New Document 1

Name: _____

Class: _____

Date: _____

Time: **36 minutes**

Marks: **36 marks**

Comments:

Q1.

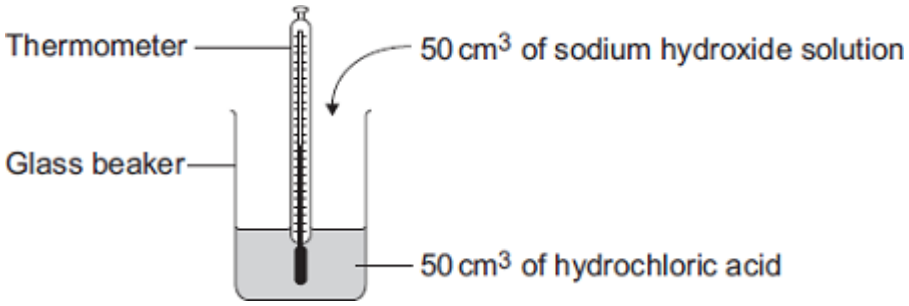
Read the information about energy changes and then answer the questions.

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

The equation which represents the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

The student used the apparatus shown in the diagram.



The student placed 50 cm^3 of hydrochloric acid in a glass beaker and measured the initial temperature.

The student then quickly added 50 cm^3 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.

_____

_____

(1)

(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.

Energy change in joules = 100 × 4.2 × 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

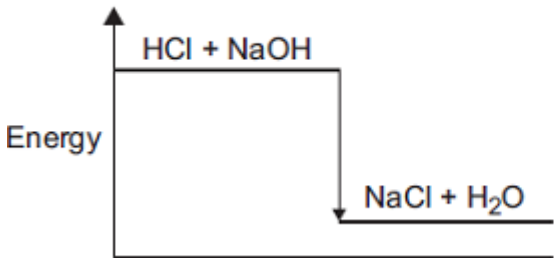
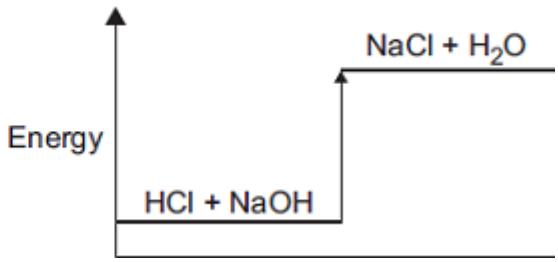


Diagram B



_____

_____

(1)

(Total 7 marks)

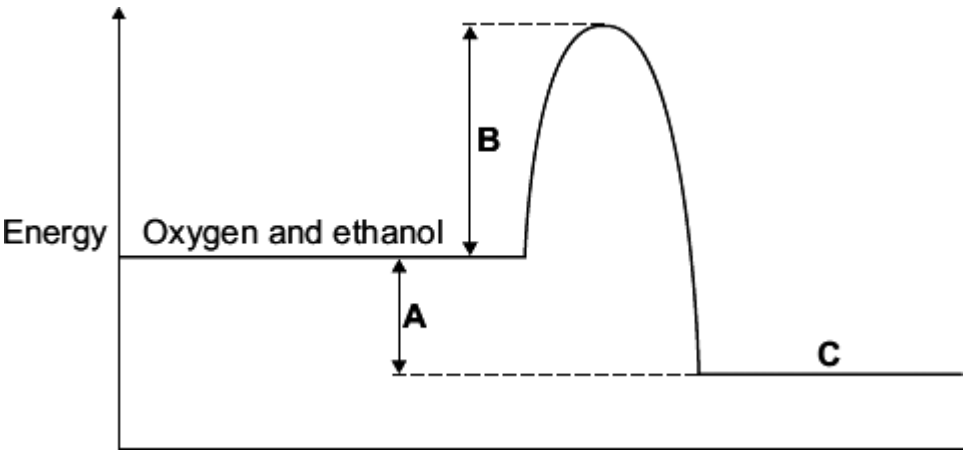
Q2.

V2 rockets were used during the Second World War.

By aronsson [CC BY-SA 2.0], via Flickr

V2 rockets were powered by liquid oxygen and ethanol. Oxygen and ethanol react to produce carbon dioxide and water.

The energy level diagram represents the energy changes during this reaction.



(a) On the energy level diagram what is represented by the letter:

A _____

B _____

C _____

(3)

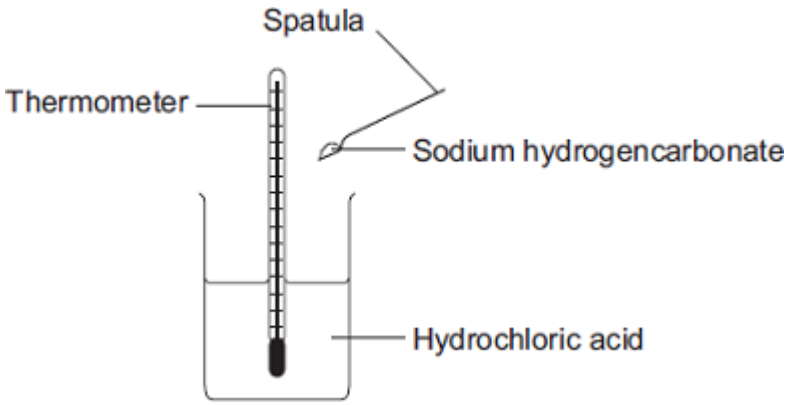
(b) What type of reaction is represented by this energy level diagram?

(1)

(Total 4 marks)

Q3.

(a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

(i) Describe, as fully as you can, the trends shown in the students' results.

(3)

(ii) State the type of energy transfer for this reaction.

(1)

(b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

The equation for the reaction is:

$$2\,NaHCO_3(s) \xrightarrow{\text{Heat}} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

(i) The cake mixture rises when baked.

© Michael Valdez/iStock

Use the equation to suggest why.

(1)

(ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

Do the reactants need to be heated?

Give a reason for your answer.

(1)

(c) (i) Calculate the relative formula mass of sodium hydrogencarbonate ($NaHCO_3$).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

_____

_____

_____

Relative formula mass (M_r) = _____

(2)

(ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

_____

_____

Percentage of carbon = _____ %

(1)

(Total 9 marks)

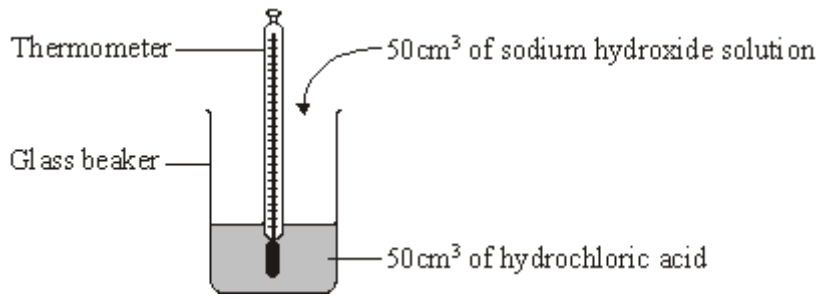
Q4.

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:

$HCl + NaOH \rightarrow NaCl + H_2O$

The student used the apparatus shown in the diagram.



The student placed 50 cm^3 of hydrochloric acid in a glass beaker and measured the temperature.

The student then quickly added 50 cm^3 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
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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.

_____

_____

(1)

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

_____

(1)

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

Explain 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.

energy change in joules = 100 × 4.2 × average temperature change

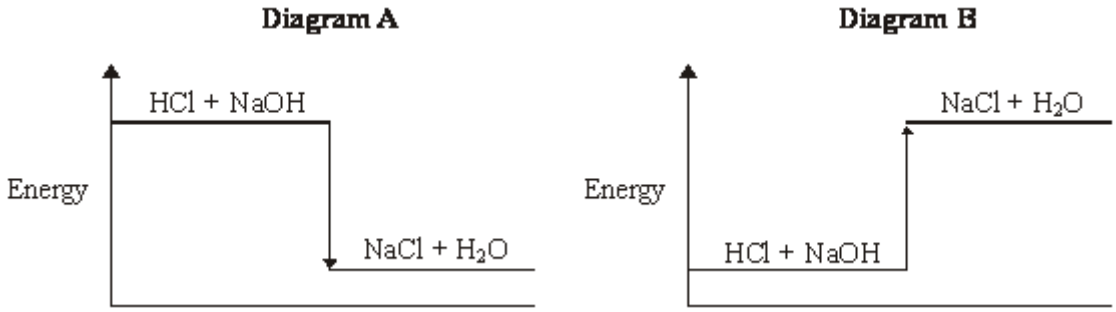
_____

Answer = _____ J

(1)

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

Explain why.



_____

_____

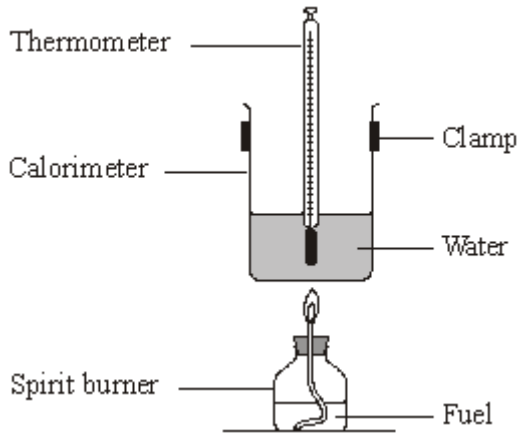
(1)

(Total 7 marks)

Q5.

A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase (°C)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky

Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

(a) The student suggested that the vegetable oil was the best fuel for producing heat.

Explain why.

_____

_____

_____

_____

(2)

(b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

_____

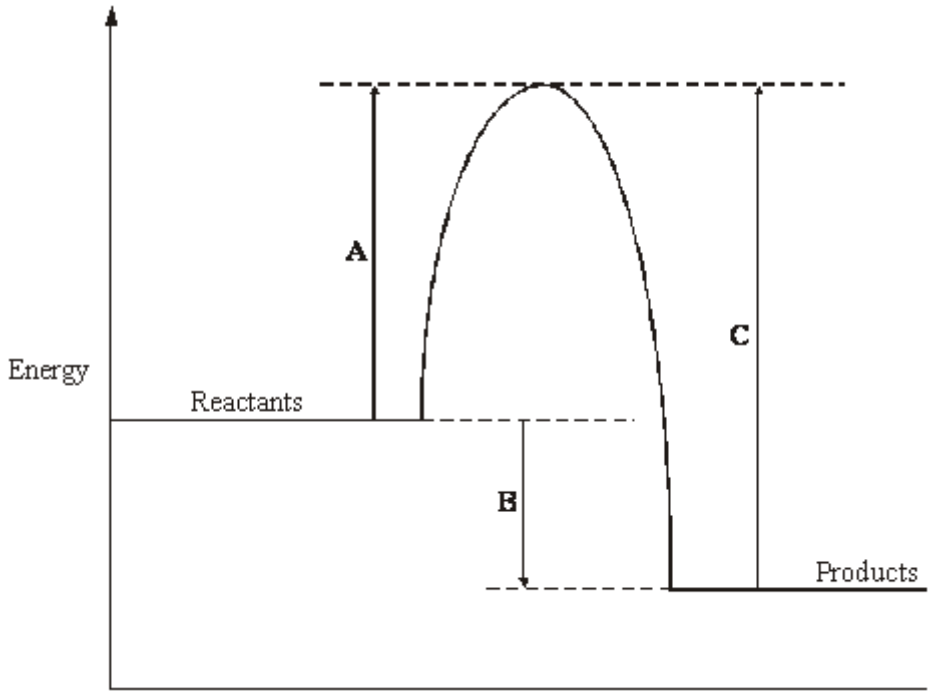
_____

_____

_____

(2)

(c) An energy level diagram for the burning of vegetable oil is shown below.



Which of the energy changes **A**, **B** or **C:**

(i) represents the activation energy

_____

(1)

(ii) shows the amount of energy given out during the reaction?

_____

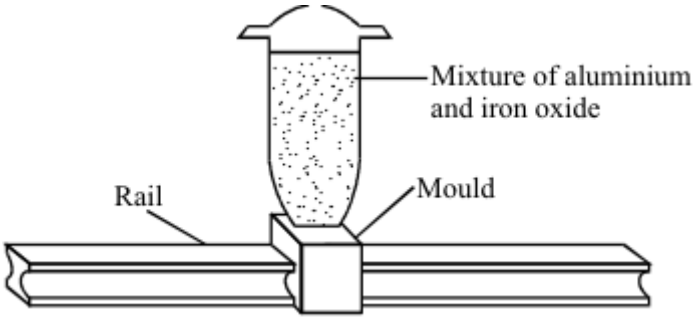
(1)

(Total 6 marks)

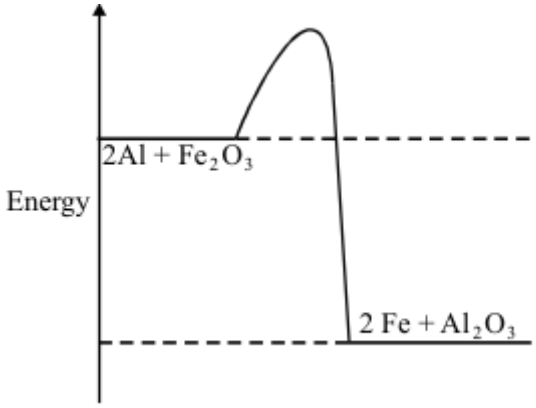
Q6.

The reaction between aluminium and iron oxide is used to weld together railway lines.

$$2Al(s) + Fe_2O_3(s) \rightarrow 2Fe(l) + Al_2O_3(s)$$



A simple, qualitative energy level diagram for this reaction is shown.



Use the energy level diagram to:

(i) describe the idea of activation energy;

_____

_____

(1)

(ii) explain why the reaction produces molten iron.

_____

_____

_____

_____

(2)

(Total 3 marks)

Mark schemes

Q1.

(a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed

any sensible modification to reduce heat loss

ignore prevent draughts

ignore references to gas loss

ignore bomb calorimeter

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

*do **not** accept rate of reaction increase / make reaction faster*

1

(c) experiment 2 **and**
different / higher / initial / starting temperature

*accept experiment 2 **and** the room is hotter / at higher temperature*

*do **not** accept temperature change / results higher*

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 × 4.2 × 7) = 2940

ecf from (e)

1

(g) diagram A **and**
reaction exothermic / heat evolved / Δ H 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) A = energy / enthalpy change / difference

*allow heat change **or** ∆H*

allow energy released

1

B = activation energy / EA

allow definition of activation energy

1

C = carbon dioxide and water

accept products

1

(b) exothermic

allow combustion / redox / oxidation

ignore reduction / burning

1

[4]

Q3.

(a) (i) the more sodium hydrogencarbonate the greater the temperature change

accept examples from the table

1

up to 8 spatula measures

accept any correct indication of when change occurs

1

then the temperature change is constant

*if no marks awarded allow **1** mark for:*
the more sodium hydrogencarbonate the lower the final temperature

1

(ii) energy is taken in from the surroundings **or** endothermic

1

(b) (i) gas / carbon dioxide / steam / water is produced

*accept carbon dioxide is a gas **or** steam / water is a gas*

allow gas / air expands when heated

1

(ii) no, because (reaction) is exothermic

or

yes, to start the reaction

allow no, because (reactants) were formed by heating

ignore references to cooling

1

(c) (i) 84

*correct answer with or without working gains **2** marks*

*if no answer or incorrect answer then evidence of 23 +1 + 12 + (3 × 16) gains **1** mark*

2

(ii) 14.29

accept rounding to 14.3 or 14

allow ecf from (c)(i)

1

[9]

Q4.

(a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed

any sensible modification to reduce heat loss

ignore prevent draughts

ignore references to gas loss

1

(b) all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat

accept to mix them

'so they react' is insufficient for the mark

accept increase chances of (successful) collisions / collision rate increase

*do **not** accept rate of reaction increase / make reaction faster*

1

(c) experiment 2 **and** different / higher / initial / starting temperature

*accept experiment 2 **and** the room is hotter / at higher temperature*

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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 <u>to the others</u>*

'results are different' is insufficient

1

(e) 7 / 7.0

1

(f) (100 × 4.2 × 7) = 2940

ecf from (e)

1

(g) diagram A **and** reaction exothermic / heat evolved / Δ H is negative / temperature rises

accept energy is lost (to the surroundings)

1

[7]

Q5.

(a) either:
calculations: all correct (ethanol = 6, methanol = 3, peanut oil = 10, vegetable oil = 15)

ignore repetition of data from table unqualified

or

implication of correct calculation

(vegetable oil) gives largest temperature / heat increase <u>per gram</u> (owtte)

allow 'produced most heat in proportion to the fuel used'
*owtte for **1** mark*

2

(b) any **one** from:

owtte

- smoke

  ignore references to crops/food
- soot
- carbon
- carbon monoxide
- carbon dioxide
- global warming / climate change / greenhouse gases
- (air) pollution
- harmful/poisonous

1

scrub / wash the gases owtte

filter / remove (gases / fumes / appropriate named substance) owtte

(add extra oxygen) can burn more efficiently owtte

use a cleaner fuel owtte

plant more trees or similar linked to CO_2

any sensible answer

'don't burn so much fuel' insufficient alone

ignore extractor fans / air conditioning

1

(c) (i) A

1

(ii) B

1

[6]

Q6.

(i) the energy needed by reactants before reaction can occur

accept energy required for particles to collide successfully

accept energy required to break bonds

accept energy needed to start reaction

1

(ii) reference to reactants 'energy' higher than products 'energy'

accept exothermic reaction

accept heat (energy) released

1

melting point of iron is exceeded

accept temperature is above melting point of iron

1

[3]