Activity worksheet: rate of reaction

Name	Group	Date

What you will learn

With the rate of reaction simulation you will see a chemical reaction as collisions between molecules. You will find out what it takes for a collision to produce a reaction and why temperature, concentration and catalysts make a reaction go faster.

How to work. Each activity has three steps:

1. **Predict.** Before looking at the simulation, write down what you think will happen and why.
2. **Observe.** Set up the simulation, watch what happens and note down the data.
3. **Explain.** Compare what happened with your prediction and explain why.

If your prediction turns out to be wrong, don't rub it out: getting it wrong and understanding why is the best way to learn.

Each activity has a link that opens the simulation already set up. If you have the worksheet on paper, go to **simulaciencia.es/en/simulations/velocidad-reaccion** and set it up as described under “Set up the simulation”.

The reaction. Molecules A (blue) and B (orange) are the reactants and they form the product C (green). K (violet) is a catalyst. Each molecule A and B has a light-coloured end: its **reactive site**. The simulation is random, so your numbers will not come out the same as your classmates’: look at what is bigger and what is smaller.

Before you start

What do you think now? Write T (true) or F (false). You will come back to this table at the end.

Statement	T or F
a) Every time two reactant molecules collide, they react.	
b) New atoms appear in a chemical reaction.	
c) When heated, molecules get bigger, and that is why they collide more.	
d) The catalyst is used up during the reaction, like another reactant.	
e) A reaction always goes at the same rate from start to finish.	

Activity 1. Is every collision a reaction?

Set up the simulation: Reaction mode, temperature 4, 16 molecules A, 16 molecules B and no catalyst. Open the simulation ready to use

Predict. Molecules A and B collide many times. Do you think they react every time they collide?

My prediction

Observe. Press "↺ Restart" and let the simulation run for one minute. Then press "⏸ Pause" and look for a molecule C.

Reactions in one minute	How many blue and orange atoms does a molecule C have?

Explain.

1. Are there many more collisions than reactions? What does that mean?
2. Where do the atoms in molecule C come from?

My answers

Activity 2. A single collision, close up

Set up the simulation: Collision mode, collision energy 5. Open the simulation ready to use

Predict. Which two conditions do you think a collision must meet for the molecules to react?

My prediction

Observe. Press "▶ Launch" for each case and "↺ Reset" before the next one. To change the orientation, drag molecule A with the mouse or your finger.

Case	Collision energy	Orientation	Successful collision?	Which condition is not met?
1	5	Reactive sites facing each other		
2	5	A turned upwards		
3	3	Reactive sites facing each other		

Case	Collision energy	Orientation	Successful collision?	Which condition is not met?
4	4	Reactive sites facing each other		

Explain. Write the two conditions for a successful collision. What is the minimum energy in this simulation?

My explanation

Activity 3. Temperature

Set up the simulation: Comparison mode, variable **Energy (temperature)**: temperature 2 on the left and 8 on the right. Open the simulation ready to use

Predict. In which chamber will there be more reactions in one minute? Why?

My prediction

Observe. Let it run for one minute and write down the reactions in each chamber. Also look at the "Relative speed of collisions" box: the green part is the collisions with enough energy.

Chamber	Temperature	Reactions in one minute	Is the green part big or small?
Left	2		
Right	8		

Explain. Why does a higher temperature speed up the reaction? Use the two conditions from activity 2.

My explanation

Activity 4. Concentration

Set up the simulation: Comparison mode, variable **Number of molecules**: 8 of A and 8 of B on the left, 24 and 24 on the right. Open the simulation ready to use

Predict. The two chambers are the same size. In which one will there be more reactions per second?

My prediction

Observe. Let it run for one minute.

Chamber	Molecules of A and of B	Reactions in one minute
Left	8 + 8	
Right	24 + 24	

Explain. Why does the reaction go faster with more molecules in the same space? Give an example from everyday life.

My explanation

Activity 5. The catalyst

Set up the simulation: Comparison mode, variable **Presence of catalyst**: 0 catalysts on the left and 4 on the right. Open the simulation ready to use

Predict. Which chamber will finish first? Will the catalyst be used up?

My prediction

Observe. Let the simulation run until it stops on its own.

Chamber	Catalysts at the start	Catalysts at the end	Conversion when it stops (%)
Left	0		
Right	4		

Explain. What does the catalyst do? Why is it not used up?

My explanation

Activity 6. Challenge: does it always go at the same rate?

Set up the simulation: Reaction mode, temperature 8, 16 A, 16 B and 2 catalysts. Open the simulation ready to use

Predict. Sketch what you think the graph of the rate of reaction (reactions per second) will look like, from the start until the reactants run out.

My prediction (graph)

Observe. Press "↺ Restart" and watch the "RATE OF REACTION" graph until there are no reactants left.

When is the rate highest?	When is it lowest?	How many molecules of A and B are left at the end?

Explain. Why does the reaction slow down? Link it to activity 4.

My explanation

Apply what you have learnt

Answer without the simulation. Use collision theory in each answer.

1. Why does food last longer in the fridge?
2. Why does a pile of sawdust burn faster than a log of the same wood?
3. Why does an effervescent tablet dissolve faster in hot water than in cold water?
4. Cars have a catalytic converter in the exhaust. What is it for? Does it have to be replaced every time the car is used?

Question	Answer
1	
2	
3	
4	

Review your ideas

Go back to the "Before you start" table. Would you change any of your answers? Write which one and explain why, using something you saw in the simulation.

What has changed in my ideas

What has changed in my ideas

Going further (Year 13)

1. In Reaction mode, move the temperature from 1 to 10 and write down how much of the "Relative speed of collisions" box is green at three temperatures. Link it to the Arrhenius equation, $k = A \cdot e^{-Ea/RT}$.
2. With 16 A, 10 B and 4 catalysts, which is the limiting reactant? How many molecules of C will form? Check it.

My answers

Self-assessment

Put an X to show how confident you feel at the end.

I can...	Yes	Nearly	Not yet
Explain a reaction as collisions that rearrange the atoms			
State the two conditions for a successful collision			
Explain the effect of temperature, concentration and a catalyst			
Apply collision theory to everyday situations			
Use a prediction and an observation to change an idea I had			

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