Insight Publications

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Trial Exam Paper

2007

CHEMISTRY

Written examination 1

STUDENT NAME:

QUESTION AND ANSWER BOOK

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

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	8	8	61
			Total 81

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

Materials provided
- The question and answer book of 19 pages, with a removable data sheet.
- An answer sheet for multiple-choice questions.

Instructions
- Remove the data sheet from this book during reading time.
- Write your **name** in the box provided.
- You must answer the questions in English.

At the end of the examination
- Place the multiple-choice answer sheet inside the front cover of this question and answer book.

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

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for the multiple-choice questions.
Choose the response that is **correct** or that **best answers** the questions.
1 mark will be awarded for a correct answer; no marks will be awarded for an incorrect answer.
Marks are **not** deducted for incorrect answers
No marks will be awarded if more than one answer is complete for any question.

Question 1

Aspirin is an organic compound used widely in headache preparations. The concentration of aspirin in a particular tablet is best determined by

A. flame tests
B. atomic absorption spectroscopy
C. paper chromatography
D. high performance liquid chromatography

Question 2

In which of the following species does sulfur have the lowest oxidation number?

A. SO_4^{2-}
B. SO_2
C. SO_3
D. H_2SO_4

Question 3

1.50 g of calcium carbonate reacts with 20.0 mL of 1.0 M HCl according to the equation

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

In a second reaction mixture, the volume of HCl is increased to 50.0 mL. Which of the following best describes the difference between the first and second reaction mixtures?

A. The increased amount of HCl in the second reaction will cause it to proceed at a greater rate than the first.
B. A shorter period of bubbling will be observed in the second reaction mixture.
C. Equal volumes of carbon dioxide will be produced by the first and second reaction mixtures.
D. A greater amount of $CaCl_2$ will be produced in the second reaction.

Question 4

The number of carbon atoms present in 5.00 g of butane is

A. 0.345

B. 5.19×10^{22}

C. 2.08×10^{23}

D. 2.73×10^{23}

Question 5

A colorimeter is used to determine the concentration of phosphate in a detergent. A blue solution is prepared for analysis by treating detergent solution with sodium molybdate. Which of the following best describes the colour of the light source used?

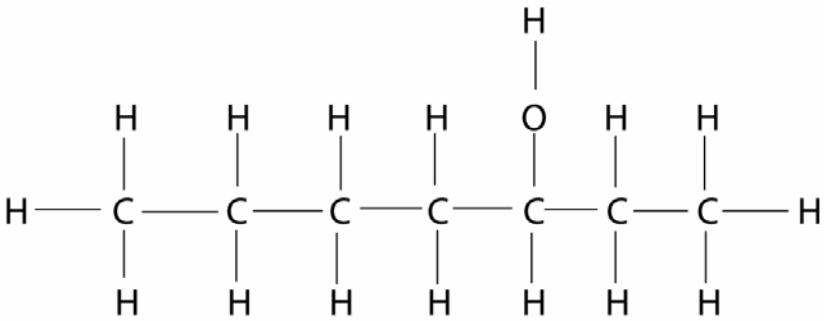
A. Orange as it will mainly be absorbed by the detergent solution.

B. Orange as it will mainly be reflected and transmitted by the detergent solution.

C. Blue as it will mainly be absorbed by the detergent solution.

D. Blue as it will mainly be reflected and transmitted by the detergent solution.

Question 6



The best name for the hydrocarbon with the structural formula shown above is

A. heptane-3-hydroxide.

B. heptanoic acid.

C. 3-heptanol.

D. 5-heptanol.

Question 7

A student used gravimetric analysis in a laboratory to determine that the percentage, by mass, of sodium chloride in a biscuit is 0.35%. This result was lower than expected. The error that could have produced the lower result is

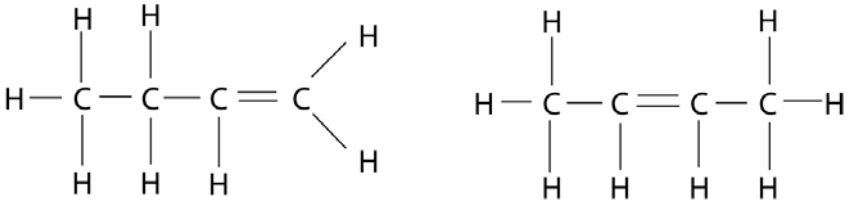
A. The precipitate was not dried completely before weighing.

B. Some co-precipitation occurred.

C. When the biscuit was dissolved and filtered, not all of the solids were removed before the precipitation was carried out.

D. Not all of the biscuit was dissolved before solids were filtered and the precipitation was carried out.

Question 8



Which of the following is **incorrect** about the two molecules represented above?

A. They have the same empirical formula.
B. They contain the same percentage, by mass, of hydrogen.
C. They can both react with water to produce 2-butanol.
D. They have the same semi-structural formula.

Question 9

The molecule that is **not** a possible product of the thermal cracking of a mixture of pentane, C_5H_{12}, is

A. C_3H_6
B. C_4H_8
C. C_5H_{10}
D. C_6H_{12}

Question 10

1.50 kg of aluminium oxide is used to produce aluminium metal and oxygen gas according to the equation

$$2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$$

All of the oxygen produced is collected and reacted with solid carbon according to the equation

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

The volume, in L, of carbon dioxide produced, at STP, is closest to

A. 988
B. 494
C. 220
D. 110

Question 11

8.40 g of metal X reacted completely with oxygen to produce 11.32 g of a metal oxide with the formula X_2O. The identity of metal X is

A. Li

B. Na

C. Ti

D. Y

Question 12

The volume, in L, occupied by 4.50 g of $N_2(g)$ at 100°C and 500 mmHg is

A. 1.00

B. 2.00

C. 7.48

D. 209

Question 13

Which statement regarding the pH of pure water is correct?

A. Pure water at different temperatures is always neutral, however, the pH may vary slightly.

B. Pure water at different temperatures is always neutral and always has a pH of 7.00.

C. Pure water at a temperature less than 25°C has a pH below 7.00 and is acidic.

D. Pure water at a temperature less than 25°C has a pH above 7.00 and is basic.

Question 14

35.0 g of magnesium nitrate is dissolved in 1.50 L of distilled water. The concentration of $NO_3^-(aq)$ ions, in mol L^{-1}, in the solution is

A. 0.157

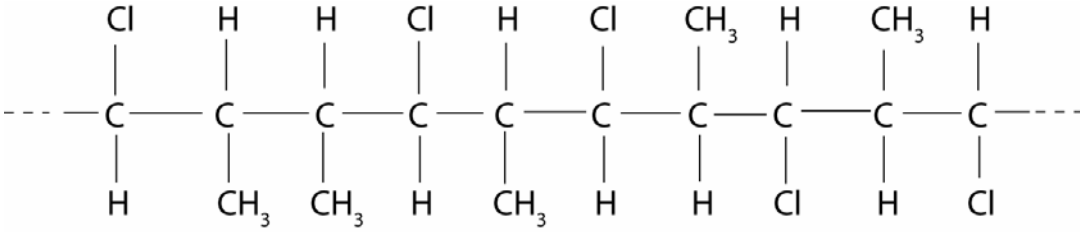
B. 0.270

C. 0.315

D. 0.541

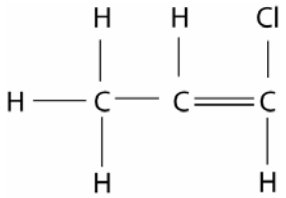
Question 15

Consider the polymer

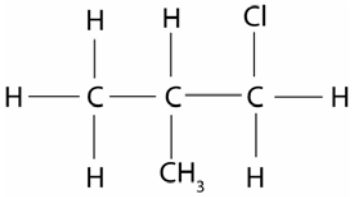


The structure of the monomer from which this polymer was produced by addition polymerisation would be

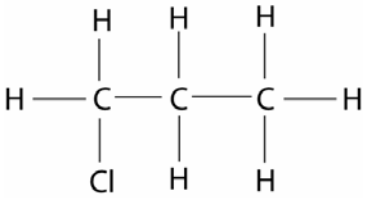
A.



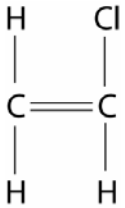
B.



C.



D.



Question 16

Consider the reaction

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad K = 0.052 \text{ at } 400°C$$

A 500 mL flask contains a mixture of these gases at 400°C. At equilibrium, 0.90 mol of $H_2(g)$ and 0.075 mol of $NH_3(g)$ are present. The amount, in mol, of $N_2(g)$ present is

A. 0.037

B. 0.074

C. 0.15

D. 0.80

Question 17

Consider the reaction

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g) \qquad \Delta H = +129.6 \text{ kJ mol}^{-1}$$

Carrying out the reaction at a higher temperature will increase the yield of H_2. Which one of the following gives the best explanation for this?

A. Increasing the temperature decreases the activation energy of the forward reaction, making it easier to form products.

B. Increasing the temperature causes a net forward reaction because the forward reaction is endothermic.

C. Increasing the temperature causes a net forward reaction because the forward reaction is exothermic.

D. Increasing the temperature increases the number of collisions between reactant particles, increasing the rate of reaction.

Question 18

Of the hydrocarbons listed below, which has the highest boiling temperature?

A. pentane

B. hexane

C. heptane

D. octane

Question 19

Consider the reaction

$$2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g) \quad \Delta H = -571.6 \text{ kJ mol}^{-1}$$

Which statement regarding this reaction is correct?

A. The activation energies for the forward and backward directions are of the same magnitude.

B. The activation energy of the forward reaction is greater than that of the backward reaction.

C. The activation energy of the forward reaction is less than that of the backward reaction.

D. Increasing the pressure will increase the reaction rate because it lowers the activation energy.

Question 20

The active ingredient in Grofast plant fertiliser is ammonium sulfate, $(NH_4)_2SO_4$. The mass, in kg, of nitrogen present in a 20 kg bag is

A. 0.21

B. 2.1

C. 2.5

D. 4.2

END OF SECTION A

SECTION B – Short-answer questions

Instructions for Section B

Answer **all** questions in the spaces provided
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 working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

Give concise explanations for each of the following.

a. The rate of a chemical reaction can be increased by increasing the temperature.

_____

_____

_____

_____

2 marks

b. The pH of a solution of 0.10 M H_2SO_4 is lower than the pH of a solution of 0.10 M HCl, even though they are both solutions of acids with the same concentration.

_____

_____

1 mark

Total 3 marks

Question 2

Atomic absorption spectroscopy (AAS) is used to analyse a wide range of substances. One such analysis involves determining the lead (Pb^{2+}) concentration in paint.

a. Explain why a lead lamp is used for this analysis.

_____

_____

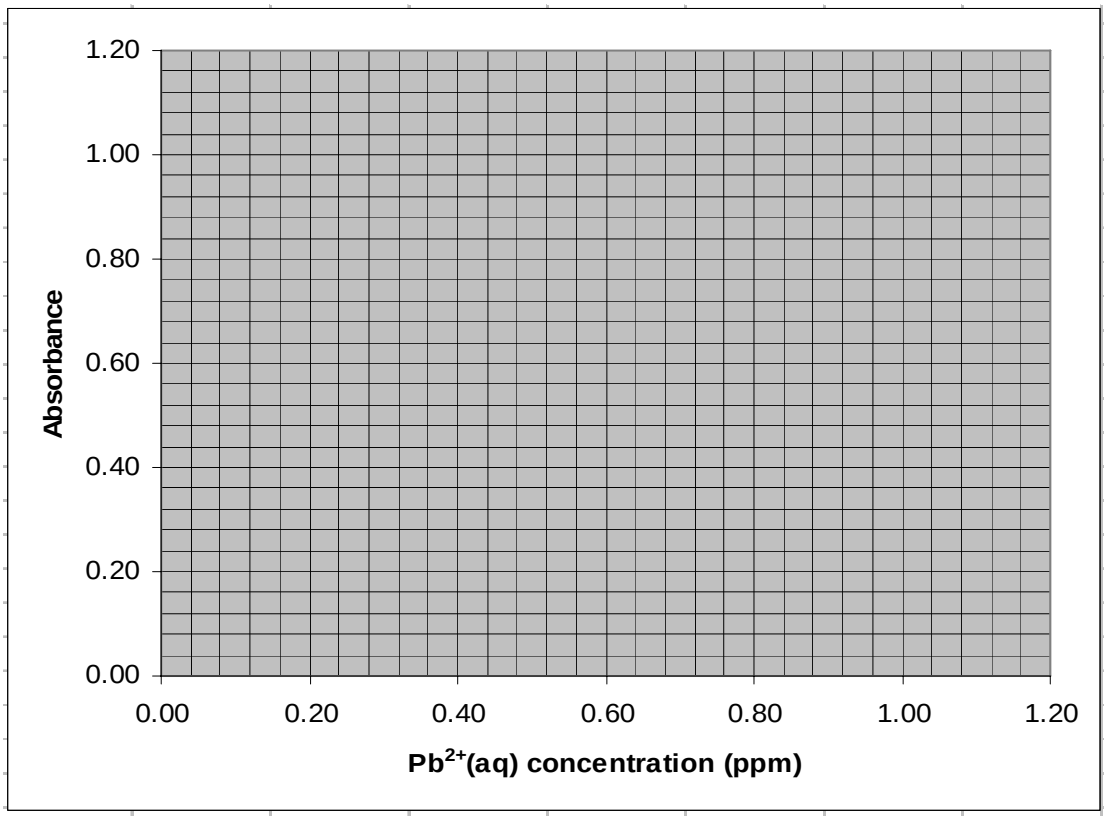
_____

1 mark

The student prepares several standard solutions of different concentrations and measures the absorbance of each.

Pb^{2+}(aq) concentration (ppm)	**Absorbance**
0	0.002
0.1	0.078
0.2	0.163
0.4	0.297
0.6	0.464

b. Use the data above for the Pb^{2+}(aq) standards to plot a calibration line on the graph below.



2 marks

SECTION B – continued
TURN OVER

c. A 10.0 mL sample of paint is diluted to 1000 mL, filtered and a sample taken for analysis. Its absorbance is measured as 0.193.

i. Determine the concentration of lead in the paint, in ppm.

_____

_____

_____

2 marks

ii. A concentration of 1.00 ppm is the same as a concentration of 1.00 mg L^{-1}. Calculate the concentration of $Pb^{2+}(aq)$ in the paint, in mol L^{-1}.

_____

_____

_____

_____

_____

2 marks

Total 7 marks

Question 3

A student wishes to determine the purity of a sample of calcium carbonate. The student dissolves a 1.15 g sample of calcium carbonate in water in a 250 mL volumetric flask and adds 50.0 mL of 1.00 M hydrochloric acid. Once the solution has stopped fizzing it is made up to the mark with deionised water. A 20.0 mL aliquot of this solution is pipetted into a conical flask and three drops of phenolphthalein indicator are added. The mixture is titrated with a 0.100 M standard solution of sodium hydroxide until a permanent faint pink colour is reached. This is repeated three times. The titres obtained are shown below.

Titre	Volume (mL)
1	22.30
2	22.35
3	23.00
4	22.35

a. Write an equation for the reaction between

i. calcium carbonate and hydrochloric acid.

_____

_____

1 mark

ii. hydrochloric acid and sodium hydroxide.

_____

_____

1 mark

b. Calculate the amount, in mol, of sodium hydroxide in the average titre.

_____

_____

_____

_____

2 marks

c. **i.** Calculate the amount, in mol, of hydrochloric acid added to the 250 mL flask.

_____

_____

1 mark

ii. Use the appropriate reaction equation to calculate the amount, in mol, of excess hydrochloric acid in the 250 mL volumetric flask.

_____

_____

_____

_____

2 marks

iii. Calculate the amount, in mol, of hydrochloric acid that reacted initially.

_____

_____

_____

1 mark

d. Use the appropriate reaction equation to determine the amount, in mol, of calcium carbonate in the sample.

_____

_____

_____

_____

1 mark

e. Calculate the percentage purity, by mass, of the calcium carbonate.

_____

_____

_____

_____

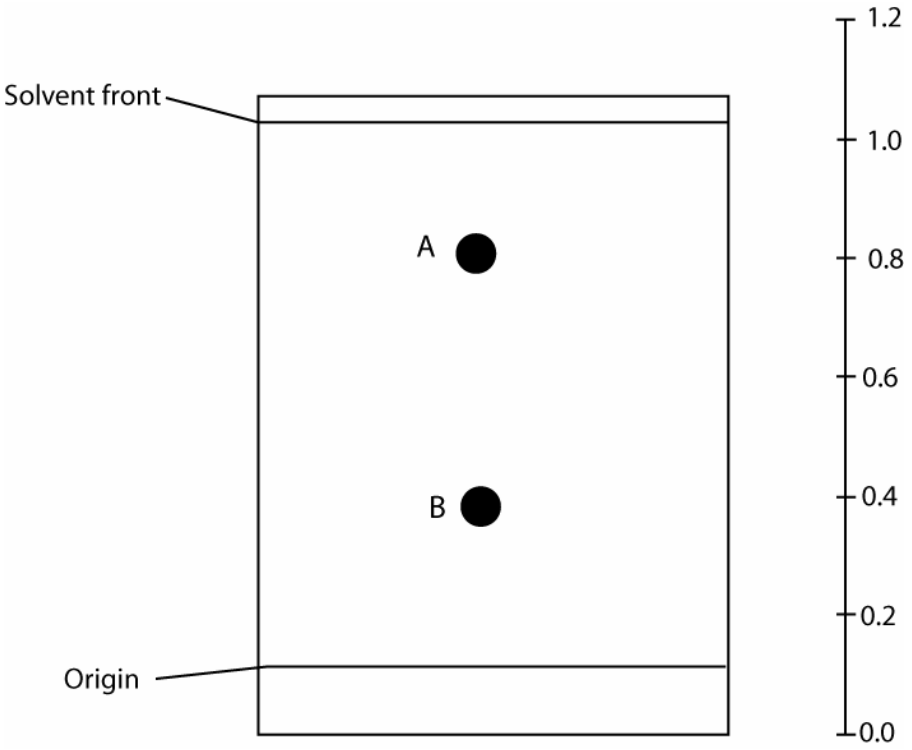
_____

3 marks

Total 12 marks

Question 4

The diagram below represents a paper chromatograph obtained by a student who was analysing the colours present in a particular brand of blue ink.



a. Calculate the R_f values of each component shown.

_____

_____

_____

_____

2 marks

b. Which component was most strongly absorbed to the stationary phase?

_____

1 mark

c. Suggest a way that the student could ensure that each of the spots evident on the chromatogram represents only one component in the ink.

_____

_____

1 mark

Total 4 marks

Question 5

The following chemical reactions both represent the ionisation of an acid in water.

$$HCl(g) + H_2O(l) \rightarrow Cl^-(aq) + H_3O^+(aq)$$

$$CH_3COOH(l) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

a. Explain, with reference to acid strength, why the two equations use different arrows.

_____

_____

1 mark

b. Calculate the pH of 100 mL of 0.500 M HCl solution.

_____

_____

_____

1 mark

c. Calculate the pH of 100 mL of 0.500 M CH_3COOH solution that has the K_a value 1.7×10^{-5}.

_____

_____

_____

3 marks

d. Bases such as sodium hydroxide also ionise in water.

i. Give a definition of a base.

_____

_____

1 mark

ii. Calculate the pH of 100 mL of 0.500 M NaOH solution.

_____

_____

_____

_____

_____

2 marks

Total 8 marks

Question 6

A student investigating equilibrium uses a mixture of NO_2 and N_2O_4 in a container of fixed volume. The reaction is exothermic.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

a. Complete the table by placing ticks in the appropriate boxes to indicate the effect of each change the student made to the mixture on

I. the amount, in mol, of NO_2; and
II. the concentration of NO_2.

Change to the equilibrium	**I.** Amount, in mol, of NO_2 at new equilibrium compared with initial equilibrium		**II.** $[NO_2]$ at new equilibrium compared with initial equilibrium	
	decreased	increased	decreased	increased
Sample 1: The container is heated				
Sample 2: The pressure is decreased by pulling out the piston				
Sample 3: More NO_2 gas is added				

6 marks

b. The equilibrium reaction for the transport of oxygen in the blood by haemoglobin (Hb) can be represented as:

$$Hb(aq) + O_2(aq) \rightleftharpoons HbO_2(aq)$$

Carbon monoxide (CO) reacts with haemoglobin in the same way as oxygen, but with a much higher *K* value.

$$Hb(aq) + CO(aq) \rightleftharpoons HbCO(aq)$$

Explain how relatively low levels of carbon monoxide in air can cause carbon monoxide poisoning.

_____

_____

_____

_____

2 marks

Total 8 marks

Question 7

a. Write the name and molecular formula of an alkane that has three carbon atoms.

_____

1 mark

b. This alkane can be converted to a chloroalkane, which can then be used to produce an alcohol.

i. Give a name and structural formula of the alcohol.

_____

2 marks

ii. Name the type of reaction in the production of the alcohol from the chloroalkane.

_____

1 mark

c. Describe, in a series of steps, how you could use a sample of the alcohol above to produce an ester in the laboratory.

_____

_____

_____

_____

_____

_____

_____

_____

5 marks

Total 9 marks

Question 8

A number of steps are involved in the conversion of mined sulfur to sulfuric acid via the Contact Process.

Step 1: The Burner

a. Write an equation for the reaction that occurs here.

_____

_____

1 mark

Step 2: The Converter

b. **i.** Write an equation for the reaction that occurs here.

_____

_____

1 mark

ii. Explain why a catalyst is used to increase the reaction rate in the converter, rather than increasing the temperature.

_____

_____

_____

2 marks

Step 3: The Absorber

c. The reaction that produces oleum in the absorber is represented by the equation

$$SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$$

i. Explain why SO_3 isn't simply reacted with water to produce sulfuric acid in one step.

_____

_____

_____

2 marks

ii. Write an equation for the production of sulfuric acid from oleum.

_____

_____

1 mark

d. Sulfuric acid is a very useful chemical that can react in a number of ways. Write equations to show sulfuric acid

i. acting as an acid when reacting with calcium carbonate.

_____

_____

2 marks

ii. dehydrating a sample of sucrose, $C_{12}H_{22}O_{11}$.

_____

_____

1 mark

Total 10 marks

END OF QUESTION AND ANSWER BOOK