

Energy changes

Question Paper 3

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Energy changes- Physical Chemistry
Booklet	Question Paper 3

Time Allowed: 46 minutes

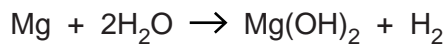
Score: /38

Percentage: /100

Grade Boundaries:

1 Magnesium powder is used to generate heat for battlefield soldiers wanting a hot drink.

9.0g of magnesium powder is added to 30.0g, an excess, of water.



(a) Calculate the amount, in mol, of magnesium.

..... mol [1]

(b) Calculate the mass of water that is in excess.

..... g [2]

(c) Calculate the volume of hydrogen gas, in dm^3 , produced at room temperature and pressure.

..... dm^3 [1]

(d) Use the standard enthalpy change of formation data in the table to calculate the standard enthalpy change of reaction for magnesium reacting with water.

substance	$\Delta_f H^\ominus / \text{kJ mol}^{-1}$
H_2O	-285.8
$\text{Mg}(\text{OH})_2$	-924.5

..... kJ mol^{-1} [2]

- (e) Calculate the heat energy, in kJ, released when 9.0 g of magnesium powder is added to 30.0 g of water.

..... kJ [1]

- (f) When the magnesium powder and water are mixed, the temperature of the drink being heated can rise to 60 °C in about 10 minutes.

Calculate how much energy, in kJ, is required to heat 150 g of the drink from 15 °C to 60 °C. Assume that the specific heat capacity of the drink is $4.2 \text{ J g}^{-1} \text{ K}^{-1}$.

..... kJ [1]

- (g) How would using 9.0 g of magnesium **granules** affect the amount of energy released, and the temperature reached by the drink? Explain your answer.

.....
.....
..... [2]

- (h) Exothermic reactions that do **not** produce hydrogen gas are being explored.

- (i) One example is mixing calcium oxide with water. Write an equation for this reaction and give the approximate pH of the resulting solution.

..... pH..... [2]

- (ii) Another example is the reaction of phosphorus(V) oxide with water. Write an equation for this reaction and give the approximate pH of the resulting solution.

..... pH..... [2]

- (iii) Calcium oxide reacts with phosphorus(V) oxide to make calcium phosphate(V). Write an equation for this reaction.

..... [1]

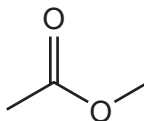
[Total: 15]

2. (a) Simple esters are flammable liquids. Flammability is affected by volatility. Write the following homologous series in order of boiling point, assuming molecular masses are similar.

alcohols	alkanes
highest boiling point
↑
lowest boiling point

[1]

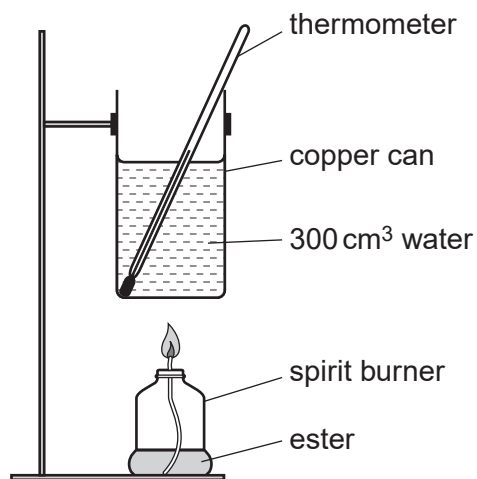
(b) The structure of methyl ethanoate, $C_3H_6O_2$, is shown below.



Write an equation for the complete combustion of methyl ethanoate.

.....[1]

(c) A student used the apparatus shown in the diagram to carry out experiments to determine the standard enthalpy change of combustion for ethyl ethanoate.



- mass of copper pot = 250g
- volume of water = 300 cm³

An initial experiment was carried out using methyl ethanoate. This ester was combusted in a spirit burner underneath a copper can so that the flame from the burner heated 300 cm³ of water in the can. It was found that 0.980g of ester was required to raise the temperature of the water in the can by 10.0 °C.

- (iii) The theoretical standard enthalpy change of combustion of methyl ethanoate is $-1592.1 \text{ kJ mol}^{-1}$. Calculate the total theoretical thermal energy in kJ released by the mass of methyl ethanoate combusted in this initial experiment.

..... kJ [2]

- (iv) Heat losses are significant but can be taken into account by using the known value of $\Delta_c H^\ominus$ of $-1592.1 \text{ kJ mol}^{-1}$ for methyl ethanoate. A similar experiment with ethyl ethanoate produced the following results.

mass of ethyl ethanoate combusted = 0.948 g

increase in temperature of 300 cm^3 water = 11.5°C

Calculate the most accurate possible value for the standard enthalpy change of combustion for ethyl ethanoate.

..... kJ mol^{-1} [4]

