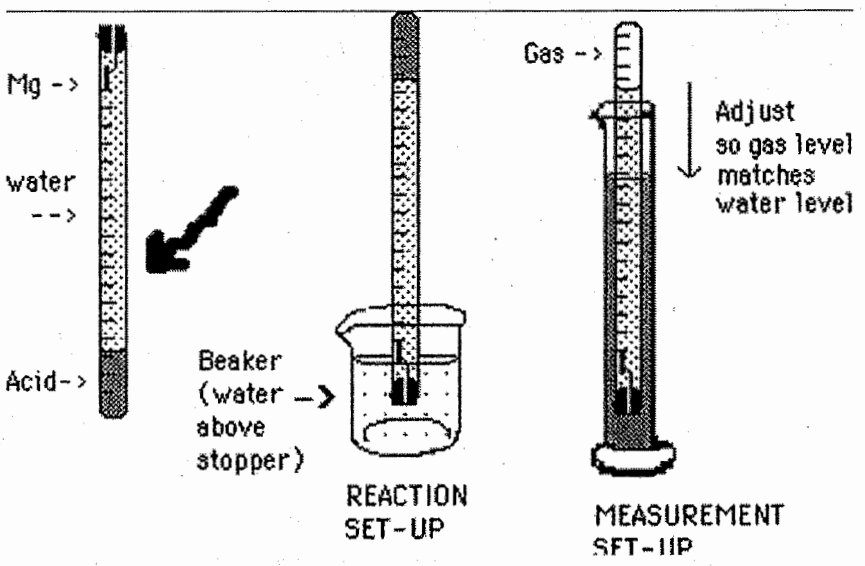
Name: _____ date: _____ period: _____

ch. 12 & 14 stochi & gas 60 points (5 ec) honors chemistry

In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) proper number of significant figures in your answer.

1. In a gas stoichiometry experiment: Mg(s) + excess HCl(aq) → $MgCl_2 + H_2$



2 pts

If the volume of gas is 45 mL, it's temperature is 23 °C, and the atmospheric pressure is 88 kPa, what is the mass of Mg before the reaction happens ? [10 points]

i) $P_{total} = P_{atm} = 88 kPa \frac{1 atm}{101.3 kPa} = 0.87 atm$ b/c $\Delta P = 0$

ii) @ 23°C, $P_{H_2O} = 21.07 torr \frac{1 atm}{760 torr} = 0.028 torr$

iii) $P_{total} = P_{H_2} + P_{H_2O}$

$0.87 atm = P_{H_2} + 0.028 atm$

$P_{H_2} = 0.84 atm$

iv) $n_{H_2} = \frac{P_{H_2} V}{RT} = \frac{0.84 atm (45 mL \frac{L}{10^3 mL})}{(0.0821 \frac{L \cdot atm}{mol \cdot K})(23 + 273)K}$

$= 0.0016 mol$

v) $0.0016 mol H_2 \frac{mol Mg}{mol H_2} \frac{24 g Mg}{mol Mg} = 0.037 g Mg$

2. Fill-in the blank. [15 points]

5.0 g C_2H_6 + 15.0 g O_2 → ___ g CO_2 + H_2O

i) $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

ii) $5\text{g } C_2H_6 \times \frac{1\text{ mol } C_2H_6}{30\text{ g } C_2H_6} \times \frac{7\text{ mol } O_2}{2\text{ mol } C_2H_6} \times \frac{32\text{ g } O_2}{\text{mol } O_2} = 18.7\text{ g } O_2$ needed

$\therefore O_2$ is limiting

iii) $15\text{ g } O_2 \times \frac{1\text{ mol } O_2}{32\text{ g } O_2} \times \frac{4\text{ mol } CO_2}{7\text{ mol } O_2} \times \frac{44\text{ g } CO_2}{\text{mol } CO_2} = 11.8\text{ g } CO_2$

3. 2.0 g $CaCl_{2(aq)}$ + excess $Na_3PO_{4(aq)}$ → ___ g precipitate; % yield = 88 % [15 points]

i) $3CaCl_2 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6NaCl$

ii) $2\text{ g } CaCl_2 \times \frac{1\text{ mol } CaCl_2}{111\text{ g } CaCl_2} \times \frac{1\text{ mol } Ca_3(PO_4)_2}{3\text{ mol } CaCl_2} \times \frac{310\text{ g } Ca_3(PO_4)_2}{1\text{ mol } Ca_3(PO_4)_2}$

$= 1.86\text{ g } Ca_3(PO_4)_2$

iii) $\%\text{ yield} = \frac{\text{exp}}{\text{calc}}$

$88\% = \frac{\text{exp}}{1.86}$

$\text{exp} = 1.63\text{ g } Ca_3(PO_4)_2$

4. A 5.0 L container at STP has 12 g He and 42 g N_2. What is ___ ? [15 points]

a. P_{He}

2 pt
2
1

i) $12\text{ g He} \times \frac{1\text{ mol He}}{4\text{ g He}} = 3\text{ mol He}$

ii) $P_{He} = \frac{n_{He} RT}{V} = \frac{3\text{ mol}\left(0.0821 \frac{\text{L atm}}{\text{mol K}}\right) 275\text{ K}}{5\text{ L}}$

$= 13.4\text{ atm}$

b. x_{N_2}

2 pt
2
1

i) $42\text{ g } N_2 \times \frac{1\text{ mol } N_2}{28\text{ g } N_2} = 1.5\text{ mol } N_2$

ii) $x_{N_2} = \frac{n_{N_2}}{n_{total}} = \frac{n_{N_2}}{n_{N_2} + n_{He}} = \frac{1.5}{1.5 + 3}$

$= 0.333$

c. P_{total}

2 pt
2
1

i) $x_{N_2} + x_{He} = 1$

$0.333 + x_{He} = 1$

$x_{He} = 0.667$

ii) $P_{He} = x_{He} P_{total}$

$13.4\text{ atm} = 0.667\ P_{total}$

$P_{total} = 20.1\text{ atm}$

OR

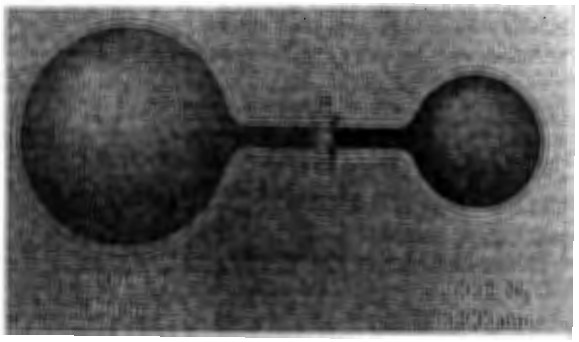
(i) $n_{total} = 4.5\text{ mol}$ (see above)

(ii) $P_{total} = \frac{n_{total} RT}{V_{total}}$

$= \frac{4.5\text{ mol}\left(0.0821 \frac{\text{L atm}}{\text{mol K}}\right) 275\text{ K}}{5\text{ L}}$

$= 20.2\text{ atm}$

5. Assume that the temperature in both containers is the same and opening the valve does not change the temperature. Also, assume that the volume of the connection between the two containers is zero. When the valve is open, what is __ ? [10 points]



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a. $P_{total} = \frac{n_{total} RT}{V_{total}} = \frac{(n_{H_2} + n_{N_2}) RT}{V_{total}}$ (open valve) (1)

i) $n_{H_2} = \frac{P_{H_2} V_{H_2}}{RT} = \frac{475 \text{ torr } (2L)}{RT}$ (2)

$n_{N_2} = \frac{P_{N_2} V_{N_2}}{RT} = \frac{0.2 \text{ atm } (1L)}{RT}$ (3)

ii) Use (1), (2), (3): $P_{total} = \frac{\left(\frac{475 \text{ torr } (2L)}{RT} + 0.2 \text{ atm } (1L)\right) RT}{V_{total}}$

$= \frac{475 \text{ torr } (2L) + 0.2 \text{ atm } \left(\frac{760 \text{ torr}}{1 \text{ atm}}\right) 1L}{(2+1)L}$

b. $P_{N_2} = 367 \text{ torr}$ (or 0.483 atm)

Use (3): $P_{N_2} = \frac{n_{N_2} RT}{V_{total}} = \frac{\left(\frac{0.2 \text{ atm } (1L)}{RT}\right) RT}{V_{total}} = \frac{0.2 \text{ atm } (1L)}{(2+1)L}$

$= 0.0667 \text{ atm}$ (or 50.7 torr)

OR

$P_1 V_1 = P_2 V_2$

$0.2 \text{ atm } (1L) = P_{N_2} (3L)$

$P_{N_2} = 0.0667 \text{ atm}$