MODULE: *Chemical Change*

Episode 1: Chemistry Watch

Episode Teaching Guide

Learning outcomes

Students will be able to:

- state the 3 states of matter
- state the change in the state of matter in physical processes
- give examples of elements and compounds
- state that heat is a form of energy
- give examples of uses of heat
- give examples of daily observations which show a change in the state of matter
- explain that changes in the state of matter involve absorption and release of heat

Curriculum Links

1.2 Understanding the three states of matter

2.2 Understanding elements, compounds and mixtures

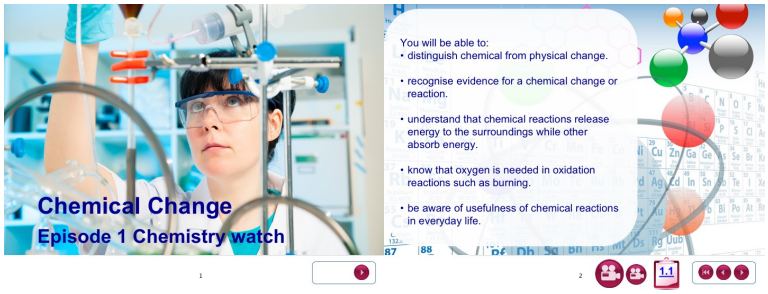
2.1 Understanding heat as a form of energy

2.3 Analysing the effect of heat on matter

Running the activity

Period 1

Activity Sheet 1.1: Distinguish chemical from physical change and identify evidence of chemical and physical change (Applying, Reasoning)



- Show slides 1 and 2; introduce the episode and present the learning outcomes.
- Show the video clip ‘Good Morning Kazakhstan’ (repeat for reinforcement). Allow about 5 minutes.
- Give out Activity Sheet 1.1. In groups of 3–4 ask students to read the worksheet instructions carefully and then discuss and tabulate their views about the different scientific events/ changes that the family are involved in during the video. They should then write their own descriptions for the changes that take place in the blank squares in column 2 of the table.
- Ask students to study the information about chemical/physical changes and the evidence to look for when identifying these changes.
- Students should then cut out the squares in columns 2 and 3 to use as cards. In their groups ask them to do a card sort exercise to match their description cards with either a chemical or physical change card. Emphasise to the group that they should be able to give their reasons and justification for their decisions.
- Briefly review the activity to test their learning. Ask ‘Can they distinguish between chemical and physical change? Can they now state what a chemical change is? How do they know if a chemical reaction has taken place?’
- Give Out of School Activity 1 to students to do at home and/or run as a class quiz.

Answers

Answers to questions posed on the slides are provided in the information given in the Activity Sheet 1.1.
Answers for Activity Sheet 1.1
Table 1.1 Understanding physical and chemical change

Event observed	What changes take place?	Is it a physical change?	Is it a chemical change?
Gas is turned on and lit to produce a flame.	Blue colored flame/yellow and very hot.	No	Yes
An eggshell is cracked.	The eggshell is broken but still looks like an eggshell.	Yes	No
An egg is heated in a pan over a flame.	The egg cooks, changes appearance, colour, shape and becomes solid.	No	Yes
Bread is being heated in a toaster.	The bread cooks and has a brown burnt appearance.	No	Yes
A man is eating food.	He is chewing, swallowing, digesting food.	No	Yes
A kettle of water is being heated	The water is bubbling, boiling and producing steam.	Yes	No
Sugar is added to tea	The sugar dissolves in the hot tea.	Yes	No
Ice is added to hot water	The ice melts in the hot water.	Yes	No
A vitamin C tablet is added to water.	The tablet reacts with the water, fizzes, bubbles and gives off a gas	No	Yes
Cleaning teeth and washing hands	Toothpaste mixes with water and removes food on teeth; soap mixes with water and removes dirt from hands	No	Yes
A car starts and moves away and exhaust gases are seen	Petrol reacts with air to produce heat and exhaust gases.	No	Yes

Answers to Out of School Activity 1 (Applying)

1. Physical change
2. Physical change
3. Chemical change
4. Chemical change
5. Physical change
6. Chemical change
7. Physical change
8. Chemical change
9. Physical change
10. Physical change
11. Chemical change
12. Chemical change
13. Physical change
14. Physical change
15. Chemical change
16. Chemical change
17. Physical change
18. Chemical change
19. Chemical change
20. Chemical change

Safety

Students will be using scissors to cut out cards so teachers should tell students to take care.

Learning resources

PowerPoint presentation
Prezi presentation

Activity Sheet 1.1 Distinguish chemical from physical change and identify evidence of chemical and physical change

Equipment (per group)

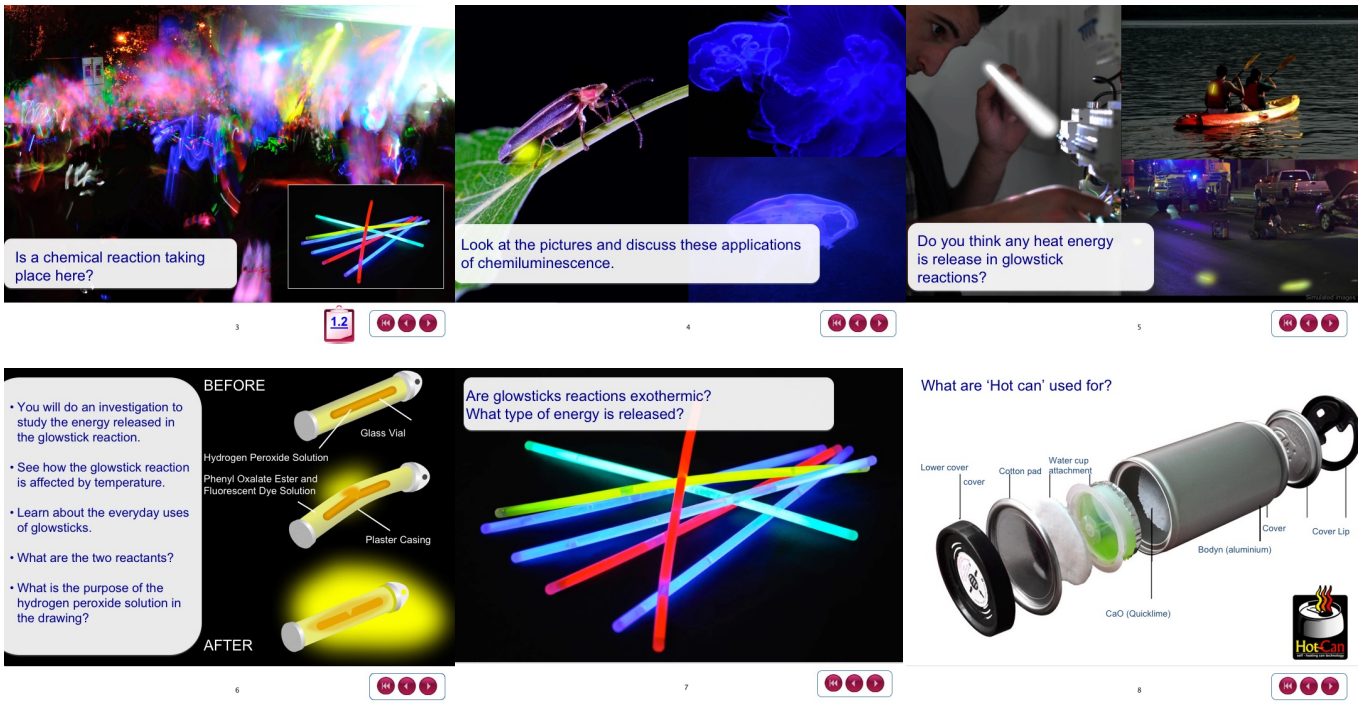
- Sufficient activity sheets for each student for personal notes and revision.
- 1 pair of scissors per group.

Suggested alternative strategies

Activity Sheet 1.1 should be suitable for all schools. If you are not able to show the PowerPoint you can print it off with multiple slides per page and use it as a student handout.

Period 2

Activity Sheet 1.2: Energy – exothermic and endothermic reactions (comprehension, applying, synthesis, reasoning, evaluation)



- Show Slides 3–5 to introduce Activity 1.2 and have a question and answer session, posing the questions on the slide (allow about 5 minutes).
- Teacher demonstrates a glow stick by breaking it and passing it around asking students if it feels warm and if not, why not? (about 2 minutes).
- Give out Activity Sheet 1.2 and ask students to read and discuss with a partner the information in Part 1 Energy – Exothermic and Endothermic Reactions (about 10 minutes).
- Show Slide 5 again and reinforce the useful applications of glow sticks, allowing students to feedback from reading the information in Part 1. Then show Slides 6 and 7 reviewing how a glow stick works, ensuring that students give reasons for their answers to the questions on Slide 7 (about 5 minutes).
- Tell students that in the next double period they will do an investigation using glow sticks.

Periods 3 and 4

- Ask students to work in groups of 3–4 to plan and carry out an investigation. They should look at stage 2 of Activity Sheet 1.2.
- Introduce the investigation and the context, which is set out in Activity Sheet 1.2. If students are having difficulty understanding the brief or getting started you may want to help by posing questions such as:

  -Do you think raising or lowering the temperature will affect the intensity of the glow and/ or the length of time the glow lasts for (about 10 minutes)?
- Tell students they have 20 minutes to plan and make notes and 30 minutes to carry out their plan using the materials and equipment available.
- Two groups will be asked to report back to the class (5 minutes each), which will be followed by a brief review (5 minutes). Any time left can be spent completing Activity Sheet 1.2, which could be finished as homework.

Answers for Slide 3

- The young people in the picture are holding up glow sticks; at a pop concert or other event.
- There is a chemical reaction taking place inside the glow stick. We know a chemical reaction is taking place because light is emitted; exothermic reaction or chemiluminescence reaction.

Answers for Slide 4

- Examples of chemiluminescence in insects (firefly - to attract other fireflies) and jelly-fish to attract organisms in the sea they feed on.

Answers for Slide 5

- The uses for the glow sticks in their hands are: emergency lighting where no power is available; lures and lights for night fishing; medical/dentistry; to identify mouth/gum disease, military night operations, parties, concerts and festivities.
- No heat energy is released in glow stick reactions; all energy is released as light.
- Yes, it is an exothermic reaction and light energy is released (fluorescent).

Answers for Slide 6

- Answers given on slide and on Activity Sheet 1.2, page 3

Answers for Slide 7 and during demonstration of glowstick

- The glow stick does not feel warm because all of the energy released is given out as light.

Answers to questions in Part 3 of Activity Sheet 1.2 – Energy – exothermic and endothermic reactions:

Q1: The glow stick from a cold environment would glow brighter when swapped to a hot environment and vice-versa.
Q2: Yes it would be good to store glow sticks in a fridge and they would give off a glow for a longer period of time.
Q3: The brightness of glow would be less when glow stick is cooler.
Q4: Increasing the temperature increases the brightness of glow over a shorter period

Safety

Glow sticks are used daily at home, for parties, concerts, etc. and are safe if handled properly and the chemicals are kept inside the glow stick. They should therefore not be cut open. Although the packaging says glow sticks are non-toxic it also says they should not be punctured, cut or damaged. If they are of decent quality, handled as instructed and the chemicals inside are kept contained using them is a safe activity. If for any unusual reason, accident or irresponsible behaviour, chemicals leak onto skin or eyes it is recommended to rinse with water for 15 minutes and seek medical attention.

Instruct students how to break the glowstick carefully to start the reaction and not to handle them roughly – they should be treated sensibly as with any chemical in the laboratory.

Hot water around 55–60 °C is required for the investigation. This could be boiled in a kettle or pan by the teacher/technician, left to cool until about 70 °C and then put into each group's beaker to avoid students carrying or heating up water. Make sure students are told to handle the hot water carefully and that it is 55–60 °C, so there is no danger of melting the glow stick's casing.

Suggested alternative strategies

Activity Sheet 1.2 should be suitable for all schools with a supply of very basic materials. Beakers could be substituted with plastic/polystyrene beakers (ensure hot water is not too hot – test first). If you are not able to show a PowerPoint you can print it off with multiple slides per page and use it as a student handout.

Learning resources

PowerPoint presentation: Episode 1 Chemistry Watch
Prezi presentation: Episode 1 Chemistry Watch
Activity Sheet 1.2 Energy – exothermic and endothermic reactions

Equipment (per group)

- 3 small beakers (100 or 250 ml)
- 2 thermometers
- 3 identical glow sticks (could be different colours if one colour not available)
- Supply of hot water
- Supply of ice
- Supply of newspaper/or similar/cardboard/sticky tape or glue to create a shade from bright sunlight (this will help when observing the glow stick)
- Sufficient activity sheets for working in groups of 3–4 for personal notes and revision.
- 1 pair of scissors per group

Period 5 Hot-Can

Activity Sheet 1.3: Investigating hot can chemistry (comprehension, applying, analysis, synthesis, reasoning)

- Show Slide 8 to introduce Activity Sheet 1.3 and have a question and answer session asking questions:
    - Have you seen or heard of these hot cans?
    - What do you think they are used for?
    - Where do you think they were first developed? (5 minutes)
- Bring out an actual hot can (e.g. self-heating coffee); let some students look at it. Open it and demonstrate it heating up the coffee. Get some feedback:
    - How do you think heat energy might be generated to heat up the coffee or soup in the can?
    - Can you think what chemical reaction might be used to do this? (5 minutes).
- To help them (ask them to think back to Activity Sheet 1.2 with glow sticks and Part 1 of Activity Sheet 1.2, which also gave information on exothermic reactions. Give them some time for small group discussion to think about this and come up with answers (5 minutes).
- Hand out worksheet Activity Sheet 1.3, giving information about the calcium oxide/water reaction used in the Hot-Cans in Part 1 and give time to read it (5 minutes).
- Tell students they will be asked to draw up a design plan for an investigation to model a hot can reaction in class, which will then be demonstrated by the teacher. Set the context for the task given in Activity 1.3 Part 2.

  If students are having difficulty understanding the brief or getting started you may want to help by posing questions or comments such as:
    - You know that the hot can is a 'can within a can', so how can you model that with the equipment available?

- Where is the coffee kept in the can and where does the reaction take place?
- How will you ensure as little heat as possible escapes into the classroom?
- Think about your variables – which will be your fixed variables and which your manipulated variables?
- What is your hypothesis? – what do you predict will happen to the temperature when you use e.g. two different amounts of calcium oxide with the same amount of water and coffee?

Note: Some students may suggest in their design that the coffee can go in the central or inner compartment of the can or small beaker and the calcium oxide/water reaction takes place in the outer can/large beaker, while others suggest the reverse. This is the case for the Hot-Can Malaysia product. Other products put the drink in the central/inner can (15 minutes).

Periods 6 and 7

- At the start of the period tell students they have 20 minutes to work on their design plan and also to produce a line diagram of the apparatus for the investigation demonstration.
- Review student designs and then carry out a teacher demonstration of the investigation (you may want 1 or 2 students to help to read the thermometer (They must wear goggles) (20 minutes). For details of the demonstration and how to carry it out refer to the Teacher Demonstration notes at the end of this section.
- Show Slide 9 and use the question on the slide to review the findings of the investigation (10 minutes).
- Outline these questions and use them as a basis for a mini project (see Out of School Activity 2).
    - Can you identify other exothermic reactions, which might also work?
    - Can you research other endothermic reactions?
    - Do you think it might be possible to make 'Chill Cans' for cool drinks?
    - Why not research this?
- Suggest to students that they use the information in Activity Sheet 1.3 to help with this and ask them to give attention to the section in the notes on endothermic reactions (15 minutes). View the video demonstration of the endothermic reaction between barium hydroxide and ammonium nitrate and discuss (10 minutes): http://www.youtube.com/watch?v=5RJLvQXce4A

Answers

Answers to the slides:

- The hot can is used to heat drink inside the can.
- The hot can was first developed in Kazakhstan in 1994 and became commercially available in 1995.
- Heat energy is generated to heat up the coffee or soup in the can by an exothermic chemical reaction, releasing its heat energy and transferring the heat to the drink.
- The chemical reaction used to do this is calcium oxide (or calcium chloride) reacting with water and releasing heat.

Answers to Activity Sheet 1.3

Q1: It is important to insulate the outer container so that the 'drink/coffee' does not lose heat to the surroundings
Q2: The calcium oxide/water reaction is strongly exothermic and gives off a significant amount of heat energy to heat the coffee quickly and to a suitable temperature

Answers to questions posed for Out of School Activity 2 are found in Activity Sheets 1.2 and 1.3.

Safety

Teacher demonstration of student design of hot can laboratory model:

Calcium oxide/water reaction is quite a vigorous exothermic reaction, generating a significant amount of heat. The oxide is corrosive and an irritant to skin and eyes, so safety glasses must be worn and disposable plastic gloves are recommended. Take care when handling containers or beakers during the reaction, as these could be hot. Do not dispose of residues in normal wash basins but collect in a separate container for disposal of corrosive chemicals. The reaction is straightforward if safety precautions are followed.

If student helpers are used e.g. to read the thermometer to confirm readings to the class, they should also wear goggles and gloves just in case of any spillage.

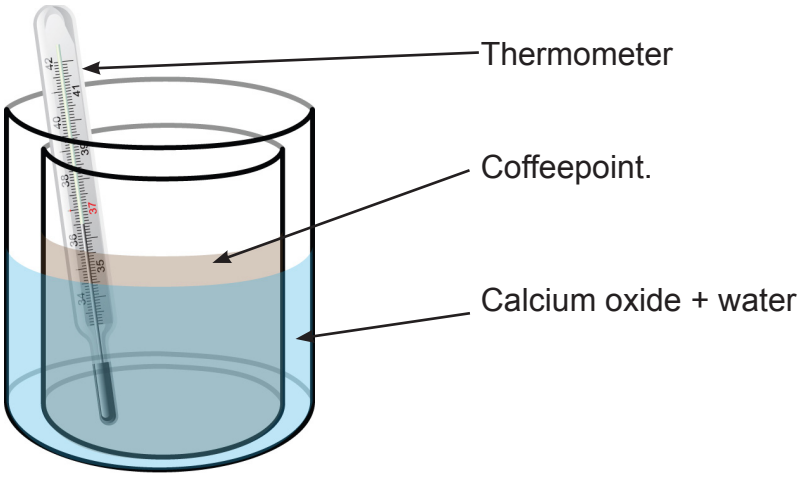
Learning resources

- Episode Teaching Guide
- PowerPoint presentation
- Prezi presentation
- Activity Sheet 1.3 Investigating hot can chemistry

Equipment (per group)

- Sufficient activity sheets for working in pairs or groups of 3–4. All students would benefit from individual copies, so they could retain them for personal notes and revision, particularly for the Out of School Activity 2.
- Although students will not actually be undertaking a practical investigation, it would be helpful for their design and planning exercise to be able to see a selection of equipment and materials that is available for the investigation.
- One set of the equipment and materials can be displayed:
    - A selection of beakers of varying sizes: small (100 ml), medium (250 ml), large (400 ml)
    - 2 Thermometers
    - 1 Place mat
    - 1 Pair of tongs
    - Insulation materials, e.g. strips of polystyrene, felt or serrated card to cover outside of large beaker, sticky tape to stick insulation on.
    - Two small bottles with lids, containing calcium oxide powder or granulated form, (or anhydrous calcium chloride substitute) labelled ‘Calcium oxide – look but do not open – 5 grams’ and the other labelled ‘Calcium oxide look but do not open – 10 grams’
    - Labelled bottle of water
    - Coffee powder soluble in water (optional – to give appearance of coffee)
    - Weighing machine (to check masses are accurate for investigation)

Teacher demonstration of hot can model



- Select the equipment shown above to set up a demonstration of the investigation below.
- Put 50ml of room temperature (measure this first) ‘coffee solution’ in one of the large (250ml) beakers. Place one of the small (100ml) beakers containing 5g of calcium oxide inside the larger beaker with the coffee solution. Make sure it sits on the bottom of the large beaker (weight it down with a small weight if necessary). Then add the 20ml of water slowly to the calcium oxide, carefully stir and measure the highest temperature of the coffee. Repeat with the second set of beakers and 10g of calcium oxide.
- Insulate the outside of the large beakers and also across the top, allowing a hole for the thermometer to pass through.
- Try out the demonstration well before hand to check the optimum amounts of calcium oxide/ water mixes to get significant temperature changes because calcium oxide samples vary depending on age and quality. Be prepared to change the mixes to get good temperature increases for your experiment. During the demonstration ask students about fixed variables (e.g. water in calcium oxide/water mix and the coffee sample) and manipulated variables (calcium oxide).
- Carefully follow the safety procedures (goggles, disposable gloves) given in the safety comments section.

Additional teaching notes for investigation demonstration by teacher:

- You know that the Hot-Can is a 'can within a can' so you can model this with a small beaker (calcium oxide/water mix) placed inside a larger beaker to hold the coffee drink around the outside of the small beaker.
- The coffee drink is in the outside section of the can, which surrounds the central or inner section of the can where the chemical reaction takes place. In some hot cans this is reversed and the central section has the coffee and the outer section holds the reactants.
- You can ensure as little heat as possible escapes into the classroom by using some insulation material, such as polystyrene or lagging fastened with sticky tape to the outer beaker and a piece of card or polystyrene with a hole in for a thermometer over the top of larger beaker.
- Fixed variables: one of the reactants in the calcium oxide/water mixture (preferably the calcium oxide) and the volume of coffee (e.g. 50ml).
- Prediction/hypothesis: When the amount of calcium oxide reactant is increased (keeping both the volume of water reactant fixed and the volume of coffee fixed) the temperature will rise.

Suggested alternative strategies

Only a very small amount of basic laboratory equipment is needed for the teacher demonstration of the hot can laboratory/classroom model and unless there is a problem acquiring the chemical calcium oxide or anhydrous calcium chloride then this should work in most schools. Other containers instead of glass beakers e.g. glass jars may be suitable substitutes although avoid plastic or even polystyrene cups as a considerable amount of heat is released in the reaction.

If equipment is available the students themselves could do the whole practical investigation assuming the students are mature enough to conduct the experiment safely, are safety conscious and use safety goggles, disposable gloves. Younger students would need very careful oversight if this was to go ahead as a class practical investigation.
For an initial demonstration of a hot-can in use and if unable to get hold of a hot can show the video clip:

http://hot-can.com/Malaysia/about_video.html

or a useful video of a self-heating Chinese meal:
http://www.youtube.com/watch?v=5OdMtr9UlKc