Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary

Unit 1: The Core Principles of Chemistry

Monday 23 May 2011 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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7/7/5/2/

P 3 8 4 3 3 A 0 1 2 4

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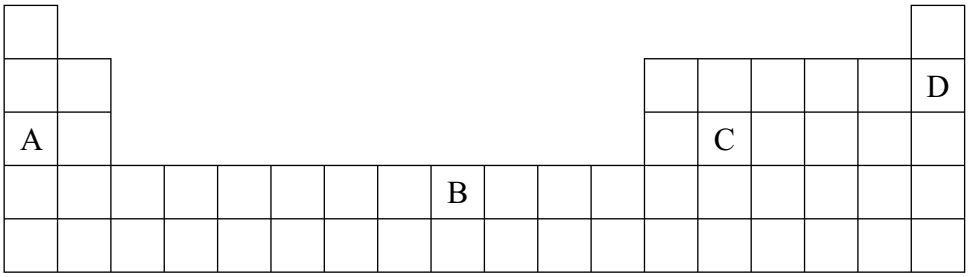
SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 In the following outline of the Periodic Table, the letters A to D are **not** the symbols of the elements.



Select from **A to D** the element which

(a) is a non-metal with a high melting temperature and boiling temperature.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) is in the d block of the Periodic Table.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) has a very stable electronic structure.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) is a metal with a high melting temperature and boiling temperature.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 4 marks)

2 The elements in Group 1 of the Periodic Table have very similar chemical properties. This is because

☒ **A** they have the same number of outer electrons.

☒ **B** they have the same number of filled shells of electrons.

☒ **C** their outer electrons are in the s sub-shell.

☒ **D** their outer electrons have very similar shielding.

(Total for Question 2 = 1 mark)

3 The European Union has set a limit (with effect from January 2010) of 3.13 ppm for the proportion of the toxic gas carbon monoxide in the air that we breathe. This is equivalent to

☒ **A** 3.13%

☒ **B** 0.0313%

☒ **C** 0.000313%

☒ **D** 0.00000313%

(Total for Question 3 = 1 mark)

4 For drivers in the UK, the legal limit of the concentration of ethanol (molar mass 46 g mol^{-1}) in the blood is 80 mg per 100 cm^3. This is equivalent to a concentration of

☒ **A** 17.4 mol dm^{-3}

☒ **B** 1.74 mol dm^{-3}

☒ **C** 0.0174 mol dm^{-3}

☒ **D** 0.00174 mol dm^{-3}

(Total for Question 4 = 1 mark)

5 An important reaction which occurs in the catalytic converter of a car is

$$2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$$

In this reaction, when 500 cm^3 of CO reacts with 500 cm^3 of NO at 650 °C (the operating temperature of the catalyst) and at 1 atm, the **total** volume of gases produced at the same temperature and pressure is

☒ **A** 500 cm^3

☒ **B** 750 cm^3

☒ **C** 1000 cm^3

☒ **D** impossible to calculate without knowing the molar volume of gases under these conditions.

(Total for Question 5 = 1 mark)

---

6 When a solution of barium chloride is added to sulfuric acid, a white precipitate is formed. The ionic equation (including state symbols) for this reaction is

☒ **A** $H^+(aq) + Cl^-(aq) \rightarrow HCl(s)$

☒ **B** $Ba^+(aq) + SO_4^-(aq) \rightarrow BaSO_4(s)$

☒ **C** $Ba^{2+}(aq) + 2SO_4^-(aq) \rightarrow Ba(SO_4)_2(s)$

☒ **D** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

(Total for Question 6 = 1 mark)

---

7 The enthalpy change for the reaction between hydrochloric acid and sodium hydroxide is –56 kJ mol^{-1}. Therefore

☒ **A** the reaction is exothermic and the temperature rises.

☒ **B** the reaction is exothermic and the temperature falls.

☒ **C** the reaction is endothermic and the temperature rises.

☒ **D** the reaction is endothermic and the temperature falls.

(Total for Question 7 = 1 mark)

---

8 The standard enthalpy changes of formation of some sulfur species are:

Species	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$S_8(s)$	0
$S_8(g)$	+103
S(g)	+279

The enthalpy of atomization of sulfur is (in kJ mol^{-1})

☒ **A** 103 ÷ 8

☒ **B** 279 ÷ 8

☒ **C** 279

☒ **D** (103 ÷ 8) + 279

(Total for Question 8 = 1 mark)

9 For which of the following reactions is the enthalpy change equal to the bond enthalpy of H–I?

☒ **A** $HI(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}I_2(s)$

☒ **B** $HI(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$

☒ **C** $HI(g) \rightarrow H(g) + I(g)$

☒ **D** $HI(g) \rightarrow H^+(g) + I^-(g)$

(Total for Question 9 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

10 The equation for the complete combustion of pentane is

$$C_5H_{12}(g) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l) \qquad \Delta H_c^{\ominus} = -3509 \text{ kJ mol}^{-1}$$

The standard enthalpy change of formation of $CO_2(g)$ is –394 kJ mol^{-1} and that of $H_2O(l)$ is –286 kJ mol^{-1}.

The standard enthalpy change of formation of pentane (in kJ mol^{-1}) is

☒ **A** 5(–394) + 6(–286) + (–3509)

☒ **B** 5(–394) + 6(–286) – (–3509)

☒ **C** –5(–394) – 6(–286) + (–3509)

☒ **D** –5(–394) – 6(–286) – (–3509)

(Total for Question 10 = 1 mark)

11 All alkenes have

☒ **A** the same empirical formula and the same general formula.

☒ **B** the same molecular formula and the same general formula.

☒ **C** the same molecular formula and the same empirical formula.

☒ **D** the same empirical formula and the same structural formula.

(Total for Question 11 = 1 mark)

12 Covalent bonding results from the strong electrostatic attractions between

☒ **A** instantaneous dipoles.

☒ **B** electron clouds.

☒ **C** electrons in the bonding pair.

☒ **D** bonding pairs of electrons and nuclei.

(Total for Question 12 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

13 This question concerns the reaction of hydrogen bromide with propene.

(a) This reaction requires

(1)

☒ **A** normal laboratory conditions.

☒ **B** the presence of UV light.

☒ **C** the presence of a suitable catalyst.

☒ **D** heating under reflux.

(b) The reaction is best described as

(1)

☒ **A** nucleophilic substitution.

☒ **B** electrophilic substitution.

☒ **C** nucleophilic addition.

☒ **D** electrophilic addition.

(c) The major product of the reaction will be

(1)

☒ **A** 1-bromopropane

☒ **B** 2-bromopropane

☒ **C** 1,2-dibromopropane

☒ **D** 2-bromopropene

(Total for Question 13 = 3 marks)

14 Many organic compounds have toxic vapours. For this reason

☒ **A** a naked flame should never be used when carrying out experiments with organic compounds.

☒ **B** gloves should usually be worn when carrying out experiments with organic compounds.

☒ **C** a fume cupboard should be used wherever possible when carrying out experiments with organic compounds.

☒ **D** most experiments with organic compounds are banned in schools and colleges.

(Total for Question 14 = 1 mark)

15 Ethanol (molar mass 46 g mol^{-1}) is manufactured by the hydration of ethene (molar mass 28 g mol^{-1}):

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

In a typical process 28 tonnes of ethene produces 43.7 tonnes of ethanol. The percentage yield of ethanol in this process is

☒ **A** 64%

☒ **B** 95%

☒ **C** 100%

☒ **D** 156%

(Total for Question 15 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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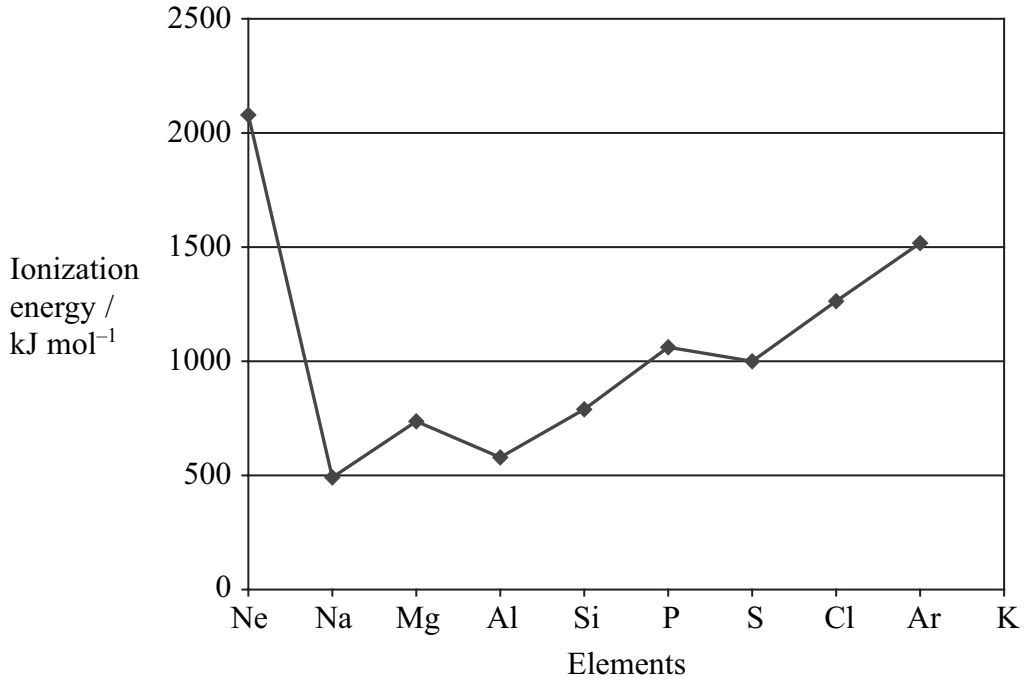
SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

16 The first ionization energy of each of the elements from neon to argon is shown on the graph below. The first ionization energy of potassium has been omitted.



(a) Define the term **first ionization energy**.

(3)

(b) Explain why, in moving from Na to Ar, the general trend is for the first ionization energy to increase.

(3)

(c) Explain why the first ionization energy decreases from P to S.

(2)

(d) Estimate the value of the first ionization energy of potassium, K, and write your answer below.

(1)

..... kJ mol^{-1}

(Total for Question 16 = 9 marks)

17 0.400 g of magnesium ribbon reacted with exactly 22.2 cm^3 of hydrochloric acid of concentration 1.50 mol dm^{-3}.

400 cm^3 of hydrogen gas was formed, the volume being measured at room temperature and pressure.

In the calculations that follow, use the following molar masses:

$$Mg = 24.0\ g\,mol^{-1}$$
$$Cl = 35.5\ g\,mol^{-1}$$

(a) Calculate the amount (in moles) of magnesium used.

(1)

(b) Calculate the amount (in moles) of hydrochloric acid used.

(1)

(c) Calculate the amount (in moles) of hydrogen produced.

[Molar volume of any gas at room temperature and pressure = 24 000 $cm^3\,mol^{-1}$]

(1)

(d) Show that the calculated amounts of magnesium, hydrochloric acid and hydrogen are consistent with the following equation for the reaction

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(1)

(e) Calculate the maximum mass of magnesium chloride that would be formed in this reaction. Give your answer to **three** significant figures.

(3)

(Total for Question 17 = 7 marks)

18 Copper(II) sulfate exists as blue hydrated crystals and white anhydrous crystals. The enthalpy changes of solution for these two substances may be represented by the following simplified equations:

$$\underset{\text{blue}}{CuSO_4.5H_2O(s)} + aq \rightarrow CuSO_4(aq) \qquad \Delta H_1 = +11.5 \text{ kJ mol}^{-1}$$

$$\underset{\text{white}}{CuSO_4(s)} + aq \rightarrow CuSO_4(aq) \qquad \Delta H_2 = -66.1 \text{ kJ mol}^{-1}$$

(a) (i) Fill in the box and add labelled arrows to complete the Hess cycle to enable you to calculate $\Delta H_{reaction}$.

(3)

$$CuSO_4.5H_2O(s) \xrightarrow{\Delta H_{reaction}} CuSO_4(s) + 5H_2O(l)$$

(ii) Calculate a value for the enthalpy change $\Delta H_{reaction}$.

(2)

(b) Suggest why it is not possible to directly measure the enthalpy change for the conversion of the blue hydrated copper(II) sulfate crystals into the white anhydrous crystals.

(1)

.....

.....

.....

.....

*(c) (i) $CuSO_4.5H_2O(s) + aq \rightarrow CuSO_4(aq)$ $\Delta H_1 = +11.5$ kJ mol^{-1}

Describe briefly the experimental procedure that **you** would use to obtain the data necessary to calculate ΔH_1, given a known mass of hydrated copper(II) sulfate crystals, $CuSO_4.5H_2O(s)$.

You should state the apparatus that you would use and any measurements that you would make.

You are **not** required to calculate the amounts of substances or to explain how you would use the data obtained.

(4)

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(ii) The value for the enthalpy change from (c)(i) obtained by experiments in a school laboratory is likely to be significantly different from a data book value.

List **three** possible reasons for this which do **not** relate to the quality of the apparatus or chemicals used or possible mistakes in carrying out the procedure.

(3)

1 .....

.....

2 .....

.....

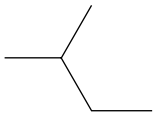
3 .....

.....

(Total for Question 18 = 13 marks)

19 This question is about alkanes.

(a) The skeletal formulae of two alkanes (**A** and **B**) are shown below.



A

B

(i) Write the general formula of the alkanes.

(1)

(ii) Compounds **A** and **B** are ..... of each other.

(1)

(iii) Draw the displayed formula of compound **A**.

(1)

(iv) Give the systematic name of compound **B**.

(1)

.....

(b) The largest use for alkanes is as fuels. However, there are problems associated with the combustion of alkanes, whether complete or incomplete.

(i) An incomplete combustion of methane, CH_4, results in the formation of carbon monoxide and water only.

Write the equation for this reaction. State symbols are **not** required.

(2)

(ii) When does incomplete combustion occur?

(1)

.....

.....

(iii) State **two** problems that result from the incomplete combustion of alkane fuels.

(2)

1 .....

.....

2 .....

.....

*(iv) State and explain the main environmental problem arising from the **complete** combustion of alkane fuels.

(3)

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.....

(c) The reactions of organic compounds, including alkanes, may be broken down into a series of steps; this is the mechanism for the reaction. The reaction between methane and chlorine may be represented by a mechanism involving three stages – **initiation**, **propagation** and **termination**.

(i) Reaction mechanisms often involve the use of 'curly arrows'. Explain the meaning of the curly arrows shown below.

(2)

Arrow I

Arrow II

Arrow I .....

.....

Arrow II .....

.....

(ii) Using the curly arrow notation, show the **initiation** step of the reaction between methane and chlorine.

(2)

(iii) Give the two **propagation** steps of the reaction between methane and chlorine.

Curly arrows are **not** required.

(2)

(iv) Suggest why a small amount of UV light can result in the formation of a large amount of product.

(1)

(v) Ethane is a trace product of this reaction. By means of an equation, show how the ethane is formed.

(1)

(d) Scientists never detect molecular hydrogen, H_2, amongst the products of the chlorination of methane.

Use the data below to suggest why this is so.

The frequency of UV light used corresponds to an energy of about 400 kJ mol^{-1}.

Bond	Bond enthalpy / kJ mol^{-1}
C—H	435
Cl—Cl	243

(2)

(Total for Question 19 = 22 marks)

20 Metals are good conductors of heat and electricity and usually have high melting temperatures and boiling temperatures.

(a) (i) Describe the **structure** of a metal.

(2)

(ii) Describe the **bonding** in a metal.

(2)

(b) Explain why the melting temperature of magnesium (650 °C) is much higher than that of sodium (98 °C).

(3)

(c) Explain how metals conduct electricity.

(2)

.....

.....

.....

.....

(Total for Question 20 = 9 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											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	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series

* Actinide series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103