



Year 11 Semester Two Examination, 2009

Question/Answer Booklet

CHEMISTRY 2A/2B

| | |
|---------------------|--|
| Student Name | |
| Teacher Name | |

| Section | Mark |
|---------|------|
| 1 | /50 |
| 2 | /80 |
| 3 | /60 |
| Total | /190 |
| | % |

Time allowed for this paper

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Material required/recommended for this paper

To be provided by the supervisor

Question/answer booklet
Separate multiple-choice answer sheet
Data sheet

To be provided by the candidate

Standard items: Pens, pencils, eraser, correction fluid, ruler, highlighter
Special items: Scientific calculator

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

This paper is for students who have completed Units 2A and 2B.

Structure of this paper

| Section | Suggested working time | Number of questions available | Number of questions to be attempted | % of paper | Marks |
|----------------------------|------------------------|-------------------------------|-------------------------------------|------------|-------|
| ONE Multiple choice | 50 minutes | 25 | 25 | 26 | 50 |
| TWO Short response | 60 minutes | 14 | 14 | 42 | 80 |
| THREE Extended response | 70 minutes | 3 | 3 | 32 | 60 |
| | | | Total | 100 | 190 |

Instructions to candidates

- The rules for the conduct of Curriculum Council examinations are detailed in the *Student Information Handbook*. Sitting this examination implies that you agree to abide by these rules.
- Answer the questions according to the following instructions.

Section One Answer all questions in the separate multiple-choice answer sheet provided.

Section Two Answer **all** questions in the spaces provided in this Question/Answer Booklet.

Section Three Answer **all** questions in the spaces provided in this Question/Answer Booklet
- A blue or black ballpoint or ink pen should be used.
- For full marks**, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be **ions** [for example $\text{Ag}^+(\text{aq})$], **molecules** [for example $\text{NH}_3(\text{g})$, $\text{NH}_3(\text{aq})$, $\text{CH}_3\text{COOH}(\text{l})$, $\text{CH}_3\text{COOH}(\text{aq})$] or **solids** [for example $\text{BaSO}_4(\text{s})$, $\text{Cu}(\text{s})$, $\text{Na}_2\text{SO}_4(\text{s})$].
- Additional information which may be necessary to answer questions is located on the separate Chemistry data sheet.

See next page

SECTION ONE—MULTIPLE-CHOICE**(50 marks)**

This section has TWENTY FIVE (25) questions. Attempt **ALL** questions.

Answer all questions in Section 1 on the separate Multiple-Choice Answer Sheet provided, using a blue or black pen or B or 2B pencil. Each question in this part is worth 2 marks.

Suggested working time: 50 minutes.

1. A covalent bond would **not** be expected to form between atoms of electron configuration:
 - (a) 2.8.7 and 2.7
 - (b) 2.8.4 and 2.6
 - (c) 2.8.1 and 2.8.7
 - (d) 2.7 and 2.6

2. What is the conjugate acid of HSO_4^- ?
 - (a) H_2SO_4
 - (b) SO_4^{2-}
 - (c) H^+
 - (d) H_2O

3. What would be the chemical formula of the compound formed between magnesium and nitrogen?
 - (a) Mg_2N_3
 - (b) Mg_3N_2
 - (c) Mg_2N
 - (d) MgN

4. Which of the following chemicals are least likely to be found in a typical Perth home?
 - (a) Bicarbonate of soda (NaHCO_3); and methane
 - (b) Ethanol; and bleaching agents
 - (c) Chloroform (CHCl_3); and potassium chloride
 - (d) Spirits of salts (HCl); and ethanoic acid

See next page

5. Which of the following statements is INCORRECT for an ionic solid?
- (a) Can form ordered lattice arrangements of anions and cations.
 - (b) In crystalline form are hard and have lustre.
 - (c) Have a high melting point due to strong inter-particle bonding.
 - (d) When dissolved in water electrons are free to conduct charge.
6. There are a number of patterns in the periodic table. Which one of the following statements is TRUE?
- (a) Elements in the same period have similar physical properties.
 - (b) Elements in the same group have the same number of electron shells.
 - (c) Elements in group 18 have a full outer shell or subshell.
 - (d) Many group 2 metal elements can form coloured aqueous solutions.
7. Which of the following aqueous solution combinations will form precipitates? (an equal number of moles of each of the substances are present)
- (a) Sodium chloride, barium nitrate, and potassium hydroxide
 - (b) Tin (II) nitrate, cesium nitrate, sodium sulfate
 - (c) Copper (II) sulfate, sodium hydroxide, and hydrochloric acid
 - (d) Barium hydroxide, sodium chloride, and iron (II) sulfate
8. Which substance would be BEST to add to swimming pool water to raise its pH?
- (a) sodium carbonate
 - (b) ammonia
 - (c) rock salt
 - (d) NaOCl
9. The oxidation number of nitrogen in the species, N_2 , N_2O , NO_3^- and NH_3 respectively are:
- (a) 0, 0, +5, -3
 - (b) 0, -1, -1, +3
 - (c) 0, +1, +5, -3
 - (d) 2, 2, 1, 1

See next page

10. Which species would be found in a 2M H_3PO_4 solution?
- (a) H_3PO_4 , H_2PO_4^- , H^+ , PO_4^{3-} , OH^-
 - (b) H_2PO_4^- , PO_4^{3-} , H_2O , H^+ , H_3PO_3
 - (c) H_2O , OH^- , H^+ , PO_3^{2-} , H_2PO_4^-
 - (d) H_2PO_4^+ , H_3PO_4 , H^+ , H_2O
11. Which of the following lists contain only strong electrolytes?
- I BaSO_4 , AgCl , HCl
 - II glucose, ethanol, tartaric acid
 - III HCl , CH_3COOH , HNO_3
 - IV NH_3 , NaCl , KNO_3
- (a) IV only
 - (b) II and III
 - (c) I and III and IV
 - (d) I only
12. Which of the following reactions is NOT a redox reaction?
- (a) $\text{K(s)} + \text{O}_2(\text{g}) \rightarrow \text{KO}_2(\text{s})$
 - (b) $2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2(\text{g})$
 - (c) $\text{Li}_2\text{O(s)} + \text{H}_2\text{O(l)} \rightarrow 2\text{LiOH(aq)}$
 - (d) $2\text{Na(s)} + \text{H}_2(\text{l}) \rightarrow 2\text{NaH(s)}$
13. The term "saturated" is often used in chemistry. Which of the following statements is **incorrect**?
- (a) Organic molecules which are unsaturated have double or triple carbon-carbon covalent bonds in their structures.
 - (b) An aqueous solution that cannot dissolve any more solute, at a given temperature, is saturated.
 - (c) Many cooking oils are healthier now as they are made of saturated fats.
 - (d) Solutions which are supersaturated are relatively unstable, and the solute may precipitate out.

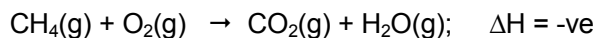
14. A normal adult has about 5.5 litres of blood, which has a pH of 7.4. When a patient is injected with a drug care must be taken to ensure that the drug does not change the pH of the blood. A small amount of drug of pH 3 is injected into a patient.

The patient will now have a blood pH of:

- (a) more than 7.4
 (b) a little less than 7.4
 (c) approximately 5.2
 (d) 3
15. Which combination of anode, cathode and electrolyte could be used to silver-plate a nickel knife?

| | Anode | Cathode | Electrolyte |
|-----|--------------|----------------|--|
| (a) | Knife | Ag | AgNO ₃ (aq) |
| (b) | Knife | Ag | Ni(NO ₃) ₂ (aq) |
| (c) | Ag | knife | AgNO ₃ (aq) |
| (d) | Ag | knife | Ni(NO ₃) ₂ (aq) |

16. The combustion of natural gas (mainly methane) can be represented by:



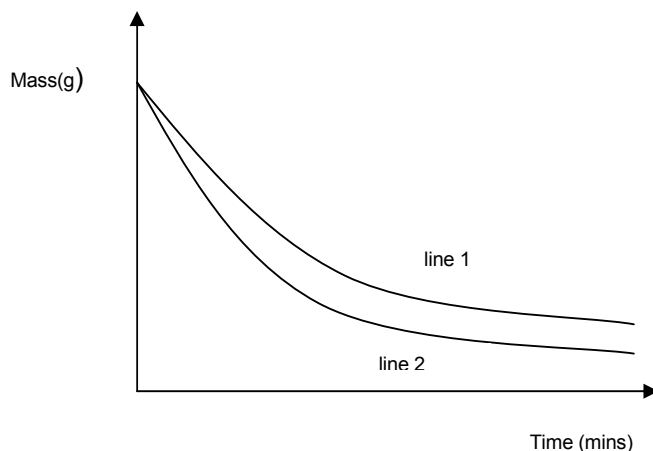
Which of the following would **decrease** the rate of the reaction?

- (a) Increasing the volume at constant temperature.
 (b) Increasing the temperature at constant volume.
 (c) Passing the gases over the surface of a catalyst.
 (d) Increasing the concentration of reactants at constant temperature.
17. Element X is in group 2, and element Y in group 7, of the periodic table. Which ions will be present in the compound formed when X and Y react together?
- (a) X⁺ and Y⁻
 (b) X²⁺ and Y⁻
 (c) X⁺ and Y²⁻
 (d) X²⁻ and Y⁺

See next page

18. What change(s) occur(s) as a liquid boils?
- I. The average kinetic energy of the particles increases.
 II. The attractive forces between the particles become stronger.
 III. The spacing between the particles increases.
- (a) I only
 (b) III only
 (c) II and III only
 (d) I and III only
19. Vapour pressure is due to gaseous molecules that have escaped the liquid/solid phases colliding with surfaces in a closed container. Which of the following statements is FALSE?
- (a) Dissolved solutes will decrease vapour pressure by reducing the number of particles on the surface undergoing phase change.
 (b) At a given temperature, water has a higher vapour pressure than ethanol.
 (c) When gases are collected over water the total pressure includes water vapour pressure.
 (d) Anti-boil agents added to car radiators reduce potential damage due to elevated gas pressure by reducing vapour pressure.
20. The rate of a reaction between two gases increases when a catalyst is added, and temperature is increased. Which statements are both correct for the effect of these changes on the reaction?
- | | | |
|-----|-----------------------------------|-------------------------------------|
| (a) | Activation energy decreases | Collision frequency decreases |
| (b) | Activation energy does not change | Collision frequency increases |
| (c) | Activation energy decreases | Collision frequency increases |
| (d) | Activation energy increases | Collision frequency does not change |
21. Which of the following obeys the IUPAC system of naming?
- (a) 1,2-dibromobut-2-ene
 (b) acetic acid
 (c) cis-1,1-dichloroethene
 (d) sodium bicarbonate

22. Magnesium hydroxide, $\text{Mg}(\text{OH})_2$, has a low solubility in water. Nevertheless, it is classed as a strong base because:
- (a) it reacts with acids.
 - (b) magnesium ions are strongly bonded to the hydroxide ions.
 - (c) it can provide two hydroxide ions for each formula unit.
 - (d) it is fully dissociated in aqueous solution.
23. Excess magnesium was added to a beaker of aqueous hydrochloric acid on a balance. A graph of the mass of the beaker and contents was plotted against time (line 1).

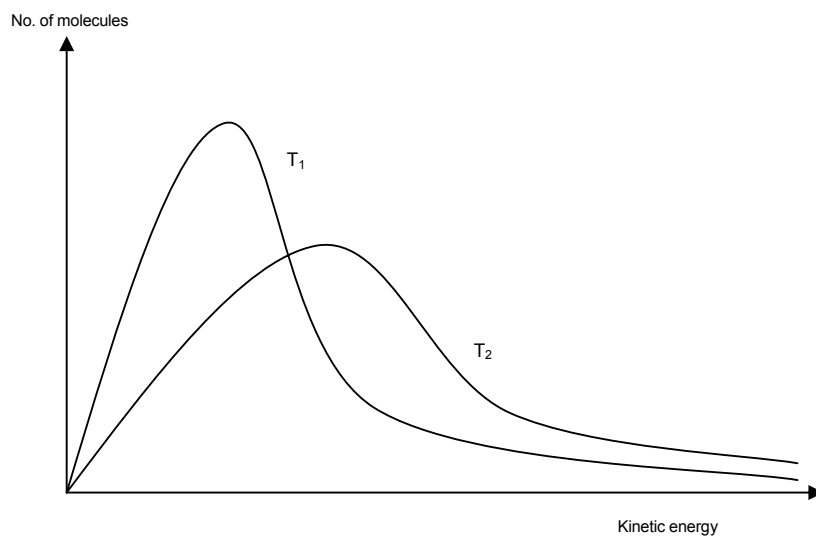


What change in the experiment could give line 2?

- I. The same mass of magnesium but in larger pieces
 - II. The same volume of a more concentrated solution of hydrochloric acid
 - III. A lower temperature
- (a) I only
 - (b) II only
 - (c) III only
 - (d) None of the above
24. From the relative positions of the elements in the Periodic Table, it may be predicted that removal of a second electron, after previous removal of one electron, would require most energy in the case of:
- (a) aluminium.
 - (b) magnesium.
 - (c) sodium.
 - (d) silicon.

See next page

25. Typical Maxwell-Boltzmann distribution curves for a gas system at two different temperatures (T_1 and T_2) can be represented as:



Consider the following statements:

- I As temperature increases the kinetic energy of all molecules increase.
- II At T_2 more molecules have a higher kinetic energy than at T_1 .
- III Those molecules with higher kinetic energy will collide more frequently.
- IV In a gas system with reacting gases, at T_1 less molecules will have the required activation energy (E_a) for chemical change.

The **correct** statements are:

- (a) II, III, and IV
- (b) I, II, and III
- (c) II, and III
- (d) I, II, III, and IV

END OF SECTION ONE

See next page

Student Name: _____ Teacher Name: _____

SECTION TWO—SHORT RESPONSE

(80 marks)

Section two contains **fourteen (14)** questions. Attempt **ALL** questions in the spaces provided.
Suggested working time: 60 minutes

1. Write balanced chemical equations, in the form indicated in the *Instructions to Candidates*, for each of the following reactions:

(a) Solid sodium chloride is added to an aqueous solution of silver nitrate.

(b) A solution of hydrochloric acid is added to an aqueous solution of potassium carbonate.

(c) Solid zinc powder is added to a copper (II) sulfate solution.

(d) Chlorine gas is bubbled through an aqueous solution of sodium iodide.

(e) Bromine water is added to cyclohexene (for the product provide the name only).

[10 marks]

2. Name the following substances:

(a) Fe_2O_3 _____

(b) CO _____

(c) NaHSO_4 _____

(d) C_2H_4 _____

[4 marks]

3. Classify the following solids as: ionic (I), metallic (M), covalent molecular (CM), or covalent network (CN)

| | | | |
|---------------------------|--|-------------------|--|
| Bronze | | Iodine | |
| Diamond | | Magnesium sulfate | |
| Silicon dioxide | | Hydrogen peroxide | |
| Dry ice (CO_2) | | Benzene | |

See next page

[8 marks]

4. Write **observations** for any reactions that occur in the following procedures. If no change is observed, then you should state this. **NO chemical equations are required to be written.**

Example: Magnesium ribbon is added to an aqueous solution of hydrochloric acid.

The metal dissolves and a colourless, odourless gas is evolved.

- (a) Burning sulfur is placed in a gas jar full of oxygen gas.

- (b) A citric acid/tartaric acid solution combination is added to an aqueous solution of baking soda.

- (c) Copper (II) oxide is added to a beaker containing an aqueous solution of sulfuric acid.

- (d) Solid aluminium hydroxide is added to a 5M solution of sodium hydroxide.

[4 marks]

5. For each of the following substances provide a property, and a use related to that property.

| Substance | Property | Related use |
|-----------|----------|-------------|
| Copper | | |
| NaOH | | |
| Iron | | |
| Ammonia | | |

[8 marks]

See next page

6. The following table gives information about the electrical conductivity of calcium nitrate, and hydrogen nitrate, in various states.

| | Electrical conductivity | | |
|------------------|-------------------------|--------|------------------|
| | Solid | Liquid | Aqueous solution |
| Calcium nitrate | Poor | Good | Good |
| Hydrogen nitrate | Poor | Poor | Good |

- (a) Explain these observations with calcium nitrate.

[3 marks]

- (b) Explain why hydrogen nitrate is a good electrical conductor in aqueous solution. Include a chemical equation to support your answer.

[2 marks]

7. Fluorine compounds are added to Perth's supplies of drinking water to give a concentration of fluoride ions of 0.950 ppm (mg/kg of solution). Assume the density of the solution is 1.00 g/mL.

What number of **fluoride ions** would you swallow if you drank 150 mL of this water?

[3 marks]

See next page

8. **Draw and name** the following:

| | |
|---|--|
| <p>(i) Three <u>structural isomers</u> of C_5H_{12}</p> | <p>(ii) Two <u>geometric isomers</u> of $C_4H_6Cl_2$</p> |
|---|--|

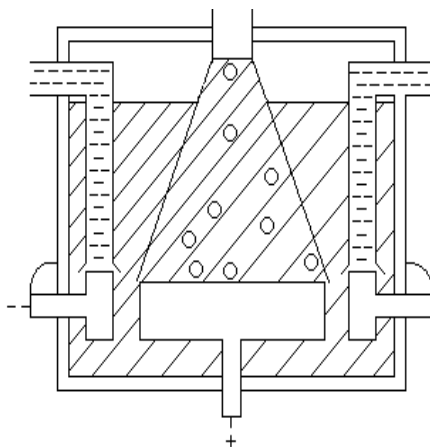
[10 marks]

See next page

9. The following cell represents the **electrolysis of molten magnesium chloride**.

(a) Clearly label the following:

- (i) anode
- (ii) cathode
- (iii) direction of ion current
- (iv) direction of electron flow



[4 marks]

(b) What are the products of the overall redox process?

_____ [1 mark]

(c) Write a balanced redox equation for the reaction.

[2 marks]

10. The element Gallium has two isotopes: Ga-69 (relative mass is 68.9) and Ga-71 (relative mass is 70.7). Given that the A_r (relative atomic mass) of Ga is 69.9, determine the % abundance of each isotope.

[3 marks]

See next page

11. The properties of five substances are given below.

| Substance | Melting point (°C) | Boiling point (°C) | Density (g mL ⁻¹) | Solubility in water | Solubility in toluene |
|----------------------------|--------------------|--------------------|-------------------------------|---------------------|-----------------------|
| Silica (SiO ₂) | 1700 | 2230 | 2.6 | No | No |
| Potassium iodide | 770 | 1407 | 2.0 | Yes | No |
| Anthracene | 216 | 340 | 1.3 | No | Yes |
| Water | 0 | 100 | 1.0 | Yes | No |
| Toluene | -95 | 111 | 1.5 | No | Yes |

You are given a mixture containing all of these substances.

Provide a flow chart of a **series of steps**, in the correct order, which could be used to separate these substances from the mixture (Use numbers in your answer to indicate the order of the steps).

See next page

[5 marks]

12. Algal blooms can be caused by the discharge of large quantities of detergent, or the leaching of fertilisers into our waterways. The main culprit is phosphate ions (PO_4^{3-}) found in these substances. Algal blooms “choke” waterways and reduce the dissolved oxygen levels in water.

(a) Suggest a possible, feasible solution to reducing algal blooms.

[1 mark]

(b) If a 0.970 g sample of detergent contains 0.123 g of phosphate, calculate the percentage composition of elemental phosphorus in the sample.

[3 marks]

(c) What substance could be added to precipitate out phosphate ions from an aqueous solution of detergent? Write an ionic equation to represent this.

[2 marks]

13. A weather balloon is filled with about 4200 litres of hydrogen gas.

(a) If measurements of the atmospheric conditions on the ground indicate a temperature of 0.0°C and a pressure of 101.3 kPa, how many **moles of gas** are present?

See next page

[2 marks]

The weather balloon lifts an instrument package into the atmosphere until the balloon bursts at an altitude of 17 km. The atmospheric conditions at this height are -60.0°C and 10.0 kPa.

(b) Explain why the balloon bursts at this altitude?

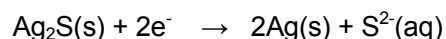
[2 marks]

(c) Explain why the balloon rises into the atmosphere.

[1 mark]

14. A traditional household method for cleaning the tarnish (black, Ag_2S) from the family silverware is to wrap the silver utensils in aluminium foil and place them in a bowl containing bicarbonate of soda solution. The solution must completely cover the object. The process usually takes several hours but when the silverware is removed it is sparkling clean.

- One half equation can be represented by:



- The other half reaction is the oxidation of aluminium metal (Al) to aluminium ions (Al^{3+}).

Combine the two reaction half equations to produce a balanced overall redox equation for the process.

[2 marks]

END OF SECTION TWO

See next page

Student Name: _____ Teacher Name: _____

SECTION THREE—EXTENDED RESPONSE (60 marks)

Section Three has **THREE (3)** questions. Attempt **ALL** questions in the spaces provided below.

In descriptive responses, marks are awarded for relevant chemical content, including equations, diagrams and illustrative examples of the chemistry you are describing. Calculations are to be set out in detail. Marks will be awarded for correct equations and clear setting out, even if you cannot complete the calculation. Express numerical answers to three (3) significant figures and provide units where appropriate.

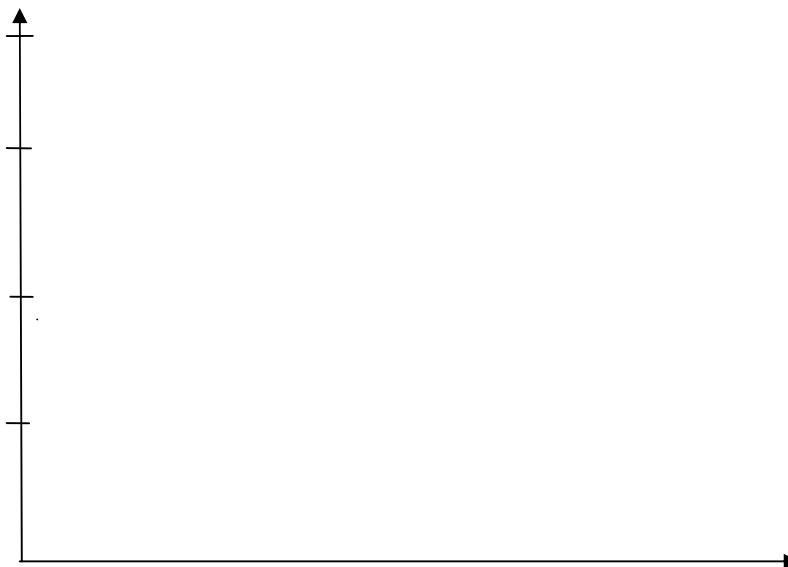
Suggested working time: 70 minutes.

Question 1 (14 marks)

Ethylene glycol has a multitude of uses, including antifreeze and anti-boil agent in car radiators and as a de-icing substance for aircraft windshields. It contains the elements carbon, hydrogen and oxygen.

- (a) The combustion of ethylene glycol in air to produce carbon dioxide and water shows an enthalpy change of $-2356 \text{ kJ mol}^{-1}$. The reaction has a high activation energy (E_a).

Represent this information on the energy profile diagram below.



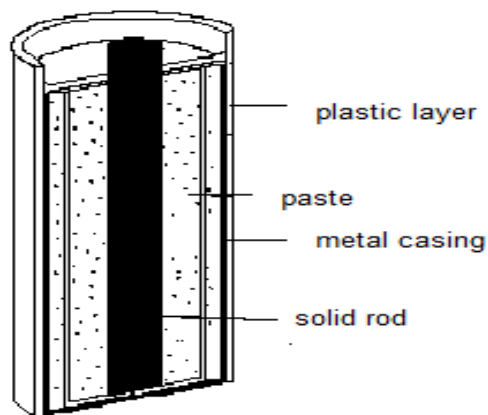
- (b) Ethylene glycol is highly soluble in water. What would this suggest about the nature of its intermolecular bonding with water molecules? [4 marks]

- (c) Suggest a reason why ethylene glycol is used in air conditioning units. [1 marks]

See next page

Question 2**(23 marks)**

A standard (non-alkaline) dry cell ('D' size) was brought from home to test at school. The cell was cut in half to reveal its internal structure and content. Each cell was composed of a metal casing surrounded by a plastic outer layer, a black wet paste, and a hard brittle central rod. There was also capping at the top and bottom of the cell. The cell was tested in three parts: metal casing, the solid rod, and the paste.

**The metal casing**

The casing was a grey metal that reacted with hydrochloric acid to produce an odourless, colourless gas. The reactivity was greater than with lead but less vigorous than with aluminium.

- (a) This is redox reaction. Which species (grey metal casing or hydrogen ions) is the reductant, and which is the oxidant?

Reductant _____ Oxidant _____ [2 marks]

The collected gas 'popped' when a lit match was placed next to it and a blue flame was observed.

- (b) What is the gas? _____ [1 mark]

- (c) Give a chemical equation for this combustion reaction.

_____ [1 mark]

After the casing metal was dissolved in acid it was found to form a white gelatinous precipitate when 1 M NaOH was added. This precipitate dissolved when more base was added.

- (d) What is the identity of the metal?

_____ [1 mark]

See next page

The black solid rod

A powdered piece of the rod was heated vigorously in a pyrex test tube that was connected by a delivery tube to a beaker containing an aqueous solution of calcium hydroxide ($\text{Ca}(\text{OH})_2$). The colourless gas released bubbled through the limewater and turned it "milky".

- (e) Write a balanced chemical equation for this reaction.

[2 marks]

Further testing indicated the rod to be made of graphite (an allotrope of carbon).

- (f) Draw a well-labelled diagram of graphite, indicating the type and nature of chemical bonding.

[3 marks]

- (g) What are two properties/characteristics of graphite that make it useful dry cells?

[2 marks]

- (h) Draw electron dot (Lewis) structures for the following compounds:

| | |
|--------------------------|--|
| CO_2 | |
| $\text{Ca}(\text{OH})_2$ | |

[4 marks]

See next page

Question 3**(23 marks)**

Barium is a highly toxic substance to higher animals and can accumulate in animal and plant tissue. High barium levels can affect the ability of plants to photosynthesize, and in higher animals can cause heart disease, respiratory failure, kidney damage, and muscle weakness. Student chemists were interested in determining the concentration of barium (II) ions in a large water pond outside of a glass making factory.

The basic technique involved adding sodium sulfate (Na_2SO_4) to a 400.0 mL water sample to precipitate out the barium as barium (II) sulfate. The acceptable level of barium in drinking water is 2.0 mg/L. Levels above 50 mg/L are considered to be immediately dangerous to life and health.

- (a) Write a balanced chemical equation for the precipitation reaction.

[1 mark]

- (b) The barium sulfate precipitate was collected and placed in a special oven at 110°C . Over time the sample was weighed and re-weighed. (1 g = 1000 mg)

| Weighing | Mass(mg) |
|----------|----------|
| 1 | 23.0 |
| 2 | 21.5 |
| 3 | 19.0 |
| 4 | 19.0 |

Why was the sample weighed four times?

[1 mark]

- (c) Calculate the mass of **barium** (in mg) in the precipitate.

[2 marks]

- (d) Determine the concentration of barium ions (in mg/L), in the polluted water sample. (Assume the density of the water is 1000 mg/L)

[2 marks]

See next page

- (e) How does the concentration of barium ions in the water sample compare with the accepted level in drinking water?

[1 mark]

- (f) The students assumed that no other ions in the water formed precipitates with the sodium sulfate solution. Name **ONE** other ion that would also form a precipitate with sulfate ions?

[1 mark]

After this preliminary result, the students decided to extend their investigation over a number of weeks to see how barium levels changed over time, and so tested more water samples. Their results are tabulated below:

| Day | Concentration of Ba ²⁺ (mg/L) |
|-----|--|
| 0 | Refer to answer in (d) |
| 3 | 30 |
| 6 | 36 |
| 9 | 45 |
| 12 | 60 |
| 15 | 55 |
| 18 | 58 |

- (g) For this extended investigation what was the:

| | |
|----------------------|--|
| independent variable | |
| dependent variable | |

[2 marks]

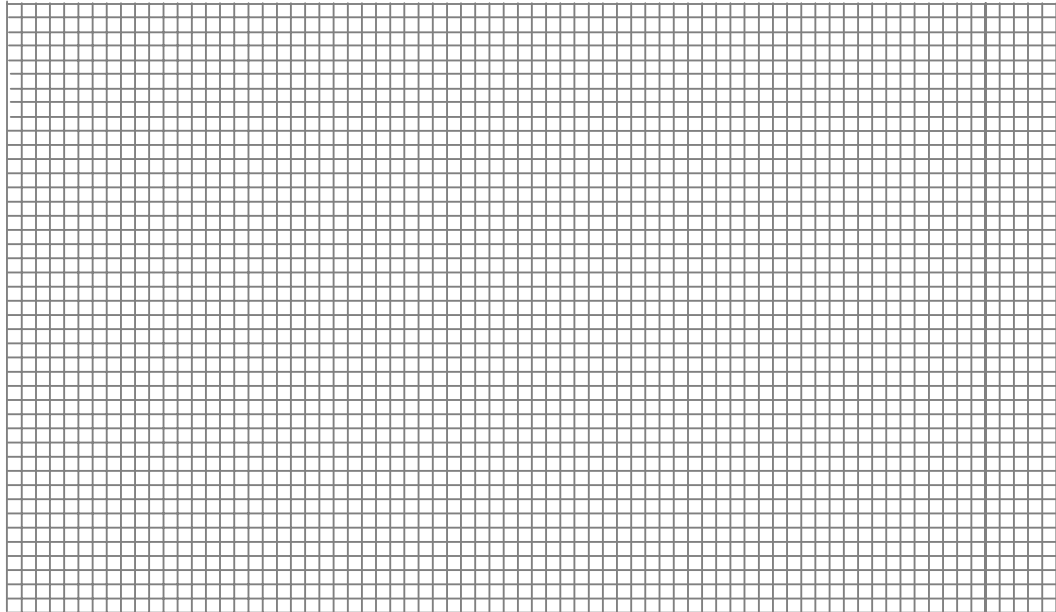
- (h) State two (2) variables that would need to be controlled?

[2 marks]

- (i) What safety measures should be used when handling the barium samples?

[2 mark]

- (j) Plot the information on the graph paper below. Include a heading and all labels.



- (k) What conclusions can be made from this investigation?

[5 marks]

[2 marks]

- (l) What environmental impact would high levels of barium from this factory have on the local environment? [Give two possibilities].

[2 mark]

