STEM Project

Chapter 4: Chemical elements

Pages 61–78

Degrees Expandium

As liquids increase in temperature, they expand and take up more space. This property has been used by humans for more than 300 years to measure temperature using a thermometer.

Thermometers have two main elements: a liquid that changes volume based on the temperature, and a numerical scale that measures how much volume change has occurred.

Measurement scales are a purely human convention, created to assign a value to things that are not automatically numeric. Quite often, completely different scales are devised by different people to measure exactly the same thing, demonstrating how arbitrary they can be.

There are many different scales that have been developed to measure temperature. The three most common ones used today are degrees Celsius (°C), degrees Fahrenheit (°F) and degrees Kelvin (K).

In this task, you will create your own basic thermometer and your own temperature scale using the expanding properties of matter.

Step 1: Create your thermometer

Materials: a clear straw, water, rubbing alcohol, food colouring, small plastic water bottle, modelling clay

1 Fill the water bottle to around one-third full with equal parts water and alcohol.

2 Add a few drops of food colouring into your bottle and swirl gently to mix it in.

3 Insert the straw into the bottle making sure one end is in the liquid and the other end is sticking out of the top of the bottle. Do not let your straw touch the bottom of the bottle, and leave as much of it as possible sticking out of the top.

4 Mould the clay around the straw at the bottle opening to hold it in place. Make sure the clay seals the straw tightly.

This water bottle contraption will act as a basic thermometer.

Step 2: Create your scale

Materials: a fine-nibbed permanent marker, a ruler

Your thermometer will measure temperature in degrees ‘Expandium’ (°E). You will create your own definition of degrees Expandium by creating a temperature scale on your straw.

Using a permanent marker and a ruler, draw marks on the part of your straw sticking out of the bottle at 5 mm intervals.

Oxford Science 8 Western Australian Curriculum Teacher obook assess ISBN 9780190307172

Now decide what number scale you will assign to your intervals. You can assign any number scale you like as long as they increase in a regular way. For example, your scale could start at 0°E and increase by 5°E with each tick mark, or it could start at 50°E and increase by 1°E with each tick mark.

Choose a number scale and indicate it on your straw.

Step 3: Take some measurements

Materials: your bottle thermometer, a real thermometer, a bowl, water of different temperatures (hot water, lukewarm water, tap water, ice water)

1 Place your bottle thermometer into the bowl.

2 Add the hot water to the bowl and wait a few minutes for the water to expand and rise in your straw.

3 Once the water level in your bottle thermometer has stabilised, measure the temperature in degrees Expandium using the intervals marked on your straw. Note down the temperature in degrees Expandium in the Data and results section.

4 Measure the temperature of the water in the bowl in degrees Celsius using the real thermometer. Note this down in the Data and results section as well.

5 Repeat this process with water of different temperatures in the bowl water, and record your results.

Data and results

Record your results in the following table.

Water sample	Degrees Expandium (°E)	Degrees Celsius (°C)
Hot water		
Lukewarm water		
Tap water		
Ice water		
Other:		
Other:		

Oxford Science 8 Western Australian Curriculum Teacher obook assess ISBN 9780190307172

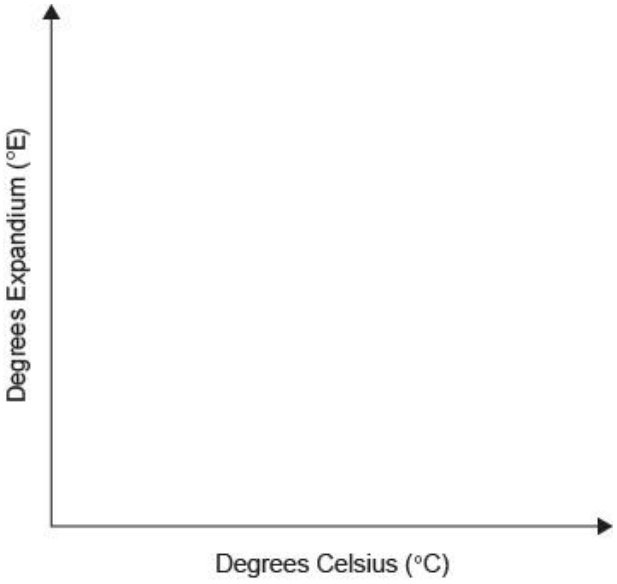
Name: Class:

Extension task

Graph your results by placing data points (dots) on the graph below. You will need to decide on an appropriate scale for your graph axes and give your graph a title.

Join up your dots in a smooth line to form a 'trend line'.

GRAPH TITLE: _____



Discussion and reflection

Using your results table (or the trend line on your graph), try to predict the approximate degrees Expandium you would expect for the following degrees Celsius. If you have created a graph and trend line, you may have to extend your trend line beyond the data points (this is called 'extrapolation').

0°C = _____°E

15°C = _____°E

30°C = _____°E

70°C = _____°E

Describe what is happening to your water-alcohol solution when you put your thermometer into the bowl with different water temperatures.

Oxford Science 8 Western Australian Curriculum Teacher obook assess ISBN 9780190307172

Name: Class:

How accurate do you think your thermometer is? (How well does it measure temperature?)

What changes to the design of the thermometer or the way the measurements were taken could make your thermometer more accurate?

Why do you think real thermometers use mercury instead of water and alcohol? If you are not sure, how could you find this out?

Oxford Science 8 Western Australian Curriculum Teacher obook assess ISBN 9780190307172