Candidate Name	Centre Number	Candidate Number

331/01

CHEMISTRY CH1

A.M. WEDNESDAY, 6 June 2007

(1 hour 30 minutes)

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
TOTAL MARK		

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- copy of the **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 **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (56 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 66.

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 12 may be used for rough work.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

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

1. State which **one** of the following statements applies to the ions $^{35}Cl^-$, $^{39}K^+$ and $^{40}Ca^{2+}$.   [1]

    A   They all contain the same number of neutrons.

    B   They all contain the same number of electrons.

    C   They are isotopes of one another.

    D   They all have the same mass number.

    ....

2. State the **full** electron sub-shell configuration for an atom of potassium, K.   [1]

    ....

3. State which **one** of the following gives the first four ionisation energies (IE) for magnesium, Mg.   [1]

	1st IE	2nd IE	3rd IE	4th IE / kJ mol^{-1}
A	496	4563	6913	9544
B	578	1817	2745	11578
C	738	1451	7733	10541
D	1086	2353	4621	6223

    ....

4. Sketch the electron density distribution for a hydrogen molecule, H_2.   [1]

5. *(a)* Define the ***mole***. [1]

....

....

(b) State the number of moles of each of the following present in 0·2 moles of ammonium carbonate, $(NH_4)_2CO_3$:

  (i) *ammonium ions*, NH_4^+; .... mol [1]

  (ii) *hydrogen atoms*, H. .... mol [1]

6. Chlorine reacts with hydrogen sulphide according to the following equation.

$$Cl_2 \ + \ H_2S \ \longrightarrow \ 2HCl \ + \ S$$
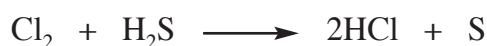
(a) Complete the following table by inserting in the appropriate unshaded boxes the oxidation numbers of all the specified atoms in the equation. [2]

Species \ Atom	Cl	H	S
Cl_2			
H_2S			
HCl			
S			

(b) On the basis of the oxidation numbers, state which atom is undergoing oxidation in this reaction. [1]

....

Section A Total [10]

SECTION B

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

7.   Although it does not occur naturally, Technetium (Tc), the element of atomic number 43, is produced in nuclear reactors. One form of ^{99}Tc is the radioactive isotope most widely used in medicine to develop "body scan" images of internal body organs. This form of ^{99}Tc decays by the emission of γ-radiation with a half-life of 6·0 hours.

   (a)   (i)   Explain what is meant by *γ-radiation*.   [1]

   ....

   (ii)   A sample of ^{99}Tc, with concentration four times greater than the dosage required to treat a patient, was prepared at 8:00 a.m. Calculate the time at which the sample concentration of ^{99}Tc would have dropped to the correct dosage to administer to the patient.   [2]

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   (b) ^{99}Tc is not supplied directly to hospitals. Instead, a kit is supplied which has the radioactive isotope ^{99}Mo in a glass vial contained within a lead case. ^{99}Mo has a half life of 66 days, producing ^{99}Tc when it decays.

$$^{99}\text{Mo} \longrightarrow \ ^{99}\text{Tc} \ + \ \text{X}$$

   (i)   Identify the species, **X**, formed when ^{99}Mo decays to ^{99}Tc.   [1]

   ....

   (ii)   State the advantage of supplying ^{99}Mo rather than supplying ^{99}Tc directly.   [1]

   ....

   ....

   (iii)   State the purpose of the lead case.   [1]

   ....

   ....

(c) One compound important in the study of technetium chemistry is potassium pertechnetate. This compound contains 19·36% potassium (K), 48·96% technetium (Tc), and 31·68% oxygen by mass and has a relative molecular mass of 202·0.

   (i) Determine the empirical formula and the molecular formula of potassium pertechnetate.

Empirical formula ....

....

....

[2]

Molecular formula ....

....

[1]

   (ii) A saturated solution contains 31·5 g potassium pertechnetate dissolved to give 250 cm^3 solution. Calculate the concentration of saturated potassium pertechnetate solution in mol dm^{-3}. [2]

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(d) Technetium is a grey metal with a melting temperature of 2180 °C and is a good conductor of electricity. Explain, in terms of the bonding in metals, why metals such as technetium have high melting temperatures and are good conductors of electricity. [3]

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Total [14]

Turn over.

8. *(a)* (i) Draw a dot and cross diagram to show the bonding in a water molecule. [1]

(ii) Using Valence Shell Electron Pair Repulsion (VSEPR) theory, state and explain the shape of a water molecule. [2]

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(b) Water can form a coordinate bond to an H^+ ion to form H_3O^+.

(i) Explain the term ***coordinate bond***. [1]

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....

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(ii) Give the shape of the H_3O^+ ion. [1]

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....

(c) Explain how hydrogen bonding occurs in water. [3]

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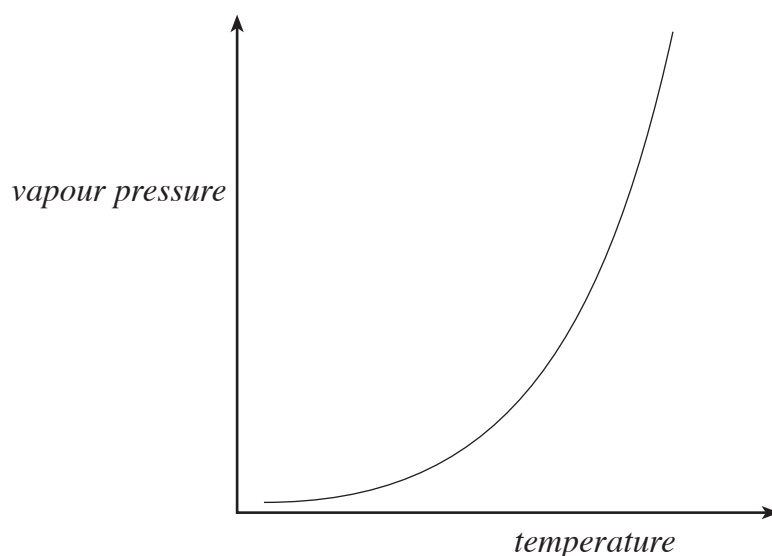..

(d) The following sketch shows the variation of the vapour pressure of liquid water with temperature.

(i) Explain why vapour pressure increases with rising temperature. [2]

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(ii) On the same axes, sketch the curve of vapour pressure against temperature which would apply if there were no hydrogen bonding present in water. [1]

(iii) Name the intermolecular force present in liquids where there are no permanent polar bonds. [1]

....

(e) Steam is produced when a hydrogen / oxygen mixture is exploded.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$
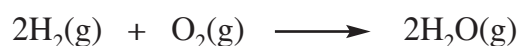
If a mixture of 0·40 mol hydrogen and 0·20 mol oxygen are completely reacted at fixed pressure and 150 °C, calculate

(i) the decrease in the total number of moles of gas present, [1]

....

....

(ii) the decrease in the volume of the gas.
(1 mole of gas occupies 34 dm^3 at 150 °C) [1]

....

....

Total [14]

Turn over.

9. Calcium bromide, $CaBr_2$, is a white ionic compound soluble in water.

(a) Give **one** test in **each** case which would confirm the presence of calcium ions and bromide ions in the compound.

Calcium ions ....

....

[1]

Bromide ions ....

....

....

....

[2]

(b) State what would be observed, and write a balanced equation for the reaction, when each of the following is added separately to calcium bromide solution.

(i) Chlorine, Cl_2 [2]

Observations ....

....

Equation ....

(ii) Excess sodium hydroxide solution. [2]

Observations ....

....

Equation ....

(c) (i) Calculate the molar mass (g mol^{-1}) of calcium bromide, $CaBr_2$. [1]

....

....

(ii) Calcium bromide exists as a crystalline hydrate $CaBr_2.xH_2O$. If the molar mass of the hydrate is 307·9 g mol^{-1}, calculate the value of x in the formula $CaBr_2.xH_2O$. [2]

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(d) (i) Name, and give the formulae of, the **two** anions formed when carbon dioxide dissolves in water. [2]

Name ....   *Formula* ....

Name ....   *Formula* ....

(ii) State how the two anions differ in their reaction with a solution containing calcium ions, such as calcium bromide. [2]

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Total [14]

Turn over.

10. This question concerns the elements in the third period of the Periodic Table:

$$Na \quad Mg \quad Al \quad Si \quad P \quad S \quad Cl \quad Ar$$

(a) Give the symbol of the element from this period which

(i) has the highest melting temperature, ... [1]

(ii) is the most electronegative, ... [1]

(iii) has the largest atomic radius, ... [1]

(iv) has a half-full p sub-shell of electrons, ... [1]

(v) has the highest second ionisation energy. .... [1]

(b) Using elements in the third period, state the formula for

(i) **one** basic oxide, ... [1]

(ii) **one** covalent chloride. .... [1]

(c) Write balanced equations to show the reaction of

(i) chlorine with water,

....

[1]

(ii) magnesium with dilute hydrochloric acid.

....

[1]

(d) (i) Discuss the ionic bonding present in a crystal of sodium chloride, NaCl. Your answer should include

- a description of the crystal structure of sodium chloride
- the crystal coordination numbers
- a description of the electrostatic forces between the ions. [4]

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(ii) Explain why caesium chloride, CsCl, has a different crystal structure to sodium chloride, NaCl. [1]

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Total [14]

Section B Total [56]

Turn over.

Rough work