Name: ______________________________ date: ______________

ch. 10 & 14 gas & kinetics **test** 60 points AP chemistry

Academic Honesty: The answers on this test are my own and I am using only the allowed set of notes as described in the syllabus. I have not discussed the test questions with anyone before or during the test nor have I seen the test questions prior to the exam. If you violate any of the preceding items or do not sign, your semester grade is a F.

Signature: ____________________

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) have the proper number of significant figures in your answer.

1. Based on the below hypothetical experimental data for the reaction: $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$

Trail	$[N_2]$ (mM)	$[H_2]$ (mM)	$\frac{\Delta [NH_3]}{\Delta t}$ $\left(\frac{\mu M}{sec}\right)$
1	1.0	1.0	5.0
2	1.0	2.0	10.0
3	2.0	4.0	80.0

What is the rate law ? include the value / units (in M, molar; & seconds) of the rate constant. [15 points]

rate = $k\,[N_2]^{\alpha}\,[H_2]^{\beta}$

4/3? i) $\frac{r2}{r1} = \frac{10\ \mu M/sec}{5\ \mu M/sec} = 1^{\alpha}\, 2^{\beta}$

$2 = 2^{\beta}$; $\beta = 1$

4 ii) $\frac{r3}{r2} = \frac{80\ \mu M/sec}{10\ \mu M/sec} = 2^{\alpha}\, 2^{\beta}$

$8 = 2^{\alpha}\, 2$; $\alpha = 2$

4 iii) $r1 = (5 \cdot 10^{-6}\ \frac{M}{sec}) = k\ (10^{-3}\ M)^2 (10^{-3}\ M)$

$= k\ 10^{-9}\ M^3$

$k = \frac{2.5 \cdot 10^{-6}\ M/sec}{10^{-9}\ M^3} = 2.5 \cdot \frac{10^{3}}{M^2\ sec}$

3 iv) rate $= \frac{2.5 \cdot 10^3}{M^2\ sec}\ [N_2]^2\, [H_2]$

assume A for Rx 1f & Rx 2B same

2. Based on the following hypothetical data, which reaction has a faster rate: the synthesis of gaseous ammonia (NH_3) from gaseous hydrogen and nitrogen versus the synthesis of gaseous hydrogen chloride from gaseous hydrogen and chlorine, where & both Rx @ same T

(1) $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$; $E_{a,f}$ = 50 kJ / $mol_{reaction}$

(2) $2\ HCl_{(g)} \rightarrow Cl_{2(g)} + H_{2(g)}$; $E_{a,f}$ = 50 kJ / $mol_{reaction}$ $\Delta H > 0 \rightarrow$

- synthesis of NH_3 > synthesis of HCl ?
- synthesis of NH_3 < synthesis of HCl ?
- synthesis of NH_3 = synthesis of HCl ?
- can not be determined ?

#@! ΔH & E_{af} for Rx 2 is inconsistent i.e. impossible

basis / rationale ? [15 points]

5 pt i) Rx 2: $\Delta H = [\Delta H_f(Cl_2) + \Delta H_f(H_2)] - [2\Delta H_f(HCl)]$

$= 0 - [2(-92.3)] = +184.6\ kJ$

5 ii) $\Delta H = E_{af} - E_{ab}$

$184.6\ kJ = 50\ kJ - E_{ab}$ for Rx 2

$E_{ab} = 234\ kJ$ for Rx 2

5 iii) $k = A e^{-E_a/RT}$, &

k(Rx 1, forward) > k(Rx 2, backward)

rate(Rx 1, forward) > rate(Rx 2, backward)

i.e. rate NH_3 synthesis > rate HCl synthesis

3. A hypothetical gaseous compound is in a 125 mL flask at 95.0 °C and there is a pressure of 95.0 kPa. The temperature is lowered to 19.0 °C and the mass of the condensed gas is 1.0 grams; what is the molar mass of the compound ? [10 points]

2 pt i) $PV = nRT$

$n = \frac{PV}{RT} = \frac{95\ kPa\left(\frac{1\ atm}{101.3\ kPa}\right)\left[125\ mL\left(\frac{L}{10^3\ mL}\right)\right]}{\left(0.0821\ \frac{L\ atm}{mol\ K}\right)(95+273)K}$

2 $= 0.0039\ mol$

2 ii) molar mass $= \frac{\#g}{\#mol} = \frac{1\ g}{0.0039\ mol} = 258\ \frac{g}{mol}$

4. A real gas is described by an equation: $\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$.
What is the relative value of a and b for helium versus neon ? basis / rationale ? [10 points]

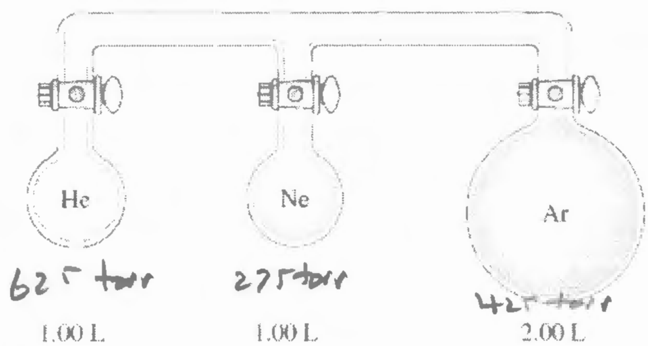
a: Imf : Ne > He b/c polarizability = Imf

b: atomic size : Ne > He b/c ↑ # e⁻ shells ↑ size

2+3pt
2+3pt

5. Three flasks are connected to each other, where the pressure of He, Ne, and Ar are 625 torr, 275 torr, and 425 torr, respectively. When all of the valves / stopcocks are open, what is the __ in the system ? Assume the volume of the connecting tube is zero and the temperature in all of the flasks are the same. [10 points; weekly quiz problem]

2 pt



$PV = nRT$

$n_i = \frac{P_i V_i}{RT}$

a. total pressure

2

$P_{total} = \frac{n_{total} RT}{V_{total}} = (n_{He} + n_{Ne} + n_{Ar}) \frac{RT}{V_{total}}$

2

$= \left(\frac{P_{He}V_{He}}{RT} + \frac{P_{Ne}V_{Ne}}{RT} + \frac{P_{Ar}V_{Ar}}{RT}\right) \frac{RT}{V_{total}}$

$= \frac{P_{He}V_{He} + P_{Ne}V_{Ne} + P_{Ar}V_{Ar}}{V_{He} + V_{Ne} + V_{Ar}}$

$= \frac{625 \text{ torr}(1L) + 275 \text{ torr}(1L) + 425 \text{ torr}(2L)}{1 + 1 + 2}$ = 438 torr

b. partial pressure of helium

2

$P_{He} = \frac{n_{He} RT}{V_{total}}$

2

$= \frac{\left(\frac{P_{He}V_{He}}{RT}\right)RT}{V_{total}}$ $= \frac{P_{He}V_{He}}{V_{total}} = \frac{625 \text{ torr}(1L)}{4L}$ = 156 torr