GEORGES RIVER COLLEGE
OATLEY SENIOR HIGH SCHOOL

**2004**

PRELIMINARY SEMESTER 2
EXAMINATION

# Chemistry

**Total marks (75)**

Attempt ALL questions

**PART A**        Pages 2-6
Total Marks (15)
- Attempt Questions 1-15
- Allow about 30 minutes for this part

**PART B**        Pages 7-18
Total Marks (60)
- Attempt Questions 16-29
- Allow about 1 hour 30 minutes for this part

## General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your Name at the top of every page

Name: _____

## PART A

Total Marks (15)

- Attempt Questions 1-15
- Allow about 30 minutes for this part

1.  X, Y and Z are mixed together in a beaker. The properties of X, Y and Z are listed below:

|  | X | Y | Z |
|---|---|---|---|
| State at 25°C | solid | liquid | solid |
| M.p. (°C) | 801 | 78 | 1350 |
| Density (g/cm$^3$) | 2.2 | 0.79 | 4.5 |
| Solubility in water | high | high | insoluble |
| Solubility in Y | high | high | insoluble |

Which physical separation technique would be best to use to obtain a pure sample of Z from the mixture?

(A)   filtration
(B)   evaporation
(C)   electrolysis
(D)   distillation

2.  The diagram below shows the uses of one common element.



Which element best fits this pattern of use?

(A)   aluminium
(B)   copper
(C)   lead
(D)   sodium

3.  Use the Periodic table provided to identify the element with the electron configuration of 2,8,7.

    (A)   carbon
    (B)   chlorine
    (C)   fluorine
    (D)   neon

4.  Identify the chemical change in the changes listed below.

    (A)   condensation of water vapour
    (B)   electrolysis of water
    (C)   grinding lumps of calcium carbonate into powder
    (D)   evaporation of water

5.  The diagram below represents the combustion of methane in oxygen to produce carbon dioxide, water and energy.



    *bonds broken*          *new bonds formed*
    *energy absorbed*       *energy released*
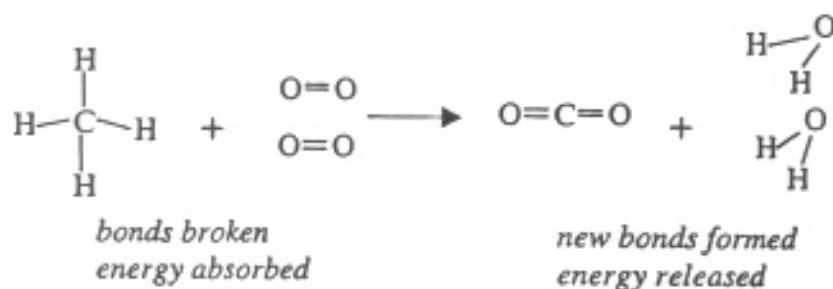
    Energy is released in this reaction because:

    (A)   bonds in the methane are broken releasing the energy
    (B)   the energy required to break the bonds in the reactants is less than the energy given out as the new bonds are made in the products
    (C)   the energy required to make the bonds in the reactants is less than the energy given out as the new bonds are broken in the products
    (D)   the energy required to break the bonds in the reactants is more than energy given out as the new bonds are made in the products

6.  Identify the group in which all of the substances have covalent bonds.

    (A)   diamond, graphite, carbon dioxide, potassium fluoride
    (B)   hydrogen iodide, water, calcium chloride, paraffin wax
    (C)   iodine, ice, zinc sulphide, ethanol
    (D)   ammonia, oxygen, water, methane

Name:

7.    Solder is a common alloy used in plumbing.  Which metals are present in solder?

    (A)    Brass and copper
    (B)    Zinc and lead
    (C)    Lead and tin
    (D)    Tin and zinc

8.    Balance the following equation, then identify the molar ratios of reactants to products in the reaction.

$$Al(s) + H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + H_2(g)$$

|        | Reactants | Products |
|--------|-----------|----------|
| (A)    | 1 : 1     | 1 : 1    |
| (B)    | 2 : 3     | 1 : 3    |
| (C)    | 3 : 2     | 3 : 1    |
| (D)    | 3 : 2     | 1 : 2    |

9.    Which series of metals is in order from most to least reactive?

    (A)    zinc, magnesium, lead, sodium
    (B)    lead, zinc, magnesium, sodium
    (C)    sodium, zinc, magnesium, lead
    (D)    sodium, magnesium, zinc, lead

10.    Which is the strongest attractive force that exists between hydrogen fluoride molecules?

    (A)    ionic bonds
    (B)    dispersion forces
    (C)    dipole-dipole forces
    (D)    hydrogen bonds

11.    The reaction between barium chloride and potassium sulfate solutions produces a precipitate of barium sulfate:

$$BaCl_2(aq) + K_2SO_4(aq) \longrightarrow BaSO_4(s) + 2KCl(aq)$$

If 50mL of 0.50 mol L$^{-1}$ BaCl$_2$ was reacted with excess K$_2$SO$_4$ solution, how many moles of BaSO$_4$(s) would be precipitated?

    (A)    0.025 mol
    (B)    2.33 mol
    (C)    25 mol
    (D)    233 mol

Name:

A student conducted an experiment on the solubility of various substances in water. Which set of results is correct?

| | Solubility in water | | | |
|---|---|---|---|---|
| | Sodium chloride | Sucrose | Silicon dioxide | Cellulose |
| (A) | soluble | not soluble | soluble | not soluble |
| (B) | not soluble | soluble | soluble | not soluble |
| (C) | soluble | soluble | not soluble | not soluble |
| (D) | not soluble | not soluble | soluble | soluble |

13. Which list below contains members of the same homologous series?

(A) $C_3H_6$, $C_5H_{10}$, $C_6H_{12}$
(B) $C_3H_8$, $C_4H_6$, $C_5H_4$
(C) $C_3H_8$, $C_4H_{10}$, $C_5H_{10}$
(D) $C_5H_{10}$, $C_7H_{12}$, $C_9H_{14}$

14. Two reaction pathways are shown for a given reaction. Which is the approximate value of the activation energy for the catalysed reaction pathway, in kJ mol$^{-1}$?



(A) 20
(B) 30
(C) 50
(D) 80
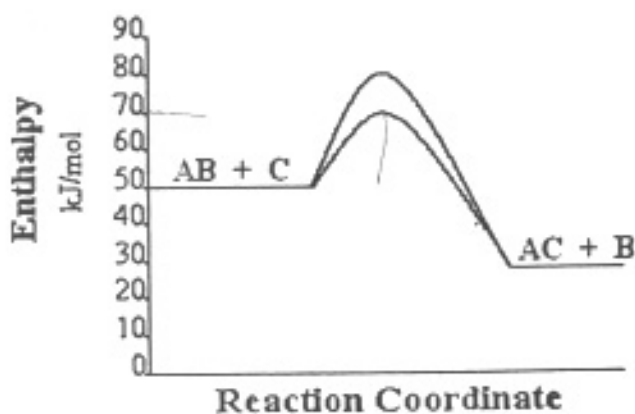
15.  The raw materials for photosynthesis include:

      (A)   Oxygen and carbon dioxide
      (B)   Oxygen and water
      (C)   Carbon dioxide and water
      (D)   Glucose and carbon dioxide

Name:

## ART B

- Total marks (60)
- Attempt Questions 16-29
- Allow about 1 hour 30 minutes for this part

Write your answers in the space provided after each question.

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**Marks**

**Question 16**        (5 marks)

You are provided with a mixture of sand, salt and water.

(a)    Describe, with the aid of a flow chart, how you would obtain samples of pure dry
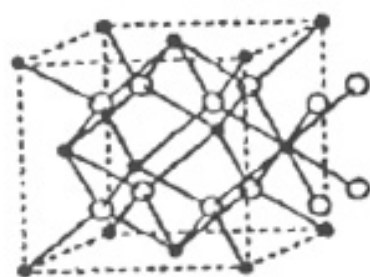       sand, pure dry salt and pure water from the mixture.                                **4**

(b)    If the total mass of the mixture provided was 250g and the mass of salt obtained
       was 8.8g, calculate the percentage (%) of salt in the original mixture.              **1**
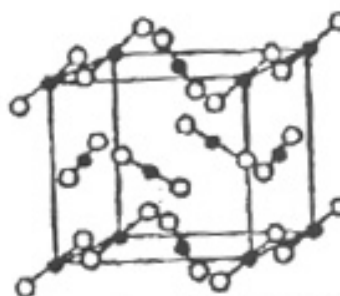
Name:

**Question 17** (6 marks)

The diagrams below show the crystalline forms of calcium fluoride and carbon dioxide.



fluorite ($CaF_2$)

($\bullet$ Ca, O F)



carbon dioxide ($CO_2$)

($\bullet$ C, O O)

(a) Compare, in detail, the bonding of these two compounds in their solid state.    3

(b) Contrast **TWO** physical properties of these compounds and relate these to the types of bonding present in them.    3

Name:

Marks

Question 18        (4 marks)

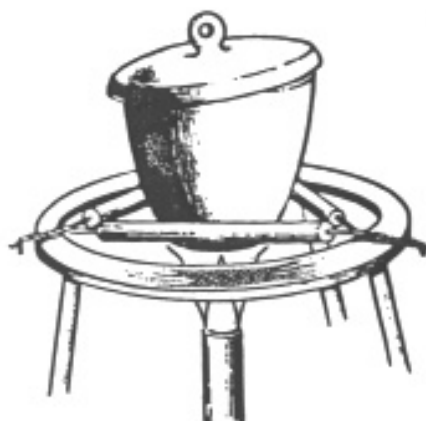(a)    Outline the electronic structure of an atom of sulphur.                                    2

(b)    Explain the formation of a sulphur ion using electron dot formulae.                        2

Name: _____

**Question 19** (4 marks)

A student performed a first-hand investigation to measure and identify the mass of the elements in magnesium oxide.



The information she recorded is as follows:

| | | |
|---|---|---|
| Mass of dry crucible + lid | = | 32.14g |
| Mass of dry crucible + lid + magnesium | = | 32.63g |
| Mass of dry crucible + lid + magnesium oxide | = | 32.95g |

(a) Determine the empirical formula of magnesium oxide. (Show all working)    2

(b) Calculate the volume of oxygen taken from the air during this experiment. Assume the air temperature and pressure was 25°C and 100kPa respectively.    2
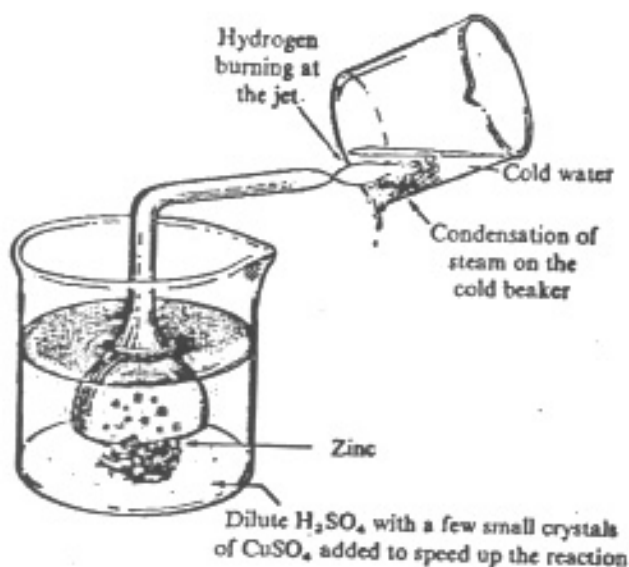
Name: _

**Marks**

**Question 20**        (5 marks)

Hydrogen can be produced and burned in air using the apparatus shown in the diagram below.



Hydrogen burning at the jet.

Cold water

Condensation of steam on the cold beaker

Zinc

Dilute $H_2SO_4$ with a few small crystals of $CuSO_4$ added to speed up the reaction

(a)   Construct an equation, in symbols, for the production of hydrogen by this reaction between sulfuric acid and zinc.

**1**

(b)   Calculate the mass of zinc needed to produce 1.0g of hydrogen.

**2**

(c)   Explain **ONE** safety precaution you would take while performing this experiment.

**2**

Name:

**Question 21** (5 marks)

(a) Proceeding from left to right across the third period (Na to Ar) of the Periodic Table describe the trends in:
- first ionisation energy
- atomic radius
- boiling point

3

(b) Account for the trend in electro negativity within any group of the Periodic Table.

2

(

**Question 22** (5 marks)

(a) Calculate the mass of magnesium chloride crystals required to prepare 200 mL of solution with a concentration of 0.25 mol $L^{-1}$.
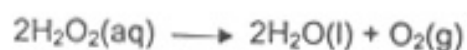
3

Name:  .

Marks

estion 22          (continued)

(b)   This solution is diluted to a volume of 500 mL.
      Determine the chloride ion concentration in the diluted solution.                2

Question 23        (2 marks)

The following equation shows the decomposition of hydrogen peroxide.  This is an exothermic reaction.  Manganese (IV) oxide is a catalyst for this reaction.
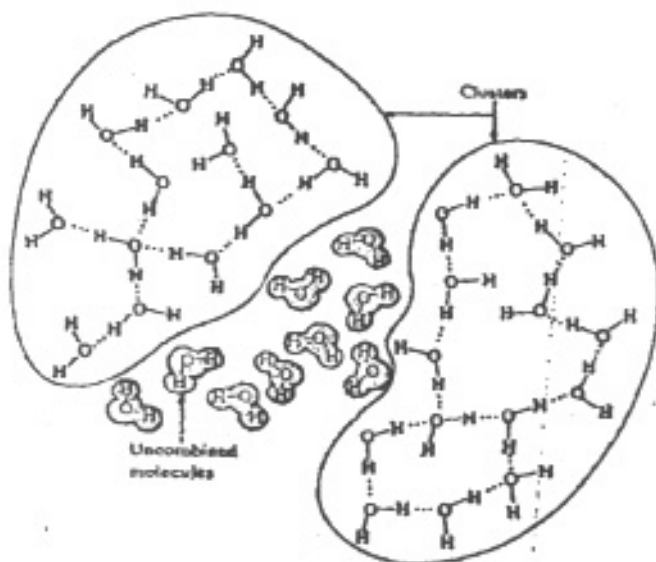
$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

Describe how a catalyst speeds up a reaction.  Illustrate with an energy profile diagram.                2

Name:

**Question 24**        (5 marks)

It seems that liquid water consists of clusters of bonded water molecules together with some separate water molecules. This is shown in the diagram below.



(a)    Explain with the aid of a diagram how the bonding between molecules of water within the clusters arises.

**2**

(b)    Explain why the boiling point of water is abnormally high compared to molecules of similar size and mass.

**1**

Name: _

Marks

Question 24          (continued)

(c)    Describe and explain the changes in particle arrangements as a compound such
       as sodium chloride dissolves in water.                                            2

(d)    Write an ionic equation to show the dissolution of sodium chloride.               1

Question 25       (2 marks)

If an aquarium tank holds 70 litres of water calculate how much heat energy would be
required to heat the tank from 18.2°C to 26.5°C.                                         2

Name:

## Question 26 (6 marks)

Describe the historical development of the Periodic Table.

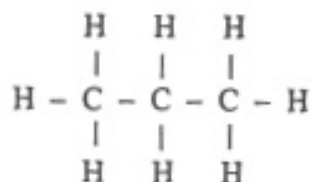In your answer you should include the following information:
- the names and contributions of at least **THREE** early scientists
- reasons why the present version of the table was accepted by scientists

6

Name:

Marks

27        (2 marks)

Below is the structural formula of a hydrocarbon.

$$\begin{array}{ccccccc} & H & & H & & H & \\ & | & & | & & | & \\ H - & C & - & C & - & C & - H \\ & | & & | & & | & \\ & H & & H & & H & \end{array}$$

(a)    State the systematic name for this compound.                1

(b)    Construct the molecular formula of hexene.                1

**Question 28**        (5 marks)

Carbon occurs as allotropes.

(i)      Identify **TWO** allotropes of carbon.                1

(ii)     Describe one property which is different for these two named allotropes of carbon.                2

(iii)    Explain this difference in properties in terms of bonding.                2

Name: _____

**Question 29**    (3 marks)

"The energy for life comes from the sun"

Outline the role of the photosynthesis process to explain what is meant by this statement    3

**End of paper**

# CHEMISTRY – Semester 2 Preliminary Exam 2004
## MARKING CRITERIA

### PART A

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| A | A | B | B | D | C | B | D | D | D  | A  | C  | A  | A  | C  |

### PART B

16. (a) Flow chart showing stages of, filtering → washing → drying sand → distilling or
evaporation/condensation → drying salt. Description of equipment and procedure
such as:

The mixture was filtered and the filtrate collected in a beaker. The sand was
removed from the filter paper, washed and dried. The filtrate was placed in a
distillation flask and distilled until only a small volume of mixture remained. The
distillate was pure water. The residue was evaporated to dryness to obtain pure
salt.    2

(b) % salt in mixture = 8.8/ 250 x 100 = 3.52%    1

17. (a) Fluorite – ionic bonds between $Ca^{2+}$ and $F^-$ ions due to electrostatic attraction    1
Carbon dioxide – strong covalent bonds by sharing electrons between C and O
within each $CO_2$ molecule.    1
$CO_2$ has much weaker bonds between molecules.    1

(b) Fluorite would have a much higher melting point.    1
When fluorite melts strong ionic bonds are disrupted. When $CO_2$ melts only weak
dispersion forces between $CO_2$ molecules are disrupted.    1
Fluorite would be much harder than solid $CO_2$    1
When fluorite is scratched strong ionic bonds are disrupted. When $CO_2$ is
scratched only weak dispersion forces between $CO_2$ molecules are disrupted.    1

18 (a) A labelled diagram or description indicating a nucleus and 16 electrons.
Must show arrangement of electrons in shells with configuration of 2.8.6    2

(b) :S: + 2e' → :S:²⁻     2
The sulphur atom gains two electrons to attain the noble gas electron configuration
and form an ion. Must have a correct electron dot formula.

19. (a) Mass of Mg = 32.63 – 32.14 = 0.49 g    1
Mass of MgO = 32.95 – 32.14 = 0.81 g    1
Mass of O = 0.32 g
Moles of Mg: 0.49/24.3 = 0.020
Moles of O: 0.32/16 = 0.020 Ratio is 1:1 therefore empirical formula is MgO    1

(b) Moles of O atoms = 0.020 mol from (a) and Moles of O2 molecules = 0.010 mol    1
Volume of oxygen = moles X molar volume = 0.010 X 24.79 = 0.25 L    1

20. (a) $Zn_{(s)} + H_2SO_4 \rightarrow ZnSO_4 + H_{2(g)}$
OR $Zn_{(s)} + 2H^+ \rightarrow Zn^{2+} + H_{2(g)}$

(b) moles $H_2$ = 1 / 2.016 = 0.496
moles Zn = 0.496
mass Zn = 0.496 * 65.38 = 32.4g

(c) Must identify a risk, outline the danger and suggest the correct procedure to
avoid the hazard. Eg wear safety goggles as chemicals such as acids being
used may splash in the eyes and damage the eyes.

21. (a) From left to right across the period:-
- first ionisation energy increases.
- atomic radius decreases.
- boiling point increases to the middle of each period, then sharply decreases for
the remainder

(b) Electronegativity decreases down any group because of increasing atomic radius
and the valence electrons, being further from the nucleus, are more weakly
attracted

22. (a) moles of magnesium chloride required = 0.02 * 0.25 = 0.05 mol    1
molar mass of magnesium chloride = 24.31 + 35.45 * 2 = 95.21g    1
mass of magnesium chloride required = 0.05 * 95.21 = 4.8g    1

(b) concentration of diluted solution = 0.25 * 200/500 = 0.10 mol $L^{-1}$    1
Chloride ion concentration = 0.20 mol $L^{-1}$.    1

| Q22 | |
|---|---|
| Correctly calculating concentration of Cl⁻ AND Magnesium chloride | 2 |
| Correctly calculating one of the above | 1 |

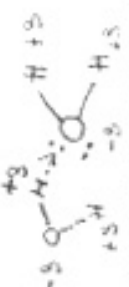| Q23 (a) | |
|---|---|
| A catalyst lowers the activation energy | 1 |

| Q23 (b) | |
|---|---|
| Energy profile showing a lowering of the activation energy | 1 |

| Description of hydrogen bonding and correct diagram | 2 |
| One of the above | 1 |
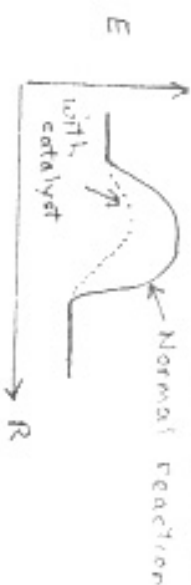
The small positive charge on the hydrogen atoms of one molecule is attracted to the lone pair of electrons on another molecule of water. This is called hydrogen bonding.

## Q24 (b)

| Description stating that hydrogen bonding is stronger than other forces. | 1 |



The hydrogen bonding between adjacent water molecules in a sample of water is stronger

## Q24 (c)

| Sodium chloride is ionic and description of sodium ions and chloride ions being surrounded by water molecules | 2 |
| Sodium chloride is ionic and description of either sodium ions or chloride ions being surrounded by water molecules | 1 |

Sodium chloride is an ionic compound composed of $Na^+$ ions and $Cl^-$ ions. When added to water the negative ends of the water molecules attract to the $Na^+$ ions, surrounding them and pulling them away from the ionic crystalline lattice. The positive ends of the polar water molecule attract the $Cl^-$ ions, surround them and pull them away from the lattice.

## Q24 (d)

| Correct ionic equation | 1 |

$$NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

## Q25

| Correct calculation of energy with correct units | 2 |
| One mistake but with correct units | 1 |

$\Delta H$ = $-mc\Delta T$

= $-70 \times 1000 \times 4.18 \times (26.5 - 18.2)$

= $-2430000J$ or $-2430$ kJ or $-2.43$ MJ.

## Q26

| Stated 3 scientists and their contribution AND 3 reasons why we accept the present periodic table | 6 |
| 5 of the above | 5 |
| 4 of the above | 4 |
| 3 of the above | 3 |
| 2 of the above | 2 |
| 1 of the above | 1 |

Dodereiner discovered the Triads of chemicals with similar chemical properties.
Newlands discovered the Law of Octaves. Mendelev produced the present periodic table and he left spaces for new elements (note he predicted their properties).
This table predicted undiscovered elements and explains the properties of elements e.g. alkali metals become more active as you go down the group.

## Q27 (a and b)

| (a) propane AND (b) $C_8H_{12}$ | 2 |
| One of the above | 1 |

## Q28 (i)

| 2 of graphite, diamond or bucky balls | 1 |

## Q28 (ii)

| One property that is different in (i) both allotropes mentioned | 2 |
| One property that is different in (i) one allotrope mentioned | 1 |

## Q28 (iii)

| Good explanation of the property in terms of bonding | 2 |
| Average explanation of the property in terms of bonding | 1 |

(i) graphite and diamond
(ii) graphite is soft and a good lubricant while diamond is very hard and strong

(iii) In diamond there is a covalent network structure that is 3D and extends throughout the crystal making it very hard to break in any direction. In graphite there is also a covalent network structure but it is 2D and there are only weak dispersion forces between the layers. This means that one layer can slip over the other making it soft and this is why it is used as a lubricant.

## Q29

| Gives equation (word or symbols), states reaction is endothermic and requires energy AND plants are the start of all food chains. | 3 |
| 2 of above | 2 |
| 1 of the above | 1 |

The overall reaction for Photosynthesis is:

$6CO_{2(g)} + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_{2(g)}$

This reaction is endothermic requiring energy. The light energy from the Sun is trapped by chlorophyll in the plants to produce glucose. Thus energy from the sun is transformed into chemical energy. All animals need this energy and all food chains start with a plant.