



VCE Unit 2 Chemistry Examination
Semester 2 2012
Question and Answer Booklet

Student Name: _____

Time allowed: **Reading time 15 minutes**

Writing time 120 minutes

Instructions

Please ensure that you write your name and circle your teacher's name in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.

Section A questions should be answered on the answer sheet provided.

Section B questions should be answered in the spaces provided in this booklet.

Working space is provided throughout this booklet.

Data page is included and needs to be returned at the end of the exam.

All written responses should be in English.

At the end of the task place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

Number of questions	Number of questions to be answered	Total marks
Section A: Multiple choice	30	30
Section B: Short Answer	9	73

SECTION A: MULTIPLE-CHOICE QUESTIONS (30 marks, 40 minutes)

This section contains 30 multiple choice questions.

For each question choose the response that is correct or that best answers the question.

Indicate your answer **on the answer sheet provided**.

Choose only **one** answer for each 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

The amount of ions, in mol, in 200 mL of an aqueous solution of 0.40 M potassium fluoride would be

- A. 0.040
- B. 0.080
- C. 0.160
- D. 0.200

Question 2

Which of the following is the conjugate acid of HCO_3^- ?

- A. H_2CO_4
- B. H_2CO_3
- C. CO_3^{2-}
- D. HCO^{2-}

Question 3

During a redox reaction the dichromate ion, $\text{Cr}_2\text{O}_7^{2-}$ changes to the chromium ion, Cr^{3+} . For this reaction which statement is true?

- A. chromium atoms have gained electrons and reached a lower oxidation state
- B. chromium atoms have gained electrons and reached a higher oxidation state
- C. chromium atoms have lost electrons and reached a high oxidation state
- D. chromium atoms have lost electrons and reached a high oxidation state

Question 4

Even though rainwater in Melbourne is unpolluted it is still slightly acidic. This is primarily due to the partial dissolution of which atmospheric gas?

- A. nitrogen dioxide
- B. sulphur dioxide
- C. carbon dioxide
- D. oxygen

Question 5

Consider the following chemical equation: $A + 2B \rightarrow 3C$

What is the amount, in mol, of C that would be produced if 6.0 mol of A reacted with 4.0 mol of B?

- A. 2.0
- B. 3.0
- C. 4.0
- D. 6.0

Question 6

Which of the following solutions contains the smallest amount of H_3O^+ ions?

- A. 10 mL of 0.20 M sulphuric acid
- B. 10 mL of 0.20 M nitric acid
- C. 20 mL of 0.40 M ethanoic acid
- D. 20 mL of 0.40 M hydrochloric acid

Question 7

A household cleaning product was found to have a pH of 10.0. The H_3O^+ concentration is most likely to be

- A. $10^{-10.0}$ M
- B. $10^{-4.0}$ M
- C. $10^{10.0}$ M
- D. $10^{4.0}$ M

Question 8

Which one of the following species is the most abundant in an aqueous solution of the weak acid, CH_3COOH ?

- A. CH_3COOH
- B. CH_3COO^-
- C. OH^-
- D. H_3O^+

Question 9

Which of the following best explains why pure water is a very poor conductor of electricity?

- A. The intermolecular hydrogen bonding requires a large amount of energy to disrupt it.
- B. Water molecules undergo self-ionisation to a very small extent only
- C. The latent heat of vaporisation of water is very high compared to many other liquids
- D. Only very few electrons can escape the covalent bonds in water molecules and become delocalised

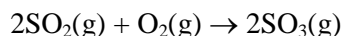
Question 10

When a piece of metal S is placed into a green coloured solution of TCl_2 , the metal develops a coating and the solution colour lightens. A valid conclusion could be that

- A. chloride ions, Cl^- , are generally inert during chemical reactions
- B. the S^{2+} ions are more easily oxidised than T^{2+} ions
- C. metal S is more easily reduced than metal T
- D. metal T is more reactive than S

Question 11

If 30 L of sulphur dioxide was completely reacted with excess oxygen according to the following equation



what volume of sulphur trioxide would form at STC?

- A. 0 L
- B. 24.5 L
- C. 30 L
- D. 60 L

Question 12

Which of the following lists contains only amphoteric substances?

- A. H_2O , HCO_3^- , HPO_4^{2-} , H_2SO_4
- B. $H_2PO_4^-$, HCl , SO_4^{2-} , CH_3COO^-
- C. NH_4^+ , H^+ , PO_4^{3-} , OH^-
- D. HSO_4^- , $H_2PO_4^-$, HCO_3^- , H_2O

Question 13

When oxygen atoms become oxide ions,

- A. each oxygen atom accepts one electron.
- B. oxidation has occurred.
- C. protons are transferred from the oxygen atoms.
- D. the oxygen atom acts as an oxidant.

Question 14

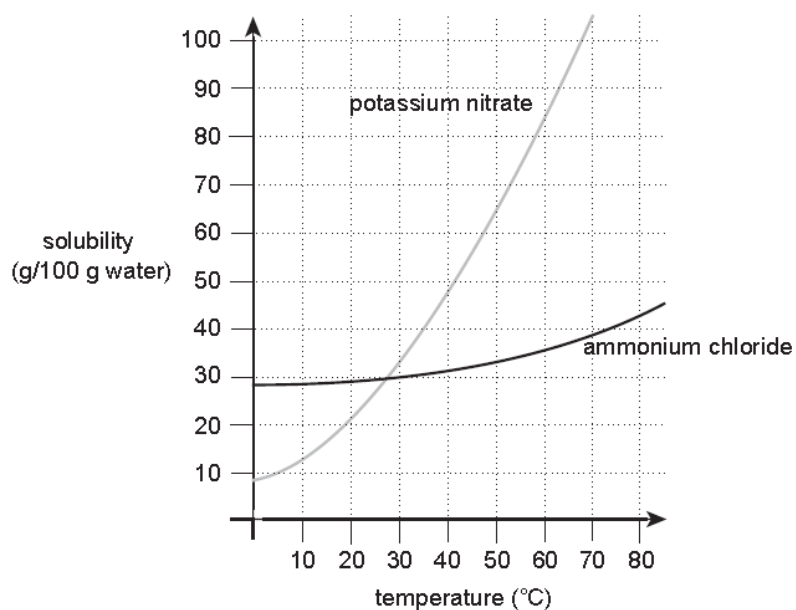
Identical masses of the gases NH_3 and PH_3 were placed into separate containers, A and B, respectively. Both containers had the same volume and were at the same temperature.

Which one of the following statements concerning the two gases is correct?

- A. The average kinetic energy of the particles in both containers is the same
- B. The pressure in container B is higher than the pressure in container A
- C. The average speed of the molecules in both containers is the same
- D. The number of gas molecules in container A is less than the number in container B

Question 15

The solubility curves for two compounds are shown in the graph below



Saturated solutions of each solute were made, each using 50 grams of water, at the temperature where their solubilities are equivalent. Both solutions were then heated to 60 °C.

What mass of each solute must be added to the 60 °C solutions to achieve saturation of each solution?

- | | ammonium chloride | potassium nitrate |
|----|-------------------|-------------------|
| A. | 6 | 54 |
| B. | 3 | 27 |
| C. | 36 | 84 |
| D. | 18 | 42 |

Question 16

Which of the following is not a redox reaction?

- A. $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
- B. $\text{Pb}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
- C. $\text{O}_3(\text{g}) + 2\text{I}^-(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
- D. $\text{O}_3(\text{g}) + 2\text{I}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{I}_2(\text{aq}) + 3\text{OH}^-(\text{aq})$

Question 17

Deionised water is rarely found in the natural environment because

- A. water is immiscible with non-polar liquids
- B. rain is deionised as it flows over rocks
- C. water is purified by evaporation to form clouds
- D. water is an excellent solvent

Question 18

When in an aqueous solution, which of the following species is least likely to form a chemical bond to a metal ion?

- A. NH_4^+
- B. NH_3
- C. H_2O
- D. F^-

Question 19

Which of the following metals could not be used as the anode in the sacrificial electrochemical protection of a tin cathode?

- A. magnesium
- B. zinc
- C. lead
- D. iron

Question 20

An unknown substance has a relatively high melting point and conducts electricity both as a solid and a liquid. The bonding holding this substance together is most likely to be

- A. ionic
- B. covalent
- C. metallic
- D. dipole-dipole

Question 21

The equation for aluminium metal production is: $2\text{Al}_2\text{O}_3(\text{s}) + 3\text{C}(\text{s}) \rightarrow 4\text{Al}(\text{l}) + 3\text{CO}_2(\text{g})$

The percentage atom economy of this process is closest to

- A. 32 %
- B. 45 %
- C. 53 %
- D. 78 %

Question 22

Which of the following equations best represents the complete combustion of octane, C_8H_{18} , in excess oxygen?

- A. $\text{C}_8\text{H}_{18(\text{l})} + 8\text{O}_{2(\text{g})} \rightarrow 8\text{CO}_{(\text{g})} + 9\text{H}_{2(\text{g})}$
- B. $\text{C}_8\text{H}_{18(\text{l})} + 4\text{O}_{2(\text{g})} \rightarrow 8\text{CO}_{(\text{g})} + 9\text{H}_{2(\text{g})}$
- C. $2\text{C}_8\text{H}_{18(\text{l})} + 25\text{O}_{2(\text{g})} \rightarrow 16\text{CO}_{2(\text{g})} + 18\text{H}_2\text{O}_{(\text{g})}$
- D. $2\text{C}_8\text{H}_{18(\text{l})} + 17\text{O}_{2(\text{g})} \rightarrow 16\text{CO}_{(\text{g})} + 18\text{H}_2\text{O}_{(\text{g})}$

Question 23

A standard solution is usually prepared in a

- A. volumetric flask
- B. conical flask
- C. beaker
- D. measuring cylinder

Question 24

Which list correctly orders the strength of bonding interactions?

- A. dispersion forces > dipole-dipole forces > hydrogen bonding > ionic bonding
- B. ionic bonding > dipole-dipole forces > hydrogen bonding > dispersion forces
- C. ionic bonding > hydrogen bonding > dipole-dipole forces > dispersion forces
- D. hydrogen bonding > dispersion forces > ionic bonding > dipole-dipole forces

Question 25

Which one of the following salts is insoluble in water?

- A. lead chloride
- B. ammonium chloride
- C. potassium chloride
- D. magnesium chloride

Question 26

Which one of the following covalent molecules would have a triangular pyramidal shape?

- A. NH_3
- B. CH_4
- C. H_2O
- D. HF

Question 27

Which electronic configuration is representative of the most reactive metal?

- A. $1s^2 2s^2 2p^6 3s^1$
- B. $1s^2 2s^2 2p^6 3s^2$
- C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
- D. $1s^2 2s^2 2p^6 3s^1 3p^6 4s^2$

Question 28

Which of the following atmospheric gases has the least impact on the enhanced greenhouse effect?

- A. CH_4
- B. CO_2
- C. N_2O
- D. N_2

Question 29

Which of the following liquids is least likely to conduct electricity?

- A. molten potassium bromide
- B. hexane
- C. mercury
- D. an aqueous solution of sodium sulphate

Question 30

The relative atomic mass of magnesium is 24.31. The most important reason why it is not a whole number is that

- A. magnesium atoms lose electrons when they react
- B. the relative atomic mass given is only an approximation
- C. not all atoms of magnesium have the same number of neutrons
- D. the mass of the magnesium atom is compared to the mass of the ^{12}C isotope

SECTION B: SHORT-ANSWER QUESTIONS (73 marks, 80 minutes)

This section contains 9 short-answer questions. 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;
- 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.
- include appropriate units for all quantities
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$.

Question 1

Hydrogen chloride and sodium chloride are both soluble in water.

- a. Name and briefly describe the type of bonding present in these two compounds.

(2 marks)

- b. Briefly explain the differences in the mechanism of how these compounds dissolve in water. Using equations and a diagram may assist you.

(2 marks)

- c. Explain, using a diagram, why liquid water has a slightly greater density than ice.

(2 marks)

Total 6 marks

Question 2

When 2.30 g of a magnesium alloy was treated with 1.20 M hydrochloric acid solution, 60.0 mL of the acid was required to react with all the magnesium.

- a. The products of this reaction are magnesium chloride and hydrogen gas. Write the overall, balanced equation for the reaction of magnesium with the acid (include state symbols).

(2 marks)

- b. What test could be used to identify the gas produced in the above reaction?

(1 mark)

- c. Calculate the amount, in mole, of acid used in the reaction.

(1 mark)

- d. Determine the amount, in mole, of magnesium in the 2.30 g of alloy

(1 mark)

- e. What percentage, by mass, of magnesium was present in the sample?

(2 marks)

- f. What volume, in litres, of hydrogen gas at 20.0 °C and 1.06×10^5 Pa would be produced in the reaction?

(3 marks)

- g. What species is the reductant in this reaction?

(1 mark)

Total 11 marks

Question 3

- a. A sample of ammonia gas is taken from STP to SLC and ends up having a volume of 150 mL. What was the volume, in litres, of gas at STP?

(2 marks)

- b. A sample of sulphur dioxide gas is held under the same conditions and has the same volume as ammonia gas.

- i. What conclusion can be reached from this information?

(1 mark)

- ii. How would the average kinetic energy of the molecules in each sample of gas compare?

(1 mark)

- iii. In which gas is the average speed of molecules greater? Explain your response.

(2 marks)

Total 6 marks

Question 4

The results obtained from a series of experiments using 0.5 M solutions of acid A and acid B are shown below.

Test	Acid A	Acid B
1. Electrical conductivity (in amperes) of each solution	0.45 A	0.023 A
2. Time taken for 20 mL of acid to react completely with identical pieces of zinc	4 minutes	25 minutes
3. Volume of acid required to react completely with 20 mL of 0.5 M NaOH(aq)	10 mL	20 mL

- a. Explain why the acids gave different results in **both** tests 1 and 2.

(2 marks)

- b. Name the type of reaction which occurred in test 3.

(1 mark)

- c. What conclusion can be drawn about acid A from the results of test 3?

(1 mark)

- d. Calculate the pH of the 0.5 M NaOH solution at 25 °C

(3 marks)

Total 7 marks

Question 5

Two aqueous solutions were prepared: a 0.90 M silver nitrate solution and a 0.20 M magnesium chloride solution.

- a. What mass of magnesium chloride would be needed to make a 0.20 M solution in a 250 mL volumetric flask?

(2 marks)

- b. Write a balanced equation, showing state symbols, for the reaction between the two solutions.

(2 marks)

- c. If 35 mL of 0.90 M silver nitrate solution is mixed with 75 mL of 0.20 M magnesium chloride solution, what reactant will be in excess, and by how many moles?

(3 marks)

- d. What is the name of the precipitate formed, and how many grams of it will be obtained?

(3 marks)

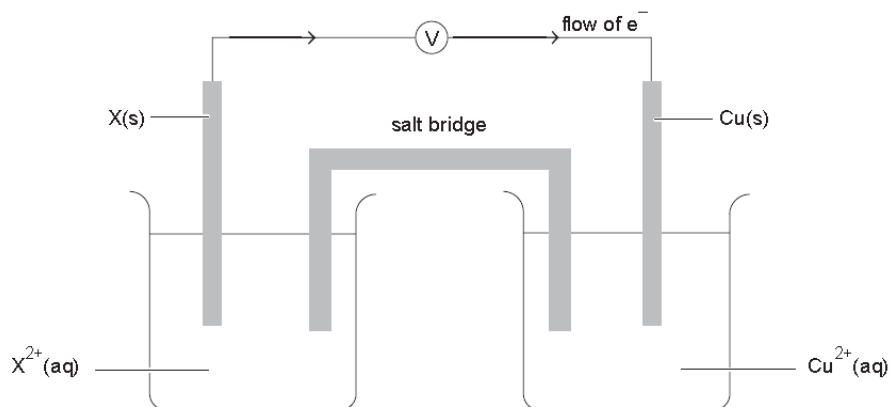
- e. Write the ionic equation for the reaction and give the formula of the spectator ions.

(2 marks)

Total 12 marks

Question 6

A galvanic cell is formed by the combination of two half-cells: $X^{2+}_{(aq)}/X_{(s)}$ and $Cu^{2+}_{(aq)}/Cu_{(s)}$. When the cell is operating, the electron flow is as shown.



- a.
- Write a balanced ionic equation for the reaction occurring in the cell.

 - Which electrode (X or Cu) is the cathode?

 - Which electrode (X or Cu) carries a negative charge?

 - In which direction (towards X or towards Cu) do anions move through the salt bridge?

 - Give the symbol for a metal that would be suitable for use as metal X in this cell

(1 + 1 + 1 + 1 + 1 = 5 marks)

- b. In another galvanic cell the $Cu^{2+}_{(aq)}/Cu_{(s)}$ half-cell was connected to an $Ag^{+}_{(aq)}/Ag_{(s)}$ half-cell. After some time the silver electrode had changed in mass by 2.5 g. What is the expected change in mass of the copper electrode (remember to state whether it increases or decreases)?

(4 marks)

Total 9 marks

Question 7

An organic compound has a percentage composition by mass of carbon 54.4 %, hydrogen 9.2 % and oxygen 36.4 %.

- a. Calculate the empirical formula of the organic compound.

(3 marks)

- b. A 1.32 g sample of the organic compound has a volume of 0.347 L at a temperature of 395 K and a pressure of 9.46×10^4 Pa.

- i. Calculate the molar mass of the hydrocarbon

- ii. Determine the molecular formula of the organic compound.

(3 + 2 = 5 marks)

- c. Draw and name all the structural isomers having the molecular formula, C_4H_{10}

(4 marks)

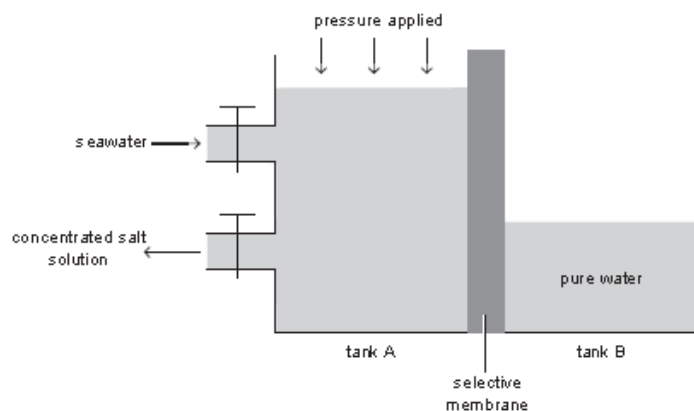
Total 12 marks

Question 8

A number of methods are in operation for the desalination of seawater, including distillation and reverse osmosis.

The Victorian desalination plant uses **reverse osmosis** to purify sea water, as shown in the simplified diagram below.

The electricity needed to drive the process is obtained from a coal-fired power station.



- a. The concentration of sodium chloride in a saltwater sample was 3.1 % w/v. Express this concentration of sodium chloride in mol L⁻¹

(3 marks)

- b. Explain why the output from tank A has a higher concentration of ions than seawater.

(1 mark)

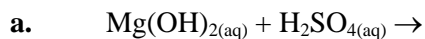
- c. Give a specific example from the Victorian desalination plant using the reverse osmosis process which **does not** illustrate the 'prevent pollution' principle of green chemistry.

(1 mark)

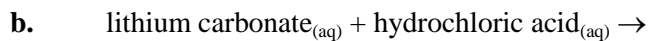
Total = 5 marks

Question 9

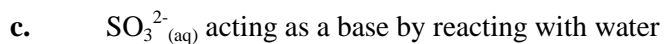
Write complete and balanced equations for the following partial equations (including state symbols).



(1 mark)



(1 mark)



(1 mark)



(1 mark)



(1 mark)

Total = 5 marks

END OF QUESTION AND ANSWER BOOKLET