HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013

CHEMISTRY PAPER 1

8.30 am – 11.00 am (2 hours 30 minutes)

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 45 minutes.

2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book **B**.

3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book **B**. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**

4. A Periodic Table is printed on page 20 of Question-Answer Book **B**. Atomic numbers and relative atomic masses of elements can be obtained from the Periodic Table.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.

2. When told to open this book, you should check that all the questions are there. Look for the words **'END OF SECTION A'** after the last question.

3. All questions carry equal marks.

4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.

5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

6. No marks will be deducted for wrong answers.

Not to be taken away before the
end of the examination session

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This section consists of two parts. There are 24 questions in PART I and 12 questions in PART II.

Choose the best answer for each question.
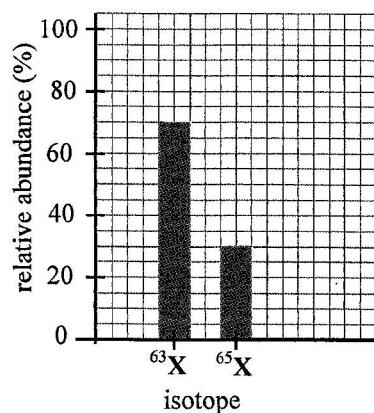
Candidates may refer to the Periodic Table printed on page 20 of Question-Answer Book B.

PART I

1. Silicon is an element in Group IV of the Periodic Table. The oxide of silicon has the chemical formula SiO_2. Which of the following statements about silicon and its oxide is correct ?

    A. Silicon is a good conductor of heat.
    B. Silicon exists as simple molecules.
    C. SiO_2 is a hard material at room temperature.
    D. SiO_2 dissolves in water to give an acidic solution.

2. Suppose that element **X** has only two isotopes, ^{63}**X** and ^{65}**X**. The graph below shows the relative abundance of the two isotopes:

Which of the following is the relative atomic mass of **X** ?

    A. 63.3
    B. 63.5
    C. 63.6
    D. 64.0

3. Solid **Y** is soluble in cold water. When an aqueous solution of **Y** is added separately to sodium hydroxide solution and to acidified silver nitrate solution, a white precipitate is formed in both cases. Which of the following compounds might **Y** be ?

    A. ammonium carbonate
    B. zinc carbonate
    C. lead(II) chloride
    D. magnesium chloride

4. Scandium (Sc) is a metal. Scandium, in its compounds, exhibits only one oxidation number. The chemical formula of scandium nitrate is $Sc(NO_3)_3$. Which of the following is most likely to be the chemical formula of scandium phosphate ?
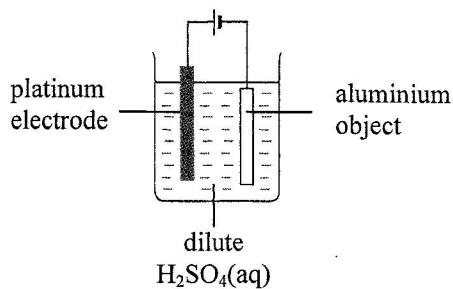
   A. $Sc_2(PO_4)_3$
       B. $ScPO_4$
       C. $Sc(PO_4)_2$
       D. $Sc(PO_4)_3$

5. Which of the following methods can be used to obtain magnesium from magnesium compounds ?
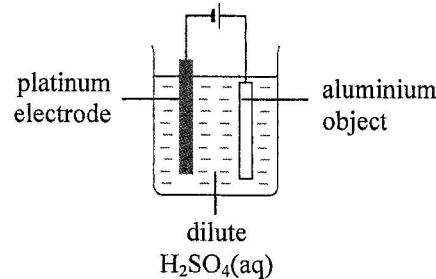
       A.   electrolysis of a molten magnesium compound
       B.   electrolysis of an aqueous solution of a magnesium compound
       C.   heating magnesium oxide with carbon
       D.   heating magnesium oxide strongly

6. Which of the set-ups shown below can best be used to anodise an aluminium object ?

A.

platinum electrode — aluminium object

dilute $H_2SO_4(aq)$

B.

platinum electrode — aluminium object

dilute $H_2SO_4(aq)$

C.

platinum electrode — aluminium object

concentrated NaCl(aq)

D.

platinum electrode — aluminium object

concentrated NaCl(aq)
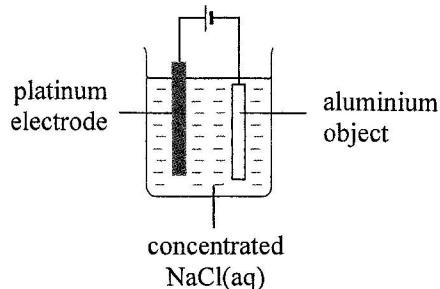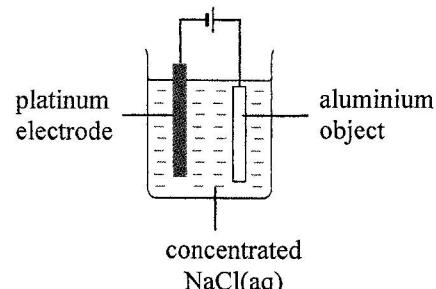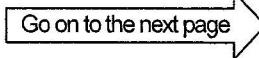
7. Both the frame and gear system of a bicycle are made of steel. Which of the following combinations can be used to prevent these parts of the bicycle from rusting ?

	Frame	Gear system
A.	painting	greasing
B.	painting	galvanising
C.	tin-plating	greasing
D.	tin-plating	galvanising

8. Which of the following reaction routes can best be used to prepare barium sulphate from barium carbonate ?

A. $BaCO_3(s) \xrightarrow{H_2SO_4(aq)} BaSO_4(s)$

B. $BaCO_3(s) \xrightarrow{conc.\ H_2SO_4} BaSO_4(s)$

C. $BaCO_3(s) \xrightarrow{HCl(aq)} BaCl_2(aq) \xrightarrow{H_2SO_4(aq)} BaSO_4(s)$

D. $BaCO_3(s) \xrightarrow{conc.\ HCl} BaCl_2(aq) \xrightarrow{Na_2SO_4(aq)} BaSO_4(s)$

9. Which of the following statements about potassium hydroxide solution is INCORRECT ?

A. When potassium hydroxide solution is added to iron(III) sulphate solution, a dirty green precipitate is formed.

B. When potassium hydroxide solution is heated with ammonium chloride solution, ammonia gas is liberated.

C. Dilute potassium hydroxide solution contains $K^+(aq)$ ions, $H^+(aq)$ ions and $OH^-(aq)$ ions.

D. Concentrated potassium hydroxide solution is corrosive.

10. Consider the four solutions W, X, Y and Z listed below:

W: $0.01\ mol\ dm^{-3}\ HNO_3(aq)$

X: $0.01\ mol\ dm^{-3}\ H_2SO_4(aq)$

Y: $0.01\ mol\ dm^{-3}\ KOH(aq)$

Z: $0.10\ mol\ dm^{-3}\ KOH(aq)$

Which of the following represents the four solutions arranged in increasing order of pH ?

A. W, X, Y, Z
B. W, X, Z, Y
C. X, W, Y, Z
D. X, W, Z, Y

11. Which of the following pairs of aqueous solutions, when mixed, would give a precipitate ?

A. lead(II) nitrate and ammonia
B. copper(II) sulphate and sodium nitrate
C. calcium chloride and sodium nitrate
D. iron(II) sulphate and acidified potassium dichromate

12. Both radium (Ra) and calcium (Ca) belong to the same group of the Periodic Table. Which of the following statements is INCORRECT ?
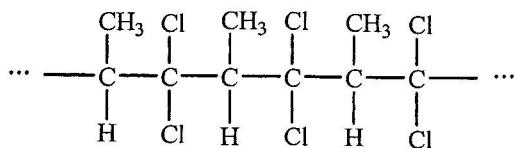
A. Radium is a good conductor of electricity in the solid state.
B. Radium atoms readily donate electrons to form Ra^{2+} ions.
C. Both radium and calcium become tarnished after exposed to air for some time.
D. Radium is less reactive than calcium.

13. Titanium (Ti) is a metal. 2.66 g of a sample of titanium powder is heated in excess oxygen until the metal is completely oxidised. The mass of the oxide formed is 4.44 g. Which of the following is the empirical formula of the oxide formed ?

(Relative atomic masses: O = 16.0, Ti = 47.9)

    A. TiO
    B. Ti_2O_3
    C. Ti_3O_4
    D. TiO_2

14. A portion of the structure of an addition polymer **X** is shown below:
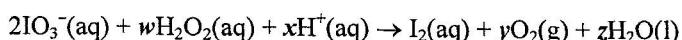

Which of the following is the systematic name of the monomer of **X** based on the given structure ?

    A.   1,1-dichloro-2-methylethene
    B.   1,1-dichloropropene
    C.   1,2-dichloropropene
    D.   3,3-dichloropropene

15. For which of the following reactions must its enthalpy change be determined by INDIRECT methods ?

    A. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
    B. $2C(s) + O_2(g) \rightarrow 2CO(g)$
    C. $CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
    D. $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$

16. Consider the following chemical equation:

$$2IO_3^-(aq) + wH_2O_2(aq) + xH^+(aq) \rightarrow I_2(aq) + yO_2(g) + zH_2O(l)$$

Which of the following is the correct combination of the reaction coefficients y and z ?

	y	z
A.	4	5
B.	5	4
C.	5	6
D.	6	5

17. Potassium peroxodisulphate ($K_2S_2O_8$) can be obtained from the electrolysis of a saturated solution of potassium hydrogensulphate ($KHSO_4$).

   Which of the following correctly describes the oxidation number of sulphur in $KHSO_4$, and the electrode at which $K_2S_2O_8$ is produced during the electrolysis ?

	Oxidation number of S	Electrode at which $K_2S_2O_8$ is produced
A.	+6	anode
B.	+6	cathode
C.	+4	anode
D.	+4	cathode

18. Under standard conditions, complete combustion of 0.050 mol of propane (C_3H_8) gives 111 kJ of heat. Which of the following is the standard enthalpy change of formation of propane ?
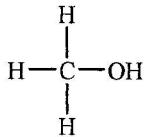
   (Standard enthalpy change of formation of $H_2O(l) = -286$ kJ mol^{-1};
   standard enthalpy change of formation of $CO_2(g) = -394$ kJ mol^{-1})

   A. -106 kJ mol^{-1}
   B. $+106$ kJ mol^{-1}
   C. -569 kJ mol^{-1}
   D. $+569$ kJ mol^{-1}

19. Which of the following statements about limestone is/are correct ?

   (1)   It gives a golden yellow flame in a flame test.
   (2)   It gives a colourless gas when heated strongly.
   (3)   It dissolves in dilute sulphuric acid to give a clear solution.

   A.   (1) only
   B.   (2) only
   C.   (1) and (3) only
   D.   (2) and (3) only

20. An organic compound has the following structure:

$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}}-OH$$

   Which of the following statements about this compound is/are correct ?

   (1)   It is immiscible with water.
   (2)   It is neutral to litmus solution.
   (3)   It burns with a non-luminous flame.

   A.   (1) only
   B.   (2) only
   C.   (1) and (3) only
   D.   (2) and (3) only

21. Which of the following is/are secondary cell(s) ?

    (1) alkaline manganese cell
    (2) lithium ion cell
    (3) nickel metal hydride cell

        A. (1) only
        B. (2) only
        C. (1) and (3) only
        D. (2) and (3) only

22. Which of the following reagents can be used to distinguish between sodium sulphite and sodium sulphate ?

    (1) iron(II) chloride solution
    (2) acidified potassium permanganate solution
    (3) concentrated nitric acid

        A. (1) only
        B. (2) only
        C. (1) and (3) only
        D. (2) and (3) only

23. To which of the following molecules is/are the 'octet rule' NOT applicable ?

    (1) OF_2
    (2) NO_2
    (3) CS_2

        A. (1) only
        B. (2) only
        C. (1) and (3) only
        D. (2) and (3) only

Directions : Question 24 consists of two separate statements. Decide whether each of the two statements is true or false; if both are true, then decide whether or not the second statement is a *correct* explanation of the first statement. Then select one option from A to D according to the following table :

| A.	Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B.	Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C.	The 1st statement is false but the 2nd statement is true.
D.	Both statements are false.
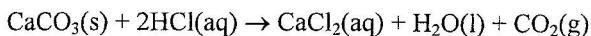
|	**1st statement**	**2nd statement**
24.	The boiling point of hydrogen chloride is higher than that of hydrogen fluoride.	The molecular size of hydrogen chloride is greater than that of hydrogen fluoride.
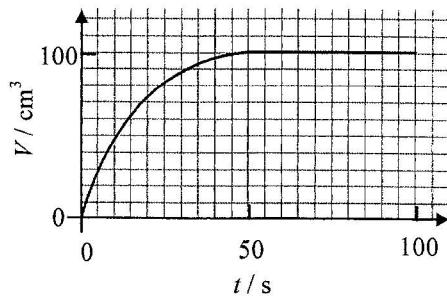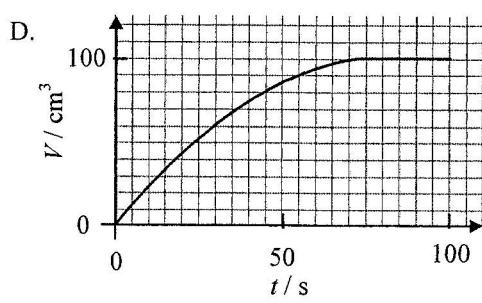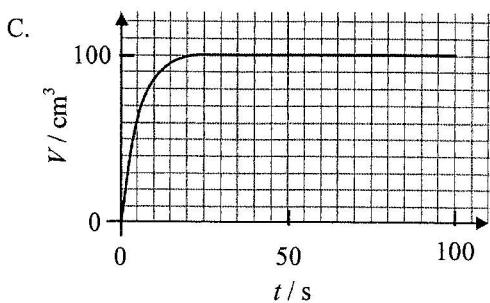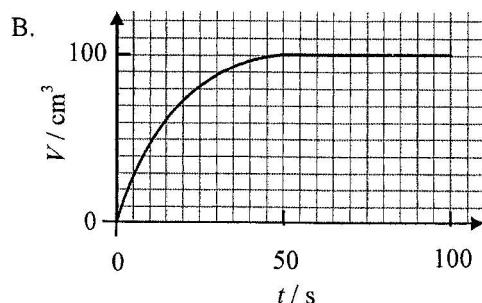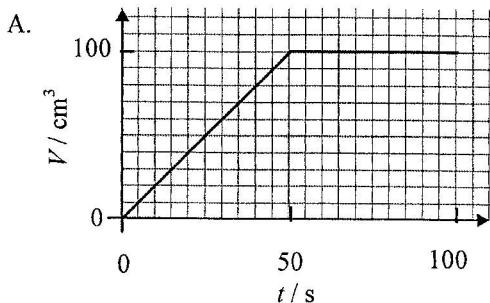
25.   In an experiment to study the rate of the following reaction, a small amount of powdered calcium carbonate was added to excess hydrochloric acid and the volume of gas liberated was recorded.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

The graph below shows the volumes of gas liberated (V) at different times (t) during the experiment:
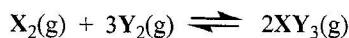

The experiment was repeated under the same conditions using the same mass of calcium carbonate granules instead of powdered calcium carbonate.   Which of the following graphs would best represent the results obtained in the repeated experiment ?

A.

B.

C.

D.

26.   Which of the following is NOT a characteristic property of transition metals ?

    A.   They form coloured compounds.
    B.   They exhibit variable oxidation numbers in their compounds.
    C.   They react with dilute hydrochloric acid to give hydrogen gas.
    D.   They exhibit catalytic property in elemental state or as compounds.

**Directions**: Q. 27 and Q.28 refer to the following reversible reaction:

$$X_2(g) + 3Y_2(g) \rightleftharpoons 2XY_3(g)$$

27. A mixture of $X_2(g)$ and $Y_2(g)$ was introduced into a 2.0 dm^3 closed vessel kept at a fixed temperature. When the system attained equilibrium, the vessel contained 0.4 mol of $X_2(g)$, 0.3 mol of $Y_2(g)$ and 0.4 mol of $XY_3(g)$.
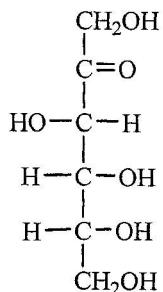
    Which of the following is the numerical value of K_c for the above reaction at this temperature ?

    A. 3.3
    B. 6.7
    C. 14.8
    D. 59.3

28. Which of the following combinations shows the effects of a catalyst on the rate of forward reaction, rate of backward reaction and the yield of $XY_3(g)$?

	Rate of forward reaction	Rate of backward reaction	Yield of $XY_3(g)$
A.	increased	increased	unchanged
B.	unchanged	unchanged	unchanged
C.	increased	decreased	increased
D.	decreased	increased	decreased
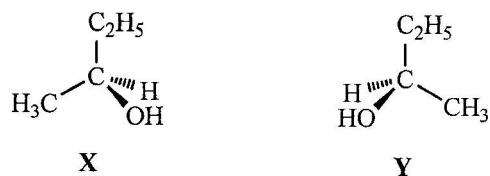
29. The structure of fructose is shown below:

$$
\begin{array}{c}
CH_2OH \\
| \\
C=O \\
| \\
HO-C-H \\
| \\
H-C-OH \\
| \\
H-C-OH \\
| \\
CH_2OH
\end{array}
$$

    Which of the following statements about fructose is correct ?

    A. Its empirical formula is $C_6H_{12}O_6$.
    B. It can turn acidified potassium dichromate solution from orange to green.
    C. It is insoluble in water.
    D. Its molecule has five chiral carbon centres.

9

Go on to the next page
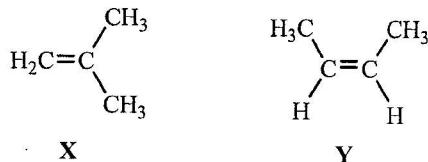
30. The three-dimensional structure of a molecule of compound **X** and that of compound **Y** are shown below:

X **Y**

Which of the following statements about **X** and **Y** is correct ?

   A.   **X** and **Y** are identical.
    B.   **X** and **Y** are a pair of structural isomers.
    C.   A mixture of **X** and **Y** can be separated by fractional distillation.
    D.   **X** and **Y** have the same standard enthalpy change of combustion.

31. Consider the compounds **X** and **Y** shown below:

    X   **Y**

Which of the following statements about **X** and **Y** is correct ?

    A.   **X** and **Y** are a pair of geometrical isomers.
    B.   Both **X** and **Y** react with $H_2(g)$ in the presence of $Ni(s)$.
    C.   **X** and **Y** react separately with Br_2 in CH_3CCl_3 to give the same organic product.
    D.   Both the polymerisation of **X** and that of **Y** give the same addition polymer.

32. Which of the following statements about the action of sodium hydroxide solution on ethanamide is/are correct ?

    (1)   Sodium ethanoate is formed in the reaction.
    (2)   In the reaction, sodium hydroxide acts as a catalyst.
    (3)   The reaction attains equilibrium if the reaction mixture is heated under reflux.
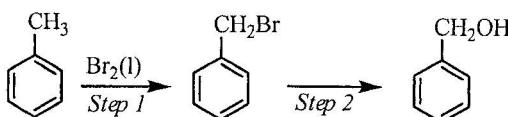
    A.   (1) only
    B.   (2) only
    C.   (1) and (3) only
    D.   (2) and (3) only

33. For which of the following can their progress of reaction be followed by colorimetry ?

    (1) $2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$
    (2) $SO_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(aq) + H_2O(l)$
    (3) $Br_2(aq) + HCO_2H(aq) \rightarrow 2Br^-(aq) + CO_2(g) + 2H^+(aq)$

    A.   (1) and (2) only
    B.   (1) and (3) only
    C.   (2) and (3) only
    D.   (1), (2) and (3)
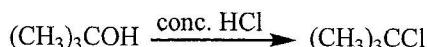
34.   Consider the following conversion of organic compounds:

Which of the following statements about the above conversion are correct ?

(1)   Excess $Br_2(l)$ should be used in *Step 1*.
(2)   Light is needed in *Step 1*.
(3)   The reagent used in *Step 2* can be KOH(aq).

           A.   (1) and (2) only
           B.   (1) and (3) only
           C.   (2) and (3) only
           D.   (1), (2) and (3)

35.   In order to prepare 2-chloro-2-methylpropane, a mixture of 2-methylpropan-2-ol and concentrated hydrochloric acid is shaken vigorously.

$$(CH_3)_3COH \xrightarrow{\text{conc. HCl}} (CH_3)_3CCl$$

Which of the following statements about this preparation are correct ?

(1)   Two layers of liquids can be observed in the reaction mixture after shaking.
(2)   The crude product should be washed with sodium carbonate solution.
(3)   The unreacted 2-methylpropan-2-ol can be removed by simple distillation.

           A.   (1) and (2) only
           B.   (1) and (3) only
           C.   (2) and (3) only
           D.   (1), (2) and (3)

Directions :   Question 36 consists of two separate statements.   Decide whether each of the two statements is true or false; if both are true, then decide whether or not the second statement is a *correct* explanation of the first statement.   Then select one option from A to D according to the following table :

A.   Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B.   Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C.   The 1st statement is false but the 2nd statement is true.
D.   Both statements are false.

1st statement	**2nd statement**
36. Both aluminium oxide and magnesium oxide exhibit similar acid-base properties.	Both aluminium oxide and magnesium oxide are ionic oxides.

END OF SECTION A

B

Candidate Number

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013
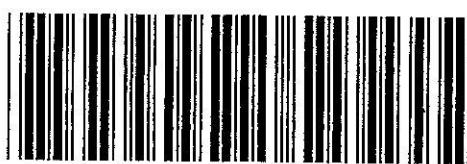
CHEMISTRY PAPER 1

SECTION B : Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) This section consists of TWO parts, Parts I and II.

(4) Answer ALL questions in both Parts I and II. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) An asterisk (*) has been put next to the questions where one mark will be awarded for effective communication.

(6) Supplementary answer sheets will be provided on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string INSIDE this Question-Answer Book.

(7) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.
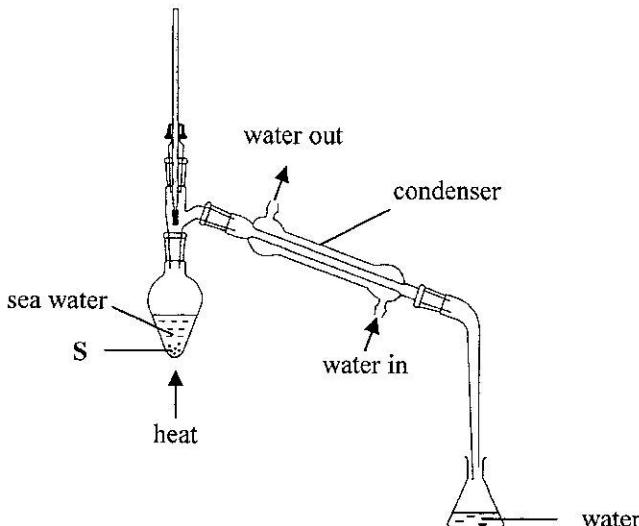
PART I

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

1.   Water is the most abundant compound on the Earth's surface. It is very important to life on Earth.

   (a)   Draw the electron diagram for a water molecule, showing *electrons in the outermost shells* only.

(1 mark)

   (b)   Nearly 98% of the water on Earth is sea water, which is not fit for human consumption.
          The diagram below shows the set-up used in a simple distillation experiment for obtaining water from sea water.

   (i)   Outline the underlying principle of this simple distillation experiment.

   (ii)   Insoluble solid **S** was placed into the flask before heating. Why ?

(3 marks)

1.   (c)   Explain, from molecular level, why the density of ice is lower than that of water.

(3 marks)

3

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2. Both BF_3 and NH_3 exist as simple molecules.

(a) For each of these molecules, draw its three-dimensional structure.

BF₃

NH₃

(2 marks)

(b) For each of these molecules, explain whether or not it is polar.

(2 marks)

(c) BF_3 reacts with NH_3 to give F_3BNH_3. Describe the bond formation between BF_3 and NH_3.

(2 marks)

3.   Compound **W** contains carbon, hydrogen and oxygen only. The relative molecular mass of **W** is 88.0.
      Complete combustion of 1.32 g of **W** gives 2.64 g of carbon dioxide and 1.08 g of water.

   (a)   Deduce the molecular formula of **W**.
          (Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(3 marks)

   (b)   Given that **W** has only one functional group, draw TWO possible structures of **W**.

(2 marks)

4.   The structure of a dibasic acid with chemical formula $H_2C_2O_4$ is shown below:

$$\text{COOH}$$
$$|$$
$$\text{COOH}$$

(a)   Give the systematic name of this dibasic acid.

(1 mark)

(b)   A student expected a 0.0500 mol dm^{-3} standard $H_2C_2O_4$(aq) to have a pH of 1.0. However, the pH of the solution, when measured with a calibrated pH meter, was found to be greater than 1. Explain this observation with the aid of a chemical equation.

(2 marks)

(c)   Solid sodium hydroxide is available in school laboratories. However, standard NaOH(aq) CANNOT be directly prepared by weighing NaOH(s) and then dissolving it in water. Explain why.

(1 mark)

(d)   In a titration experiment, 25.00 cm^3 of a 0.0500 mol dm^{-3} standard $H_2C_2O_4$(aq) and a few drops of phenolphthalein indicator were placed in a conical flask. NaOH(aq) of unknown concentration was then added from a burette into the flask. 17.20 cm^3 of the NaOH(aq) was required to reach the titration end point.

(i)   State the colour change at the titration end point.

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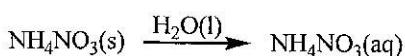
4.   (d)   (ii)   From the titration results, calculate the concentration of the NaOH(aq), in mol dm^{-3}.

<div style="text-align: right">(3 marks)</div>

(e)   The following were considered as INAPPROPRIATE practices when carrying out the experiment in (d). For each of them, explain why it would lead to inaccurate titration results:

(i)   rinsing the conical flask with the standard $H_2C_2O_4(aq)$ before transferring 25.00 cm^3 of the acid solution to it

(ii)   carrying out the titration with the filter funnel remained on top of the burette after using it to fill the burette with the NaOH(aq)

<div style="text-align: right">(2 marks)</div>

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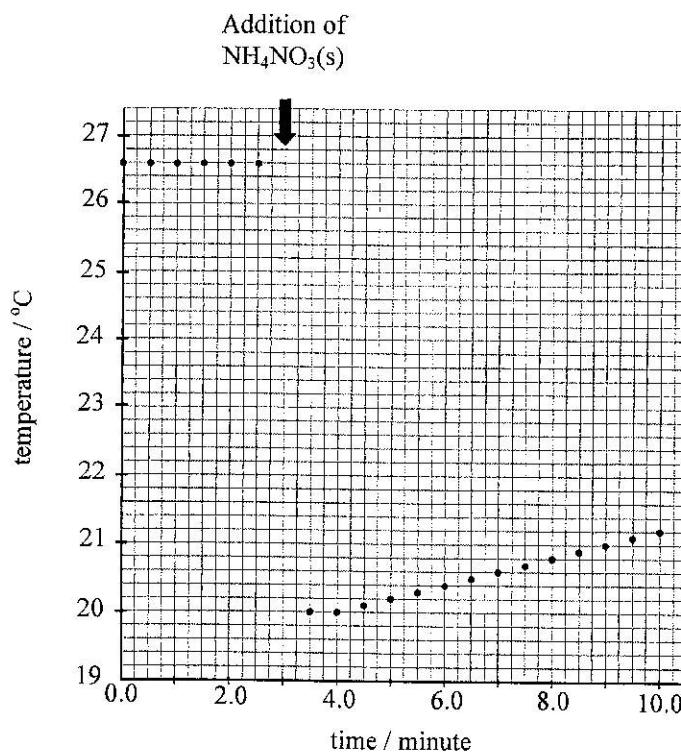
5.   The following experiment was carried out to determine the enthalpy change of solution of ammonium nitrate:

$$NH_4NO_3(s) \xrightarrow{H_2O(l)} NH_4NO_3(aq)$$

A certain volume of water was placed in an expanded polystyrene cup. The temperature of the water in the cup was measured with a thermometer at half-minute intervals. Right at the third minute, 2.0 g of $NH_4NO_3(s)$ was added to the cup. The solution in the cup was then stirred thoroughly and its temperature was measured for an additional 7 minutes.

The recordings of temperature are shown in the graph below:

Addition of
$NH_4NO_3(s)$

(a)   (i)   From the graph, estimate the greatest temperature drop of the solution in the cup.

       (ii)   The mass of the $NH_4NO_3(aq)$ obtained was found to be 21.8 g. Calculate the enthalpy change of solution of ammonium nitrate, in $kJ\ mol^{-1}$, under the experimental conditions. (Assume that the heat capacity of the expanded polystyrene cup is negligible, and the specific heat capacity of the $NH_4NO_3(aq)$ obtained is $4.3\ J\ g^{-1}\ K^{-1}$.)

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5.

(4 marks)

(b)   Suggest ONE way of keeping $NH_4NO_3(s)$ dry during storage.

(1 mark)

*6.   Briefly describe how polypropene can be produced from naphtha.

(4 marks)
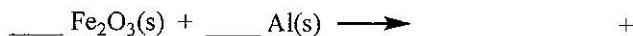
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7.   Thermite reactions broadly refer to exothermic oxidation-reduction reactions between a metal powder and a metal oxide. One example is the reaction of finely divided iron(III) oxide with aluminium powder. This reaction results in a very high temperature, and is commonly used in the welding of rail tracks for trains. At this very high temperature, the molten iron formed joins the rail tracks together.

(a)   (i)   Complete and balance the chemical equation for the following thermite reaction.

____ $Fe_2O_3(s)$ + ____ $Al(s)$ ⟶   +

(ii)   Sketch a labelled enthalpy level diagram for this reaction.

(2 marks)

(b)   Copper powder CANNOT be used to replace aluminium powder in carrying out the thermite reaction with iron(III) oxide. Explain why.

(1 mark)

(c)   The extraction of iron from its ores also involves the reduction of iron oxides.

(i)   Suggest why aluminium is NOT used as the reducing agent in iron extraction.

(ii)   Suggest ONE reducing agent commonly used in iron extraction.

(2 marks)

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8. Both caesium (Cs) and sodium (Na) are elements in Group I of the Periodic Table. Caesium reacts with chlorine to form caesium chloride.

(a) Write the chemical equation for the reaction of caesium with chlorine.

(1 mark)

(b) Solid caesium chloride has a giant ionic structure.

(i) Draw a diagram to show the structure of caesium chloride.

(ii) Explain why solid caesium chloride is brittle.

(3 marks)
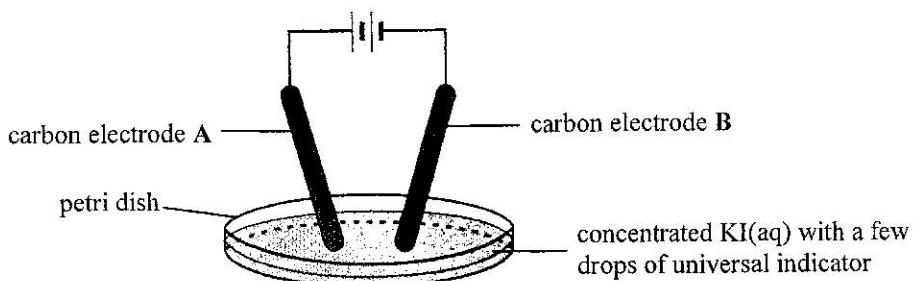
(c) Predict, with ONE reason, whether sodium or caesium is more reactive towards chlorine.

(1 mark)

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9. The diagram below shows the set-up used in an investigation on the electrolysis of concentrated potassium iodide solution:

carbon electrode A

carbon electrode B

petri dish

concentrated KI(aq) with a few drops of universal indicator

(a) State and explain the expected observation around carbon electrode **A** during the electrolysis.

(2 marks)

(b) The solution near carbon electrode **B** gradually turned blue.

(i) Explain this observation.
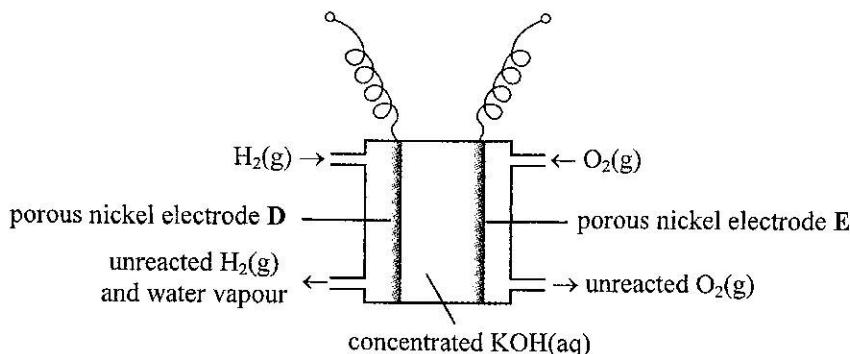
(ii) Would there be any change in observation if carbon electrode **B** is replaced by a copper electrode in the investigation ? Explain.
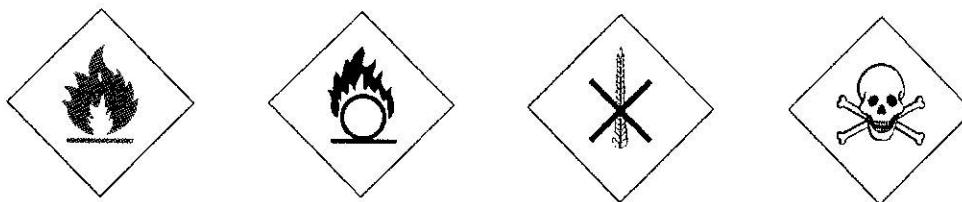
(3 marks)

The diagram below shows the structure of a hydrogen-oxygen fuel cell using concentrated potassium hydroxide solution as the electrolyte.

$H_2(g) \rightarrow$

$\leftarrow O_2(g)$

porous nickel electrode **D**

porous nickel electrode **E**

unreacted $H_2(g)$ and water vapour $\leftarrow$

$\rightarrow$ unreacted $O_2(g)$

concentrated KOH(aq)

(a) An oxygen cylinder can be used to provide oxygen for the above fuel cell. From the hazard warning labels shown below, circle the label that should be displayed on the oxygen cylinder.

(1 mark)

(b) Write the half equation for the change occurring at each of the following electrodes when this fuel cell is producing a current.

electrode **D**

electrode **E**

(2 marks)

(c) Some people have the view that cars powered by hydrogen-oxygen fuel cells are more environmentally friendly than those powered by petrol.

Comment on this view from each of the following aspects:

(i) source of fuel
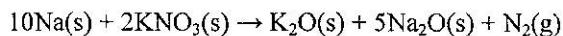
(ii) the car emissions

(2 marks)

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

11.   Safety airbags are important devices installed in vehicles. During a serious car crash, the chemicals in the airbag immediately react to release a large amount of gas. An airbag hence inflates instantly, protecting the passenger. The main chemicals in safety airbags are sodium azide (NaN_3) and potassium nitrate (KNO_3). The equations below show the reactions involved when an airbag is inflated:

$$2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$$

$$10Na(s) + 2KNO_3(s) \rightarrow K_2O(s) + 5Na_2O(s) + N_2(g)$$

(a)   Explain why the $NaN_3(s)$ and $KNO_3(s)$ used in the airbags are in the form of fine powder.

                                                                                                          (1 mark)

(b)   An airbag contains 100.0 g of $NaN_3(s)$ and 200.0 g of $KNO_3(s)$. Calculate the theoretical volume, measured at room temperature and pressure, of the gas produced when the bag is inflated.
(Formula masses: $NaN_3 = 65.0$, $KNO_3 = 101.1$;
molar volume of gas at room temperature and pressure = 24 dm^3)
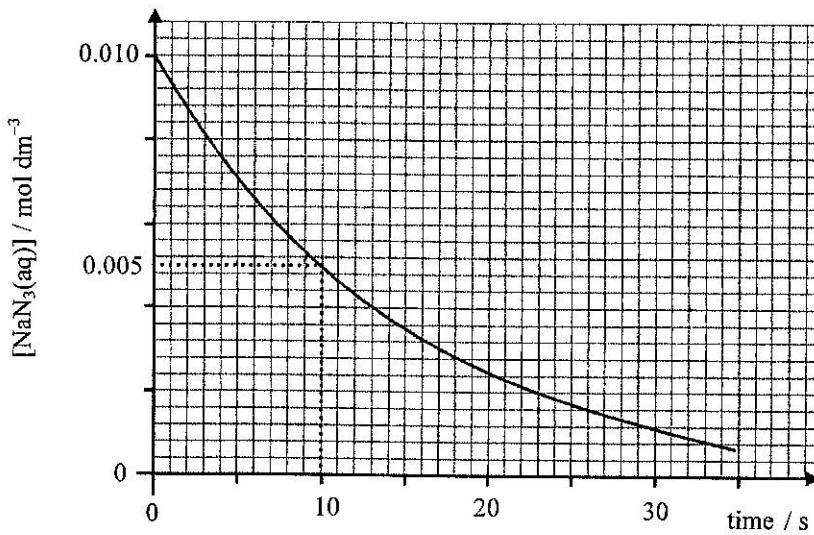
                                                                                                          (3 marks)

(c)   The main function of $NaN_3(s)$ is to produce $N_2(g)$ for inflating the airbags. Suggest why it is necessary to include $KNO_3(s)$ in the airbags.

                                                                                                          (1 mark)

11.   (d)   Sodium azide is a toxic chemical. Thus any NaN_3 waste remained during the manufacture of safety airbags needs special treatment before disposal. The treatment involves first dissolving NaN_3 in water, and then reacting the solution formed with excess nitrous acid, $HNO_2(aq)$. The graph below shows the variation of the concentration of $NaN_3(aq)$ in the reaction mixture with time in one such process:
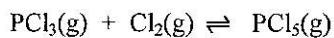
(i)   Calculate the average rate of consumption of $NaN_3(aq)$ in the first 10 seconds.

(ii)   Suggest how the instantaneous rate of consumption of $NaN_3(aq)$ at the 10th second can be determined from the graph.

(2 marks)

Provided by dse.life

12. At 250°C, the equilibrium constant K_c for the following reaction is 25 $mol^{-1}dm^3$.

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$$

A 10.0 dm^3 sealed container, which is maintained at 250°C, initially contains 0.50 mol of $PCl_3(g)$, 0.20 mol of $Cl_2(g)$ and 0.40 mol of $PCl_5(g)$.

(a) For this system under the initial conditions, calculate its reaction quotient. Predict and explain, under the initial conditions, whether the forward reaction rate or the backward reaction rate would be greater.

(2 marks)
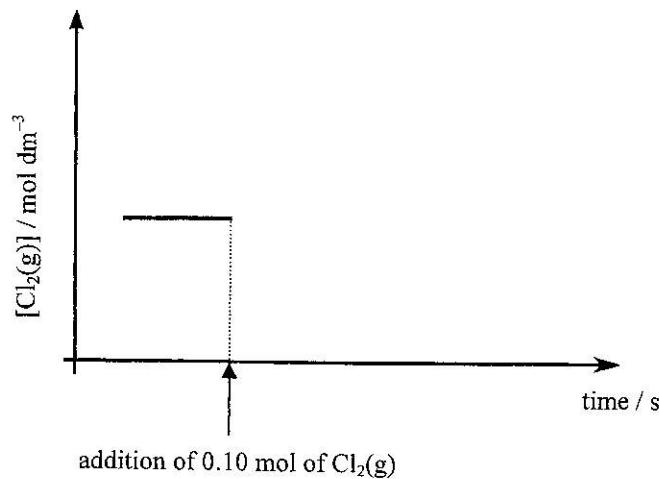
(b) Calculate the concentration of $Cl_2(g)$ when the system attains equilibrium at 250°C.

(2 marks)

12.　(c)　0.10 mol of $Cl_2(g)$ is added to the equilibrium mixture in (b). Sketch, in the graph below, the variation of the concentration of $Cl_2(g)$ with time until a new equilibrium is attained. (Assume that the temperature of the system remains at 250°C throughout the whole process.)

addition of 0.10 mol of $Cl_2(g)$

(1 mark)

*13.　Lithium, beryllium, carbon (graphite) and nitrogen are elements of the second period of the Periodic Table. Arrange them in increasing order of melting point, and explain the order in terms of structure and bonding.

(5 marks)
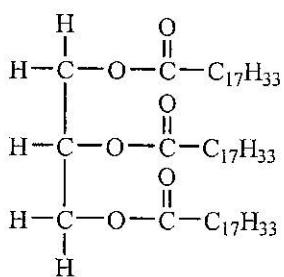
14. An unsaturated fat **F** is a component of a vegetable oil. The structure of **F** is shown below:

$$
\begin{array}{l}
\text{H} \\
| \\
\text{H}-\text{C}-\text{O}-\overset{\overset{\displaystyle O}{\|}}{\text{C}}-\text{C}_{17}\text{H}_{33} \\
| \\
\text{H}-\text{C}-\text{O}-\overset{\overset{\displaystyle O}{\|}}{\text{C}}-\text{C}_{17}\text{H}_{33} \\
| \\
\text{H}-\text{C}-\text{O}-\overset{\overset{\displaystyle O}{\|}}{\text{C}}-\text{C}_{17}\text{H}_{33} \\
| \\
\text{H}
\end{array}
$$

(a) State the reagents needed for converting **F** to a saturated fat.

(1 mark)

(b) Vegetable oils can be used to make soap.

   (i) Write the chemical equation involved for the formation of soap from **F**.

   (ii) In the presence of an acid, the soap formed in (i) can react with methanol to give compound **G**, which can be used as a biodiesel. Draw the structure of **G**.

(2 marks)
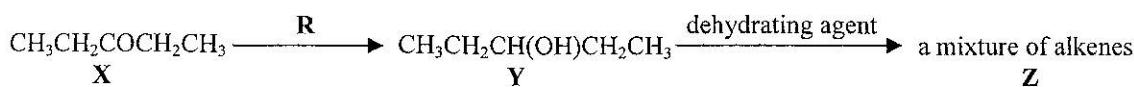
(c) With reference to their relative molecular masses and physical properties, explain why **G** can be used as a fuel for cars, but **F** cannot.

(2 marks)

15. Consider the conversions of organic compounds shown below:

$$CH_3CH_2COCH_2CH_3 \xrightarrow{\text{R}} CH_3CH_2CH(OH)CH_2CH_3 \xrightarrow{\text{dehydrating agent}} \text{a mixture of alkenes}$$

X   Y   Z

(a) Suggest a chemical test to distinguish between **X** and **Y**.

(2 marks)

(b) Suggest what reagent **R** might be.

(1 mark)

(c) The mixture **Z** contains two alkenes with the same structural formula. Draw the respective structures of these two alkenes, and state their isomeric relationship.

(2 marks)

(d) The alkenes in (c) can react with HCl to form an optically active chloroalkane. Write the structural formula of this chloroalkane.

(1 mark)

END OF SECTION B

END OF PAPER

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