FUKIEN SECONDARY SCHOOL

S4 First Term Examination (2020-2021)

Chemistry

(1 hour 30 minutes)

Date: 6th January 2021                                    Name:_____

Time: 10:30a.m. - 12:00nn                                 Class: _____ No.: _____

**Instructions to students:**

1.  Write your name, class and class number on both the question paper and the answer sheets.

2.  Answer ALL questions.

3.  Write down all the answers on the answer sheets.

4.  Hand in the question paper and the answer sheets at the end of the examination.

5.  The total mark of the paper is 70.


**I.   Multiple Choice Questions (30 marks)**


1.  Which of the following methods can be used to distinguish between solid sodium carbonate and solid calcium carbonate?

    (1)  heating the solid and testing the gaseous product with lime water

    (2)  testing the solubility of the solid in water

    (3)  conducting a flame test on the solid

    A.  (1) and (2) only

    B.  (1) and (3) only

    C.  (2) and (3) only

    D.  (1), (2) and (3)

2.  Which of the following diagrams can represent a mixture of two compounds?
    (In these diagrams , ● and ○ represent a nitrogen atom and an oxygen atom respectively.)

A.

B.

C.

D.
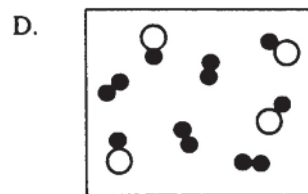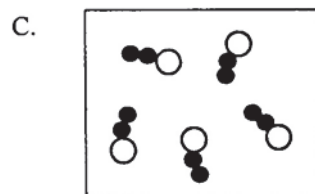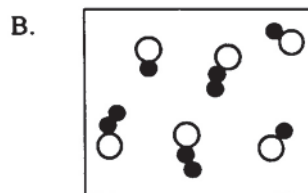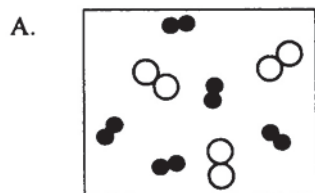
3.  The melting points and boiling points of four substances at 1 atm pressure are listed in the table.

| Substance | Melting point/℃ | Boiling point/℃ |
|---|---|---|
| argon | −189 | −186 |
| bromine | −7 | 59 |
| chlorine | −101 | −35 |
| sulphur dioxide | −75 | −10 |

Which substance exists as a liquid at −90℃ and 1 atm pressure?

A.  argon
B.  bromine
C.  chlorine
D.  sulphur dioxide

4.  When a flame test is performed on copper(II) chloride, what is the colour of the flame observed?

A.  golden yellow
B.  pale purple
C.  brick-red
D.  bluish-green

5.  Which of the following correctly describes the sequence of procedures to separate sand, salt and water from a mixture of sand and salt solution?

    A.  filtration, evaporation
    B.  filtration, distillation
    C.  crystallisation, filtration
    D.  crystallisation, filtration, distillation


6.  Which of the following substances contain calcium carbonate as the main chemical constituent?

    (1)  limestone
    (2)  chalk
    (3)  marble

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


7.  A cation of a certain element has 22 electrons and a mass number of 55. If the charge on the cation is +3, the number of neutrons in the cation is

    A.  19.
    B.  23.
    C.  25.
    D.  30.


8.  The atomic numbers of element X and element Y are 13 and 16 respectively. The formula of the compound formed between X and Y is likely to be

    A.  $XY_2$.
    B.  $X_2Y$.
    C.  $X_2Y_3$.
    D.  $X_3Y_2$.

9.   Which of the following combinations concerning the isotopes of an element is correct?

|     | No. of protons | No. of neutrons | No. of electrons |
|-----|----------------|-----------------|------------------|
| A.  | same           | different       | same             |
| B.  | same           | same            | different        |
| C.  | different      | same            | different        |
| D.  | same           | different       | different        |

10.  Bromine has a low melting point because

   A.   it is a non-metal.

   B.   it is a member of the halogen family.

   C.   the atoms in each bromine molecule are bonded together by a covalent bond.

   D.   the bromine molecules are attracted together by van der Waals' forces.

11.  Dry zinc chloride solid is a non-conductor of electricity because

   A.   it is a non-electrolyte.

   B.   it exists as molecules.

   C.   its ions are not mobile.

   D.   metallic bonding is not present.

12.  Refer to the following table.

| Element          | W | X | Y  | Z  |
|------------------|---|---|----|----|
| Atomic number    | 4 | 8 | 14 | 20 |

   Which of the following elements are likely to be metals?

   A.   W and X

   B.   W and Z

   C.   X and Y

   D.   Y and Z

13. The reaction between lead(II) nitrate solution and sodium hydrogencarbonate solution can be represented by the equation below:

    $Pb^{2+}(aq) + 2HCO_3^-(aq) \rightarrow PbCO_3(x) + H_2O(y) + CO_2(z)$

    Which of the following combinations is correct?

    |     | x   | y   | z   |
    |-----|-----|-----|-----|
    | A.  | aq  |     | aq  |
    | B.  | aq  | l   | g   |
    | C.  | s   | aq  | g   |
    | D.  | s   | l   | g   |

14. X, Y and Z are metals. Y can displace X from a solution of the nitrate of X. Oxides of X and Y can be reduced by hydrogen but not the oxide of Z. Which of the following arrangements represents the correct descending order of reactivity of the metals?

    A. $Z > Y > X$

    B. $X > Y > Z$

    C. $Z > X > Y$

    D. $X > Z > Y$

15. Which of the following substances, when heated, can react with oxygen?

    (1) sodium

    (2) sulphur

    (3) iron

    A. (2) only

    B. (1) and (2) only

    C. (1) and (3) only

    D. (1), (2) and (3)

16. Rubidium (Rb) is a group I element below potassium in the Periodic table. Which of the following statements about rubidium is correct?

    A.  Rubidium forms an acidic oxide.

    B.  Rubidium is more reactive than potassium.

    C.  Rubidium can be obtained from its oxide by reduction with carbon.

    D.  The formula for rubidium chloride is $RbCl_2$.

17. Which of the following ions is/are coloured?

    (1)  $Pb^{2+}(aq)$

    (2)  $Cr^{3+}(aq)$

    (3)  $MnO_4^{-}(aq)$

    A.  (1) only

    B.  (3) only

    C.  (1) and (2) only

    D.  (2) and (3) only

18. Which of the following metals can be obtained by reducing their oxides with carbon?

    (1)  Iron

    (2)  Calcium

    (3)  Lead

    A.  (1) and (2) only

    B.  (1) and (3) only

    C.  (2) and (3) only

    D.  (1), (2) and (3)

19. The molecular formula of a gas is $X_3$. If the Avogadro's Number is $L$ mol$^{-1}$, how many molecules are there in 96g of $X_3$?

    (Relative atomic mass of X = 16.0)

    A.  0.5 L

    B.  2L

    C.  3L

    D.  6L

20. If 2g of carbon dioxide gas contain x molecules, how many molecules are present in 2g of helium gas?

    (Relative atomic masses: He$=4.0$, C$=12.0$, O$=16.0$)

    A.   x

    B.   5.5x

    C.   7x

    D.   11x

21. 16.1g of a hydrated metal sulphate was heated to constant mass. After cooling to room temperature, the anhydrous metal sulphate weighed 7.1g. How many moles of water crystallization are there in one more of the hydrated metal sulphate?

    (Relative molecular masses: anhydrous metal sulphate$=142.0$; water$=18.0$)

    A.   4

    B.   5

    C.   7

    D.   10

22. Which of the following gases, each having a mass of 10.0g, has the greatest number of molecules at room temperature and pressure?

    (Relative atomic masses: C=12.0; N=14.0; O=16.0; F=19.0; Ne=20.2)

    A.   Nitrogen

    B.   Fluorine

    C.   Neon

    D.   Carbon monoxide

23. The molecular formula of a gaseous element X is $X_2$. If the relative atomic mass of X is 19, what is the number of molecules in 114g of the gas?

    (Avogadro's number$=6.02 \times 10^{23}$ mol$^{-1}$)

    A.   3

    B.   6

    C.   $3 \times 6.02 \times 10^{23}$

    D.   $6 \times 6.02 \times 10^{23}$

24. Which of the following contains the same number of atoms as 2.20g of carbon dioxide?

    (Relative atomic masses：H =1.0 , C=12.0, N=14.0 O=16.0, S=32.0, Cl=35.5)

    A.   1.70g of ammonia

    B.   2.25g of nitrogen monoxide

    C.   2.80g of sulphur dioxide

    D.   3.55g of chlorine

25. Zinc blocks are often attached to the steel legs of off-shore oil platforms because

    A.   zinc can protect steel from corrosion.

    B.   zinc is more resistant to corrosion than steel.

    C.   zinc is harder than steel.

    D.   zinc does not react with crude oil.

26. Aluminium is used to make window frames because

    (1)   it is strong.

    (2)   it can resist corrosion.

    (3)   it is the most abundant metallic element in the earth crust.

    Which of the above statements are correct?

    A.   (1) and (2) only

    B.   (1) and (3) only

    C.   (2) and (3) only

    D.   (1), (2) and (3)

27. In which of the following situations is iron prevented from rusting by sacrificial protection?

    A.   Iron plates are jointed together with copper rivets.

    B.   Iron pipes are connected to lead blocks.

    C.   Iron sheets are plated with zinc.

    D.   Iron cans are coated with tin.

28. Iron cans used for canning food are usually coated with tin instead of zinc. This is because

    A.  tin is more reactive than zinc.

    B.  tin ions are non-toxic but zinc ions are toxic.

    C.  tin forms an alloy with iron and this alloy is corrosion resistant.

    D.  tin prevents iron cans from rusting by sacrificial protection.


29. Which of the following statements concerning aluminium is correct?

    A.  Aluminium is used to make stainless steel.

    B.  The strength of aluminium can be enhanced by anodization.

    C.  Aluminium is the most abundant element in the earth's crust.

    D.  When aluminium is exposed to air, a layer of aluminium oxide is formed on its surface.


30. Which of the following rust prevention methods does NOT match with the iron-made object?

| | Rust prevention method | Iron-made object |
|---|---|---|
| A. | painting | gate |
| B. | greasing | machinery parts |
| C. | zinc plating | bicycle gear |
| D. | chromium plating | car bumper |

## II.   Structured Questions (40 marks)

1.   In an experiment, carbon dioxide is passed into limewater until excess.

(a)   State the expected observations and write the chemical equations for the reactions involved.

(3 marks)

(b)   Explain whether the similar observations in (a) would be made if sodium hydroxide solution is used instead of limewater.

(1 mark)

(c)   Explain whether the similar observations in (a) would be made if air is used instead of carbon dioxide.

(1 mark)

(d)   Carbon dioxide can be obtained from the reaction of solid sodium carbonate with dilute hydrochloric acid. Write an ionic equation for the reaction.

(1 mark)

2.   Neon, a monatomic gas, occurs naturally as a mixture of three isotopes. The relative abundance of these isotopes is tabulated below:

| Isotope | $_{10}^{20}Ne$ | $_{10}^{21}Ne$ | $_{10}^{22}Ne$ |
|---|---|---|---|
| Abundance(%) | 90.52 | 0.31 | 9.17 |

(a)   State the number of electrons in the outermost shell of a neon atom.

(1 mark)

(b)   Explain why neon gas is monatomic.

(1 mark)

(c)   What is meant by the term 'isotope'?

(1 mark)

(d)   Calculate the relative atomic mass of neon.

(2 marks)

3.  The table below lists some physical properties of lead, bromine and lead(II) bromide.

|  | Lead | Bromine | Lead(II) bromide |
|---|---|---|---|
| Melting point | 328℃ | −7℃ | 370℃ |
| Electrical conductivity in the solid state | conducting | Non-conducting | Non-conducting |
| Electrical conductivity in the liquid state | Conducting | Non-conducting | --- |

(a) Explain the difference in melting points between bromine and lead(II) bromide.

(2 marks)

(b) Explain the difference in electrical conductivity between lead and lead(II) bromide in the solid state.

(2 marks)

(c) Will lead(II) bromide conduct electricity in the liquid state? Explain your answer.

(1 mark)


4.  Silvery metal A reacts vigorously with water to form colourless solution B. When B is subjected to the flame test, it gives a golden yellow flame. When B is added to copper(II) nitrate solution, precipitate C is formed. C decomposes into black solid D and water upon strong heating.

(a) What is metal A? Write a balanced equation for the reaction between A and water.

(2 marks)

(b) Describe how the flame test on B can be carried out in the laboratory.

(2 marks)

(c) C is copper (II) hydroxide. Write an ionic equation for the formation of C.

(1 mark)

(d) Give the name for D.

(1 mark)

5.   A student used the following set-up to determine the empirical formula of an oxide of iron.
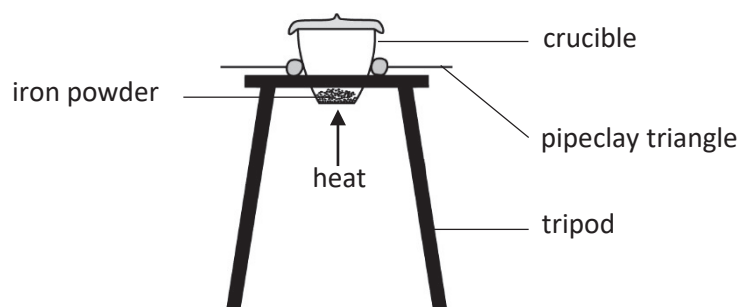


Before the experiment, the student was instructed to remove any rust from it.

After weighing a sample of pure iron powder, the student then heated it strongly in a crucible, opening and closing the lid from time to time until the reaction was complete. He then reweighed the content after cooling.

The following results were obtained:

| Mass of crucible+lid | 25.27g |
|---|---|
| Mass of crucible+lid+iron powder before heating | 26.16g |
| Mass of crucible+lid+content after cooling | 26.50g |

(a)   Describe briefly how the rust could be removed chemically. Write an appropriate equation for the reaction.

(3 marks)

(b)   Give TWO reasons why the crucible lid was opened and closed from time to time during heating.

(2 marks)

(c)   Calculate the empirical formula of the oxide of iron from the above data.
      (Relative atomic masses : O=16.0 ; Fe = 56.0)

(4 marks)

6.    The set-up below was used to investigate the corrosion of iron.

| A | B |
|---|---|
| 0.1M HCl(aq)<br><br>iron nail | tap water<br><br>iron nail |
| C | D |
| tap water<br>iron nail wrapped<br>with zinc wire | methanol<br><br>iron nail |
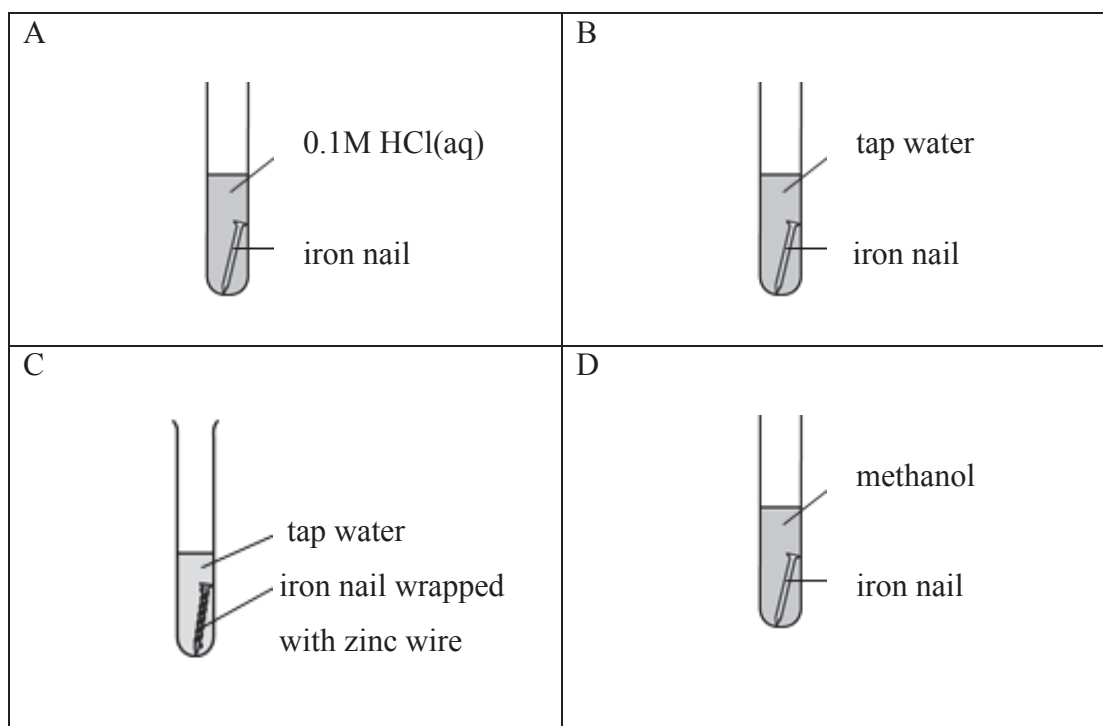
After some time, the solution from each tube was tested with potassium hexacyanoferrate(III) solution. It was found that corrosion of iron occurred only in tubes A and B.

(a)  State the colour change when the solution from tube A was tested with potassium hexacyanoferrate(III) solution.

(1 mark)

(b)  The iron nail in the tube B corroded.

(i)    Indicate what cation and anion were produced.

(ii)   Write the half equation to show the formation of each ion.

(4 marks)

(c)  In which of the tubes would bubbles of gas be observed? Write an equation for the reaction involved.

(2 marks)

(d)  Explain why corrosion of iron did not occur in

(i)    tube C and

(ii)   tube D.

(2 marks)

**End of Paper**

PERIODIC TABLE    週期表

GROUP 族

| I | II | | | | | | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 2<br>**He**<br>4.0 |
| 3<br>**Li**<br>6.9 | 4<br>**Be**<br>9.0 | | | | | | 5<br>**B**<br>10.8 | 6<br>**C**<br>12.0 | 7<br>**N**<br>14.0 | 8<br>**O**<br>16.0 | 9<br>**F**<br>19.0 | 10<br>**Ne**<br>20.2 |
| 11<br>**Na**<br>23.0 | 12<br>**Mg**<br>24.3 | | | | | | 13<br>**Al**<br>27.0 | 14<br>**Si**<br>28.1 | 15<br>**P**<br>31.0 | 16<br>**S**<br>32.1 | 17<br>**Cl**<br>35.5 | 18<br>**Ar**<br>40.0 |
| 19<br>**K**<br>39.1 | 20<br>**Ca**<br>40.1 | 21<br>**Sc**<br>45.0 | 22<br>**Ti**<br>47.9 | 23<br>**V**<br>50.9 | 24<br>**Cr**<br>52.0 | 25<br>**Mn**<br>54.9 | |  | | | | |
| 37<br>**Rb**<br>85.5 | 38<br>**Sr**<br>87.6 | 39<br>**Y**<br>88.9 | 40<br>**Zr**<br>91.2 | 41<br>**Nb**<br>92.9 | 42<br>**Mo**<br>95.9 | 43<br>**Tc**<br>(98) | | | | | | |
| 55<br>**Cs**<br>132.9 | 56<br>**Ba**<br>137.3 | 57 *<br>**La**<br>138.9 | 72<br>**Hf**<br>178.5 | 73<br>**Ta**<br>180.9 | 74<br>**W**<br>183.9 | 75<br>**Re**<br>186.2 | | | | | | |
| 87<br>**Fr**<br>(223) | 88<br>**Ra**<br>(226) | 89 **<br>**Ac**<br>(227) | 104<br>**Rf**<br>(261) | 105<br>**Db**<br>(262) | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26<br>**Fe**<br>55.8 | 27<br>**Co**<br>58.9 | 28<br>**Ni**<br>58.7 | 29<br>**Cu**<br>63.5 | 30<br>**Zn**<br>65.4 | | | | | | |
| 44<br>**Ru**<br>101.1 | 45<br>**Rh**<br>102.9 | 46<br>**Pd**<br>106.4 | 47<br>**Ag**<br>107.9 | 48<br>**Cd**<br>112.4 | | | | | | |
| 76<br>**Os**<br>190.2 | 77<br>**Ir**<br>192.2 | 78<br>**Pt**<br>195.1 | 79<br>**Au**<br>197.0 | 80<br>**Hg**<br>200.6 | | | | | | |

atomic number 原子序

| 1 |
|---|
| **H** |
| 1.0 |

relative atomic mass 相對原子質量

* 
| 58<br>**Ce**<br>140.1 | 59<br>**Pr**<br>140.9 | 60<br>**Nd**<br>144.2 | 61<br>**Pm**<br>(145) | 62<br>**Sm**<br>150.4 | 63<br>**Eu**<br>152.0 | 64<br>**Gd**<br>157.3 | 65<br>**Tb**<br>158.9 | 66<br>**Dy**<br>162.5 | 67<br>**Ho**<br>164.9 | 68<br>**Er**<br>167.3 | 69<br>**Tm**<br>168.9 | 70<br>**Yb**<br>173.0 | 71<br>**Lu**<br>175.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

** 
| 90<br>**Th**<br>232.0 | 91<br>**Pa**<br>(231) | 92<br>**U**<br>238.0 | 93<br>**Np**<br>(237) | 94<br>**Pu**<br>(244) | 95<br>**Am**<br>(243) | 96<br>**Cm**<br>(247) | 97<br>**Bk**<br>(247) | 98<br>**Cf**<br>(251) | 99<br>**Es**<br>(252) | 100<br>**Fm**<br>(257) | 101<br>**Md**<br>(258) | 102<br>**No**<br>(259) | 103<br>**Lr**<br>(260) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| III | IV | V | VI | VII |
|---|---|---|---|---|
| 31<br>**Ga**<br>69.7 | 32<br>**Ge**<br>72.6 | 33<br>**As**<br>74.9 | 34<br>**Se**<br>79.0 | 35<br>**Br**<br>79.9 |
| 49<br>**In**<br>114.8 | 50<br>**Sn**<br>118.7 | 51<br>**Sb**<br>121.8 | 52<br>**Te**<br>127.6 | 53<br>**I**<br>126.9 |
| 81<br>**Tl**<br>204.4 | 82<br>**Pb**<br>207.2 | 83<br>**Bi**<br>209.0 | 84<br>**Po**<br>(209) | 85<br>**At**<br>(210) |

| VI | VII | 0 |
|---|---|---|
| | | 36<br>**Kr**<br>83.8 |
| | | 54<br>**Xe**<br>131.3 |
| | | 86<br>**Rn**<br>(222) |