CSE CENTRE FOR STRATEGIC EDUCATION

Leading educational thinking and practice

IARTV

STUDENT:	TEACHER:

CSE TEST – OCTOBER 2007

YEAR 11 - 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	Suggested times (minutes)
A	20	20	20	24
B	8	8	54	66
			Total 74	90

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

Materials
- Question and answer book of 15 pages with a detachable data sheet in the centrefold.
- Answer sheet for multiple choice questions.

Instructions
- Detach the data sheet from the centre of this book during reading time.
- Write your **name** in the space provided above **and** on the multiple choice answer sheet.
- All written responses must be in English.

At the end of the test
- 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 other electronic communication devices into the test room.

72CHE11QA

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

In which one of the following processes is carbon dioxide removed from the atmosphere?

A. Respiration

B. Combustion

C. Photosynthesis

D. Decay of plant and animal matter

Question 2

Which one of the following gases is **not** considered to be a greenhouse gas?

A. Nitrogen

B. Methane

C. Water vapour

D. Carbon dioxide

Question 3

Which major group of chemicals is associated with the depletion of the ozone layer?

A. chlorofluorocarbons

B. sulfuric acid and nitric acid

C. argon and other inert gases

D. carbon dioxide and water vapour

Question 4

Which one of the following **does not follow** the principles of green chemistry?

A. To prevent waste rather than to clean up waste.

B. To replace toxic chemicals with safer alternatives.

C. To take into account energy requirements for chemical processes.

D. To use processes which incorporate into the products as few of the reactants' atoms as possible.

Question 5

A flask holds 1 mole of helium at a pressure of 100 kilopascals. Another 4 mole of helium is added, at constant temperature. The pressure, in kilopascals, inside the flask is now

A. 20

B. 100

C. 400

D. 500

Question 6

Using the symbols P for pressure, V for volume and T for absolute temperature, which one of the following expressions correctly combines Boyle's Law and Charles' Law?

A. $P_1V_1 = P_2V_2$

B. $V_1T_1 = V_2T_2$

C. $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$

D. $\dfrac{V_1T_1}{P_1} = \dfrac{V_2T_2}{P_2}$

Question 7

Which one of the following statements is **not consistent** with the kinetic molecular theory?

A. The forces of attraction between gas molecules are negligible.

B. All particles at the same temperature have the same kinetic energy.

C. There is negligible energy loss in collisions between gas molecules.

D. The volume occupied by a gas molecule is negligible compared with the total volume of the gas.

Question 8

The mass of 4.90 L of nitrogen gas (N_2) at SLC is

A. 0.175 g

B. 2.80 g

C. 4.90 g

D. 5.60 g

Question 9

A beaker contains 500 mL of hydrochloric acid solution with a pH of 1.0. The concentration of hydrogen ions in the solution is

A.   0.05 M

B.   0.10 M

C.   0.20 M

D.   1.0 M

Question 10

0.040 g of sodium hydroxide (NaOH) is dissolved in water, to form 10.0 L of solution.

The pH of this solution is

A.   11.0

B.   10.0

C.   4.0

D.   3.0

Question 11

If more water is added to the sodium hydroxide solution in Question 10

A.   the concentration of the hydroxide ions increases, and the pH increases.

B.   the concentration of the hydroxide ions increases, and the pH decreases.

C.   the concentration of the hydroxide ions decreases, and the pH increases.

D.   the concentration of the hydroxide ions decreases, and the pH decreases.

Question 12

A beaker contains 20 mL of 0.050M KNO_3 solution. The volume of water that must be added to dilute the solution to a concentration of 0.0010 M is

A.   100 mL

B.   400 mL

C.   980 mL

D.   1000 mL

Question 13

Which one of the following equations represents an acid-base reaction?

A. $H_2CO_3(aq) \rightarrow H_2O(g) + CO_2(g)$

B. $2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$

C. $NH_3(aq) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

D. $2AgNO_3(aq) + CaCl_2(aq) \rightarrow 2AgCl(s) + Ca(NO_3)_2(aq)$

Question 14

Which one of the following equations represents a redox reaction?

A. $H_2CO_3(aq) \rightarrow H_2O(g) + CO_2(g)$

B. $2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$

C. $NH_3(aq) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

D. $2AgNO_3(aq) + CaCl_2(aq) \rightarrow 2AgCl(s) + Ca(NO_3)_2(aq)$

Question 15

The molar volume of argon at STP is 22.4 L. If the pressure, in kiloPascals, is doubled, and the temperature, in Kelvin, is halved, the molar volume of argon under the new conditions is

A. 5.6 L

B. 22.4 L

C. 44.8 L

D. 89.6 L

Question 16

A sealed cylinder contains gas at a pressure of 50 kPa and a temperature of 50 °C. If the temperature is increased to 100 °C, the new pressure is closest to

A. 25 kPa

B. 50 kPa

C. 58 kPa

D. 100 kPa

Question 17

In the reaction $2Fe^{2+}(aq) + Br_2(aq) \rightarrow 2Fe^{3+}(aq) + 2Br^-(aq)$

A.   bromine is being reduced, and is acting as an oxidant.

B.   bromine is being oxidised, and is acting as an oxidant.

C.   bromine is being reduced, and is acting as a reductant.

D.   bromine is being oxidised, and is acting as a reductant.

Question 18

Which of the following statements regarding carbon dioxide is **incorrect**?

A.   It is denser than air.

B.   It is slightly soluble in water.

C.   It does not support combustion.

D.   It forms a basic oxide when added to water.

Question 19

When barium chloride solution, $BaCl_2$ (aq), is added to sodium sulfate solution, Na_2SO_4(aq), a white precipitate of barium sulfate forms. The spectator ions in this reaction are

A.   sodium ions and sulfate ions.

B.   sodium ions and chloride ions.

C.   barium ions and sulfate ions.

D.   barium ions and chloride ions.

Question 20

When sodium hydrogencarbonate reacts with hydrochloric acid, the products are

A.   sodium chloride, carbon dioxide, and water

B.   sodium chloride, carbon dioxide, and hydrogen

C.   sodium carbonate, hydrogen, and chlorine

D.   sodium carbonate, carbon dioxide, and chlorine

END OF SECTION A

SECTION B – Short answer questions

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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 $H_2(g)$; $NaCl(s)$

</div>

Question 1

(a) The diagram below represents an ionic solid in the process of forming an aqueous solution. A cation and an anion have left the surface of the solid.

On the diagram sketch one water molecule showing the orientation of its atoms when it is attracted to the cation, and a second water molecule showing the orientation of its atoms when it is attracted to the anion.
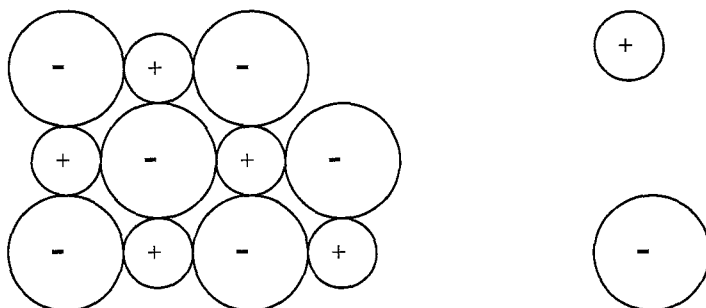
2 marks

(b) Ethanol, C_2H_5OH, is soluble in water. Its structural formula is shown below. Name the type of bonding between ethanol and water when ethanol dissolves in water, and identify the atoms involved.

_____

_____
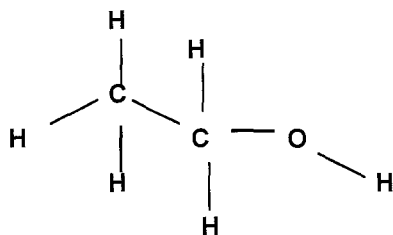
2 marks

Total 4 marks

Question 2

Sulfur dioxide reacts with water to produce a solution known as sulfurous acid, H_2SO_3. When it forms in the atmosphere, the solution is a component of acid rain.

(a) Write an equation for the reaction.

_____

1 mark

(b) Sulfurous acid is a **weak** acid. Explain what this term means.

_____

1 mark

(c) Sulfurous acid is a **diprotic** acid. Explain, using two relevant equations, what this term means.

_____

_____

_____

3 marks

(d)   The hydrogensulfite ion, HSO_3^- is **amphiprotic.** Write the chemical formula of the

(i) conjugate acid of the hydrogensulfite ion   _____

(ii) conjugate base of the hydrogensulfite ion _____

2 marks

(e)   The main sources of sulfur dioxide emissions are from smelters producing metals such as copper and lead from their ores, and from coal fired power stations. State one principle of green chemistry, and describe how it could be used to reduce sulfur dioxide emissions.

_____

_____

_____

_____

_____

2 marks

Total 9 marks

Question 3

(a) Silver nitrate is formed in the reaction between pure silver and concentrated nitric acid.

The equation for this reaction is

$$Ag(s) + 2HNO_3(aq) \rightarrow AgNO_3(aq) + NO_2(g) + H_2O(l)$$

(i) Calculate the amount, in mol, of silver in a 1.00 kg bar of pure silver.

_____

_____

(ii) Calculate the amount, in mol, of 14.0 M nitric acid required to react with 1.00 kg of silver.

_____

_____

(iii) Calculate the volume, in L, of 14.0 M nitric acid required to react with 1.00 kg of silver.

_____

_____

3 marks

(b) The equation for the reaction between aluminium and bromine is:

$$2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$$
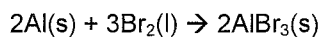
(i) Calculate the amount, in mol, of aluminium in 6.00 g

_____

_____

(ii) Calculate the amount, in mol, of bromine in 12.0 g
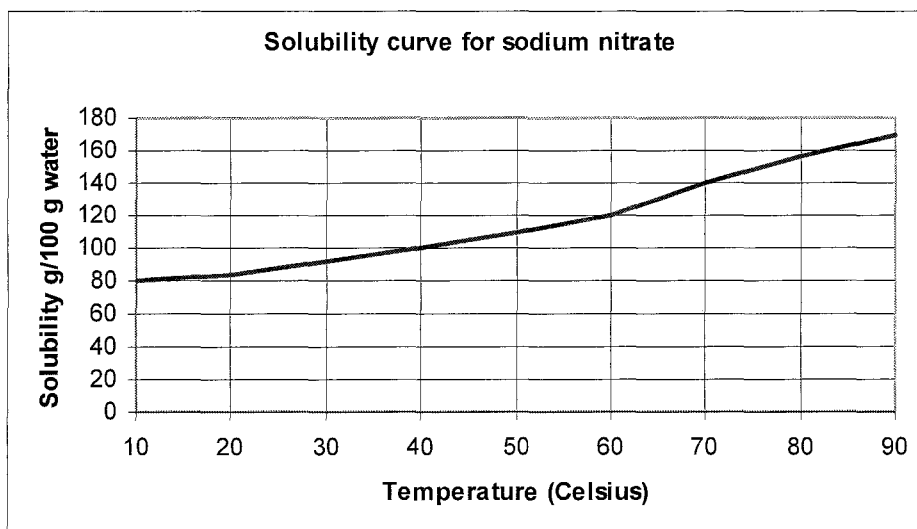
_____

_____

(iii) State the reactant in excess when 6.00 g of aluminium is added to 12.0 g of bromine, and allowed to react. Calculate the amount, in mol, by which the reactant is in excess.

_____

_____

_____

_____

4 marks

Total 7 marks

Question 4

The graph below represents the solubility of sodium nitrate, $NaNO_3$, in water at different temperatures.

Solubility curve for sodium nitrate

(a) At what temperature would 80 g of sodium nitrate form a saturated solution in 80 mL of water?

_____

                                                                                                      1 mark

(b) What mass of sodium nitrate should be added to 250 mL of water at 60 $^{\circ}$C to form a saturated solution?

_____

                                                                                                      2 marks

(c) 125 g of sodium nitrate is stirred into 100 g of water at 70 $^{\circ}$C. State whether the solution that forms is saturated, unsaturated, or supersaturated.

_____

                                                                                                      1 mark

(d) The solution was then quickly cooled to 40 $^{\circ}$C and no crystals formed. State whether the solution now is saturated, unsaturated, or supersaturated.

_____

                                                                                                      1 mark

(e) If the solution then crystallised, still at 40 $^{\circ}$C, what mass of crystals should form?

_____

                                                                                                      2 marks

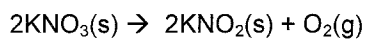   **Total 7 marks**

Question 5

(a) Oxygen is produced in large quantities in an industrial process that uses the fractional distillation of liquid air. Describe how the oxygen is separated from nitrogen in this process.

_____

_____

_____

_____

_____

_____

_____

3 marks

(b) Oxygen can be produced in the laboratory when potassium nitrate decomposes on heating according to the equation:

$$2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$$

If 1.01 g of potassium nitrate was decomposed,

(i) Calculate the amount, in mol, of oxygen produced.

_____

_____

_____

2 marks

(ii) Calculate the volume, in L, occupied by the oxygen if the reaction was carried out under SLC conditions.

_____
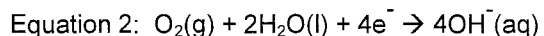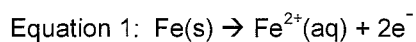
1 mark

(iii) Calculate the volume, in L, occupied by the oxygen if the reaction was carried out at 15 °C and 100 kPa pressure.

_____

_____

_____

_____

2 marks

Total 8 marks

Question 6

(a) The corrosion of iron can be represented by the following partial ionic equations.

Equation 1: $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

Equation 2: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

(i) Which equation represents the oxidation step? _____

(ii) Combine the two partial ionic equations to write a balanced overall ionic equation to represent the corrosion of iron.

_____

(iii) Corrosion of iron occurs more quickly in a salty environment, for example near the sea. Explain the role of salt in the corrosion process.

_____

4 marks

(b) The following table contains the results recorded by a student who was trying to determine the order of reactivity of metals. The experiment consisted of placing a small piece of metal in the aqueous solutions of the nitrates of the other metals in the test. An observed reaction is recorded as a tick (✔). A cross means no reaction was observed.

	Ag^+	Co^{2+}	Pb^{2+}	Zn^{2+}
Ag		X	X	X
Co	✔		✔	X
Pb	✔	X		X
Zn	✔	✔	✔	

(i) From the results in this table, which metal ion is the strongest oxidant? Give an explanation for your choice.

_____

_____

(ii) List the metals in order of decreasing reducing strength.

_____

(iii) Write an ionic equation for the reaction between Ag^+ and Co

_____

4 marks

Total 8 marks

Question 7

Argon gas is contained in a syringe with a movable plunger that can be used to increase or decrease the volume of gas in the cylinder. A pressure gauge attached to the end of the syringe measures the pressure of the gas inside the cylinder.

Movable plunger   Syringe
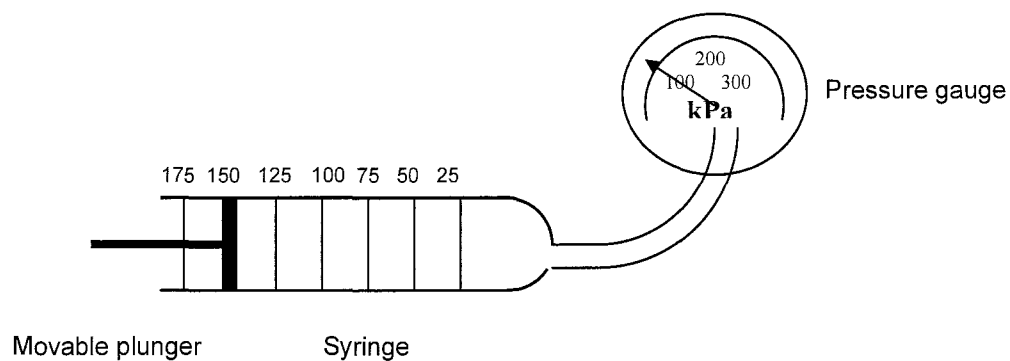
(a) The syringe contains 150.0 mL of argon gas at a pressure of 100 kPa and a temperature of 20 $^\circ$C. Calculate the amount, in mol, of argon present in the syringe.

_____

_____

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

(b) The piston can be pushed into the syringe to compress the gas. Calculate the volume of argon when the pressure gauge reads 200 kPa. The temperature remains constant throughout.

_____

_____

_____
<div align="right">1 mark</div>

(c) Use the kinetic molecular theory to explain why the gas pressure changes when its volume is compressed at constant temperature.

_____

_____

_____
<div align="right">2 marks</div>
<div align="right">**Total 5 marks**</div>

Question 8

(a) Nitrogen is circulated through the biosphere by a series of processes called the nitrogen cycle. An important process in the nitrogen cycle is called nitrogen fixation.
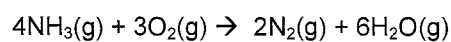
(i) What is meant by the term "nitrogen fixation"?

_____

_____

(ii) Describe a process by which nitrogen is fixed naturally, i.e. not as a result of human activity.

_____

_____

(iii) Describe a process by which nitrogen is fixed as a result of human activity.

_____

_____

3 marks

(b) Ammonia burns in air, represented by the equation

$$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$$

For the following questions assume that the reaction takes place under conditions of constant pressure and temperature.

(i) 40 L of ammonia and 30 L of oxygen are initially added to the reaction vessel and allowed to react. Calculate the total volume of gases remaining after the reaction.

_____

_____

(ii) 20 L of ammonia and 30 L of oxygen are initially added to the reaction vessel and allowed to react. Calculate the total volume of gases remaining after the reaction.

_____

_____

_____

3 marks

Total 6 marks

END OF SECTION B

END OF QUESTION BOOK