Kinetics Take-home Quiz **(Due Nov 2nd by 8:00 AM)**

1. Consider the synthesis of $C_2H_4O_2$ from solid carbon, oxygen gas (O_2), and hydrogen gas (H_2). Using the information below, determine the initial concentration of H_2

   [$C_2H_4O_2$] = 138 mM and [H_2] = 926 mM after 10 minutes.

2. Using this rearranged form of the Arrhenius equation shown below and the information provided, determine the activation energy for each reaction. Report your answer in kJ mol^{-1}.

$$lnk_2 - lnk_1 = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

T_1 (K)	T_2 (K)	k_1	k_2
298.15	398.15	82 M^{-1} s^{-1}	272.8764 M^{-1} s^{-1}

3. For the reaction in problem 2, determine the order of the reaction and write the simplest rate law possible (e.g. 3rd order would be rate=k[A]^3).

4. For the reaction below, use the method of initial rates to determine the rate constant and rate law. Make sure to use the correct units.

Experiment	[CH_3COCH_3] (M)	[Br_2] (M)	[H^+] (M)	Rate (M s^{-1})
1	1.00	1.00	1.00	4.0 x 10^{-3}
2	1.75	1.00	1.00	7.0 x 10^{-3}
3	1.75	1.40	1.00	9.8 x 10^{-3}
4	1.00	1.40	2.00	11.3 x 10^{-3}

5. For each reaction in problem 4, determine the rate when the concentration of each reactant is 0.25 M.

6. For each of the following datasets, **determine the rate law** (including the rate constant with correct units) and **the reactant concentration after 25 seconds has passed**.

NO_2 (g) → NO (g) + $\frac{1}{2}$ O_2 (g)	
Time (s)	**[NO_2] (M)**
0	0.0831
4.2	0.0666
7.9	0.0567
11.4	0.0497
15.0	0.0441

7. What is activation energy and how can it be decreased?

8. What are 3 ways to change the rate of a reaction?

1. $2C(s) + O_2(g) + 2H_2(g) \rightarrow C_2H_4O_2$

$$\text{rate} = \frac{\Delta[C_2H_4O_2]}{\Delta t} = -\frac{1}{2}\frac{\Delta[H_2]}{\Delta t}$$

$$\text{rate} = \frac{138-0}{10-0} = \frac{13.8\text{ mM}}{\text{min}} = -\frac{1}{2}\frac{926-x}{10-0}$$

$x = 1202\text{ mM}$

2. $$\ln 272.8764 - \ln 82 = \frac{-E_a}{8.314}\left(\frac{1}{398.15} - \frac{1}{298.15}\right)$$

$$E_a = \frac{-9.996}{-0.00084} = 11899.9\ \frac{J}{mol} = 11.9\ kJ/mol$$

3. 2^{nd} order → you can tell this by looking at the units of the rate constant

$\text{rate} = k[A]^2$

4. $\text{rate} = k[CH_3COCH_3]^a[Br_2]^b[H^+]^c$

1 vs. 2 $$\frac{4\times10^{-3}}{7\times10^{-3}} = \frac{k}{k}\cdot\frac{(1)^a}{(1.75)^a}\cdot\left(\frac{1}{1}\right)^b\cdot\left(\frac{1}{1}\right)^c$$

$0.571 = 0.571^a$

$a = 1$

2 vs. 3 $$\frac{7\times10^{-3}}{9.8\times10^{-3}} = \frac{k}{k}\cdot\left(\frac{1.75}{1.75}\right)^a\left(\frac{1}{1.4}\right)^b\left(\frac{1}{1}\right)^c$$

$0.714 = 0.714^b$

$b = 1$

3 vs. 4 $$\frac{11.3\times10^{-3}}{9.8\times10^{-3}} = \frac{k}{k}\cdot\left(\frac{1}{1.75}\right)^1\left(\frac{1.4}{1.4}\right)^1\left(\frac{2}{1}\right)^c$$

$1.15 = (0.571)(2)^c$

$2 = 2^c$

$c = 1$

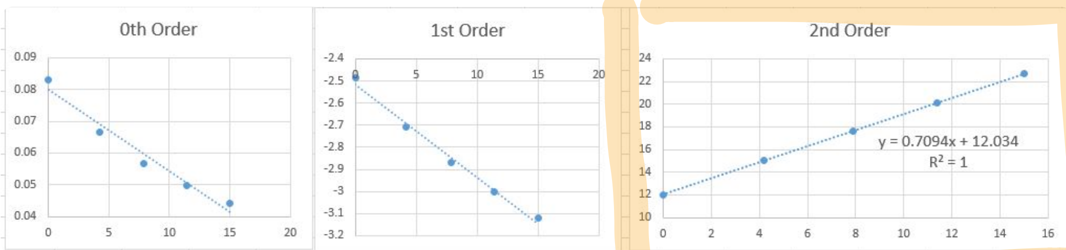
$11.3\times10^{-3} = k(1)^1(1.4)^1(2)^1$

$k = 4.04\times10^{-3}\ M^{-2}s^{-1}$

$\text{rate} = 4.04\times10^{-3}\ M^{-2}s^{-1}[CH_3COCH_3][Br_2][H^+]$

5. rate $= 4.04 \times 10^{-3}\ M^{-2} s^{-1} (0.25)^3 = 6.313 \times 10^{-5}\ M\ s^{-1}$

6.



- plot of $\frac{1}{[A]}$ is linear ($r^2 = 1$)   slope $= 0.7094$

2nd order $k = 0.7094\ M^{-1} s^{-1}$ rate $= 0.7094\ M^{-1} s^{-1} [NO_2]^2$

$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$ $\frac{1}{[A]} = 0.7094\ M^{-1} s^{-1} (25\ s) + \frac{1}{0.0831\ M}$

$[A] = 0.0336\ M$

7. The amount of energy that reactants must overcome for products to form. High Ea means a slow reaction. If a catalyst is added to the reaction, the Ea will become smaller.

8. ① change the concentration of reactants
② add a catalyst
③ change the temperature