

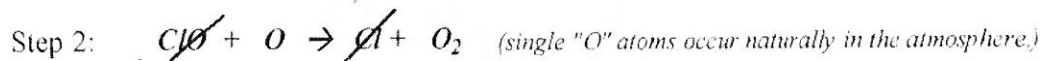
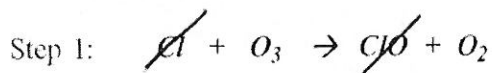
Chemistry 12

Worksheet 1-3 - Reaction Mechanisms

1. It is known that compounds called *chlorofluorocarbons* (C.F.C.s) (eg. 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 (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.

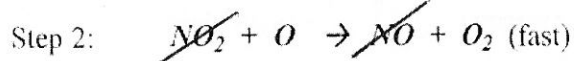
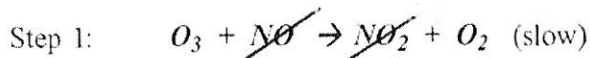
Cl from CFCl_3 = catalyst =
not used up by the rxn ∴ free to

- e) What breaks the bond in the CFCl_3 and releases the free Cl atom?

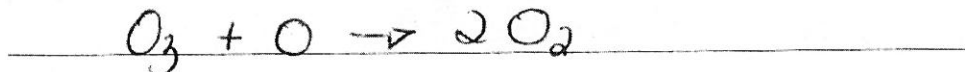
UV radiation

catalyze rxn
after rxn

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



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



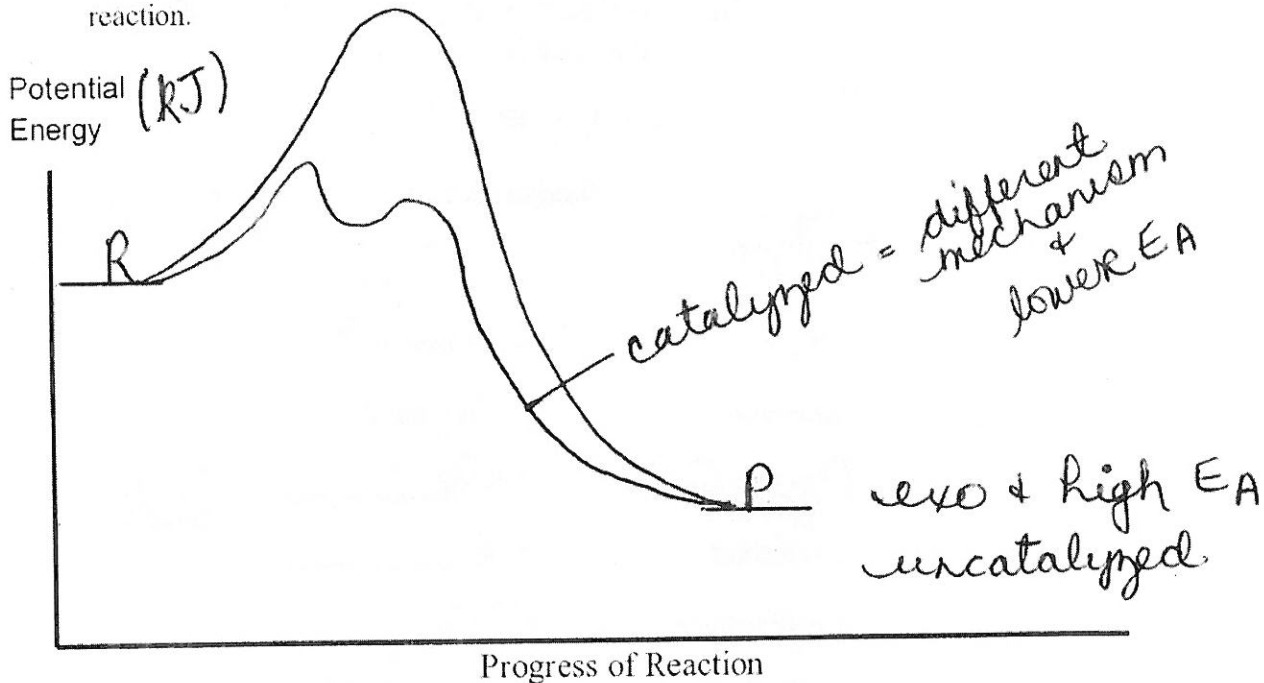
- b) What could the *catalyst* be in this mechanism?

NO

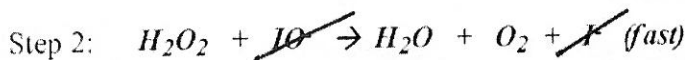
- c) What is an *intermediate* in this mechanism?

NO_2

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.

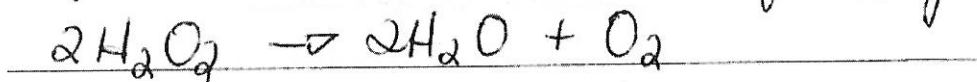


3. Consider the following mechanism:



catalyzed decomposition of hydrogen peroxide = foaming monster

a) Give the equation for the overall reaction.



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

c) What acts as an *intermediate* in this mechanism? IO_2^- ion

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

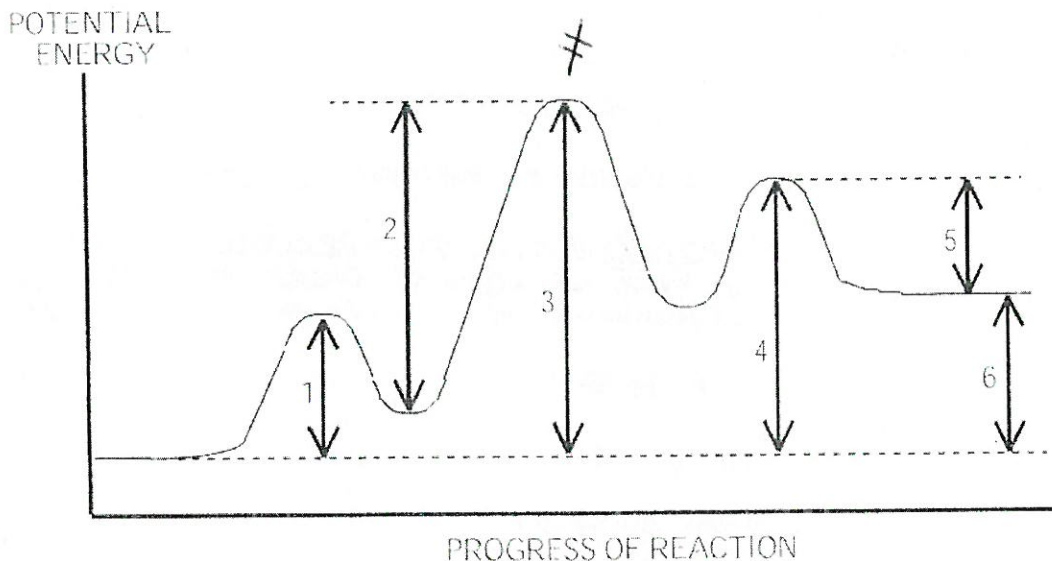
step = highest EA

5. What is meant by a *reaction mechanism*? the steps a rxn

takes from R to P

6. How are reaction mechanisms determined? experimentally,
changing the concentration of a R + measuring
how it affects rate

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? not for the full rxn 2
- d) Which arrow indicates the *enthalpy change* (ΔH) or "*enthalpy change*" for the overall forward reaction? 6
- e) Which arrow indicates the *enthalpy change* (ΔH) or "*enthalpy change*" for the overall reverse reaction? 6

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

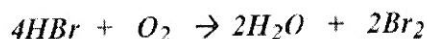
3

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

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.

8. Given the reaction:

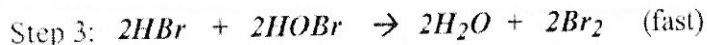
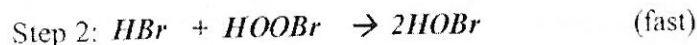
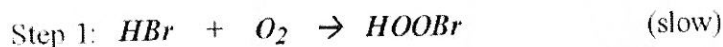


a) Would you expect this reaction to take place in a single step? no

Why or why not?

too many molecules (5) to collide with the proper orientation at the same time

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



c) Identify the two *intermediates*

HOBr & H₂O

d) A catalyst is discovered which increases the rate of *Step 3*. How will this affect the rate of the *overall reaction*? not much

Explain your answer.

step 3 already fast =

problem is step 1 the rate determining step = must speed this step up.

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

Explain your answer.

step 1 = \neq

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

step 1 = \neq

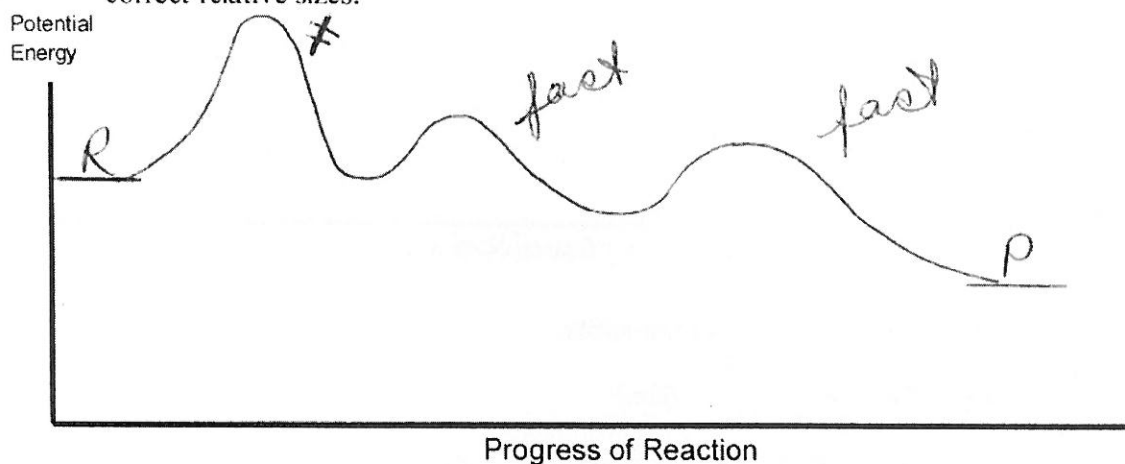
g) How many "bumps" will the potential energy diagram for the reaction mechanism have?

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 orientation

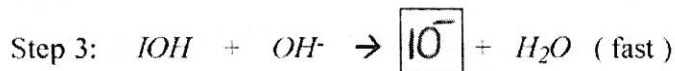
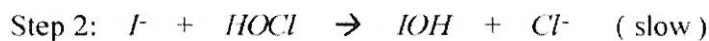
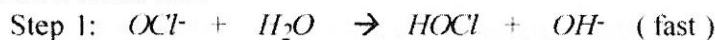
j) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is exothermic! Make sure you get the "bumps" the correct relative sizes.



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!

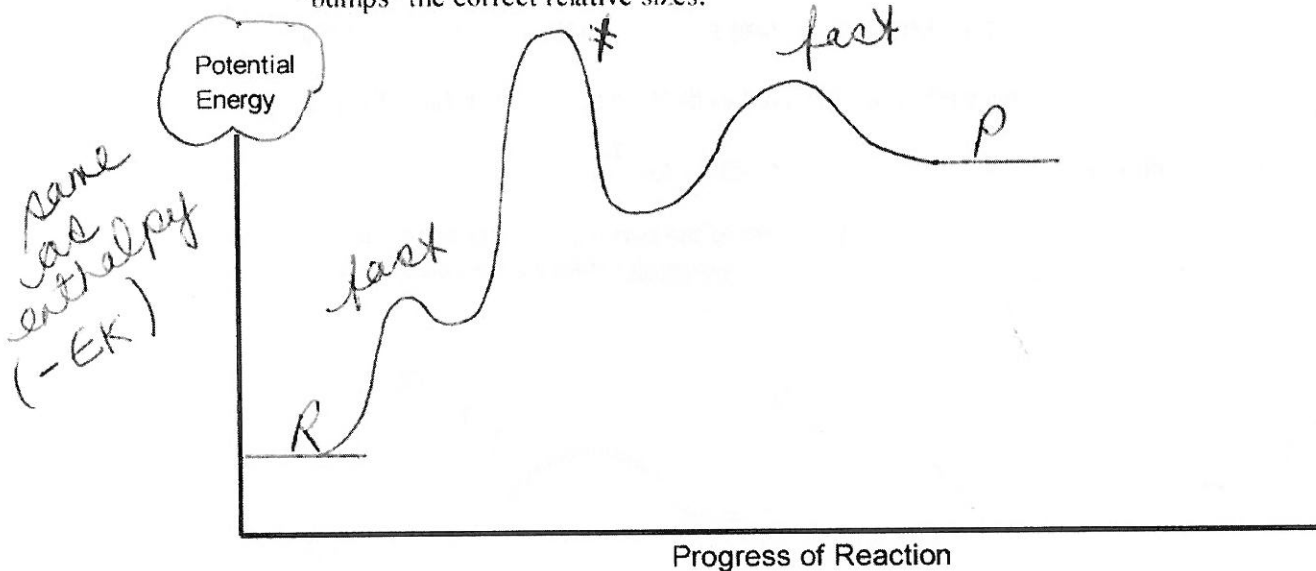


b) Which species in the mechanism above acts as a *catalyst*? H₂O

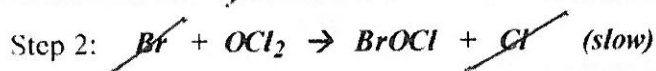
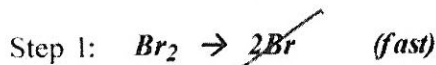
c) Which three species in the mechanism above are *intermediates*? HOCl, OH⁻, IOH

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

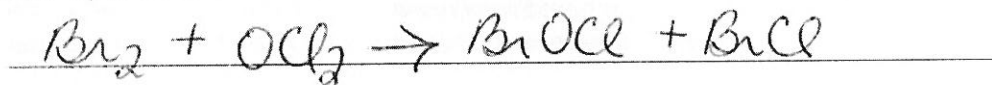
- c) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is *endothermic*! Make sure you get the "bumps" the correct relative sizes.



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? no effect

Give a reason for your answer.

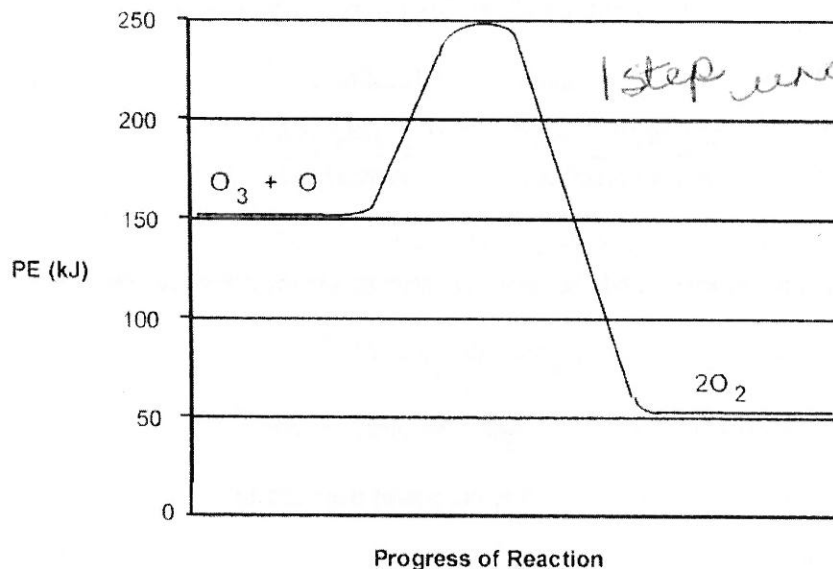
step 1 is already fast step 1 is already fast!

- c) Is there a *catalyst* in this mechanism? no. If so, what is it? _____

- d) Is there an *intermediate* in this mechanism? Br. If so, what is it? _____

- e) Which step is the *rate determining step*? step 2

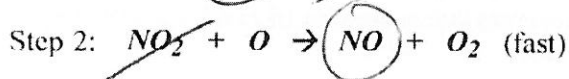
11. The following **potential energy diagram** refers to a very slow one-step reaction of ozone (O_3) and oxygen atoms in the upper atmosphere.



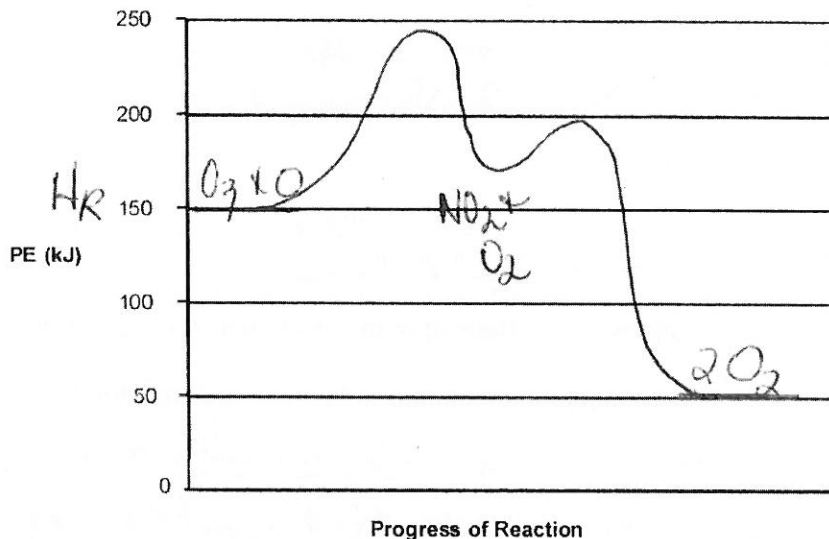
1 step uncatalyzed =
hi EA

a catalyst
→ changes
the
rate
mechanism
& lower
EA

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



NO =
catalyst



&
usually
a
number
of steps

*
a catalyst
doesn't
change ΔH
or ΔH^\ddagger

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?

As an inhibitor or negative catalyst ↓ rate of rxn

= inhibitor

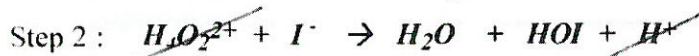
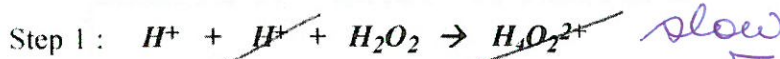
Explain your answer.

provides a diff mech that has a higher EA + slows down the rxn (but is

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



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



not used up by the rxn

Would you agree or disagree with this proposed mechanism?

disagree

Explain your answer

step 1 involves the collision of 3 particles whh would probably be slow. therefore the overall rxn could not be fast as observed.

14. Consider the following reaction:

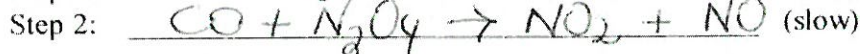
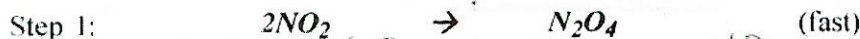


- a) The first step in each of two proposed reaction mechanisms for the above reaction is listed below. If each proposed reaction mechanism consists of only two steps, determine the second step for each mechanism.

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? 1

Explain your answer. bec CO is involved in a

fast step in mech 1, changing its conc will have little effect on how fast the rxn goes.

In Mech 2, CO is involved in a slow step (RDS) so a change in conc will have to have an effect.