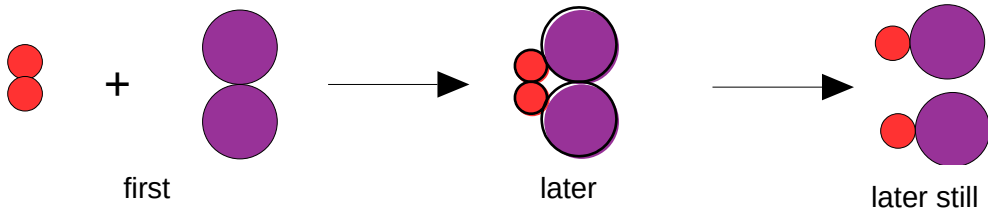
Chapter 1.1 Collision Theory and Equilibrium

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

$H_2 + I_2 \longrightarrow 2HI$



first later later still

successful collision (reaction)

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

_____

_____

_____

_____

_____

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

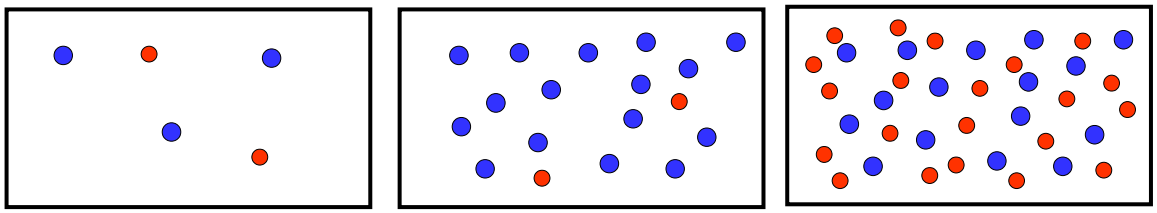
_____

3. 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
low conc. red

high conc. both

i. _____ chance of collision

ii. speed of reaction_____

iii. amount of product produced

_____

i._____ chance of collision

ii. speed of reaction_____

iii. amount of product produced

_____

i. _____ chance of collision

ii. speed of reaction_____

iii. amount of product produced

_____

4. There are a few golden rules for rates of reaction that are important to stamp indelibly on your brain prior to learning about equilibrium.

a) Most reactions do not go to completion. In other words, _____

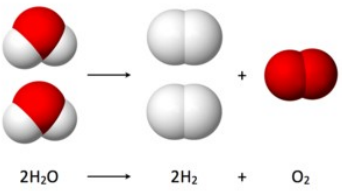
_____

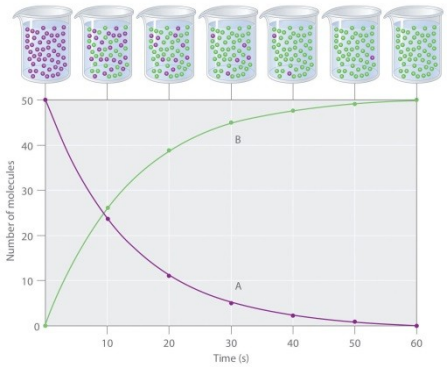
_____

Nitrogen + Hydrogen ⇌ Ammonia

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

b) 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.





c) 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:

$$A \rightarrow B + C$$

$$CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$$

limestone ‘quicklime’

d) 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.

_____

_____

_____

_____

_____

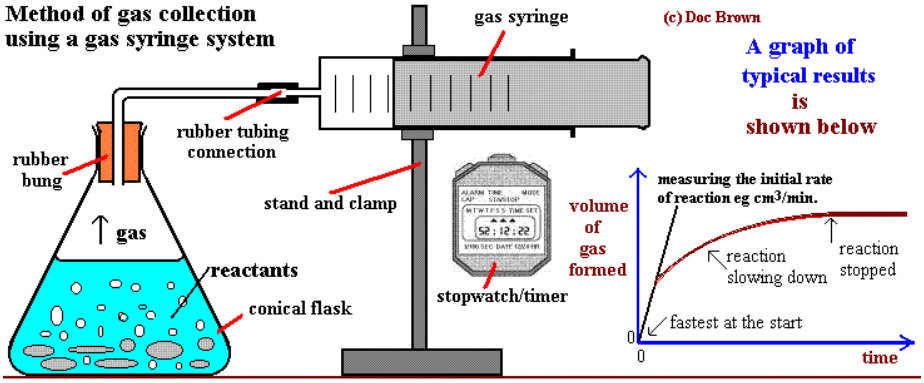
_____

_____

Example Problem:

Given the following reaction:

$$CaCO_{3(s)} + HCl_{(aq)} \rightleftharpoons CO_{2(g)} + H_2O_{(l)} + CaCl_{2(aq)}$$

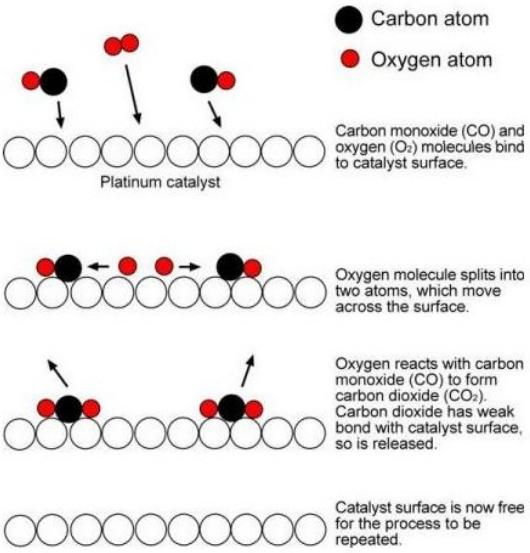


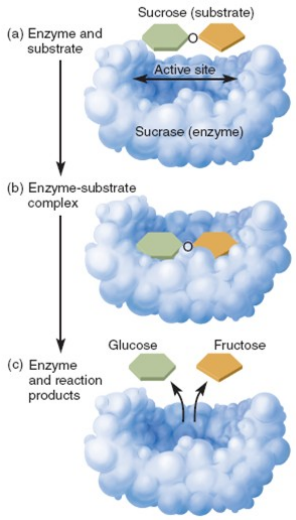
Fill in the table below describing how the following changes to the reaction would affect the rate of reaction.

Change made to system	Predict outcome	Use collision theory to justify your prediction
Raise the temperature by 20°C		
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:

5. Chemical catalysts are very different from enzymes in two ways. Explain how they are different in terms of:
   i. structure
   ii. affect on rate of reaction of forward and reverse reactions
   iii. affect temperature has on these two different forms of catalysts.

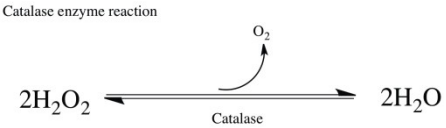




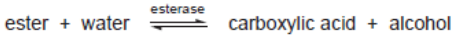
6. How do I know whether the enzyme affects the forward or reverse reaction?

For example:

a) Catalase reaction affects the rate of reaction in the _____direction only. The result would be to have more_____than _____ produced as a result.



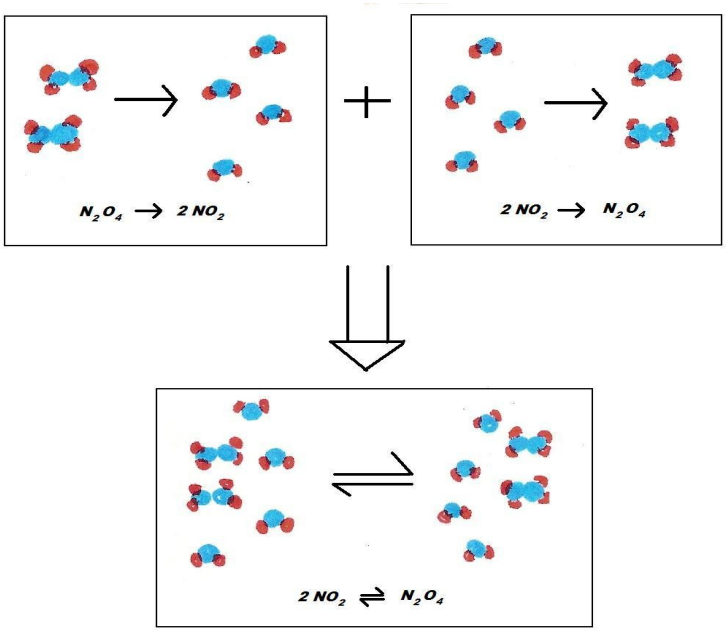
b) The enzyme for this reaction is called_____



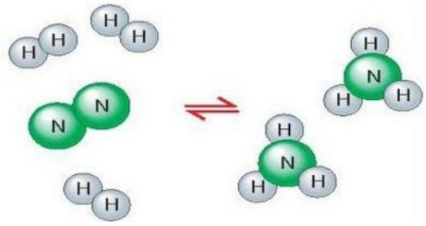
and based on how this reaction is written the rate of the _____ reaction will be greater than the_____reaction, thus resulting in more

Reversible Reactions

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



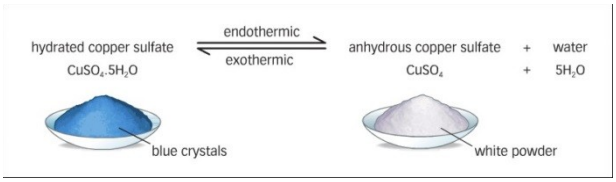
8. a) Write the equation for the reaction in the diagram to the right.



b) Write only the forward reaction

c) Write only the reverse reaction

9. a) Write the forward and reverse reactions for copper (II) sulfate pentahydrate.



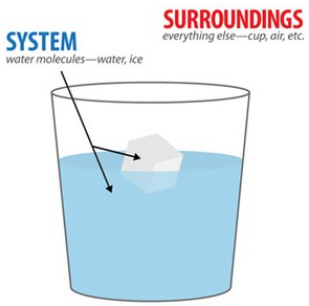
i. Forward rxn:_____

ii. Reverse rxn:_____

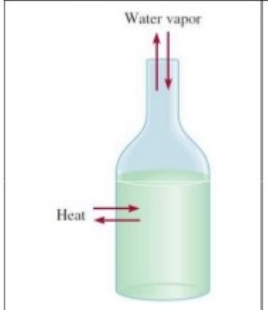
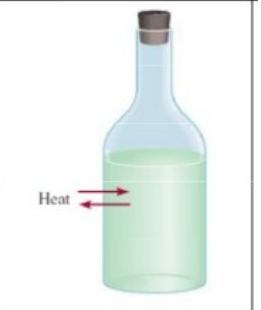
b) When the forward reaction is endothermic what do you notice about the reverse reaction?

_____

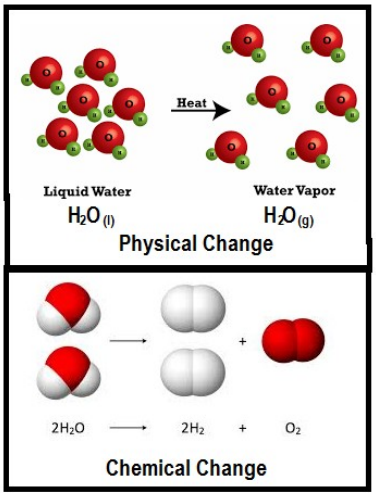
10. What is a chemical system?



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

Open system	Closed system
	
An ***open system*** *can exchange mass and energy, usually in the form of heat with its surroundings*	***closed system,*** which *allows the transfer of energy (heat) but not mass.*

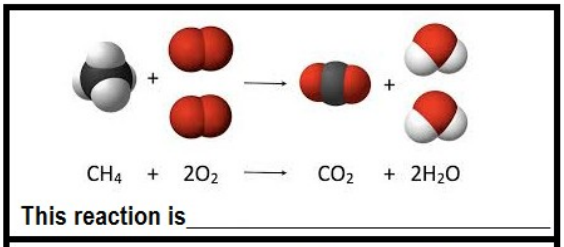
12. Explain the difference between a physical and chemical change that can occur inside a system.



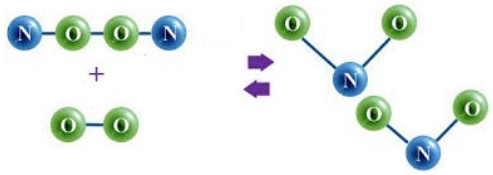
13. Are all physical changes reversible? Explain and give examples.

14. Are all chemical changes reversible? Explain.

_____



This reaction is_____



This reaction is_____

_____

_____

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

_____

_____

_____

_____

16. What are activation energy and the activated complex?

_____

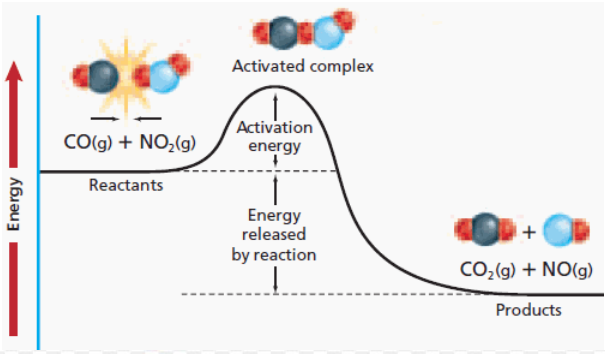
_____

_____

_____

_____

_____



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

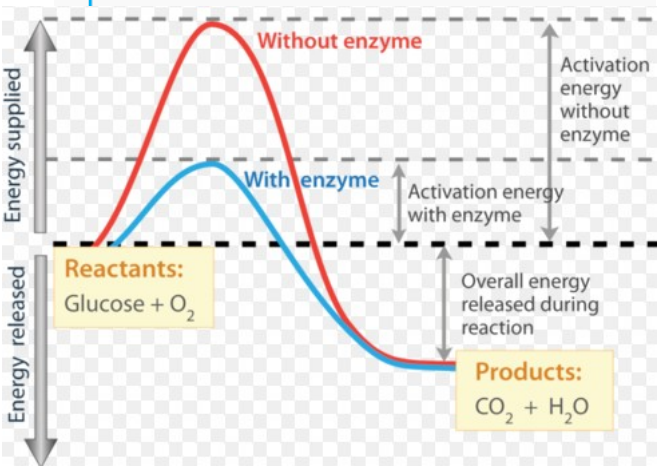
_____

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

_____

_____

_____



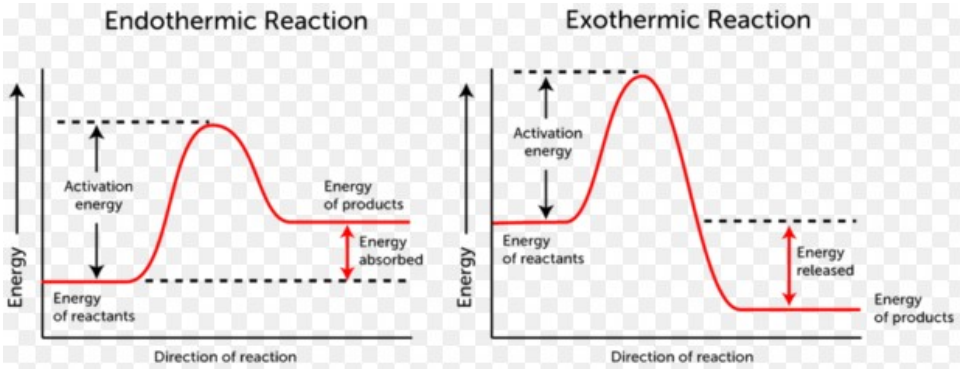
c) Refer to the diagram above and explain which of these reactions (red or blue) is more likely to occur…or do they have the same likelihood? What should you be looking at to make this decision? Assume that both reactions have the same scale on the x and y axis.

_____

_____

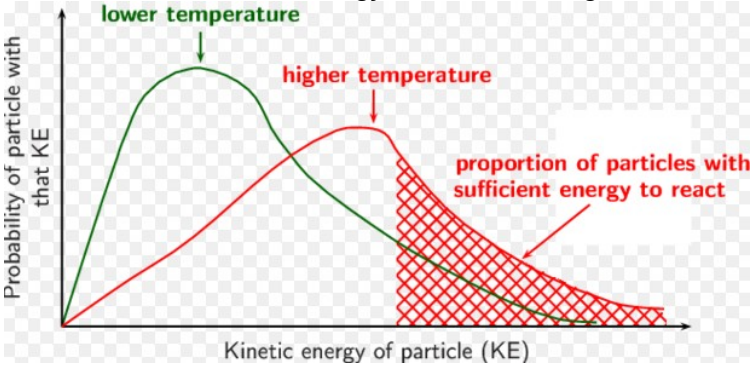
_____

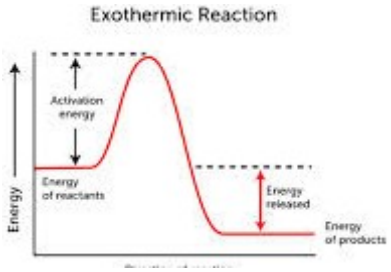
d) Which of these two reactions (red or blue) is more likely to be reversible? Explain.



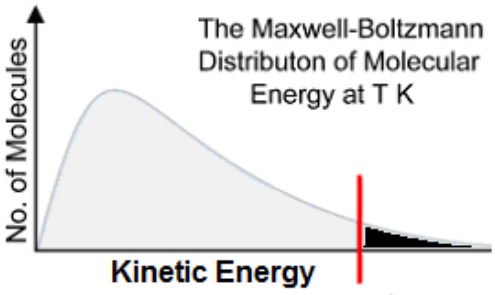
18. Refer to the diagram above and explain which of these reactions is more likely to occur…or do they have the same likelihood? What should you be looking at to make this decision? Assume that both reactions have the same scale on the x and y axis.

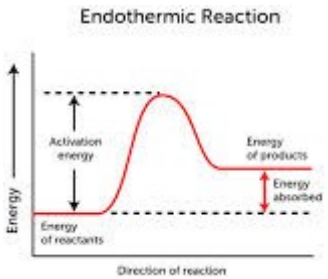
19. Remember kinetic energy distribution diagrams for reactions?





a) 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.





b) 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.

_____

_____

_____

Review:

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

_____

_____

_____

_____