Neap:

Trial Examination 2010

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	6	6	50
			Total 70

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 16 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.

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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.

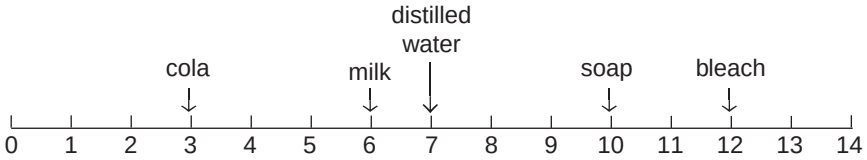
A correct answer scores 1, an incorrect answer scores 0.

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

The pH of some household liquids at 25°C is shown on the scale below.



Which of the following statements concerning these liquids is incorrect?

A. The hydrogen ion concentration in cola is 0.001 M.

B. In the soap solution, $[H_3O^+] < [OH^-]$.

C. Milk is 10^6 times more acidic than bleach.

D. In distilled water, $[H_3O^+]$ is 10^{-7} M at any temperature.

Question 2

Under which of the following conditions of temperature and pressure do real gases behave most like an ideal gas?

A. high temperature and low pressure

B. high temperature and high pressure

C. low temperature and high pressure

D. low temperature and low pressure

Question 3

The range of processes which occur in the nitrogen cycle include

I lightning discharges producing nitrogen(II) oxide gas

II ammonium ions produced by certain soil-borne bacteria

III nitrogen gas returned to the air by microbial decay

IV production of man-made nitrogenous fertilisers

In which of these processes does nitrogen fixation occur?

A. II and III only

B. I, II and III only

C. II, III and IV only

D. I, II and IV only

Question 4

When a piece of metal, X, is placed into a solution of YCl_2, the green colour of the solution fades and the metal becomes coated in a dark-coloured deposit.

Which of the following conclusions is consistent with the observations made?

A. X^{2+} ions are more readily reduced than Y^{2+} ions
B. metal Y is more reactive than metal X
C. metal X is oxidised more readily than metal Y
D. the Cl^- ion is more readily oxidised than metal X

Question 5

Which of the following conditions is most likely to produce photochemical smog?

A. temperature inversion, ozone, cool weather, hydrocarbons, nitrogen oxides
B. strong light, temperature inversion, hydrocarbons, nitrogen oxides, oxygen gas
C. hot weather, ozone, nitrogen oxides, carbon dioxide gas, ultraviolet light
D. mild temperatures, still air, oxygen gas, nitrogen monoxide gas, carbon monoxide gas

Question 6

A sample of argon gas occupies 48 L at 15°C and 720 mmHg.

If the sample is heated to 30°C and the volume drops to 24 L, the new pressure (in kPa) will be closest to

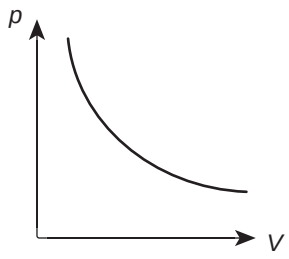
A. 200
B. 300
C. 2000
D. 3000

Question 7

Which of the following graphs does not represent the behaviour of an ideal gas?

Note: V = volume (L); T = temperature (°C); p = pressure (atm); n = number of mole (mol)

A.



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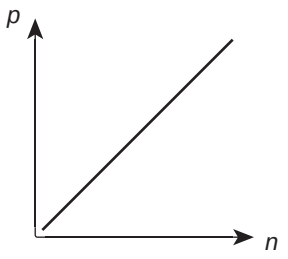
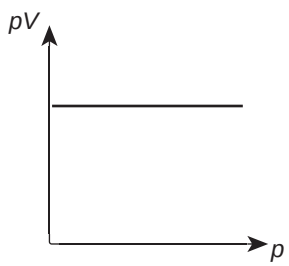
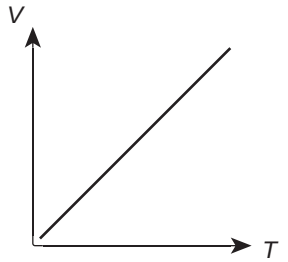


C.



D.



Questions 8 and 9 relate to the following information.

Gas	Solubility in water (mL of gas per 100 mL of water)		
	0 °C	**20 °C**	**40 °C**
Nitrogen	2.4	1.6	1.3
Oxygen	4.8	3.3	2.5
Carbon dioxide	171	92.3	56.6
Sulfur dioxide	7980	4250	2170

Question 8

Which of the following is not a reasonable conclusion concerning the data presented?

A. Small non-polar molecules seem to have low solubility in water.
B. The solubility of gases in water decreases with increasing temperature.
C. The higher solubility of sulfur dioxide is due only to its higher molar mass.
D. Oxygen gas will come out of solution in boiling water and be seen as bubbles.

Question 9

When sulfur dioxide and carbon dioxide are dissolved in water, it is likely that

A. both solutions formed from the gases will be basic.
B. only carbon dioxide will form an acidic solution.
C. both solutions formed from the gases will be acidic.
D. only sulfur dioxide will form an acidic solution.

Question 10

Which of the following solutions contains the smallest amount (in mol) of hydronium ions?

A. 10.0 mL of 0.3 M HNO_3
B. 10.0 mL of 0.3 M H_2SO_4
C. 30.0 mL of 0.1 M HCl
D. 30.0 mL of 0.1 M CH_3COOH

Question 11

A significant chemical reaction in the rusting of iron is shown in the equation:

$$2Fe(s) + O_2(aq) + 2H_2O(l) \rightarrow 2Fe^{2+}(aq) + 4OH^-(aq)$$

It can be deduced from this equation that

A. both hydrogen and oxygen are reduced.
B. oxygen causes reduction and undergoes oxidation.
C. hydrogen is oxidised and iron is reduced.
D. iron is the reductant and undergoes oxidation.

Questions 12 and 13 relate to the following information.

As world demand for fresh water increases, more sea water is being desalinated to produce fresh water.

Question 12

Which of the following methods would not be suitable for the desalination of a sea water sample to obtain fresh water?

A. the addition of a precipitating agent, followed by sedimentation
B. use of an ion-exchange resin
C. distillation under reduced atmospheric pressure
D. reverse osmosis using a semi-permeable membrane

Question 13

Which one of the following activities, associated with the operation of the new Victorian desalination plant, is likely to have the least impact on the environment?

A. returning concentrated salt water from the plant to the sea
B. adding fresh water from the plant to depleted dams
C. generation of electricity as the energy source for the plant
D. construction of pipelines to carry fresh water to dams

Question 14

If 149 mL of water is used to dilute 1 mL of 0.15 M HNO_3, the pH of the diluted solution is

A. 1
B. 2
C. 3
D. 4

Question 15

This question concerns the three chemical equations shown below.

I $H^-(aq) + H_2O(l) \rightarrow H_2(g) + OH^-(aq)$

II $NH_3(g) + H_2O(l) \rightarrow NH_2^-(aq) + H_3O^+(aq)$

III $2H_2SO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + 2H_2O(l) + SO_2(g)$

In which of these chemical equations is the first reactant acting as an acid?

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

Question 16

This question concerns the following chemical equation:

$$3P + 2Q \rightarrow 5R$$

The minimum amount (in mol) of P which must be added to 1.50 mol of Q in order to produce exactly 3.00 mol of R is

A. 1.65

B. 1.80

C. 2.25

D. 2.40

Question 17

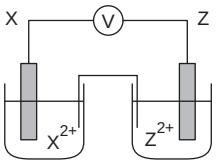
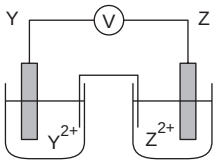
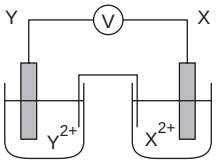
Samples of three acids, of the same volume and concentration, are neutralised with 0.050 M NaOH solution. Two of the acids are strong acids, H_2SO_4 and HCl, and the other is a weak acid, HCOOH. The volume of NaOH solution required to neutralise HCl is 10.0 mL.

Which of the following shows the volume (in mL) of NaOH solution required to neutralise the other two acids?

	Volume of NaOH required to neutralise the acid	
	H_2SO_4	**HCOOH**
A.	20.0	10.0
B.	20.0	less than 10.0
C.	10.0	10.0
D.	10.0	less than 10.0

Questions 18 to 20 relate to the following information.

Two experiments were conducted using three metals identified by the symbols X, Y and Z. 1.0 M solutions of XCl_2, YCl_2 and ZCl_2 were placed in each of three beakers. A strip of each metal was placed in the appropriate beaker to construct a half-cell. Half-cells were connected via wires, a voltmeter and a salt bridge containing KNO_3(aq). Three cells were constructed as shown below. For cells 1 and 2, the direction of electron flow and the cell voltage were recorded. Cell voltage provides an indication of the extent of reaction occurring. Results are shown below.

Cell number	Cell structure	Direction of electron flow	Cell voltage
1		from X to Z	0.31 V
2		from Y to Z	0.10 V
3		?	?

Question 18

In cell number 1, electrode Z is the

A. positively charged cathode
B. positively charged anode
C. negatively charged cathode
D. negatively charged anode.

Question 19

Which of the following represents the expected reaction occurring at the negative electrode in cell 3?

A. $X^{2+}(aq) + 2e \rightarrow X(s)$
B. $Y^{2+}(aq) + 2e \rightarrow Y(s)$
C. $X(s) \rightarrow X^{2+}(aq) + 2e$
D. $Y(s) \rightarrow Y^{2+}(aq) + 2e$

Question 20

If metal X is identified as iron, and Z is identified as lead, then, with the aid of the electrochemical series, metal Y is possibly

A. copper
B. nickel
C. calcium
D. unable to be determined from the data provided

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 5.25 g sample of hydrogen gas is held in a container at STP.

a. Calculate the volume of the container.

_____

_____

_____

_____

2 marks

b. All of the hydrogen gas is pumped into another container of volume 25 L which already contains 0.301 mol of oxygen gas. The temperature of this container is raised to 250°C and held at this temperature throughout the experiment.

i. Calculate the total gas pressure in the 25 L container.

_____

_____

_____

_____

ii. The gas mixture is ignited.

Write the balanced equation for the chemical reaction which occurs.

_____

iii. Calculate the number of mole of gas in the mixture resulting from the reaction.

_____

_____

_____

_____

2 + 1 + 3 = 6 marks

c. The mixture from part **b.** is cooled to 150°C.

Use the kinetic molecular theory to explain why the pressure in the container decreases as the temperature decreases.

_____

_____

_____

2 marks

Total 10 marks

Question 2

A student conducted electrical conductivity and pH tests on a range of aqueous solutions and pure water. The results are displayed in the table below.

Substance	Electrical conductivity	pH at 25°C
pure water	very low	7.0
1.0 M HCl(aq)	high	0
1.0 M CH_3COOH(aq)	low	2.7
1.0 M NH_3(aq)	low	11.6

a. Explain the very low electrical conductivity of pure water.

_____

_____

1 mark

b. Explain why the two acids in the table conduct electricity to different extents.

_____

_____

_____

_____

2 marks

c. Calculate the amount (in mol) of hydroxide ions in 250 mL of the 1.0 M NH_3 solution.

_____

_____

_____

_____

3 marks

d. The water molecule is amphiprotic.

Using chemical equations, show that $H_2PO_4^-(aq)$ is also amphiprotic.

_____

_____

2 marks

e. When the HCl solution was being made, 75 mL of concentrated (10 M) HCl was accidentally spilt on the bench.

i. Calculate the minimum mass (in g) of solid sodium hydrogen carbonate which could be used to neutralise the spilt acid if reaction occurs according to the equation:

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

_____

_____

_____

_____

ii. It is recommended that sodium hydroxide pellets are not used to neutralise the split acid.

Explain why.

_____

_____

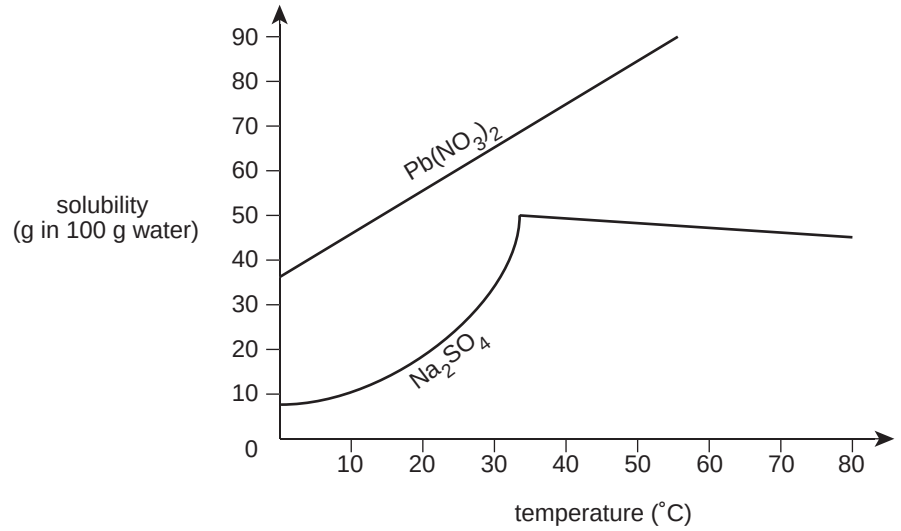
_____

3 + 1 = 4 marks

Total 12 marks

Question 3

The graph below shows the solubility curves for lead(II) nitrate and sodium sulfate.



A 0.136 mol sample of lead(II) nitrate was added to 60.0 g of water. The mixture was heated until the solid had dissolved. 17.5 g of sodium sulfate was added to the solution of lead(II) nitrate. A white solid formed.

a. **i.** What is the minimum temperature to which the water must be heated to dissolve the 0.136 mol lead(II) nitrate sample?

_____

_____

_____

_____

ii. Express the concentration of the lead(II) nitrate solution in the unit % m/v.

_____

_____

2 + 1 = 3 marks

b. Write an ionic equation to explain the formation of the white solid.

_____

1 mark

c. A student performed the following incorrect calculation to determine the mass of white solid expected to form.

n(*white solid*) = n(*lead(II) nitrate*) = *0.136 mol*

m(*white solid*) = n × M = *0.136* × M = *41.2 g*

When correctly calculated the expected mass of white solid is 37.3 g.

i. Explain why the student's calculation is incorrect.

_____

_____

_____

ii. When the white solid was collected, dried and weighed, the mass obtained was 38.5 g.

Suggest one reason why the mass obtained was greater than the expected mass of 37.3 g.

_____

_____

_____

2 + 1 = 3 marks
Total 7 marks

Question 4

a. A 2.0 g sample of magnesium was added to a beaker of water. The mixture was warmed and reaction occurred according to the equation:

$$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$$

In this reaction, is the water acting as an acid, a base, an oxidant or a reductant?

Explain your choice.

_____

_____

_____

_____

2 marks

b. A 2.0 g sample of copper was added to a beaker of aqueous silver nitrate solution.

i. What observations, if any, would you expect to make?

_____

_____

ii. Write a balanced chemical equation to account for the expected observations, or explain why no reaction would occur.

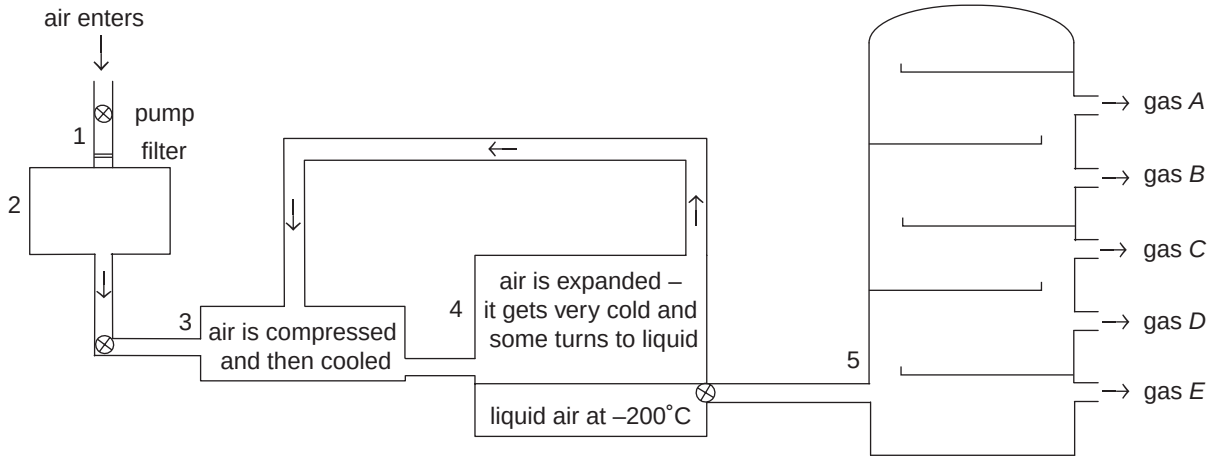
_____

_____

1 + 1 = 2 marks
Total 4 marks

Question 5

Nitrogen and oxygen gas are prepared industrially by the fractional distillation of air using the procedure shown in the diagram below.



The boiling points of a range of gases in the air are shown in the following table.

Gases in the air	Boiling point (°C)
carbon dioxide (sublimes)	–78
xenon	–108
krypton	–153
oxygen	–183
argon	–186
nitrogen	–196
neon	–246
helium	–249

a. The process of distillation is used widely in chemistry.

Explain what occurs during distillation of a mixture of liquids.

_____

_____

_____

_____

_____

2 marks

b. Water and carbon dioxide are removed in step 2 to prevent them blocking the pipes when frozen. Water may even damage the pipes when frozen.

Explain how and why this damage would occur.

_____

_____

_____

_____

_____

2 marks

c. Name the gases which would not be liquefied in step 4.

_____

_____

1 mark

d. In step 5, the liquid air is slowly warmed and the gases are collected at different points in the tower.

Identify gas *D*.

_____

1 mark

e. Describe the laboratory preparation of one gas which is present in the atmosphere. Include a relevant chemical equation, and explain how the gas would be collected.

_____

_____

_____

_____

_____

_____

3 marks

Total 9 marks

Question 6

One application of green chemistry is the use of supercritical carbon dioxide (sCO_2) to produce the air pockets in polystyrene foam. Polystyrene foam is used as protective packing for transporting electronic goods such as iPods and computers, and as insulating material for boxes used to keep food and drinks cold.

a. An old method employed to produce polystyrene foam was to use chlorofluorocarbons (CFCs) to produce the air pockets.

Outline two major environmental problems which result from the use of CFCs.

_____

_____

_____

_____

2 marks

b. It is claimed that using sCO_2 in the production of polystyrene foam is 'carbon neutral' which means that no extra carbon dioxide is added to the atmosphere.

Explain how the use of sCO_2 could be 'carbon neutral'.

_____

_____

_____

1 mark

c. The use of polystyrene foam does not accord with green chemistry principles. Polystyrene foam can be replaced with packaging made from corn starch.

Give one reason why using corn starch packaging is a desirable alternative which satisfies green chemistry principles.

_____

_____

1 mark

d. Describe another application of green chemistry principles (other than the use of sCO_2 or corn starch packaging).

_____

_____

_____

_____

2 marks

e. Carbon dioxide is a component of the carbon cycle.

i. Humans release carbon dioxide into the atmosphere as a result of the process of respiration.

Write a balanced equation for **another** chemical reaction resulting from human activities which releases carbon dioxide into the atmosphere.

_____

ii. Write a balanced equation for a chemical reaction of a natural process which removes carbon dioxide from the atmosphere.

_____

1 + 1 = 2 marks
Total 8 marks

END OF QUESTION AND ANSWER BOOKLET