Name: _____ date: _____ period: _____

Ch. 25 & 27 nuclear chem & kinetics **test** 65 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; reactions are hypothetical. [10 points]

3+2 pts a. $^{235}_{92}U \rightarrow {}^{140}_{56}Ba + {}^{95}_{36}Kr$; type of nuclear reaction = fission

b. Alpha decay of ^{235}U; the reaction is represent as: $^{235}_{92}U \rightarrow {}^{4}_{2}He + {}^{231}_{90}Th$

2. A hypothetical radioactive isotope takes 125 years to decay from 275 radioactive isotopes to 75 radioactive isotopes. [20 points]

a. What is the decay constant of the isotope ?

$k = \frac{\ln\left(\frac{N_0}{N}\right)}{t} = \frac{\ln\left(\frac{275}{75}\right)}{125\ \text{years}} = \frac{\ln(3.66)}{125} = 0.0104\ \frac{1}{\text{year}}$

(3 pts) (2 pts)

$N = N_0 e^{-kt}$

$\frac{N}{N_0} = e^{-kt}$

$kt = -\ln\left(\frac{N}{N_0}\right) = \ln\left(\frac{N_0}{N}\right)$

(5 pts)

b. What is the half-life of the isotope ?

5 pts

3

2

$k t_{\frac{1}{2}} = \ln 2$

$t_{\frac{1}{2}} = \frac{\ln 2}{k} = \frac{\ln 2}{\left(0.0104\ \frac{1}{\text{year}}\right)} = 66.6\ \text{years}$

$N = N_0 e^{-kt}$; @ $t_{\frac{1}{2}}$,

$\frac{1}{2}N_0 = N_0 e^{-k t_{\frac{1}{2}}}$

$\ln\left(\frac{1}{2}\right) = -k t_{\frac{1}{2}}$

$k t_{\frac{1}{2}} = \ln 2$

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

3. What is the rate law of the reaction: $N_2 + 3 H_2 \rightarrow 2 NH_3$ based on the following hypothetical experimental data ? [15 points]

Experiment	$[N_2]$; (M)	$[H_2]$; (M)	Rate ($\frac{mM}{sec}$)
1	1.0	1.0	2.0
2	1.0	3.0	9.0
3	2.0	1.0	4.0

i) $\frac{r2}{r1} = \frac{9}{2} = 3^{\beta}$

$\beta \ln 3 = \ln(\frac{9}{2})$

$\beta = 1.37$

ii) $\frac{r3}{r1} = \frac{4}{2} = 2^{\alpha}$; $\alpha = 1$

iii) $r_1 = 2 \cdot 10^{-3} \frac{M}{s} = k (1M)^1 (1M)^{1.37}$

$k = \frac{2 \cdot 10^{-3}}{s \; M^{1.37}}$

iv) rate $= \frac{2 \cdot 10^{-3}}{s \; M^{1.37}} [N_2]^1 [H_2]^{1.37}$

4 pt

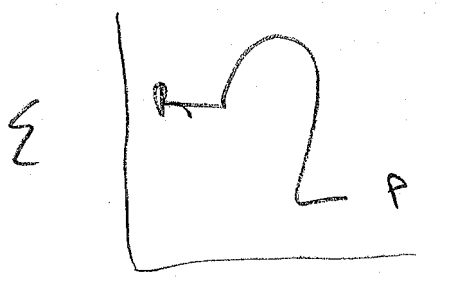
4

4

3

4. In regards to the reaction: $N_2 + 3\,H_2 \rightarrow 2\,NH_3$ [20 points]

a. Sketch and label the axis of a reaction energy profile for the reaction; use: Insert → Drawing → New . . .



$\Delta H = 2\,\Delta H_f\, NH_3 - (\Delta H_f\, N_2 + 3\,\Delta H_f\, H_2)$

$= 2(-46)$

$= -92\ kJ$

3 + 2 pts

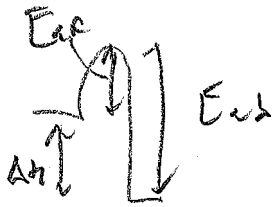
formula

answer

2 + 3 pts

relative E_R & E_P

b. If the activation energy of the forward reaction is 25 kJ, what is the activation energy of the backward reaction ?



3 pts

3 + 2 pts

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

$25 - E_{ab} = -92$

$E_{ab} = 117\ kJ$