

STUDENT:
TEACHER:

UNIT 2 — NOVEMBER EXAM

CHEMISTRY

Written test 2

Reading time: 15 minutes

Writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks	Suggested times (minutes)
A	20	20	20	20
B	10	10	64	70
			Total 84	90

Instructions

- Students are permitted to bring into the test room: pens, pencils, highlighters, erasers, sharpeners, rulers and a scientific calculator.
- Write your name in the space provided above.
- All written responses must be in English.
- Marks are awarded for correct setting out.
- Significant figures are considered as part of a correct numerical answer.

Question 5.

Which of the following can act as a diprotic acid?

- A. NaHSO_4
- B. Mg(OH)_2
- C. NaH_2PO_4
- D. CH_2Cl_2

Question 6.

When 20.00 mL of 0.050 mol L⁻¹ hydrochloric acid is mixed with 30.00 mL of 0.010 mol L⁻¹ hydrochloric acid, the molarity of the resultant mixture is:

- A. 0.026 mol L⁻¹
- B. 0.036 mol L⁻¹
- C. 0.043 mol L⁻¹
- D. 0.045 mol L⁻¹

Question 7.

Which one of the following is an amphiprotic substance that is indirectly formed as a result of the combustion of fossil fuels?

- A. HNO_3
- B. NaHSO_4
- C. H_2SO_3
- D. H_2SO_4

Question 8.

When ozone is formed in the upper atmosphere, the reaction is associated with the term:

- A. isotopes.
- B. redox reaction.
- C. allotropes.
- D. greenhouse effect.

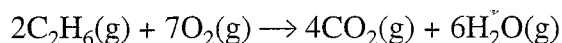
Question 9.

Which of the following is *not* a redox reaction?

- A. $2\text{Ba(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{BaO(s)}$
- B. $\text{Ag}^+\text{(aq)} + \text{Cl}^-\text{(aq)} \rightarrow \text{AgCl(s)}$
- C. $\text{Mg(s)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{H}_2\text{(g)}$
- D. $\text{Cu(s)} + 2\text{Ag}^+\text{(aq)} \rightarrow \text{Cu}^{2+}\text{(aq)} + 2\text{Ag(s)}$

Question 14.

The volume of carbon dioxide produced when 10.0 mL of ethane reacts with excess oxygen according to the equation below, at constant temperature and pressure, is



- A. 10.0 mL
- B. 20.0 mL
- C. 30.0 mL
- D. 35.0 mL

Question 15.

A major pollution issue in some cities is the formation of photochemical smog. Governments have tried to minimise this problem by:

- A. encouraging the use of CFCs in car air-conditioners.
- B. insisting on the introduction of catalytic converters in car exhausts.
- C. encouraging the use of LPG as an alternative fuel.
- D. encouraging the use of leaded fuel.

Question 16.

Which combination of chemicals would be the most practical to produce carbon dioxide in the laboratory?

- A. lithium carbonate and sodium hydroxide
- B. methane and oxygen
- C. potassium carbonate and sulfuric acid
- D. sodium hydroxide and hydrochloric acid

Question 17.

Most governments in the world acknowledge that human activities such as agriculture have contributed to the greenhouse effect. Which of the following gases is produced as a result of agriculture and is the second most significant contributor to the greenhouse effect?

- A. CH_4
- B. CO
- C. O_3
- D. CFCs

Section B

Question 1.

Large-scale municipal water-softening involves the treatment of hard water with slaked lime, calcium hydroxide, and soda ash, sodium carbonate. The water is subsequently sterilised using chlorine gas bubbled into the water.

- a. Magnesium ions react with hydroxide ions to form a precipitate. Write a chemical equation to show this reaction.

- b. Calcium ions react with soda ash solution. Write an ionic equation to show this reaction.

- c. The chlorine gas reacts with the water to form Cl^- and HClO . Write the two half-equations for this reaction.

- d. Write a balanced redox equation from the half-equations written in (c) above.

- e. In the reaction given in (c) above, what is the oxidant?

6 marks

Question 2.

Normally the boiling point of a liquid matches the molar mass of the liquid molecules.

Consider the following table.

Formula of hydride in group 16 of the periodic table	Boiling point ($^{\circ}\text{C}$)	Molar mass
H_2O	100	18
H_2S	-60	34
H_2Se	-40	80
H_2Te	-2	130

- a. Name all of the types of bonding occurring in water.

- b. H_2S , H_2Se and H_2Te show the expected trend in boiling point and molar mass. Explain this observation in terms of the type of bonding.

- c. Draw and label water molecules to show how bonding can explain the unexpected boiling point of water.

- d. Solid sodium chloride dissolves readily in water.

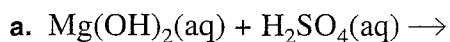
- Write a chemical equation to show the reaction between sodium chloride and the solvent water.
- Draw and label all bonds associated with water's unique ability to dissolve ionic salts.

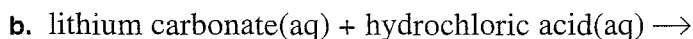
- e. Explain why distillation is a possible desalination technique used to purify saline solutions.

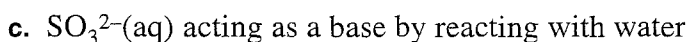
7 marks

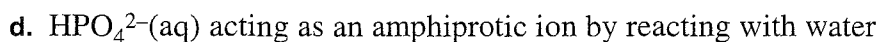
Question 3.

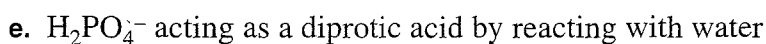
Write *complete* and *balanced* equations for the following partial equations.











6 marks

Question 4.

The Earth's atmosphere consists mainly of N_2 and O_2 , as well as traces of argon, oxygen and water vapour and CO_2 . To determine the chemical composition of a non-polluted sample of the atmosphere, 500 L of air was collected and compressed. The total sample collected had a mass of 0.500 g. The carbon dioxide was dissolved in water and the sample was neutralised by 5.23 mL of a 0.100 mol L^{-1} aqueous solution of NaOH.

- a. Write a chemical equation for the reaction that occurs when CO_2 reacts with excess aqueous NaOH solution to form sodium carbonate and water.

2 marks

- b. Calculate the percentage by mass of CO_2 in the atmosphere.

4 marks

- c. Calculate the concentration, in mol L^{-1} , of CO_2 in the atmosphere.

1 mark

Question 5.

Write chemical reactions for the following situations.

- a. Ozone breaks down to form oxygen gas.

- b. Iron(III) oxide on a rusty hammer comes in contact with an aluminium metal boat hull.

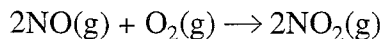
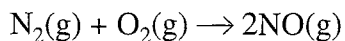
- c. Write the two half-reactions that occur when nitric acid formed by acid rain falls on a galvanised iron roof. The zinc reacts with the nitric acid to form zinc nitrate and nitrogen(IV) oxide, NO_2 , as the major products.

4 marks

Question 6.

Many complex chemical reactions occur in the atmosphere. The reactions associated with combustion engines make a significant contribution to atmospheric pollution.

One such reaction occurs between nitrogen and oxygen gas:

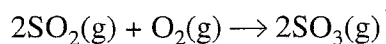


- a. In which of the molecules is nitrogen in the lowest oxidation state?
- _____
- _____
- b. Which of the above molecules has undergone reduction?
- _____
- _____
- c. The nitrogen(IV) oxide subsequently reacts with rain to form a mixture of nitric and nitrous acids. Write a chemical equation to show this reaction.
- _____
- _____
- d. The Acropolis in Athens is made of the rock called marble, calcium carbonate. Provide a chemical equation to show how the nitric acid produced by acid rain can have a devastating effect on the marble.
- _____
- _____
- e. At 27°C and 124.8 kPa pressure, the sample of pure atmospheric pollutant of mass 10.10 g occupies 3.15 L. Determine the molecular mass of the gas.
- _____
- _____
- _____
- _____
- _____
- f. The atmospheric pollutant mentioned in part (e) was found to contain the elements sulfur and oxygen. Suggest an empirical formula for the gas and provide a chemical reaction to show how an oxide of sulfur reacts with rain to form an acid.
- _____
- _____

8 marks

Question 8.

Consider the following atmospheric chemical equation.



- a. What is the volume of sulfur trioxide, SO_3 , that will form at SLC when 2.50 L of sulfur dioxide reacts with an excess of oxygen gas?

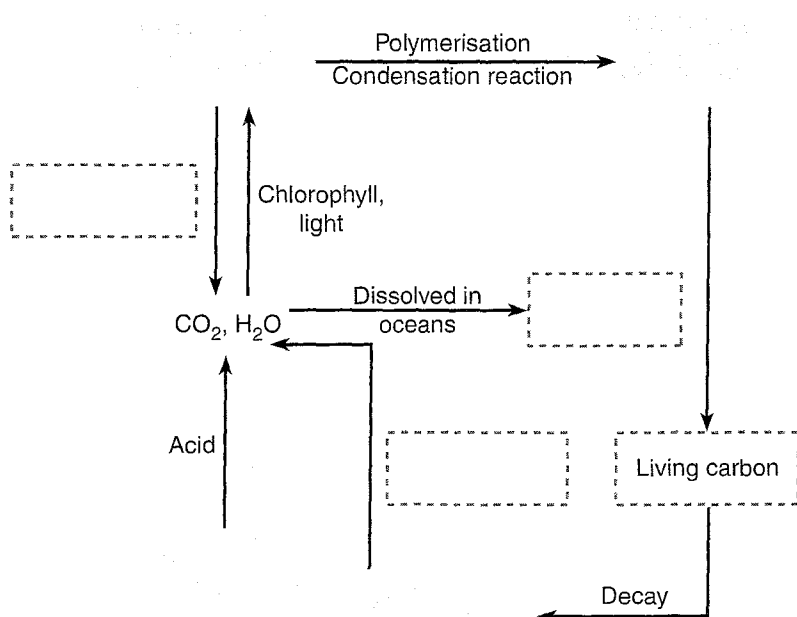
- b. If the sulfur trioxide dissolves in 25.0 mL of water, what will be the pH of this solution?

- c. Given $[\text{H}^+][\text{OH}^-] = 10^{-14}$, what is the pH of a $0.0010 \text{ mol L}^{-1}$ solution of NaOH?

7 marks

Question 9.

Complete the following diagram by entering the chemical formula or the name of the chemical process or reaction. Write the names or types of molecule in the solid boxes and the chemical or biochemical reactions in the dashed boxes.



7 marks

Question 10.

The atmosphere consists of many gases vital to the biosphere.

a. Which gas is the most abundant in the atmosphere?

b. What is the name of the chemically unreactive gases found in the atmosphere?

c. Which gas is primarily responsible for the greenhouse effect?

d. Which molecule protects us from UV radiation?

4 marks

End of Section B

Question 7.

Carbon dioxide plays a vital role in the biosphere. The gas occurs in trace amounts in the atmosphere.

- a. Give two important equations that show the *formation* of carbon dioxide in the carbon cycle.

- b. By means of a diagram show the preferred *laboratory* method of making carbon dioxide.
Label the important apparatus parts.

- c. What is the equation associated with the laboratory preparation of carbon dioxide?

- d. What is one important industrial use of carbon dioxide?

- e. What is the biochemical equation that links oxygen and carbon dioxide in the carbon cycle?

8 marks