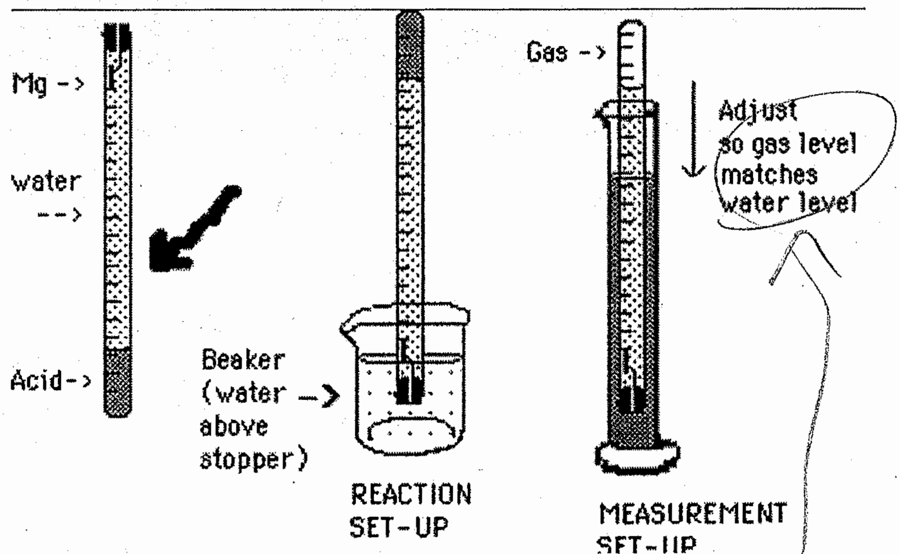
Name: ______________________________ date: ____________ period: _____

ch. 10 & 14 gas & kinetics 60 points ap 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 2 HCl(aq) → H_2 + $MgCl_2$



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) @ 23 °C, P_{H_2O} = 21.07 torr

ii) $\Delta P = P_{atm} - P_{total} = 0$ b/c

$P_{total} = P_{atm} = 88$ kPa

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

$88\ kPa \frac{atm}{101.3\ kPa} = P_{H_2} + (21.07\ torr \frac{atm}{760\ torr})$

$P_{H_2} = 0.840$ atm

iv) $n_{H_2} = \frac{P_{H_2} V}{RT} = \frac{0.840\ atm\ (45\ mL \frac{L}{10^3\ mL})}{(0.0821 \frac{L\ atm}{mol\ K})(23 + 273)\ K}$

$= 0.0016$ mol

v) $0.0016\ mol\ H_2 \frac{1\ mol\ Mg}{1\ mol\ H_2} \frac{24\ g\ Mg}{1\ mol\ Mg} = 0.037\ g\ Mg$

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

a. P_{He}

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

ii) $P_{He} = \frac{n_{He} RT}{V}$

$= \frac{3\ mol\ (0.0821\ \frac{L\ atm}{mol\ K})\ 273\ K}{5\ L}$

$= 13.4\ atm$

b. x_{N_2}

i) $42\ g\ N_2 \cdot \frac{mol\ N_2}{28\ g\ N_2} = 1.5\ mol\ N_2$

ii) $x_{N_2} = \frac{n_{N_2}}{n_{N_2} + n_{He}} = \frac{1.5}{1.5 + 3} = 0.33$

c. P_{total}

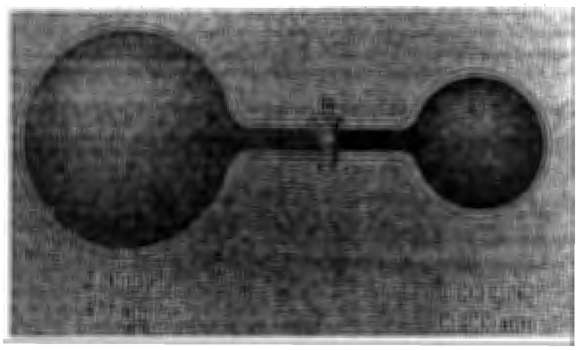
i) $n_{total} = n_{N_2} + n_{He} = 1.5 + 3 = 4.5\ mol$

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

$= \frac{4.5\ mol\ (0.0821\ \frac{L\ atm}{mol\ K})\ 273\ K}{5\ L}$

$= 20.2\ atm$

3. 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} Boyles' law b/c n & T = constant

2 i)

	valve close	valve open
P_{H_2}	475 torr	?
V_{H_2}	2 L	3 L

2 ii) $P_c V_c = P_o V_o$

475 torr (2 L) = P_o 3 L

P_o = 317 torr $\frac{atm}{760\ torr}$ = 0.4167 atm ~ P_{H_2}

2 iii) $P_{total} = P_{H_2} + P_{N_2}$

= 0.4167 + 0.0667 = 0.483 atm

Boyles' law b/c n & T no change

b. P_{N_2}

2 i)

	valve close	valve open
P_{N_2}	0.2 atm	?
V_{N_2}	1 L	3 L

2 (ii) $P_c V_c = P_o V_o$

0.2 atm (1 L) = P_o 3 L

P_o = 0.0667 atm = P_{N_2}

4. What is the activation energy of the backward reaction if the activation energy of the forward reaction

$N_{2(g)} + 3\ H_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$

is 50 kJ / $mole_{reaction}$? [10 points]

3 pt i) $\Delta H = 2\Delta H_f(NH_3) - [\Delta H_f(N_2) + 3\Delta H_f(H_2)] = 2(-46) = -92\ kJ$

3 ii) $\Delta H = E_{a,f} - E_{a,b}$

$-92\ kJ = 50\ kJ - E_{a,b}$

$E_{a,b} = 142\ kJ$

5. What is the rate law of the reaction: $N_{2(g)} + 3\ H_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$ based on the below hypothetical data ? Include appropriate units in your rate constant. [15 points]

$r = k[N_2]^a[H_2]^b$

expt	$[N_2]$ (mM)	$[H_2]$ (mM)	Initial rate (μM / sec)
1	1.0	1.0	9.0
2	1.0	2.0	18.0
3	4.0	1.0	18.0

4 pt i) $\frac{r2}{r1} = \frac{18\ \mu M/s}{9\ \mu M/s} = 1^a 2^b$; $b = 1$

4 ii) $\frac{r3}{r1} = \frac{18\ \mu M/s}{9\ \mu M/s} = 4^a$; $a = \frac{1}{2}$

4 iii) $r1 = k[N_2]^{\frac{1}{2}}[H_2]$

$9 \cdot 10^{-6}\ \frac{M}{sec} = k\ (10^{-3} M)^{\frac{1}{2}}\ (10^{-3} M)$

$= k\ 0.0316 \cdot 10^{-3}\ M^{3/2}$

$k = \frac{9 \cdot 10^{-6} M}{0.0316 \cdot 10^{-3}\ M^{3/2}\ sec} = \frac{0.285}{M^{\frac{1}{2}}\ sec}$

3 iv) $rate = \frac{0.285}{M^{\frac{1}{2}}\ sec}[N_2]^{\frac{1}{2}}[H_2]$