Chem 152 Spring 2009 p.1

Gas Laws PPT - 4/30/2009

Learning Checks

(1) $V = 5.0\,L\ O_2$ $\quad PV = nRT$ $\quad$ molar mass $= 16.00 \times 2 = 32.00\ g/mol$

$T = 20^\circ C + 273 = 293\,K$ $\quad n = \frac{PV}{RT}$

$P = 0.85\ atm$

$n = ?$ (mass)

$$n = \frac{(0.85\ atm)(5.0\,L)}{(.08206\ \frac{L\cdot atm}{K\cdot mol})(293\,K)} = 0.1768\ mol\ O_2$$

$$0.1768\ mol\ O_2 \times \left(\frac{32.00\ g}{1\ mol}\right) = \boxed{5.7\ g}$$

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(2) H_2 $\quad PV = nRT = constant$ (n and T aren't changing)

$V_1 = 120\,mL$ $\quad P_1 = 850\ mm\,Hg$

$V_2 = ?$ $\quad P_2 = 425\ mm\,Hg$

$$P_1V_1 = P_2V_2$$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{(850\ mm\,Hg)(120\,mL)}{(425\ mm\,Hg)} = \boxed{240\,mL}$$

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(3) O_2 $\quad V_1 = 12.0\,L$ $\quad V_2 = 36.0\,L$

$P_1 = 600.\ mm\,Hg$ $\quad P_2 = ?$

$$P_1V_1 = P_2V_2 \rightarrow P_2 = \frac{P_1V_1}{V_2} = \frac{(600.\ mm\,Hg)(12.0\,L)}{(36.0\,L)} = \boxed{200.\ mm\,Hg}$$

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(4) $V_1 = 785\,mL$ $\quad T_1 = 21^\circ C + 273 = 294\,K$

$V_2 = ?$ $\quad T_2 = 0^\circ C + 273 = 273\,K$

$PV = nRT$

$$\frac{V}{T} = \frac{nR}{P} = const \rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow V_2 = \frac{V_1T_2}{T_1} = \frac{(785\,mL)(273\,K)}{(294\,K)}$$

↑ n and P

(5) O_2 $V_1 = 420\ mL$ $T_1 = 18°C + 273 = 291\ K$
$V_2 = 640\ mL$ $T_2 = ?$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $T_2 = \frac{V_2 T_1}{V_1} = \frac{(640\ mL)(291\ K)}{(420\ mL)} = \frac{443}{440\ K}$

↑ 2 s.f.

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(6) $P_1 = 2.0\ atm$ $P_2 = ?$
$T_1 = 18°C + 273 = 291\ K$ $T_2 = 62°C + 273 = 335\ K$

$PV = nRT$

$\frac{P}{T} = \frac{nR}{V} = const \rightarrow \frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow P_2 = \frac{P_1 T_2}{T_1} = \frac{(2.0\ atm)(335\ K)}{(291\ K)}$

↑ V, n constant

$= 2.3\ atm$

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(7) $n_1 = 0.75\ mol$ $n_2 = 1.2\ mol$
$V_1 = 1.5\ L$ $V_2 = ?$

$PV = nRT$

$\frac{V}{n} = \frac{RT}{P} = const \rightarrow \frac{V_1}{n_1} = \frac{V_2}{n_2} \rightarrow V_2 = \frac{V_1 n_2}{n_1} = \frac{(1.5\ L)(1.2\ mol)}{(0.75\ mol)}$

↑ T, P const.

$= 2.4\ L$

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(8) $V_1 = 0.180\ L$ $V_2 = 90.0\ mL$
$P_1 = 0.800\ atm$ $P_2 = 3.20\ atm$
$T_1 = 29°C + 273 = 302\ K$ $T_2 = ?$

$PV = nRT$

$\frac{PV}{T} = nR = const \rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \rightarrow T_2 = \frac{P_2 V_2 T_1}{P_1 V_1} = \frac{(3.20\ atm)(90.0\ mL)(302\ K)\left(\frac{1\ L}{1000\ mL}\right)}{(0.800\ atm)(.180\ L)}$

↑

(9) $V_1 = 675$ mL $V_2 = ?$ mL

$T_1 = 35°C + 273 = 308$ K $T_2 = -95°C + 273 = 178$ K

$P_1 = .850$ atm $P_2 = 802$ mm Hg

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{(.850\text{ atm})(675\text{ mL})(178\text{ K})}{(308\text{ K})(802\text{ mm Hg})\left(\frac{1\text{ atm}}{760\text{ mm Hg}}\right)}$

$= \boxed{314\text{ mL}}$

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(10) Density of O_2 at STP

$D = \frac{\text{molar mass}}{\text{molar volume}} = \frac{16.00 \times 2\text{ g/mol}}{22.4\text{ L/mol}} = \boxed{1.43\text{ g/L}}$

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(11) N_2O $PV = nRT$

$V = 20.0$ L $P = \frac{nRT}{V} = \frac{(2.86\text{ mol})\left(.08206\frac{\text{L·atm}}{\text{K·mol}}\right)(296\text{ K})}{(20.0\text{ L})}$

$n = 2.86$ mol

$T = 23°C + 273 = 296$ K $= \boxed{3.47\text{ atm}}$

$P = ?$

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(12) $4\,NH_{3(g)} + 5\,O_{2(g)} \rightarrow 4\,NO_{(g)} + 6\,H_2O_{(g)}$

28.0 g $V = ?$ at $24°C + 273 = 297$ K $.950$ atm

↓ mol → mol → $PV = nRT$ ✓

molar mass NH_3: $14.01 + 1.008 \times 3 = 17.034$ g/mol

$28.0\text{ g } NH_3\left(\frac{1\text{ mol } NH_3}{17.03\text{ g } NH_3}\right)\left(\frac{5\text{ mol } O_2}{4\text{ mol } NH_3}\right) = 2.05\text{ mol } O_2$

$PV = nRT$

$V = \frac{nRT}{P} = \frac{(2.05\text{ mol})\left(.08206\frac{\text{L·atm}}{\text{K·mol}}\right)(297\text{ K})}{.950\text{ atm}} = \boxed{52.7\text{ L}}$

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(13) O_2 $P = 0.450$ atm

He $P = 855$ mm Hg

$P_{TOT} = P_{O_2} + P_{He}$

$= (450 \text{ atm})\left(\frac{760 \text{ mm Hg}}{1 \text{ atm}}\right) + 855 \text{ mm Hg}$

$= \boxed{1197 \text{ mm Hg}}$

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(14) $2 KClO_3 \rightarrow 2KCl + 3O_2$

$V = 124$ mL

$P = 762$ mm Hg

$T = 20.0°C$ ~~$+273 = 293$~~

$+273.15 = 293.2$ K

$P_{O_2} = P_{TOTAL} - P_{H_2O}$ At 20.0°C, P_{H_2O} is 17.5 mm Hg

$= 762 - 17.5 = 744.5$ mm Hg

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(744.5 \text{ mm Hg})\left(\frac{1 \text{ atm}}{760 \text{ mm Hg}}\right)(124 \text{ mL})\left(\frac{1 \text{ L}}{1000 \text{ mL}}\right)}{\left(.08206 \frac{\text{L atm}}{\text{K mol}}\right)(293.2 \text{ K})}$

$= \boxed{5.05 \times 10^{-3} \text{ moles } O_2}$