CSE CENTRE FOR STRATEGIC EDUCATION
Leading educational thinking and practice

IARTV

STUDENT:	TEACHER:

CSE TEST – OCTOBER 2010

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	10	10	65
			Total 85

- 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 18 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 2010

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.

	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

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.

Question 1

Consider the following equation.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g) \qquad \Delta H = +91 \text{ kJ mol}^{-1}$$

Which of the following changes will increase the concentration of the product but decrease the yield of the reaction?

A. Addition of a catalyst and an increase in the vessel temperature.

B. A decrease in the volume of the reaction vessel.

C. A decrease in the temperature of the reaction vessel.

D. An increase in the volume of the reaction vessel.

Question 2

To adjust the pH of 10.00 mL sodium hydroxide solution from 10 to 8 by adding distilled water, the volume of water needed is

A. 10 mL

B. 90 mL

C. 990 mL

D. 1000 mL

Question 3

The pH of a 0.010 M solution of HF in water is closest to

A. 0.010

B. 2.0

C. 2.6

D. 3.1

Question 4

What energy change occurs when 3.0 g of hydrogen reacts with 14.0 g of oxygen according to the following equation?

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

A. 858 kJ of energy is absorbed

B. 858 kJ of energy is released

C. 430 kJ of energy is released

D. 250 kJ of energy is released

Question 5

For the reaction

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad \Delta H = +57.2 \text{ kJ mol}^{-1}$$

At 60°C, the K_w and pH for pure water are

	K_w	pH
A.	greater than 10^{-14}	greater than 7
B.	greater than 10^{-14}	less than 7
C.	less than 10^{-14}	greater than 7
D.	less than 10^{-14}	less than 7

Question 6

For the reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196 \text{ kJ mol}^{-1} \text{ and } K = 4.6 \text{ M}^{-1} \text{ at } 600K$$

It then follows that ΔH and K for

$$SO_3(g) \rightleftharpoons SO_2(g) + \tfrac{1}{2}O_2(g)$$

would be

A. +98 kJ mol^{-1} and 0.47 M^{½}.

B. -46 kJ mol^{-1} and 0.32 M^{½}.

C. +92 kJ mol^{-1} and 2.2 M^{½}.

D. -92 kJ mol^{-1} and 0.32 M^{½}.

Question 7

At high temperatures, carbon disulfide reacts with oxygen according to the equation

$$CS_2(g) + 3O_2(g) \rightleftharpoons CO_2(g) + 2SO_2(g)$$

In one experiment in a sealed container, the equilibrium concentrations at a certain temperature were

CS_2	0.040 M
O_2	0.050 M
CO_2	0.12 M
SO_2	0.15 M

What is the value of the equilibrium constant?

A. 1.9×10^{-3}

B. 0.037

C. 27

D. 540

Question 8

One of the equilibria in the body that keeps human 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 9

If the following solutions are mixed, in which is a reaction expected to occur?

A. iron(II) chloride and iron(II) iodide

B. iron(III) chloride and tin(II) iodide

C. tin(II) chloride and tin(IV) iodide

D. tin(IV) chloride and tin(II) iodide

Question 10

Which of the following can all be reduced by hydrogen sulfide gas?

A. $H^+(aq)$, $Fe^{2+}(aq)$, $Zn^{2+}(aq)$

B. $H_2(g)$, $Fe(s)$, $Zn(s)$

C. $Cu(s)$, $Fe^{2+}(aq)$, $Cl^-(aq)$

D. $Cu^{2+}(aq)$, $Fe^{3+}(aq)$, $Cl_2(g)$

Question 11

Ammonium perchlorate NH_4ClO_4 is one of the ingredients found in solid rocket fuel used by the Space Shuttle rockets. It decomposes according to the following equation

$$2NH_4ClO_4(s) \rightarrow Cl_2(g) + N_2(g) + 2O_2(g) + 4H_2O(g) \quad \Delta H = -295 \text{ kJ mol}^{-1}$$

The energy produced per mole of gaseous products when 955 kg of ammonium perchlorate completely decomposes is

A. 1.5×10^5 kJ

B. -1.5×10^5 kJ

C. 3.0×10^5 kJ

D. 1.20×10^6 kJ

Question 12

Electricity can be generated in many different ways. Which of the following statements about electricity generation are correct?

I Coal-fired power stations are more efficient than solar cells.
II Gas-fired power stations produce more waste than fuel cells.
III Nuclear power stations produce more air pollution than coal-fired powered stations.

A. I and II only

B. I and III only

C. II and III only

D. II only

Question 13

Most of the energy needs in the world are met by the use of fossil fuels. Fossil fuels listed in order of increasing reserves are

A. oil, gas, wood.

B. gas, coal, oil.

C. wood, coal, uranium.

D. oil, gas, coal.

Question 14

A simple galvanic cell is designed to produce a voltage of 1.5 volts. Which two half cells will theoretically produce a voltage closest to this value under standard conditions?

A. $Zn^{2+}(aq)/Zn(s)$ and $I_2(s)/I^-(aq)$

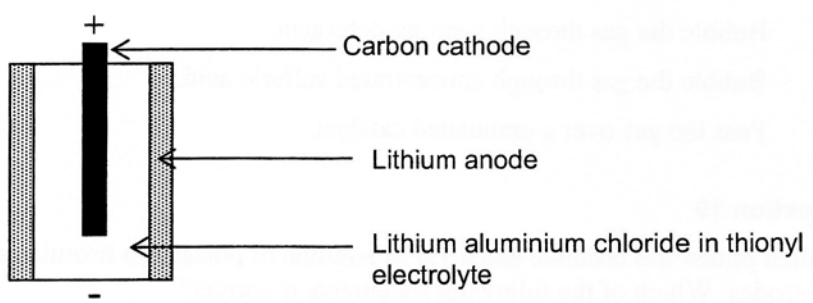
B. $Pb^{2+}(aq)/Pb(s)$ and $Cl_2(g)/Cl^-(aq)$

C. $Ni^{2+}(aq)/Ni(s)$ and $Br_2(l)/Br^-(aq)$

D. $Mg^{2+}(aq)/Mg(s)$ and $Mn^{2+}(aq)/Mn(s)$

Questions 15 and 16 refer to the following information.

The diagram below is a simplified cross-section of a lithium thionyl chloride cell.



Question 15

If the overall equation for the cell is

$$2SOCl_2(l) + 4Li(s) \rightarrow SO_2(g) + S(s) + 4LiCl(l)$$

then the reaction occurring at the cathode is

A. $Li(s) \rightarrow Li^+(l) + e^-$

B. $Li^+(l) + e^- \rightarrow Li(s)$

C. $2SOCl_2(l) + 4e^- \rightarrow SO_2(g) + S(s) + 4Cl^-(l)$

D. $SO_2(g) + S(s) + 4Cl^-(l) \rightarrow 2SOCl_2(l) + 4e^-$

Question 16

Lithium thionyl chloride cells are

A. primary cells that can be recharged.

B. secondary cells that can be recharged.

C. primary cells that cannot be recharged.

D. secondary cells that cannot be recharged.

Question 17

Salt bridges are essential components of galvanic cells. In the laboratory they are prepared by soaking filter paper strips in a salt solution. The charge is balanced in the cell by the migration of ions from the salt bridge. The most suitable salt solution is

A. potassium chloride with the chloride ions migrating towards the anode and the potassium ions migrating towards the cathode.

B. potassium chloride with the chloride ions migrating towards the cathode and the potassium ions migrating towards the anode.

C. sodium nitrate with the nitrate ions migrating towards the anode and the sodium ions migrating towards the cathode.

D. sodium nitrate with the nitrate ions migrating towards the cathode and the sodium ions migrating towards the anode.

Question 18

Release of sulfur dioxide into the atmosphere is a contributing cause of acid rain pollution. Which of the following can be used to minimise this problem?

A. Pass the gas over calcium carbonate.

B. Bubble the gas through a strong detergent.

C. Bubble the gas through concentrated sulfuric acid.

D. Pass the gas over a granulated catalyst.

Question 19

Molten potassium bromide and a 1.0 M solution of potassium bromide are separately electrolysed using graphite electrodes. Which of the following statements is correct?

A. The products formed at both the positive and negative electrodes are all different.

B. Gases form at both electrodes when 1.0 M potassium bromide is electrolysed but liquid products form when molten potassium bromide is electrolysed.

C. The products formed at both the negative electrodes are the same in both cells.

D. The products formed at the positive electrode are the same but at the negative electrode they are different.

Question 20

One method of protecting steel hulls of yachts is to hang a sacrificial anode over the side made of a more reactive metal such as zinc. If a current of 2.4×10^{-5} A flows between the two metals what is the loss of zinc in moles per second?

A. 5.0×10^{-10}

B. 2.5×10^{-10}

C. 1.2×10^{-10}

D. 8.1×10^{-9}

SECTION B – Short answer questions

Instructions for Section B

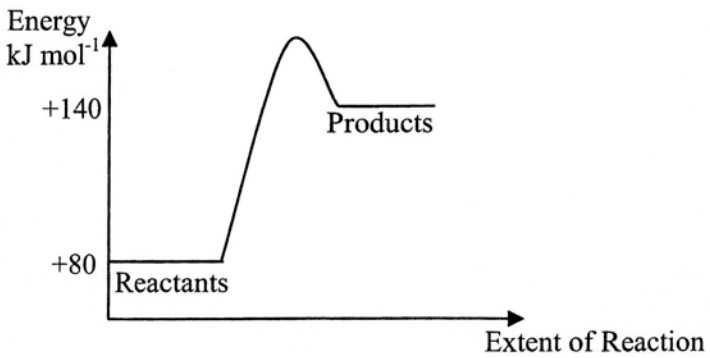
Answer **all** questions in the spaces provided.

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

Below is an energy profile diagram



a. Use the information above to calculate the ΔH value for the reaction.

1 mark

b. Will the E_A (activation energy) be greater than, less than or equal to the ΔH value?

1 mark

c. Which will be stronger, the bonds in the products or reactants? Explain your answer.

1 mark

d. What effect will the introduction of a catalyst have on the E_A?

1 mark

e. What effect will the introduction of a catalyst have on the ΔH?

1 mark

Total 5 marks

Question 2

a. 10.0 mL of water is added to 10.0 mL of 0.100 M ethanoic acid in a beaker.
Explain whether the pH of the resulting solution will increase or decrease.

1 mark

b. Write an expression K_a for the above reaction.

1 mark

c. What will be the numerical change in pH after the addition of the water?

2 marks

d. What will be the effect on K_a as dilute sodium hydroxide is added to the ethanoic acid?

1 mark

e. Write the name of a suitable indicator to monitor the pH of a titration between ethanoic acid and sodium hydroxide.

1 mark

Total 6 marks

Question 3

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

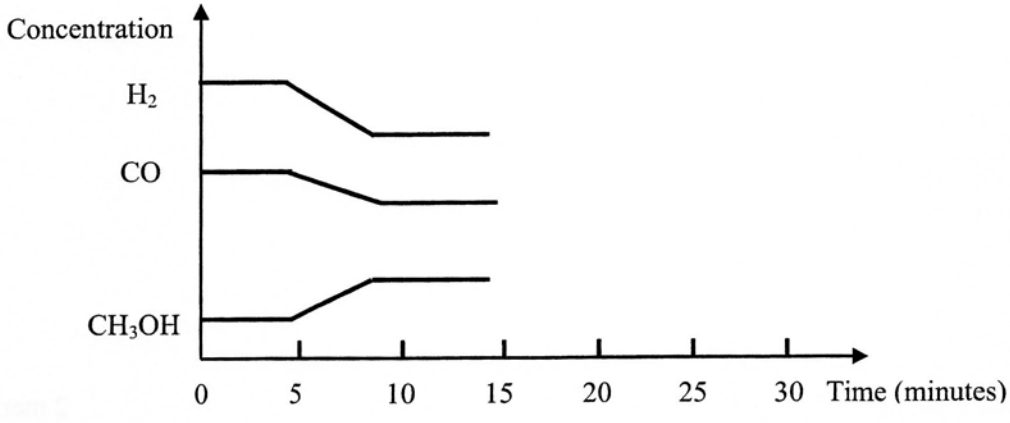
$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

Refer to the graph below.

i. After 5 minutes, what change was done to the system?

ii. Sketch on the graph what happens to the system at 15 minutes when hydrogen gas is added. The system then establishes equilibrium again at 20 minutes.

iii. Sketch on the graph what happens when the volume of the system is increased at 25 minutes and then re-establishes equilibrium at 30 minutes.



3 marks

b. Consider the exothermic equilibrium reaction carried out in a reaction vessel at 120°C between hydrogen chloride gas 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 Cl_2**
Addition of nitrogen gas at constant volume			
Increase in pressure			
The temperature is raised to 150°C.			
Steam is removed			
Addition of a catalyst			

5 marks

Total 8 marks

Question 4

The heat of combustion of sucrose can be determined by using a bomb calorimeter.
In one experiment, a current of 2.50 A was passed through the electric heater of a bomb calorimeter for 60.0 seconds at a voltage of 5.50 V causing a rise in temperature of 0.53°C.

1.50 g of sucrose was reacted with excess oxygen in the calorimeter according to the equation

$$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$$

The temperature rose from 17.30°C to 31.30°C

a. Calculate the calibration factor of the calorimeter.

1 mark

b. Calculate ΔH for the combustion of sucrose.

2 marks

c. Explain why the calculated value of ΔH for this reaction might not be the same as the published value of ΔH.

1 mark

Total 4 marks

Question 5

The molar heat of fusion ΔH_{fusion} is the heat necessary to melt one mole of a substance. When ice melts, ΔH_{fusion} for water is +6.02 kJ mol^{-1}

a. Write a complete thermochemical equation for the fusion of ice.

1 mark

b. Calculate the molar heat of fusion for water in J g^{-1}.

1 mark

c. Calculate the energy needed to melt 50.0 g of ice at 0°C .

1 mark

d. Calculate the energy needed to raise the temperature of 50.0 g of ice at 0°C to water at 25.0°C.

2 marks

e. A 93.5 g ice cube at 0°C absorbs 5.50 kJ of heat. Calculate the mass of the ice cube that remains.

2 marks

f. Give a value for $\Delta H_{freezing}$

1 mark

g. Ice at 0°C can be heated to produce water at 0°C. Explain why the temperature does not rise.

1 mark

Total 9 marks

Question 6

Triuranium octoxide (U_3O_8), found in uranium ore, can be converted to uranium dioxide (UO_2), used in nuclear power stations. This can be achieved by bubbling hydrogen gas through acid solution containing U_3O_8 powder. U_3O_8 and UO_2 are both insoluble solids.

a. What is the oxidation number of uranium in U_3O_8?

1 mark

b. Write a balanced half-equation for the reduction reaction.

1 mark

c. Write a balanced half-equation for the oxidation reaction.

1 mark

d. Write a balanced overall equation.

1 mark

e. Australia has large supplies of uranium ore, but there are no nuclear power stations in Australia.

i. Give two problems associated with possible use of nuclear power stations in Australia.

ii. Give two advantages of using nuclear power generation in Australia over traditional methods.

iii. Explain how the process of energy production in uranium is different from energy production in the Sun.

iv. Apart from nuclear, name two methods of producing energy used in Australia that do not rely on fossil fuels.

4 marks

Total 8 marks

Question 7

Ceramic Fuel Cells Limited has launched the Gennex™ fuel cell. The first unit has been installed by VicUrban, the sustainable urban development agency of the Victorian government, in a house in Epping and more installations are to follow. Known as *BlueGen* these fuel cells use natural gas.

a. Write an equation for the electrode reaction where natural gas is involved. Assume that methane is the predominant gas involved.

1 mark

b. At which electrode does this reaction occur?

1 mark

c. *BlueGen* units desulfurise the natural gas before reaction. Why is this necessary?

1 mark

d. Carbon dioxide is a by-product in this fuel cell. Explain why *BlueGen* units contribute less to greenhouse emissions than coal-fired electricity.

1 mark

e. *BlueGen* cells are known as SOFCs (solid oxide fuel cells). Why are they called this?

1 mark

Total 5 marks

Question 8

The surface of aluminium is coated with a thin film of aluminium oxide that protects it from further corrosion. To further protect aluminium objects from corrosion, they may be anodised. This is an electrolytic process that builds up the layer of surface aluminium oxide. In the anodising cell, the aluminium object is made the anode and a carbon cathode is used. Hydrogen is released at the cathode and the electrolyte is acidic.

a. Sketch a suitable cell labelling the electrodes, their polarities and the nature of the electrodes.

3 marks

Aluminium	Oxide Coating	Electrolyte
	$\Leftarrow O^{2-}$	H_2O
	$\Rightarrow Al^{3+}$	H_2O

The diagram above shows the movement of ions in the oxide coating. Two reactions occur, one at the aluminium/oxide interface and one at the oxide/electrolyte interface.
At the aluminium/oxide interface the reaction is

$$2Al(s) + 3O^{2-}(s) \rightarrow Al_2O_3 + 6e^-$$

At the oxide/electrolyte interface the reaction is

$$2Al^{3+}(s) + 3H_2O(l) \rightarrow Al_2O_3(s) + 6H^+(aq)$$

i. Write the equation for the reaction occurring at the cathode.

1 mark

ii. From the above equations derive the overall equation for anodising aluminium.

1 mark

c. An aluminium lampshade is to be anodised. It has a surface area of 1130 cm^2 and the designer wants the oxide layer to be 90.0 μm thick. The density of aluminium oxide in this instance is 3.95 g cm^{-3}.

i. Calculate the volume of aluminium oxide required.

1 mark

ii. Use the density of the aluminium oxide calculate the mass oxide needed for the anodising

1 mark

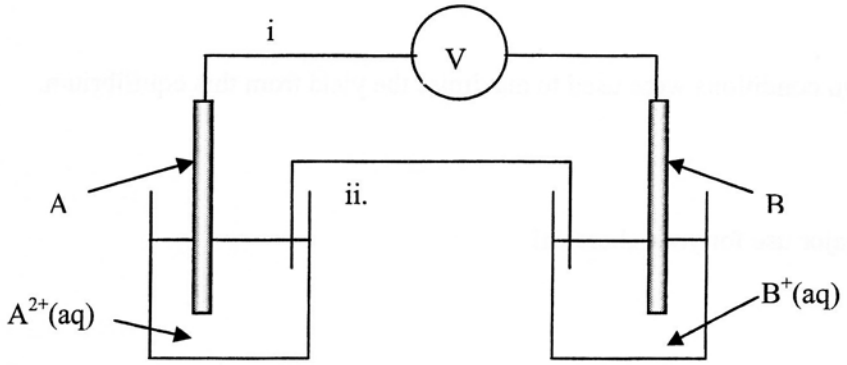
iii. A current of 2.5 amps is supplied. Calculate the time in hours that would be required to anodise the lampshade.

2 marks

Total 9 marks

Question 9

A galvanic cell was set up as shown in the diagram below. The electrodes in both cases were metals immersed in solutions of their respective metal ions. Before inserting them in the solutions, the electrodes were weighed.



After an hour the electrodes were removed, dried and reweighed. Electrode A had decreased in mass by 3.2 g while electrode B had increased in mass by 5.8 g.

a. Label the diagram to show

i. the direction in which the electrons move.

ii. the direction in which the anions move in the salt bridge.

2 marks

b.

i. Write an equation for the reaction occurring at electrode A..

ii. Write an equation for the reaction occurring at electrode B.

2 marks

c. If the electrode at B is made of silver, use the data above to identify electrode A.

2 marks

Total 6 marks

Question 10

a. **i.** Name the industrial process that you studied and write an equation for the part of the process that involves an equilibrium reaction.

ii. Explain why two conditions were used to maximise the yield from this equilibrium.

iii. Suggest one major use for your chemical.

3 marks

b. The Pidgeon process is one of the methods used to produce magnesium. It involves reduction of magnesium oxide by using silicon in the form of a ferrosilicon alloy. The iron remains as a spectator in the reaction. The reaction can be represented by the following equilibrium equation.

$$Si(s) + MgO(s) \rightleftharpoons SiO_2(s) + Mg(g)$$

and

$$Mg(g) \rightarrow Mg(s)$$

The yield is favoured by using high temperatures. What other measures could be taken to favour the yield?

2 marks

Total 5 marks

END OF QUESTION AND ANSWER BOOK