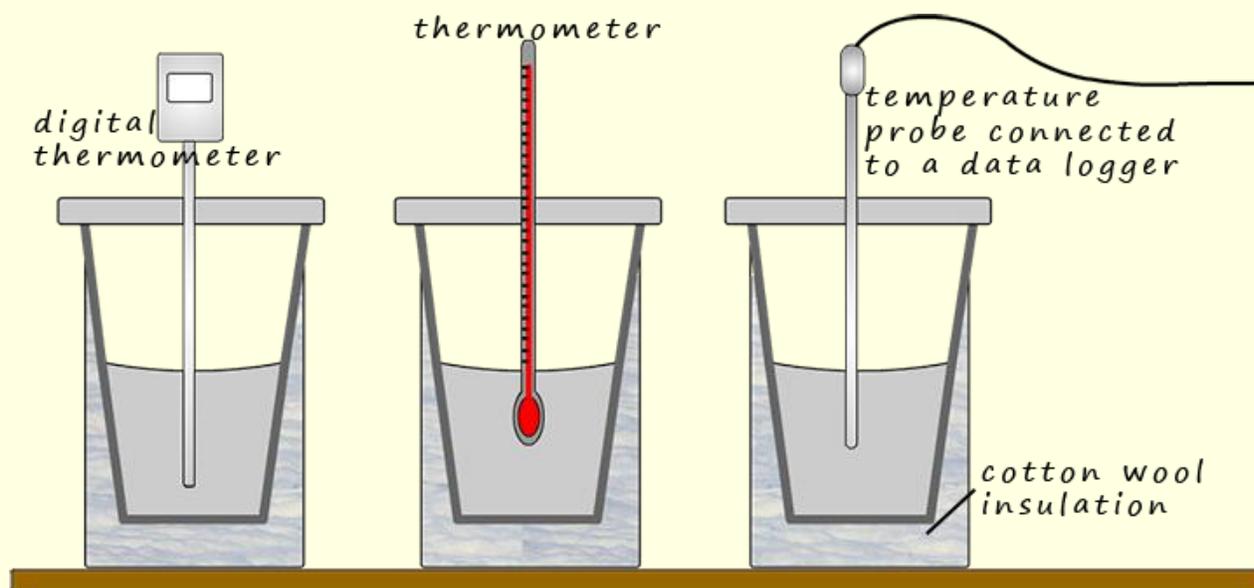


Exothermic and endothermic reactions

Answer all the questions below and then check your answers

1. Which type of reactions release heat energy to the surroundings? Exothermic or endothermic?
2. Eating sherbet sweets releases carbon dioxide gas, this gives you the fizzing feeling in your mouth. Your mouth also feels a bit cooler. Is this an exothermic or endothermic reaction?
3. A student was planning an investigation to investigate the temperature changes in a range of chemical reactions. One of the reactions she decided to investigate was the neutralisation reaction between hydrochloric acid and sodium hydroxide. She was going to use one of the apparatus set-ups shown below.



She planned to measure out 25ml of 1M hydrochloric acid with a 50ml measuring cylinder and add it to a polystyrene cup sitting in a beaker packed with insulation. She then intended to add 5ml of 1M sodium hydroxide and record the temperature change, then repeat the experiment but this time add 10ml of sodium hydroxide and then repeat up to a maximum volume of 30ml of sodium hydroxide added.

- What was the independent variable in this experiment? What type of variable was the independent variable?
- What was the dependent variable?
- To make the experiment fair what variables will need to be controlled?
- Why did the student use a polystyrene cup and why was the beaker filled with cotton wool?
- The student decided to repeat the experiment three times for each volume of sodium hydroxide added. Why did she decide to repeat the experiment?
- The student's results are shown below

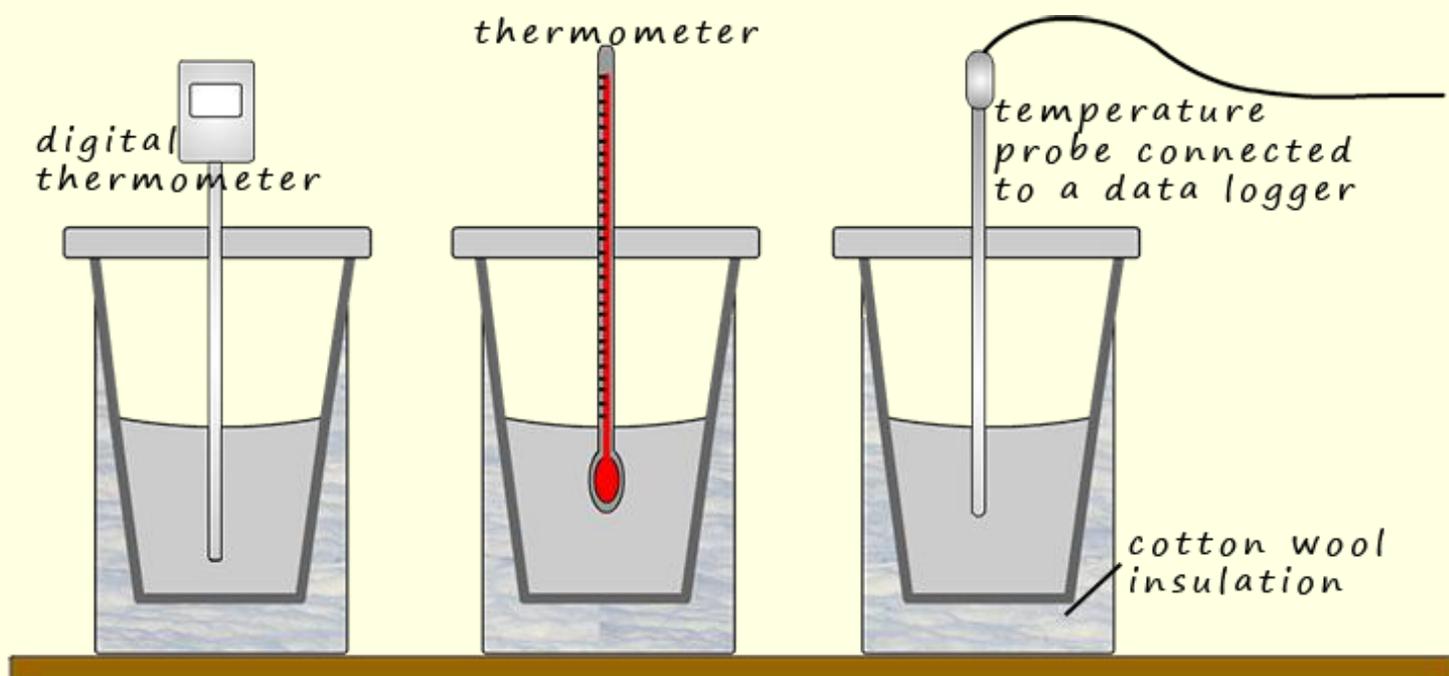
Volume of sodium hydroxide added/ml	Temperature change/ $^{\circ}\text{C}$ Experiment 1	Temperature change/ $^{\circ}\text{C}$ Experiment	Temperature change/ $^{\circ}\text{C}$ Experiment 3	Average temperature change
5	5	4	5	
10	10	9	9	
15	16	26	15	
20	21	20	20	
25	25	25	26	
30	22	22	23	

- i Which one of the student's results is anomalous? How do you know it is anomalous?
 - ii Calculate the mean temperature rise for each experiment the student did.
 - iii. Explain what the student found out.
 - iv. Are the student's results precise? How do you know?
4. Which of the three methods above do you think the student should use. Explain your choice?
5. Suggest some improvements to the students experiment.
6. What safety precautions should the student take while carrying out this experiment?

Exothermic and endothermic reactions

Answers

1. Which type of reactions release heat energy to the surroundings? Exothermic or endothermic? **Exothermic**
2. Eating sherbet sweets releases carbon dioxide gas, this gives you the fizzing feeling in your mouth. Your mouth also feels a bit cooler. Is this an exothermic or endothermic reaction? **Endothermic**
3. A student was planning an investigation to investigate the temperature changes in a range of chemical reactions. One of the reactions she decided to investigate was the neutralisation reaction between hydrochloric acid and sodium hydroxide. She was going to use one of the apparatus set-ups shown below.



She planned to measure out 25ml of 1M hydrochloric acid with a 50ml measuring cylinder and add it to a polystyrene cup sitting in a beaker packed with insulation. She then intended to add 5ml of 1M sodium hydroxide and record the temperature change, then repeat the experiment but this time add 10ml of sodium hydroxide and then repeat up to a maximum volume of 30ml of sodium hydroxide added.

- a. What was the independent variable in this experiment? What type of variable was the independent variable? *Volume of sodium hydroxide added, it's a continuous variable (a number variable)*
- b. What was the dependent variable? *Temperature rise, it's also a continuous variable*
- c. To make the experiment fair what variables will need to be controlled?

Control variables:

- *Volume of hydrochloric used.*
 - *Concentration of hydrochloric acid*
 - *Starting temperature of hydrochloric acid*
- d. Why did the student use a polystyrene cup and why was the beaker filled with cotton wool? *Polystyrene is an excellent insulator and so is the cotton wool, both along with the lid should help insulate the experiment and keep all heat loss to a minimum.*
 - e. The student decided to repeat the experiment three times for each volume of sodium hydroxide added. Why did she decide to repeat the experiment? *To improve the accuracy of her experiment and help spot an anomalous results. With repeated results you can calculate a mean which will improve the accuracy of your results.*

f. The student's results are shown below

Volume of sodium hydroxide added/ml	Temperature change/ $^{\circ}\text{C}$ Experiment 1	Temperature change/ $^{\circ}\text{C}$ Experiment 2	Temperature change/ $^{\circ}\text{C}$ Experiment 3	Average temperature change/ $^{\circ}\text{C}$
5	5	4	5	4.6
10	10	9	9	9.3
15	16	26	15	15.5
20	21	20	20	20.3
25	25	25	26	25.3
30	22	22	23	22.3

i Which one of the student's results is anomalous? How do you know it is anomalous?
Result 2 for 15°C does not fit the pattern of the other results.

ii Calculate the mean temperature rise for each experiment the student did.

Add results and divide by 3. Note ignore any anomalous results, these are wrong and should not be used to calculate a mean.

iii. Explain what the student found out.

Up to a maximum volume of 25 ml of sodium hydroxide, as you add more sodium hydroxide the temperature rise increases. For every 5ml of sodium hydroxide the temperature rise is approximately 5°C .

iv. Are the student's results precise? How do you know? Yes, they are all close together for any volume of sodium hydroxide added.

4. Why of the three methods above do you think the student should use. Explain your choice? Any method is OK, the temperature probe would allow continuous monitoring of the temperature and reading are likely to be most accurate. Using the analogue thermometer is likely to give the biggest error in reading due to errors in reading the scale, a larger thermometer with a scale with smaller scale divisions would improve the accuracy.

5. Suggest some improvements to the students experiment.

A magnetic stirrer to continuously stir the solutions would help improve the accuracy of the results.

Use class results to have more results to calculate her mean.

6. What safety precautions should the student take while carrying out this experiment? Goggles, gloves, eye wash, equipment to deal with splashes and spills.