

Write your name here

Surname

Other names

Centre Number

Candidate Number

**Edexcel GCE**

**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 ►

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**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)

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

- ☐ A C<sub>8</sub>H<sub>18</sub>  
☐ B C<sub>7</sub>H<sub>16</sub>  
☐ C C<sub>6</sub>H<sub>14</sub>  
☐ D C<sub>5</sub>H<sub>12</sub>

(Total for Question 2 = 1 mark)

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

- ☐ A grams of any element which contains  $6.02 \times 10^{23}$  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)



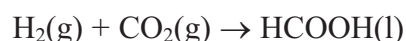
- 4 In an experiment to determine the enthalpy change of combustion of an alcohol, a spirit burner containing the alcohol was weighed, lit and placed under a copper can containing a known volume of water. The temperature rise of the water was measured and the burner re-weighed. The enthalpy change calculated 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)

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



- ☐ A  $-803 \text{ kJ mol}^{-1}$
- ☐ B  $-15 \text{ kJ mol}^{-1}$
- ☐ C  $+803 \text{ kJ mol}^{-1}$
- ☐ D  $+15 \text{ kJ mol}^{-1}$

(Total for Question 5 = 1 mark)

- 6 For which of the following changes is the value of  $\Delta H$  negative?

- ☐ A  $\text{K}(\text{g}) \rightarrow \text{K}^+(\text{g}) + \text{e}^-$
- ☐ B  $\text{K}^+\text{Cl}^-(\text{s}) \rightarrow \text{K}^+(\text{g}) + \text{Cl}^-(\text{g})$
- ☐ C  $\text{Cl}(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$
- ☐ D  $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$

(Total for Question 6 = 1 mark)



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

|                            | Radius | Charge |
|----------------------------|--------|--------|
| <input type="checkbox"/> A | small  | small  |
| <input type="checkbox"/> B | small  | large  |
| <input type="checkbox"/> C | large  | small  |
| <input type="checkbox"/> D | large  | large  |

(Total for Question 7 = 1 mark)

8 Magnesium chloride,  $\text{MgCl}_2$ , has two lattice energy values quoted in the data booklet. The first is the experimental value, obtained from the Born-Haber cycle,  $-2526 \text{ kJ mol}^{-1}$ ; the second is the theoretical value,  $-2326 \text{ kJ mol}^{-1}$ . 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?

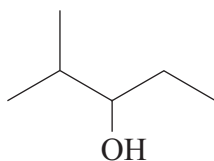
- ☐ A  $\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{g})$
- ☐ B  $\frac{1}{2}\text{Br}_2(\text{g}) \rightarrow \text{Br}(\text{g})$
- ☐ C  $\text{Br}_2(\text{l}) \rightarrow \text{Br}^+(\text{g}) + \text{Br}^-(\text{g})$
- ☐ D  $\text{Br}_2(\text{g}) \rightarrow \text{Br}^+(\text{g}) + \text{Br}^-(\text{g})$

(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  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
- ☐ B  $(\text{CH}_3)_2\text{CHC}(\text{OH})(\text{CH}_3)_2$
- ☐ C  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}(\text{OH})\text{CH}_3$
- ☐ D  $(\text{CH}_3)_2\text{CHCH}(\text{OH})\text{CH}_2\text{CH}_3$

(Total for Question 10 = 1 mark)

11 How many structural isomers does the alkane  $\text{C}_5\text{H}_{12}$  have?

- ☐ A 4
- ☐ B 3
- ☐ C 2
- ☐ D 1

(Total for Question 11 = 1 mark)

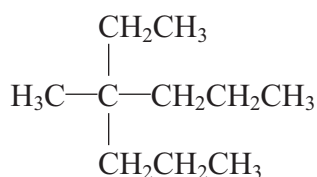
12 When methane reacts with chlorine, a mixture of products forms. Which product provides the strongest evidence for a free radical mechanism?

- ☐ A  $\text{C}_2\text{H}_6$
- ☐ B  $\text{CH}_3\text{Cl}$
- ☐ C  $\text{HCl}$
- ☐ D  $\text{CHCl}_3$

(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  $\text{CHO}_2$
- ☐ B  $\text{C}_2\text{H}_2\text{O}_4$
- ☐ C  $\text{CHO}$
- ☐ D  $\text{C}_2\text{H}_2\text{O}_2$

(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

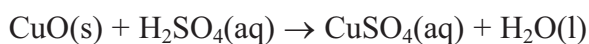
(Total for Question 16 = 1 mark)

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,  $\text{YX}_2$ .
- ☐ B ionic,  $\text{YX}_2$ .
- ☐ C covalent,  $\text{YX}$ .
- ☐ D ionic,  $\text{YX}$ .

(Total for Question 17 = 1 mark)

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



The **ionic** equation for the reaction is

- ☐ A  $\text{Cu}^{2+}\text{(s)} + \text{SO}_4^{2-}\text{(aq)} \rightarrow \text{CuSO}_4\text{(aq)}$
- ☐ B  $\text{O}^{2-}\text{(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{H}_2\text{O(l)} + \text{SO}_4^{2-}\text{(aq)}$
- ☐ C  $\text{CuO(s)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Cu}^{2+}\text{(aq)} + \text{H}_2\text{O(l)}$
- ☐ D  $\text{CuO(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{Cu}^{2+}\text{SO}_4^{2-}\text{(aq)} + \text{H}_2\text{O(l)}$

(Total for Question 18 = 1 mark)



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

|                            | 1s            | 2s            | 2p            |               |              |
|----------------------------|---------------|---------------|---------------|---------------|--------------|
| <input type="checkbox"/> A | <div>↑↓</div> | <div>↑</div>  | <div>↑↓</div> | <div>↑</div>  | <div>↑</div> |
| <input type="checkbox"/> B | <div>↑↓</div> | <div>↑</div>  | <div>↑↓</div> | <div>↑↓</div> |              |
| <input type="checkbox"/> C | <div>↑↓</div> | <div>↑↓</div> | <div>↑</div>  | <div>↑</div>  | <div>↑</div> |
| <input type="checkbox"/> D | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> | <div>↑</div>  |              |

(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?

|                            | 1s            | 2s            | 2p            |               |               |
|----------------------------|---------------|---------------|---------------|---------------|---------------|
| <input type="checkbox"/> A | <div>↑↓</div> | <div>↑↓</div> | <div>↑</div>  | <div>↑</div>  |               |
| <input type="checkbox"/> B | <div>↑↓</div> | <div>↑↓</div> | <div>↑</div>  | <div>↑</div>  | <div>↑</div>  |
| <input type="checkbox"/> C | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> | <div>↑</div>  |
| <input type="checkbox"/> D | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> | <div>↑↓</div> |

(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  $^{35}\text{Cl}$  and 24.47% of  $^{37}\text{Cl}$ .

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

(2)

(ii) Two of the peaks in the mass spectrum of chlorine,  $\text{Cl}_2$ , 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 / $\text{kJ mol}^{-1}$ | 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)

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(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)

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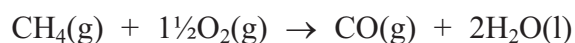
(Total for Question 22 = 9 marks)



23 (a) State Hess's Law.

(1)

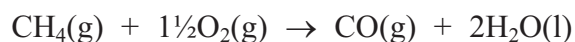
(b) Methane burns in a limited supply of oxygen to give carbon monoxide and water.



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  $\text{CH}_4$ ,  $-890 \text{ kJ mol}^{-1}$ , and for  $\text{CO}$ ,  $-283 \text{ kJ mol}^{-1}$ .

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



(2)

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

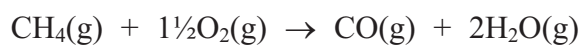
(2)



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

(1)

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



(2)

**(Total for Question 23 = 8 marks)**



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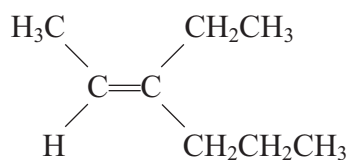
24 (a) Give the general formula for the homologous series of **alkenes**.

(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,  $\text{CH}_2=\text{CH}_2$ , with

(i) hydrogen.

(1)

(ii) chlorine.

(1)

(iii) acidified aqueous potassium manganate(VII).

(1)

(iv) bromine **water**.

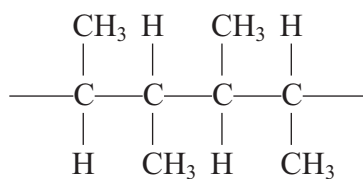
(1)

(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  $78 \text{ g mol}^{-1}$ . Give the molecular formula of **X**.

(1)

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(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  $\text{dm}^3$  (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  $24 \text{ dm}^3 \text{ mol}^{-1}$ .)

(2)

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

(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,  $\text{CH}_4$

(1)

(ii) ethene,  $\text{CH}_2=\text{CH}_2$

(1)

(iii) nitrogen,  $\text{N}_2$

(1)

(iv) the ammonium ion,  $\text{NH}_4^+$

(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)

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

(2)

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**(Total for Question 26 = 9 marks)**

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



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## 4

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