

Exothermic/Endothermic Changes and Basic Energy Profiles

Q1. (2018)

- 4 Ethanol can be used as a liquid fuel.

A student investigates how much heat energy is released when a known mass of ethanol is burned.

The apparatus is set up as shown in Figure 3.

A known volume of water is placed in a metal can.

The temperature of the water is measured.

The ethanol is ignited and placed under the beaker so that the flame is touching the beaker.

The water is heated by the flame.

The flame is extinguished.

The final temperature of the water is measured.

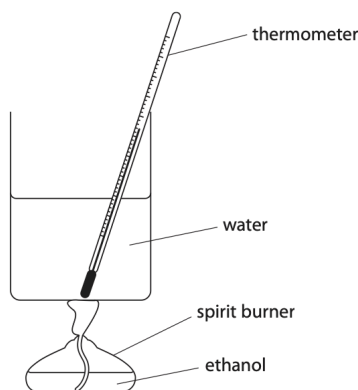


Figure 3

- (a) The theoretical temperature rise for burning a given mass of ethanol is 82.4°C .

In the experiment the actual temperature rise for burning this mass of ethanol was only 34.8°C .

One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

A)

- (i) Give a reason why, even if the ethanol burns completely, the actual temperature rise is much less than the theoretical value.

(1)

B)

- (ii) Explain how the method described above could be improved to give a temperature rise closer to the theoretical value.

(2)

Q2. (2018) – 6d (ii)

- (d) When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 9 shows the relative amounts of six of the fractions present in a crude oil and the relative demand for each of these fractions.

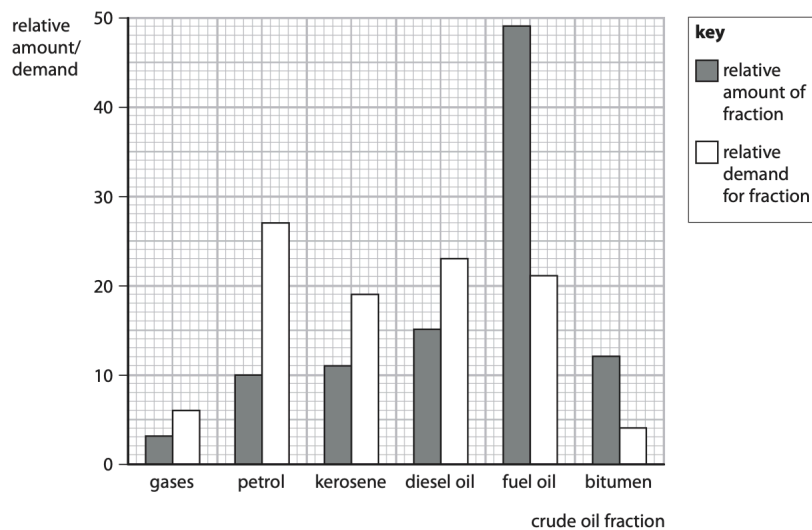


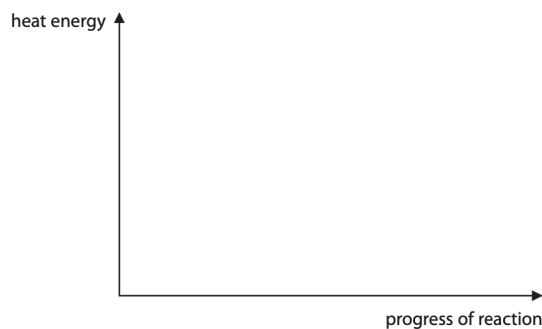
Figure 9

Cracking is used to match the relative amount of a fraction of crude oil to the demand for that fraction.

- (ii) In a cracking reaction, reactants are heated to form products.
This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction.
Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



Q3. (2019) – 4c

A)

- (c) (i) The apparatus in Figure 3 can be used to investigate the temperature rise produced in a known mass of water when a sample of ethanol is burned.

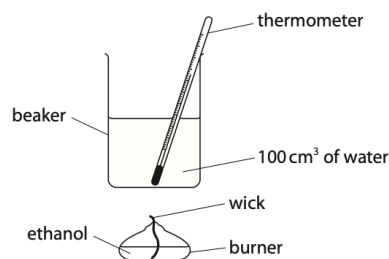


Figure 3

The first steps of the method are

1. put 100cm³ of water into a beaker
2. determine the mass of the burner containing ethanol
3. measure the initial temperature of the water
4. place the burner under the beaker of water
5. light the wick

Describe the remaining steps of the method that are needed to determine the mass of ethanol required to raise the temperature of the water by 30 °C.

(3)

B)

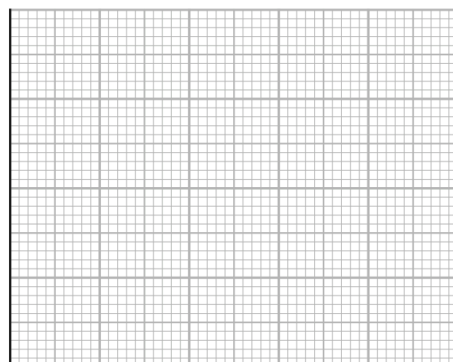
- (ii) In a different experiment, separate samples of the alcohols methanol, ethanol, propanol, butanol and pentanol were burned to determine the mass of each alcohol that needs to be burned to raise the temperature of 100 cm³ water by 10 °C.

alcohol	number of carbon atoms in one molecule of alcohol	mass of alcohol burned in g
methanol	1	0.37
ethanol	2	0.28
propanol	3	0.25
butanol	4	0.23
pentanol	5	0.22

Draw a graph of the mass of each alcohol required to raise the temperature of 100cm³ of water by 10 °C against the number of carbon atoms in one molecule of that alcohol.

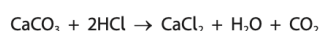
(3)

mass of alcohol
burned in g



number of carbon atoms in
one molecule of alcohol

- 8 Calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.



- (b) The reaction between calcium carbonate and dilute hydrochloric acid is exothermic.

Explain, in terms of bond breaking and bond making, why some reactions are exothermic.

(3)

Q5. (2021) – 2b

- (b) Dissolving ammonium chloride in water is an endothermic process. Figure 2 shows part of the reaction profile for this process.

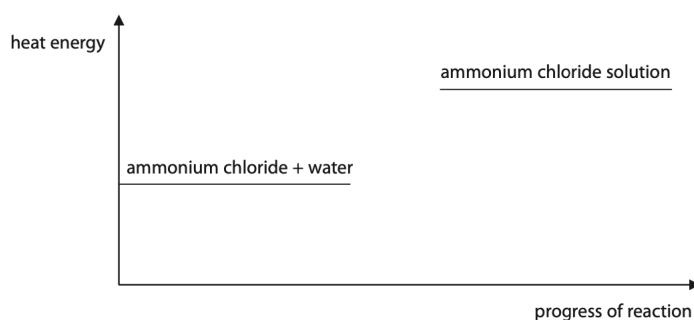


Figure 2

A)

- (i) Explain how Figure 2 shows that dissolving ammonium chloride in water is an endothermic process.

(2)

B)

- (ii) Complete the reaction profile in Figure 2 and label the activation energy.

(2)

Q6. (2022)

- 9 (a) In some chemical reactions, bonds are broken in the reactant molecules and new bonds are formed to make the product molecules.

- (i) Which row is correct about the energy changes for these processes?

(1)

energy change		
	breaking a bond	making a bond
☐ A	energy is released	energy is released
☐ B	energy is released	energy is absorbed
☐ C	energy is absorbed	energy is released
☐ D	energy is absorbed	energy is absorbed

Q7. (2022) – 10b (iii)

(b) Figure 15 shows the arrangement of atoms in a molecule of an alcohol.

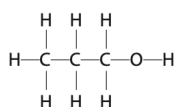


Figure 15

(iii) A student wants to investigate the amount of energy released when 1.00 g of the alcohol is burned.

They set up the apparatus shown in Figure 16 to measure the temperature rise of the water.

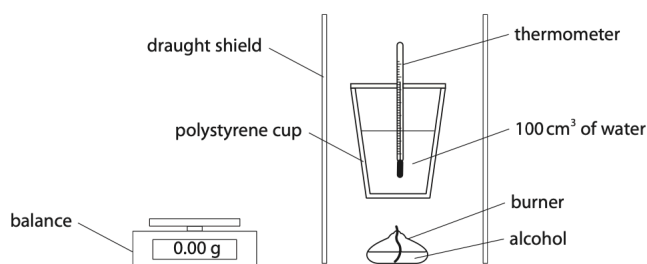


Figure 16

State why this apparatus is not suitable for use in this experiment.

(1)

Q8. (2023) – 1a, 1c

1 Butanol is a liquid fuel.

A student investigated the mass of butanol needed to increase the temperature of 100 cm³ of water by 1 °C.

The student used the following method.

step 1 add 100 cm³ of water to a beaker

step 2 measure the mass of a spirit burner containing butanol

step 3 measure the initial temperature of the water in the beaker

step 4 place the spirit burner containing butanol under the beaker of water

step 5 light the wick of the burner and start to stir the water with the thermometer

step 6 stop heating the water when the temperature of the water has increased by 30 °C

step 7 remeasure the mass of the spirit burner containing butanol.

Figure 1 shows the apparatus used.

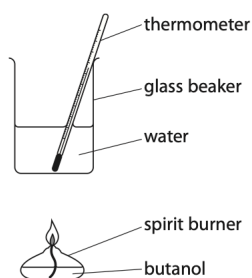


Figure 1

A)

(a) Figure 2 shows the student's results.

mass of spirit burner at start in g	mass of spirit burner at end in g
134.67	133.59

Figure 2

In the student's investigation, the temperature of the 100 cm³ water increased by 30 °C.

Calculate the mass of butanol needed to increase the temperature of the 100 cm³ water by 1 °C.

(2)

mass of butanol = ... g

B)

(c) Suggest **two** improvements that the student could make to their apparatus so that more of the heat energy is transferred to the water.

(2)

improvement 1

improvement 2

Q9. (2023) – 8b

8 Ammonia can be produced from the reaction of hydrogen with nitrogen.

(b) The reaction between hydrogen and nitrogen is exothermic.

Figure 13 shows the reaction profile of this exothermic reaction.

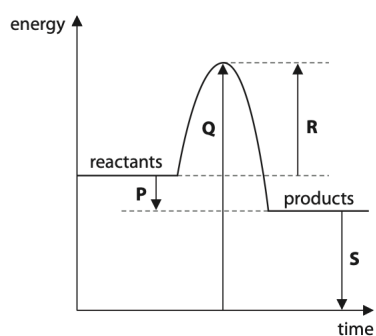


Figure 13

A)

(i) Which arrow represents the activation energy for the reaction?

(1)

- ☐ A arrow P
- ☐ B arrow Q
- ☐ C arrow R
- ☐ D arrow S

B)

(ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.

(2)

Q10. (2024) – 7b (ii)

- (ii) The reaction of potassium with water is exothermic.

On Figure 9, draw and label the reaction profile diagram for this reaction, labelling the activation energy.

(2)



Figure 9

Q11. (2024) – 7c

- (c) Some reactions are endothermic.

Explain, in terms of bond breaking and bond forming, why some reactions are endothermic.

(3)

Q12. (2024) – 10a (i, iii)

- 10 (a) Figure 13 shows the apparatus used to burn different alcohols.

The mass of each alcohol required to raise the temperature of the water by 40°C is found.

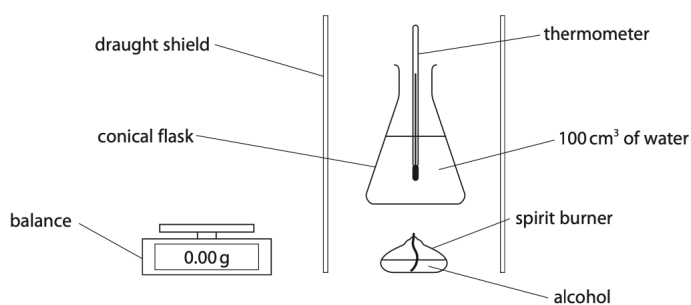


Figure 13

A)

- (i) State **one** variable, apart from the volume of water, that should be kept the same when each alcohol is burned.

(1)

B)

- (iii) The mass of ethanol used to raise the temperature of the water by 40°C is higher than the theoretical value.

The experiment is repeated and the same result obtained.

Give a reason why the mass of ethanol used is higher than expected.

(1)