

Endothermic and Exothermic Reactions

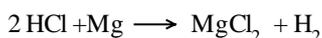
When a chemical reaction takes place, there is very often a heat change. This is because there is a difference in the energy between the substances that are reacting, and the products of the reaction.

Some reactions give out heat and these are known as *exothermic* reactions. In exothermic reactions, the reactants have more energy than the products.

Other reactions take in heat these and these are called *endothermic* reactions. In these reactions, the products have more energy than the reactants. Where do they get this extra energy? They get it by taking some heat away from the system. Consequently, the system becomes colder.

In this investigation, we will study one endothermic reaction, and one exothermic reaction.

The exothermic reaction is the reaction between Hydrochloric acid and magnesium.



The endothermic reaction is between citric acid (found in citrus fruits), and sodium hydrogen carbonate (baking soda). This is the reaction used in the manufacture of sherbet.

MATERIALS

CBL with 2 temp probes	10 grams sodium hydrogen carbonate
Graphing Calculator	5 cm strip magnesium ribbon
2 50 cm ³ graduated cylinder.	50 cm ³ dilute (1M) HCl
2 Styrofoam cups	10 grams citric acid.
2 250 cm ³ beakers	50 cm ³ water

Procedure

Plug two temperature probes into channel 1 and channel 2 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)	19.6
CH 2: TEMP(C)	19.8
MODE: TIME GRAPH-180	
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**.

TIME GRAPH SETTINGS	
TIME INTERVAL:	1
NUMBER OF SAMPLES:	180
EXPERIMENT LENGTH:	180
1: OK	3: ADVANCED
2: CHANGE TIME SETTINGS	

Screen 3

Select **2: Change time settings**

Type "2" as the time between samples in seconds press **ENTER**.

Type "60" as the number of samples and Press **ENTER** to get Screen 4

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```
TIME GRAPH SETTINGS
TIME INTERVAL: 2
NUMBER OF SAMPLES: 60
EXPERIMENT LENGTH: 120
-----
1:OK          3:ADVANCED
2:CHANGE TIME SETTINGS
```

Screen 4

To set the axes on the graph select **3: Advanced**

```
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

The values on the Y axis (temperature) are set between -25 and $+125$ this range of values is too wide for the two reactions in this investigation. To change these values select **2: Change graph settings** to get screen 6

```
SELECT GRAPH
-----
1:CH1-TEMP(C)
2:CH2-TEMP(C)
3:NONE
```

Screen 6

Select **1: Ch1 - Temp(C)** and type "10" as Y MIN and press **ENTER** Type "40" as Y MAX and press **ENTER** type "2" as YSCL and press **ENTER** to get screen 7

```
ADV. TIME GRAPH SETTINGS
LIVE GRAPH:TEMP(C)
YMIN  YMAX  YSCL
10    40    2
TRIGGERING:NONE
-----
1:OK
2:CHANGE GRAPH SETTINGS
3:CHANGE TRIGGERING
```

Screen 7

Select **1: OK**. Twice to return to the main menu

Pour 50cm^3 dilute HCl into one of the Styrofoam cups. Dissolve the citric acid in 50cm^3 of water in the other Styrofoam cup, and place them inside the glass beakers.

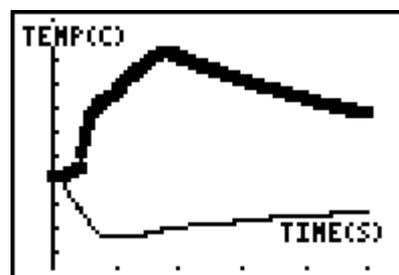
Place a temperature probe into each of the cups.

When everything is ready, commence data collection by pressing **2: Start**

Once the temperatures in each beaker have stabilized, record the temperature in both beakers. This is the initial temperature.

After about 10 seconds, add the sodium hydrogen carbonate to the citric acid, and the magnesium ribbon to the dilute HCl. Gently stir each of the mixtures.

When the sampling is complete, the calculator will auto scale the data. To view the graphs Press **ENTER**



Screen 8

Examine the graph of temperature against time. Record the maximum and minimum temperatures of each solution.

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Results

Temp	Citric Acid + NaHCO ₃	HCl + Magnesium
Initial		
Max/Min		
Change		