Name: _____ period: _____ date: _____

ch. 25 & 17 nuclear chem & kinetics - **test** 55 ~~60~~ 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) nuclear transmutation type of nuclear reaction

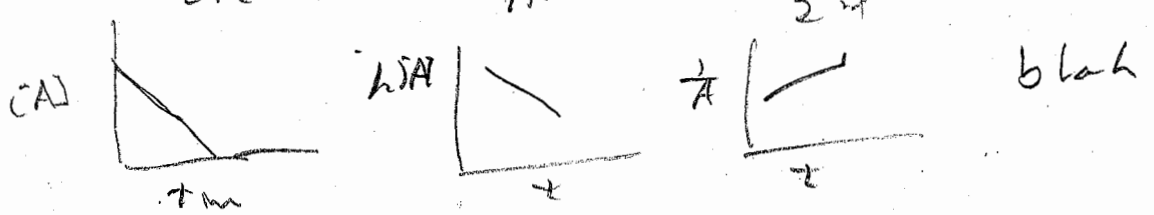
2. In the reaction: a A + b B → c C + d D , the rate law is

   rate = k $[A]^x$ $[B]^y$

describe how to determine the value of x, where x = 0, 1, or 2 -- using graphical analysis and label the axis of the graphs. Include basis / rationale of your analysis. [10 points]

i) @ [B] >> [A], rate = k'[A]^x ; k' = k[B]^y

ii)



3. Based on the hypothetical experiment data for the reaction: $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ [20 points] 15

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 ?

2 pt-1

3

i) $\frac{r2}{r1} = \frac{4\ mM/sec}{2\ mM/sec} = 1^x \cdot 4^y$

$2 = 4^y \Rightarrow y = \frac{1}{2}$

ii) $\frac{r3}{r1} = \frac{8\ mM/sec}{2\ mM/sec} = 2^x \cdot 4^{\frac{1}{2}}$

$4 = 2^x \cdot 2$

$2 = 2^x$

$x = 1$

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

1 pt-1

2

2

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

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

$= k\ 1M^{\frac{1}{2}}$

$k = \frac{2 \cdot 10^{-3}}{sec\ \sqrt{M}}$

c. what is the rate if the $[N_2]$ = 3.0 M and $[H_2]$ = 9.0 M ← rate = k [N₂] [H₂]^½

1/2 pt

1

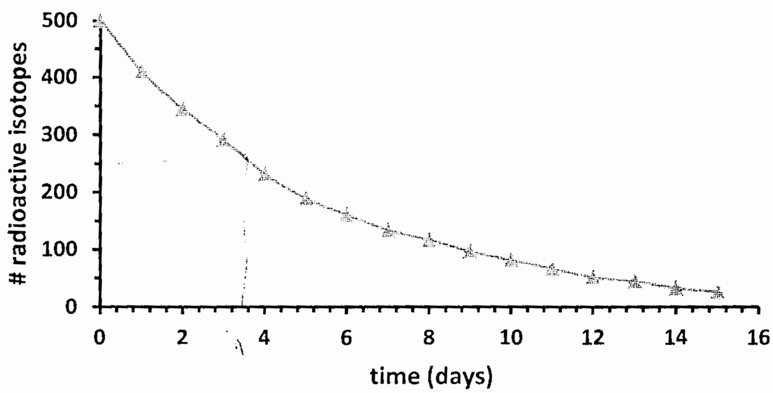
1

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

$= \frac{2 \cdot 10^{-3} \cdot 9\ \frac{M}{sec}}{}$

$= 18 \cdot 10^{-3}\ \frac{M}{sec}$

4. Based on the below graph,



7 pt

~ 3.6 days

what is the decay constant in the simulation of the decay of a radioactive isotope ? [10 points]

6 pt

$\ln 2 = k\, t_{1/2}$

$\ln 2 = k\ 3.6\ \text{day}$

$k = \frac{0.19}{\text{day}}$

5. In the nuclear reaction: A* → B, where A* is radioactive, while B is nonradioactive. Assume that the only source of B is the radioactive decay of A* and the half life of A* is 825 years. An object currently has 85 mmole of A* and 35 mmole of B; what is the age of the object ? [10 points]

4 pt

i) A* → B

t=0 120 0

Δ −35 +35

now (85) (35)

3

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

$\ln 2 = k\,(825\ \text{years})$

$k = 8.4218 \cdot 10^{-4}\ /\text{years}$

iii) $t = \frac{\ln\left(\frac{A_0}{A}\right)}{k}$

$= \frac{\ln\left(\frac{120}{85}\right)}{\left(8.4218 \cdot 10^{-4}\ /\text{year}\right)}$

$= 410$ years