Neap:

Trial Examination 2017

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*	*Suggested time (minutes)*
A	20	20	20	25
B	4	4	52	65
			Total 72	Total 90

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 correction fluid/tape.

Materials supplied

Question and answer booklet of 14 pages

Data booklet

Answer sheet for multiple-choice questions

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

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.
You may keep the data booklet.

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.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Use the following information to answer Questions 1 and 2.

The elements of group 16 form compounds with hydrogen known as hydrides.

Question 1

Which one of the group 16 hydrides has the lowest boiling point?

A. H_2O

B. H_2S

C. H_2Se

D. H_2Te

Question 2

Which one of the following statements best explains why the melting point of one group 16 hydride is higher than the melting points of all other hydrides in the group?

A. Only this hydride with the highest melting point has dipole-dipole bonding.

B. Of all the hydrides in the group, this hydride has the strongest covalent bonds.

C. Larger molecules always have stronger intermolecular bonds than smaller ones.

D. This hydride has the strongest dipole-dipole attraction between its molecules.

Question 3

Which one of the following chemical species is both amphiprotic and diprotic?

A. H_3PO_4

B. $H_2PO_4^-$

C. HPO_4^{2-}

D. PO_4^{3-}

Question 4

A 10 mL sample of a particular acid has a pH of 3. The sample was diluted with water to give a final volume of 1.0 L.

The pH of the diluted solution is

A. 0.03

B. 3

C. 5

D. 7

Question 5

The two equations below show water as a reactant.

I $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$

II $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

Which of the following correctly shows the way in which water is functioning in these reactions?

	Reaction I	Reaction II
A.	acid	oxidant
B.	oxidant	oxidant
C.	oxidant	acid
D.	acid	acid

Question 6

An experiment was conducted to determine which metals (identified by the letters L, M and Q) would displace the metal ions from aqueous solutions of various metal compounds. The results are shown below.

Metals	$FeSO_4$	$Sn(NO_3)_2$	$CuSO_4$
L	no reaction	no reaction	no reaction
M	displacement	displacement	displacement
Q	no reaction	no reaction	displacement

Based on the observations made, which of the following shows the order of reactivity of the metals from least reactive to most reactive?

A. L < Cu < Q < Sn < Fe < M
B. Q < Cu < L < Sn < Fe < M
C. L < Fe < Sn < Q < Cu < M
D. M < Fe < Sn < Q < Cu < L

Question 7

Methanoic acid (HCOOH) is a weak acid.

It can be concluded that in a methanoic acid solution,

A. only HCOOH molecules and water molecules are present.
B. the solute is partially ionised to produce COO^{2-} ions.
C. all the hydrogen atoms present are converted to hydronium ions.
D. the concentration of ionised solute particles in solution is very low.

Question 8

At 25°C, the value of the ionic product of pure water is $10^{-14}\ M^2$.

Which of the following statements is **incorrect**?

A. The pH of pure water is always 7 regardless of the temperature.
B. $[H_3O^+]$ is equal to $[OH^-]$ in pure water at any temperature.
C. Less than 0.001% of water molecules are ionised in pure water at 25°C.
D. Changing the temperature of pure water will change $[H_3O^+]$ and $[OH^-]$.

Use the following information to answer Questions 9 and 10.

The water in a dam on a farm is sampled to determine the level of salinity due to the presence of chloride ions.

Question 9

100 mL samples of water were collected from various dam locations and taken back to a laboratory for analysis.

In which vessel must each of the water samples be placed when collected?

A. disposable, single-use plastic bottles with lids

B. clean 100 mL plastic measuring cylinders

C. 250 mL beakers which have been rinsed with the dam water

D. sterile containers which can be sealed tightly

Question 10

Some steps in various laboratory analytical techniques used to determine the chloride ion concentration in a sample include the following.

I making a series of standard solutions of known chloride ion concentrations

II identifying cations which will cause the chloride ions to form a precipitate

III reading the electrical conductivity of a solution under investigation

IV constructing a calibration curve linking conductivity to concentration

The chloride ion concentration in the samples was determined by finding the amount of electrical current which passed through each solution.

Which of the above steps would be utilised in this analysis?

A. I and II only

B. II and III only

C. I, III and IV only

D. II, III and IV only

Question 11

The specific heat capacity of water is 4.18 J g^{-1} $°C^{-1}$. The specific heat capacity of copper is 0.390 J g^{-1} $°C^{-1}$. Heat was added to 75.0 g of water to raise its temperature from 28.1°C to 93.2°C.

If the same amount of heat was added to 138.5 g of copper, what temperature change will occur in the metal?

A. 21.6°C

B. 57.5°C

C. 197°C

D. 378°C

Use the following information to answer Questions 12 and 13.

The latent heat values for water are shown in the table below.

latent heat of fusion	6.0 kJ mol^{-1}
latent heat of vaporisation	44.0 kJ mol^{-1}

Question 12

Which one of the following statements about this information is **incorrect**?

A. Methane (CH_4) would have similar values as it has a similar molar mass to water.
B. For a set mass of water, more energy is required for evaporation than for melting.
C. The magnitude of these values is related to the strength of intermolecular forces.
D. Latent heat values show the amount of energy required to change the state of water.

Question 13

Which property of water is most influenced by the value of the latent heat of vaporisation?

A. ability to act as a solvent
B. effectiveness as a coolant
C. expansion on freezing
D. being a colourless liquid

Question 14

Acid X and acid Y were reacted separately with identical pieces of cleaned magnesium ribbon and the hydrogen gas produced in each instance was collected. The results are shown in the table below.

	Initial contents of flask	**Time taken to collect 25 mL of H_2 gas**
Flask 1	100 mL of acid X + magnesium ribbon	38 seconds
Flask 2	100 mL of acid Y + magnesium ribbon	97 seconds

Which conclusion can be made from the results of the experiment?

A. Acid Y must be more dilute than acid X.
B. Acid X must be a stronger acid than acid Y.
C. Acid X could be a concentrated, weak acid and acid Y could be a dilute, strong acid.
D. Acid Y could be a concentrated, strong acid and acid X could be a dilute, weak acid.

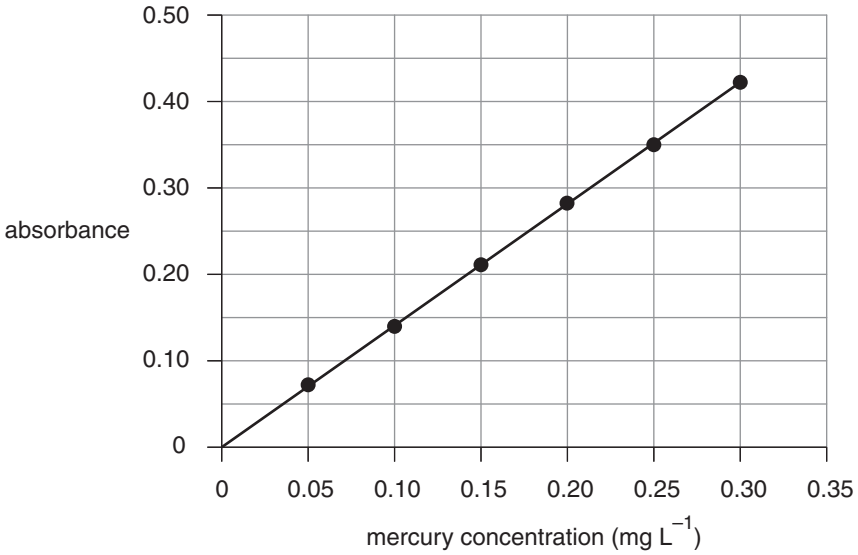
Question 15

How many mole of a strong diprotic acid would be required to neutralise 1 mole of the weak base ammonia (NH_3)?

A. less than 0.5 mole
B. 0.5 mole
C. 2.0 mole
D. more than 2.0 mole

Question 16

Soil samples were taken from an industrial site where mercury was used in a chemical industry. Each sample was treated to release any mercury present into solution. Each solution was analysed by Atomic Absorption Spectroscopy (AAS) to determine the mercury concentration using the following calibration graph.



The absorbance of one solution from a soil sample was 0.58. The following suggestions were made to overcome the inadequacy of the calibration graph.

I Extend the graph so that the absorbance of 0.58 has a corresponding mercury concentration.

II Construct another calibration graph so that the absorbance 0.58 has a corresponding mercury concentration.

III Dilute the solution from the soil sample and calculate the mercury concentration by taking the dilution into account.

Which of these actions could be taken to produce an accurate result?

A. I or II only

B. II or III only

C. I or III only

D. I, II or III

Question 17

A large test tube contains a saturated solution of potassium nitrate, together with some undissolved potassium nitrate solid.

Which of the following processes would increase the concentration of the potassium nitrate solution in the test tube?

A. shaking the solution vigorously

B. adding more water to the solution

C. increasing the temperature of the solution

D. adding more potassium nitrate solid to the solution

Use the following information to answer Questions 18–20.

The concentration of methanoic acid in a waterway as a result of a chemical spill was investigated using volumetric analysis. 20.00 mL aliquots of the affected water were separately titrated with a standardised 0.100 M solution of sodium hydroxide (NaOH) using a suitable indicator.

Question 18

During the volumetric analysis, three pieces of glassware were used and then rinsed with water before each was reused.

Which pieces of glassware can be left wet with water after rinsing and be reused directly without introducing error into the volumetric analysis?

A. conical flask only
B. pipette and burette only
C. pipette, burette and conical flask
D. none, as all glassware must be dry before use

Question 19

Five titrations were completed and the following titres (in mL) were recorded.

18.95; 19.15; 18.90; 19.25; 18.90.

Which of the following shows the correctly expressed average of the concordant titres (in mL)?

A. 18.90
B. 18.917
C. 18.92
D. 19.03

Question 20

The endpoint of the titration is the point at which

A. the reactants have been mixed in the mole ratios given in the balanced equation for the reaction.
B. the pH of the solution in the titration flask is 7.
C. equal volumes of reactant solutions have been added.
D. the indicator changes colour.

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

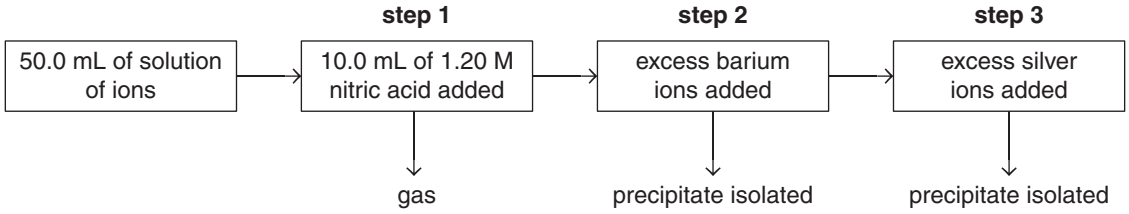
Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, NaCl(s).

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1 (17 marks)

A solution containing sodium ions (Na^+), carbonate ions (CO_3^{2-}), sulfate ions (SO_4^{2-}) and chloride ions (Cl^-) was analysed as shown in the flowchart below. All solutions were at a temperature of 25°C.



The nitric acid (HNO_3) used in step 1 was made by diluting 4.50 M nitric acid stock solution.

a. **i.** Calculate the pH of 4.50 M nitric acid. 2 marks

_____

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ii. What volume of 4.50 M nitric acid was needed to produce the 10.0 mL of 1.20 M nitric acid used in step 1? 1 mark

_____

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iii. Calculate the hydroxide ion concentration in the 1.20 M nitric acid used in step 1. 2 marks

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b. Draw a labelled diagram, including water molecules, to show why the Na^+ ion is soluble in water. Name all bond types shown on your diagram. 2 marks

c. Write a balanced ionic equation for the chemical reaction in step 1. 2 marks

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d. In step 2, the barium sulfate precipitate was isolated by filtration using filter paper which was weighed before being used.

i. The precipitate was washed with pure water.
Explain the purpose of this washing. 1 mark

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ii. The washed precipitate was dried and weighed.
Describe a procedure which could be used to ensure that the precipitate was completely dry. 2 marks

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iii. The mass of the dry precipitate of $BaSO_4$ was found to be 3.267 g.
Calculate the concentration of sulfate ions (in % m/v) in the original solution of ions. 3 marks

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e. What problems, if any, would occur in the analysis if the order of steps 2 and 3 in the procedure shown in the flowchart were reversed – that is, if step 3 was conducted before step 2? 2 marks

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Question 2 (12 marks)

The solubility of solids, liquids and gases in water is dependent on the temperature.

a. The solubility of three substances (labelled A, B and C) in water at three different temperatures are shown in the table below.

Substances	Solubility in water (mL per 100 g water)		
	At 0°C	**At 20°C**	**At 40°C**
A	171	92.3	56.6
B	2.4	1.6	1.3
C	75 100	52 900	48 700

i. What information in the table suggests that the three substances are likely to be gases at room temperature? 1 mark

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ii. The formulas of the gases in random order are shown below.

Match the substances in the table by placing one of the letters A, B or C next to the formula of the corresponding gas. 2 marks

N_2 _____ CO_2 _____ NH_3 _____

iii. Name the type of bonding between water molecules and molecules of substance B. 1 mark

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iv. Some industries produce a large amount of heated waste water. Before this water is released into natural waterways, it is cooled in large shallow ponds.

Why could releasing the heated water directly into natural waterways adversely affect the environment? 1 mark

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b. Information about the solubility of two liquid compounds is given in the table.

Name of compound	ethanol	1-hexanol
Formula	CH_3CH_2OH	$CH_3CH_2CH_2CH_2CH_2CH_2OH$
Solubility in water	soluble in all proportions	0.59 g/100 g water at 20°C

Explain the difference in the solubility of these two compounds. 3 marks

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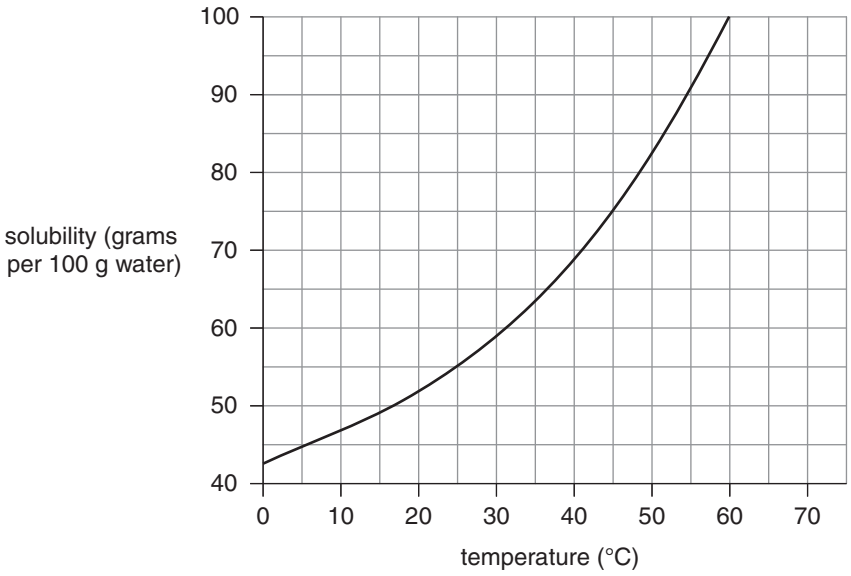
c. The variation of the solubility of a particular solid in water with temperature is shown in the graph below.



i. 30 g of the solid was added to 55 g of water and heated.
What is the lowest temperature at which all of the solid will dissolve? 2 marks

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ii. A solution is made by dissolving 150 g of the solid in 150 g of water.
If the solution is cooled to 15°C, what mass of solid will crystallise? 2 marks

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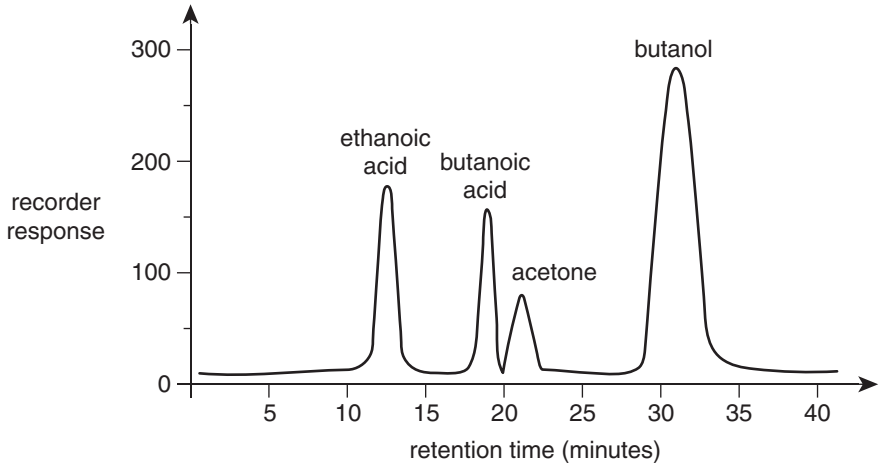
Question 3 (12 marks)

a. A particular chemical industry produces waste water contaminated with organic solvents. Analysis by high performance liquid chromatography (HPLC) identified which solvents were present. The results of the analysis are shown below.



i. Describe the procedure used to identify each solvent in the waste water. 2 marks

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ii. How could the concentration of acetone in the waste water be determined? 2 marks

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iii. The concentration of butanol ($C_4H_{10}O$) in the waste water could also be determined using volumetric analysis based on the reaction represented by the unbalanced equation shown below.

$$C_4H_{10}O + MnO_4^- + H^+ \rightarrow C_4H_8O_2 + Mn^{2+} + H_2O$$

Write the balanced ionic equation for the oxidation process occurring in this reaction (states are not required). 1 mark

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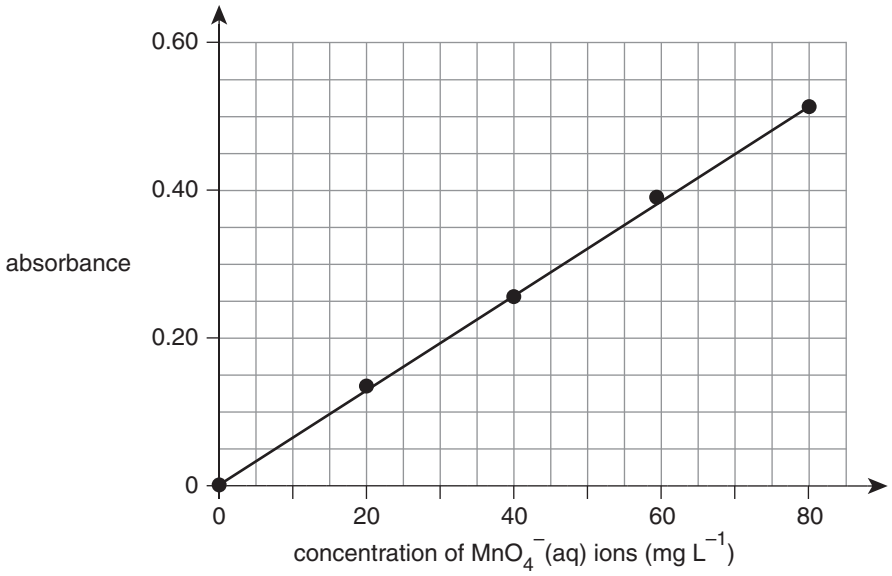
b. Another chemical industry produces waste water containing potassium permanganate ($KMnO_4$). The permanganate ion (MnO_4^-) is coloured purple and so its concentration can be determined by colorimetry using a yellow filter in the colorimeter. To calibrate the colorimeter, a distilled water 'blank' and four standard solutions of permanganate ion were prepared, and the calibration graph shown below was generated.



i. Why was a 'blank' reading of distilled water made? 1 mark

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ii. How would the results have been affected if a purple filter was used instead of a yellow filter? 1 mark

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iii. 20.0 mL of the waste water was diluted to a final volume of 250.0 mL. The absorbance of a sample of the diluted waste water was 0.35.

Determine the concentration of MnO_4^- in the undiluted waste water. 2 marks

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iv. Before the waste water is discharged into the environment, it is treated so that the concentration of MnO_4^- is 20 parts per million (20 ppm).

How many mole of MnO_4^- must be removed from 5000 L of waste water containing 78 ppm MnO_4^- to reduce the concentration of MnO_4^- to 20 ppm? 3 marks

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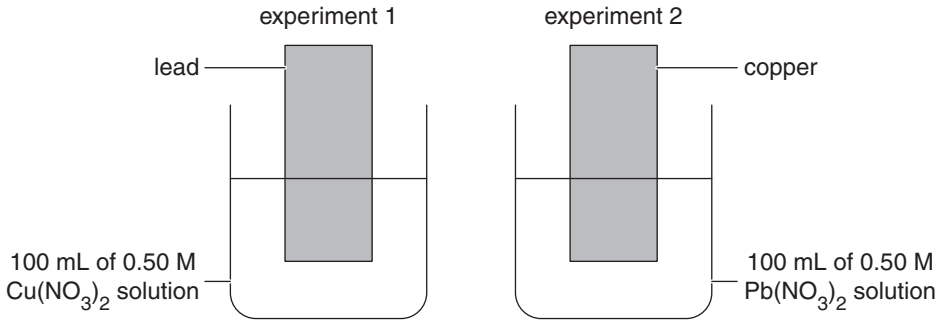
Question 4 (11 marks)

The following experiments were set up in an investigation into the reactivity of metals.



a. For experiment 1, describe how 100.0 mL of 0.50 M copper(II) nitrate solution was prepared. Include in your answer any laboratory techniques used, the glassware used and specify the mass of solute needed. 4 marks

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After several hours in experiment 1, the colour of the blue copper(II) nitrate solution had faded and a red-brown deposit of copper was found on the lead. The mass of copper deposited was 2.362 g.

b. **i.** Write a balanced overall ionic equation for the chemical reaction occurring in experiment 1. 1 mark

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ii. Give the symbol of the oxidant in experiment 1. 1 mark

_____

iii. Write the oxidation half-equation for the reaction in experiment 1. 1 mark

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iv. Calculate the concentration of the copper(II) nitrate solution after the deposition of copper on the lead. 3 marks

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c. What results would be expected in experiment 2? 1 mark

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END OF QUESTION AND ANSWER BOOKLET