**Chapter 1.1 Collision Theory and Equilibrium**

Video showing a successful collision: <https://www.youtube.com/watch?v=IkqoBbFZV4Q>

<http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/NO+O3singlerxn.html>

H2 + I2 2HI



first later later still

successful collision (reaction)

1. Describe the 3 requirements of a successful collision according to collision theory?

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1. What is another scientific term used to describe the number of successful collisions in a given time?

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1. Collision theory can help us understand the factors that affect reaction rate. List 5 factors that affect the rate of reaction.

a.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ b.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ d.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ f.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now we will look at each factor in detail:

### Effect of concentration

low conc. both high conc. blue high conc. both low conc. red

i. \_\_\_\_\_\_\_\_\_ chance of collision i.\_\_\_\_\_\_\_\_\_ chance of collision i. \_\_\_\_\_\_\_\_\_\_\_\_ chance of collision   
ii. speed of reaction\_\_\_\_\_\_\_\_\_ ii. speed of reaction\_\_\_\_\_\_\_\_\_\_\_\_\_ ii. speed of reaction\_\_\_\_\_\_\_\_\_\_\_\_\_

iii. amount of product produced iii. amount of product produced iii. amount of product produced

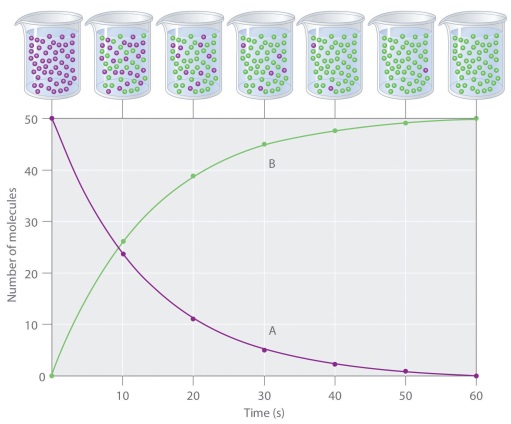
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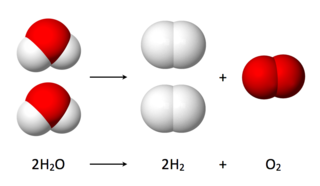
1. There are a few golden rules for rates of reaction that are important to stamp indelibly on your brain prior to learning about equilibrium.
2. Most reactions do not go to completion. In other words, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. When dealing with rates of reaction **only** look at the concentration of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ never worry about the concentration of the\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ unless they ask you about the rate of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_reaction.

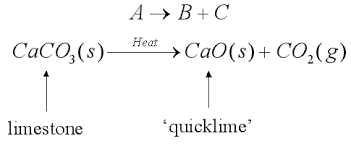


1. Increasing temperature always increases the

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for both the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_reaction, but it can have a very different effect on equilibrium.

For every 10 degree Celsius rise in temperature the rate of reaction approximately

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

For example:

1. Only look at the state of reactants when considering rates of reaction. Explain this statement and what this might involve doing to ascertain rates? Give examples.

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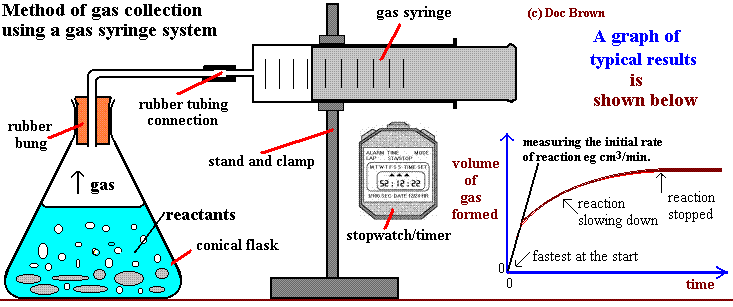
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Example Problem:

Given the following reaction:

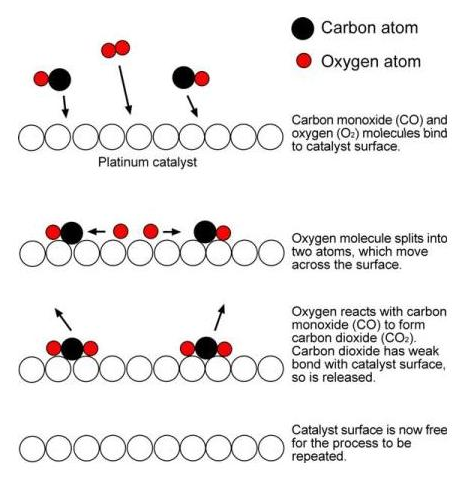
CaCO3(s) + HCl(aq) CO2(g) + H2O(l) + CaCl2(aq)



Fill in the table below describing how the following changes to the reaction would affect the rate of reaction.

|  |  |  |
| --- | --- | --- |
| Change made to system | Predict outcome | Use collision theory to justify your prediction |
| Raise the temperature by 20oC |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Use 0.1 M HCl instead of 1.0 M HCl |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Crush the CaCO3 pellets into a powder |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Add CaCl2 to the original solution |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Add a chemical catalyst |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**Understanding how catalysts affect rates of reaction**:

1. Chemical catalysts are very different from enzymes in two ways. Explain how they are different in terms of:
2. structure
3. affect on rate of reaction of forward and reverse reactions
4. affect temperature has on these two different forms of catalysts.

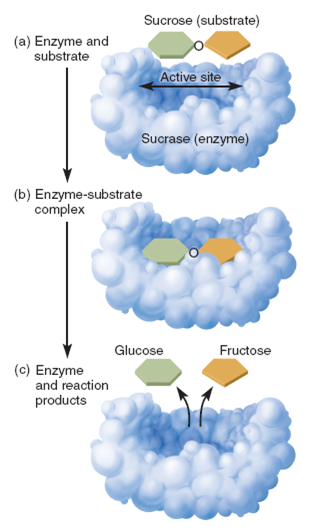
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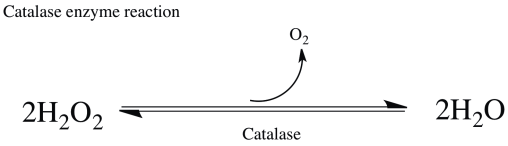
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1. How do I know whether the enzyme affects the forward or reverse reaction?

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For example:

1. Catalase reaction affects the rate of reaction in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_direction only. The result would be to have more\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_than

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced as a result.

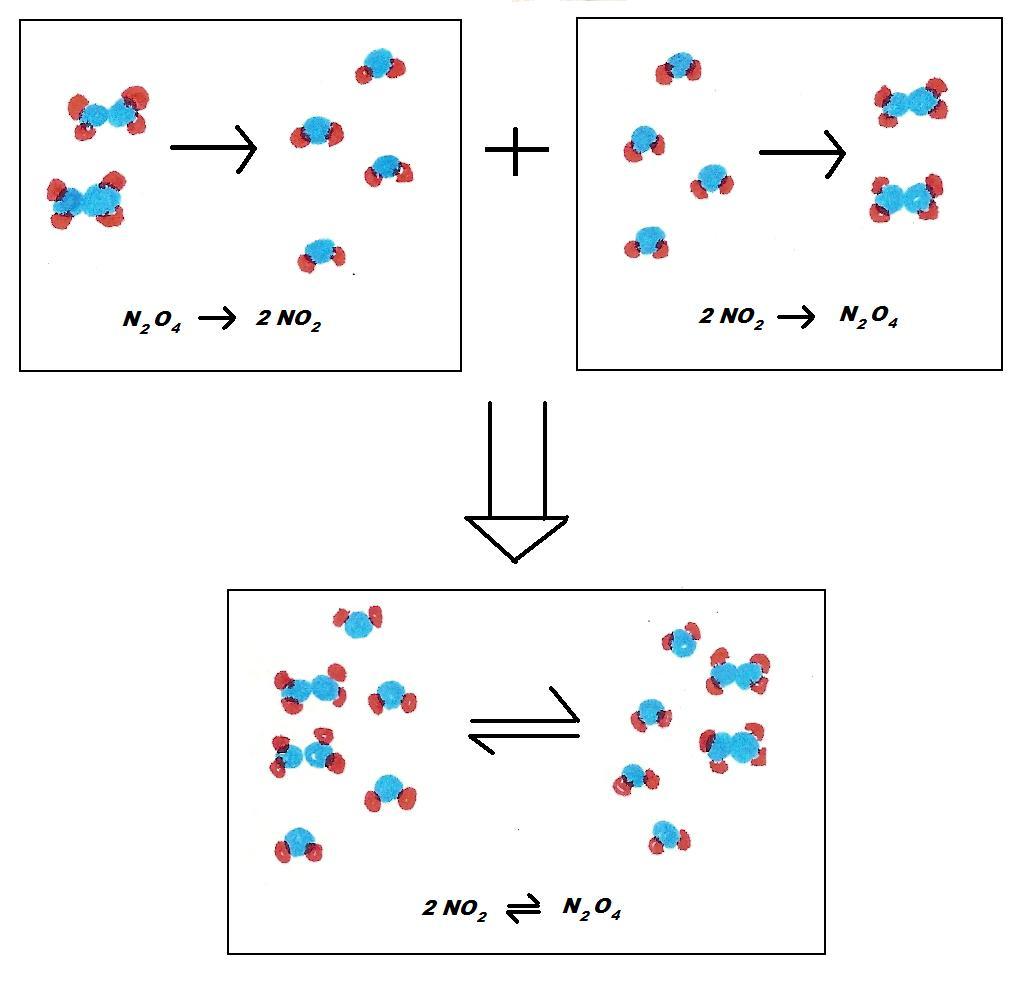


1. The enzyme for this reaction is called\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

and based on how this reaction is written the rate of the \_\_\_\_\_\_\_\_\_\_\_ reaction will be greater than the\_\_\_\_\_\_\_\_\_\_\_\_\_reaction, thus resulting in more

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Reversible Reactions**



1. What does it mean when we say a reaction is reversible?

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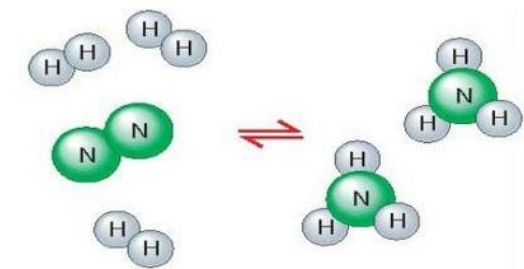
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1. a) Write the equation for the reaction in the diagram to the right.

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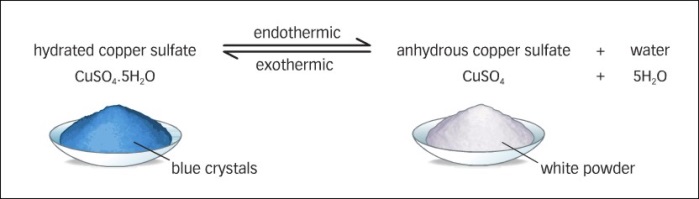
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b) Write only the forward reaction

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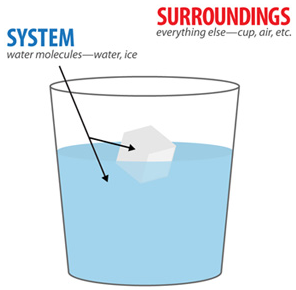
c) Write only the reverse reaction

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. a) Write the forward and reverse reactions for copper (II) sulfate pentahydrate.
2. Forward rxn:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Reverse rxn:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) When the forward reaction is endothermic what do you notice about the reverse reaction?

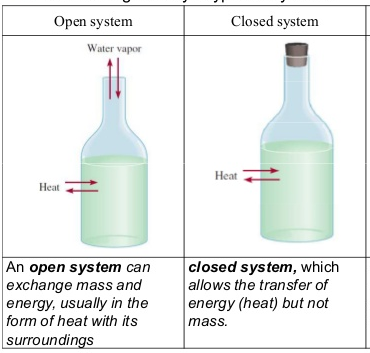
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1. What is a chemical system?

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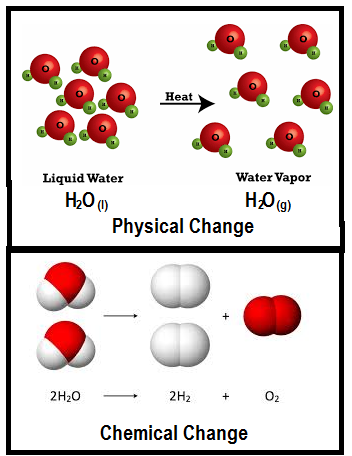
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1. Describe the difference between an opened and closed system.

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1. Explain the difference between a physical and chemical change that can occur inside a system.

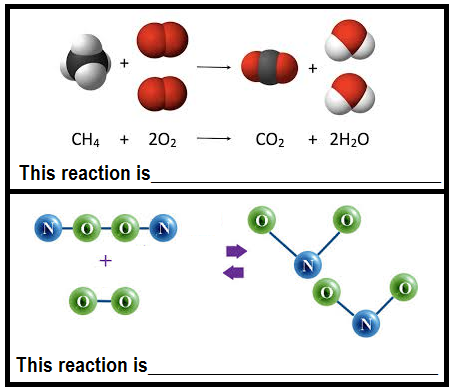
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1. Are all physical changes reversible? Explain and give examples.

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1. Are all chemical changes reversible? Explain.

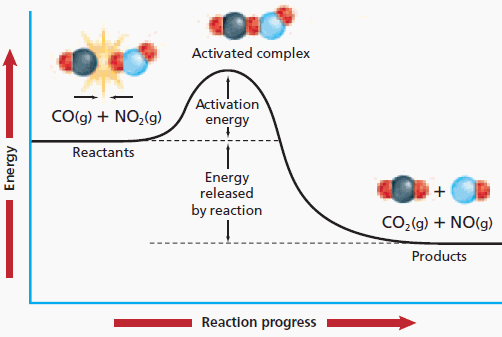
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1. Explain why some reactions are irreversible and why they are irreversible.

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1. What are activation energy and the activated complex?

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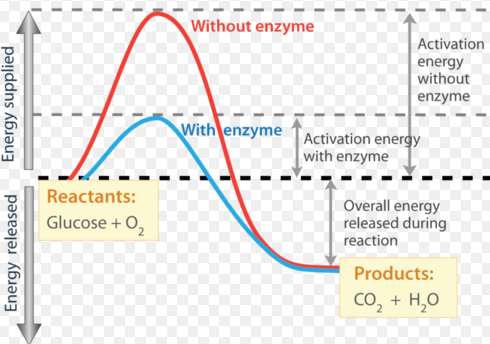
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1. a) Write the formula equation for this reaction.

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b) Would you need an open or closed system in order for this reaction to have a hope of being reversible? Explain.

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c) Refer to the diagram above and explain which of these reactions (red or blue) is more likely to occur…or do they have the same likelihood? What should you be looking at to make this decision? Assume that both reactions have the same scale on the x and y axis.

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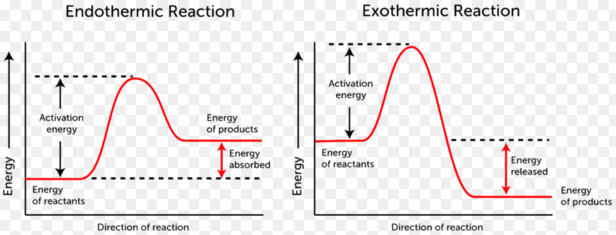
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d) Which of these two reactions (red or blue) is more likely to be reversible? Explain.

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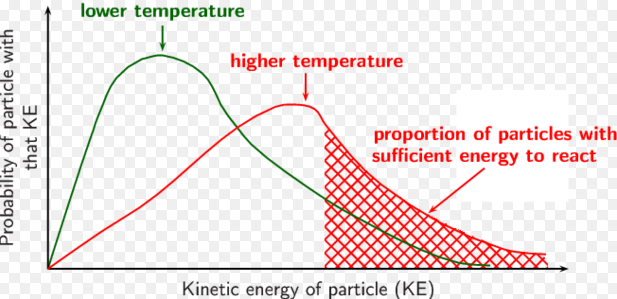
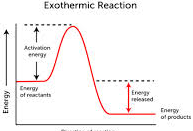
1. Refer to the diagram above and explain which of these reactions is more likely to occur…or do they have the same likelihood? What should you be looking at to make this decision? Assume that both reactions have the same scale on the x and y axis.

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1. Remember kinetic energy distribution diagrams for reactions?

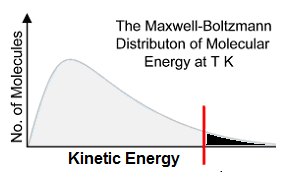


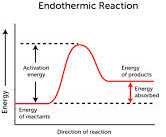
1. Where is the Activation Energy on this graph? If this is representing an exothermic reaction then where will the Activation Energy for the reverse reaction require more or less kinetic energy? Draw where the Activation energy for the reverse reaction would be on this graph and explain your answer below.

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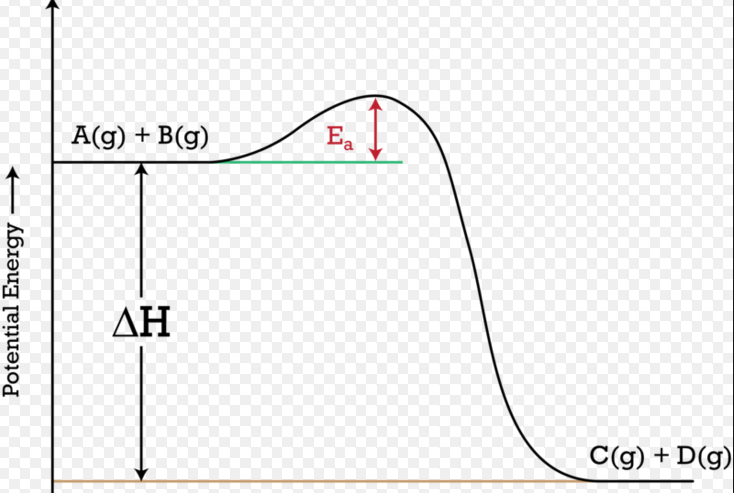


1. Label the Activation Energy (Ea) on this graph? If this is representing an endothermic reaction then where will the Activation Energy for the reverse reaction require more or less kinetic energy? Draw where the Activation energy for the reverse reaction would be on this graph and explain your answer below.

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**Review:**

1. Does this reaction have a high or low likelihood of being reversible? Explain your answer.

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