Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1091/01

CHEMISTRY CH1

P.M. MONDAY, 23 May 2011

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- copy of the **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 18 may be used for rough work.

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SECTION A

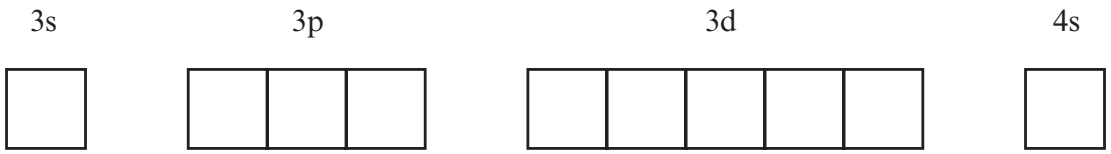
Answer **all** *questions in the spaces provided.*

1. Enter the number of protons, neutrons and electrons present in the atoms/ions listed in the table below.

Atom/ion	Number of protons	Number of neutrons	Number of electrons
^{24}Mg			
^{26}Mg			
$^{24}Mg^{2+}$			

[3]

2. By inserting arrows to represent electrons, complete the boxes below to show the electronic configuration of an iron atom, Fe. The 1s, 2s and 2p orbitals are assumed to be already filled.



[1]

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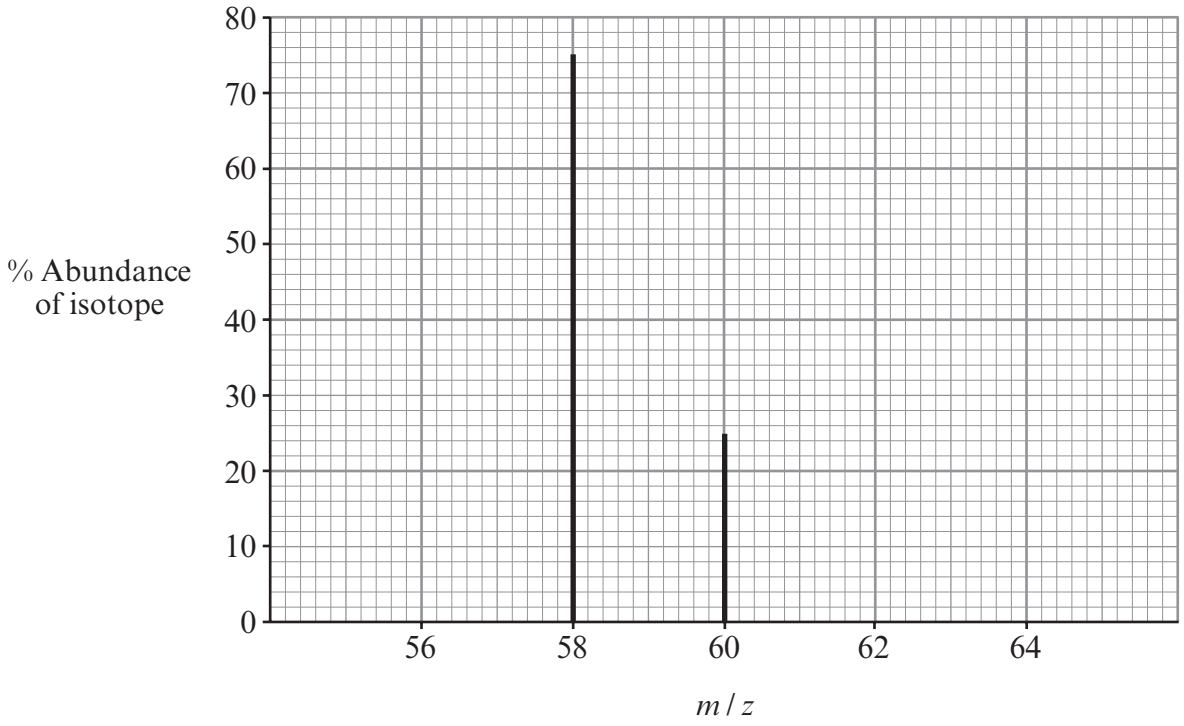
3. The mass spectrum of a sample of nickel is shown below.



Use the data to calculate the relative atomic mass of this sample to **three** significant figures. **You must show your working.** [1]

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4. State which of the following letters corresponds to the number of moles of each element in 53 g of sodium carbonate, Na_2CO_3, which has an M_r of 106.

	Na	C	O
A	0.5	0.5	0.5
B	1	0.5	3
C	1	0.5	1.5
D	2	1	3

[1]

Letter .....

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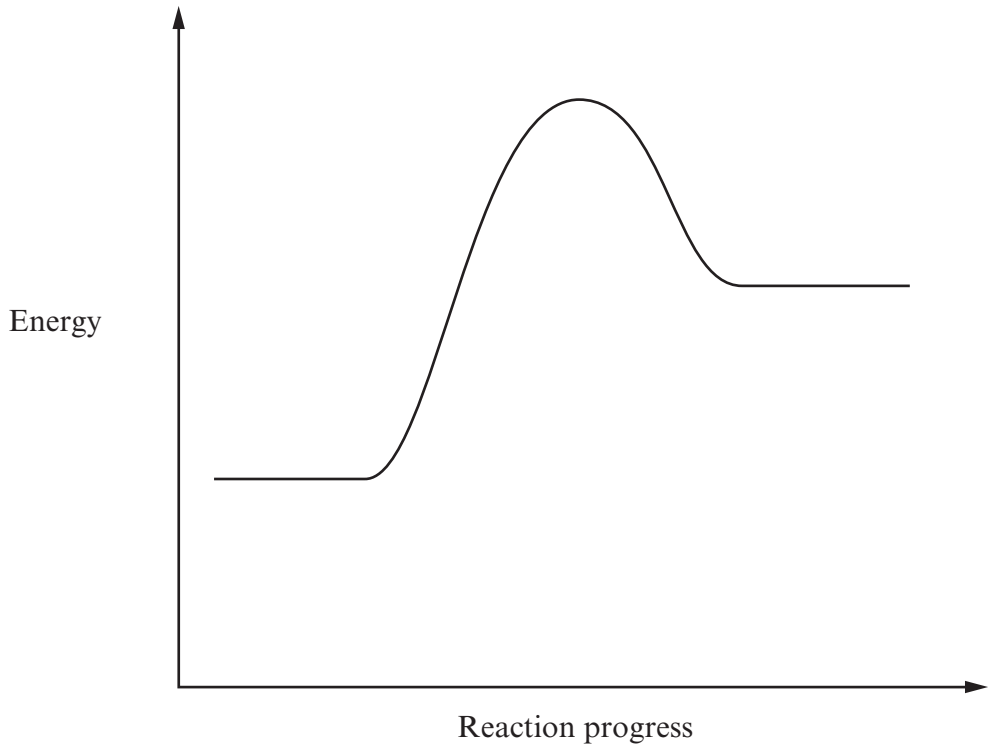
5. Label clearly on the energy profile diagram below the forward (E_f) and reverse (E_b) activation energies and the enthalpy change (ΔH) for the reaction. [2]



6. An oxide of nitrogen has a relative molecular mass of 92 and contains 30.4 % of nitrogen and 69.6 % of oxygen, by mass.

Calculate

(a) the empirical formula, [1]

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(b) the molecular formula of this oxide. [1]

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Section A Total [10]

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SECTION B

Answer **all** *questions in the spaces provided.*

7. An understanding of atoms is a vital part of chemistry and this is gained by studies of spectra, ionisation energies and radioactivity.

(a) Explain briefly the origin of atomic absorption spectra in terms of electron transitions. [2]

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(b) Describe the visible emission spectrum of a hydrogen atom and explain, in terms of the atom's electronic structure, why it does not consist of a continuous, rainbow-like spectrum. [3]

QWC [1]

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(c) Describe and explain the **general** change in ionisation energies

(i) across a period e.g. from Na to Ar, [2]

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(ii) down a group e.g. from Li to Cs. [2]

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(d) Complete the table below to show the effects that the emission of alpha, beta and gamma radiation have on the atomic number and mass number of a radioactive atom (by inserting e.g. +1, –2, etc). [3]

Radiation	Effect on atomic number	Effect on mass number
alpha particle		
beta particle		
gamma radiation		

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(e) (i) The half-life of carbon-14 is 5500 years and that of uranium-238 is 4.5 billion years. State what is meant by the *half-life* of an isotope and explain in principle how knowledge of such half-lives is useful in studies of rocks **or** ancient organic objects. [2]

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(ii) Give **two other** uses of radioactive materials in analysis, industry or medicine. [2]

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Total [17]

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8. *(a)* Chloroethane, C_2H_5Cl, can be made from ethene by the addition of hydrogen chloride, HCl.

$$C_2H_4 + HCl \longrightarrow C_2H_5Cl \qquad \text{Reaction } \mathbf{A}$$

M_r values	28.0	36.5	64.5

(i) Calculate the maximum possible (theoretical) mass of chloroethane obtainable from 42.0 g of ethene. [2]

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(ii) The actual mass of chloroethane obtained from 42.0 g of ethene in an experiment was 79.0 g. Calculate the percentage yield in this experiment. [2]

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(b) Chloroethane can be formed by another reaction as in the following equation.

$$C_2H_5OH + NaCl + H_2SO_4 \longrightarrow C_2H_5Cl + NaHSO_4 + H_2O \qquad \text{Reaction } \mathbf{B}$$

M_r values	46.0	58.5	98.0	64.5	120	18.0

(i) Describe what is meant by *atom economy*. [1]

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(ii) Calculate the % atom economy for reactions **A** and **B**. [2]

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(iii) State which of reactions **A** and **B** is preferred, giving your reason. [1]

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(c) Describe how industry is adapting to the challenges of *Green Chemistry*. Your answer should include reference to the

- overall aim of Green Chemistry,
- materials used or produced,
- energy used. [3]

QWC [1]

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Total [12]

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9. This question is about equilibria in seawater and the effect of carbon dioxide from burning fuels on the acidity of seawater. It involves the use of Le Chatelier's principle.

(a) State *Le Chatelier's principle*. [1]

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(b) Describe in simple terms what is meant by pH. [1]

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(c) About half of the carbon dioxide formed by burning fossil fuels dissolves in the oceans. The equilibrium may be written simply as:

$$CO_2 + H_2O \rightleftharpoons H^+ + HCO_3^-$$

(i) State, giving a reason in both cases, the effect that increasing carbon dioxide concentrations have on

I the ocean's acidity, [1]

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II the pH of seawater. [1]

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(ii) Another important equilibrium in the ocean is that between hydrogencarbonate and carbonate ions.

$$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$$

State, giving a reason, the effect of increasing acidity on the amount of carbonate present. [1]

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(iii) Many animals in the ocean make shells of calcium carbonate using the equilibrium:

$$Ca^{2+}(aq) + CO_3^{2-}(aq) \rightleftharpoons CaCO_3(s)$$

Using your answer to parts (i) and (ii), state and explain the effect of increasing acidity on their ability to make shells. [1]

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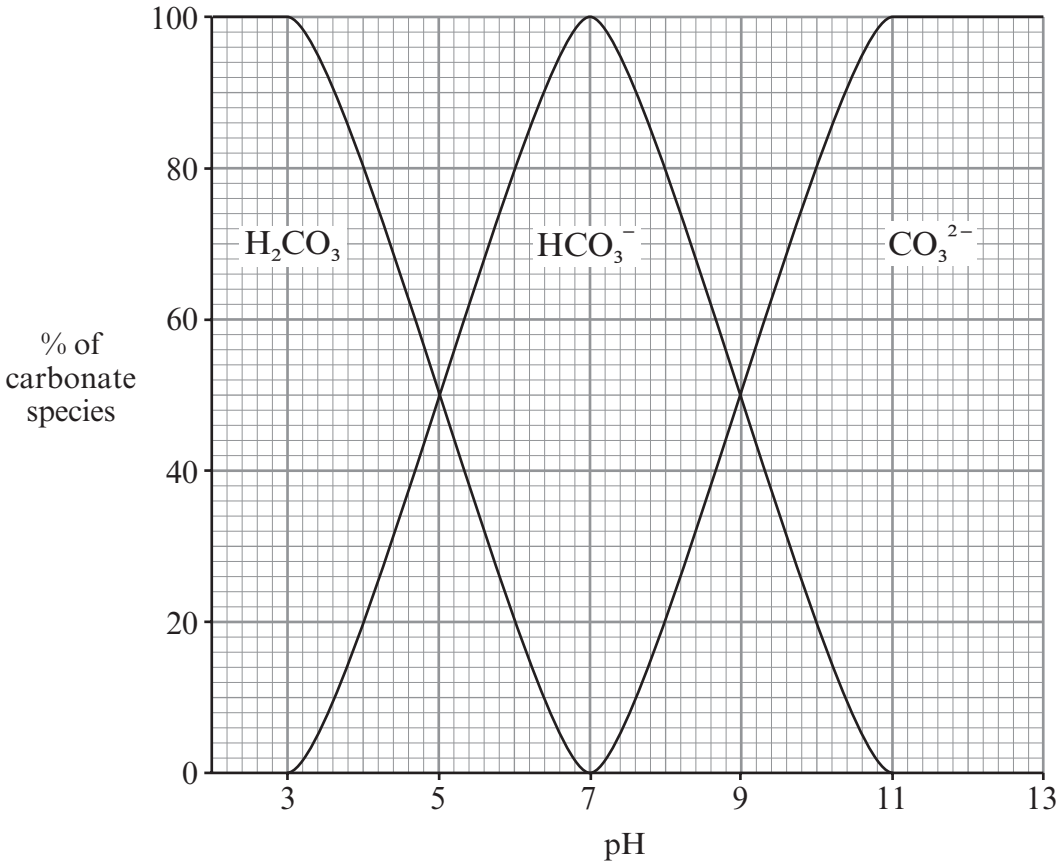
(d) The plot below shows how the proportions of the three carbonate species in the ocean change with pH.



Using the graph, find the pH of the ocean if it contains 90% hydrogencarbonate ions and 10% carbonate ions. [1]

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(e) A study of a model ocean included measuring a hydrogencarbonate concentration by titrating with acid.
25.00 cm^3 of hydrogencarbonate solution was neutralised by 19.60 cm^3 of hydrochloric acid of concentration 0.095 mol dm^{-3}, the equation being:

$$HCO_3^- + H^+ \longrightarrow H_2CO_3$$

Calculate the concentration of hydrogencarbonate ions in the solution. [2]

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Total [9]

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10. Measuring the rates of chemical reactions is very important in industrial processes, environmental studies and medical work.

(a) Name **three** factors that can affect the rate of a chemical reaction. [3]

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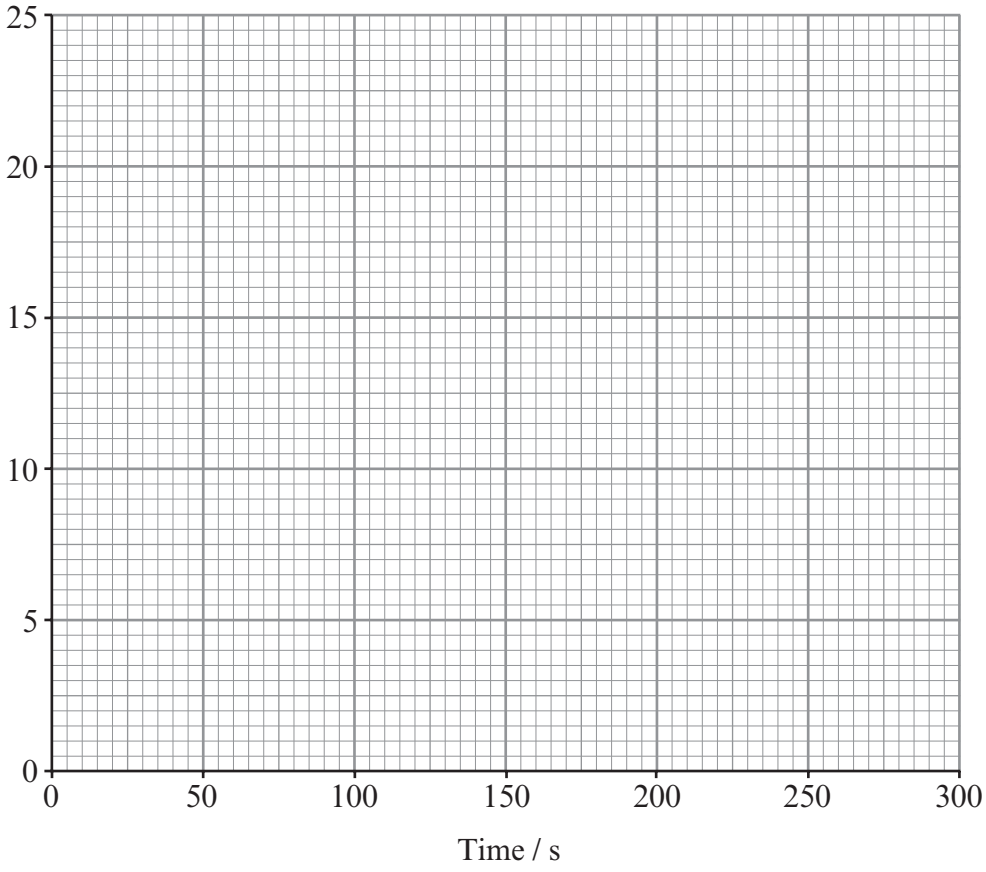
(b) The following results were obtained in an experiment to find the rate of decomposition of hydrogen peroxide.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

Time / s	0	50	100	150	200	250	300
Volume O_2 / cm^3	0	5.0	10.0	14.8	19.0	22.5	25.0

(i) Plot these results on the grid below and calculate the initial rate of reaction from your plot. **Show your working and state the units for the rate**. [5]



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(ii) State how the rate of reaction changes over time and give a reason for any difference. [2]

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(iii) Describe briefly how this experiment could be carried out. [2]

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(c) Using collision theory for a reaction such as

$$A(g) + B(g) \longrightarrow C(g)$$

explain why the rate of reaction depends on both the pressure of the reactants and the temperature. [4]

QWC [1]

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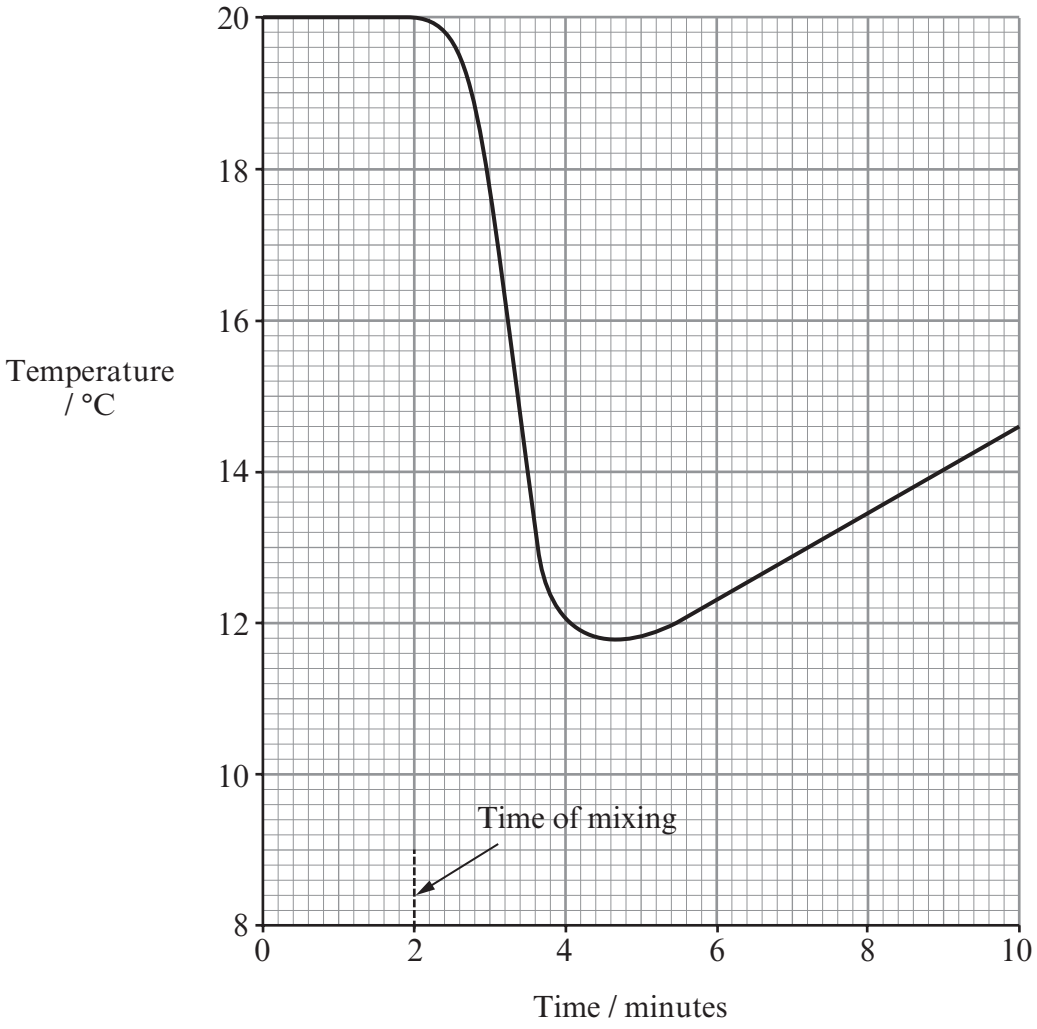
Total [17]

Examiner only

11. The study of energy changes is important in chemistry and concerns most aspects of modern life such as the efficiency of fuels.

(a) The plot below resulted from an experiment to find the enthalpy change that occurs when sodium nitrate(V), $NaNO_3$, is dissolved in water.



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(i) Describe how you could carry out such an experiment, using a diagram if you wish. [4]

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(ii) Using the plot and drawing lines where necessary, find ΔT and thus calculate ΔH using the equation

$$\Delta H = \frac{-mc\Delta T}{n} \text{ Jmol}^{-1}$$

where the mass of water (m) was 50 g, the heat capacity (c) was 4.2 J g^{-1} K^{-1} and the amount of nitrate used (n) was 0.10 mol. [4]

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ΔH = ... kJ mol^{-1}

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(b) (i) State *Hess's Law*. [1]

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(ii) Use this law to calculate the enthalpy change when sulfur trioxide and water react to form sulfuric acid.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

The standard enthalpy changes of formation of the compounds ($\Delta H_f^{\ominus}$) are given in the following table.

Compound	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
H_2O	–286
SO_3	–395
H_2SO_4	–811

[2]

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(c) State what is meant by the *average bond enthalpy* of an O—H bond and explain why the word *average* must be used. [2]

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(d) The most important chemical reactions in terms of tonnage used are the combustion of coal and hydrocarbons to produce energy. There are major problems arising from these combustion reactions. Describe **one** such problem and discuss what can be done about it. [2]

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Total [15]

Section B Total [70]

Rough Work

WJEC CBAC

GCE AS/A level

1091/01-A

CHEMISTRY
PERIODIC TABLE FOR USE WITH CH1

P.M. MONDAY, 23 May 2011

THE PERIODIC TABLE