

Energetics

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Double Award (Paper 1C)
Topic	Physical Chemistry
Sub-Topic	Energetics
Booklet	Question Paper

Time Allowed: 68 minutes

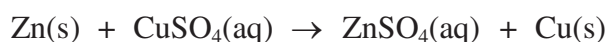
Score: /57

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

- 1 Some students investigated displacement reactions involving three different metals and solutions of their salts. This equation represents one of these reactions:



This reaction occurs because zinc is more reactive than copper.

When a displacement reaction occurs, there is a temperature rise. The bigger the difference in reactivity between the two metals, the bigger the temperature rise.

- (a) What word is used to describe reactions in which there is a temperature rise?

(1)

- (b) The students used this method.

- Pour some metal salt solution into a beaker, place a thermometer in the beaker and record the temperature.
- Add some of the metal and stir the mixture
- Record the maximum temperature.

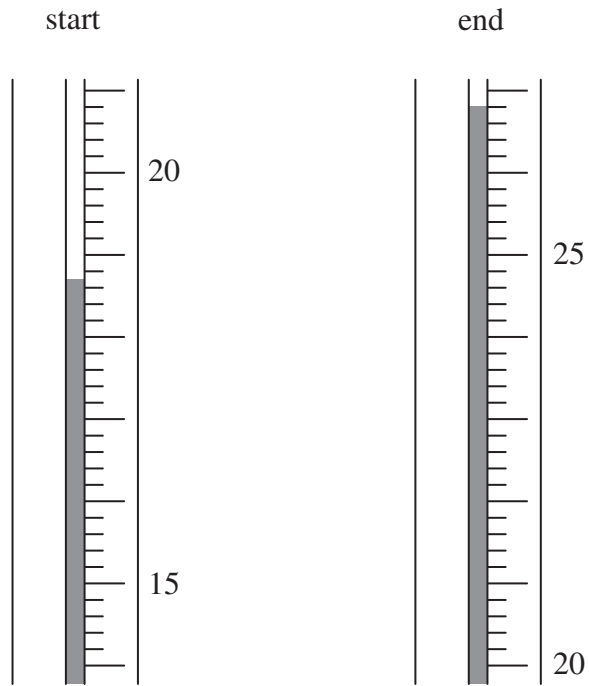
- (i) State **two** variables that the students should keep the same to ensure that the experiment was valid.

(2)

1

2

(ii) The diagrams show the thermometer readings at the start and at the end of one of the experiments.



Record the temperatures and calculate the temperature rise in this experiment.

(3)

Temperature at start °C

Temperature at end °C

Temperature rise °C

(iii) Each experiment was repeated twice. The table shows the average temperatures obtained.

Metal and metal salt used	Average temperature rise in °C
Zn + CuSO ₄	12.2
X + CuSO ₄	8.3
X + ZnSO ₄	0.0
Cu + ZnSO ₄	0.0
Zn + XSO ₄	2.7
Cu + XSO ₄	0.0

Use these results to identify the more reactive metal in each of the following pairs.

(2)

Zn and X

Cu and X

(c) Write an equation for the reaction with a temperature rise of 2.7 °C.

(1)

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(d) Suggest why the students did not use calcium metal in their experiments.

(1)

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(Total for Question 1 = 10 marks)

2 The reactivity of metals can be studied using displacement reactions. In these reactions, one metal is added to a solution of a salt of a different metal.

If a displacement reaction occurs, there is a temperature rise.

A student used the following method in a series of experiments.

- Pour some metal salt solution into a polystyrene cup supported in a glass beaker and record the temperature of the solution.
- Add a known mass of a metal and stir.
- Record the maximum temperature of the mixture.

(a) Suggest **three** variables that should be kept the same for the student's experiments to be a fair test.

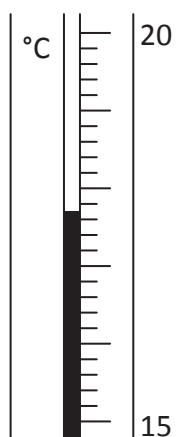
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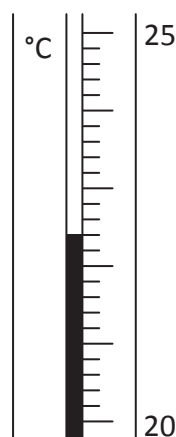
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3

(b) The student used a thermometer to measure the temperature rise. The diagrams show the thermometer readings before and after adding the metal.



before adding metal



after adding metal

Use the diagrams to complete the table.

(3)

Temperature after adding the metal in °C	
Temperature before adding the metal in °C	
Temperature change in °C	

- (c) The student used copper(II) sulfate solution in all her experiments. She used five different metals. She did not know the identity of the metal labelled **X**.

The student did each experiment twice. The table shows her results.

Metal	Temperature rise in °C		Average temperature rise in °C
	Run 1	Run 2	
magnesium	10.5	15.5	13.0
silver	0.0	0.0	0.0
iron	3.5	4.5	4.0
X	0.0	0.0	0.0
zinc	8.0	9.0	8.5

- (i) Which of the metals gave the least reliable temperature rise?

Explain your choice.

(2)

Metal

Explanation

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- (ii) Identify the most reactive of the metals used.

Explain how the results show that it is the most reactive.

(2)

Metal

Explanation

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- (iii) Why is there no temperature rise when silver is added to copper(II) sulfate solution?

(1)

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(iv) Why do the results make it impossible to decide which of the metals is the least reactive?

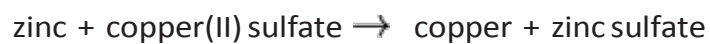
(1)

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(d) A word equation for one of the reactions is



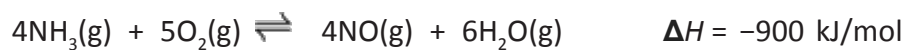
Write a chemical equation for this reaction.

(1)

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(Total for Question 2 = 13 marks)

3 The equation for a reaction that occurs in the manufacture of nitric acid is



(a) (i) State the meanings of the symbols \rightleftharpoons and ΔH .

(2)

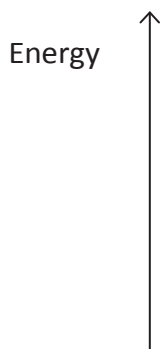
ΔH

(ii) What does the negative sign of ΔH indicate about the reaction?

(1)

(b) Complete the energy level diagram for this reaction.

(2)



(c) Typical conditions used for this reaction are a temperature of 900 °C and a pressure of 10 atmospheres.

Deduce the effects of changing the conditions as shown in the table. Choose from the words **increased**, **decreased** or **unchanged** to complete the table.

(4)

Change	Effect on rate of reaction	Effect on yield of products
increase in temperature		
addition of catalyst		

(d) A manufacturer considers using a pressure of 5 atm instead of 10 atm.

(i) Predict and explain the effect on the rate of reaction of changing the pressure to 5 atm.

(3)

Effect on rate of reaction

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Explanation

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(ii) Predict and explain the effect on the position of equilibrium of changing the pressure to 5 atm.

(2)

Effect on position of equilibrium

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Explanation

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(e) Balance the equation that represents the last stage in the manufacture of nitric acid.



(1)

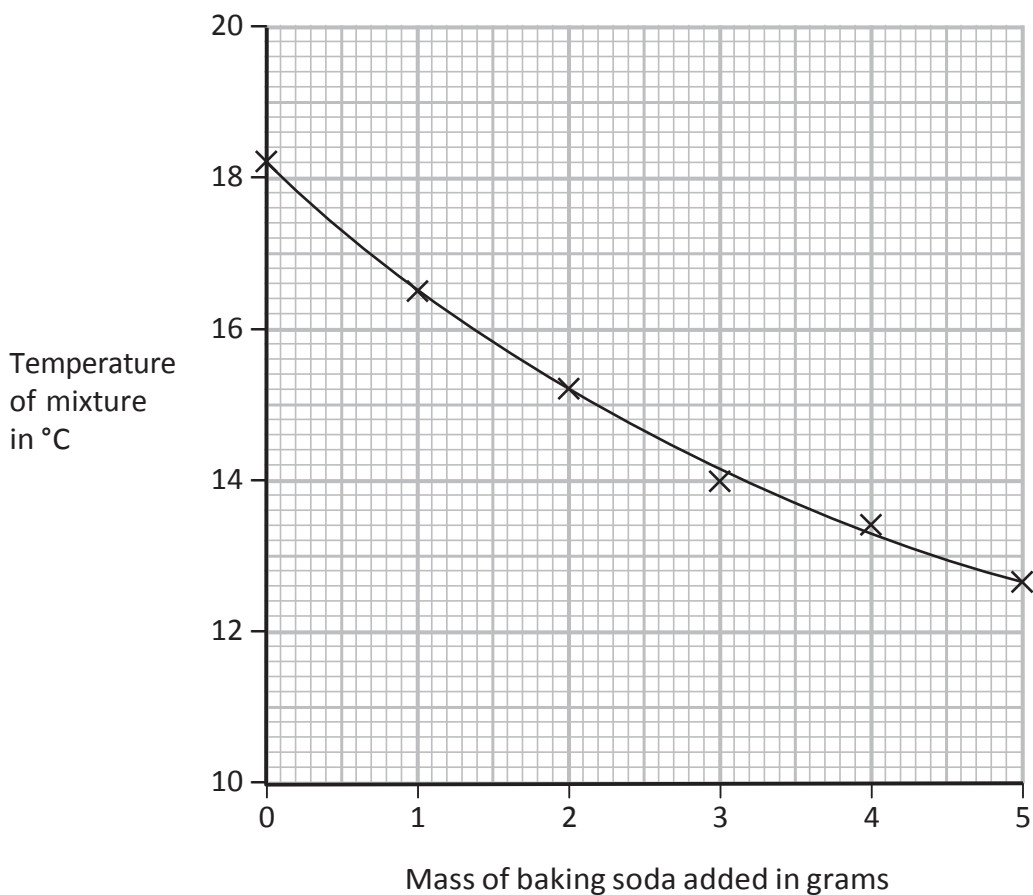
(Total for Question 3= 15 marks)

4. A teacher asked her students to suggest some experiments that could be done using chemicals found in the home. One student planned an experiment to measure the temperature change when baking soda is added to vinegar.

She wrote this plan.

- pour 100 cm³ of vinegar into a polystyrene cup
- weigh out five separate 1 g portions of baking soda
- measure the temperature of the vinegar
- add 1 g of baking soda to the vinegar and stir
- record the new temperature
- add the other portions of baking soda, stirring and recording the temperature after each portion is added

The graph shows her results.



(a) The student said that the reaction in her experiment was not complete.

How does the graph support her statement?

(1)

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(b) The student used a polystyrene cup rather than a glass beaker.

Why is it better to use a polystyrene cup?

(1)

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(c) Vinegar contains ethanoic acid. Baking soda contains sodium hydrogencarbonate.

The student found this equation for the reaction:



(i) There is no colour change during this reaction.

Suggest one observation, other than the change in temperature, that could be made during the reaction.

(1)

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(ii) The compound CH_3COOH is an acid and the compound CH_3COONa is a salt.

The graph shows that the temperature goes down during the reaction.

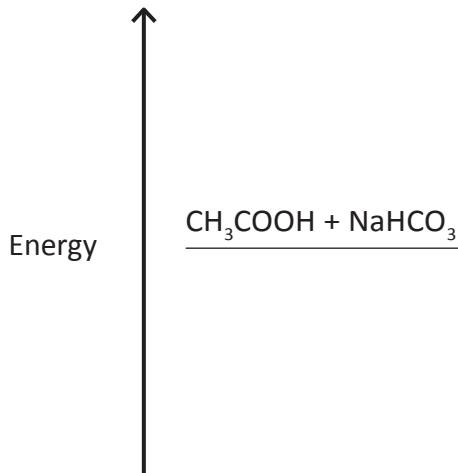
Use this information to state the two types of reaction occurring.

(2)

1

2

(d) (i) Complete the energy level diagram by showing the products of the reaction. (1)



(ii) Label the diagram to show the energy change, H , for the reaction. (1)

(e) The student repeated the experiment using the same method with a different sample of vinegar. She recorded these results.

Volume of vinegar = 100 cm³

Mass of baking soda = 5.0 g

Temperature at start = 18.7 °C

Temperature at end = 13.2 °C

(i) Calculate the heat energy change in this experiment using the expression

$$\text{heat energy change} = \text{volume of vinegar} \times 4.2 \times \text{temperature change} \quad (2)$$

Heat energy change = J

(ii) The student wanted to calculate the amount, in moles, of ethanoic acid in the vinegar.

Apart from the volume of vinegar, what other information would she need to be able to calculate the amount of ethanoic acid?

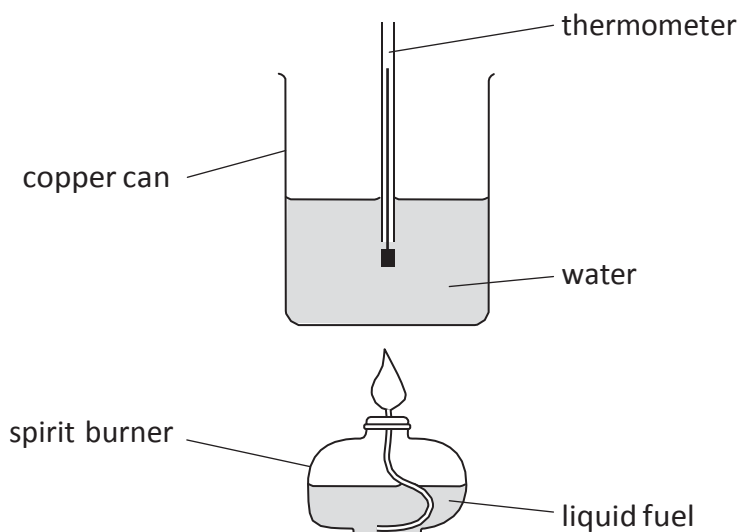
(1)

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(Total for Question 4 = 10 marks)

5 A student burned four liquid fuels in order to compare the amount of energy they released, in the form of heat.

She used this apparatus.



The energy released when each fuel was burned was used to raise the temperature of 100 g of water. For each fuel, the student recorded the mass of fuel burned and the increase in temperature of the water.

Her results are shown in the table.

Fuel	Average relative formula mass	Mass of fuel burned in g	Amount of fuel burned in mol	Increase in temperature in C
diesel	170	4	0.024	15
ethanol	46	3	0.065	10
methanol	32	2	0.063	5
petrol	114	1	0.009	4

The best fuel is the one that releases the most energy.

(a) The student suggested that petrol was the best fuel.

Explain why, using the information in the table.

(1)

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(b) Another student suggested that diesel was the best fuel.

Explain why, using the information in the table.

(1)

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(c) In another experiment, a student burned propanol and then used his results to calculate the energy released when one mole of propanol was burned.

He then compared his result with a value from a data book.

The values are shown in the table.

	Energy released per mole of propanol burned in kJ
Student's result	1020
Data book value	2010

Suggest two reasons why the student's result is lower than the data book value.

(2)

1

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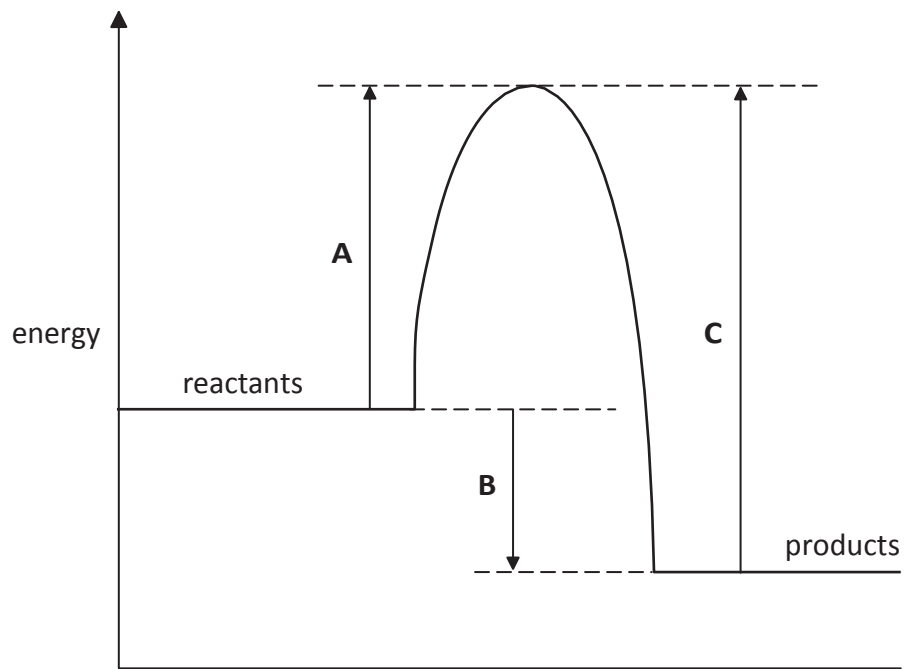
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(d) The diagram shows the energy profile for burning a fuel.



Which of the energy changes A, B or C represents

- the activation energy for the reaction
- the amount of energy given out during the reaction?

(2)

Activation energy =

Energy released =

(e) Explain, in terms of bond breaking and bond making, why this reaction gives out energy.

(3)

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(Total for Question 5 = 9 marks)