

Required Practical Review



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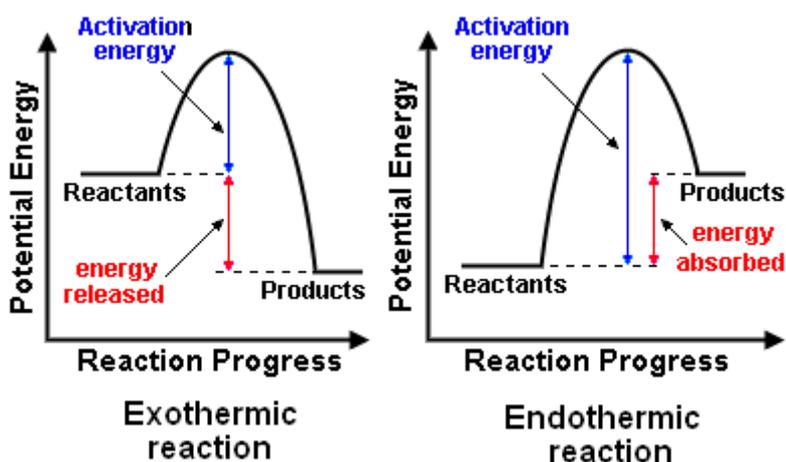
Chemistry Practical – Energy changes.

Free science video: <https://www.youtube.com/watch?v=rdI7xEg4Ew8>

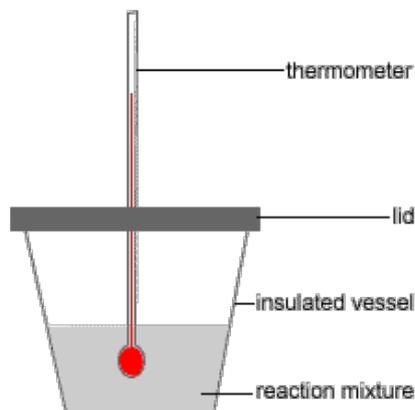
GCSEpod: <https://members.gcsepod.com/shared/podcasts/title/12343>

Know it:

- An exothermic reaction is a reaction that gives out heat energy to its surrounding.
- An Endothermic reaction is a reaction that takes in heat energy from its surroundings.



- As a result these reactions can be monitored by looking at temperature change in the surroundings using a thermometer.
- Neutralisation reactions happen with an energy change and can be monitored by monitoring the temperature.
- The temperature will change as the Acid neutralises the base, but the temperature will no longer change once the reaction is complete and the acid is neutralised. In fact the temperature will often decrease as the excess alkali being added to the solution is at a cooler temperature than the products of the reaction.



1. Use the 50 cm³ measuring cylinder to put 30 cm³ dilute hydrochloric acid into the polystyrene cup.
2. Stand the cup inside the beaker. This will make it more stable.
3. Use the thermometer to measure the temperature of the acid.
4. Put 5 cm³ sodium hydroxide solution into the 10 cm³ measuring cylinder.
5. Pour the sodium hydroxide into the cup. Fit the lid and gently stir the solution with the thermometer through the hole.

When the reading on the thermometer **stops changing**, write the temperature in the next space in the table.

6. Repeat steps 4 and 5 to add further 5 cm³ amounts of sodium hydroxide to the cup. A total of 40 cm³ needs to be added.

The last few additions should produce a temperature fall rather than a rise.

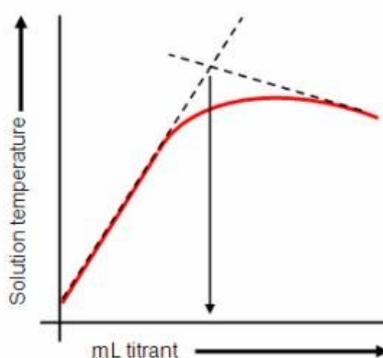
7. Repeat steps 1–6 and record the results in the second blank column of the table.
8. Calculate the **mean** maximum temperature reached for each of the sodium hydroxide volumes. Record these means in the third blank column.
9. Plot a graph with:
 - 'Mean maximum temperature in °C' on the y-axis
 - 'Total volume of sodium hydroxide added in cm³' on the x-axis.

Draw two straight lines of best fit:

- one through the points which are increasing
- one through the points which are decreasing

Ensure the two lines are extended so they cross each other.

10. Use the graph to estimate how much sodium hydroxide solution was needed to neutralise 25 cm³ dilute hydrochloric acid.



Variables:

There are many variables in this reaction:

1. The volume of the Acid
2. The concentration of the Acid
3. The concentration of the Alkali
4. The rate and level of stirring.

These must be controlled to get repeatable results. The experiment is repeated to allow us to remove anomalies and take a mean average of the results.

Review it

Up to grade 4

1. What is an exothermic reaction?
2. What is an endothermic reaction?
3. List 2 variables in the reaction above

Grade 5-7

4. Draw a reaction profile for an endothermic reaction and label onto it the activation energy, reactants and products and the enthalpy change.
5. Draw a reaction profile for an endothermic reaction and label onto it the activation energy, reactants and products and the enthalpy change.
6. Suggest 2 errors in the method above that would result in an anomalous result.

Grade 7+

1. Explain why it is necessary to conduct the reaction in a polystyrene cup with a lid.
2. Explain in terms of bond breaking and bond making why a reaction would be exothermic.

Test it

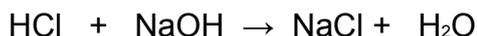
Answer the exam questions below into your book.

Q1.

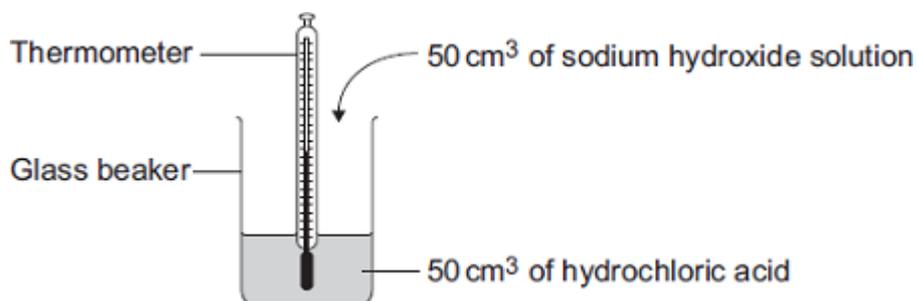
Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:



The student used the apparatus shown in the diagram.



The student placed 50 cm³ of hydrochloric acid in a glass beaker and measured the initial temperature.

The student then quickly added 50 cm³ of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

(a) The biggest error in this experiment is heat loss.

Suggest how the apparatus could be modified to reduce heat loss.

(b) Suggest why it is important to mix the chemicals thoroughly.

(1)

(c) Which **one** of these experiments was probably done on a different day to the others?

Give a reason for your answer.

(1)

(d) Suggest why experiment **4** should **not** be used to calculate the average temperature change.

(1)

(e) Calculate the average temperature change from the first three experiments.

Answer = _____ °C

(1)

(f) Use the following equation to calculate the energy change for this reaction.

$$\text{Energy change in joules} = 100 \times 4.2 \times \text{average temperature change}$$

Answer = _____ J

(1)

(g) Which **one** of these energy level diagrams represents the energy change for this reaction?

Give a reason for your answer.

Diagram A

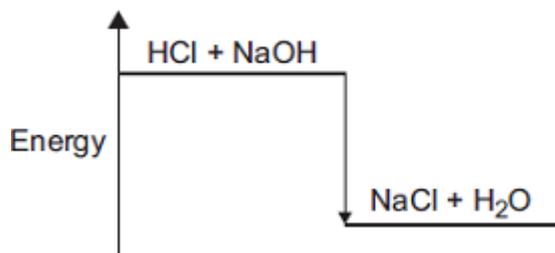
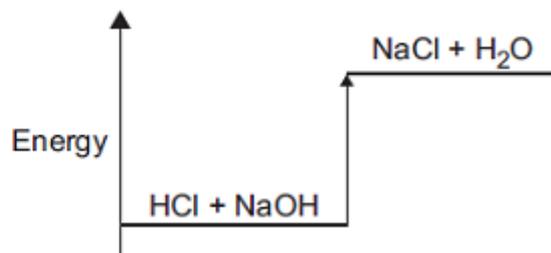


Diagram B



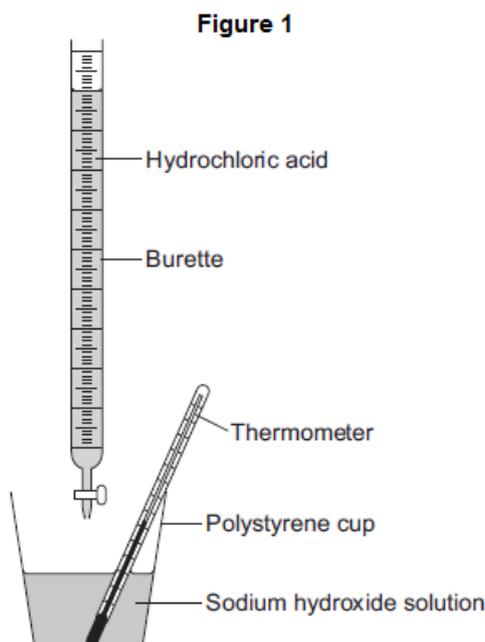
(1)

(Total 7 marks)

Q2.

A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.

The student uses the apparatus shown in **Figure 1**.



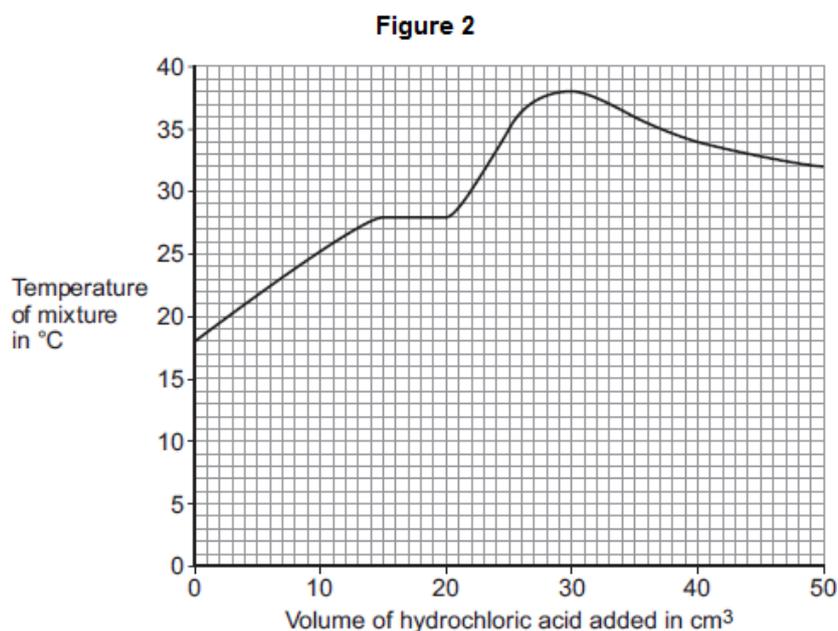
The student:

- measures 25 cm³ sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm³ hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm³ portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

(a) The student has plotted a graph of the results.

The graph line has been incorrectly drawn by including an anomalous result.

The graph is shown in **Figure 2**.



- (i) Suggest a cause for the anomalous result when 20 cm³ of hydrochloric acid is added.

(1)

- (ii) Suggest the true value of the temperature of the anomalous point.

Temperature = _____ °C

(1)

- (iii) What was the **total** volume of the mixture when the maximum temperature was reached?

Total volume of the mixture = _____ cm³

(1)

- (iv) Calculate the overall temperature increase in this experiment.

Overall temperature increase = _____ °C

(1)

- (v) Use your answers to (iii) and (iv) and the equation to calculate the energy released in the reaction. Give the unit.

Assume the volume in cm³ is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$

where:

Q = energy released

m = mass of solution (g)

c = 4.2 (J per g per °C)

ΔT = change in temperature (°C)

Energy released = _____ Unit = _____

(2)

- (b) The student did the experiment again, starting with 50 cm³ of sodium hydroxide solution instead of 25 cm³.

Explain why this would make no difference to the overall temperature increase.

(2)

(Total 8 marks)

Q3.

Dilute nitric acid reacts with potassium hydroxide solution.

The equation for the reaction is:



A student investigated the temperature change in this reaction.

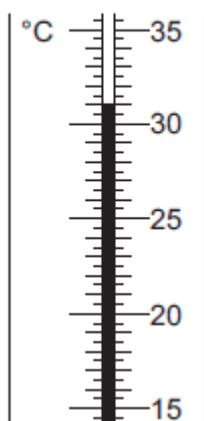
This is the method the student used.

- Step 1 Put 25 cm³ of dilute nitric acid in a polystyrene cup.
- Step 2 Use a thermometer to measure the temperature of the dilute nitric acid.
- Step 3 Use a burette to add 4 cm³ of potassium hydroxide solution to the dilute nitric acid and stir the mixture.
- Step 4 Use a thermometer to measure the highest temperature of the mixture.
- Step 5 Repeat steps 3 and 4 until 40 cm³ of potassium hydroxide solution have been added.

The dilute nitric acid and the potassium hydroxide solution were both at room temperature.

- (a) **Figure 1** shows part of the thermometer after some potassium hydroxide solution had been added to the dilute nitric acid.

Figure 1



What is the temperature shown on the thermometer?

The temperature shown is _____ °C

(1)

- (b) Errors are possible in this experiment.

- (i) Suggest **two** causes of random error in the experiment.

(2)

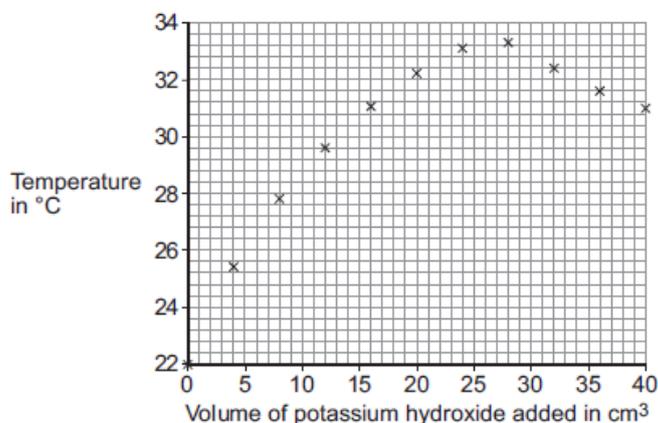
(ii) Another student used a glass beaker instead of a polystyrene cup.

This caused a systematic error.

Why does using a glass beaker instead of a polystyrene cup cause a systematic error?

(1)

(c) The results of the student using the polystyrene cup are shown in **Figure 2**.



(i) How do the results in **Figure 2** show that the reaction between dilute nitric acid and potassium hydroxide solution is exothermic?

(1)

(ii) Explain why the temperature readings decrease between 28 cm³ and 40 cm³ of potassium hydroxide solution added.

(2)

(iii) It is difficult to use the data in **Figure 2** to find the exact volume of potassium hydroxide solution that would give the maximum temperature.

Suggest further experimental work that the student should do to make it easier to find the exact volume of potassium hydroxide solution that would give the maximum temperature

(2)

- (d) The student did further experimental work and found that 31.0 cm³ of potassium hydroxide solution neutralised 25.0 cm³ of dilute nitric acid.

The concentration of the dilute nitric acid was 2.0 moles per dm³.



Calculate the concentration of the potassium hydroxide solution in moles per dm³.

Concentration = _____ moles per dm³

(3)

- (e) The student repeated the original experiment using 25 cm³ of dilute nitric acid in a polystyrene cup and potassium hydroxide solution that was twice the original concentration.

She found that:

- a smaller volume of potassium hydroxide solution was required to reach the maximum temperature
- the maximum temperature recorded was higher.

Explain why the maximum temperature recorded was higher.

(2)

(Total 14 marks)

Mark it

- Q1.** (a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed
any sensible modification to reduce heat loss 1
- (b) all the substances react **or** all (the substances) react fully / completely **or**
heat evolved quickly **or** distribute heat
'so they react' is insufficient for the mark
accept increase chances of (successful) collisions / collision
rate increase 1
- (c) experiment 2 **and**
different / higher / initial / starting temperature
accept experiment 2 and the room is hotter / at higher
temperature 1
- (d) temperature change does not fit pattern
accept anomalous / odd or it is the lowest or it is lower than
the others or it is different to the others
'results are different' is insufficient 1
- (e) 7 / 7.0 1
- (f) $(100 \times 4.2 \times 7) = 2940$ *ecf from (e)* 1
- (g) diagram A **and**
reaction exothermic / heat evolved / ΔH is negative / temperature rises
accept energy is lost (to the surroundings)
accept energy of products lower than reactants
allow arrow goes downwards 1 [7]

Q2. (a) (i) any **one** from:

- incorrect measurement of temperature or volume
- incorrect recording of temperature
- failure to stir
- heat loss

1

(ii) 32 – 33 1

(iii) 55 1

(iv) 20 1

(v) 4620 *allow 4.62 kJ for 2 marks* 1

J / joules

allow kJ if evidence of dividing by 1000 1

(b) twice as much energy released 1

but twice as much water to heat

*allow more energy released but more water to heat for 2 marks
if no other mark awarded, allow twice the amount of hydrochloric
acid used for 1 mark*

1 [8]

Q3. (a) 31 1

(b) (i) any **two** from:

- incorrect reading of thermometer / temperature
- incorrect measurement of volume of acid
- incorrect measurement of volume of alkali (burette). 2

(ii) glass is a (heat) conductor **or** polystyrene is a (heat) insulator
*answer needs to convey idea that heat lost using glass **or**
not lost using polystyrene
accept answers based on greater thermal capacity of glass
(such as “glass absorbs more heat than polystyrene”)*

1

(c) (i) temperature increases 1

(ii) no reaction takes place **or** all acid used up **or** potassium hydroxide in excess 1
cool / colder potassium hydroxide absorbs energy **or** lowers temperature 1

(iii) take more readings *ignore just “repeat”* 1

around the turning point **or** between 20 cm³ and 32 cm³
*accept smaller ranges as long as no lower than 20 cm³ and
no higher than 32 cm³*

1

(d) 1.61 **or** 1.6(12903)
*correct answer with or without working scores 3
if answer incorrect, allow a maximum of **two** from:
moles nitric acid = (2 × 25 / 1000) = 0.05 for 1 mark
moles KOH = (moles nitric acid) = 0.05 for 1 mark
concentration KOH = 0.05 / 0.031
answer must be correctly rounded (1.62 is incorrect)*

3

(e) same amount of energy given out 1

which is used to heat a smaller total volume **or** mixture has lower thermal
capacity **or**

number of moles reacting is the same
but the total volume / thermal capacity is less

*if no other marks awarded award 1 mark for idea of reacting
faster*

1 [14]