

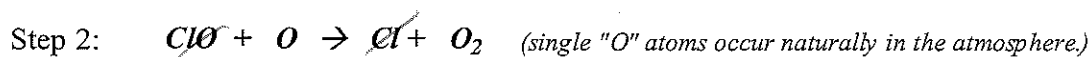
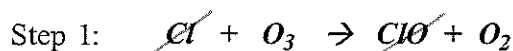
## Chemistry 12

### Worksheet 1-3 - Reaction Mechanisms

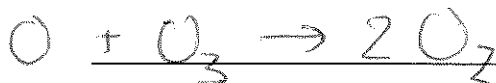
1. It is known that compounds called *chlorofluorocarbons* (C.F.C.s) (eg.  $\text{CFCl}_3$ ) will break up in the presence of ultraviolet radiation, such as found in the upper atmosphere, forming single chlorine atoms:



The Cl atoms then react with Ozone ( $\text{O}_3$ ) as outlined in the following mechanism.



- a) Write the equation for the *overall reaction*. (Using steps 1 and 2)



- b) What is the *catalyst* in this reaction?

Cl

- c) Identify an *intermediate* in this reaction

ClO

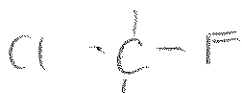
- d) Explain how a *small* amount of chlorofluorocarbons can destroy a *large* amount of ozone.

- Not consumed

- speeds up process, less energy needed to rxn.

- e) What breaks the bond in the  $\text{CFCl}_3$  and releases the free Cl atom?

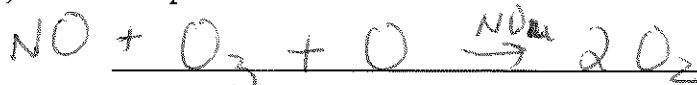
ultraviolet radiation



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



- a) Give the equation for the *overall reaction*.



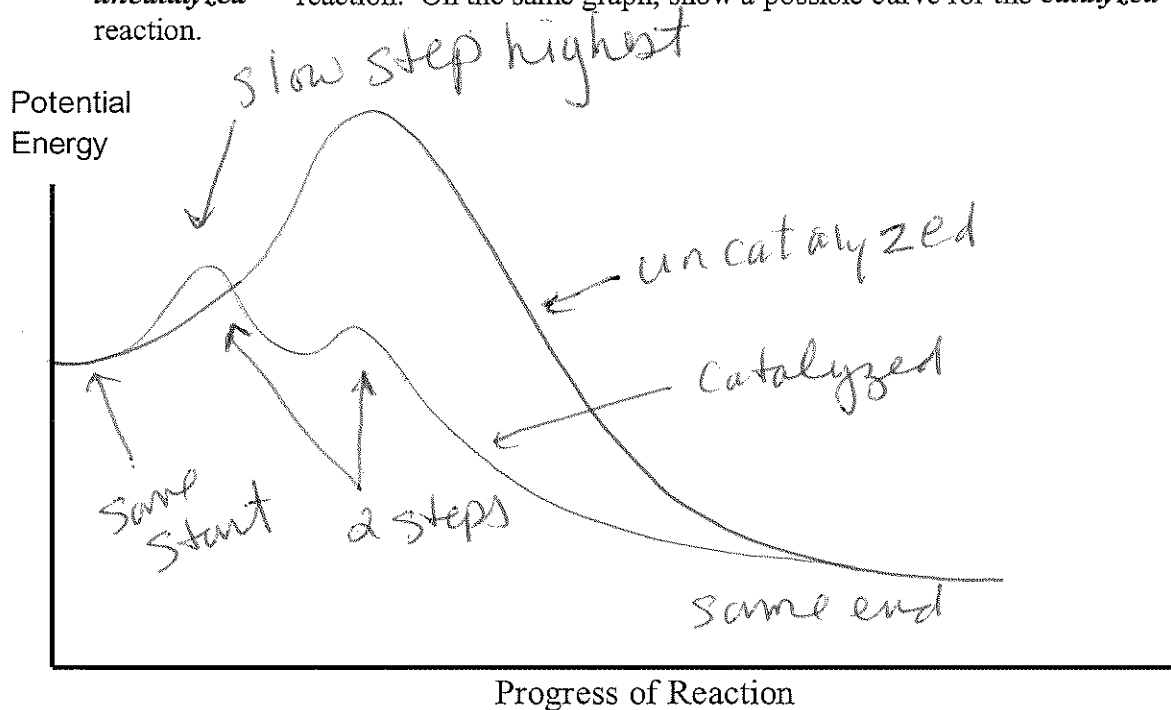
- b) What could the *catalyst* be in this mechanism?

NO

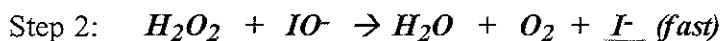
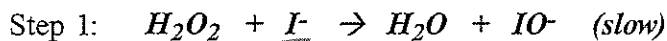
- c) What is an *intermediate* in this mechanism?

NO<sub>2</sub>

- d) Given that the **uncatalyzed** overall reaction is a *slow exothermic* reaction, draw a *potential energy graph* which shows the possible shape of the curve for the **uncatalyzed** reaction. On the same graph, show a possible curve for the **catalyzed** reaction.



3. Consider the following mechanism:



- a) Give the equation for the overall reaction.



- b) What acts as a *catalyst* in this mechanism?



- c) What acts as an *intermediate* in this mechanism?



4. What is meant by the *rate determining step* in a reaction mechanism?

slow step, Needs most energy, High PE

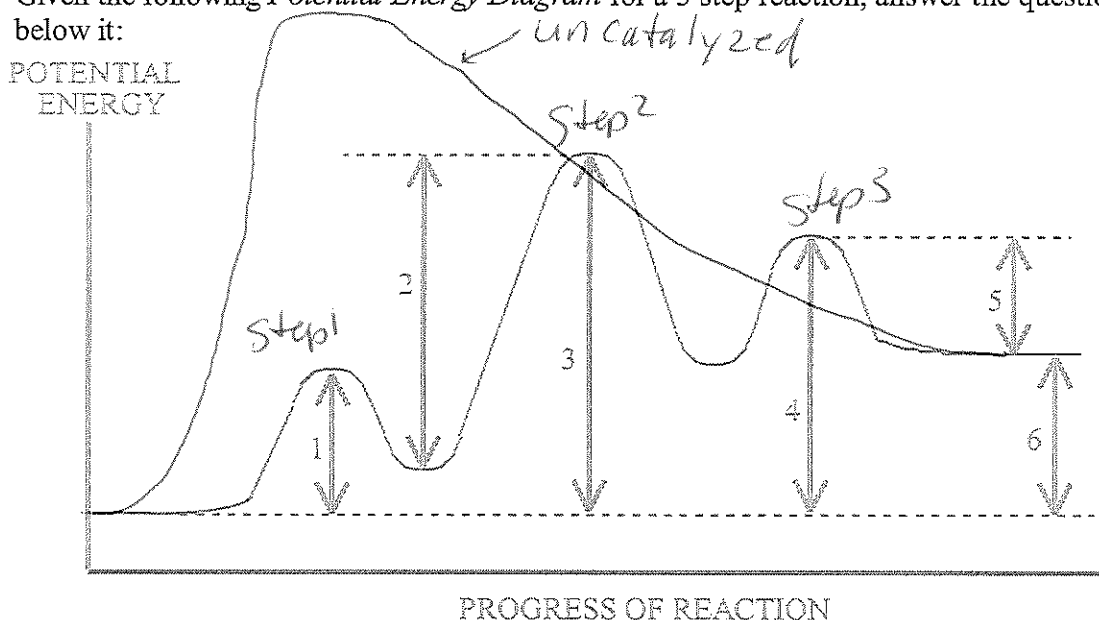
5. What is meant by a *reaction mechanism*?

How atoms/molecules collide giving Reactants  $\rightarrow$  Products

6. How are reaction mechanisms determined?

Hypothetical, since you can determine order, a lab experiment can confirm order.

7. Given the following *Potential Energy Diagram* for a 3 step reaction, answer the questions below it:



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* ( $\Delta H$ ) or "*enthalpy change*" for the *overall forward* reaction?

#6

e) Which arrow indicates the *enthalpy change* ( $\Delta H$ ) or "*enthalpy change*" for the *overall reverse* reaction?

#6

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

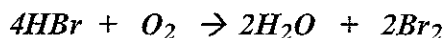
#3

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

step 2

h) In a dashed line or another colour sketch a possible curve that would represent the route for the *uncatalyzed overall reaction*. Label this on the graph. see graph

8. Given the reaction:

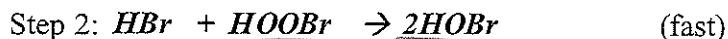
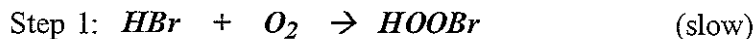


a) Would you expect this reaction to take place in a single step? No,

Why or why not?

would required 5 particles to collide at 1 time to react.

b) This reaction is thought to take place by means of the following mechanism:



c) Identify the two *intermediates*

HOBr, HOBr

d) A catalyst is discovered which increases the rate of *Step 3*. How will this affect the rate of the *overall reaction*?

will not (no change)

Explain your answer.

Does not speed up slow step.

e) A catalyst is discovered which increases the rate of *Step 1*. How will this affect the rate of the *overall reaction*?

increase,

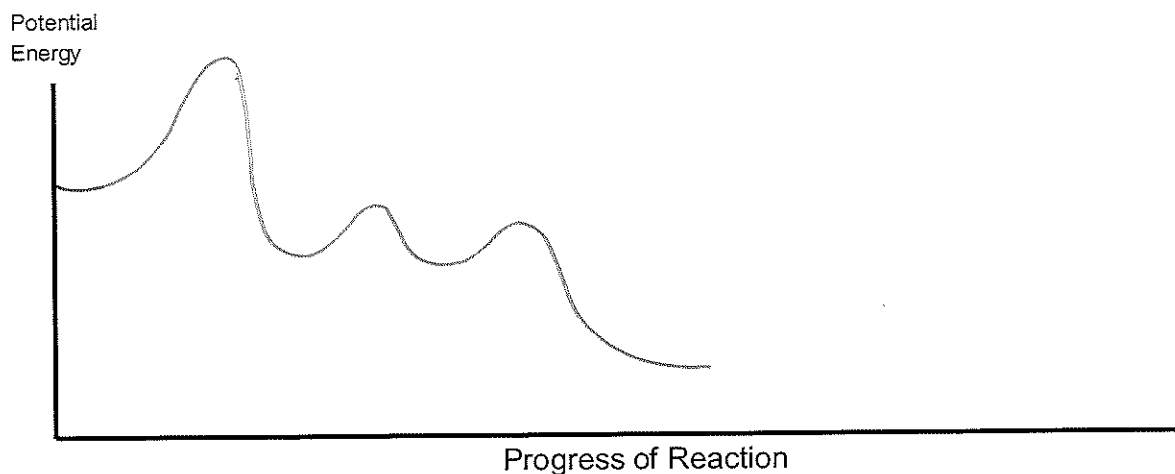
Explain your answer.

speeds up slow step.

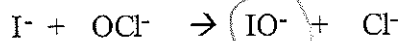
f) Which step has the greatest *activation energy*?

Step 1

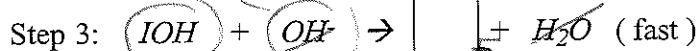
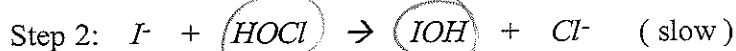
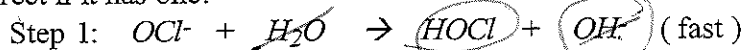
- g) How many "bumps" will the potential energy diagram for the reaction mechanism have?  
3
- h) Which step is called the *rate determining step* in this mechanism? Step 1
- i) In order to have successful collisions, the colliding particles must have **both** the proper amount of *energy* and the proper geometry
- j) 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.



9. The equation for an *overall* reaction is:



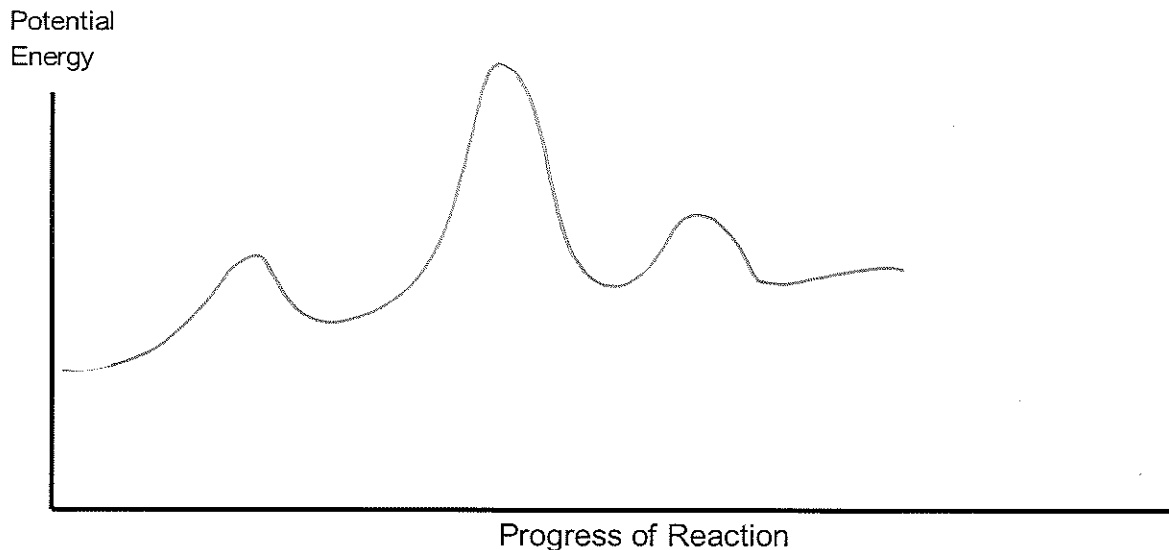
- a) The following is a proposed *mechanism* for this reaction. One of the species has been left out. **Determine what that species is and write it in the box.** Make sure the *charge* is correct if it has one!



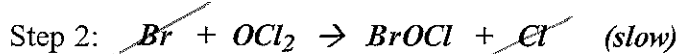
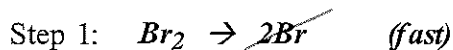
- b) Which species in the mechanism above acts as a *catalyst*?  $\text{H}_2\text{O}$
- c) Which three species in the mechanism above are *intermediates*?  $\text{HOCl}, \text{OH}^-, \text{IOH}$
- d) Step 2 is the *rate determining step*.



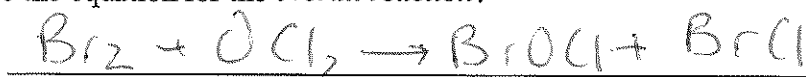
- e) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is endothermic! Make sure you get the "bumps" the correct relative sizes.



10. Given the following steps for a mechanism:



- a) Write the equation for the *overall reaction*.



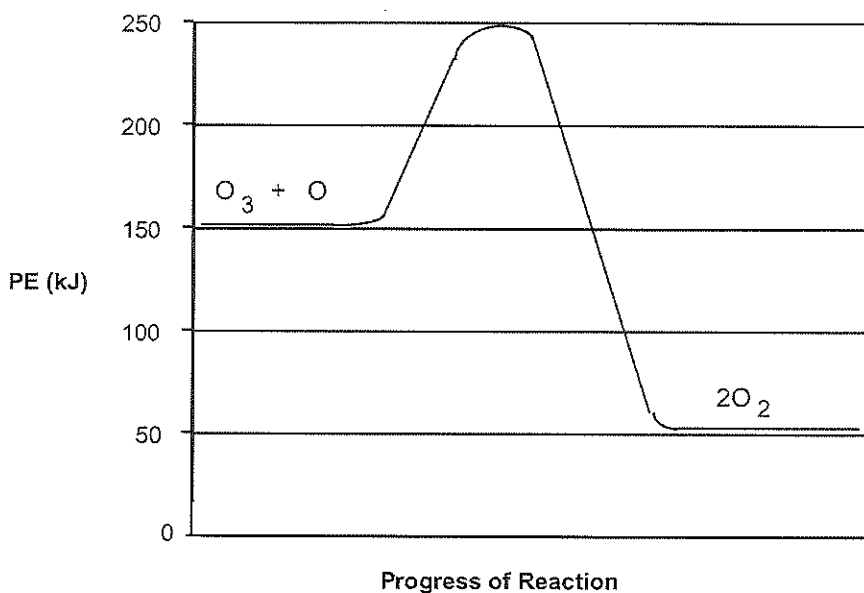
- b) A substance is added that *decreases* the *activation energy* for step 1. Will this speed up, slow down, or have no effect on the rate of the overall reaction? \_\_\_\_\_

Give a reason for your answer.

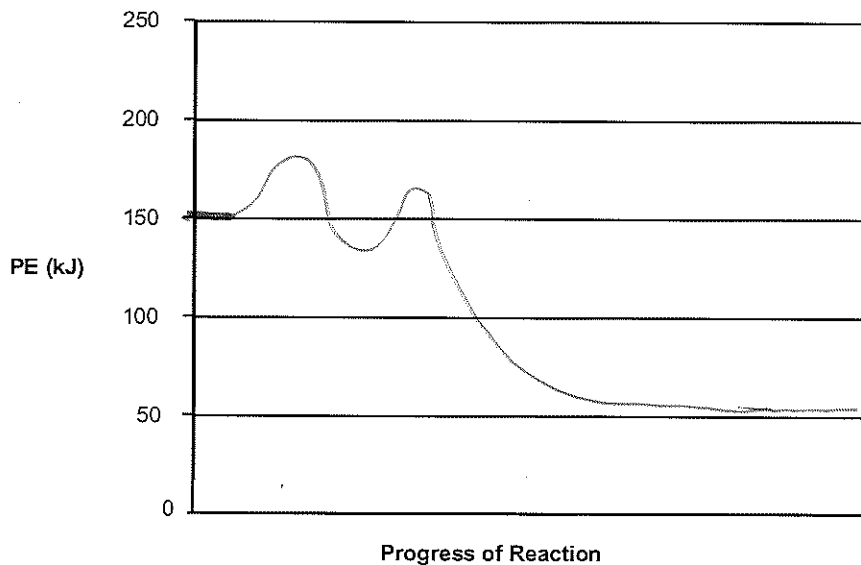
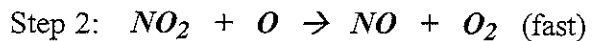
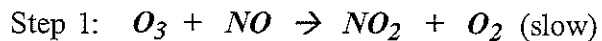
Not Reducing Rate Step

- c) Is there a *catalyst* in this mechanism? No. If so, what is it? \_\_\_\_\_
- d) Is there an *intermediate* in this mechanism? BrCl. If so, what is it? \_\_\_\_\_
- e) Which step is the *rate determining step*? 2

11. The following *potential energy diagram* refers to a very slow one-step reaction of ozone ( $O_3$ ) and oxygen atoms in the upper atmosphere.



On the axis below, draw a potential energy diagram which could represent the *catalyzed mechanism* for the reaction:

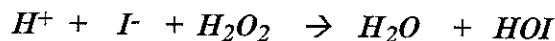


Same  
Start/end

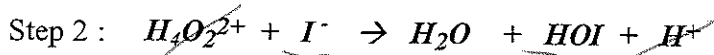
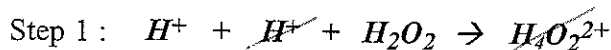
12. A certain chemical can provide a reaction with an alternate mechanism having a *greater* activation energy. What will happen to the *rate of the reaction* when this chemical is added?

Explain your answer. Reaction, likely would not take that path so nothing / either nothing or slow.

13. The following overall reaction is *fast* at room temperature:



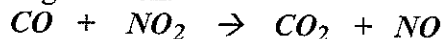
A student proposes the following two-step mechanism for the above reaction:



Would you agree or disagree with this proposed mechanism? yes,

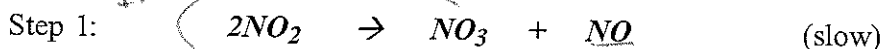
Explain your answer 1st these are hypothetical, very difficult to know real mechanism. this does add up to overall.

14. Consider the following reaction:

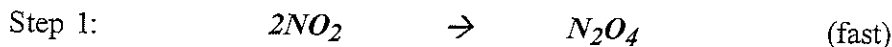


- a) The *first step* in each of two proposed reaction mechanisms for the above reaction is listed below. If each proposed reaction mechanism consists of only *two* steps, *determine the second step for each mechanism.*

Proposed Mechanism One:



Proposed Mechanism Two:



- b) Experimental data show that the rate of the reaction is *not* affected by a change in the

[CO]. Which of these two mechanisms would be consistent with these data? \_\_\_\_\_

Explain your answer. "a" slow step is 1st.