HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2021

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

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.

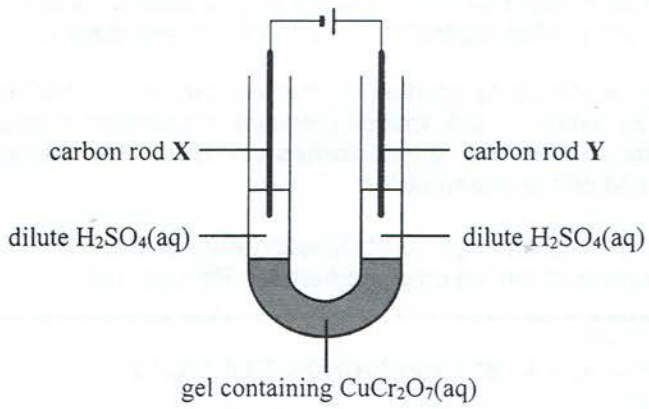
Candidates may refer to the Periodic Table printed on page 20 of Question-Answer Book B.

PART I

1. The melting point of a chemical species is 146 °C. It is soluble in water and the solution formed does not conduct electricity. Which of the following structures would this chemical species have ?

   A. giant ionic structure
   B. giant metallic structure
   C. giant covalent structure
   D. simple molecular structure

2. Consider the following experimental set-up :



   Which of the following statements is correct when an electric current passes through the circuit ?

   A. Blue colour is observed in the dilute $H_2SO_4(aq)$ around **Y**.
   B. Gas bubbles are observed in the dilute $H_2SO_4(aq)$ around **Y**.
   C. Orange colour is observed in the dilute $H_2SO_4(aq)$ around **X**.
   D. Electrons flow from **X** to **Y** through the external circuit.

3. Which of the following statements is INCORRECT ?

   A. Cracking of heavy oil can give ethene.
   B. Electrolysis of sea water can give chlorine.
   C. Strong heating of limestone can give oxygen.
   D. Fractional distillation of liquefied air can give nitrogen.

4. **M**, **Q** and **R** are three different metals. When their oxides are separately heated, only the oxide of **M** gives a metallic lustre. When their carbonates are separately heated with a Bunsen burner, only the carbonate of **R** gives no observable changes. Which of the following shows the increasing order of reactivity of the metals ?

   A. **R < Q < M**
   B. **R < M < Q**
   C. **M < R < Q**
   D. **M < Q < R**

5. 15.0 cm^3 of 0.20 M $Ba(NO_3)_2(aq)$ is added to 25.0 cm^3 of 0.10 M $Na_2SO_4(aq)$. After the reaction is completed, which of the following ions has the highest concentration in the mixture ?

A. $SO_4^{2-}(aq)$
B. $NO_3^-(aq)$
C. $Ba^{2+}(aq)$
D. $Na^+(aq)$

6. Refer to the information in the table below :

Solution	Contents	pH
X	50 cm^3 of 0.001M HCl(aq)	3.0
Y	25 cm^3 of 0.001M $H_2SO_4(aq)$	2.7
Z	50 cm^3 of 0.1M $CH_3COOH(aq)$	2.9

Which of the following statements is correct ?

A. **X** has a higher pH than **Z** because HCl is a stronger acid than CH_3COOH.
B. **Y** has a lower pH than **X** because the volume of $H_2SO_4(aq)$ is smaller than that of HCl(aq).
C. **Y** has a lower pH than **X** because H_2SO_4 is a strong dibasic acid but HCl is a strong monobasic acid.
D. **Y** has a lower pH than **Z** because the concentration of $H_2SO_4(aq)$ is lower than that of $CH_3COOH(aq)$.

7. The oxidation number of Pb in $Pb_{10}(VO_4)_6F_2$ is +2. What is the oxidation number of V ?

A. –3
B. +2
C. +4
D. +5

8. Consider two compounds with their structures shown below :

Which of the following statements is correct ?

A. Both of them are flammable.
B. They have different empirical formulae.
C. They belong to the same homologous series.
D. Both of them can decolourise bromine solution in the dark.

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9. Gases discharged from coal-fired power plants contain SO_2. SO_2 is also regarded as an air pollutant. What is the most suitable way to remove the SO_2 before discharging these gases into the atmosphere ?

A. Pass these gases through calcium oxide.
B. Pass these gases through concentrated sulphuric acid.
C. Cool these gases to liquefy SO_2 for subsequent removal.
D. Pass these gases through an organic solvent such as hexane.

10. Which of the following processes involves the breaking of hydrogen bonds ?

A. $H_2(l) \rightarrow H_2(g)$
B. $HBr(l) \rightarrow HBr(g)$
C. $CH_3OH(l) \rightarrow CH_3OH(g)$
D. $CH_3CHO(l) \rightarrow CH_3CHO(g)$

11. The monosubstitution of methane with chlorine under diffuse sunlight involves several steps. Which of the following steps initiates the reaction ?

A. $Cl_2 \rightarrow 2\ Cl\bullet$
B. $CH_4 \rightarrow CH_3\bullet + H\bullet$
C. $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
D. $CH_4 + Cl_2 \rightarrow CH_3Cl + H\bullet + Cl\bullet$

12. Given that :

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ $\quad \Delta H_1$
$Mg(s) + \frac{1}{2}O_2(g) + CO_2(g) \rightarrow MgCO_3(s)$ $\quad \Delta H_2$
$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$ $\quad \Delta H_3$

What is ΔH_3 ?

A. $\Delta H_1 - \Delta H_2$
B. $\Delta H_2 - \Delta H_1$
C. $\Delta H_2 - \frac{1}{2}\Delta H_1$
D. $\frac{1}{2}\Delta H_1 - \Delta H_2$

13. **W**, **X**, **Y** and **Z**, each represents one of the following solutions :

$HCl(aq)$ $\quad NaOH(aq)$ $\quad MgCl_2(aq)$ $\quad Na_2CO_3(aq)$

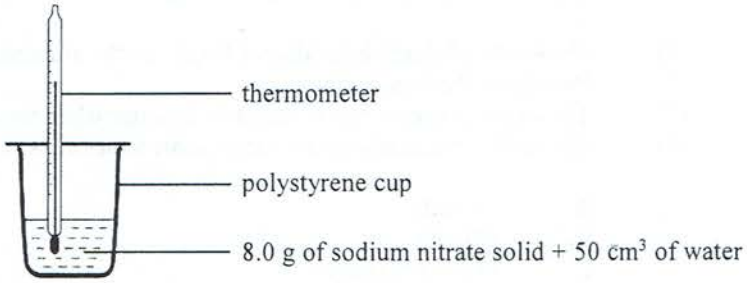
Given that :

- Mixing **W** and **X** gives a white precipitate.
- Mixing **W** and **Y** gives a white precipitate.
- Mixing **W** and **Z** gives a clear colourless solution.

What is **Z** ?

A. $HCl(aq)$
B. $NaOH(aq)$
C. $MgCl_2(aq)$
D. $Na_2CO_3(aq)$

14. Based on the experimental set-up in the diagram below, after 8.0 g of sodium nitrate solid is completely dissolved in 50 cm^3 of water, the temperature drops by 6 °C.



Which of the following would give a drop of temperature by 3 °C under the same experimental conditions ?

A. After 2.0 g of sodium nitrate solid is completely dissolved in 25 cm^3 of water.
B. After 4.0 g of sodium nitrate solid is completely dissolved in 100 cm^3 of water.
C. After 16.0 g of sodium nitrate solid is completely dissolved in 100 cm^3 of water.
D. After 24.0 g of sodium nitrate solid is completely dissolved in 75 cm^3 of water.

15. When 7.89 g of carbon monoxide gas burns completely, 80 kJ of heat is released. Under those experimental conditions, the enthalpy change of formation of carbon dioxide gas is −394 kJ mol^{-1}. What is the enthalpy change of formation of carbon monoxide gas under the same experimental conditions ?

(Relative atomic masses : C = 12.0, O = 16.0)

A. −678 kJ mol^{-1}
B. −474 kJ mol^{-1}
C. −314 kJ mol^{-1}
D. −110 kJ mol^{-1}

16. A sample of sulphuric acid was completely neutralised by 25.0 cm^3 of 0.200 M potassium hydroxide solution. The salt solution obtained was then made up to 100.0 cm^3 with deionised water. What is the concentration of the resulting salt solution ?

A. 0.0125 M
B. 0.0250 M
C. 0.0375 M
D. 0.0500 M

17. What is the systematic name of $CH_2BrCHBrCH_2CH_2I$?

A. 1-iodo-3,4-dibromobutane
B. 4-iodo-1,2-dibromobutane
C. 1,2-dibromo-4-iodobutane
D. 3,4-dibromo-1-iodobutane

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18. Both aluminium and iron form oxides on their surfaces when they are exposed in air. The oxide of aluminium can prevent the aluminium from further corrosion, but the oxide of iron cannot prevent the iron from further corrosion. What is / are the reason(s) ?

(1) The oxide of aluminium adheres firmly on the aluminium surface while the oxide of iron adheres loosely on the iron surface.
(2) The oxide of aluminium is insoluble in water while the oxide of iron is soluble in water.
(3) The oxide of aluminium has a giant ionic structure while the oxide of iron does not.

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

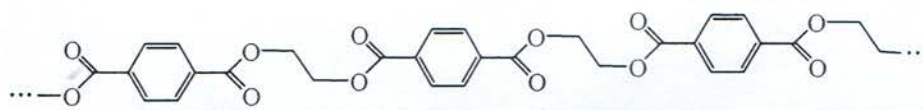
19. The composition by mass of element **X** in the compound K_2XO_4 is 26.8%. Which of the following statements concerning **X** is / are correct ?

(Relative atomic masses : O = 16.0, K = 39.1)

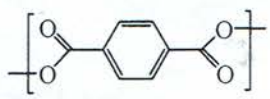
(1) **X** is a transition metal.
(2) **X** is an element in Group VI of the Periodic Table.
(3) **X** is an element in the fourth period of the Periodic Table.

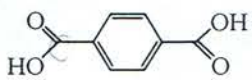
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

20. The structure of a portion of a polymer is shown below :



Which of the following statements concerning the polymer is / are correct ?

(1)  is the repeating unit of it.

(2)  is a monomer of it.

(3) $HOCH_2COOH$ is a monomer of it.

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

21. Which of the following solids has / have delocalised electrons in its / their structure(s) ?

(1) graphite
(2) silicon
(3) silver

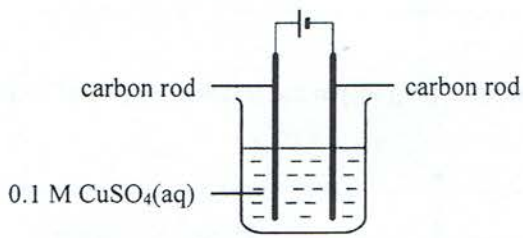
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

22. Which of the following statements concerning hydrogen-oxygen fuel cells are correct ?

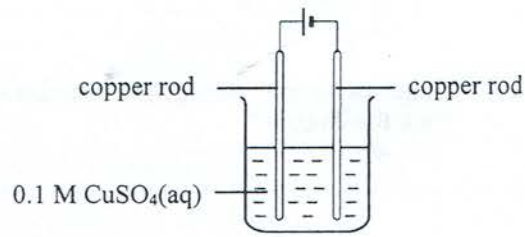
(1) When used to power vehicles, they are more environmentally friendly than using petrol engine.
(2) When used in space stations, they can produce drinking water in addition to energy.
(3) When used as a back-up power source in hospitals, they do not produce noise pollution.

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

23. Consider the following two electrolytic cells :



Electrolytic cell 1



Electrolytic cell 2

During electrolysis, which of the following would occur in **Electrolytic cell 1** but not in **Electrolytic cell 2** ?

(1) Gas bubbles are given out.
(2) The blue solution becomes paler.
(3) A reddish brown solid is deposited.

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

24. Consider the following statements and choose the best answer :

1st statement	**2nd statement**
Iron(II) hydroxide is a base.	Iron(II) hydroxide is insoluble in water.

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.

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PART II

Direction: Questions 25 and 26 refer to the following experiment on the study of the rate of reaction between $HCO_2H(aq)$ and $Br_2(aq)$ at a certain temperature. It is given that the rate depends on both the concentrations of $HCO_2H(aq)$ and $Br_2(aq)$:

$$HCO_2H(aq) + Br_2(aq) \rightarrow 2HBr(aq) + CO_2(g)$$

5.0 cm^3 of 0.05 M $HCO_2H(aq)$ are separately added to four conical flasks each containing $Br_2(aq)$ prepared by mixing different volumes of 0.05 M $Br_2(aq)$ and water as shown in the table below :

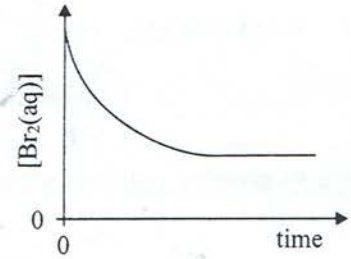
Conical flask	Volume of 0.05 M $Br_2(aq)$ / cm^3	Volume of water / cm^3
A	1.0	4.0
B	2.0	3.0
C	3.0	2.0
D	4.0	1.0

25. In which of the above conical flasks does the reaction have the fastest initial rate ?

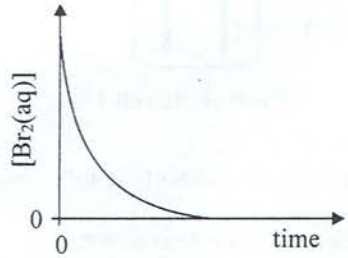
A. **A**
B. **B**
C. **C**
D. **D**

26. Which of the following graphs best represents the variation of $[Br_2(aq)]$ in the reaction mixture of conical flask **B** with time ?

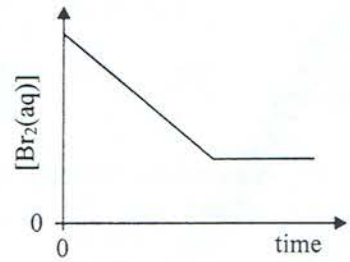
A.



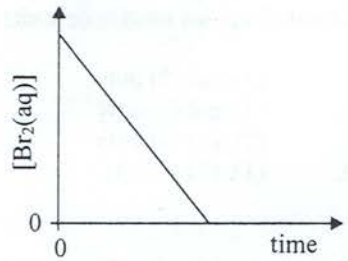
B.



C.



D.



27. Copper(II) oxide can catalyse the decomposition of hydrogen peroxide to form oxygen and water. In an experiment, hydrogen peroxide solution is shaken with copper(II) oxide in a test tube. What would be observed in the test tube after the completion of the reaction ?

A. a pale blue liquid
B. a blue solid and a colourless liquid
C. a black solid and a colourless liquid
D. a reddish brown solid and a colourless liquid

28. Which of the following statements correctly describes the property of an amphoteric oxide ?

A. It can react as an acid or as a base.
B. It can react with water to form an acid and an alkali.
C. It can be simultaneously oxidised and reduced in a reaction.
D. It can react with water to form an oxidising agent and a reducing agent.

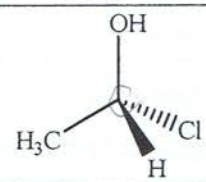
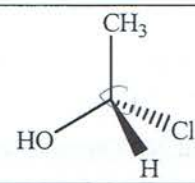
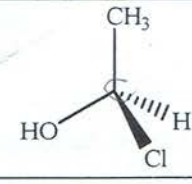
29. Consider the following reaction :

$$HOOCCH_2COCH_2CHO \xrightarrow{NaBH_4(aq)} \mathbf{Y}$$

What is **Y** ?

A. $HOOCCH_2COCH_2CH_2OH$
B. $HOOCCH_2CH(OH)CH_2CHO$
C. $HOOCCH_2CH(OH)CH_2CH_2OH$
D. $HOCH_2CH_2CH(OH)CH_2CH_2OH$

30. Consider the information shown in the table below :

Structure of the molecules of the liquid in		
bottle **A**	bottle **B**	bottle **C**
		

Which of the following liquids have identical boiling point ?

A. liquids in bottle **A** and bottle **B** only
B. liquids in bottle **A** and bottle **C** only
C. liquids in bottle **B** and bottle **C** only
D. liquids in bottle **A**, bottle **B** and bottle **C**

31. Consider the following reaction under certain conditions :

$$2\mathbf{X}_3(g) \rightleftharpoons 3\mathbf{X}_2(g) \qquad K_c = 4.0 \text{ mol dm}^{-3}$$

The reaction quotient is 2.0 mol dm^{-3} at a certain moment. Which of the following statements is / are correct ?

(1) The reaction quotient is larger than 2.0 mol dm^{-3} after a period of time.
(2) The backward reaction is faster than the forward reaction at that moment.
(3) The concentration of $\mathbf{X}_2(g)$ must be equal to the concentration of $\mathbf{X}_3(g)$ at that moment.

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

Go on to the next page

32. Consider the following equilibrium system :

$$\underset{\text{colourless}}{HA(aq)} \rightleftharpoons \underset{\text{pink}}{H^+(aq) + A^-(aq)} \qquad \Delta H > 0$$

Which of the following statements is / are correct ?

(1) Adding $Na_2CO_3(s)$ would make its colour become paler.
(2) Increasing the temperature would make its colour become darker.
(3) Adding a few drops of concentrated HCl(aq) would increase the concentration of $A^-(aq)$.

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

33. Which of the following statements concerning the elements in the third period of the Periodic Table going from Na to Cl is / are correct ?

(1) The bond type of the elements changes from metallic bonding to covalent bonding.
(2) The oxide of the elements changes from acidic to basic.
(3) The electrical conductivity of the elements keeps decreasing.

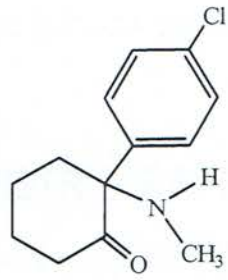
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

34. Which of the following mixtures would NOT separate into two liquid layers after heating under reflux for a period of time ?

(1) $HCOOCH_2CH_3(l)$ and excess NaOH(aq)
(2) $CH_3CH_2CH_2Cl(l)$ and excess concentrated NaOH(aq)
(3) $CH_3CH_2CHO(l)$ and excess acidified $K_2Cr_2O_7(aq)$

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

35. The diagram below shows the structure of a compound.



Which of the following statements concerning the compound are correct ?

(1) It has an amide group.
(2) Its structure has only one chiral carbon.
(3) It can be converted to an alcohol by using an appropriate reducing agent.

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

36. Consider the following statements and choose the best answer :

1st statement	**2nd statement**
Methyl ethanoate and ethyl methanoate have similar chemical properties.	Methyl ethanoate and ethyl methanoate are isomers.

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.

END OF SECTION A