 10^2\,L$

2 sf → 200L

3.) $P_1 = 34{,}470\,kPa$
$V_1 = 473.18\,mL$
$V_2 = 13.16\,mL$
$P_2 = ?$

Boyle's Law

$P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1V_1}{V_2}$$

$$P_2 = \frac{(34{,}470)(473.18)}{13.16}$$

$P_2 = 1{,}239{,}401\,kPa$
$1.239 \times 10^6\,kPa$

4 sig figs

4.) $T_1 = 23.6°C = 296.6 K$

$V_1 = 31.4 L$

$V_2 = 25.0 L$

$T_2 = ?$

Charles' Law

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

$$T_2 = \frac{T_1 V_2}{V_1} = \frac{(296.6)(25.0)}{31.4}$$

$$T_2 = 236 K$$
$$-37°C$$

5.) $d_1 = 1.75\ g/dm^3$

$P_1 = 110\ kPa$

$T = 45°C = 318 K$

$d_2 = ?$

$P_2 = 101.3\ kPa$

$T_2 = 0°C = 273 K$

$$MM = \frac{dRT}{P}$$

$$\frac{d_1 \cancel{R_1} T_1}{P_1} = \frac{d_2 \cancel{R_2} T_2}{P_2}$$

$$d_2 = \frac{d_1 T_1 P_2}{P_1 T_2}$$

$$= \frac{(1.75)(318)(101.3)}{(110)(273)}$$

$$d_2 = 1.88\ g/L$$

6.) $V = 120 L$

$T = 147°C = 420 K$

$P = 6\ atm$

oxygen O_2

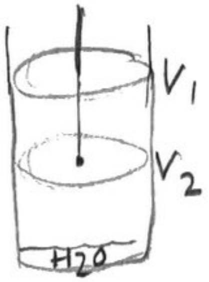
$$MM = \frac{dRT}{P} =$$

$$d = \frac{(MM)(P)}{(R)(T)}$$

$$= \frac{(32.00)(6)}{(.08206)(420)} = 5.57\ g/L$$

$$D = \frac{M}{V} \quad M = (D)(V) = (5.57)(120)$$

$$M = 668\ g$$



7.) $T = 25\,°C = 298\,K$

$P_T = 600\,mmHg$

$\frac{1}{2}V$ will double P_{N_2}

$\frac{1}{2}V$ will <u>not</u> double P_{H_2O} → depends only on the T of the water.

P_{H_2O} at $25°C = 23.756\,mmHg$

$600\,mmHg - 23.756\,mmHg = 576\,mmHg$ → P_{N_2} at V_1

$\frac{1}{2}V$, P_{N_2} increases to 1152 mmHg.

$$\begin{array}{r} 1152\ mmHg \\ +\ 23.756\ mmHg \\ \hline 1175.756 \end{array}$$

P_T at the new Volume → 1176 mmHg

8.) $P_{max} = 36.2\,atm$

mass $= 36.0\,g\ N_2$

$T_1 = 25\,°C = 298\,K$

$P_1 = 12.7\,atm$

Guy-Lussac's Law

$$\frac{P_1}{T_1} = \frac{P_{max}}{T_{max}}$$

$$\frac{12.7}{298} = \frac{36.2}{T_{max}}$$

$T_{max} = 849\,K$
$576°C$