CSE CENTRE FOR STRATEGIC EDUCATION
Leading educational thinking and practice

IARTV

STUDENT:	TEACHER:

CSE TEST – OCTOBER 2008

YEAR 12 - CHEMISTRY

Written examination 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*
A	20	20	20
B	9	9	64
			Total 84

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

Materials supplied

- Question and answer book of 16 pages.
- Data book
- Answer sheet for multiple-choice questions.

Instructions

- Write your **name** and that of your teacher in the space provided above on this page AND on the answer sheet for multiple-choice questions.
- All written responses must be in English

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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

SECTION A – Multiple choice questions

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions.

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

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

Marks will not be deducted for incorrect answers.

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

Questions 1, 2 and 3 all refer to the equilibrium system shown below.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Question 1

The rate of reaction in the above equilibrium will be increased by

A. increasing the surface area.

B. decreasing the pressure.

C. increasing the volume of the reaction vessel.

D. increasing the temperature.

Question 2

The equilibrium system above ΔH has a value of +520 kJ mol^{-1} and an activation energy of 700 kJ. The ΔH value and activation energy for the reverse reaction are

A. ΔH = -520 kJ mol^{-1} and E_A = 180 kJ.

B. ΔH = +520 kJ mol^{-1} and E_A = -180 kJ.

C. ΔH = -180 kJ mol^{-1} and E_A = 520 kJ.

D. ΔH = -520 kJ mol^{-1} and E_A = 700 kJ.

Question 3

0.800 mol of PCl5 is initially placed in a 4.00 L vessel at 400oC and allowed to come to equilibrium. At equilibrium, 0.760 mol of chlorine forms. The equilibrium constant at 400oC is

A. 3.61 mol L^{-1}.

B. 7.22 mol L^{-1}.

C. 14.4 mol L^{-1}.

D. 27.7 mol L^{-1}.

Question 4

When an acid is mixed with a base, heat is evolved. From this we can deduce that the ionisation of water is

A. endothermic and the pH increases as temperature increases.

B. endothermic and the pH decreases as temperature increases.

C. exothermic and the pH increases as temperature increases.

D. exothermic and the pH decreases as temperature increases.

Question 5

The use of a catalyst in an exothermic reaction will increase

A. the value of ΔH.

B. the temperature at which the reaction proceeds.

C. the activation energy.

D. the rate of the back reaction.

Question 6

In humans one of the equilibria that keeps the blood within a very narrow pH range is

$$H_2CO_3(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$$

Which of the following statements is correct?

A. If the pH rises there will be a net shift to the left to offset the increase in the concentration of $H_3O^+(aq)$.

B. If the concentration of OH^- increases there will be a net shift to the right to offset the increase of pH.

C. If the concentration of H_2CO_3 increases there will be a net shift to the right to offset the increase of pH.

D. If the concentration of HCO_3^- increases there will be a net shift to the left and this will result in the pH decreasing.

Question 7

A solution of limewater contains 5.00×10^{-5} mol of $Ca(OH)_2$ in 10.0 mL of the solution at 25°C. The pH of this solution is

A. 2.00

B. 2.30

C. 11.7

D. 12.0

Question 8

A 10.0 mL solution of hypobromous acid has a pH of 5.0. What is the concentration of hypobromous acid?

A. 0.000010 mol L^{-1}

B. 0.0010 mol L^{-1}

C. 0.042 mol L^{-1}

D. 4.2 mol L^{-1}

Question 9

Which of the following methods of electricity production is the most sustainable?

A. Natural gas-fired power station

B. Brown coal-fired power station

C. Hydrogen fuel cell

D. Hydroelectric power station

Question 10

Nuclear power stations are common in parts of Europe. A nuclear power station converts

A. nuclear energy → thermal energy → mechanical energy → electrical energy

B. chemical energy →thermal energy → mechanical energy → electrical energy

C. nuclear energy → mechanical energy → electrical energy

D. nuclear energy → electrical energy

Question 11

A well insulated calorimeter is first calibrated electrically and the temperature noted. A substance is dissolved and the temperature is again noted. The reaction is endothermic. The temperature noted in the calorimeter

A. rises then falls.

B. rises then rises again.

C. falls then rises.

D. falls then falls again.

Question 12

When 2.20 g of hydrogen reacts with 16.0 g of oxygen according to the following equation

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) \quad \Delta H = -572 \text{ kJ mol}^{-1}$$

A. 286 kJ of energy is absorbed

B. 286 kJ of energy is released

C. 572 kJ of energy is absorbed

D. 572 kJ of energy is released

Question 13

A hydrogen powered fuel-cell car would require about 27.0 kg of hydrogen to travel a reasonable distance before refuelling. The mass of water produced would be about

A. 27.0 kg

B. 120 kg

C. 240 kg

D. 490 kg

Question 14

Which of the following fuel cells would provide the greatest amount of energy in units of kJ g^{-1}?

A. Natural gas fuel cell

B. Methanol fuel cell

C. Hydrogen fuel cell

D. Ethanol fuel cell

Question 15

Which of the following will oxidise copper metal to copper(II) ions?

A. $I_2(s)$

B. $I^-(aq)$

C. $Pb(s)$

D. $Pb^{2+}(aq)$

Question 16

The overall equation for the discharge of a battery can be written as

$$Pb(s) + PbO_2(s) + 2SO_4^{2-}(aq) + 4H^+(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

The chemical reaction that occurs at the negatively charged electrode is

A. $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$

B. $PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}(aq)$

C. $PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

D. $PbSO_4(s) + 2H_2O(l) \rightarrow PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$

Question 17

Three electrolysis cells are connected in series, each one producing a different metal. The metals produced are aluminium, magnesium and sodium. After one hour with a constant applied current, which cell deposits the greatest mass of metal?

A. Aluminium

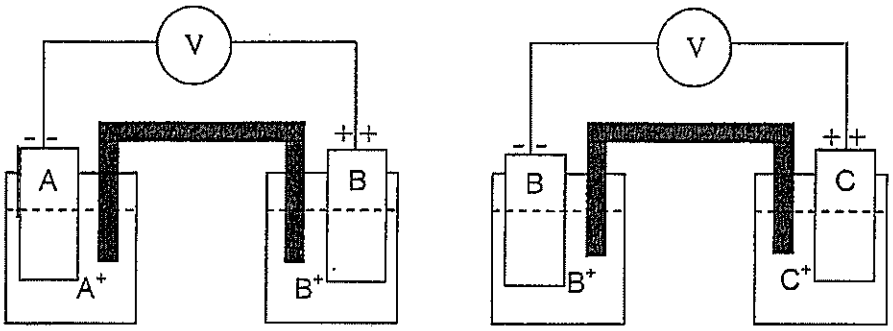
B. Magnesium

C. Sodium

D. No metal is deposited

Question 18

Two cells are shown in the diagram below. The experiment was conducted at 25oC and the electrolyte solutions had a concentration of 1.0 mol L-1 solutions.



The polarities indicate that the strongest oxidant is

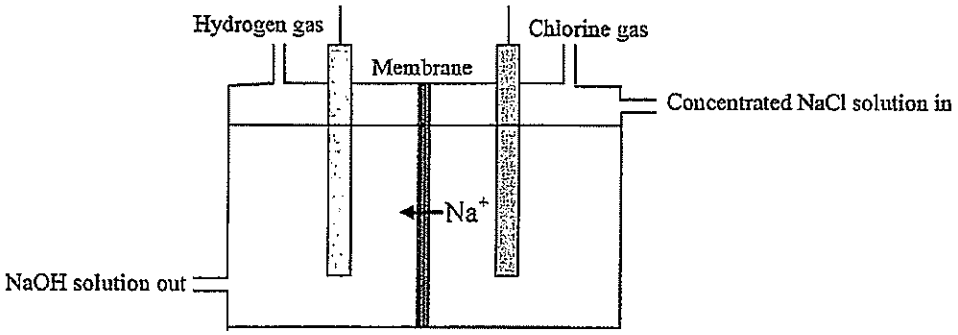
A. A

B. A^+

C. C

D. C^+

Question 19



In a membrane cell, pictured above, when an electrical current is passed through the cell, hydroxide ions are produced at

A. the positive anode.

B. the negative anode.

C. the positive cathode.

D. the negative cathode.

Question 20

When a current of 278 A is passed through molten calcium chloride for 26 seconds, the mass of calcium metal formed is

A. 1.5 g

B. 3.0 g

C. 6.0 g

D. 8.3 g

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 the 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(aq)

Question 1

a. A 25.00 mL solution of 5.00 mol L^{-1} NaOH is diluted to 500.0 mL. What is the pH of the diluted solution?

2 marks

b. A simplified equation for the ionisation of the indicator bromophenol blue can be written as

$$HIn(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + In^-(aq)$$

Calculate the concentration of In^- if the concentration of HIn is 0.15 mol L^{-1}.

2 marks

c. Use the equation in b. and your understanding of equilibria to explain why bromophenol blue is yellow in acid solution and blue in alkaline solutions.

1 mark

Total: 5 marks

Question 2

a. Consider the exothermic equilibrium reaction between hydrochloric acid and oxygen gas.

$$4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$$

Complete the table below after the following changes are made.

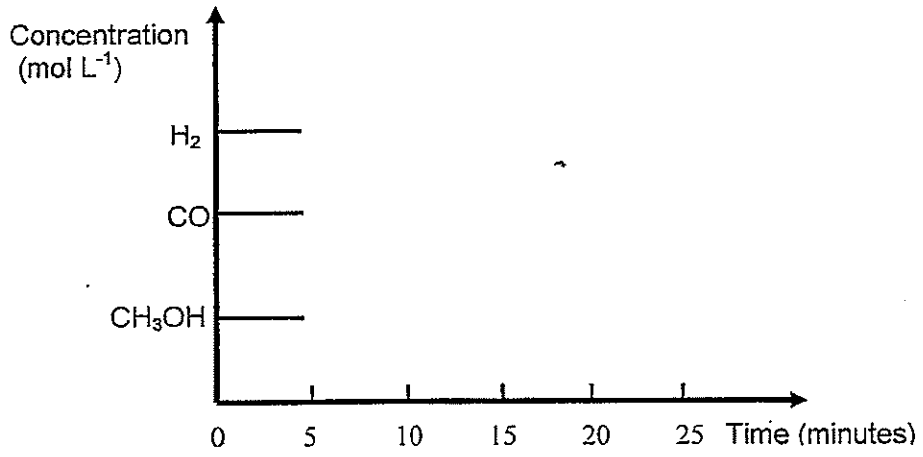
Change to the system	Net shift	Effect on the number of moles of O_2	Effect on the concentration of O_2
Addition of nitrogen gas at constant volume			
Decrease in pressure			
Increase in temperature			
Volume is halved			
Steam is removed			

5 marks

b. The equation for the equilibrium involved in the production of methanol can be written as

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

Sketch a concentration–time graph if at 5 minutes the temperature is decreased. After this the system comes to equilibrium but at 15 minutes the concentration of hydrogen is increased. The system then establishes equilibrium again at 20 minutes.



2 marks

Total: 7 marks

Question 3

Complete the table by placing a tick or ticks where appropriate in the correct boxes.

	Primary cell	Secondary cell	Fuel cell
Reactants are supplied continuously			
Cell reactions are able to be reversed			
Redox reactions are involved at the anode and cathode			
Cells contain an electrolyte			
Products of discharge remain in contact with electrode			
Mass of the cell remains constant during discharge			
Direct conversion of chemical energy to electrical energy			

Total: 7 marks

Question 4

Methanol and ethanol have both been used in fuel cells.
The anode reaction for the acidic ethanol fuel cell is

$$C_2H_5OH(aq) + 3H_2O(l) \rightarrow 2CO_2(g) + 12H^+(aq) + 12e^-$$

a. For the acidic ethanol fuel cell

i. give the cathode reaction

1 mark

ii. give the overall equation

1 mark

b. Give the anode reaction for the acidic methanol fuel cell.

1 mark

c. Which of the two alkanols produces a greater mass of carbon dioxide for each 100 g of fuel? Show calculations.

3 marks

d. Fuels cells have been trialed in a bus in Perth.

i. Give two advantages of fuel cells over a petrol engine in a bus.

1 mark

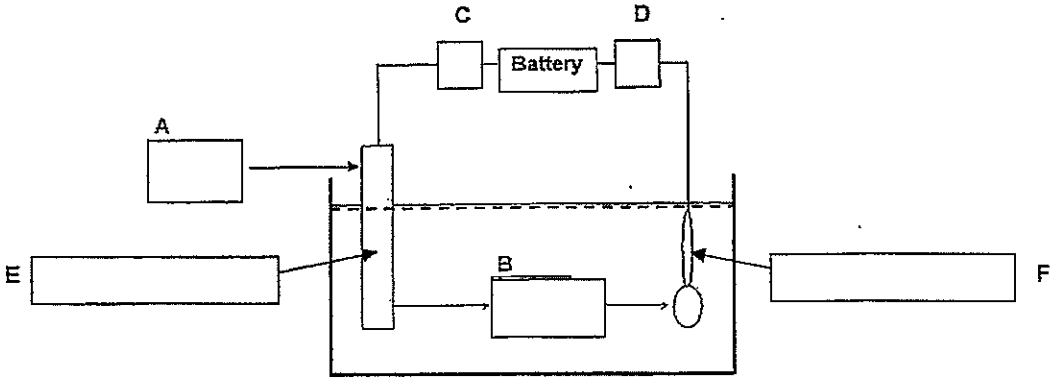
ii. Give two disadvantages of fuel cells over a petrol engine in a bus.

1 mark

Total: 8 marks

Question 5

Equipment is set up to silver-plate a spoon, as shown below.



a. In boxes A and B, write the chemical formula of an appropriate substance.

1 mark

b. Label box C and D with the correct polarity of the battery.

1 mark

c. Label box E and F with the appropriate term anode/cathode.

1 mark

d. Write the half-equation for the reaction occurring at the cathode.

1 mark

e. Apart from plating valuable metals to improve appearance, what is another common use of electroplating?

1 mark

Total: 5 marks

Question 6

The following half-cells are provided at standard conditions.

Half-Cell	Cell Composition
A	$Fe^{2+}(aq)/Fe(s)$
B	$Fe^{3+}(aq)/Fe^{2+}(aq)$
C	$H^{+}(aq)/H_2(g)$
D	$Cu^{2+}(aq)/Cu(s)$

Half-cells are connected by a salt-bridge.

a. Which possible pairing of half-cells gives the highest voltage?

1 mark

b. A galvanic cell is made using half-cells A and B.

i. Write the two half-cell equations which occur

1 mark

ii. Write the balanced overall equation for the cell.

1 mark

iii. In another experiment with this cell, a student obtained a different cell voltage. Give a possible reason for this.

1 mark

iv. Give two reasons why potassium nitrate used in the salt-bridge was appropriate.

1 mark

v. Give the name of a suitable electrode for half-cell B.

1 mark

c. Half-cells C and D are connected.

i. What happens to the pH in half-cell C. Explain?

1 mark

ii. What happens to the pH in half-cell D? Explain?

1 mark

iii. Over time, what happens to the colour in half-cell D? Explain.

1 mark

iv. Over time, what happens to the mass of the electrode in half-cell D? Explain.

1 mark

Total: 10 marks

Question 7

A laboratory experiment is performed to determine the heat of combustion of butane. Butane in a pressurised can is used as a fuel in a small one-burner portable stove. An open container filled with 100 mL of water is placed on top of the stove and the stove is ignited to heat the water.

The following data is recorded.

Mass of butane can before heating:	220.0 g
Mass of butane can after heating:	219.2 g
Temperature of water before heating:	23.5 °C
Temperature of water after heating:	76.3 °C

a. Use the change in temperature of the water to determine the amount of energy in kJ added during the heating.

2 marks

b. Determine an experimental value of the enthalpy, in kJ mol^{-1} for combustion of butane.

2 marks

c. By comparing your experimentally determined value of the heat of combustion with the theoretical one given in the data sheet, determine the percentage of chemical energy of the butane that ends up as heat energy in the water.

2 marks

d. The heat of combustion of butane was then determined using a bomb calorimeter. Would you expect the numerical value of the heat of combustion of butane obtained using the bomb calorimeter to be greater than that obtained using the portable stove? Give two reasons for your answer.

2 marks

Total: 8 marks

Question 9

In VCE Chemistry Unit 4, you investigated the industrial production of a selected chemical.

a. Write the chemical formula of the chemical you studied and name the industrial process that produced this chemical.

1 mark

b. What are the raw materials used in this process?

1 mark

c. Write a balanced chemical equation for a reaction in which the chemical in part **a.** is the final product of the industrial production of this chemical.

1 mark

d. Describe one step in your chosen process that involves an equilibrium reaction. Discuss the conditions that maximise the rate and yield in this step.

3 marks

e. List two important uses of your chosen chemical.

1 mark

f. Discuss what measures are taken to manage waste in this industrial process.

2 marks

Total: 9 marks

END OF QUESTION BOOK