U1 Kinetics

Review

Rate = amount / time

~~Chemistry 12 Quiz #1: Reaction Kinetics~~

Name: _____

1. Consider the following reaction:

$2\ H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

The rate of production of oxgen gas is 1.2×10^{-2} mol/s. How many seconds will it take to decompose 100.0g water?

$$\text{Rate} = \frac{1.2 \times 10^{-2}\ \text{mol}\ O_2}{1\ \text{s}} \times \frac{2\ \text{mol}\ H_2O}{1\ \text{mol}\ O_2} \times \frac{18.0\ \text{g}\ H_2O}{1\ \text{mol}\ H_2O} = 0.43\ \text{g/s}\ H_2O$$

$$100.0\ \text{g} \times \frac{1\ \text{s}}{0.43\ \text{g}} = 230\ \text{s}$$ 2 s.f

2. Consider the reaction: $C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(g)}$

At certain conditions, 0.15 mol carbon dioxide is produced in 2.0 minutes. What is the rate of consuption of ethene in g/s?

$\times 60 = 120\ \text{s}$

$$\frac{0.15\ \text{mol}\ CO_2}{120\ \text{s}} \times \frac{1\ \text{mol}\ C_2H_4}{2\ \text{mol}\ CO_2} \times \frac{28.0\ \text{g}\ C_2H_4}{1\ \text{mol}\ C_2H_4} = 0.018\ \text{g/s}$$ 2 s.f

3. Name 5 factors which have been proven to affect the rate of reactions.

- ↑ temp. °C
- ↑ concentration of reactants
- adding a catalyst
- increasing pressure or decreasing volume for gas
- increasing surface area

4. Which factor affects only heterogeneous reactions? Why? Explain in 1-2 sentences.

Surface area → when they are the same phase, they mix evenly already (aq + g) or do not mix (s). If heterogeneous, exposing a greater number of particles of solid (crushing it) or a greater surface area of liquid or a gas will increase chances of collision.

5. Which of the following reactions is the fastest? Explain why.

$Cu_{(s)} + S_{(s)} \rightarrow CuS_{(s)}$

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

$Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$

$2NaOCl_{(aq)} \rightarrow 2NaCl_{(aq)} + O_{2(g)}$

no bonds need to be broken, only 2 particles, both reactants are aqueous ions.

6. Given the following reaction, state 3 ways that a scientist could measure the rate of the reaction. State the unit that would be used in each case.

$$Sn_{(s)} + 2\,HCl_{(aq)} \rightarrow H_{2(g)} + SnCl_{2(aq)}$$

a) decrease mass of Sn in g/s
b) decrease in $[H^+]$ in M/s
c) production of $H_2(g)$ in g/s or mL/s

7. Look at the following reaction: : $H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$

a) What would happen to the rate if the volume of the container is increased?
decrease
b) What would happen to the rate if the temperature was decresed?
increase
c) What would happen to the rate if the iodine was in its crystal form instead of its gas form?
decrease

8. Which of the following could be used to describe the rate of a reaction?

A. $\frac{\text{change in time}}{\text{change in concentration}}$ ✗

B. $\frac{\text{change in mass}}{\text{change in concentration}}$ ✗

C. $\frac{\text{change in concentration}}{\text{change in time}}$ ← time on bottom!

D. $\frac{\text{change in concentration}}{\text{change in mass}}$

9. Consider the following reaction. $2H_2O_{2(aq)} \rightarrow 2H_2O_{(\ell)} + O_{2(g)}$
Explain why the above reaction speeds up in the presence of Manganese dioxide.

MnO_2 is a catalyst which changes the reaction mechanism but lowers the activation energy

10. Consider the following reaction: $Mg_{(s)} + 2HBr_{(aq)} \rightarrow H_{2(g)} + MgBr_{2(aq)}$
If you were to monitor the $[H^+]$ it would decrease over time.
If you were to monitor the $[Mg^{2+}]$ it will increase over time.
Why would it be a bad idea to monitor the $[Br^-]$?
It is present as a reactant and product.
It is a spectator ion.

Review

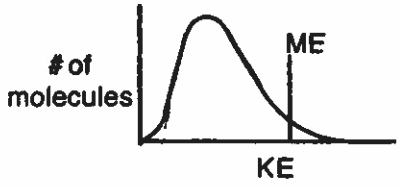
Reaction Kinetics ~~Quiz #2: Kinetic and Potential Energy~~

Name:_____

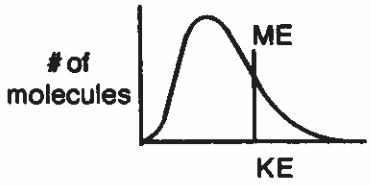
1. The reaction _____ proceeds very fast at room temperature.

a) Which of the following KE diagrams would best explain this reaction. (ME= Ea) (1 mark)

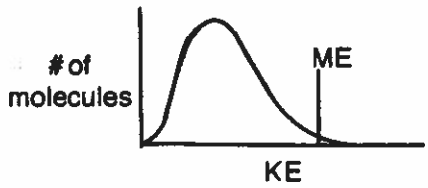
(i)



(ii)



(iii)



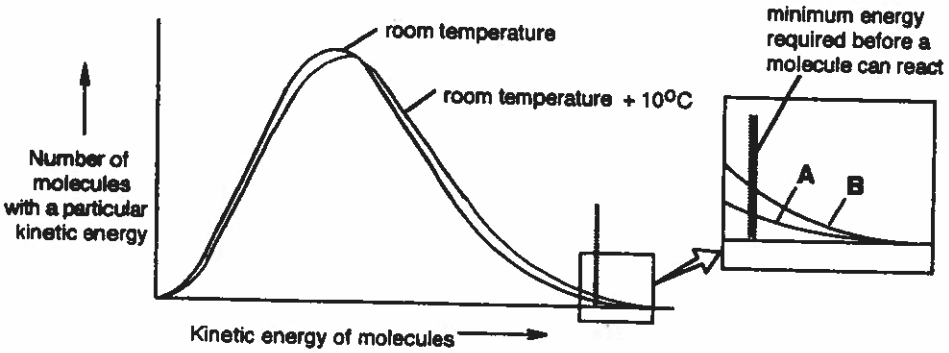
b) Explain why your chose the graph that you did? (1 mark)

ii) It has a lower activation energy and so more molecules have enough KE.

c) If the temperature were increased by 10 degrees Celsius, would the reaction rate double? Why or why not? (2 marks)

No because Ea is not at the tail end of the curve.

2. Look at the following graph. If the reaction rate A is very slow: 1.0×10^{-7}mol/s. What is the reaction rate of B? (1 mark)



2.0×10^{-7} mol/s

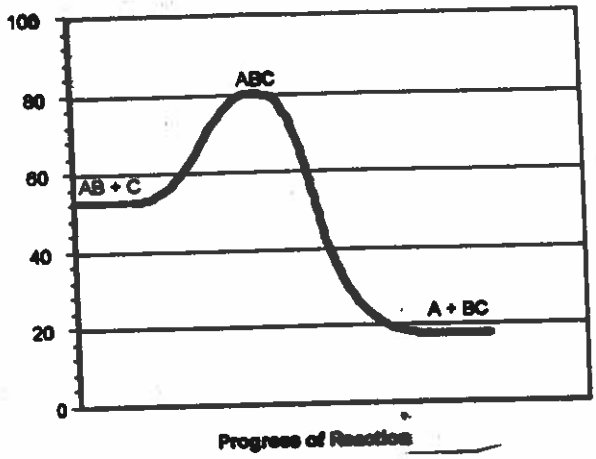
3. In order to have a successful collision, what two traits must the particles have? (2 marks)

- enough energy (moving quickly enough)
- correct orientation

not real bonds to begin with

4. As an activation complex breaks into its products what happens to:
   a) ~~the bonds~~ of the activation complex? break
   b) The potential energy? decreases
   c) The kinetic energy? increases
   d) The total energy? stays the same
(4 marks)

5. Look at the following graph. (of Potential Energy)



   a) What is the activation energy of the forward reaction? 28 kJ
   b) What is the activation energy of the reverse reaction? 64 kJ
   c) What is the enthalpy change (H) for the forward reaction? -38 kJ
   d) Is the forward reaction exothermic or endothermic? exothermic
   e) What is the enthalpy change (H) for the reverse reaction? + 38 kJ
   f) Is the reverse reaction exothermic or endothermic? endothermic
   g) What is the strongest bond ? B-C
   h) Which group of chemicals are moving faster? (AB + C or A + BC) A + BC
(8 marks)

6. Consider the reaction of $S_2O_8^{2-}$ ions with I^- ions, for which a suggested mechanism has been determined by supporting empirical evidence. Assume that the overall reaction is slightly exothermic.

$2\,Cu^{2+}_{(aq)} + 2\,I^-_{(aq)} \rightarrow 2\,Cu^{+}_{(aq)} + I_{2(aq)}$ (fast)

$Cu^{+}_{(aq)} + S_2O_8^{2-}{}_{(aq)} \rightarrow CuSO_4^{+}{}_{(aq)} + SO_4^{2-}{}_{(aq)}$ (slow)

$Cu^{+}_{(aq)} + CuSO_4^{+}{}_{(aq)} \rightarrow 2\,Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$ (fast)

(a) Identify the catalyst and the intermediate products in this reaction. catalyst = Cu^{2+} intermediate = $CuSO_4^{+}$

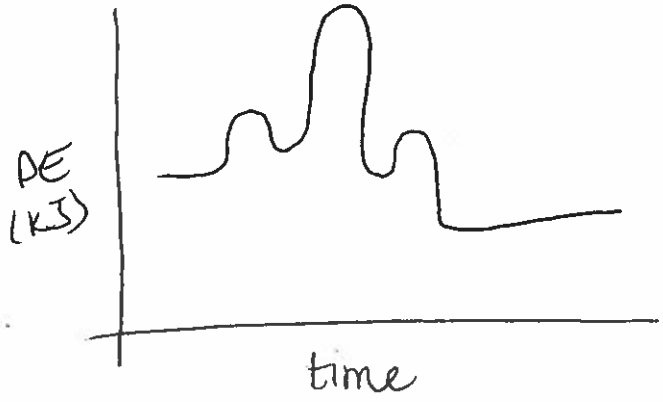
(b) Identify the reactants and products, and write the overall reaction equation.

$2I^- + S_2O_8^{2-} \rightarrow I_2 + 2SO_4^{2-} + heat$

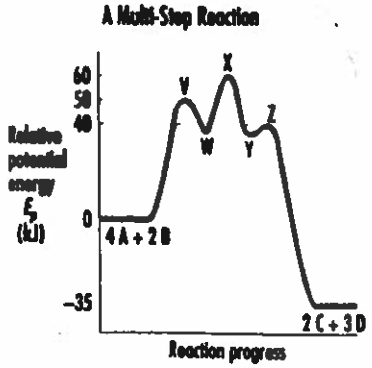
(d) Explain what effect increasing the concentration of I^- ions would have on the overall rate.

No effect as it is in a fast step, not the RDS

(c) Sketch a potential energy vs reaction progress graph for this reaction.



7 Consider the potential energy diagram for the hypothetical reaction below. This reaction is reversible as under certain conditions products will react to re-form products.



a) What is the activation energy for the following net forward reaction?
$4A + 2B \rightarrow 2C + 3D$ Ea= 60 kJ

b) What is the activation energy for the following net reverse reaction?
$2C + 3D \rightarrow 4A + 2B$ Ea= 95 KJ

c) What is the reaction enthalpy for the net forward reaction? -35 kJ

d) What is the reaction enthalpy for the net reverse reaction? +35 KJ

e) What is the rate-determining step for the forward reaction? step 2

f) What is the rate-determining step for the reverse reaction? step 2

g) Which reaction (forward or reverse) is exothermic? forward

h) Which letters represent activation complexes? V, X, Z

i) Which letters represent intermediate products? W, Y

c) Which arrow indicates the *activation energy* for the *second* step of the forward reaction? _____

d) Which arrow indicates the *enthalpy change* (ΔH) *or "heat of reaction"* for the *overall* **forward** reaction? _____

e) Which arrow indicates the *enthalpy change* (ΔH) *or "heat of reaction"* for the *overall* **reverse** reaction? _____

f) Which arrow indicates the *activation energy* for the ***overall*** forward reaction? _____

g) Which step would be the ***rate determining step*** in the *forward* reaction? _____

25. Given the reaction: $HCOOH \rightarrow CO + H_2O$

a) This reaction, without a catalyst, is *very slow* at room temperature. Suggest why. _____

b) This reaction is thought to take place by means of the following mechanism when the catalyst H^+ is added:

Step 1: $HCOOH + H^+ \rightarrow HCOOH_2^+$ (fast)

Step 2: $HCOOH_2^+ \rightarrow H_2O + HCO^+$ (slow)

Step 3: $HCO^+ \rightarrow CO + H^+$ (fast)

c) Identify the two ***intermediates*** $HCOOH_2^+$ & HCO^+

d) Identify the ***catalyst*** in this mechanism H^+

e) Another catalyst is discovered which increases the rate of only *Step 1*. How will this affect the rate of the *overall reaction*? no change

Explain your answer. step 1 is not the RDS

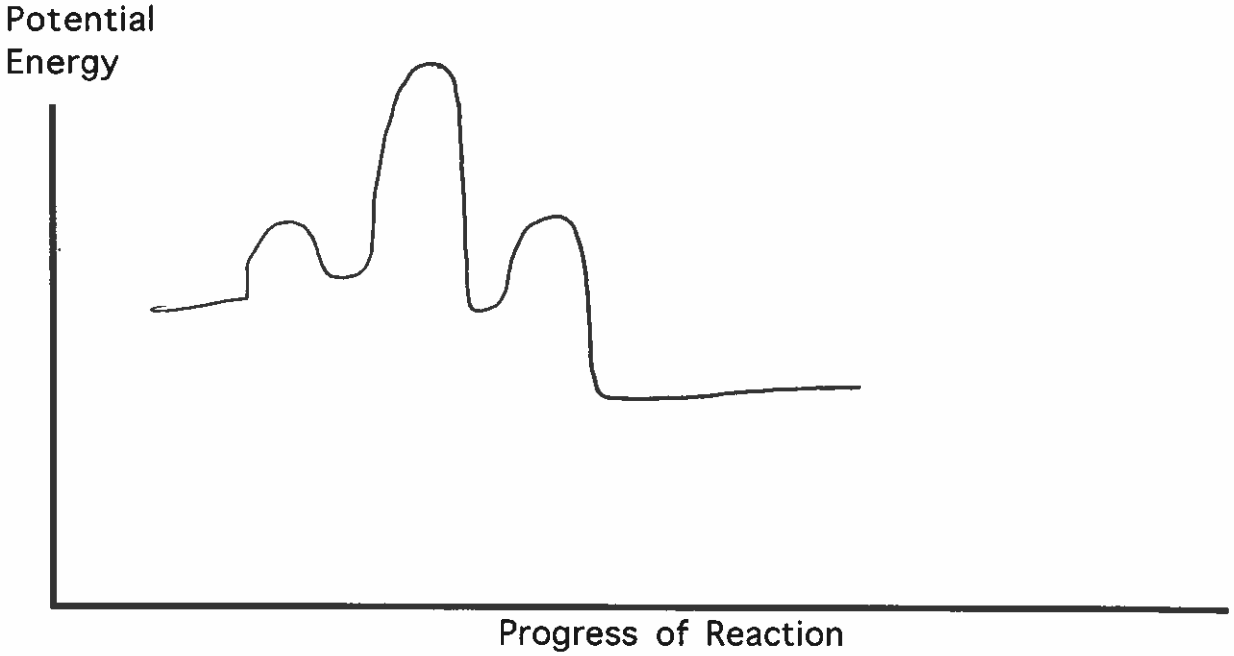
f) Which step has the greatest ***activation energy***? Step 2

g) How many "bumps" will the potential energy diagram for the catalyzed reaction have? 3

h) Which step is called the ***rate determining step*** in this mechanism? Step 2

i) In order to have successful collisions, the colliding particles must have **both** the proper amount of *energy* and the proper orientation

f) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is *exothermic*! Make sure you get the "bumps" the correct relative sizes.



26. Given the following mechanism, answer the questions below:

Step 1: $O_3 + NO \rightarrow NO_2 + O_2$ (slow)

Step 2: $NO_2 + O \rightarrow NO + O_2$ (fast)

a) Give the equation for the ***overall reaction***. $O_3 + O \rightarrow 2O_2$

b) What could the ***catalyst*** be in this mechanism? NO

c) What is an ***intermediate*** in this mechanism? NO_2

28. The equation for an ***overall*** reaction is: $I^- + OCl^- \rightarrow IO^- + Cl^-$

a) The following is a proposed *mechanism* for this reaction. One of the species has been left out. ***Determine what that species is and write it in the box.*** Make sure the *charge* is correct if it has one!

Step 1: $OCl^- + H_2O \rightarrow HOCl + OH^-$ (fast)

Step 2: $I^- +$ [HOCl] $\rightarrow IOH + Cl^-$ (slow)

Step 3: $IOH + OH^- \rightarrow IO^- + H_2O$ (fast)

b) Which species in the mechanism above acts as a ***catalyst***? H_2O

c) Which three species in the mechanism above are ***intermediates***? IOH, OH^-, HOCl

d) Step 2 is the ***rate determining step.***

e) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is *endothermic*! Make sure you get the "bumps" the correct relative sizes.