Student Name: _____

CHEMISTRY

Unit 2 – Written Examination 2

2007 Trial Examination

Reading Time: 15 minutes
Writing Time: 1 hour and 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	5	5	50
			Total 70

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and 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 book of 15 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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.
Choose the response that is **correct** for the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks are **not** deducted for incorrect answers.
If more than 1 answer is completed for any question, no mark will be given.

Question 1

The recent increase in carbon dioxide concentrations within the atmosphere can be best explained by:

A. An increase in the world's population which produce more carbon dioxide during respiration.

B. Deforestation resulting in less trees undergoing photosynthesis.

C. Increased usage of fossil fuels.

D. Extreme weather patterns with increased volcanic eruptions.

Question 2

Which of the following **is not** an example of Green Chemistry?

A. Solventless reactions

B. Use of catalysts

C. Use of several small scale reactions

D. Utilising less hazardous synthetic procedures

Question 3

Which of the following **is not** an assumption of the Kinetic Molecular Theory of Gases?

A. Gas molecules move all the time in random directions.

B. Gas molecules are very light and easily move.

C. Gas molecules experience negligible intermolecular forces of attraction or repulsion.

D. Individual gas molecules occupy negligible volume compared to the total gas volume.

Question 4

Nitrogen boils at 77 K. What is this temperature in °C?

A. -96 °C

B. -169 °C

C. -196 °C

D. -200 °C

SECTION A-continued

Question 5

800 mmHg is equal to how many kilopascals?

A. 101 325

B. 101.3

C. 1.05

D. 106.7

Question 6

A gas storage tank with a volume of 3.50×10^6 L contains natural gas at a temperature of 17°C and a pressure of 100 kPa. On a hot day, the temperature of the gas increases to 37° C. Calculate the pressure of the gas

A. 106 atm

B. 10.6 kPa

C. 106 Pa

D. 106 kPa

Question 7

An ideal gas will obey all the Gas Laws. However, real gases can deviate significantly from such ideal behaviour. This is most like to occur when the gas is:

A. under low pressure and high temperature

B. reacting with a catalyst

C. under low pressure at low temperature

D. at low temperature and high pressure

Question 8

Nitrogen and oxygen gases can be obtained in pure form using the technique of fractional distillation which separates the gases based upon which physical property?

A. Melting points

B. Boiling points

C. Molecular weight

D. Electronegativity

Question 9

Which of the following **does not** represent part of the nitrogen cycle?

A. Nitrolysis
B. Denitrification
C. Nitrification
D. Nitrogen fixation.

Question 10

Zinc powder may react with chlorine gas according to the equation:

$$Zn(s) + Cl_2(g) \rightarrow ZnCl_2(s)$$

In this equation the oxidising agent is?

A. chloride ions
B. chlorine gas
C. zinc ions
D. zinc atoms

Question 11

The oxidation number of manganese in $KMnO_4$ is?

A. +2
B. +3
C. +5
D. +7

Question 12

Metal corrosion can be reduced using which of the following techniques?

i. Galvanising
ii. Immersion in a saline solution
iii. Sacrificial protection
iv. Cathodic protection

A. i, ii and iii
B. i and iv
C. all of the above
D. i, iii and iv

SECTION A-continued

Question 13

The mass of K_2CO_3 required to prepare 3.00 L of a 0.005 M solution would be?

A. 15.9 g
B. 2.07 g
C. 1.59 g
D. 1.49 g

Question 14

What volume of 3.35 M H_2SO_4 will just neutralise 12.0 g of NaOH?

A. 0. 90 ml
B. 9.0 ml
C. 19.0 ml
D. 17.9 ml

Question 15

0.05 mol L^{-1} NH_3 solution could be described as a

A. dilute weak base
B. concentrated strong base
C. concentrated weak base
D. dilute strong base

Question 16

Which of the following solution will have the highest pH?

A. 36.5 g of HCl in 2.0 L of water
B. 120 g of ethanoic acid dissolved in 1.0 L of water
C. 5 ml of 2.5 M HNO_3
D. 5 ml of 2.5 M NaOH

Question 17

The conjugate acid of $H_2PO_4^-$ would be:

A. H_3PO_4
B. PO_4^{3-}
C. HPO_4^{2-}
D. All of the above

SECTION A-continued
TURN OVER

Question 18

Indicators are commonly used during titration experiments. The **main reason** for this would be:

A. To eliminate errors when titrating

B. To accurately calculate the equivalence point

C. To enable visual determination of the titration end point

D. To make the experiment visually appealing

Question 19

The Kyoto Protocol is an international agreement of 160 countries that are committed to reducing greenhouse gases. Which of the following lists contains **only** greenhouse gases?

A. CS_2, NH_3, CO_2, O_3, H_2O

B. CF_2Cl_2, O_3, O_2, CH_4, H_2O

C. N_2O, O_3, CH_4, H_2O, CO_2

D. BF_3, O_3, CF_2Cl_2, CH_4, CO_2

Question 20

A student conducted some experiments and discovered that for a fixed mass of gas at constant temperature the volume was inversely proportional to the pressure exerted upon the gas. This relationship was initially discovered by?

A. Robert Boyle

B. Jacques Charles

C. Joseph Louis Gay-Lussac

D. Amedeo Avogadro

END OF SECTION A

SECTION B - Short-answer questions

Instructions for Section B
Answer all questions in the spaces provided.

Question 1

a. Propane, C_3H_8, a gas, burns in oxygen to form carbon dioxide and water. 20 mL of propane is reacted with 140 mL of oxygen with all volumes measured at STP.

i. Write a balanced equation including state for the reaction occurring.

ii. Calculate the volume of carbon dioxide produced.

iii. Calculate the volume of oxygen remaining.

iv. The change in total volume, which occurs due to the reaction.

v. Calculate the mass of propane used?

_____

_____

3 + 2 + 1 + 2 + 3 = 11 marks

Total 11 marks

SECTION B-continued

Question 2

a. A student spilt a solution containing 18.6g of nitric acid on a bench and decides to neutralise this by sprinkling some bicarbonate of soda ($NaHCO_3$) over it to produce water, a salt and carbon dioxide.

i. Write a balance equation including states for the neutralisation reaction.

ii. Find the number of mole of $NaHCO_3$ required for neutralisation.

3 + 2 = 5 marks

b.

i. What mass of calcium hydroxide must be dissolved in 500mL of water to give a pH of 11.50?

SECTION B-Question 2-continued

TURN OVER

ii. Give two safety precautions to be undertaken when handling concentrated strong acids or alkalis.

_____

_____

4 + 2 = 6 marks

Total 11 marks

SECTION B-continued

Question 3

a. Aqueous hydrogen sulphide (H_2S) is oxidised to colloidal sulphur in the presence of nitric acid which is reduced to nitrogen monoxide gas (NO). Name the oxidant and reducing agent.

i. Oxidant

_____

_____

ii. Reducing Agent

_____

_____

1 + 1 = 2 marks

b. Give the oxidation states for:

i. Sulphur in hydrogen sulphide and colloidal sulphur

_____

_____

ii. Nitrogen in nitric acid and nitrogen monoxide

_____

_____

1 + 1 = 2 marks

SECTION B-Question 3-continued

TURN OVER

c. From the reaction occurring in **a.** give balanced equations for the following:

i. Reduction half-equation:

_____

_____

ii. Oxidation half-equation:

_____

_____

iii. Full redox reaction:

_____

_____

2 + 2 + 2 = 6 marks

Total 10 marks

SECTION B-continued

Question 4

a. A beaker contains a strip of copper metal in a 1M copper sulphate solution and a second beaker contains a strip of zinc metal in a 1M zinc sulphate solution. Using these two beakers draw a diagram of a galvanic cell. Sodium sulphate may be used as a salt bridge.

i. Clearly label the following:

- Anode
- Cathode
- Electrode where oxidation occurs
- Electrode where reduction occurs
- Direction of electron flow
- Direction of anion and cation flow in the salt bridge

6 marks

b.

i. After several hours one of the solutions has changed colour. Which beaker has changed colour and how can you account for this?

_____

_____

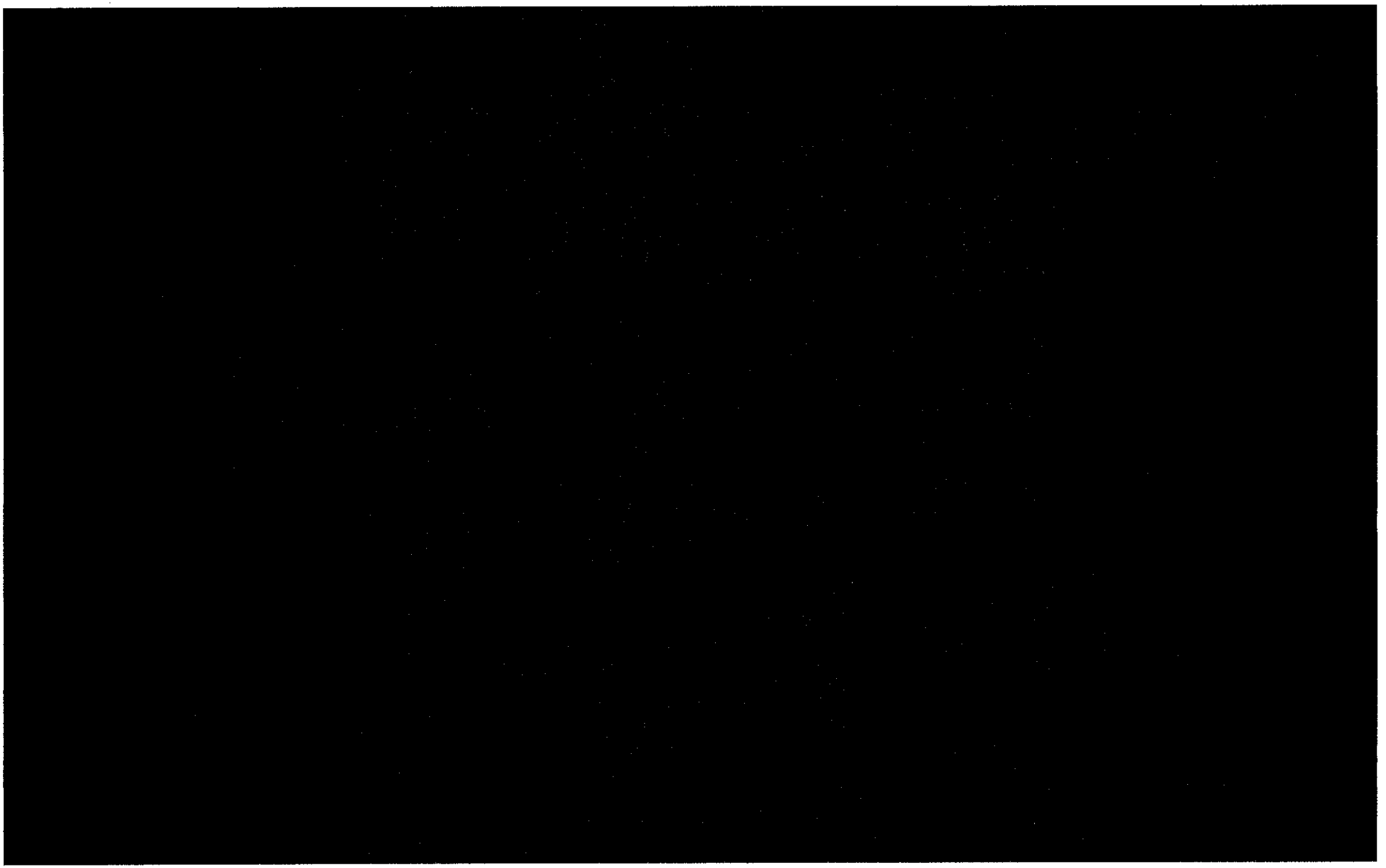
ii. Give two different reasons why the electrons will eventually stop flowing in the galvanic cell.

_____

_____

2 + 2 = 4 marks
Total 10 marks

TURN OVER



v. Give two applications for the gas carbon dioxide.

_____

_____

_____

1 + 2 + 2 + 1 + 2 = 8 marks
Total 8 marks

END OF QUESTION AND ANSWER BOOK

CHEMISTRY

Unit 2 – Written examination 2

2007 Trial Examination

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: C

Explanation:

The reliance of fossil fuels catalysed by increasing demand for energy in the Western world (and more recently China and India) is the main reason causing rising carbon dioxide levels.

Question 2

Answer: C

Explanation:

Small scale reactions are not necessarily an example of Green Chemistry. The small-scale reaction could still be energy inefficient, generate toxic gases, consume several reactants or be part of a multi-step reaction.

Question 3

Answer: B

Explanation:

A C and D are all correct assumptions of the KMT. To state gas molecules are light is irrelevant to KMT.

Question 4

Answer: C

Explanation:

$77 - 273 = -196\,°C$ which is D.

Question 5

Answer: D

Explanation:

760 mmHg = 101.325 *kPa*. $\frac{800}{760} \times 101.325 = 106.658\,kPa.$

Question 6

Answer: D

Explanation:

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ Insert values using appropriate units.

$$\frac{100kPa \times 3.5 \times 10^6 L}{290K} = \frac{P_2 \times 3.50 \times 10^6 L}{310K}$$

$$P_2 = 106kPa$$

Question 7

Answer: D

Explanation:

As the gas cools and condenses to form a liquid it will cease to exhibit the properties of a gas and not behalf as an ideal gas. The conditions of low temperature and high pressure favour the condensation of a gas to a liquid.

Question 8

Answer: B

Explanation:

The relative difference in boiling points enables the different gases of the liquefied air to boil out of solution at a temperature specific to that gas.

Question 9

Answer: A

Explanation:

Nitrolysis is a made up word. All the other terms represent stages of the nitrogen cycle.

Question 10

Answer: B

Explanation:

An oxidising agent (oxidant) causes a species to be oxidised. From assigning of oxidation numbers it can be seen that the chlorine gas facilitates the oxidation of zinc from Zn (0) to Zn^{2+}

Question 11

Answer: D

Explanation:

K is always +1 and O is almost always -2. Since Mn is a transition element this does allow variable oxidation states. However, since K and O are fixed the Mn must have an oxidation state of +7.

Question 12

Answer: D

Explanation:

Saline solutions contain salts which function as electrolytes thus enhancing not reducing corrosion! Sacrificial and cathodic protection is a similar process which involves the use of a more reactive metal that is preferentially oxidised. Galvanising specifically relates to the use of Zn in coating the metal.

Question 13

Answer: B

Explanation:

Firstly find the number of moles of K_2CO_3 required then calculate the mass of K_2CO_3

$C = \frac{n}{V}$, therefore $n = CV = 0.005M \times 3.00L = 0.015$ moles

$n = \frac{m}{M}$, therefore $m = nM = 0.015 \times (39 \times 2 + 12 + 16 \times 3) = 2.07g$

Question 14

Answer:

Explanation:

Determine the balanced equation for the reaction between acid and the base:

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Calculate the number of moles of NaOH. $n = \frac{m}{M} = \frac{12.0g}{40} = 0.30$ moles of NaOH

From the equation n(H_2SO_4) : n(NaOH) = 1:2 therefore 0.30 moles of NaOH will require 0.15 moles of H_2SO_4.

Using $C = \frac{n}{V}, V = \frac{n}{C}$. Vol $(H_2SO_4) = \frac{0.15mol}{3.35} = 17.9ml$

Question 15

Answer: A

Explanation:

Dilute or concentrated refers to the actual amount of acid or base in solution. 0.05 mol L^{-1} would be considered dilute. A strong or weak base is determined by the extent to which the base is accepts a proton (H^+). NH_3 solutions only partially accept protons and hence are weak bases.

Question 16

Answer: D

Explanation:

The question asks for the highest pH. At 25 °C acids have pH values below 7 and bases have pH values above 7. A, B and C are all acids and hence pH values below 7. D is a base which would have a pH value above 7 and hence the highest pH of the four options.

Question 17

Answer: A

Explanation:

To determine the conjugate acid, $H_2PO_4^-$ must be considered to act as a base as in the equation below:

$H_2PO_4^- + H_3O^+ \rightarrow H_3PO_4 + H_2O$
(Base) **(Conjugate Acid)**

Question 18

Answer: C

Explanation:

The main reason is to visually determine the end point. The equivalence point is when you have chemically equivalent amounts acid and base. The end point is when the indicator changes colour which is close to the equivalence point.

Question 19

Answer: C

Explanation:

N_2O, O_3, CH_4, H_2O, CO_2 are all gases that contribute to the enhanced Greenhouse Effect.

Question 20

Answer: A

Explanation:

The relationship described is the definition of Boyle's Law which was published by Robert Boyle in 1662.

SECTION B: Short-answer questions

Question 1

a.

i. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

One mark each for correct chemical formulae, states and balanced equation.

ii. Since all volumes are measured at STP, volume can be used as an indicator of amount of gas. For example, 20 mL of propane will react with 5×20 mL of oxygen for the above equation. Oxygen is the excess reagent. 20 mL of propane will produce 3×20 mL of CO_2. Answer is 60 mL of CO_2.

iii. 100mL of O_2 reacts from an initial 140 mL. 40 mL of O_2 remains.

iv. Initial volume = 20 mL C_3H_8 + 140 ml O_2 = 160 mL.
Final volume = 60 mL CO_2 + 80 mL H_2O + 40 mL excess O_2 = 180 ml
There is a 20 mL increase in volume.

v. At STP 1 mole occupies 22.4 L.

20 ml = 0.020 L. $\frac{0.020}{22.4} = 8.92 \times 10^{-4}$ mol of propane.

$n = \frac{m}{M} and\ m = n \times M.$

$m = 8.92 \times 10^{-4} \times (12 \times 3 + 1 \times 8) = 39.2mg\ or\ 0.0392g\ propane.$

3 + 2 + 1 + 2 + 3 = 11 marks
Total 11 marks

Question 2

a.

i. $HNO_3(aq) + NaHCO_3(s) \rightarrow NaNO_3(aq) + CO_2(g) + H_2O(l)$

One mark each for correct chemical formulae, states and balanced equation

ii. 1 mole nitric acid = 1 mole of bicarbonate of soda

moles of nitric acid $= \frac{m}{M} = \frac{18.6g}{(14+1+16\times3)} = 0.295$ m moles of $NaHCO_3$ required.

3 + 2 = 5 marks

b.

i. $[H_3O^+] = 10^{-pH}$

$[H_3O^+] = 10^{-11.50} = 3.16\times10^{-12}\,M$

Since at 25°C $[H_3O^+] \times [OH^-] = 10^{-14}$, the concentration of $[OH^-] = 3.16\times10^{-3}\,M$

$C = \frac{n}{V}$ rearranging gives $n(OH^-) = CV = 3.16\times10^{-3}\,M \times 0.5L = 1.58\times10^{-3}$ moles of OH^-

The formula of calcium hydroxide is $Ca(OH)_2$. Two moles of OH^- are required for 1 mole of $Ca(OH)_2$. Moles of $Ca(OH)_2 = \frac{1.58\times10^{-3}}{2} = 7.91\times10^{-4}$ 1.58 x 10^{-3}moles of $Ca(OH)_2$.

Finally, since $n = \frac{m}{M}$,

Rearranging gives $m = n \times M = 7.91\times10^{-4} \times (40 + (16+1) + (16+1)) = 0.0585g$ of $Ca(OH)_2$

ii. Several answers are possible. May include wear gloves, labcoat, fume cupboard, goggles, etc. Also do not add to the acid to water when diluting.

4 + 2 = 6 marks

Total 11 marks

Question 3

a.

i. Oxidant is HNO_3 or nitric acid

ii. Reducing agent is hydrogen sulphide or H_2S.

1 + 1 = 2 marks

b.

i. S is -2 and 0 respectively for H_2S and S

ii. N is +5 and +2 respectively for HNO_3 and NO

1 + 1 = 2 marks

c.

i. $HNO_3(aq) + 3H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(aq)$

ii. $H_2S(aq) \rightarrow S(s) + 2H^+(aq) + 2e^-$

iii. $2HNO_3(aq) + 3H_2S(aq) \rightarrow 2NO(g) + 4H_2O(aq) + 3S(s)$

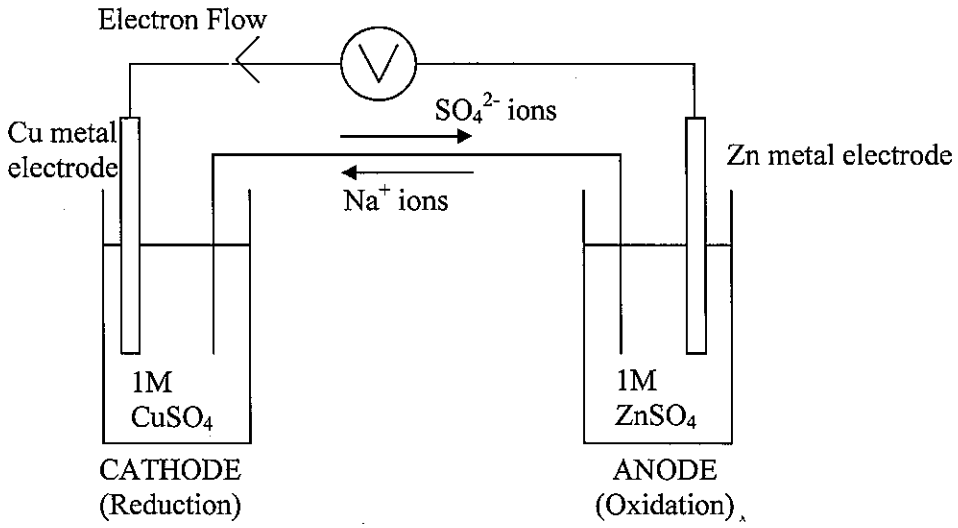
2 + 2 + 2 = 6 marks

Total 10 marks

Question 4

a.

i.



One mark for each item clearly labelled.

6 marks

b.

i. The copper sulphate solution will become a lighter shade of blue due to the removal of the Cu^{2+} ion which is reduced to copper metal.

ii. Several answers are possible. Typical answers may include: The Zn electrode is total reduced to Zn2+ and the Zn electrode does not complete the circuit. The anions or cations in the salt bridge are totally depleted. Copper ions depleted. Water evaporated from either the solutions or the salt bridge.

2 + 2 = 4 marks
Total 10 marks

Question 5

a.

i. The ozone layer is able to absorb biologically harmful ultraviolet (UV) radiation emitted from the Sun.

ii. The greenhouse effect is a natural phenomenon due to the presence of carbon dioxide and other greenhouse gases in the atmosphere. Global warming is the addition of further greenhouse gases to create an 'enhanced greenhouse effect' resulting in rapidly increasing temperatures on the planet.

iii. Carbon dioxide gas can be detected by bubbling through limewater. A positive result can be inferred if a cloudy precipate forms. Carbon dioxide will also readily extinguish a flame.

iv. The oceans contain vast quantities of 'locked' carbon dioxide in the form of carbonate and hydrogencarbonate ions.

v. Fire extinguishers and dry ice are the two most common applications. Also supercritical carbon dioxide and packing of fruit.

$1 + 2 + 2 + 1 + 2 = 8$ marks
Total 8 marks