Rates of chemical reactions

Lesson plan and teacher's notes · Form 2 Chemistry · 1 period of 40 minutes

School	(write school name)	**Teacher**	(write name)
Date	(date)	**Class**	Form 2
Subject	Chemistry	**Enrolment**	Boys ___ Girls ___ Total ___
Time	40 minutes	**Topic**	Rates of chemical reactions

Learners say what the rate of a reaction means, describe rate as reactants used up or products formed in a unit of time, carry out the magnesium ribbon and hydrochloric acid experiment, and use the time a reaction takes to compare how fast different reactions are. Examples come from a compost heap, an egg shell in hot vinegar and ripening bananas.

Specific outcomes

By the end of the lesson, learners should be able to:

1. Say what the rate of a chemical reaction means
2. Describe rate as the amount of reactants used up or products formed in a given time
3. Carry out a simple experiment with magnesium ribbon and hydrochloric acid
4. Use the time a reaction takes to compare how fast different reactions are

Prior knowledge

- A chemical reaction makes new substances
- Using a stopwatch and measuring a volume of liquid
- Safe handling of laboratory chemicals

Teaching and learning materials

- 20 cm3 of 1.0 M hydrochloric acid for each group
- 250 cm3 beaker
- 3 cm piece of magnesium ribbon
- stopwatch
- chalk and board

References

Ministry of Education (CDC) Form 2 Chemistry syllabus and module; 25Schools learners' note: Rates of chemical reactions.

Lesson development

Stage and time	Teacher activities	Learner activities
Introduction 5 min	Ask which is faster: a compost heap turning plant waste into fertiliser or hot vinegar dissolving a crushed egg shell. Tell learners that the speed of a reaction is called its rate.	Give answers and copy the lesson title and key words.
Development: what is the rate of a reaction 10 min	Define rate of reaction, chemical kinetics, reactant and product. Explain rate as the amount of reactants used up, or products formed, in a unit of time. Name the fields where kinetics matters.	Copy the definitions and write two ways of describing rate.
Development: the magnesium and acid experiment 15 min	Demonstrate safely or supervise groups. Measure 20 cm3 of 1.0 M hydrochloric acid into a 250 cm3 beaker, add a 3 cm piece of magnesium ribbon and start the stopwatch at once. Stop it when the ribbon has reacted or the fizzing stops. Warn learners that they are handling acid.	Observe the bubbles and the ribbon getting smaller, record the time and say whether the reaction was fast or slow.
Development: comparing reactions 7 min	Compare the egg shell and vinegar reaction, which finishes in seconds, with the ripening of bananas, which takes days. Ask which has the higher rate and why.	Compare the times and state which reaction has the higher rate.
Conclusion 3 min	Ask what a short time and a long time tell us about the rate. Set the homework.	Answer orally and copy the homework.

Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

What is the rate of a reaction

The rate of a chemical reaction is the speed at which the reaction takes place. We can describe it as the amount of reactants used up, or the amount of products formed, in a unit of time. A reactant is a substance that is used up in a reaction, and a product is a substance that is formed in a reaction. Controlling the rate of reactions is important. It helps industries work efficiently, keeps processes safe and makes them sustainable.

Chemical kinetics

Chemical kinetics is the study of the rates of chemical reactions. It matters in manufacturing, mining, agriculture, environmental conservation and developing efficient energy sources. Some reactions are slow and some are fast. A compost heap on a farm takes months to turn plant waste into fertiliser, while hot vinegar on a crushed egg shell fizzes and dissolves it in seconds.

Measuring the rate with magnesium and acid

Measure 20 cm3 of 1.0 M hydrochloric acid into a 250 cm3 beaker. Place a 3 cm piece of magnesium ribbon in the acid and start the stopwatch at once. Watch the bubbles and the ribbon getting smaller. Stop the watch when the ribbon has completely reacted or the fizzing stops, and record the time. Work carefully because you are handling acid. A short time means a fast reaction and a long time means a slow reaction. The rate can be seen from the bubbling or from the solid disappearing.

Rates in daily life

Compare two reactions: calcium carbonate reacting with an acid, and bananas ripening. The egg shell and vinegar reaction finishes in seconds, while the ripening of bananas takes days. Comparing the time each one takes is how we say which has the higher rate. A longer reaction time means the reaction is slower, so the rate is lower.

Questions to ask during the lesson

Question	Expected answer
A farmer in Luangwa notices that a compost heap takes months to turn plant waste into fertiliser, while hot vinegar on a crushed egg shell dissolves it in seconds. (a) What do we call the speed at which a reaction takes place. (b) Which of the two reactions is faster. (c) Name the study of the rates	(a) The rate of the reaction. (b) The egg shell in hot vinegar. (c) Chemical kinetics.
A learner is asked to describe the rate of a reaction in terms of substances before an experiment. (a) Give one way using reactants. (b) Give one way using products. (c) Say what a reactant is and what a product is.	(a) The amount of reactants used up per unit time. (b) The amount of products formed per unit time. (c) A reactant is used up in a reaction and a product is formed in a reaction.
A factory manager and a farmer both say that controlling the rate of reactions helps their work. (a) Name two fields where chemical kinetics is important. (b) Give one reason controlling rate matters in industry. (c) Name one more field from the note.	(a) Any two of manufacturing, environmental conservation, mining, agriculture, developing efficient energy sources. (b) It helps industries work efficiently, keeps processes safe and makes them sustainable. (c) Any other field from the note.
A learner reads that a longer reaction time means a slower reaction. (a) What does a short time tell you about the rate. (b) What does a long time tell you. (c) Why is it useful to measure the time.	(a) The reaction is fast, so the rate is higher. (b) The reaction is slow, so the rate is lower. (c) Measuring the time lets you compare the rates of different reactions.

Worked examples for the board

Example 1: the magnesium and acid experiment

Measure 20 cm3 of 1.0 M hydrochloric acid into a 250 cm3 beaker. Place a 3 cm piece of magnesium ribbon in the acid and start the stopwatch at once. Watch the bubbles and the

ribbon getting smaller. Stop the watch when the ribbon has completely reacted or the fizzing stops and record the time. Work carefully because you are handling acid.

Example 2: comparing two groups

Group A's ribbon disappears after 40 seconds and Group B's after 90 seconds. A shorter time means a faster rate, so Group A had the faster reaction. Group B took 90 - 40 = 50 seconds longer.

Example 3: comparing the egg shell and the bananas

The egg shell and vinegar reaction finishes in seconds, while the ripening of bananas takes days. The reaction that takes less time has the higher rate, so the egg shell reaction has the higher rate and the ripening of bananas has the lower rate.

Board plan

Write the title and key words. Left: the definition of rate and its two descriptions. Centre: the steps of the magnesium experiment. Right: the table comparing reactions by the time they take.

Reaction	Time it takes	Rate
Egg shell in hot vinegar	Seconds	Higher
Ripening of bananas	Days	Lower
Compost heap	Months	Lower

Comparing reactions by the time they take

Mistakes to expect

Learners often think	Put it right
A reaction that takes a long time has a high rate.	A short time means a fast reaction and a long time means a slow reaction, so a longer time means a lower rate.
Two reactions that both finish in the end have the same rate.	Compare the time each one takes. The egg shell dissolves in seconds, while bananas ripen in days, so their rates differ.
Rate only means how much product is made.	Rate can be described as the amount of reactants used up or the amount of products formed in a unit of time, so time is always part of it.
The acid is safe to handle without care.	Work carefully because you are handling acid.

Differentiation

Learners who struggle

Give learners a table with the two columns time and rate and let them fill in fast or slow for each reaction. Write the experiment steps on the board in order and let learners tick each step as they do it.

Learners who finish early

Ask learners who finish early to explain how two groups can make sure their results can be compared, and to name two fields where chemical kinetics is important.

Hearing or visual impairment

For learners with visual impairment, let them listen for the fizzing and tell the time with a talking or tapping timer while a partner reads the stopwatch. For learners with hearing impairment, write each step of the experiment on the board and show the bubbles to them.

No projector, no printing

If acid and magnesium are not available, compare the egg shell in hot vinegar with the ripening of bananas and a compost heap using the times in the note, and discuss the rates on the board.

If time is short

Teach the definition of rate and how to describe it, then compare the egg shell and the bananas by time. Do the magnesium experiment in the next lesson.

Evaluation

Question or task	A correct answer shows
Two groups at a school in Luangwa each put a 3 cm piece of magnesium ribbon into 20 cm3 of 1.0 M hydrochloric acid. Group A's ribbon disappears after 40 seconds and Group B's after 90 seconds. (a) Which group had the faster reaction. (b) Explain how you know. (c) Say what the groups must keep the same to compare fairly.	(a) Group A. (b) A shorter time means a faster rate. (c) The same size of ribbon, the same volume and strength of acid, and time from the moment the ribbon goes in.
A learner says that a compost heap on a farm and a crushed egg shell in hot vinegar react at the same rate because both break down in the end. (a) Do you agree. (b) Use the idea of reaction time to explain. (c) Describe how you would compare the two reactions.	(a) No. (b) The egg shell dissolves in seconds, while the compost heap takes months, so the rates differ. (c) Compare the time each reaction takes.
A teacher asks learners to describe the rate of the magnesium and acid reaction in two ways. (a) Name two things you can observe. (b) Give one way of describing rate in terms of reactants. (c) Give one way in terms of products.	(a) Bubbling and the magnesium ribbon disappearing. (b) The amount of reactants used up per unit time. (c) The amount of products formed per unit time.

Homework

A learner in Lusaka puts magnesium ribbon into acid and the ribbon disappears after 120 seconds, while a friend's ribbon in another beaker disappears after 60 seconds. (a) Which reaction had the higher rate. (b) How many seconds longer did the slower reaction take. (c) Explain how the time shows the rate.

Extra practice with answers

Question	Answer
1. Two groups at Kapoche school each put a 3 cm piece of magnesium ribbon into 20 cm3 of 1.0 M hydrochloric acid. Group A's ribbon disappears after 40 seconds and Group B's after 90 seconds. (a) Which group had the faster reaction. (b) Explain how you know. (c) What should the groups do to make sure th	(a) Group A. (b) A shorter time means a faster rate. (c) Use the same size of ribbon, the same volume and strength of acid, and time both from the moment the ribbon goes in.
2. A learner says that a compost heap and a crushed egg shell in hot vinegar react at the same rate because both break down in the end. (a) Do you agree. (b) Use the idea of reaction time to explain. (c) Describe how you would compare the two reactions.	(a) No. (b) The egg shell dissolves in seconds and the compost heap takes months. (c) Compare the time each reaction takes.
3. A learner times the ribbon in acid and gets 80 seconds in one beaker and 30 seconds in another. (a) Which beaker had the faster reaction. (b) How many seconds longer did the slower reaction take. (c) Say what a longer time tells you about the rate.	(a) The beaker with 30 seconds. (b) 80 - 30 = 50 seconds. (c) The reaction is slower, so the rate is lower.
4. A class watches magnesium ribbon in hydrochloric acid and wants to be sure the reaction is happening. (a) Name two things they can observe. (b) When do they start the stopwatch. (c) When do they stop it.	(a) Bubbling and the ribbon disappearing. (b) At once, when the ribbon goes into the acid. (c) When the ribbon has completely reacted or the fizzing stops.

Answers to the learners' check-yourself questions

1. What is meant by the rate of a chemical reaction?
   The speed at which a given reaction takes place.
2. Write two ways of describing the rate of a reaction in terms of substances.
   The amount of reactants used up per unit time, or the amount of products formed per unit time.
3. Name two fields where chemical kinetics is important.
   Any two of manufacturing, environmental conservation, mining, agriculture, developing efficient energy sources.
4. What does a longer reaction time tell you about the rate?
   The reaction is slower, so the rate is lower.
5. Name two things you can observe that show magnesium is reacting with acid.
   Bubbling and the magnesium ribbon disappearing.
6. At Kapoche school, two groups each put a 3 cm piece of magnesium ribbon into 20 cm3 of 1.0 M hydrochloric acid. Group A's ribbon disappears after 40 seconds and Group B's after 90 seconds. (a) Which group had the faster reaction? (b) Explain how you know. (c) Say what the group should do to make sur
   (a) Group A. (b) A shorter time means a faster rate. (c) Use the same size of

ribbon, the same volume and strength of acid, and time both from the moment the ribbon goes in.

7. A learner says a compost heap and a crushed egg shell in hot vinegar react at the same rate because both break down in the end. (a) Do you agree? (b) Use the idea of reaction time to explain. (c) Describe how you would compare the two reactions.
   (a) No. (b) The egg shell dissolves in seconds and the compost takes months, so the egg shell reaction is much faster. (c) Record the time each takes to finish and compare the times.

Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: