STUDENT:	TEACHER:

CSE TEST – OCTOBER 2011

YEAR 12 – 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
A	20	20	20
B	8	8	55
		Total	75

- 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 14 pages.
- Data book
- Detachable answer sheet for multiple choice questions. You may detach this during reading time.

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.

CENTRE FOR STRATEGIC EDUCATION – YEAR 12 CHEMISTRY
Written Test 2 – October 2011

ANSWER SHEET

STUDENT NAME:

INSTRUCTIONS:

Use a **PENCIL** for **ALL** entries. For each question, shade the box which indicates your answer.
All answers must be completed like **THIS** example:
Marks will not be deducted for incorrect answers.
NO MARK will be given if more than **ONE** answer is completed for any question.
If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

A	■	C	D

| ONE ANSWER PER LINE				ONE ANSWER PER LINE			
1 A	B	C	D	11 A	B	C	D
2 A	B	C	D	12 A	B	C	D
3 A	B	C	D	13 A	B	C	D
4 A	B	C	D	14 A	B	C	D
5 A	B	C	D	15 A	B	C	D
6 A	B	C	D	16 A	B	C	D
7 A	B	C	D	17 A	B	C	D
8 A	B	C	D	18 A	B	C	D
9 A	B	C	D	19 A	B	C	D
10 A	B	C	D	20 A	B	C	D

SECTION A – Multiple choice questions

Question 1

Hydrogen chloride gas decomposes at a high temperature according to the equation
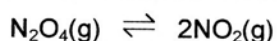
$$2HCl(g) \rightleftharpoons H_2(g) + Cl_2(g)$$
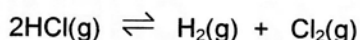
Which graph best shows the change of concentration of hydrogen chloride gas when it is added to an empty container?

A. Concentration vs Time

B. Concentration vs Time

C. Concentration vs Time

D. Concentration vs Time
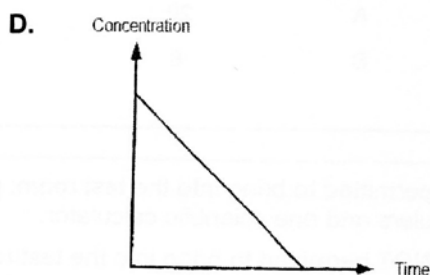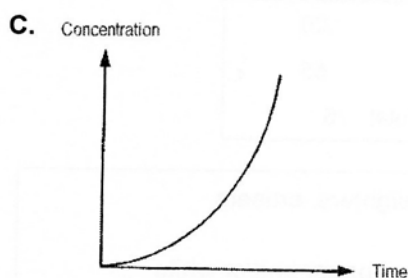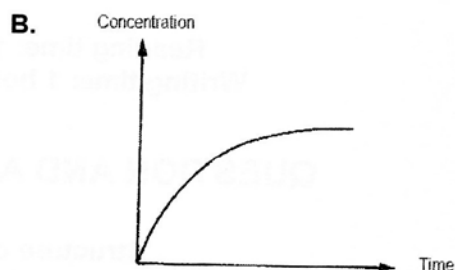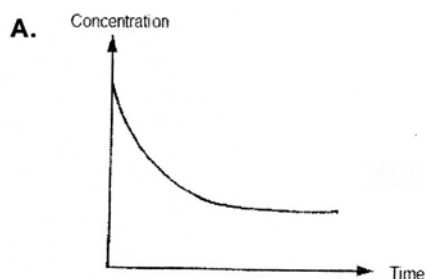
Question 2

The equilibrium constant for the reaction

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

is 0.98 M at 298 K.
In a 2.00 L vessel the amount of $N_2O_4(g)$ is found to be 0.425 mol at equilibrium. The concentration of $NO_2(g)$ in this system will therefore be

A.   0.21 M

B.   0.42 M

C.   0.46 M

D.   0.65 M

Questions 3 and 4 refer to the following information.

Limewater is prepared by dissolving calcium hydroxide in water in an exothermic reaction. The equation for this reaction is

$$Ca(OH)_2(s) \; \underset{}{\overset{H_2O}{\rightleftharpoons}} \; Ca^{2+}(aq) + 2OH^-(aq)$$
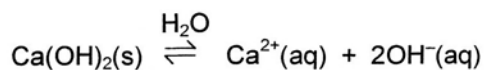
Question 3

Limewater often looks cloudy due to undissolved calcium hydroxide. If a few drops of 1M HCl were added to a slightly cloudy sample of limewater, what would be the observation?

A. No change.

B. The limewater becomes more cloudy.

C. The limewater becomes less cloudy.

D. A gas is produced.

Question 4

A saturated solution of limewater, at 25°C, has some solid calcium hydroxide added to it and the solution is stirred.
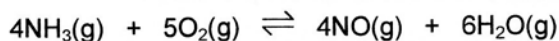
Which of the following statements is/are true?

I   The pH of the solution will increase.

II   The pH of the solution will decrease.

III   The equilibrium constant will increase.

IV   The temperature of the solution will increase.

V   The concentration of the limewater will remain unchanged.

A. I and III

B. II and IV

C. I, III and IV

D. V

Question 5

Ammonia gas can be reacted exothermically with oxygen to produce nitrogen monoxide and water in the following reaction

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Consider the following statements:

Statement I   Increasing pressure causes the equilibrium to move to the right.

Statement II   Increasing temperature causes the equilibrium to move to the right.

Which of the following applies?

A. Both statements are TRUE.

B. Statement I is TRUE, statement II is FALSE.

C. Statement I is FALSE, statement II is TRUE.

D. Both statements are FALSE.

Question 6

Barium hydroxide is a strong base. A 10 mL sample of 0.005 M barium hydroxide solution is diluted to 100 mL. The pH of the resulting solution is approximately

A.   3.3

B.   10.7

C.   11.0

D.   12.0

Question 7

Two different chemical reactions A and B are used to study the rate of chemical reactions. The reaction rate of A is observed to be faster than the reaction rate of B at the same temperature.

Consider the following statements:

Statement I   The reaction A must have included a catalyst; reaction B did not use a catalyst.

Statement II   There are more fruitful collisions between reactants in reaction A than B.

Which of the following applies?

A.   Both statements are TRUE.

B.   Statement I is TRUE, statement II is FALSE.

C.   Statement I is FALSE, statement II is TRUE.

D.   Both statements are FALSE.

Question 8

The combustion of a sample of octane releases 2495 kJ. What is the volume of the original sample if the density of octane at room temperature is 0.703 g mL^{-1}?

A.   52.1 mL

B.   74.0 mL

C.   250 mL

D.   355 mL

Question 9

Enthalpy density is a term sometimes used to describe the enthalpy per litre of fuel. Which fuel has the highest energy density at room temperature and 1 atmosphere pressure?

A. H_2

B. CH_4

C. C_2H_6

D. C_3H_8

Question 10

It is likely that a spontaneous reaction will occur when

A.   cobalt metal is added to zinc chloride solution.

B.   hydrogen sulfide is bubbled through iron(III) nitrate solution.

C.   bromine solution is added to lithium sulfate solution.

D.   hydrogen peroxide is added to copper(II) sulfate solution.

Question 11

A wheel rim cannot be coated with manganese using 1.0 M $MnBr_2$ solution because

A. Br^- is a weaker reductant than water.

B. Mn^{2+} is a weaker oxidant than water.

C. Mn^{2+} is a weaker reductant than water.

D. Br^- is a weaker oxidant than water.

Question 12

A 30 g sample of brown coal from the LaTrobe Valley is sufficient to provide enough energy to light an 18 watt fluorescent globe for 83 minutes. The sample contains 60% water. If the dry coal contains 63% carbon and all of this is fully combusted in the electricity production process, what volume of carbon dioxide at SLC will be added to the atmosphere?

A. 15 L

B. 23 L

C. 37 L

D. 39 L

Question 13

By world standards, LaTrobe coal contains very little sulfur. In the electricity production process the sulfur burns to form oxides. Which of the following could be used to trap these oxides?

A. $CaO(s)$

B. $NaCl(aq)$

C. $HCl(aq)$

D. $KNO_3(s)$

Question 14

Which of the following cells, at standard conditions, could **NOT** produce an electric current?

A. $Cu^{2+}(aq)/Cu(s)$ and $Zn^{2+}(aq)/Zn(s)$

B. $Cu^{2+}(aq)/Cu(s)$ and $Mg^{2+}(aq)/Zn(s)$

C. $Cu^{2+}(aq)/Cu(s)$ and $Zn^{2+}(aq)$ with Pt electrode

D. $Zn^{2+}(aq)/Zn(s)$ and $Cu^{2+}(aq)$ with Pt electrode

Question 15

Which of the following statements about fuel cells is most likely to be correct?

A. Waste products must be continuously removed from the cell.

B. The cell is recharged by an external power supply.

C. The same number of anions is produced as the number of cations.

D. Gases are recycled to increase the rate of electricity production.

Question 16

Two cells are connected as shown in the diagram below. The experiment is conducted at 25°C and all solutions are 1 M.
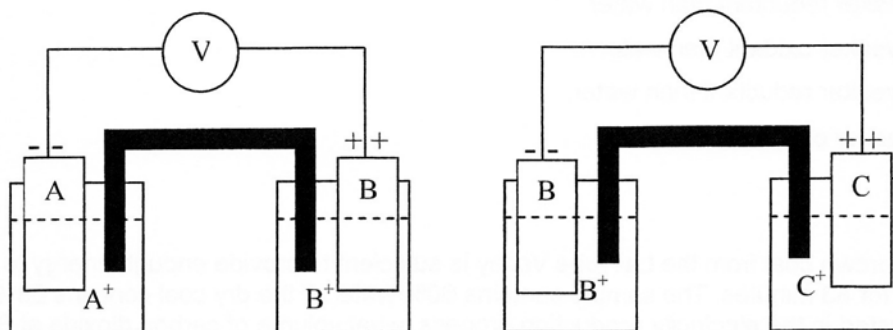
The polarities indicate that the strongest oxidant is

A.   A

B. A^+

C.   C

D. C^+

Question 17

Four electrolytic cells contain four different 1.0 M metal nitrate solutions. If a current of 1.05 amps was passed through each solution for 50.0 minutes, the mass of metal deposited on the cathode is

A.   0.400 g of magnesium.

B.   1.04 g of copper.

C.   1.76 g of silver.

D.   1.91 g of nickel.

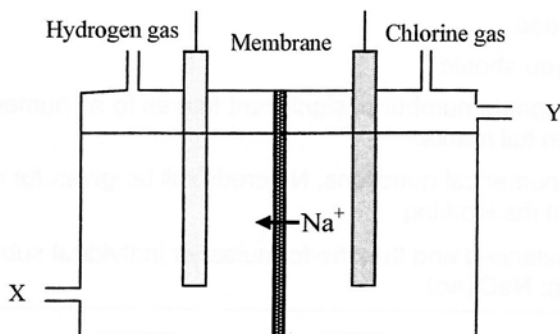## Question 18

The number of Faradays of electricity needed to produce 2.24 L of chlorine gas at STP from molten NaCl is

A.   0.0500

B.   0.100

C.   0.200

D.   9650

Questions 19 and 20 refer to the following information.

The membrane cell pictured below uses brine (saturated sodium chloride solution) as the electrolyte.

Question 19

When an electrical current is passed through the cell, hydroxide ions are produced at the

A.   positive anode and Y is brine.

B.   negative anode and Y is sodium hydroxide.

C.   positive cathode and Y is sodium hydroxide.

D.   negative cathode and Y is brine.

Question 20

The substance X produced is

A.   sodium hydroxide.

B.   hydrochloric acid.

C.   sodium hypochlorite.

D.   sodium metal.

END OF SECTION A
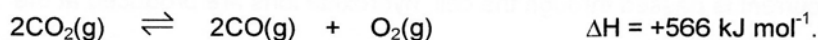
SECTION B – Short answer questions

Question 1

The following reaction was allowed to come to equilibrium

$$2CO_2(g) \quad \rightleftharpoons \quad 2CO(g) \quad + \quad O_2(g) \qquad \Delta H = +566 \text{ kJ mol}^{-1}.$$

Changes were made to the system and the equilibrium allowed to re-establish. Place a tick in the box for the change to the equilibrium concentration of **oxygen** due to the stated change of reaction conditions.

Change	Increase	Decrease	No change
a. Addition of NaOH(s) to the reaction vessel at constant temperature			
b. Halving of the reaction vessel volume at constant temperature			
c. Addition of a catalyst to the reaction vessel at constant temperature			
d. Addition of helium gas			
e. Increasing the vessel temperature at constant volume			
f. Addition of more CO(g) to the reaction vessel at constant temperature			

g. Which of the above changes will cause an increase in the value of the equilibrium constant? ☐

h. Which of the above changes will initially increase the rate of the forward reaction? ☐

Total: 8 marks

Question 2

In an exothermic industrial process at 450°C in a 2.00 L closed evacuated container, 1.56 mol of sulfur dioxide and 0.860 mol of oxygen gas were added to the container. The reaction was allowed to come to equilibrium and 1.48 mol of sulfur trioxide was detected.

a. Write a complete balanced equation for this reaction.

1 mark

b. Calculate the final concentration of each component in the equilibrium mixture.

3 marks

c. Write the equilibrium expression for this reaction.

1 mark

d. Calculate the equilibrium constant for the reaction at 450°C

1 mark

e. What would happen in the manufacturing process if there was a temperature drop in the reaction?

2 marks

Total: 8 marks

Question 3

A typical fat, glycerol trioleate, with a molecular formula $C_{57}H_{104}O_6(s)$, is completely oxidised by the body to carbon dioxide and water. ΔH for the reaction is -3351 kJ mol^{-1}.

a. Write a complete balanced equation for this reaction.

1 mark

b. How much energy is produced when 1.00 g of this fat is oxidised?

2 marks

c. If a tennis player uses up 2000 kJ in one hour, what mass of the fat is theoretically lost in a match lasting 2 hours 15 minutes?

2 marks

Total: 5 marks

Question 4

A student is measuring enthalpy changes. A mass of 2.43 g ammonium nitrate is dissolved in 100 mL of water in a calorimeter. The heat of solution for ammonium nitrate is +25.0 kJ mol^{-1}.

a. What will be the temperature change in a well insulated calorimeter with a calibration factor of 295 J$^{\circ}$C^{-1}?

2 marks

b. If the initial temperature of the water is 18.5°C what will be the final temperature?

1 mark

c. If the student used 50.0 mL water instead of 100 mL water what would be the effect on the calibration factor? Circle the correct answer.

Increase   **No change**   **Decrease**

1 mark

d. Bomb calorimeters are also used to calculate the change in enthalpy. Complete the table below indicating whether a bomb or a solution calorimeter should be used and whether energy would be released or absorbed.

Reaction	Solution or bomb calorimeter	Energy released or absorbed
Magnesium metal is dissolved in sulfuric acid		
Iron is reacted with oxygen		
Oxidation of glucose		

3 marks

e. If octane burns in insufficient air, carbon monoxide may form as represented in the equation below.

$$2C_8H_{18}(l) + 17O_2(g) \rightarrow 16CO(g) + 18H_2O(l)$$
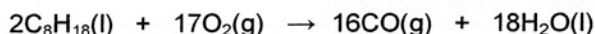
Using the molar enthalpy table in your data book and the thermochemical equation below,

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g) \quad \Delta H = -556.0 \text{ kJ mol}^{-1}$$

find the ΔH for the incomplete combustion of octane.

2 marks

Total: 9 marks

Question 5

a. List two advantages of a gas-fired power station over a coal-fired power station.

2 marks

b. Explain why Australia relies more on coal-fired power stations than on gas-fired power stations.

1 mark

c. Explain why a fuel cell is considerably more efficient than a coal-fired power station.

1 mark

Explain what is meant by the term biogas and how biogas is produced.
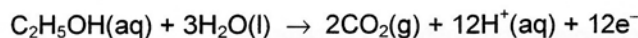
1 mark

Total: 5 marks

Question 6

a. 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			

3 marks

Ethanol is used in fuel cells.
The anode reaction for the acidic ethanol fuel cell is

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

b. Write the reaction occurring at the cathode in the acidic ethanol fuel cell.
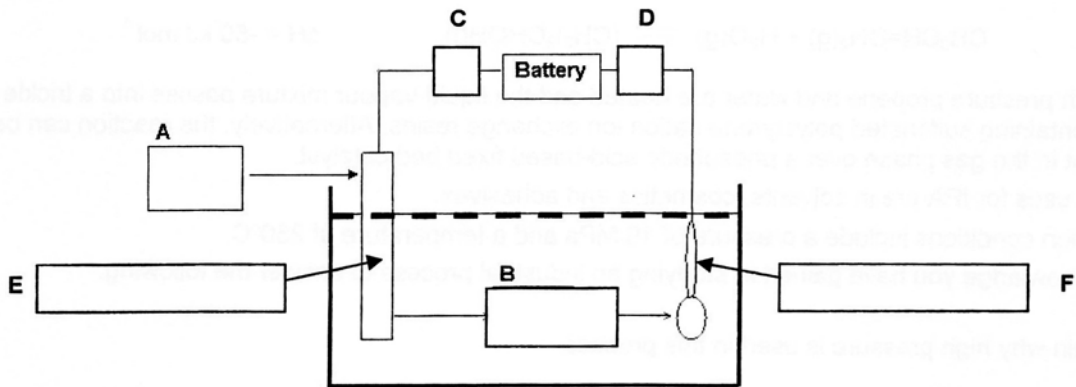
1 mark

c. Write the overall reaction.

1 mark

Total 5 marks

Question 7

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

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

1 mark

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

1 mark

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

1 mark

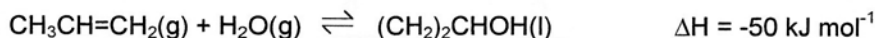d. Write the half-equation for the reaction occurring at the cathode.

1 mark

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

1 mark

Total 5 marks

Question 8

One method used to produce isopropanol (propan-2-ol or IPA) is the direct hydration of propene.

$$CH_3CH=CH_2(g) + H_2O(g) \rightleftharpoons (CH_2)_2CHOH(l) \qquad \Delta H = -50 \text{ kJ mol}^{-1}$$

Under high pressure propene and water are heated and the liquid-vapour mixture passes into a trickle flow reactor containing sulfonated polystyrene cation ion exchange resins. Alternatively, the reaction can be carried out in the gas phase over a phosphoric acid-based fixed bed catalyst.

The main uses for IPA are in solvents, cosmetics and adhesives.

The reaction conditions include a pressure of 10 MPa and a temperature of 250°C.

Use the knowledge you have gained in studying an industrial process to answer the following.

a. Explain why high pressure is used in this process.

1 mark

b. Give two reasons why a temperature of 250°C must be carefully monitored.

2 marks

c. Give two reasons why the phosphoric acid-based fixed catalyst is a benefit to production.

2 marks

d. Give two ways the production of IPA can be made more efficient.

2 mark

e. Waste management and efficiency are serious issues for manufacturers of industrial chemicals. Give two ways that waste can be reduced.

2 marks

f. During the production and transport of IPA, spills must be avoided as it is highly flammable, burns with an invisible flame and does not produce smoke.

Give one safety precaution that should be carried out when IPA is being produced or transported.

1 mark

Total: 10 marks

END OF QUESTION BOOK