Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Tuesday 15 May 2012 – 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 ▶

P39306A

7/7/5/5/5/

P 3 9 3 0 6 A 0 1 2 4

PEARSON

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 A solution contains 66 ppm of a solute. The mass of the solute dissolved in 1 kg of this solution is

☒ **A** 66 g

☒ **B** 0.66 g

☒ **C** 0.066 g

☒ **D** 0.000066 g

(Total for Question 1 = 1 mark)

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2 Complete combustion of 50 cm^3 of a hydrocarbon vapour gave 350 cm^3 of carbon dioxide, both gas volumes being measured at the same temperature and pressure. The formula of the hydrocarbon could be

☒ **A** C_8H_{18}

☒ **B** C_7H_{16}

☒ **C** C_6H_{14}

☒ **D** C_5H_{12}

(Total for Question 2 = 1 mark)

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3 Which of the following statements is true? The Avogadro constant is the number of

☒ **A** grams of any element which contains 6.02×10^{23} atoms of that element.

☒ **B** atoms contained in one mole of any element.

☒ **C** atoms contained in one mole of any monatomic element.

☒ **D** particles (atoms, molecules or ions) required to make one gram of a substance.

(Total for Question 3 = 1 mark)

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4 In an experiment to determine the enthalpy change of combustion of an alcohol, a spirit burner containing the alcohol was weighed, lit and placed under a copper can containing a known volume of water. The temperature rise of the water was measured and the burner re-weighed. The enthalpy change calculated from the results was much less exothermic than the value reported in the literature.

Which of the following factors is **most** likely to be the cause of this error?

☒ **A** Heat loss around the side of the copper can.

☒ **B** The use of a thermometer with a range of 0 – 110 °C rather than 0 – 50 °C.

☒ **C** The use of a measuring cylinder for measuring the water rather than a pipette.

☒ **D** Evaporation of the alcohol during the weighing.

(Total for Question 4 = 1 mark)

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5 The standard enthalpy changes of formation of carbon dioxide and of methanoic acid are -394 kJ mol^{-1} and -409 kJ mol^{-1} respectively. Calculate the enthalpy change for the reaction

$$H_2(g) + CO_2(g) \rightarrow HCOOH(l)$$

☒ **A** -803 kJ mol^{-1}

☒ **B** -15 kJ mol^{-1}

☒ **C** $+803$ kJ mol^{-1}

☒ **D** $+15$ kJ mol^{-1}

(Total for Question 5 = 1 mark)

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6 For which of the following changes is the value of ΔH negative?

☒ **A** $K(g) \rightarrow K^+(g) + e^-$

☒ **B** $K^+Cl^-(s) \rightarrow K^+(g) + Cl^-(g)$

☒ **C** $Cl(g) + e^- \rightarrow Cl^-(g)$

☒ **D** $Cl_2(g) \rightarrow 2Cl(g)$

(Total for Question 6 = 1 mark)

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7 In which of the following cases would a cation be most polarizing?

	Radius	Charge
☒ **A**	small	small
☒ **B**	small	large
☒ **C**	large	small
☒ **D**	large	large

(Total for Question 7 = 1 mark)

8 Magnesium chloride, $MgCl_2$, has two lattice energy values quoted in the data booklet. The first is the experimental value, obtained from the Born-Haber cycle, -2526 kJ mol^{-1}; the second is the theoretical value, -2326 kJ mol^{-1}. Why are the two values different?

☒ **A** The cation polarizes the anion leading to some covalent bonding.

☒ **B** The anion polarizes the cation leading to some covalent bonding.

☒ **C** Magnesium chloride is a covalent substance.

☒ **D** The results from the Born-Haber cycle are too inaccurate to be reliable.

(Total for Question 8 = 1 mark)

9 Which of the following represents the process occurring when the enthalpy change of atomization of bromine is measured?

☒ **A** $\frac{1}{2}Br_2(l) \rightarrow Br(g)$

☒ **B** $\frac{1}{2}Br_2(g) \rightarrow Br(g)$

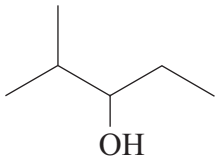
☒ **C** $Br_2(l) \rightarrow Br^+(g) + Br^-(g)$

☒ **D** $Br_2(g) \rightarrow Br^+(g) + Br^-(g)$

(Total for Question 9 = 1 mark)

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

10 An organic compound is represented by the skeletal formula shown below.



The compound is

☒ **A** $CH_3CH_2CH_2CH(OH)CH_2CH_3$

☒ **B** $(CH_3)_2CHC(OH)(CH_3)_2$

☒ **C** $(CH_3)_2CHCH_2CH(OH)CH_3$

☒ **D** $(CH_3)_2CHCH(OH)CH_2CH_3$

(Total for Question 10 = 1 mark)

11 How many structural isomers does the alkane C_5H_{12} have?

☒ **A** 4

☒ **B** 3

☒ **C** 2

☒ **D** 1

(Total for Question 11 = 1 mark)

12 When methane reacts with chlorine, a mixture of products forms. Which product provides the strongest evidence for a free radical mechanism?

☒ **A** C_2H_6

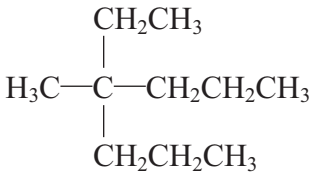
☒ **B** CH_3Cl

☒ **C** HCl

☒ **D** $CHCl_3$

(Total for Question 12 = 1 mark)

13 What is the IUPAC name of the compound shown below?



- ☒ **A** 2-ethyl-2-propylpentane
- ☒ **B** 3-methyl-3-propylhexane
- ☒ **C** 4-methyl-4-propylhexane
- ☒ **D** 4-ethyl-4-methylheptane

(Total for Question 13 = 1 mark)

14 The reaction of bromine with propene is an example of

- ☒ **A** electrophilic substitution.
- ☒ **B** free radical substitution.
- ☒ **C** electrophilic addition.
- ☒ **D** free radical addition.

(Total for Question 14 = 1 mark)

15 A compound **Z** contains, by mass, 26.7% carbon, 2.2% hydrogen, and 71.1% oxygen.
The empirical formula of **Z** is

- ☒ **A** CHO_2
- ☒ **B** $C_2H_2O_4$
- ☒ **C** CHO
- ☒ **D** $C_2H_2O_2$

(Total for Question 15 = 1 mark)

16 In which of the following series does the melting temperature of the element **increase** from left to right?

☒ **A** Li, Na, K

☒ **B** Al, Si, P

☒ **C** Si, P, S

☒ **D** Na, Mg, Al

(Total for Question 16 = 1 mark)

17 If **X** represents the element of atomic number 9 and **Y** the element of atomic number 20, the compound formed between these two elements is

☒ **A** covalent, $\mathbf{YX_2}$.

☒ **B** ionic, $\mathbf{YX_2}$.

☒ **C** covalent, **YX**.

☒ **D** ionic, **YX**.

(Total for Question 17 = 1 mark)

18 The equation representing the reaction between copper(II) oxide and dilute sulfuric acid is

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

The **ionic** equation for the reaction is

☒ **A** $Cu^{2+}(s) + SO_4^{2-}(aq) \rightarrow CuSO_4(aq)$

☒ **B** $O^{2-}(s) + H_2SO_4(aq) \rightarrow H_2O(l) + SO_4^{2-}(aq)$

☒ **C** $CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$

☒ **D** $CuO(s) + H_2SO_4(aq) \rightarrow Cu^{2+}SO_4^{2-}(aq) + H_2O(l)$

(Total for Question 18 = 1 mark)

19 Which of the following represents the electronic structure of a nitrogen atom?

	1*s*	2*s*	2*p*		
☒ **A**	↑↓	↑	↑↓	↑	↑
☒ **B**	↑↓	↑	↑↓	↑↓	
☒ **C**	↑↓	↑↓	↑	↑	↑
☒ **D**	↑↓	↑↓	↑↓	↑	

(Total for Question 19 = 1 mark)

20 The electronic structures of four elements are given below. Which of these elements has the highest first ionization energy?

	1*s*	2*s*	2*p*		
☒ **A**	↑↓	↑↓	↑	↑	
☒ **B**	↑↓	↑↓	↑	↑	↑
☒ **C**	↑↓	↑↓	↑↓	↑↓	↑
☒ **D**	↑↓	↑↓	↑↓	↑↓	↑↓

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

21 (a) Define the term **relative isotopic mass**.

(2)

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.....

(b) Naturally occurring chlorine contains 75.53% of ^{35}Cl and 24.47% of ^{37}Cl.

(i) Calculate the relative atomic mass of chlorine to **four** significant figures.

(2)

(ii) Two of the peaks in the mass spectrum of chlorine, Cl_2, are at *m/e* 70 and 74. Identify the species giving rise to these peaks.

(2)

70 .....

74 .....

(iii) What is the *m/e* value of the other peak that you would expect to see in this region of the mass spectrum and the identity of the species giving rise to it?

(2)

Value .....

Species .....

(Total for Question 21 = 8 marks)

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

(2)

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*(b) Explain why the first ionization energy of the elements down Group 1 decreases even though the atomic number increases.

(2)

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(c) The eleven successive ionization energies for sodium are given below.

Electron removed	1	2	3	4	5	6	7	8	9	10	11
Ionization energy / kJ mol^{-1}	496	4563	6913	9544	13352	16611	20115	24491	28934	141367	159079

(i) Explain why the successive ionization energies increase.

(1)

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.....

*(ii) Explain how these ionization energies give evidence for the electronic structure of sodium. You may use a sketch graph if you wish.

(2)

(d) The first ionization energy of aluminium (element 13) is lower than that of magnesium (element 12).

(i) Give the electronic structures of magnesium and of aluminium in *s*, *p* and *d* notation.

(1)

Magnesium .....

Aluminium .....

*(ii) Explain the difference in the first ionization energies of the two metals.

(1)

(Total for Question 22 = 9 marks)

23 (a) State Hess's Law.

(1)

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.....

.....

(b) Methane burns in a limited supply of oxygen to give carbon monoxide and water.

$$CH_4(g) + 1\frac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(l)$$

The enthalpy change for this reaction cannot be determined directly, but can be found using the standard enthalpy changes of combustion of methane and carbon monoxide, together with Hess's Law.

The standard enthalpy changes of combustion needed are for CH_4, -890 kJ mol^{-1}, and for CO, -283 kJ mol^{-1}.

(i) Draw a Hess's Law diagram which would enable you to calculate the enthalpy change for the combustion of methane to carbon monoxide.

$$CH_4(g) + 1\frac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(l)$$

(2)

(ii) Calculate the enthalpy change for this reaction, in kJ mol^{-1}.

(2)

(iii) Explain why the enthalpy change for this reaction cannot be determined directly.

(1)

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.....

.....

(c) Explain why the calculation in part (b)(ii) would give an incorrect result for the enthalpy change for the reaction below.

$$CH_4(g) + 1\frac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(g)$$

(2)

.....

.....

.....

.....

(Total for Question 23 = 8 marks)

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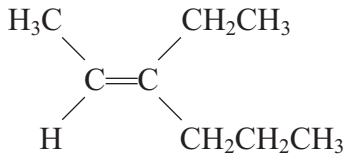
24 (a) Give the general formula for the homologous series of **alkenes**.

(1)

(b) What is meant by the term **unsaturated** as applied to alkenes?

(1)

(c) (i) Name the alkene below using *E-Z* nomenclature.



(2)

(ii) Suggest why this alkene cannot be named using the *cis-trans* naming system.

(1)

(d) Give the structural formula of the organic product of the reaction of ethene, $CH_2{=}{=}CH_2$, with

(i) hydrogen.

(1)

(ii) chlorine.

(1)

(iii) acidified aqueous potassium manganate(VII).

(1)

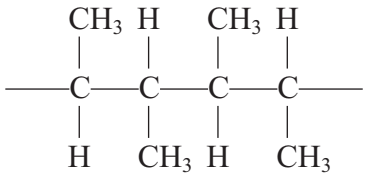
(iv) bromine **water**.

(1)

(e) Draw the mechanism for the reaction of **propene** with hydrogen bromide to give the major product.

(4)

(f) The structure below shows **two** repeat units of a polymer.



(i) Give the displayed formulae of **two** isomeric alkenes, either of which could have given rise to this polymer.

(2)

(ii) State why the empirical formula of a poly(alkene) is the same as that of the monomer from which it is produced.

(1)

(iii) State, with a reason, the atom economy for the production of a poly(alkene) from an alkene.

(1)

(Total for Question 24 = 17 marks)

25 Sodium burns in oxygen to give a pale yellow solid **X**.

(a) (i) 1.73 g of sodium reacts with 1.20 g of oxygen.

Calculate the empirical formula of **X**.

(2)

(ii) The molar mass of **X** is 78 g mol^{-1}. Give the molecular formula of **X**.

(1)

(iii) Write the equation, including state symbols, for the reaction of sodium with oxygen to produce **X**.

(2)

(iv) Calculate the volume of oxygen in dm^3 (at room temperature and pressure) which reacts with 1.73 g of sodium. (The molar volume of any gas at room temperature and pressure is 24 dm^3 mol^{-1}.)

(2)

(v) Calculate the number of oxygen **molecules** that react with 1.73 g of sodium. (The Avogadro constant = 6.02×10^{23} mol^{-1}.)

(1)

(b) If sodium is burnt in **air**, compound **X** is not the only product. Suggest why this is so.

(1)

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(Total for Question 25 = 9 marks)

26 (a) Explain how the atoms are held together by the covalent bond in a molecule of hydrogen.

(1)

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(b) Draw the dot and cross diagrams for

(i) methane, CH_4

(1)

(ii) ethene, $CH_2{=}{=}CH_2$

(1)

(iii) nitrogen, N_2

(1)

(iv) the ammonium ion, NH_4^+

(1)

(c) Silicon exists in a giant covalent lattice.

(i) The electrical conductivity of pure silicon is very low. Explain why this is so in terms of the bonding.

(2)

(ii) Explain the high melting temperature of silicon in terms of the bonding.

(2)

(Total for Question 26 = 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

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

* Lanthanide series

* Actinide series