GAS STOICHIOMETRY

at STP: 1 mol any gas = 22.4 L

Prob Type 1: at STP

$CaCO_{3\,(s)} \rightarrow CaO_{(s)} + CO_{2\,(g)}$

g — 5.00 L

Ex) How many grams of calcium carbonate must be decomposed to produce 5.00 L of CO_2 at STP?

$$5.00\,L\,CO_2\left(\frac{1\,mol\,CO_2}{22.4\,L}\right)\left(\frac{1\,mol\,CaCO_3}{1\,mol\,CO_2}\right)\left(\frac{100.09\,g}{1\,mol\,CaCO_3}\right) = 22.3\,g\,CaCO_3$$

Prob Type 2: non- STP, run stoich, then PV=nRT
(starts with g or mol given)

$WO_{3(s)} + 3H_{2\,(g)} \rightarrow W_{(s)} + 3H_2O_{(l)}$

875 g — L

How many liters of hydrogen gas at 35^{0}C and 0.980 atm are needed to react completely with 875 g of tungsten oxide?

$$875\,g\,WO_3\left(\frac{1\,mol\,WO_3}{231.84\,g}\right)\left(\frac{3\,mol\,H_2}{1\,mol\,WO_3}\right) = 11.3\ mol\ H_2 = n$$

$0.980\,atm = P$

$308\,K = T$

$$V = \frac{nRT}{P} = \frac{(11.3\,mol)\left(0.0821\,\frac{L\,atm}{mol\,K}\right)(308\,K)}{0.980\,atm}$$

$$L = 292\,L\,H_2$$

Prob Type 3: non-STP, run PV=nRT, then stoich (starts with volume given)

$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

—g 24.3L

If you have 24.3 L of O_2 at 25 C and 0.975 atm, how many grams of magnesium would you need to react with it?

$$n = \frac{PV}{RT} = \frac{(0.975\ \text{atm})(24.3\ \text{L})}{\left(0.0821\ \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(298\ \text{K})} = 0.968\ \text{mol}\ O_2$$

$$0.968\ \text{mol}\ O_2\left(\frac{2\ \text{mol}\ Mg}{1\ \text{mol}\ O_2}\right)\left(\frac{24.31}{1\ \text{mol}\ Mg}\right) = 47.1\ \text{g}\ Mg$$

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1) One mole of any ideal gas takes up ____ L at STP.

2) One mole of any ideal gas takes up _____ L at standard pressure and 546 K (273 x 2)

3) Ammonia gas (NH_3) has a volume of 22.08 L at STP. Solve for ammonia's **R** (gas constant) using this data.

4) Why is wikipedia blacked out today?

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1) 22.4 L

2) $PV = nRT$ $\quad V = \dfrac{(1.0\,mol)(0.0821\,\frac{L \cdot atm}{mol \cdot K})(546\,K)}{1\,atm}$

$V = 44.8\,L$

3) $R = \dfrac{PV}{nT} = \dfrac{(1.0\,atm)(22.08\,L)}{(1.0\,mol)(273\,K)} = 0.08088\,\frac{L \cdot atm}{mol \cdot K}$ $\quad 0.0821$