Neap:

Trial Examination 2012

VCE Chemistry Unit 2

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks
A Multiple-choice	20	20	20
B Short-answer	5	5	55
			Total 75

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 17 pages, with a detachable data booklet in the centrefold.
Answer sheet for multiple-choice questions.

Instructions

Detach the data booklet from the centre of this booklet during reading time.
Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided 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 booklet and hand them in.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

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 statements:

I Kinetic energy of the water molecules increases so that they are released from the lattice.

II All hydrogen bonding between the water molecules is broken.

III The open crystal structure of ice collapses and the density increases.

Which of the above occurs when ice is heated to commence melting?

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

Question 2

The specific heat capacities (SHC) of some substances are shown in the table.

Substance	Water	Ethanol	Iron	Lead	Copper	Sand
SHC ($J\ g^{-1}\ °C^{-1}$)	4.2	2.4	0.45	0.13	0.39	0.48

Which of the following can be concluded using the information presented?

A. The temperature of one gram of copper will rise three times as high as one gram of lead if both metals are provided with the same amount of energy.
B. Ethanol is a better coolant than water, as its temperature will not rise as much when an identical amount of heat is applied.
C. At a given temperature, a given mass of water will store almost nine times as much heat energy as the same mass of sand.
D. The temperature of one kilogram of iron will rise well above 100°C if it is placed in one kilogram of boiling water.

Question 3

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 4

Which of the following lists contains only amphiprotic 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_3O^+, PO_4^{3-}, OH^-

D. HSO_4^-, $H_2PO_4^-$, HCO_3^-, H_2O

Question 5

At 25°C the pH of rainwater is 6.

Consider the following statements:

I The concentration of hydroxide ion in rainwater is 10^{-6} M as $[H_3O^+] = [OH^-]$ in all water samples.

II Boiling the rainwater and then cooling it to 25°C is likely to increase its pH above 6.

III The pH is less than 7 due to oxides of nitrogen dissolving in the rainwater.

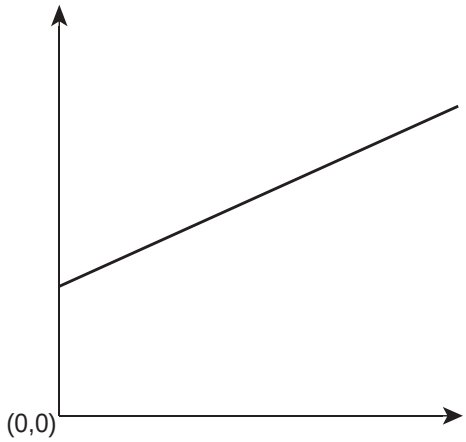
IV Carbon dioxide in the air is the main reason for the acidity of the rainwater.

Which of the above statements concerning rainwater is accurate?

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

Question 6

The graph shown below represents the relationship between two variables for a fixed amount (in mol) of gas.



Which of the following relationships is most likely to be represented by the graph shown?

A. *V* versus *T* (*K*) at constant pressure
B. *V* versus 1/*P* at constant temperature
C. *V* versus *P* at constant temperature
D. *V* versus *T* (°C) at constant pressure

Question 7

Which of the following actions would be classified as nitrogen fixation?

A. Manufacturing ammonia from hydrogen and nitrogen gases
B. Bacteria breaking down nitrates to release nitrogen gas into the atmosphere
C. Isolating nitrogen gas from liquid air by fractional distillation
D. Plants using nitrates from the soil to produce proteins

Question 8

An experiment was conducted to determine the level of salinity in a sample of water. A fixed volume of water was treated with excess silver nitrate solution to precipitate the chloride ions. The mixture was filtered and the filter paper was dried and weighed to determine the mass of precipitate.

Which of the following statements about the procedure is incorrect?

A. The mass of sodium chloride present in the water could be calculated using stoichiometry.
B. All moisture must be removed from the filter paper and precipitate before the final weighing is completed.
C. If a more concentrated silver nitrate solution was used, the same mass of precipitate would be formed.
D. When the mixture was filtered, the liquid passing through the filter paper was pure water.

Question 9

The concentration of the hydroxide ion in 250.0 mL of a solution containing 4.50 g of dissolved barium hydroxide (M = 171.3 g mol^{-1}) is closest to

A. 0.026 M.
B. 0.053 M.
C. 0.105 M.
D. 0.210 M.

Question 10

Consider the following statements of the kinetic molecular theory of gases.

I Collisions between gas particles are elastic.

II Forces between the gas particles are extremely weak.

III The volume of the gas particles is very small compared to the volume occupied by the gas.

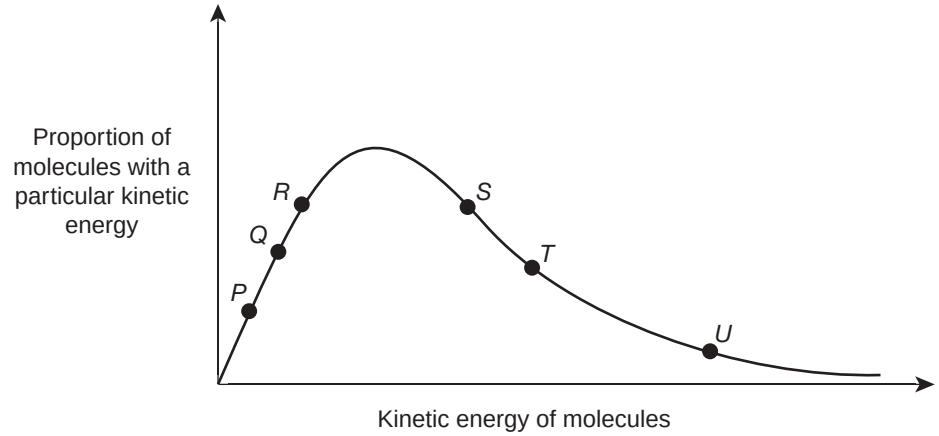
IV Gas particles collide with each other and with the walls of the container.

Which of these statements are **not** valid for a gas at low temperature and high pressure?

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

Question 11

The distribution of energies of the particles in a gas at 30°C is shown in the graph below. Several points on the graph are identified by the letters *P* to *U*.



The gas temperature was lowered to 20°C.

Which of the following shows how the value of the points on the graph would change?

	Higher values	Lower values
A.	*P, Q*	*R, S, T, U*
B.	*P, Q, R*	*S, T, U*
C.	*S, T, U*	*P, Q, R*
D.	*S, T*	*P, Q, R, U*

Question 12

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 13

The ionic equation below shows the reaction between acidified dichromate ions and iodide ions:

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3I_2(aq)$$

0.0090 mol of $Cr_2O_7^{2-}$ ions are mixed with 0.058 mol of I^- ions.

The expected amount (in mol) of iodine that would be produced as a result of the reaction would be

A. 0.0030 mol

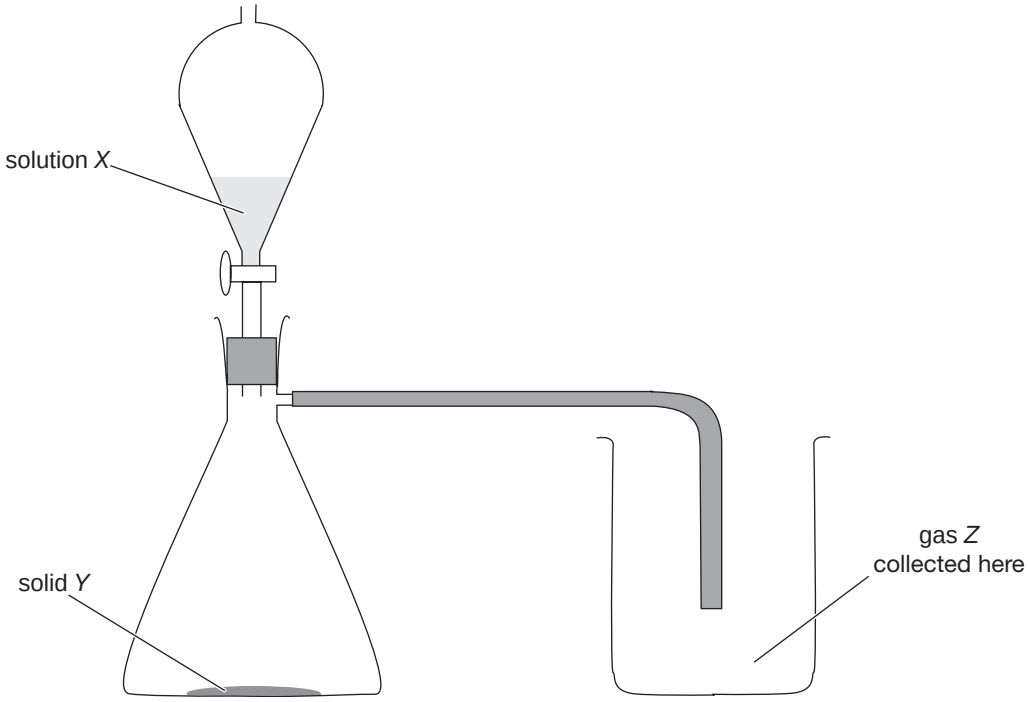
B. 0.027 mol

C. 0.029 mol

D. 0.116 mol

Question 14

A sample of gas *Z* was conveniently prepared and collected in a laboratory using the equipment and chemicals shown.



Which of the following shows the most likely properties of gas *Z*?

A. It is denser than air and insoluble in water.

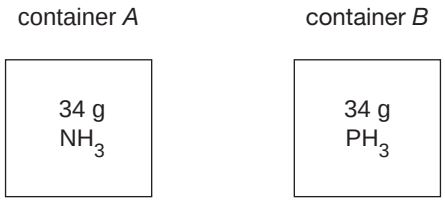
B. It is less dense than air and insoluble in water.

C. It is denser than air and soluble in water.

D. It is less dense than air and soluble in water.

Question 15

Identical masses of the gases NH_3 and PH_3 were placed into separate containers of the same volume and 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.

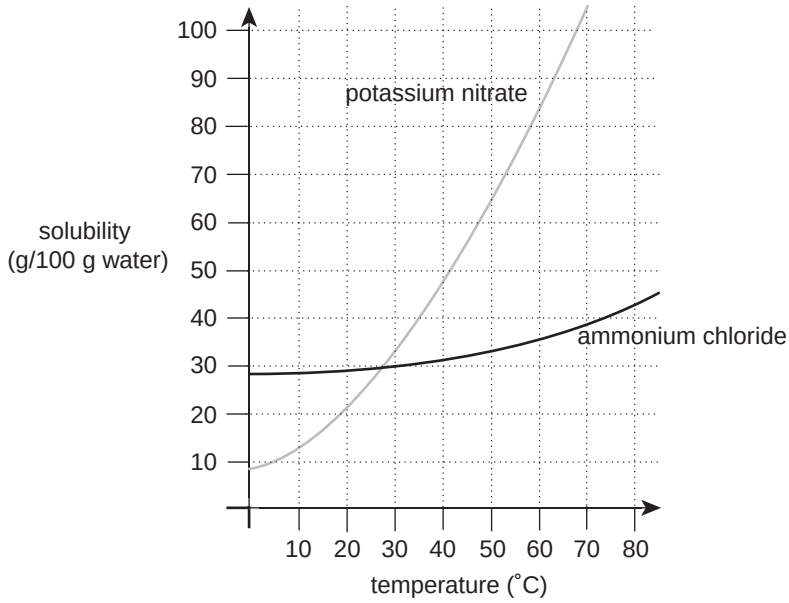
B. The pressure in container *B* is higher than the pressure in container *A*.

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 16

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 17

Which of the following is **not** a redox reaction?

A. $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

B. $Pb(s) + 2H^{+}(aq) \rightarrow Pb^{2+}(aq) + H_2(g)$

C. $Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$

D. $Ni(s) + Sn^{2+}(aq) \rightarrow Ni^{2+}(aq) + Sn(s)$

Use the following information to answer Questions 18 and 19

At a particular temperature and pressure, 100 mL of gas fills a cylinder.

The volume of the cylinder is then halved, and the absolute temperature is halved.

Question 18

The gas pressure in the cylinder would be expected to

A. remain unchanged.

B. be halved.

C. be doubled.

D. increase by a factor of four.

Question 19

In practice, the gas pressure became zero.

Which of the following is the most likely explanation for this situation?

A. The molecules in the gas were of negligible size.

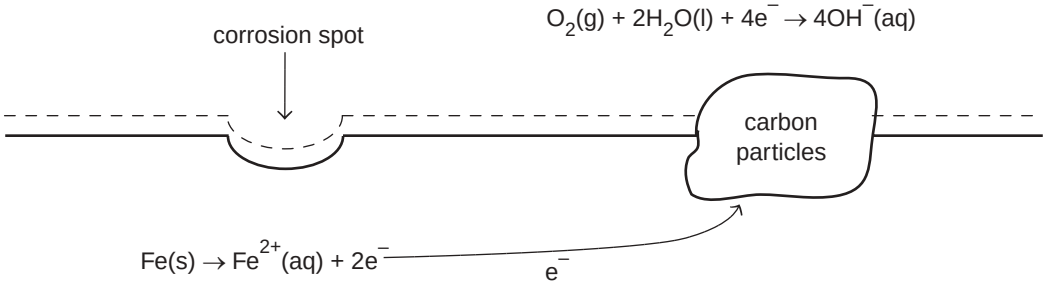
B. The cylinder was not tightly sealed.

C. The gas in the cylinder condensed into a liquid.

D. A chemical reaction occurred in the cylinder forming a new gaseous substance of very low molar mass.

Question 20

The diagram below shows the corrosion of a piece of iron.



Which of the following correctly identifies the reductant and the reaction occurring at the anode during the corrosion process?

	Reductant	Anode reaction
A.	Fe	$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
B.	Fe	$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$
C.	H_2O	$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
D.	H_2O	$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

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(s).

Question 1

A series of experiments were conducted to investigate the properties of acids.

a. The first experiment involved dissolving hydrogen chloride gas in two different solvents and determining the properties of the solutions formed. The results are shown in the table below.

Property tested	HCl dissolved in water	HCl dissolved in methylbenzene (C_7H_8)
1. Electrical conductivity	High	None
2. Effect on litmus	Turns litmus red	No effect on litmus
3. Reaction with magnesium ribbon	H_2 gas evolved	No reaction
4. Reaction with sodium carbonate powder	CO_2 gas evolved	No reaction

i. With the aid of a chemical equation, explain the high conductivity of the aqueous solution of HCl.

_____

_____

_____

ii. Explain why HCl dissolved in methylbenzene showed none of the properties of HCl dissolved in water.

_____

_____

_____

iii. Write a balanced chemical equation for the reaction occurring in test 3 with the aqueous HCl solution.

_____

_____

iv. Calculate the volume of hydrogen gas evolved at 101 kPa and 18°C if 0.576 g of magnesium ribbon completely reacted in test 3.

_____

_____

_____

_____

v. How could it be shown that another substance was formed in addition to the carbon dioxide gas produced in test 4?

_____

_____

2 + 1 + 2 + 3 + 1 = 9 marks

b. In the second experiment, 2.0 M solutions of acid A and acid B were each subjected to a series of tests. The results obtained are shown below.

Test	Acid A	Acid B
1. Measure the electrical conductivity (in amperes) of each solution	0.42 A	0.019 A
2. Measure the time for 20 mL of each acid to react completely with identical pieces of zinc	3 minutes	22 minutes
3. Measure volume of each acid required to react completely with 10 mL of 2.0 M NaOH(aq)	5 mL	10 mL

i. Explain why the acids gave different results in both tests 1 and 2.

_____

_____

_____

ii. Name the type of reaction which occurred in test 3.

_____

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

_____

_____

iv. Calculate the pH of the 2.0 M NaOH solution at 25°C.

_____

_____

_____

_____

2 + 1 + 1 + 2 = 6 marks
Total 15 marks

Question 2

Chlorine is manufactured in large quantities for use in the water treatment, petrochemical, refrigeration and pesticide industries.

a. Chlorine can be produced in the laboratory using the chemical reaction represented by the equation

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

i. Write the half-equation for the oxidation process in this reaction.

_____

ii. 50.0 mL of 4.0 M HCl is required for the reaction.
Calculate the volume of 10 M HCl required to produce this solution.

_____

_____

1 + 1 = 2 marks

b. **i.** The solubility of chlorine gas in water at a given temperature is 1.46 g per 100 g of water.
Calculate the molarity of the saturated solution produced by dissolving chlorine gas in water at the given temperature. Assume that the density of water at the given temperature is 1.0 g mL^{-1}.

_____

_____

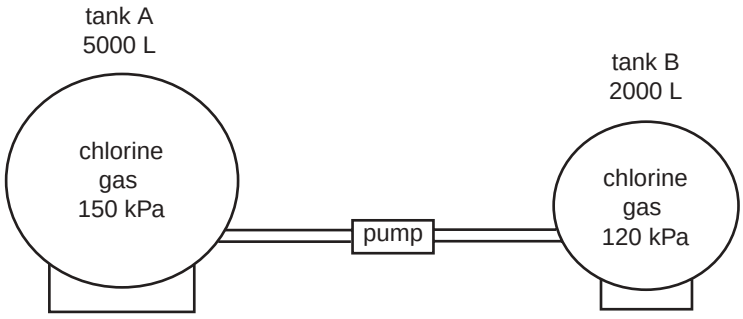
_____

ii. Circle one of the following to indicate what happens to the solubility of chlorine gas in water as the temperature is increased.

Decreased Remains unchanged Increased

2 + 1 = 3 marks

c. At a chlorine manufacturing plant, all of the chlorine gas in tank B was pumped into the larger tank A, which also contained chlorine gas.



If the temperature remained at 18°C throughout the procedure, calculate the final pressure in tank A after pumping was completed.

_____

_____

_____

_____

2 marks

d. Chlorine gas is widely used in water treatment.

i. One step in the treatment of water is to add $Al_2(SO_4)_3$ so that aluminium ions cling to minute suspended solid particles. $Ca(OH)_2$ is then added to provide a source of hydroxide ions to cause precipitation.

Write the ionic equation for this precipitation reaction.

_____

ii. Outline the purpose of using chlorine gas in water treatment.

_____

_____

1 + 1 = 2 marks

e. There is evidence that particular chlorine compounds, known as CFCs, damage the ozone layer.

How is the ozone layer beneficial to humans?

_____

_____

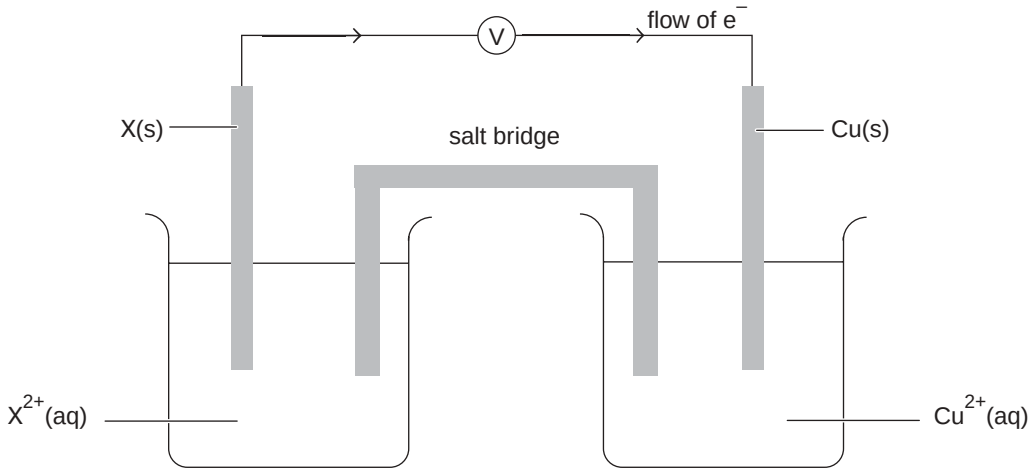
_____

2 marks

Total 11 marks

Question 3

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

_____

ii. Which electrode (X or Cu) is the cathode?

_____

iii. Which electrode (X or Cu) carries a positive charge?

_____

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

_____

v. 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?

_____

_____

_____

_____

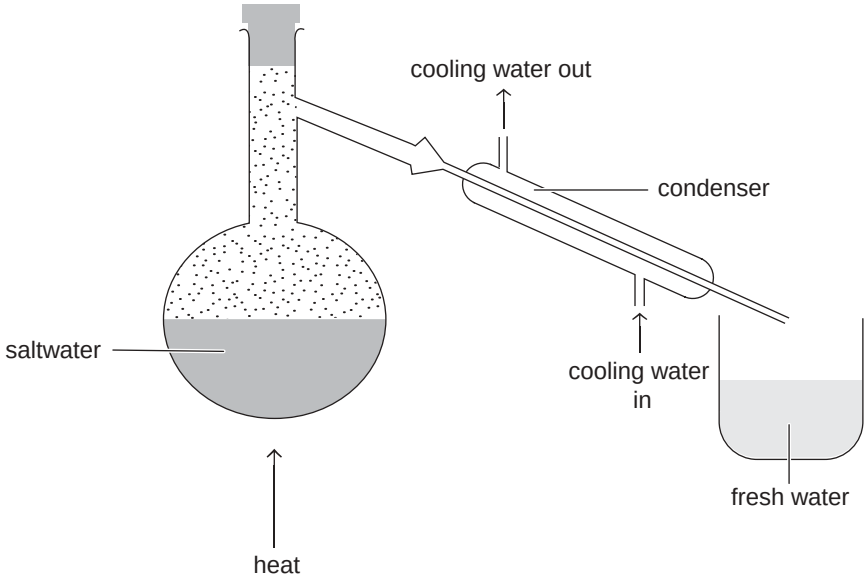
3 marks

Total 8 marks

Question 4

To ensure a supply of freshwater that is fit for human consumption, many countries are using desalination of seawater. A number of different methods are in operation, including distillation and reverse osmosis.

a. The simple distillation of saltwater shown below demonstrates the essential process used in many desalination plants around the world.



i. Describe the process by which freshwater is produced from saltwater by distillation.

_____

_____

_____

_____

_____

ii. Vacuum distillation is an older process used in some desalination plants. In this process the air pressure above the saltwater in the distillation apparatus is lowered.

Why does vacuum distillation produce freshwater at a cheaper cost per litre than simple distillation?

_____

_____

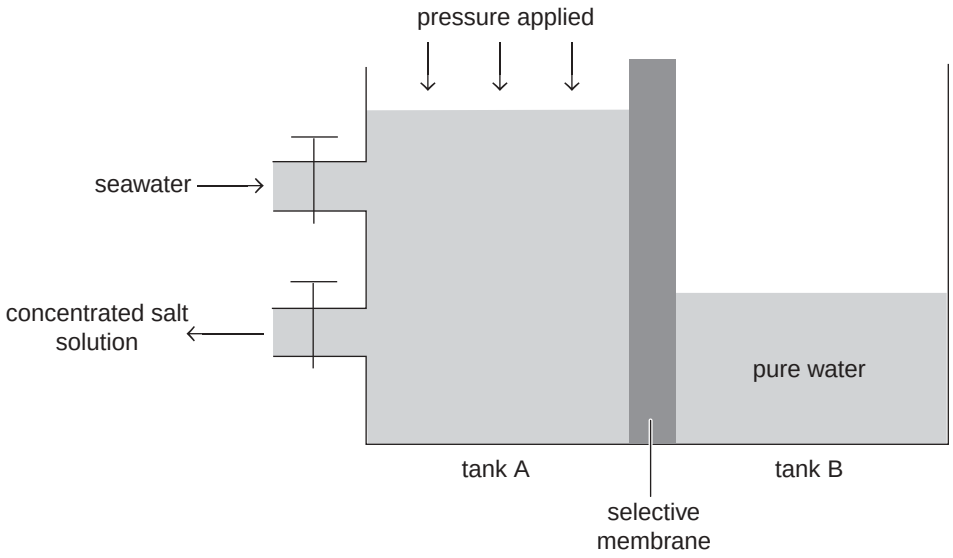
_____

_____

2 + 2 = 4 marks

b. The desalination plant planned for Victoria will use reverse osmosis technology, electricity from a coal-fired power station and storage in a reservoir 120 kilometres away from the plant. Reverse osmosis technology involves using a special membrane which allows water molecules, but not ions, to pass through it.

The simplified diagram below shows the process. When pressure is applied, water flows from tank A into tank B, but all sodium, chloride and other ions remain in tank A.



i. The concentration of sodium chloride in a saltwater sample was 3.1% m/v.

Express this concentration of sodium chloride in mol L^{-1}.

_____

_____

_____

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

_____

_____

2 + 1 = 3 marks

c. Methods for desalination of saltwater to produce freshwater may be used to illustrate some of the principles of green chemistry.

i. Give a specific example from a desalination process which illustrates the '**increase energy efficiency**' principle of green chemistry.

_____

_____

ii. 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.

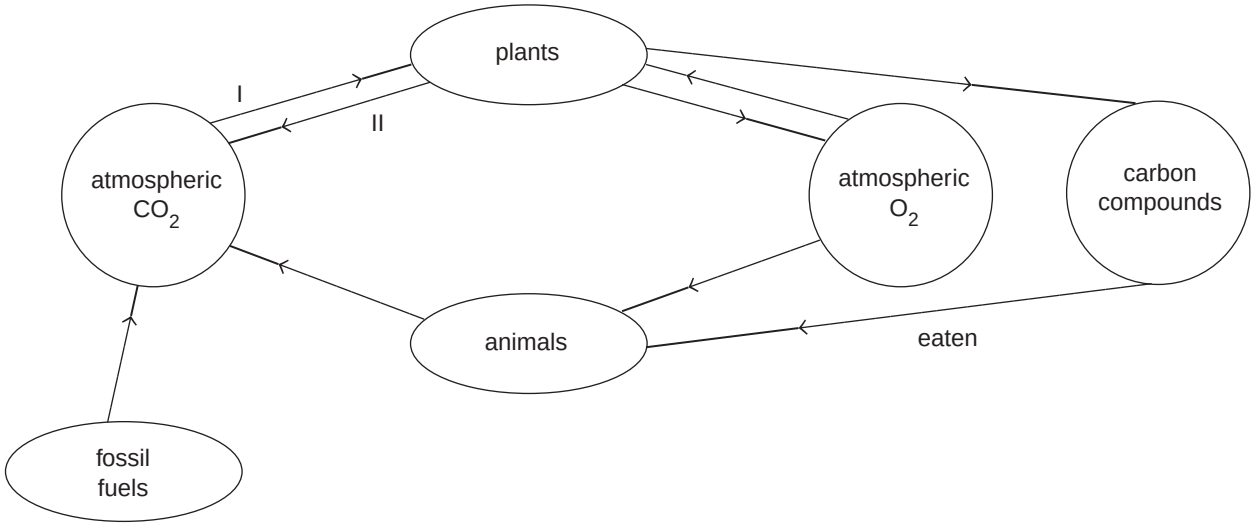
_____

_____

1 + 1 = 2 marks
Total 9 marks

Question 5

The diagram below shows a simplified version of the carbon cycle.



a. Write a balanced chemical equation for the process labelled II in the cycle.

_____

2 marks

b. One fossil fuel used in combustion is ethane (C_2H_6).

Write a balanced chemical equation for the complete combustion of ethane.

_____

2 marks

c. A clean, dry air sample was found to contain CO_2 at a concentration of 0.035% v/v.

Calculate the mass of CO_2 in 1.0 L of air at SLC.

_____

_____

_____

_____

2 marks

d. Carbon dioxide has been shown to be one of the gases responsible for the enhanced greenhouse effect.

Explain what is meant by the enhanced greenhouse effect.

_____

_____

_____

_____

_____

2 marks

e. Describe two ways in which clearing forests for use as agricultural land has an effect on the carbon dioxide concentration in the atmosphere.

_____

_____

_____

_____

_____

2 marks

f. Waste gases from power stations contribute to higher atmospheric carbon dioxide levels. It has been suggested that removing the carbon dioxide from power station waste gases could be achieved by spraying calcium hydroxide solution into the chimney to produce reaction I below. Calcium hydroxide is manufactured by reacting water with calcium oxide (reaction II). This calcium oxide is formed by heating limestone strongly (reaction III).

I $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$

II $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

III $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Will the use of reaction I lead to a reduction in the concentration of carbon dioxide in the atmosphere? Explain your response.

_____

_____

_____

_____

2 marks

Total 12 marks

END OF QUESTION AND ANSWER BOOKLET