Name:

CONTENT FORMATIVE

SCH4U: 3-4 I: Factors Affecting Rates of Reaction: Simulation

(Total : /14 marks)

Knowledge/Understanding (K/U)	Thinking/Inquiry (T/I)	Application (A)	Communication (C)
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ANSEWER KEY

In this simulation you will explore how different factors affect the rate of a reaction by measuring the appearance of one of the product molecules over time. You will be investigating a reversible reaction with the formula:

$$A + BC \leftrightarrows AB + C$$

Instructions:

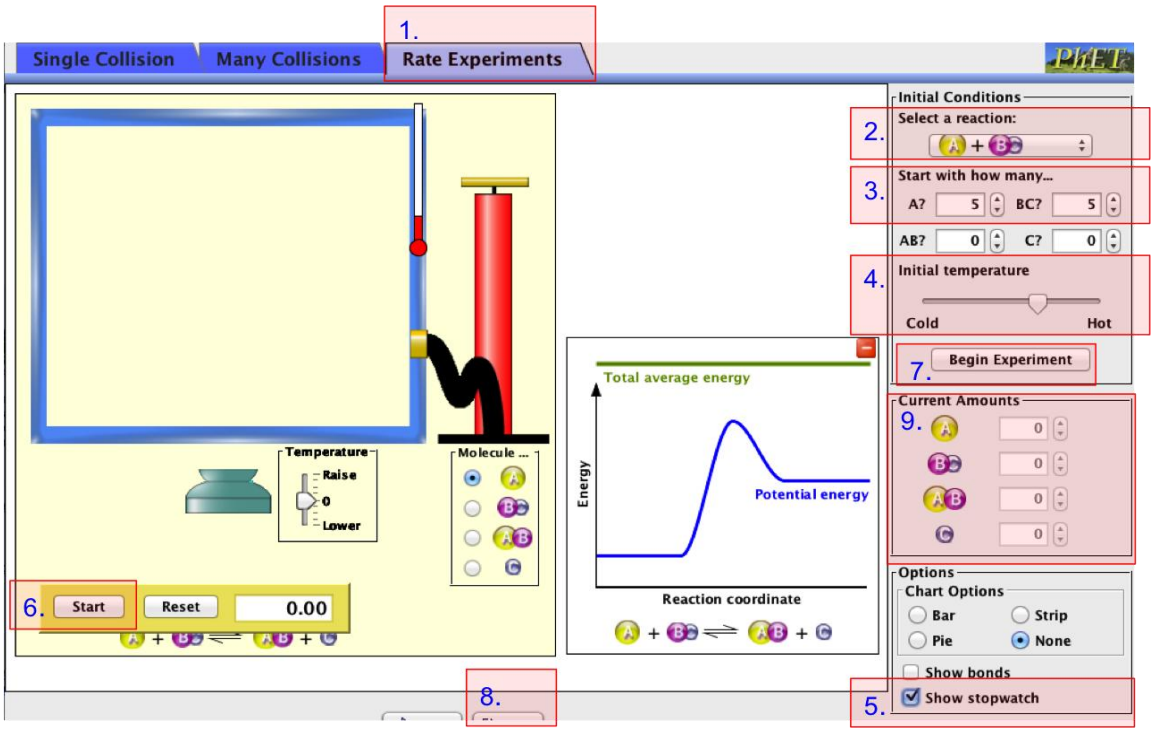
To open the simulator, click the following link:
http://phet.colorado.edu/en/simulation/reactions-and-rates

Note : If you are unable to view the simulator , talk to your CT and get sample data from them.

Experiment #1a :Affect of Concentration - Low Concentration:

Setup:

1. Click on the "Rate Experiments" tab at the top of the simulator
2. "Select a reaction": choose the first option
3. Start with how many….
    i) A?: **5**
    ii) BC?: **5**
4. Initial Temperature**:**
    i) move the sliding bar approximately 3/4 of the way towards the "Hot" end
5. Select the box at the bottom that says "Show stopwatch"
6. Click the "Start" button on the stopwatch, located in the yellow rectangle in the lower left corner
7. Click "Begin Experiment"
8. When the stopwatch passes 500 click "pause"
9. Record the current amounts of each reactant and product in table #1 below.



Experiment #1b: Affect of Concentration - High Concentration

1. Click “Reset All”
2. Start with how many….
    i) A?: **20**
    ii) BC?: **20**
3. Initial Temperature**:**
    i) move the sliding bar approximately 3/4 of the way towards the hot end
4. Select the box at the bottom that says “Show stopwatch”
5. Click the “Start” button on the stopwatch
6. Click “Begin Experiment”
7. When the stopwatch passes 500 click “pause”
8. Record the current amounts of each reactant and product in table #2 below.

Results:

*Note that the amount given on the simulator is in moles/litre

Table 1: Low Concentration(1 mark) --- Answer will vary.

Reactant/Product	Initial Amount (mol/L)	Final Amount (mol/L)
A	5	2
BC	5	2
AB	0	3
C	0	3

Table 2: High Concentration (1 mark)----Answer will vary.

Reactant/Product	Initial Amount (mol/L)	Final Amount (mol/L)
A	20	10
BC	20	10
AB	0	10
C	0	10

Experiment #2.a: Affect of Temperature on Reaction Rate – Cold

1. Click on the tab at the top "Rate Experiments"
2. Select a reaction: select the first option
3. Start with how many….
    i) A?: **20**
    ii) BC?: **20**
4. Initial Temperature**:**
    i) move the sliding bar all the way to the "Cold" end
5. Select the box at the bottom that says "Show stopwatch"
6. Click the "Start" button on the stop watch, located in the yellow rectangle in the lower left corner
7. Click "Begin Experiment"

8. When the stopwatch passes 500 click “pause”
9. Record the current amounts of each reactant and product in table #3 below.

Experiment #2.b: Affect of Temperature on Reaction Rate – Warm

1.Click “Reset All”
2. Start with how many….
    i) A?: **20**
    ii) BC?: **20**
3.Initial Temperature**:**
    i) move the sliding bar approximately *halfway* between “Cold” and “Hot”
4. Select the box at the bottom that says “Show stopwatch”
5. Click the “Start” button on the stop watch, located in the yellow rectangle in the lower left corner
6. Click “Begin Experiment”
7. When the stopwatch passes 500 click “pause”
8. Record the current amounts of each reactant and product in table #3 below.

Experiment #2.c: Affect of Temperature on Reaction Rate – Hot

1.Click “Reset All”
2. Start with how many….
    i) A?: **20**
    ii) BC?: **20**
3.Initial Temperature**:**
    i) move the sliding bar all the over to the “Hot” side
4. Select the box at the bottom that says “Show stopwatch”
5. Click the “Start” button on the stop watch, located in the yellow rectangle in the lower left corner
6. Click “Begin Experiment”
7. When the stopwatch passes 500 click “pause”
8. Record the current amounts of each reactant and product in table #3 below.

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Table 3: Temperature *(3 marks)*---Answer will varry.

Reactant/ Product	Initial Amount (mol/L)	Final Amount (mol/L)
Cold		
A	20	**20**
BC	20	**20**
AB	0	**0**
C	0	**0**
Warm		
A	20	**13**
BC	20	**13**
AB	0	**7**
C	0	**7**
Hot		
A	20	**11**
BC	20	**11**
AB	0	**9**
C	0	**9**

Analysis

1. Calculate the rate of reaction for the formation of the product AB from each table using the following formula:

$$\text{Rate} = \Delta[AB]/\Delta t$$
$$= [AB_{final}] - [AB_{initial}] / (t_{final} - t_{initial})$$

*For each calculation use the following assumptions:

- Values for the amount of AB are in moles/litre
- The final time for each trial was 500s

For example if the initial amount of AB is 0 mol/L and the final amount is 4 mol/L the rate would be calculated:

(4 mol/L - 0 mol/L) / (500s - 0s) = 0.008 mol/L*s

Calculated Rates of Reaction: ***(5 marks)***

*****ANSWERS FOR THE ANALYSIS SECTION WILL VARY DEPENDING ON RESULTS. STUDENTS RECEIVE MARKS FOR COMPLETED TABLES. CHECK THAT THE RESULTS MAKE LOGICAL SENSE****

Condition	Rate of Reaction calculations (mol/L*s)	Rate of Reaction (mol/L*s)
Concentration		
Low Concentration	**(3 mol/L - 0 mol/L) / (500s - 0s)**	**= 0.006 mol/L*s**
High Concentration	**(10 mol/L - 0 mol/L) / (500s - 0s)**	**= 0.020 mol/L*s**
Temperature		
Cold	**(0 mol/L - 0 mol/L) / (500s - 0s)**	**= 0 mol/L*s**
Warm	**(7 mol/L - 0 mol/L) / (500s - 0s)**	**= 0.014 mol/L*s**
Hot	**(9 mol/L - 0 mol/L) / (500s - 0s)**	**= 0.018 mol/L*s**

2. In your own words, explain how an increase in concentration affects the rate of reaction. *(2 marks)*

Increase in concentration adds more molecules to the same volume (or same amount of molecules in a smaller volume). This increases the likelihood that molecules will collide with each other. More collisions results in higher rate of reaction.

3. In your own words, explain how an increase in temperature affects the rate of reaction. *(2 marks)*

Increase in temperature increases the movement of the molecules (more movement at a faster rate). This increase in temp. causes the rate to increase in 2 ways:
-faster movement = more collisions.
-faster movement = collisions occur with higher energy, allowing reactants to achieve the necessary activation energy to react.