Q1. (a) Define the term *standard enthalpy of formation*.

(3)

(b) State Hess's Law and use it, together with the data given in the table below, to calculate the standard enthalpy change for the following reaction.

$MgO(s) + 2HCl(g) \rightarrow MgCl_2(s) + H_2O(l)$

	MgO	HCl(g)	$MgCl_2$	H_2O
$\Delta H_f^{\ominus}$/kJ mol^{-1}	–602	–92	–642	–286

(4)

(c) In an experiment, an excess of solid magnesium oxide was added to 50 cm^3 of 3.0 mol dm^{-3} hydrochloric acid. The initial temperature of the solution was 21 °C. After reaction, the temperature had risen to 53 °C. (The specific heat capacity of water is 4.2 J K^{-1} g^{-1})

Use this information to calculate the enthalpy change for the reaction of one mole of magnesium oxide with hydrochloric acid. For your calculation you should assume that all the heat from the reaction is used to raise the temperature of 50 g of water.

(8)

(Total 15 marks)

Q2. (a) Write an equation for the complete combustion of propanone, C_3H_6O, to form carbon dioxide and water.

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(1)

(b) In a laboratory experiment, 1.45 g of propanone were burned completely in oxygen. The heat from this combustion was used to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

(i) Calculate the number of moles of propanone in the 1.45 g.

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(ii) Calculate the heat energy required to raise the temperature of 100 g of water from 293.1 K to 351.2 K.
(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

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(iii) Hence, calculate a value, in kJ mol^{-1}, for the enthalpy of combustion of propanone.

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(5)

(c) In a similar experiment, the enthalpy of combustion of butanone, C_4H_8O, was found to be –1290 kJ mol^{-1}. A data book value for the same reaction is $\Delta H_c^{\ominus}$ = –2430 kJ mol^{-1}.

(i) Suggest one reason why the experimental value is very different from the data book value.

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(ii) This data book value of $\Delta H_c^{\ominus}$ for butanone (–2430 kJ mol^{-1}) refers to the formation of carbon dioxide gas and water in the gaseous state. How would this value differ if it referred to the formation of water in the liquid state? Explain your answer.

Difference .....

Explanation .....

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(3)

(d) Calculate a value for the standard enthalpy of formation for liquid ethanethiol, C_2H_5SH. Use the equation given below and enthalpy of combustion data from the following table.

Substance	$C_2H_5SH(l)$	C(s)	$H_2(g)$	S(s)
$\Delta H_c^{\ominus}$ / kJ mol^{-1}	–1170	–394	–286	–297

$2C(s) + 3H_2(g) + S(s) \rightarrow C_2H_5SH(l)$

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(3)
(Total 12 marks)

Q3. A 50.0 cm^3 sample of a 0.200 mol dm^{-3} solution of silver nitrate was placed in a polystyrene beaker. An excess of powdered zinc was added to this solution and the mixture stirred. Zinc nitrate, $Zn(NO_3)_2$, and silver were formed and a rise in temperature of 3.20 °C was recorded.

(a) Write an equation for the reaction between silver nitrate and zinc.

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(1)

(b) Calculate the number of moles of silver nitrate used in the experiment.

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(2)

(c) Calculate the heat energy evolved by the reaction in this experiment assuming that all the energy evolved is used to heat only the 50.0 g of water in the mixture. (Specific heat capacity of water is 4.18 J g^{-1} K^{-1})

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(2)

(d) Calculate the heat energy change for the reaction per mole of zinc reacted.

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(2)

(e) Explain why the experimental value for the heat energy evolved in this experiment is less than the correct value.

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(1)
(Total 8 marks)