Name: Key Date:

Chemistry 12: Unit 1 Review – Reaction Kinetics

You will be handing this booklet in before the test. It is not for marks, but I will be looking at what you did to prepare for the test.

Step 1: How was your understanding through the unit?

Based on your Quizzes this unit fill out what your grades were going through the unit.

Learning Targets		(1 and 2)	(3 and 4)	(5 and 6)
1-3	analyze data to Calculate & Graph Rate			
1-4	state different ways to Monitor Rate			
1-5	use collision theory to Control Rate and explain the affects			
1-6	explain changes to PE & KE as it relates to a reaction & Catalysts			
1-7	solve and identify characteristics of a reaction Mechanism			

Step 2: Self-Assessment

Based on your grades in step 1 and your perception of your own understanding of the concepts, complete the following.

a. What area(s) need the most focus before your test?

_____

_____

b. What area(s) are you the most confident with?

_____

_____

c. Was there anything in particular that made you feel more confident with some areas? If so, can you apply this to help you in the other areas? (ie. Did you complete more practice for that area? Did you come get extra help or watch a video on that area that helped increase your understanding?)

_____

_____

_____

_____

Step 3: Set a goal and make a plan

My goal for this test is to show a better understanding of _____

_____.

I am going to achieve this by _____

_____

_____

_____

_____

Step 4: If your plan involves extra practice here are some questions you can do to help you with that

LT 1-3: Analyze Data to Calculate and Graph Rate

1) A chemist wishes to determine the rate of reaction of beryllium with hydrochloric acid. The equation for the reaction is:

$$Be_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + BeCl_{2(aq)}$$

A piece of beryllium is dropped into 1.00 L of $HCl_{(aq)}$ and the following data were obtained:

Time	Mass of Beryllium
0 s	0.020 g
4 s	0.018 g
8 s	0.016 g
12 s	0.014 g
16 s	0.012 g
20 s	0.010 g

a) Calculate the rate of reaction in grams of Be consumed per second

$\frac{x\ g\ Be}{s}$ $\frac{0.010 - 0.020}{20} = -5 \times 10^{-3}$ used

Answer 5.0×10^{-4} g Be/s

b) Calculate the rate of reaction in moles of Be consumed per second

$\frac{x\ mol\ Be}{s} = 5 \times 10^{-4}\ g \times \frac{1\ mol}{9\ g} = 5.56 \times 10^{-4}$

Answer 5.6×10^{-5} mol/s

c) What will happen to the [HCl] as the reaction proceeds?

Answer decrease

2) When *pentane* (C_5H_{12}) is burned in air (oxygen), the products are carbon dioxide and water.

a. Write a balanced formula equation for the reaction.

$C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$

b. If pentane is consumed at an average rate of 2.16 g/s, determine the rate of consumption of pentane in moles/s.

$\frac{x\ mol}{s} = 2.16\ g/s \times \frac{1\ mol}{72\ g} = 0.03\ mol/s$

Answer 0.030 mol/s

c. If pentane is consumed at an average rate of 0.030 moles/s determine the rate of consumption of oxygen in moles/s.

$\frac{x\ mol\ O_2}{s} = 0.030\ mol/s \times \frac{8\ mol\ O_2}{1\ mol\ C_5H_{12}} = 0.24\ mol/s$

Answer $0.24\ mol\ O_2/s$

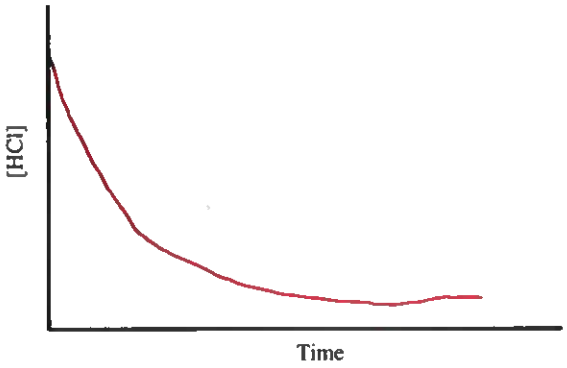
d. If pentane is consumed at an average rate of 0.030 moles/s, determine the rate of production of CO_2 in moles/s.

$\frac{x\ mol\ CO_2}{s} = 0.030\ \frac{mol}{s} \times \frac{5\ mol\ CO_2}{1\ mol\ C_5H_{12}} = 0.15$

Answer $0.15\ mol\ CO_2/s$

3) On the following set of axes, draw the shape of the curve you would expect if you plotted the [HCl] vs. time, starting immediately after the two reactants are mixed. The equation for the reaction is:

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$$



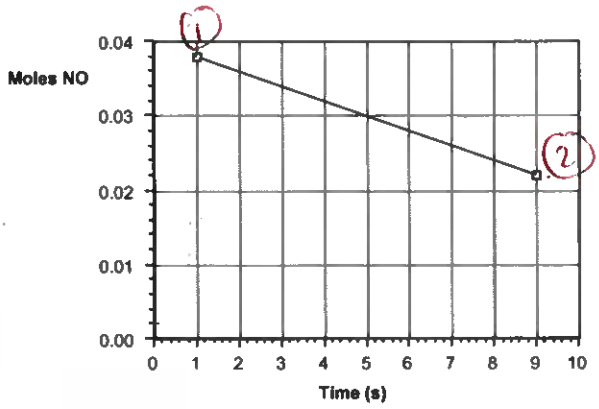
Explain how you got that particular shape. Be detailed.

The rxn will proceed very fast at first then begin to slow as the [HCl] goes down

4) Consider the following reaction:

$$2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$$

Data collected for the above reaction was used to construct the following graph:



From this graph, determine the ***rate of reaction*** in *moles of NO consumed per second.*

Find slope to get $\frac{\text{mol NO}}{\text{s}}$

$\frac{0.022 - 0.039}{9 - 1}$

Answer 2.0×10^{-3} mol/s.

LT 1-4: State different ways to monitor rate

5) Try to write at least 3 expressions that could be used for each of the following reactions to determine their reaction rate.

a) $Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$

$\frac{\Delta \text{mass Mg}}{\Delta \text{time}}$ $\frac{\Delta [HCl]}{\Delta \text{time}}$ $\frac{\Delta \text{pressure}}{\Delta \text{time}}$

b) $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$

$\frac{\Delta \text{mass AgCl produced}}{\Delta \text{time}}$ $\frac{\Delta [Ag^+]}{\Delta \text{time}}$ $\frac{\Delta [NO_3^-]}{\Delta \text{time}}$

~~$AgNO_3$~~ $Ag^+ + NO_3^- \rightarrow AgCl_{(s)}$

c) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

$\frac{\Delta \text{mass C}}{\Delta \text{time}}$

Can't do pressure or volume for gases as there are equal moles used and produced.

LT 1-5: Use collision theory to control rate and explain its effects

6) Which of the following reactions is ***most likely*** to have the *greatest rate* at room temperature?

a) $Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$

b) $H_{2\,(g)} + Cl_{2\,(g)} \rightarrow 2HCl_{\,(g)}$

c) $C_3H_{8\,(g)} + 5O_{2\,(g)} \rightarrow 3CO_{2\,(g)} + 4H_2O_{\,(g)}$

d) $Fe_{\,(s)} + S_{(s)} \rightarrow FeS_{\,(s)}$

Answer A. Explain how you arrived at your answer. Aqueous reactants react the fastest and no ~~bonds~~ bonds need to be broken here

7) A) In a room filled with H_2 and O_2 there are about 10^{32} collisions per second. Explain why the reaction between H_2 and O_2 at room temperature is so *slow* it is unnoticeable.

The particles don't have enough energy when they collide.

B) Suggest two ways in which the reaction in A can be sped up.

1- add a catalyst (Pt)

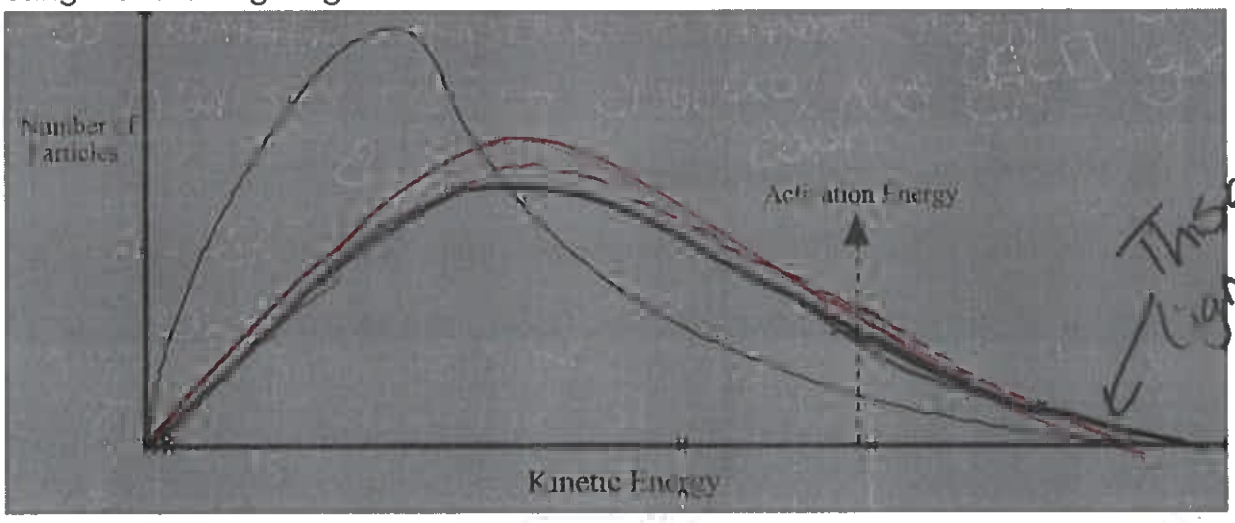
2- increase temp.

LT 1-6: explain changes to KE and PE as it relates to a reaction and catalysts

8) Describe what happens to the kinetic energy, potential energy and the total energy of reactant molecules as they approach each other.

- KE ↓ as repulsive forces increase.
- PE ↑ as KE ↓
- Total energy will stay constant.

9) Using the following diagram:



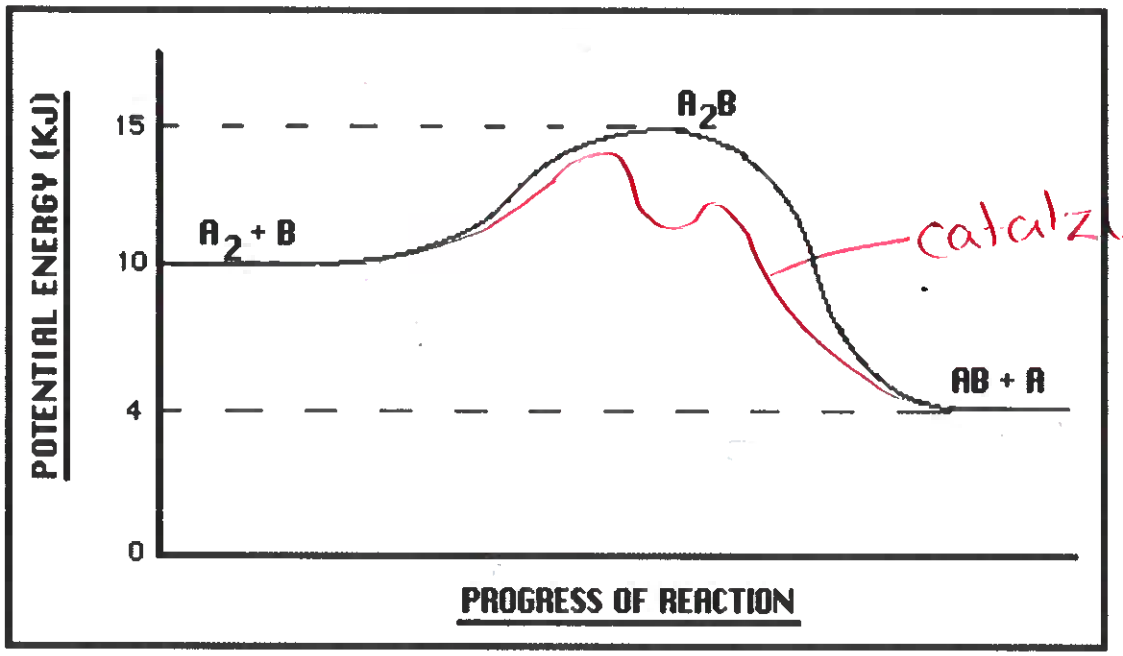
This one! (lower Ea)

a. Approximately what fraction of the molecules in the sample have enough energy for an effective collision?

Answer $\leq \frac{1}{10}$ th

b. On the diagram above, draw the curve you would expect at a higher temperature in which the rate of the reaction is doubled. Be careful to be accurate. Label it.

10) Use the following Potential energy diagram to answer all the questions below.



What is the value of ΔH for the *forward* reaction ? 4 - 10 = -6 Answer -6 kJ

b) What is the value of the ***activation energy*** for the *forward* reaction?
Answer 5 kJ

c) What is the value of the ***activation energy*** for the *reverse* reaction?
Answer 11 kJ

d) Which is a *stronger* bond, A--A or A--B ?
Answer AB

e) Explain your answer to (d)
The activation energy is higher when AB bond needs to be broken

f) Which species is the ***activated complex***? A_2B

g) Which set of species has the ***lowest potential energy***? Answer AB + A

h) Is the reaction as written *endothermic* or *exothermic*? Answer exo

i) What is the *minimum energy needed* to *start* the reaction $AB + A \rightarrow A_2 + B$?
Answer 11 kJ.

j) What happens to the ***kinetic energy*** (speed) of AB and A as the reaction ~~on as shown~~ on the graph proceeds past the activated complex and toward the products?
Answer KE ↑

k) For A_2 and B to form the *activated complex* they must have the proper *energy* and the proper alignment/geometry/orientation

l) If a catalyst C is used in this reaction, it takes place by means of a different mechanism. This one involves two steps.

$A_2 + C \rightarrow AC + A$ (slow)

$AC + B \rightarrow AB + C$ (fast)

*Draw another curve on the graph with another colour showing the **catalyzed** reaction. (Remember it has two steps so it should have two bumps! Also be aware that one of the bumps is higher than the other!)*

m) Which step in question (l) is the rate determining step? Answer First step

n) Looking at only the equations for the steps in question "*l*", how could one tell that "C" is a catalyst?

It is added then produced unchanged.

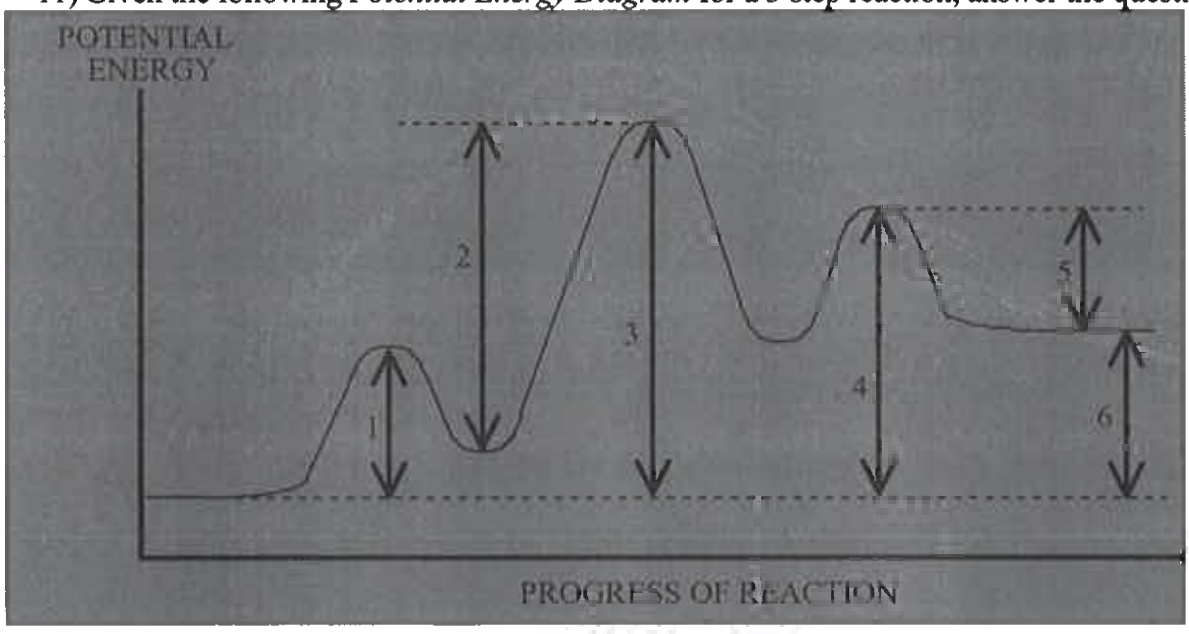
o) What is ΔH for the reverse reaction to what is shown on the graph? Answer +16kJ

p) What effect did the *catalyst* have on the *activation energy* for the *forward* reaction? It lowers the activation energy

For the reverse reaction? It lowers the Ea.

LT 1-7: Solve and identify characteristics in a reaction mechanism

11) Given the following *Potential Energy Diagram* for a 3 step reaction, answer the questions below



a) Which arrow indicates the *activation energy* for the *first* step of the reverse reaction? 5

b) Which arrow indicates the *activation energy* for the *first* step of the forward reaction? 1

c) Which arrow indicates the *activation energy* for the *second* step of the forward reaction? 2

d) Which arrow indicates the *enthalpy change* (ΔH) *or "heat of reaction"* for the *overall* **forward** reaction? 6

e) Which arrow indicates the *enthalpy change* (ΔH) *or "heat of reaction"* for the *overall* **reverse** reaction? 6

f) Which arrow indicates the *activation energy* for the ***overall*** forward reaction? 3

g) Which step would be the ***rate determining step*** in the *forward* reaction? Step 2

12) 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

13) 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)

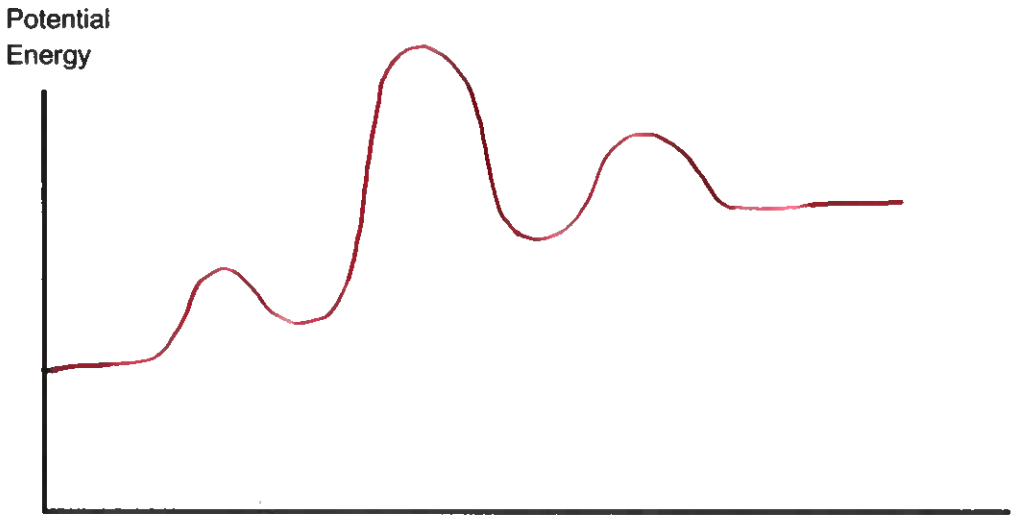
$I^- + OCl^- \rightarrow IO^- + Cl^-$

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

c) Which three species in the mechanism above are ***intermediates***? OH^-, IOH, 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 <u>*endothermic*</u>! Make sure you get the "bumps" the correct relative sizes.


Potential
Energy