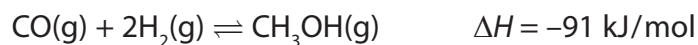


2 Carbon monoxide and hydrogen are used in the manufacture of methanol (CH₃OH).

The reaction is reversible and can reach a position of dynamic equilibrium.



The reaction is carried out at a pressure of about 100 atmospheres and a temperature of 250 °C.

(a) State two features of a reaction that is in dynamic equilibrium.

(2)

1

.....

2

.....

(b) (i) How would a decrease in temperature at constant pressure affect the amount of methanol in the equilibrium mixture?

Explain your answer.

(2)

.....

.....

.....

.....

(ii) How would an increase in pressure at constant temperature affect the amount of methanol in the equilibrium mixture?

Explain your answer.

(2)

.....

.....

.....

.....

(c) Methanol (CH_3OH) can be converted into methanal (H_2CO).

A mixture of methanol and oxygen is passed over an iron oxide catalyst at 250°C .

Methanal and water are the only two products.

(i) Write a chemical equation for the conversion of methanol into methanal.

(2)

(ii) What is meant by the term **catalyst**?

(2)

(iii) Explain how a catalyst works.

(2)

(d) Methanol can be used in racing cars as an alternative fuel to petrol.

Write the chemical equation for the complete combustion of methanol.

(2)

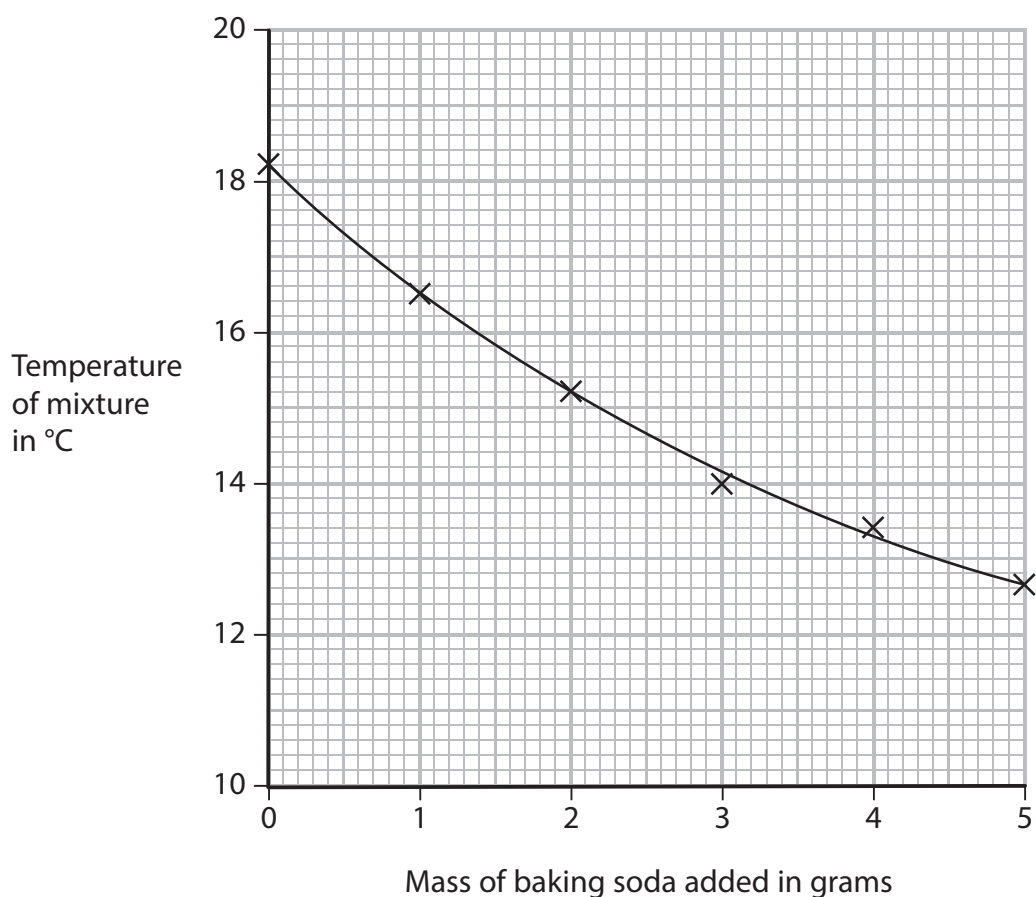
(Total for Question 2 = 14 marks)

- 1 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)

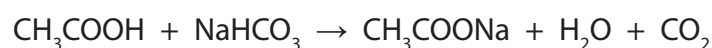
(b) The student used a polystyrene cup rather than a glass beaker.

Why is it better to use a polystyrene cup?

(1)

(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)

(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.

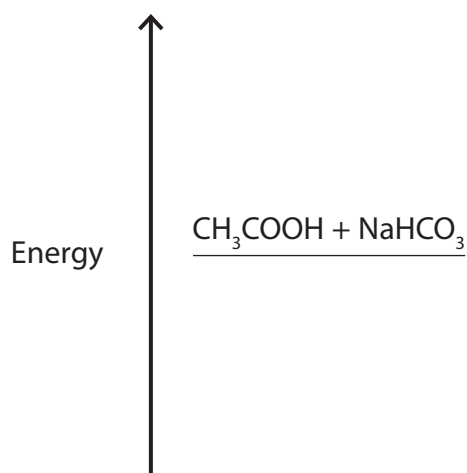
(2)

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, ΔH , 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 cm^3

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

heat energy change = volume of vinegar $\times$ $4.2 \times$ temperature change

(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)

.....
.....
(Total for Question 1 = 10 marks)