

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination



CHEMISTRY **CHM2**
Unit 2 Foundation Physical and Inorganic Chemistry

Wednesday 4 June 2008 9.00 am to 10.00 am

For this paper you must have

- a calculator.

Time allowed: 1 hour

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or blank pages will not be marked.
- Your answers to the parts of **Section B** should be on the pages indicated.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The Periodic Table/Data Sheet is provided as an insert.

Information

- The maximum mark for this paper is 60.
- The marks for each question are shown in brackets.
- You are expected to use a calculator where appropriate.
- Write your answers to the question in **Section B** in continuous prose, where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice

- You are advised to spend about 45 minutes on **Section A** and about 15 minutes on **Section B**.

For Examiner's Use			
Question	Mark	Question	Mark
1		4	
2		5	
3			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			



J U N 0 8 C H M 2 0 1

SECTION A

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

1 Metal extraction involves reduction reactions using more reactive metals, hydrogen, carbon or electrolysis.

1 (a) Titanium can be extracted from titanium(IV) chloride by reduction using either sodium or hydrogen.

1 (a) (i) Write an equation for each of these reduction reactions.

Reaction with sodium

Reaction with hydrogen

(2 marks)

1 (a) (ii) Give one reason, other than cost, why hydrogen is not the preferred reducing agent for the extraction of titanium.

.....

.....

(1 mark)

1 (b) Suggest why carbon is not a suitable reducing agent for the extraction of titanium.

.....

.....

(1 mark)

1 (c) Carbon is a reducing agent in the extraction of iron from impure iron(III) oxide. Slag is a by-product of this process.

1 (c) (i) Write an equation for the reduction of iron(III) oxide with carbon. State one condition necessary for this reaction to occur.

Equation

Condition

(2 marks)



- 1 (c) (ii) Give the name of the raw material used to remove the silicon dioxide impurity from the iron(III) oxide. Write equation(s) to show how this raw material reacts to form slag in the extraction process.

Raw material

Equation(s)

.....
(3 marks)

- 1 (c) (iii) State one use of slag.

.....
.....
(1 mark)

- 1 (d) Carbon is used for the electrodes in the extraction of aluminium from aluminium oxide. Cryolite is used in this extraction process.

- 1 (d) (i) Write a half-equation for each of the electrode reactions.

Half-equation 1

Half-equation 2

(2 marks)

- 1 (d) (ii) Give one reason why cryolite is used.

.....
(1 mark)

- 1 (e) Give the major reason why recycling of aluminium is economically viable.

.....
.....
(1 mark)

Turn over for the next question

14

Turn over ►



2 Enthalpy of combustion and bond enthalpy data can be used, with Hess's Law, to calculate enthalpy changes for other reactions.

2 (a) Define the term *standard enthalpy of combustion*.

.....

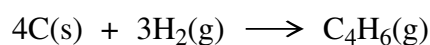
(3 marks)

2 (b) State *Hess's Law*.

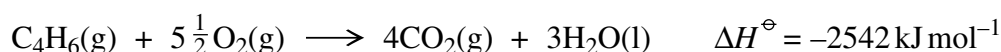
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(1 mark)

2 (c) The equation below shows the formation of buta-1,3-diene, C₄H₆



Use the following data to calculate the standard enthalpy of formation of buta-1,3-diene.



.....

(3 marks)



3 (a) State, in terms of electrons, what happens to an oxidising agent in a redox reaction.

.....
(1 mark)

3 (b) When concentrated sulphuric acid is added to solid sodium bromide, the acid reacts with Br^- ions to form SO_2 and Br_2

3 (b) (i) Write a half-equation to show how SO_2 is formed from sulphuric acid.

.....
.....
(1 mark)

3 (b) (ii) Write a half-equation to show how Br_2 is formed from Br^- ions.

.....
.....
(1 mark)

3 (b) (iii) Hence write an overall equation for the reaction of Br^- ions with sulphuric acid.

.....
.....
(1 mark)

3 (b) (iv) Deduce the role of Br^- ions in this reaction.

.....
.....
(1 mark)

3 (c) (i) Identify a halide ion that does **not** produce SO_2 when the solid sodium halide reacts with concentrated sulphuric acid.

.....
.....
(1 mark)

3 (c) (ii) Write an equation for the reaction of concentrated sulphuric acid with the halide ion that you identified in part (c)(i).

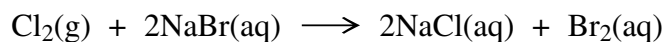
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(1 mark)



3 (c) (iii) State the role of sulphuric acid in this reaction.

.....
.....
(1 mark)

3 (d) When chlorine gas is bubbled into a solution of sodium bromide the following reaction occurs.



Deduce the role of Cl_2 in this reaction

.....
.....
(1 mark)

3 (e) In aqueous solution, silver nitrate and ammonia can be used to test for halide ions.

3 (e) (i) Identify a halide ion that reacts with silver nitrate solution to produce a precipitate which dissolves completely in dilute aqueous ammonia.

.....
.....
(1 mark)

3 (e) (ii) Write an **ionic** equation for the reaction between silver nitrate and the halide ion you identified in part (e)(i).

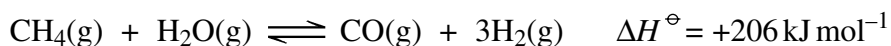
.....
.....
(1 mark)

3 (e) (iii) Identify the halide ion which cannot be detected using silver nitrate.

.....
.....
(1 mark)



4 The hydrogen used in the Haber process is made by the following reaction.



4 (a) Explain why the concentrations of the reactants and the products remain constant when equilibrium is established.

.....

.....

.....

(1 mark)

4 (b) A high temperature of over 1000 °C is used in the production of hydrogen by this reaction.

4 (b) (i) Explain why a high temperature is needed to produce a high equilibrium yield of hydrogen.

.....

.....

.....

.....

(2 marks)

4 (b) (ii) Give one disadvantage of using temperatures much higher than 1000 °C.

.....

.....

.....

(1 mark)



- 4 (c) State and explain how the overall pressure must be changed to produce an increase in the equilibrium yield of hydrogen.

Change in pressure

Explanation

.....
.....

(3 marks)

- 4 (d) Explain why the addition of a catalyst has no effect on the equilibrium yield of hydrogen in the reaction.

.....
.....
.....
.....

(2 marks)

Turn over for the next question

9

Turn over ►



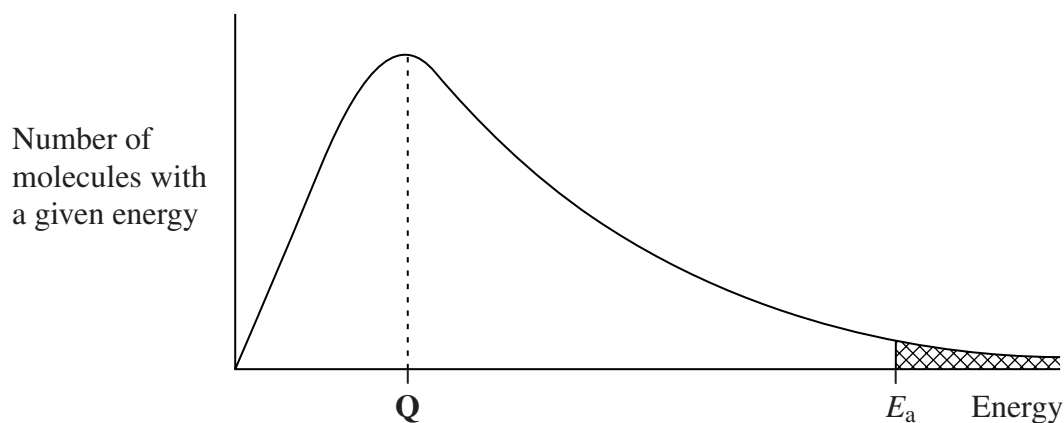
SECTION B

Answer the question below in the space provided on pages 11 to 14 of this booklet.

You should answer each part of the question on the separate page indicated.

Each part of the question is reprinted at the top of the page.

- 5 The curve shows the distribution of molecular energies for a mixture of gases which react together. The activation energy for the reaction is E_a



- 5 (a) Explain what is meant by the term *activation energy*.
(2 marks)
- 5 (b) State what **Q** represents and what the total area under the curve represents.
Explain why the curve starts at the origin and why the shaded area is very small.
(4 marks)
- 5 (c) Describe how the shape of the curve, the area under the curve, the value of E_a and the value of **Q** change if the temperature is increased.
Explain why a small increase in temperature results in a large increase in the rate of a reaction.
(7 marks)
- 5 (d) Explain why a catalyst increases the rate of a reaction.
(2 marks)

END OF QUESTIONS



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CHEMISTRY **CHM2**
Unit 2 Foundation Physical and Inorganic Chemistry

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Table 1
Proton n.m.r chemical shift data

Type of proton	δ/ppm
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
RCOCH_3	2.1–2.6
ROCH_3	3.1–3.9
RCOOCH_3	3.7–4.1
ROH	0.5–5.0

Table 2
Infra-red absorption data

Bond	Wavenumber/ cm^{-1}
C—H	2850–3300
C—C	750–1100
C=C	1620–1680
C=O	1680–1750
C—O	1000–1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

The Periodic Table of the Elements

- The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

I		II		III		IV		V		VI		VII		0	
1.0 H Hydrogen 1	9.0 Li Lithium 3	6.9 Be Beryllium 4	24.3 Na Sodium 11	40.1 K Potassium 19	87.6 Rb Rubidium 37	132.9 Cs Caesium 55	223.0 Fr Francium 87	10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	4.0 He Helium 2	20.2 Ne Neon 10	39.9 Ar Argon 18
		relative atomic mass		6.9 Li Lithium 3											
		atomic number		3											
27.0 Al Aluminium 13	28.1 Si Silicon 14	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13	27.0 Al Aluminium 13
69.7 Ga Gallium 31	72.6 Ge Germanium 32	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31
114.8 In Indium 49	118.7 Sn Tin 50	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49	114.8 In Indium 49
204.4 Tl Thallium 81	207.2 Pb Lead 82	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81	204.4 Tl Thallium 81
158.9 Tb Terbium 65	157.3 Gd Gadolinium 64	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65	158.9 Tb Terbium 65
144.9 Pm Promethium 61	144.2 Nd Neodymium 60	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61	144.9 Pm Promethium 61
140.1 Ce Cerium 58	140.9 Pr Praseodymium 59	144.9 Pm Promethium 61	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58	140.1 Ce Cerium 58
232.0 Th Thorium 90	231.0 Pa Protactinium 91	237.0 Np Neptunium 93	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90	232.0 Th Thorium 90
138.9 La Lanthanum 57	137.3 Ba Barium 56	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57	138.9 La Lanthanum 57
227 Ac Actinium 89	226.0 Ra Radium 88	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89
162.5 Dy Dysprosium 66	164.9 Ho Holmium 67	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66	162.5 Dy Dysprosium 66
167.3 Er Erbium 68	169.9 Tm Thulium 69	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68	167.3 Er Erbium 68
173.0 Yb Ytterbium 70	175.0 Lu Lutetium 71	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70	173.0 Yb Ytterbium 70
252.1 Cf Californium 98	252.1 Es Einsteinium 99	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98	252.1 Cf Californium 98
258 Md Mendelevium 101	258 Fm Fermium 100	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101	258 Md Mendelevium 101
289 U Uranium 92	238.0 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92	289 U Uranium 92
259 No Nobelium 102	259 Lr Lawrencium 103	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102	259 No Nobelium 102

* 58 – 71 Lanthanides

† 90 – 103 Actinides