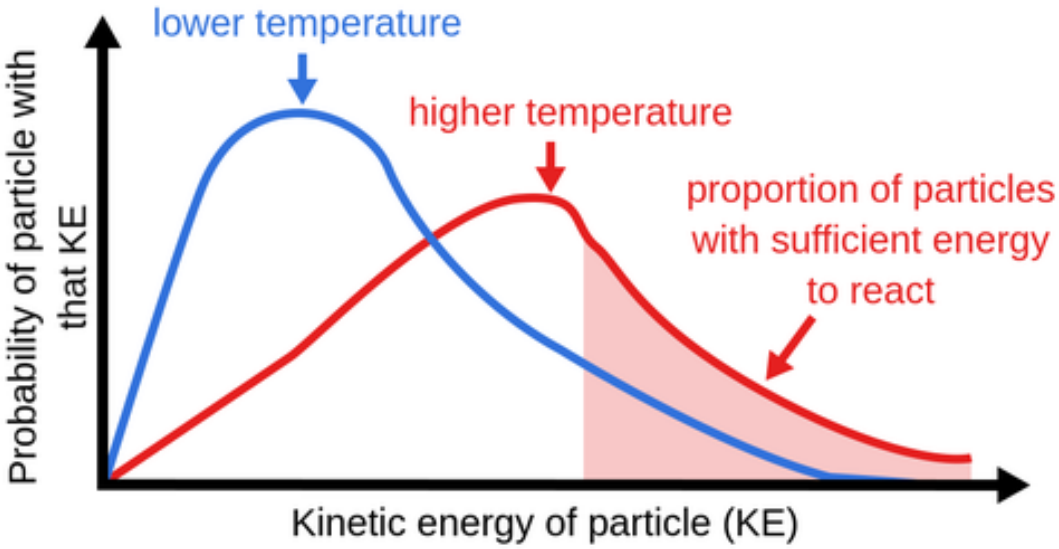
Year 11 Chemistry



Depth Study Booklet:

Factors affecting Chemical Reactions

CAMDEN HIGH 2021

Section 1: Experimental Study (TO BE COMPLETED AT HOME)

(10 marks)

Aim: To analyse the way altering **concentration** factor affects the rate of a chemical reaction.

Equipment: Sodium Bicarbonate, vinegar of varying concentrations, containers from home, stop watches

Hypothesis: Doubling the concentration of one reactant in a reaction will increase the reaction rate by a factor of _____

(1 mark)

Method:

1. Half fill container 1 with tap water
2. Half fill container 2 with ¼ vinegar and ¾ tap water
3. Half fill container 3 with ½ vinegar and ½ tap water
4. Half fill container 4 with ¾ vinegar and ¼ tap water
5. Add identical amounts of bicarbonate to each container.
6. Using a stopwatch, time the bubble release until there is less than 3 bubbles over a 5 second duration.
7. Record time.
8. Repeat steps 1-7 twice

Results

(2 marks)

	Bubble Release Times (s)			
Test Tube	Test 1	Test 2	Test 3	Average
1				
2				
3				
4				

Discussion:

Q1. Identify any trend as indicated by your results (1 mark)

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Q2. Identify the purpose of combining water and bicarbonate in container 1? (1 mark)

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Q3. How could the accuracy of your experiment be improved? (2 marks)

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Q4. How could the reliability of your data be improved? (1 mark)

Q5. Describe one change to a variable that would improve the validity of your study's conclusion. (1 mark)

Q6. What can you conclude from your tests? (1 mark)

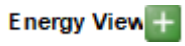
Section 2: Reaction Rate Simulator **(15 marks)**

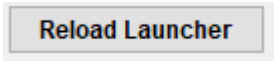
Access the reaction rate simulator from the website below:

https://phet.colorado.edu/en/simulation/legacy/reactions-and-rates

Single Collisions

Instructions:

1. Begin on the tab marked single collisions. Expand the section marked 

"energy view"
2. Pull back the handle and release whilst keeping green "Total energy" bar in the "energy view" panel below the "potential energy curve".
3. Observe the collision.
4. Click the reload launcher button 

5. Repeat steps 1-3, however this time pull back the handle so that the green "total energy" bar is above the peak of the curve.

Q1. Compare and contrast what you have observed when the two particles collide with each other at both lower and higher amount of energy. Ensure your written response makes reference to kinetic energy. (4 marks)

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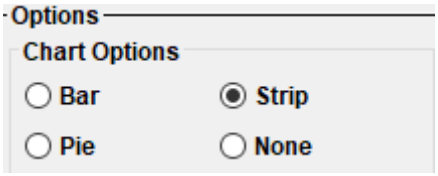
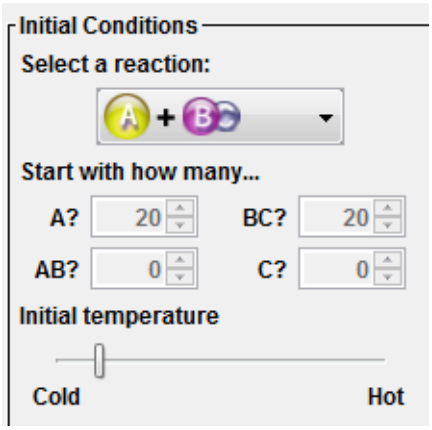
Rate Experiments

Go to the “Rate Experiments” tab **Rate Experiments** and set the experiment to the following settings:

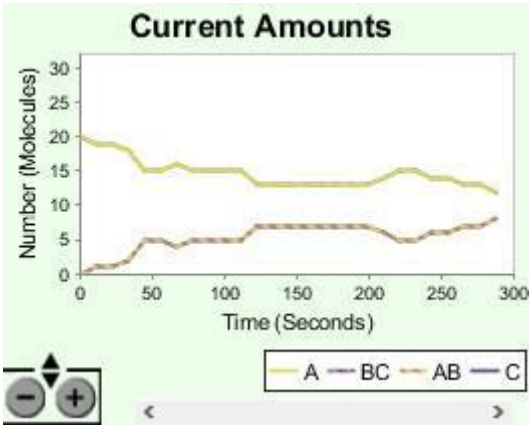
1. Under options, select the Chart Option “Strip”



2. Set the initial concentration and temperature conditions to:

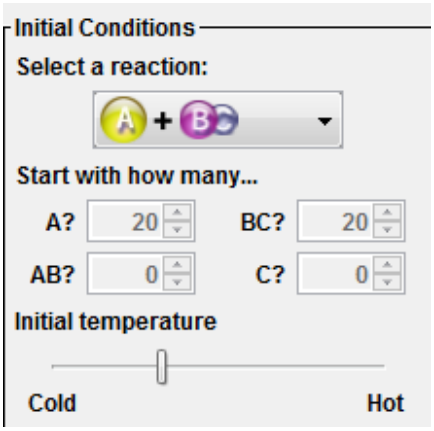


3. Record the changes in each concentration after 10 seconds
4. Repeat test twice
5. Sketch a labelled energy profile for this experiment
6. Record **one** chart showing the current amount of each substance from 0 -10 seconds by taking a screen shot of the data

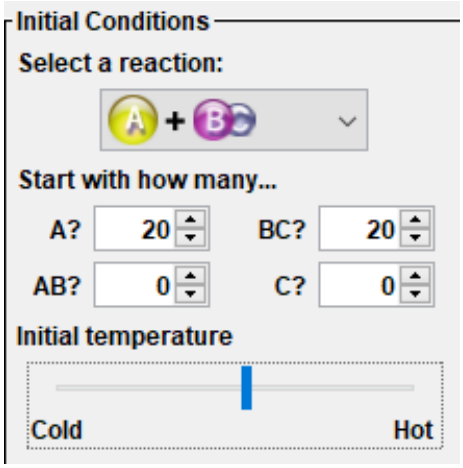


Note: ensure the zoom is adjust to show the number of molecules present for each substance

7. Reset the experiment and restart using the temperature setting below



8. Repeat steps 3-6
9. Reset the experiment and restart using the temperature setting below



10. Repeat steps 3-6

Results:

Part 1: Tabulate your results below (3 marks)

Conditions		Concentration							
Temperature	Substance	Test 1		Test 2		Test 3		Average Final Conc.	Average Difference (final conc. – Initial conc)
		Initial	Final	Initial	Final	Initial	Final		
Low	A	20		20		20			
	BC	20		20		20			
	AB	0		0		0			
	C	0		0		0			
Medium	A	20		20		20			
	BC	20		20		20			
	AB	0		0		0			
	C	0		0		0			
High	A	20		20		20			
	BC	20		20		20			
	AB	0		0		0			
	C	0		0		0			

Part 2: Energy profile diagrams and corresponding current amount chart

(3 marks)

Temperature	Energy Profile Diagram	Current Amount Chart Screen shot
Low		
Medium		

High		

Discussion

Analyse the results from the simulator, discussing whether the results provide evidence for collision theory (5 marks)

Section 3: Addressing the following question:

Assess the way collision theory allows chemist to describe the factors that affect chemical reactions

Use the alarm scaffold to plan your response on the following page

Identify	Describe	Explain	Analyse	Evaluate
What factors affect chemical reactions?	***Describe the way these factors affect chemical reaction rates***	***Explain the reason why each factor increases reaction rate referring to collision theory.***	**How do all these factors increase the likelihood of collisions, relating your information to CHAT CPT text provided (you may make reference to requirements for successful collisions, experimental data & simulations, activation energy, energy profile diagrams and Maxwell Boltzmann Distribution Curves).**	

1. Answer the following question: (10 marks)

Assess the following "ChatGPT" generated essay on how collision theory allows chemists to understand chemical reactions.

Title: Collision Theory: Unveiling the Dynamics of Chemical Reactions

Introduction:
In the realm of chemistry, the understanding of chemical reactions is vital for unraveling the mysteries of matter and driving scientific advancements. Among the various theoretical frameworks that elucidate the mechanisms behind chemical reactions, collision theory holds a prominent position. Developed in the early 20th century, collision theory provides chemists with invaluable insights into the dynamics of chemical reactions, enabling them to comprehend reaction rates, energy changes, and the factors that influence the outcomes of chemical transformations.

Principles of Collision Theory:
At its core, collision theory posits that for a chemical reaction to occur, reacting particles must collide with each other in an appropriate orientation and with sufficient energy. By examining the nature of these collisions, chemists can derive fundamental principles that govern chemical reactions.

1. Activation Energy and Collision Frequency:
Collision theory emphasizes the concept of activation energy—the minimum amount of energy required for a reaction to proceed. When particles collide, they possess a certain kinetic energy. However, not all collisions result in a chemical transformation. For a reaction to occur, the colliding particles must possess energy equal to or greater than the activation energy. Understanding this concept helps chemists predict the likelihood of a reaction and its rate by considering the frequency of collisions with sufficient energy.

2. Effective Collision:
Not all collisions between particles lead to a chemical reaction. For a collision to be effective, the colliding particles must not only possess sufficient energy but also meet the correct orientation requirement. The orientation factor determines the likelihood of a successful collision. Chemists can analyze the molecular geometry and bond arrangements of the reactants to determine the probability of effective collisions. This understanding helps explain why certain reactions occur more readily than others.

3. Reaction Rates and the Collision Theory:
The rate of a chemical reaction is a key parameter that determines how quickly the reaction progresses. Collision theory provides insights into the factors influencing reaction rates. According to the theory, the rate of a reaction is directly proportional to the frequency of effective collisions between reacting particles. By manipulating reaction conditions such as temperature, pressure, and concentration, chemists can alter the rate of a reaction by influencing the number of collisions that occur within a given time frame.

Applications and Significance:
Collision theory has far-reaching applications in the field of chemistry, enabling chemists to understand and manipulate chemical reactions in numerous ways.

1. Catalysts:
Catalysts play a crucial role in enhancing reaction rates by lowering the activation energy required for a reaction to occur. Collision theory elucidates the mechanism by which catalysts function. They provide an alternative reaction pathway that requires less energy, facilitating more collisions with the required energy threshold. The understanding of collision theory allows

chemists to design catalysts that optimize reaction efficiency, leading to more sustainable and economical processes.

2. Reaction Mechanisms:
The detailed understanding of collision theory helps chemists unravel the intricate reaction mechanisms underlying complex chemical transformations. By studying the kinetics and dynamics of reactions, scientists can propose reaction mechanisms and pathways based on the principles of collision theory. This knowledge enables them to optimize reaction conditions, develop new synthetic routes, and design molecules with specific properties.

3. Reaction Optimization:
Collision theory allows chemists to optimize reaction conditions to achieve desired outcomes. By manipulating temperature, pressure, and concentrations, they can modify the frequency of effective collisions, leading to improved reaction rates and selectivity. The ability to control these factors enables the synthesis of desired products with higher efficiency, thereby minimizing waste and maximizing resource utilization.

Conclusion:
The advent of collision theory revolutionized the understanding of chemical reactions, empowering chemists to decipher the intricate mechanisms governing transformations of matter. By considering the principles of activation energy, effective collisions, and reaction rates, chemists can predict, control, and optimize chemical reactions. Collision theory's applications extend to numerous areas of chemistry.