

## To show that there is no change of temperature during a change of state

In this investigation, we will look at the temperature changes that take place in a beaker of ice as you heat it.

As you heat ice, its temperature gradually increases until it reaches  $0^{\circ}\text{C}$ . As you continue to heat it, the temperature remains at  $0^{\circ}\text{C}$  until all the ice has melted. The energy supplied during this change of state is not causing a rise in temperature; instead it is being used to break the bonds, which hold the molecules together in the solid state.

If you continue to heat the melted ice (water) the energy supplied will cause a rise in temperature until it reaches  $100^{\circ}\text{C}$ . At this temperature, water turns to steam. The energy supplied during this change of state is used to break the bonds that hold the molecules together in the liquid state. The temperature remains at  $100^{\circ}\text{C}$  until all the water has been changed to steam.

The energy supplied during these changes of state is called *latent heat*.

When the change of state is from a solid to a liquid, the latent heat is called latent heat of fusion, when the change of state is from liquid to vapour; it is called latent heat of vaporisation.

### MATERIALS

CBL with 1 temp probes	Bunsen burner
Graphing Calculator	Ice 5 spoons salt
250 cm <sup>3</sup> beakers	50 cm <sup>3</sup> water

### Procedure

Set up the calculator to record the temperature every 5 seconds for a period of 10 minutes. Plug a temperature probe into channel 1, of the CBL. Turn on the CBL and calculator. Select **DATAMATE** programme from the **APPS** menu. Press **ENTER** at the welcome screen. Press **CLEAR** to reset the programme. The CBL will check for probes. Screen 1 will be shown.

```

CH 1:TEMP(C)      17.9

MODE:TIME GRAPH-120
-----
1:SETUP          4:ANALYZE
2:START          5:TOOLS
3:GRAPH          6:QUIT
    
```

Screen 1

Select **1: Setup** and press the up arrow  $\uparrow$  to highlight **MODE**. Press **ENTER** to get screen 2

```

SELECT MODE
-----
1:LOG DATA
2:TIME GRAPH
3:EVENTS WITH ENTRY
4:SINGLE POINT
5:SELECTED EVENTS
6:RETURN TO SETUP SCREEN
    
```

Screen 2

Select **2: Time graph** to get screen 3

```

TIME GRAPH SETTINGS
TIME INTERVAL:      3
NUMBER OF SAMPLES: 80
EXPERIMENT LENGTH: 240
-----
1:OK                3:ADVANCED
2:CHANGE TIME SETTINGS
    
```

Screen 3

Select **2: change time settings**  
Enter 5 as time between samples in seconds  
Enter 120 as number of samples  
Press **ENTER** to get screen 4

```

TIME GRAPH SETTINGS
TIME INTERVAL:      5
NUMBER OF SAMPLES: 240
EXPERIMENT LENGTH: 1200
-----
1:OK                3:ADVANCED
2:CHANGE TIME SETTINGS
    
```

Screen 4

## To show that there is no change of temperature during a change of state

The temperature probe has a default setting between  $-25^{\circ}\text{C}$  and  $+125^{\circ}\text{C}$ .

While these settings will still give an accurate result, it is better to change the graph settings so that you can get a better picture of the change in temperature as the graph is appearing on the screen.

To do this press **3**: **ADVANCED** to get screen 5

```

ADV. TIME GRAPH SETTINGS
LIVE GRAPH:TEMP(C)
YMIN   YMAX   YSCL
-25    125    25
TRIGGERING:NONE
-----
1:OK
2:CHANGE GRAPH SETTINGS
3:CHANGE TRIGGERING
    
```

Screen 5

Select **2**: **CHANGE GRAPH SETTINGS**.

From the next screen, you will be asked to select which graph you want to change.

Select **1**: **CH1-TEMP(C)**

When prompted, type in  $-5$  for Y MIN then press **ENTER** (remember to use the **(-)** key on the calculator when typing  $-5$ )

Type in  $10$  for Y MAX, press **ENTER**

Type in  $1$  for YSCL

The following screen should appear.

```

ADV. TIME GRAPH SETTINGS
LIVE GRAPH:TEMP(C)
YMIN   YMAX   YSCL
-5     10     1
TRIGGERING:NONE
-----
1:OK
2:CHANGE GRAPH SETTINGS
3:CHANGE TRIGGERING
    
```

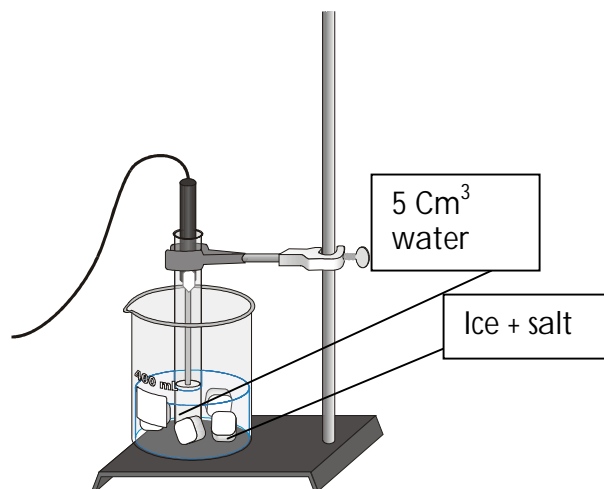
Screen 6

Press **1**: **O. K.** three times until you get screen 7

```

CH 1:TEMP(C)      22.8
-----
MODE: TIME GRAPH-1200
-----
1:SETUP      4:ANALYZE
2:START     5:TOOLS
3:GRAPH     6:QUIT
    
```

Screen 7



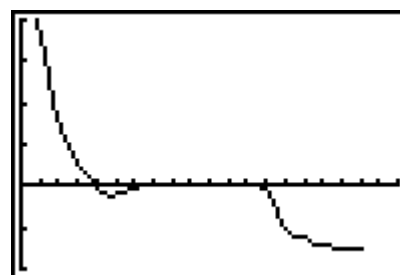
Place about  $5\text{ cm}^3$  water in a test tube, and set up as in the diagram. The calculator will give a live reading of temperature.

When the temperature reaches about  $-2^{\circ}\text{C}$  press **2**: **START** on the calculator. The calculator will start to produce a graph of temperature vs. time

Raise the test tube out of the ice bath and after about 5 minutes, lower it into a warm water bath. Stir the warm water bath during the data collection period.

Once data collection has finished, press **TRACE** on the calculator and move the **(▶)** arrow to the flat part of the graph. Record the temperature of this region of the graph

Print a graph of temperature vs time.



Screen 8

## To show that there is no change of temperature during a change of state

### Questions

1. What is the energy involved in a change of state called?
2. How does the melting point of water relate to the freezing point
3. When ice at  $0^{\circ}\text{C}$  is melted its temperature does not change until all the water has melted. Why?
4. Why does it feel colder when snow is thawing than before it starts to thaw?