INSIGHT

Trial Exam Paper

2010

CHEMISTRY

Written examination 2

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	7	7	56
			Total 76

- 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

Increasing the temperature of a chemical reaction

A.   lowers the activation energy of the reaction.

B.   increases the energy of the reactant particles only.

C.   increases the value of ΔH for the reaction.

D.   increases the energy of the reactant and product particles.

Question 2

Which of the following changes that can be made to a chemical reaction will result in a greater **proportion** of successful collisions between reactant particles?

    I   addition of a catalyst

    II   grinding reactant lumps into a powder

    III   increasing the concentration of reactants

A.   I only

B.   II and III only

C.   I and II only

D.   I, II and III

Question 3

Which of the following statements regarding the energy changes for a particular exothermic chemical reaction is **not** correct?
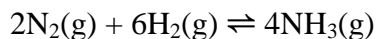
A.   The activation energy of the forward reaction is lower than the activation energy of the reverse reaction.

B.   The enthalpy value of the products is lower than the enthalpy value of the reactants.

C.   The value of the activation energy of the reverse reaction is lower than the change in enthalpy value.

D.   The forward and reverse reactions both require the absorption of some energy.

Question 4

Consider the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -91 \text{ kJ mol}^{-1}$ $K = 0.052 \text{ M}^{-2}$ at 400°C
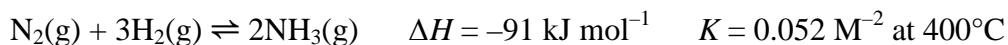
The ΔH and K values for the reaction

$2N_2(g) + 6H_2(g) \rightleftharpoons 4NH_3(g)$

will be

	ΔH	K
A.	–91	0.0027
B.	–182	0.0027
C.	–91	0.104
D.	–182	0.104

Question 5

Consider the following exothermic reaction.

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $K = 48.1$ at 460°C.

A particular reaction mixture contains the following concentrations of gases at equilibrium.
$[H_2] = 0.0345$ M, $[I_2] = 0.0835$ M, and $[HI] = 0.456$ M

The temperature of this reaction mixture is

A.   460°C
B.   greater than 460°C
C.   lower than 460°C
D.   unable to be determined.

Question 6

Which of the following changes will **not** affect the value of the equilibrium constant of a particular gaseous reaction?

I   addition of a catalyst
II   addition of a reactant
III   increasing temperature
IV   moving the reactants to a larger container

A.   I and III
B.   I, II and IV
C.   I and IV
D.   III only

Question 7

In a volumetric flask, 100.0 mL of 0.50 M HNO_3 solution is diluted to 1.00 L. In a second flask, 100.0 mL of 0.50 M CH_3COOH solution is diluted to 1.00 L. Which statement best describes the pH changes in these flasks?

A. The pH will increase in one flask and decrease in the other.

B. The pH of both flasks will change equally.

C. The pH of the HNO_3 solution will change by a greater magnitude than the pH of the CH_3COOH solution.

D. The pH of the HNO_3 solution will change by a lesser magnitude than the pH of the CH_3COOH solution.

Question 8

Which one of the following statements 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 less than 7.00 and is acidic.

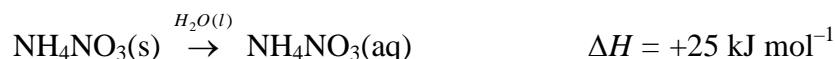**D.** Pure water at a temperature less than 25°C has a pH greater than 7.00 and is basic.

Question 9

Which of the following fuels will release the greatest energy when burnt in air?

A. 10 g of ethane

B. 10 g of propane

C. 10 g of methanol

D. 10 g of glucose

Question 10

Ammonium nitrate dissolves in water according to the equation

$$NH_4NO_3(s) \xrightarrow{H_2O(l)} NH_4NO_3(aq) \qquad \Delta H = +25 \text{ kJ mol}^{-1}$$
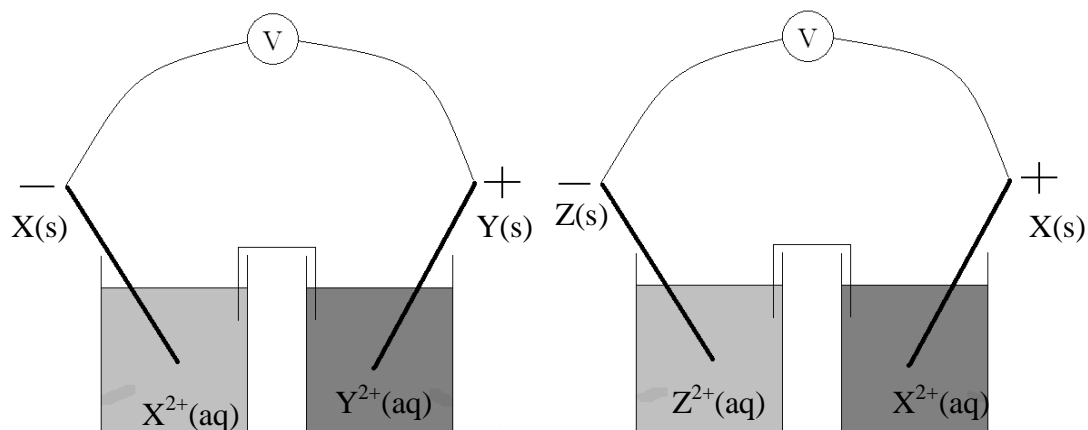
In an insulated vessel, 2.50 g of ammonium nitrate is mixed rapidly with 150 mL of water. The temperature change of the water, in °C, is closest to

A. –0.001 24

B. –0.0997

C. –1.25

D. –1.51

Question 11

Two standard galvanic cells are shown below.

The strongest reductant present in the galvanic cells is

A.   Y

**B.** Y^{2+}

C.   Z

D. Z^{2+}

Question 12

A brass ring is to be electroplated with gold. In the constructed cell, the ring is the

A.   cathode and is connected to the negative terminal of the battery.

B.   cathode and is connected to the positive terminal of the battery.

C.   anode and is connected to the negative terminal of the battery.

D.   anode and is connected to the positive terminal of the battery.

Questions 13 and 14 refer to the following information.

An **alkaline** hydrogen–oxygen fuel cell has the overall equation

$$O_2(g) + 2H_2(g) \rightleftharpoons 2H_2O(l)$$
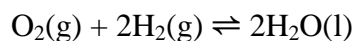
Question 13

In this fuel cell, the species reacting at the cathode would be

A. $O_2(g)$ and $H^+(aq)$
B. $H_2(g)$ only
C. $O_2(g)$ and $H_2O(l)$
**D.** $H_2(g)$ and $OH^-(aq)$

Question 14

Which one of the following statements about this fuel cell is **not** correct?

A.   The generation of electricity in this cell is more efficient than the generation of electricity by the burning of coal.
B.   The products in the cell remain in contact with the electrodes, enabling the cell to be recharged once the reactants are completely consumed.
C.   The conversion of chemical energy to electrical energy is not 100% efficient.
D.   The technology required to produce fuel cells is relatively expensive.

Questions 15 and 16 refer to the following information.

The methanol fuel cell uses methanol and oxygen to produce electricity. The half-equations are

$$CH_3OH(l) + H_2O(l) \rightarrow CO_2(g) + 6H^+(aq) + 6e^-$$
$$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$$
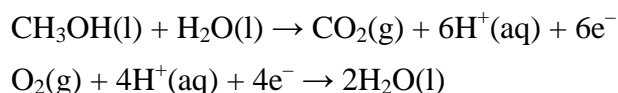
Question 15

What current, in amperes (A), is produced by the methanol fuel cell when 0.884 g of methanol is consumed in 15.0 minutes?

A.   0.494
B.   11.8
C.   17.8
D. 1.07×10^3

Question 16

The species acting as a reductant in this fuel cell is

A. CH_3OH
B. O_2
C. CO_2
D. H_2O

Question 17

Four different experiments are described below.

I   Electrolysis of 1.0 M copper(II) chloride.

II   A nickel rod is placed in a beaker of copper(II) sulfate.

III   Electrolysis of molten copper(II) chloride.

IV   A silver rod is placed in a beaker of copper(II) sulfate.

The experiments that would produce copper metal are

A.   all of them.

B.   I, II and III

C.   II, III and IV

D.   I, III and IV

Question 18

Which of the following statements about cathodes in galvanic and electrolytic cells is correct?

A.   The cathode is always the positive electrode.

B.   The cathode is always the same species as the oxidant.

C.   Electrons always move towards the cathode.

D.   The cathode is the site of oxidation in one cell and the site of reduction in the other.

Question 19

A mixture of 1.0 M NaI, 1.0 M $AlCl_3$ and 1.0 M KCl was electrolysed. Which of the following reactions is most likely to occur at the cathode?

A. $Na^+(aq) + e^- \rightarrow Na(s)$

B. $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

C. $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

D. $2I^-(aq) \rightarrow I_2(s) + 2e^-$

Question 20

Which of the following factors are important considerations in the design of an electrolytic cell for the commercial production of sodium?

I   using electrolytes that are cheap and readily available

II   using a molten electrolyte

III   keeping the products separated from each other

IV   using electrodes that are unreactive

A.   I, III and IV

B.   I, II and IV

C.   I and IV

D.   All of them.

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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

a. Use information provided in the VCE data booklet to write an overall balanced equation in which $Fe^{2+}(aq)$ is a reactant and provides a voltage of 1.90 V under standard conditions.

_____

_____

_____

1 mark

b. A rod of iron is added to a mixture of iron(III) nitrate and tin(II) chloride under standard conditions and a reaction is observed. Give the formula of the species acting as the oxidant in the observed reaction.

_____

1 mark

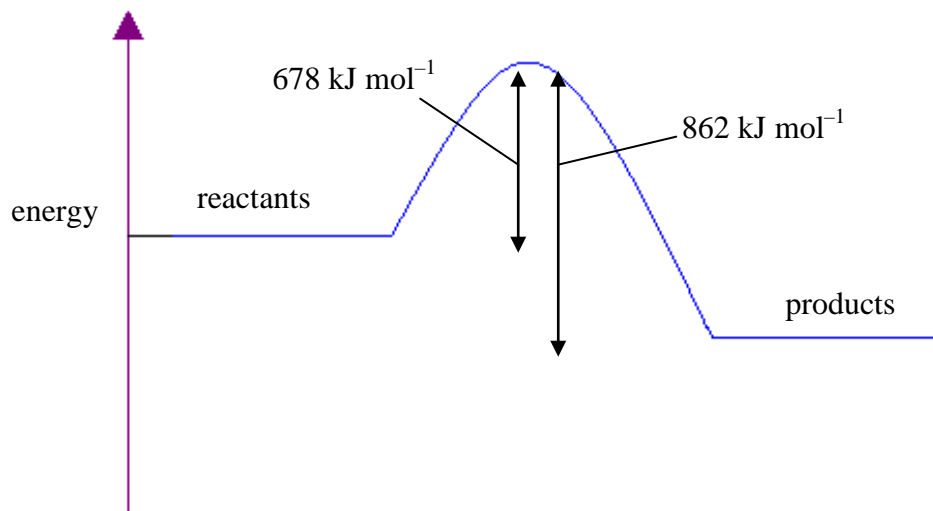**c.** List the conditions under which the electrochemical series is valid.

_____

_____

1 mark

Total 1 + 1 + 1 = 3 marks

Question 2

Hydrogen gas reacts with chlorine gas to produce gaseous hydrogen chloride. The diagram below shows the energy profile diagram of the changes that occur in chemical energy as the reaction proceeds.

a.   Write a thermochemical equation for the reaction between hydrogen and chlorine.

_____

_____

3 marks

b.   What would be the effect on the two energy values shown on the diagram by the addition of a catalyst?

_____

_____

2 marks

Total 3 + 2 = 5 marks

Question 3

Consider the expression for K below for a reaction in which all species are gases.

$$K = \frac{[NO]^2[Cl_2]}{[NOCl]^2} = 1.6 \times 10^{-5} \text{ at } 35°C$$

a. Write a balanced chemical equation for this reaction.

_____

_____

2 marks

b. Calculate the value of K for the reverse reaction.

_____

_____

_____

1 mark

c. An amount of NOCl is added to an empty 1.50 L container. The reaction is allowed to come to equilibrium, at which point 0.0156 mol of Cl_2 is present at 35°C.

i. Determine the concentration, in M, of Cl_2 at equilibrium.

_____

_____

1 mark

ii. Determine the concentration, in M, of NO at equilibrium.

_____

_____

_____

2 marks

iii. Determine the concentration, in M, of NOCl at equilibrium.

_____

_____

_____

_____

_____

_____

_____

2 marks

iv. Determine, in mol, the amount of NOCl initially added to the container.

_____

_____

_____

_____

_____

3 marks

Total 2 + 1 + 8 = 11 marks

Question 4

The energy content of fuels and food can be determined using calorimetry. The energy content of a new brand of a wheat cereal was determined by a series of experiments using a bomb calorimeter. The calorimeter was first calibrated by combusting 0.125 g of propane in the calorimeter and measuring the resultant temperature rise. The following data was collected.

Mass of propane = 0.125 g

Temperature rise = 2.35°C

a. Use the data above to calculate the calibration factor, in kJ °C^{-1}, for this calorimeter.

_____

_____

_____

_____

_____

_____

_____

_____

3 marks

b. A mass of 0.286 g of the dried wheat cereal was then burnt in the calorimeter and a temperature change of 1.24°C was recorded. Calculate the energy content of the cereal, in kJ g^{-1}.

_____

_____

_____

_____

2 marks

c. Why is the energy content of the cereal given in kJ g^{-1} rather than in kJ mol^{-1}?

_____

_____

1 mark

d. Give two possible experimental errors that that would result in the calculated value for energy content being lower than it actually is.

_____

_____

_____

2 marks

Brown coal is an important fuel source in Victoria.

e.   **i.**   Name the main use of brown coal in Victoria.

_____

1 mark

   ii.   State two advantages of using brown coal for this purpose.

_____

_____

2 marks

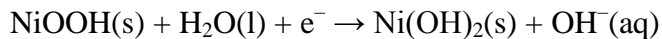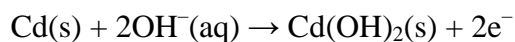   **iii.**   State two disadvantages of using brown coal for this purpose.

_____

_____

2 marks

Total 3 + 2 + 1 + 2 + 5 =13 marks

Question 5

The nickel–cadmium cell is a rechargeable cell used in mobile phones, laptop computers and many other portable electronic devices.

The two relevant half-equations for the discharge reaction are

$$Cd(s) + 2OH^-(aq) \rightarrow Cd(OH)_2(s) + 2e^-$$

$$NiOOH(s) + H_2O(l) + e^- \rightarrow Ni(OH)_2(s) + OH^-(aq)$$

a. Will the pH in the region immediately surrounding the anode increase or decrease as the cell discharges? Give a reason for your answer.

_____

_____

1 mark

b. **i.** Write a balanced overall equation for the reaction that occurs when the cell is being recharged.

_____

_____

1 mark

ii. What is the polarity of the anode when the cell is being recharged?

_____

1 mark

c. A particular secondary cell delivers 1.96×10^5 J of energy per mole of cadmium. At what voltage is this cell operating?

_____

_____

_____

_____

_____

2 marks

Total $1 + 2 + 2 = 5$ marks

Question 6

A beaker containing 250 mL of 1.00 M $CuSO_4$(aq) is electrolysed using carbon rods.

a. Write half-equations for the oxidation and reduction reactions.

    i. oxidation reaction _____

    ii. reduction reaction _____

<div align="right">2 marks</div>

b. As electrolysis proceeds, the blue colour of the solution fades. How long, in seconds, would it take the Cu^{2+} to reach a concentration of 0.347 M if the rods are connected to a power source with a current of 4.50 A and an approximate voltage of 5 V?

_____

_____

_____

_____

_____

_____

_____

<div align="right">4 marks</div>

<div align="right">Total 2 + 4 = 6 marks</div>

Question 7

A student investigating equilibrium uses mixtures of NO_2 and N_2O_4, which react according to the equation given below.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ $\qquad$ ΔH is negative

Three samples of the mixture at equilibrium undergo a change.

a. State Le Chatelier's Principle.

_____

_____

_____

2 marks

b. Complete the table below to indicate the effect of each change made by the student to the mixture on the rate of the reaction and the amount, in mol, of N_2O_4.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ $\qquad$ ΔH is negative

	Is the rate of the reaction increased, decreased or unchanged?	Is the amount, in mol, of N_2O_4 when equilibrium is re-established increased, decreased or unchanged?
Sample 1: The reaction mixture is heated.		
Sample 2: The mixture is moved to a container double the size of the first.		
Sample 3: More N_2O_4 gas is added without changing the volume.		

6 marks

c. In VCE Chemistry this year you have studied in detail the industrial production of a chemical.

i. Give the name and a major use for the chemical you studied.

_____

1 mark

ii.   Fill in the table below about the conditions used for a selected equation in the production of your chemical. **Fill in the part of the table relevant to your chosen chemical only.**

Chemical & selected equation	Would a **high or low** pressure be expected to maximise yield?	Would a **high or low** temperature be expected to maximise yield?
Ammonia $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$		
Ethene $C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$		
Nitric acid $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$		
Sulfuric acid $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$		

2 marks

iii.   Give a safety precaution that is followed by workers in the factories where your chosen chemical is produced, as well as the reason for this precaution being taken.

Safety precaution _____

Reason _____

_____

2 marks

Total 2 + 6 + 5 = 13 marks

END OF QUESTION AND ANSWER BOOK