

Student Name: _____

CHEMISTRY

Unit 3 – Written examination 1



2007 Trial Examination

Reading Time: 15 minutes
Writing Time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	6	6	47
			Total 67

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, and a scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 18 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A- Multiple-choice questions**Instructions for Section A**

Answer **all** questions.

Choose the response that is **correct** or **best answers** the question.

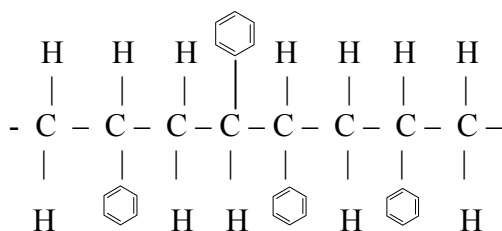
A correct answer scores 1, an incorrect answer scores 0.

No mark will be given if more than one answer is completed for any question.

Marks will **not** be deducted for incorrect answers.

Question 1

A segment of a polymer chain has the structure shown below



- A. No polymer could have a structure like this.
- B. This polymer would be formed from several different monomers.
- C. This would be formed from a condensation polymerisation reaction.
- D. This would be formed from an addition polymerisation reaction.

Question 2

The polymer $\text{-O-CO-CH}_2\text{-CO-O-CH}_2\text{-CH}_2\text{-O-CO-CH}_2\text{-CO-O-}$ could be formed from the monomers

- A. $\text{HOCH}_2\text{CH}_2\text{OH}$ and $\text{HOOCCH}_2\text{COOH}$
- B. $\text{HOCH}_2\text{CH}_2\text{COOH}$ and HOCH_2OH
- C. HOCH_2COOH and HOCH_2COOH
- D. $\text{HOCH}_2\text{CH}_2\text{OH}$ and $\text{HOCH}_2\text{CH}_2\text{COOH}$

Question 3

The molecular mass of the polymer with the structure $\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-}$ will be

- A. a multiple of the molecular mass of ethane
- B. less than the mass of the individual monomers used to make the polymer.
- C. a multiple of 28.
- D. a multiple of the molar mass of methane.

Question 4

How many hydrogen atoms are there in a molecule of heptanoic acid?

- A. 7
- B. 14
- C. 16
- D. 17

SECTION A- continued

Question 5

A compound that is a structural isomer of pentanoic acid is

- A. methylbutanoate
- B. 3-pentanoic acid
- C. 2-methylbutanol
- D. 2-methylpentanoic acid

Questions 6, 7 and 8 refer to the following information.

Vitamin C is ascorbic acid, $C_6H_8O_6$. A 25.0 mL solution is titrated against a standardised 0.100 M iodine solution. The equation is



The average titre is 28.2 mL.

Question 6

The concentration of the ascorbic acid solution is

- A. 0.089 M
- B. 0.113 M
- C. 0.020 M
- D. 1.13 M

Question 7

A 2.0 g Vitamin C tablet was used to prepare the 25 mL solution of ascorbic acid. The percentage mass of the tablet that is ascorbic acid is

- A. 12.4
- B. 24.8
- C. 49.6
- D. 55.5

Question 8

In performing the titration, the burette, the flask, and the pipette used to transfer the ascorbic acid should be rinsed with

- A. water in all cases.
- B. water, water and ascorbic acid respectively.
- C. iodine, water and ascorbic acid respectively.
- D. iodine, ascorbic acid and ascorbic acid respectively.

SECTION A – continued
TURN OVER

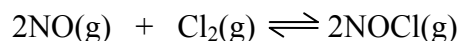
Question 9

The K_a value for the weak acid, HCN is 6.2×10^{-10} . A 0.01 M solution of HCN is prepared. The pH will be

- A. 2
- B. 3
- C. 5.6
- D. 8.4

Question 10

For the equilibrium reaction



1.6 mole of NOCl is added to an empty reactor. When equilibrium is reached, the amount of NOCl has dropped to 1.0 mole. The total number of mole of substances in the reactor at equilibrium will be

- A. 1.5 mole
- B. 1.9 mole
- C. 2.2 mole
- D. not able to be determined.

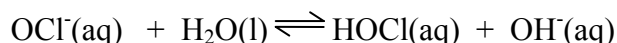
Question 11

The pH of water is 7.0 at 25°C and it is 7.5 at 0°C . This means that

- A. water is not neutral at 0°C .
- B. the self-ionisation of water is an endothermic process.
- C. water becomes more alkaline as the temperature drops.
- D. the percentage ionisation increases as the temperature drops.

Question 12

The OCl^- ion hydrolyses in water according to the equation



When several drops of 1.0 M HCl are added to an equilibrium mixture of OCl^- in water,

- A. the pH of the solution will increase.
- B. the concentration of the HOCl will increase.
- C. the concentration of the water will increase significantly.
- D. the concentration of the OCl^- will increase.

Question 13

The oxidation number of chlorine in HClO_4 is

- A. -1
- B. 0
- C. +1
- D. +7

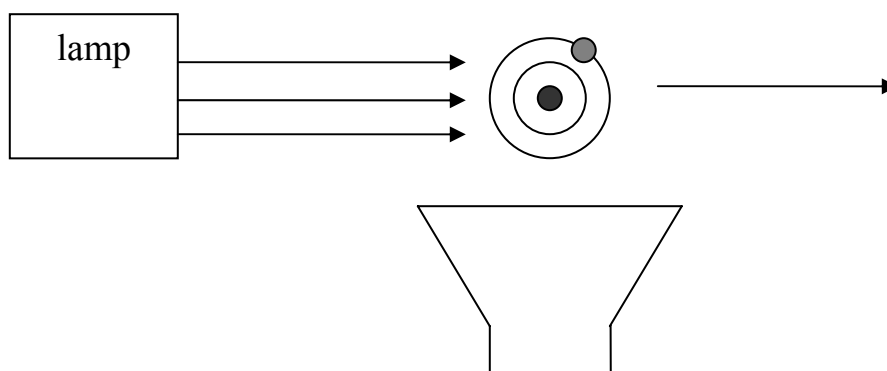
SECTION A – continued

Question 14

Pick the correct statement about the use of catalysts.

- A. Catalysts are always metal oxides.
- B. Catalysts lower the activation energy of a reaction.
- C. Catalysts lower the ΔH value of reactions, allowing more efficient use of energy.
- D. Catalysts increase the rate of a reaction by increasing the velocity of the particles.

Question 15

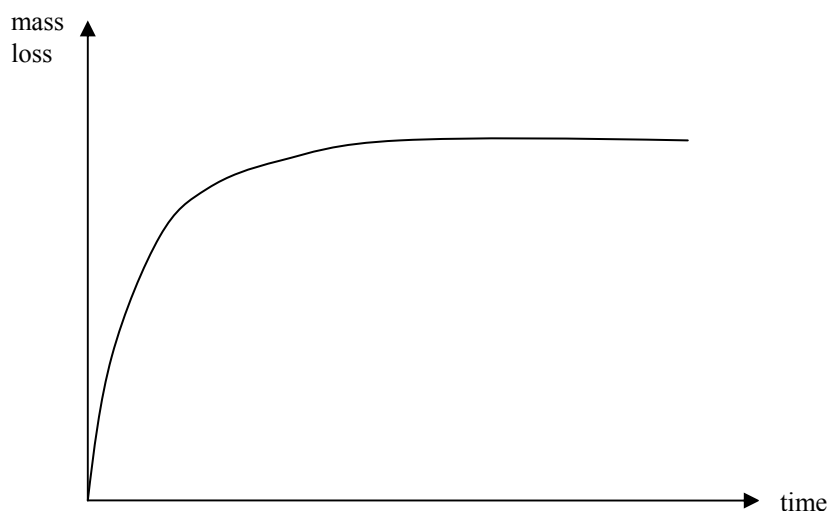


The diagram above is most likely to be a flowchart for

- A. an atomic emission spectrometer.
- B. a UV/visible spectrophotometer.
- C. an atomic absorption spectrometer.
- D. a gas/liquid chromatogram.

SECTION A – continued
TURN OVER

Question 16



The graph above could represent the measurement of changes in a typical

- A. reaction of a metal and acid.
- B. titration involving a strong acid and a weak base.
- C. precipitation reaction.
- D. equilibrium reaction.

Question 17

The retention time of an alcohol molecule in a gas chromatography column depends upon

- A. the wavelength of the light used.
- B. the charge on the ions.
- C. the speed of the liquid mobile phase
- D. the boiling point of the alcohol

Question 18

20 g of a metal, X reacts with 16 g of sulfur to form a compound with formula XS. The element X is most likely to be

- A. magnesium
- B. sodium
- C. calcium
- D. barium

Question 19

67.2 dm^3 of HCl at STP is dissolved in 30 litres of water. The pH will be

- A. 0
- B. 1
- C. 2
- D. 13

SECTION A – continued

Question 20

The percentage, by mass, of oxygen in propanoic acid is

- A. 21.6
- B. 30.0
- C. 43.2
- D. 45.4

**END OF SECTION A
TURN OVER**

SECTION B – Short-answer questions**Instructions for Section B**

Questions must be answered in the spaces provided in this book.

To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$

Question 1

Nitrosyl bromide, NOBr decomposes according to the equation;



- a. The equilibrium constant for this reaction at 350°C is $3.2 \times 10^{-2} \text{ M}$.
A mixture of the gases above at 350°C in a 1 litre vessel at 350°C contains
 $5.85 \times 10^{-2} \text{ mol}$ of NOBr
 $2.05 \times 10^{-2} \text{ mol}$ of NO and
 $5.14 \times 10^{-2} \text{ mol}$ of Br_2 .

In which direction must this reaction move to reach equilibrium? Show your working.

3 marks

SECTION B-Question 1-continued

- b.** Bromine gas is brown while the other gases in this system are both colourless.
- i.** When an equilibrium mixture is heated, it becomes darker. Is this mixture exothermic or endothermic? Explain your answer.

- ii.** If the volume of an equilibrium mixture is halved, what happens to the amount of NOBr?

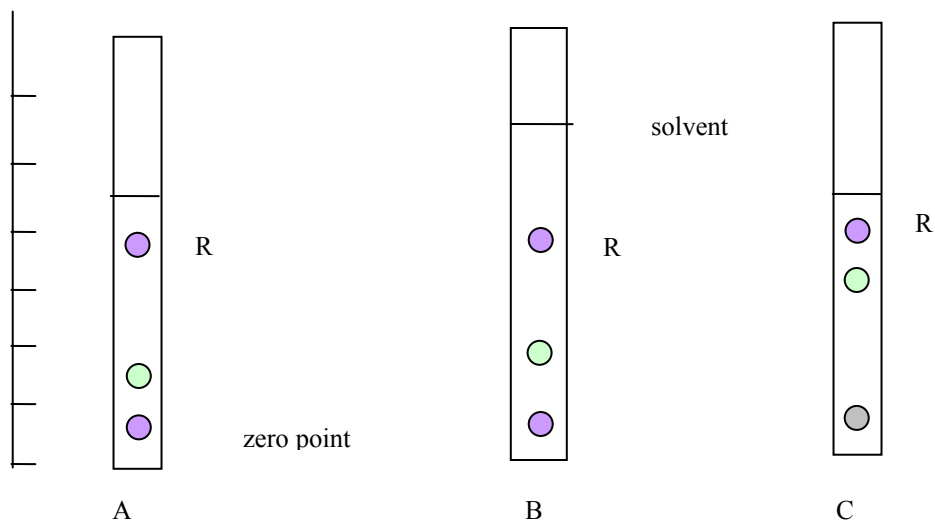
- iii.** If the pressure is halved, what happens to the amount of NO?

2 + 1 + 1 = 4 marks
Total 7 marks

SECTION B-continued
TURN OVER

Question 2

A food chemist is using paper chromatography to investigate the brown dyes used in lollies. Three separate chromatograms are shown below.



The solvent for sample A and B is ethanol, while the solvent for sample C is salt solution. Each brown dye used produces a red spot that has been marked with a R.

- a. If you are asked to calculate the R_f value of each brown spot, does it matter what units are used on the scale on the left? Explain your answer.

2 marks

- b. Is the red dye used in sample A likely to be the same as that used in sample B? Explain your answer.

1 mark

- c. Is the red dye used in sample C likely to be the same as that in sample A? Explain your answer.

1 mark

SECTION B-Question 2-continued

- d. The other spot shown in each sample is yellow. Which dye, out of yellow and red, is likely to be the more polar? Explain your answer.

1 mark

Total 5 marks

SECTION B-continued
TURN OVER

Question 3

One common method used for determining the sodium chloride concentration in mineral water is to use gravimetric analysis. Silver nitrate solution, AgNO_3 is added to the mineral water to cause a precipitate.

In a particular analysis, 20 mL of mineral water is added to a conical flask. 0.1 M silver nitrate solution is then added to the flask.

- a. Write a balanced equation for the precipitation reaction occurring.

1 mark

- b. Is it important what volume of silver nitrate solution is added? Explain your answer.

1 mark

- c. Discuss the likely impact on the concentration of sodium chloride obtained of each of the following errors.

- i. The filter paper is still wet when removed from the oven. Explain your answer.

-
-
- ii. Some precipitate remains on the side of the flask after its contents have been poured into the filter.

2 + 1 = 3 marks

SECTION B-Question 3-continued

Silver chloride is not completely insoluble. It exists in equilibrium with Ag^+ ions and Cl^- ions. The equation for this reaction is



d.

- i. How does the fact that this reaction is reversible influence the accuracy of the analysis of the mineral water? Discuss your answer.

- ii. Will the impact of this equilibrium reaction be more significant at 5°C or at 40°C ? Explain your answer.

2 + 1 = 3 marks
Total 8 marks

SECTION B-continued
TURN OVER

Question 4

- a. Calcium fluoride, CaF_2 can be added to water to limit tooth decay. 4.1 g of calcium fluoride is added to 250 mL of water. The water is stirred to dissolve all the solid. The volume is then made up to 4 litres.
- i. The concentration of this solution can be expressed in different units. Complete the table below by calculating the appropriate concentrations

Concentration	Ca^{2+} ions	F^- ions	CaF_2
M			
g L^{-1}			

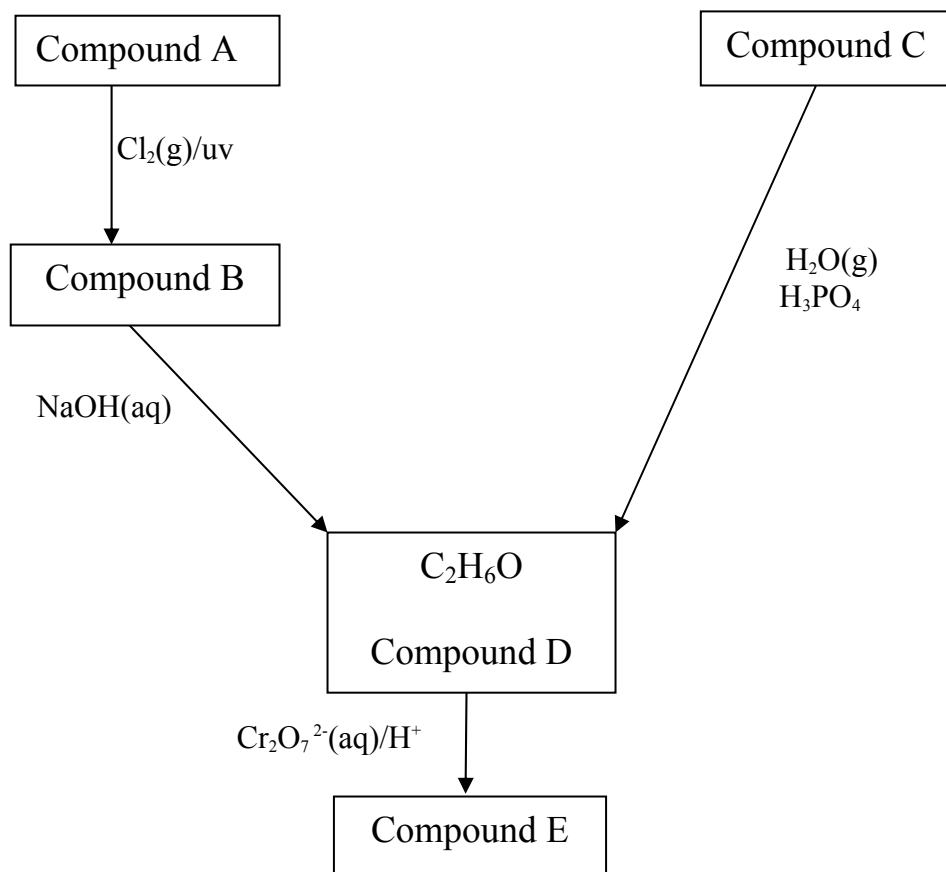
- ii. Calculate the number of fluoride ions swallowed by a person who drank one litre of this solution.

6 + 2 = 8 marks

- b. The concentration of the calcium ions can be determined using chemical instruments. Name one instrument that could be used to determine the calcium ion concentration.

1 mark
Total 9 marks

SECTION B-continued

Question 5

- a. Compound D can be formed through two different pathways.
 i. Draw a structural diagram of Compound D.

- ii. Give three uses for Compound D.

1 + 1 = 2 marks

SECTION B-Question 5-continued
TURN OVER

- b.** Name the type of reaction involved in;
- i.** The formation of Compound D from Compound B. _____
 - ii.** The formation of Compound D from Compound C. _____
 - iii.** The formation of Compound B from Compound A. _____
 - iv.** The formation of Compound E from Compound D. _____
- 1 + 1 + 1 + 1 = 4 marks

- c.** Write balanced half equations for;
- i.** The reaction of Compound D to form Compound E.

 - ii.** The reaction of $\text{Cr}_2\text{O}_7^{2-}$ to form Cr^{3+} in acid conditions.

- 1 + 1 = 2 marks

- d.** Name the molecule that could be formed from the reaction between Compound D and Compound E.

- 1 mark
Total 9 marks

SECTION B-continued

Question 6

The industrial preparation of sulfuric acid is known as the Contact process.

- a. The oxidation state of sulfur changes throughout this process. Give an example of a sulfur compound, or molecule, with an oxidation state of;

0 _____

+4 _____

+6 _____

3 marks

- b. Explain why sulfur dioxide is often used as a starting material in the manufacture of sulfuric acid.

1 mark

c.

- i. Write a balanced equation for the reaction of calcium and sulfuric acid.

- ii. Write a balanced half equation for the reaction of the calcium in its reaction with sulfuric acid.

1 + 1 = 2 marks

SECTION B-Question 6-continued
TURN OVER

d. Sulfuric acid reacts with water in two stages.

i. Write two equations to show this process.

ii. Write an expression for K_a for the second stage.

iii. Use the above equations to show why it is difficult to calculate the pH of a sulfuric acid solution, even when the concentration is known.

1 + 1 + 1 = 3 marks
Total 9 marks

END OF QUESTION AND ANSWER BOOK