Name: ______________________ period: _____ date: ______________

ch. 25 & 17 nuclear chem & kinetics **test** 55 points 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) have the proper number of significant figures in your answer.

1. Fill-in the below blank about (hypothetical ?) nuclear reactions. [10 points]

   a. alpha decay of ^{46}Ca: $^{46}_{20}Ca \rightarrow {}^{4}_{2}He + {}^{42}_{18}Ar$

   b. beta (minus) decay of ^{46}Ca: $^{46}_{20}Ca \rightarrow {}^{0}_{-1}e + {}^{46}_{21}Sc$

   c. positron (~~minus~~) decay of ^{46}Ca: $^{46}_{20}Ca \rightarrow {}^{0}_{1}e + {}^{46}_{19}K$

   d. $^{2}_{1}H + {}^{25}_{12}Mg \rightarrow {}^{27}_{13}Al$ and it's a (n) fusion type of nuclear reaction

   e. $^{2}_{1}H + {}^{25}_{12}Mg \rightarrow {}^{16}_{9}F + {}^{11}_{4}Be$ and it's a (n) transmutation / fiss type of nuclear reaction

2pt @

27 / 11

2. A hypothetical radioactive isotope has a half-life of 75 years. How much time would it take for a sample containing 100.0 mg of the isotope to decay to 33.0 mg ? [10 points]

2 pt / 3

i) $\ln 2 = k t_{1/2}$

$k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{75\ y} = \frac{0.00924}{year}$

2+3 pt

ii) $t = \frac{\ln\left(\frac{x_0}{x}\right)}{k} = \frac{\ln\left(\frac{100\ mg}{33\ mg}\right)}{\left(\frac{0.00924}{year}\right)} = 120\ years$

3. In the reaction: $2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$, what is ___ ? [10 points]

   a. rate of the reaction if carbon dioxide gas appears at a rate of 5 mmol / sec ?

$rate = \frac{1}{4}\frac{\Delta CO_2}{\Delta t} = \frac{1}{4}\left(5\ \frac{mmol}{sec}\right) = 1.25\ \frac{mmol}{sec}$

2+3pt

   b. rate the appearance of water if oxygen gas disappears at a rate of 25 mmol / sec ?

$rate = \frac{1}{6}\frac{\Delta H_2O}{\Delta t} = -\frac{1}{7}\frac{\Delta O_2}{\Delta t}$

$\frac{\Delta H_2O}{\Delta t} = -\frac{6}{7}\left(\frac{\Delta O_2}{\Delta t}\right) = -\frac{6}{7}\left(25\ \frac{mmol}{sec}\right) = 21\ \frac{mmol}{sec}$

−3148 − 248 + 249

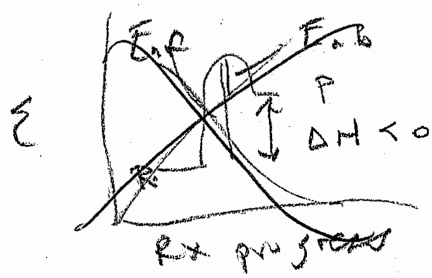
4. In regards to the reaction: 2 C_4H_{10}(g) + 13 O_2(g) → 8 CO_2(g) + 10 H_2O(g), assume that the activation energy of the forward reaction is 3,000 kJ. [10 points]

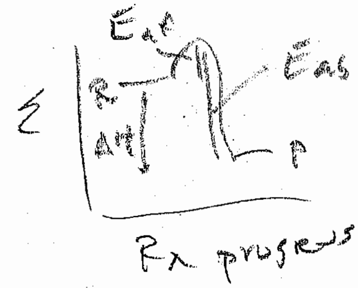
a. Sketch the reaction energy profile; label the axis, ΔH, activation energy of the forward and backward reaction

$\Delta H = [8\Delta H_f CO_2 + 10 \Delta H_f H_2O] - [2\Delta H_f C_4H_{10} + 13 \Delta H_f O_2]$

$= 8(-393.5) + 10(-241.8) - 2(-124.7) = -5317\ kJ$

5 pts





~~not consistent~~

2 pt

b. What is the numeric value of the activation energy of the backward reaction

$E_{af} - E_{ab} = \Delta H$

$3000 - E_{ab} = -5317$

$E_{ab} = 8317\ kJ$

2 pt

1

5. Based on the hypothetical experiment data for the reaction: $N_2 + 3 H_2 \rightarrow 2 NH_3$ [15 points]

rate = k [N₂]^x [H₂]^y

Expt	Rate (mM / sec)	$[N_2]$ (M)	$[H_2]$ (M)
1	2.0	1.0	1.0
2	4.0	1.0	4.0
3	8.0	2.0	4.0

a. what are the values of the exponents in the rate law ?

3+2 pt

i) $\frac{r_2}{r_1} = \frac{4\ mM/s}{2\ mM/s} = 4^x\ 1^y$

$2 = 4^x$; $x = \frac{1}{2}$

ii) $\frac{r_3}{r_2} = \frac{8\ mM/s}{4\ mM/s} = 1^x\ 2^y$

$2 = 2^y$; $y = 1$

b. the numeric value and units (involving molar, M) of the rate constant

2+3 pts

$r_1 = 2\times10^{-3}\ \frac{M}{sec} = k(1\ M)^{\frac{1}{2}}(1\ M) = k\ M^{3/2}$

$k = \frac{2\cdot10^{-3}}{M^{\frac{1}{2}}\ sec}$