Candidate Name	Centre Number	Candidate Number
		2

GCE A level

336/01

CHEMISTRY CH6a

A.M. THURSDAY, 18 June 2009

1 hour 10 minutes

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1	
B	2	
C	3	
	4	
TOTAL MARK		

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

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

Section A Answer the question in the spaces provided.
Section B Answer the question in the spaces provided.
Section C Answer **both** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)**, **Section B (15 marks)** and **Section C (25 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 50.

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 13 may be used for rough work.

Examiner only

SECTION A

Answer the questions in the spaces provided.

1. *(a)* One test for carbon dioxide is to react it with a solution of calcium hydroxide (limewater). Give the equation for the reaction that occurs, complete with state symbols. [1]

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(b) The solubility of calcium hydroxide at a certain temperature is 0·1186 g in 100 cm^3 of water. Calculate the concentration of this solution in mol dm^{-3}. [2]

.....

.....

..... mol dm^{-3}

(c) Identical samples of powdered calcium carbonate were added, in turn, to 50 cm^3 (an excess) of hydrochloric acid of concentration 2·00 mol dm^{-3} and to ethanoic acid of the same volume and concentration. Both reactions were at the same temperature. Explain why hydrochloric acid, the stronger acid, produced carbon dioxide at a faster rate than when using ethanoic acid. [1]

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(d) In another experiment, calcium carbonate and hydrochloric acid were reacted in identical amounts to those used in *(c)*, but this time the reaction was followed at different starting temperatures.

(i) Explain why, as the temperature rises, the rate of the reaction becomes faster. [1]

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(ii) Describe what would be seen when a few cm^3 of silver nitrate solution were added to the solution used in *(d)*. [1]

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(e) (i) Another Group IV oxide, silicon(IV) oxide, SiO_2, has a giant covalent structure, which is similar in structure to diamond. Use this information to put ticks in the appropriate places in the table below to describe the properties of SiO_2. [1]

Melting temperature / °C		*Conducts electricity as a solid*		*Conducts electricity when molten*	
High	Low	Yes	No	Yes	No

(ii) When silicon(IV) oxide is strongly heated with magnesium and the mixture obtained is added to water, silane, SiH_4, is produced as a gas.
Use the valence shell electron pair repulsion (VSEPR) principle to state the shape of the silane molecule, explaining your answer. [2]

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(iii) Write an equation for the combustion of gaseous silane to produce silicon(IV) oxide as one of the products. [1]

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Section A Total [10]

SECTION B

2. *Read the passage below and then answer the questions (a) to (h) in the spaces provided.*

The preparation and reactions of some chromium(VI) compounds

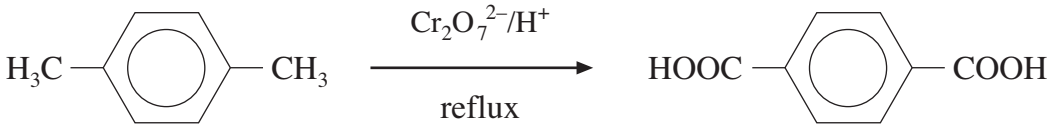
Chromium is present in many minerals but the only commercial source for chromium and its compounds is the ore chromite. This is a complex oxide of iron and chromium of formula $FeO.Cr_2O_3$. The main starting material for making chromium(VI) compounds is sodium chromate(VI), Na_2CrO_4. This is made by mixing chromite powder with sodium carbonate, and then heating the mixture in a large rotary kiln in the presence of air.

$$2FeO.Cr_2O_3 + 4Na_2CO_3 + 3\tfrac{1}{2}O_2 \longrightarrow 4Na_2CrO_4 + Fe_2O_3 + 4CO_2$$

Water is then added to the cooled product from the kiln, when the sodium chromate(VI) dissolves, leaving insoluble iron(III) oxide. The sodium chromate(VI) solution is acidified to produce an orange solution of sodium dichromate(VI) from which crystals are obtained by the evaporation of this solution.

There is a market for potassium dichromate(VI), $K_2Cr_2O_7$. This is obtained from sodium dichromate(VI) solution by adding potassium chloride. Potassium dichromate(VI) is much less soluble, at room temperature, than the other compounds present in this solution.

Both dichromates, in acidic solution, have important uses as oxidising agents in organic chemistry and are reduced themselves to chromium(III) compounds during these reactions. One example of this is the oxidation of 1,4-dimethylbenzene to benzene-1,4-dicarboxylic acid.



When chromium(VI) dichloride dioxide, CrO_2Cl_2, is used instead of the dichromates, milder oxidation of the side chain occurs giving an aldehyde.
For example ethylbenzene gives phenylethanal.

Chromium(VI) dichloride dioxide, a covalently bonded dark red liquid, reacts violently with water, giving hydrochloric acid as one of the products.

— End of passage —

Examiner only

(a) Chromite, $FeO.Cr_2O_3$, contains iron in oxidation state +2.
Calculate the oxidation state (number) of chromium in chromite. [1]

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.....

(b) 1120 kg of chromite (M_r 224) is converted to sodium chromate(VI), (M_r 162).
Use the equation given in the passage to help you calculate the maximum mass of sodium chromate(VI), in kilograms, that can be obtained. [2]

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.....

..... kg

(c) Potassium dichromate(VI) crystals are made by adding potassium chloride to an aqueous solution of sodium dichromate(VI) and then cooling the mixture in ice.
After filtering, the crystals of potassium dichromate(VI) are washed with a very small quantity of water and then dried.
Explain why

(i) the mixture is cooled in ice, [1]

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(ii) the crystals are washed with a small quantity of cold water. [1]

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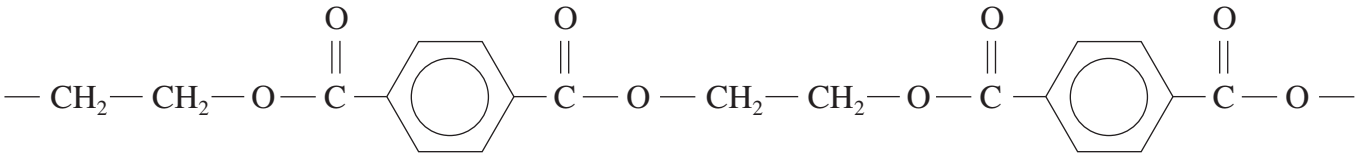
(d) (i) Part of the structure of a polyester is shown below.

This is made from benzene-1,4-dioic acid and Compound **F**.



I. **Name** Compound **F**. [1]

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II. Name the other compound that is formed when this polyester is made from benzene-1,4-dioic acid and Compound **F**. [1]

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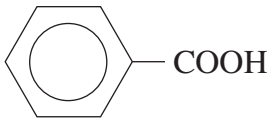
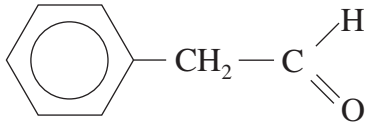
(ii) There is much interest in the development of biodegradable polyesters, of which an example is 'Biopol'. This is made by reacting sucrose with a specific micro-organism. It consists of long chains of condensed 3-hydroxybutanoic acid and 3-hydroxypentanoic acid units.

Draw the graphic (full structural) formula of 3-hydroxybutanoic acid. [1]

(e) The oxidation products of ethylbenzene include benzenecarboxylic acid and phenylethanal.



benzenecarboxylic acid



phenylethanal

Giving the reagent(s) and the result of the test in each case, describe a test that gives a positive result for

(i) the carboxylic acid group in benzenecarboxylic acid, [1]

.....

.....

(ii) the aldehyde group in phenylethanal. [1]

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(f) Chromium(VI) dichloride dioxide reacts violently with water.
Give an equation for the reaction of water with any covalently bonded chloride of your choice. [1]

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(g) A solution containing Cr^{2+} ions can be made by placing a suitable metal into a solution that contains Cr^{3+} ions.
Use the standard electrode potentials given in the table below to state and explain which metal(s) are able to produce Cr^{2+} ions in this way. [1]

System	*Standard electrode potential* $E^{\ominus}$ / V
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0·76
$Cr^{3+}(aq) + e^- \rightleftharpoons Cr^{2+}(aq)$	−0·41
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	−0·28
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0·34

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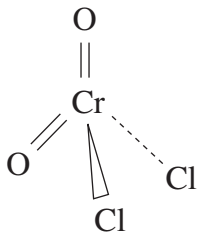
(h) Both chromium(VI) dichloride dioxide, CrO_2Cl_2, (boiling temperature 116 °C) and bromine (boiling temperature 69 °C) are covently bonded liquids. The relative molecular mass of each compound is almost the same.



Br — Br

Explain, using your knowledge of electronegativity and intermolecular forces, why the boiling temperature of the chromium compound is much higher than that of bromine. [3]

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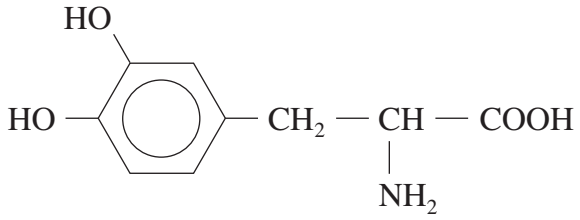
Section B Total [15]

Turn over.

SECTION C

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

3. *(a)* Compound **A**, commonly known as 'dopa' has important uses for the treatment of Parkinson's disease.



Compound **A**

(i) Identify the chiral centre in the formula of 'dopa' by using an asterisk (*). [1]

(ii) 'Dopa' contains a phenolic functional group.
State how you would test for a phenol, giving the result of the test.

Reagent ..... [1]

Observation(s) ..... [1]

(iii) 'Dopa' is an α-aminoacid.
Using the formula $R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$ to represent 'dopa', give the formula of the species produced when 'dopa' is added to a strongly alkaline solution, giving a reason for your answer. [2]

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(iv) A number of proteins act as enzymes to speed up biochemical processes. Proteins can be made from aminoacids.
Draw the chemical structure of the linkage present in all proteins that links aminoacids together. [1]

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(v) Enzymes react as homogeneous catalysts.
Give another example of a homogeneous catalyst and the system in which it is used. [1]

Catalyst .....

System .....

(b) The compound EDTA (ethylenediaminetetraacetic acid) and its salts are used in the treatment for metal poisoning and have extensive uses in analysis.

(i) One treatment for lead poisoning is for the patient to drink a solution of the sodium salt of EDTA. This compound bonds to the lead ions present by co-ordinate bonding and the lead can then be excreted from the body.
State what is meant by **co-ordinate bonding**. Use a dot and cross diagram to illustrate co-ordinate bonding in any example of your choice. [2]

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(ii) Soil contaminated by lead can be analysed by a titration using EDTA.
The lead present in a sample of contaminated soil of mass 24·00 g reacted with 40·00 cm^3 of a solution of EDTA of concentration 0·0100 mol dm^{-3}.
1 mole of lead ions react with 1 mole of EDTA.

I. Calculate the number of moles of EDTA present. [1]

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II. Use your answer to I. to find the mass of lead present in the soil sample. [1]

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III. Calculate the concentration of lead in the soil in g per kg of soil. [1]

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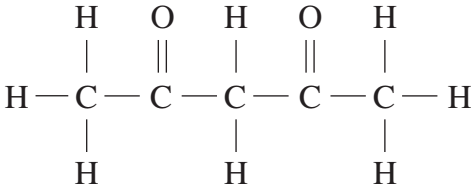
Total [12]

Examiner only

4. *(a)* Compound **B** is thought to be pentan-2,4-dione, which has the structure shown below.

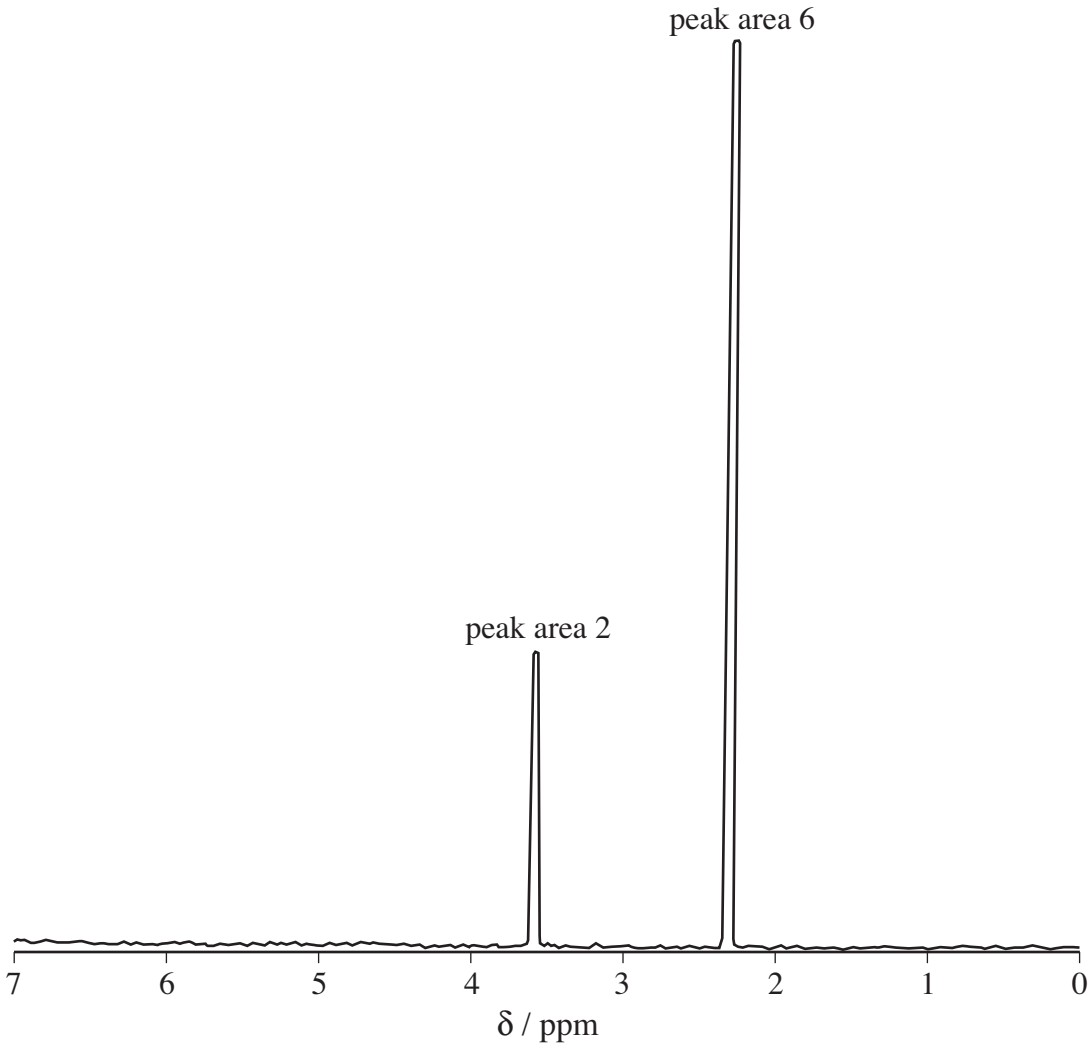


Describe a chemical test to show that Compound **B** contains the $CH_3C{=}O$ group.

Reagent ..... [1]

Observation ..... [1]

(b) A simplified high resolution NMR spectrum of Compound **B** is shown below. Use the spectrum to show that the compound is likely to be pentan-2,4-dione. [3]



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(c) Pentan-2,4-dione and aluminium ions form a complex of formula $(C_5H_7O_2)_3Al$, which has a relative molecular mass of 324.

'Alum' is a hydrated potassium aluminium sulphate, which has been used in the dyeing industry for hundreds of years.

(i) A sample of 'alum' of mass 12·0 g was reacted with pentan-2,4-dione to give 8·20 g of the complex.
Calculate the percentage of aluminium in the sample of 'alum'. [2]

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(ii) Describe a simple test to show that 'alum' contains potassium, giving the expected result. [1]

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(iii) All potassium compounds are feebly radioactive as they contain a very small percentage of the β-emitter, ^{40}K.

Give the mass number and the symbol of the isotope formed by the emission of one β-particle from one atom of the ^{40}K isotope. [1]

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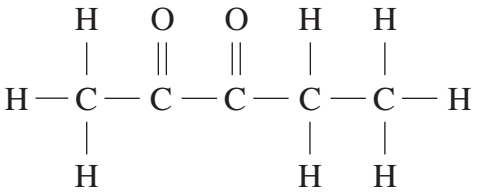
(d) The yellow liquid, pentan-2,3-dione is an isomer of pentan-2,4-dione.



pentan-2,3-dione

(i) State the name of a group producing colour in organic compounds. [1]

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(ii) Explain why pentan-2,3-dione appears yellow in white light. [1]

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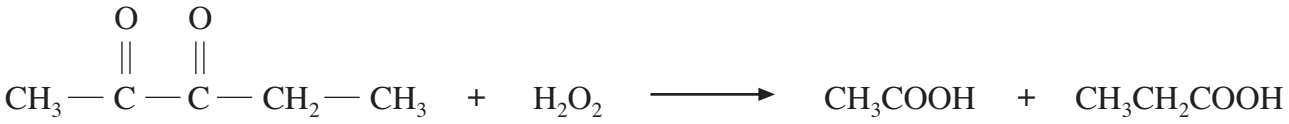
(iii) I. Hydrogen peroxide reacts with pentan-2, 3-dione to give ethanoic and propanoic acids.



Describe a method for following the rate of this reaction, stating the name of any necessary piece of equipment. [1]

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II. The mechanism of the reaction in I. above may involve free radicals. Describe what is meant by a free radical. [1]

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Total [13]

Section C Total [25]

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Rough Work