This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 03

26JAN2024

Do NOT write in this box. Your MARK will be placed here.

Subject :	Chemistry
Class :	10A
Teacher :	Mrs. Saydeh Nasrallah
Duration :	1 hour

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Answer ALL questions.

Some questions must be answered with a cross in a box. If you change your mind about an answer, put a line through the box and then mark your new answer with a cross.

1. In this question the answer to each part is a **number**.

(a) Give the pH value of a neutral solution.

(1)

.....

(b) Give a pH value of a weakly acidic solution.

(1)

.....

(c) Give the number of the Group in the Periodic Table that contains the elements that do **not** readily react.

(1)

.....

(d) Give the number of different elements present in glucose, $C_6H_{12}O_6$.

(1)

.....

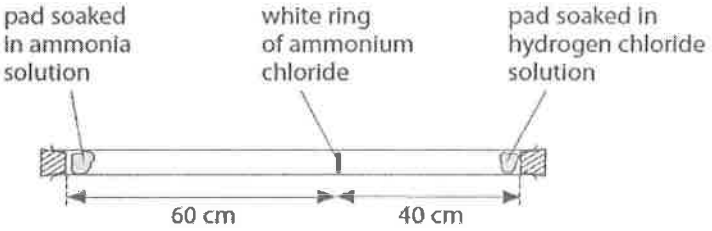
(Total for Question 1 = 4 marks)

2. When ammonia gas and hydrogen chloride gas mix, they react together to form a white solid called ammonium chloride.
The equation for the reaction is:

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

A cotton wool pad was soaked in ammonia solution and another was soaked in hydrogen chloride solution. The two pads were then put into opposite ends of a dry glass tube at the same time.

After five minutes, a white ring of solid ammonium chloride formed.



(a)(i) What name is given to the movement of the two gases?

(1)

.....

(ii) Identify which gas is moving faster and give a reason for your choice.

(1)

.....

.....

(b) The experiment was repeated at a higher temperature.
State and explain how this change would affect the time taken for the white ring to form.

(3)

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(c) Gas particles move at a speed of several hundred meters per second at room temperature. Suggest **one** reason why it took five minutes for the white ring to form.

(1)

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(Total for Question 2 = 6 marks)

3. When water is added to a mixture of sand and cement, a reaction takes place between silicon dioxide in the sand and calcium oxide in the cement.
The reaction produces a salt called calcium silicate. The equation for the reaction is:

$$SiO_2 + CaO \rightarrow CaSiO_3$$

(a) Explain why silicon dioxide reacts with calcium oxide.

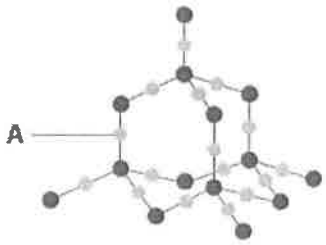
(2)

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(b) Part of the structure of silicon dioxide is shown in the diagram.



(i) What does particle **A** represent? Give a reason for your answer.

(2)

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(ii) Explain, in terms of its bonding and structure, why silicon dioxide has a very high melting point.

(4)

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(Total for Question 3 = 8 marks)

4. When sodium is burned in air, one of the products is a pale yellow solid, **X**.

(a) A sample of solid **X** was found to contain 1.15 g of sodium and 0.80 g of oxygen.

(i) Show, by calculation, that the empirical formula of **X** is NaO.

(2)

(ii) The relative formula mass of **X** is 78. Deduce the formula of **X**.

(2)

Formula of **X** .....

(b) Solid **X** reacts with water to form sodium hydroxide, NaOH, and hydrogen peroxide, H_2O_2

(i) Write a chemical equation to represent the reaction between **X** and water.

(2)

.....

(ii) The solution formed in the reaction between **X** and water turns red litmus blue.

Identify the ion that causes this change.

(1)

.....

(iii) The displayed formula for hydrogen peroxide is H—O—O—H.

Complete the dot and cross diagram to show the arrangement of the outer shell (valence) electrons in a molecule of hydrogen peroxide.

(2)



(Total for Question 4 = 9 marks)

5. This question is about the insoluble salt, lead(II) bromide.

Lead(II) bromide can be made by a precipitation reaction. This is the equation for the reaction.

$$Pb(NO_3)_2(aq) + 2KBr(aq) \rightarrow PbBr_2(s) + 2KNO_3(aq)$$

(a) Describe how solutions of lead nitrate and potassium bromide can be used to make a pure, dry sample of lead(II) bromide.

(4)

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(b) A solution containing 0.150 mol of lead(II) nitrate is reacted with an excess of potassium bromide solution.

A mass of 49.6 g of pure, dry lead(II) bromide is produced.

Show, by calculation, that the percentage yield of lead(II) bromide is 90.1%.

[$PbBr_2$, Mr = 367]

(2)

(Total for Question 5 = 6 marks)

6. A student is asked to find the concentration of a solution of nitric acid by doing a titration.

The student is provided with sodium hydroxide solution with a concentration of 0.350 mol/dm^3.

These are the first four steps in the student's method.

- use a pipette to add exactly 25.0 cm^3 of the nitric acid solution to a conical flask placed on a white tile
- add a few drops of indicator to the flask
- use a burette to add sodium hydroxide solution to the flask until the indicator has changed colour
- record the volume needed for the indicator to change colour

(a) Give the reason for using the white tile.

(1)

.....

.....

(b) Universal indicator is not a suitable indicator to use in a titration.
Complete the table to show the name of a suitable indicator and its final colour in this titration.

(2)

Indicator	Final colour in titration

(c) The student wants to obtain a reliable value for the volume of sodium hydroxide solution needed to neutralise the 25.0 cm^3 of nitric acid.
Describe all the further steps the student should take.

(5)

(d) This is a summary of the student's results.

volume of HNO_3 used = 25.0 cm^3
concentration of NaOH solution = 0.350 mol/dm^3
volume of NaOH solution needed for neutralisation = 18.80 cm^3

The equation for the reaction is

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

(i) Calculate the amount, in moles, of NaOH that reacts.

(1)

amount of NaOH = ... mol

(ii) Determine the amount, in moles, of HNO_3 that reacts.

(1)

amount of HNO_3 = ... mol

(iii) Calculate the concentration, in mol/dm^3, of HNO_3.

(1)

concentration = ... mol/dm^3.

(Total for Question 6 = 11 marks)

7. A student investigates the solubility of potassium nitrate in water.
She measures the masses of potassium nitrate that dissolve in 25 cm^3 of water at different temperatures.
The table shows the student's results. One of the results is anomalous.

Temperature in °C	10	20	30	40	50	60	70
Mass of potassium nitrate in g	9.0	10.0	12.5	16.0	17.5	26.5	34.0

(a) (i) Plot the results on the grid.

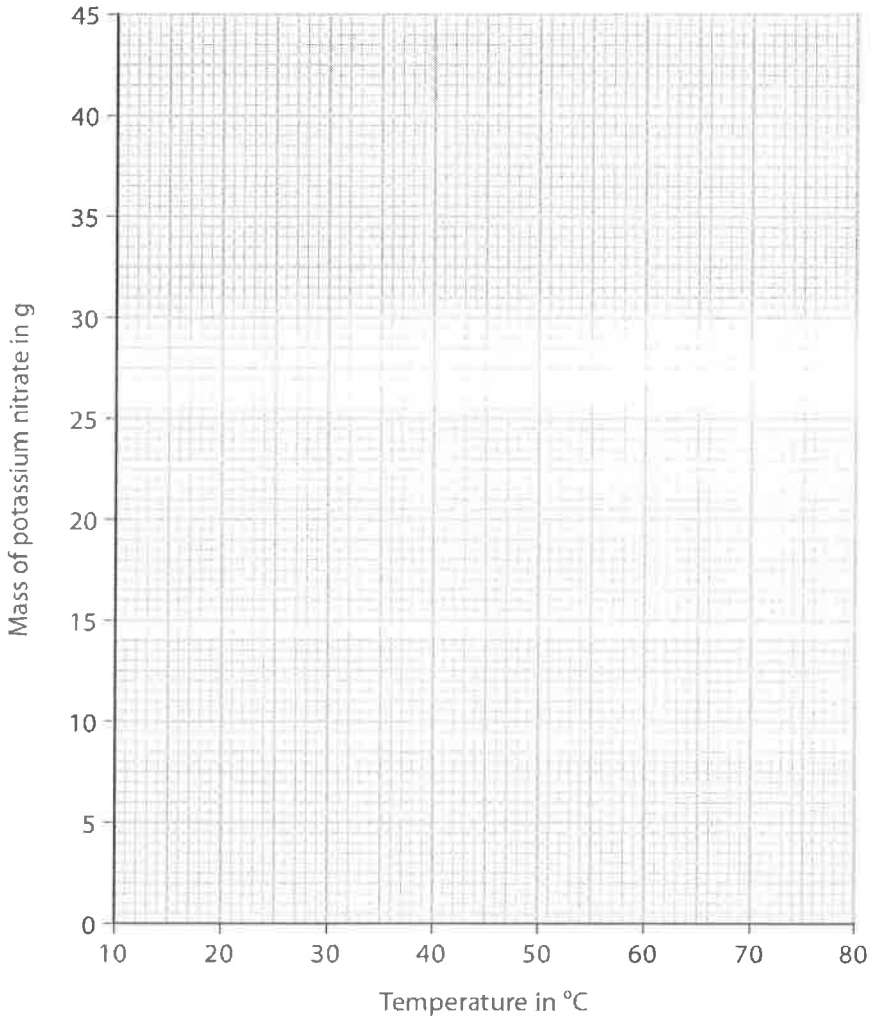
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Ignoring the anomalous result, draw a curve of best fit.

(1)



(b) Suggest **two** possible mistakes that could have caused the anomalous result.

(2)

1 .....

.....

2 .....

.....

(c) Use your graph to find the maximum mass of potassium nitrate that dissolves in 25 cm^3 of water at 75°C.
Show on your graph how you obtained your answer.

(2)

mass = ... g

(d) Use your graph to calculate the solubility of potassium nitrate in g per 100 g of water at 25°C.
[1.0 cm^3 of water has a mass of 1.0 g]

(2)

solubility = ... g per 100 g of water

(Total for Question 7 = 9 marks)

8. Carbon dioxide gas forms when dilute nitric acid is added to marble chips.
The word equation for the reaction is

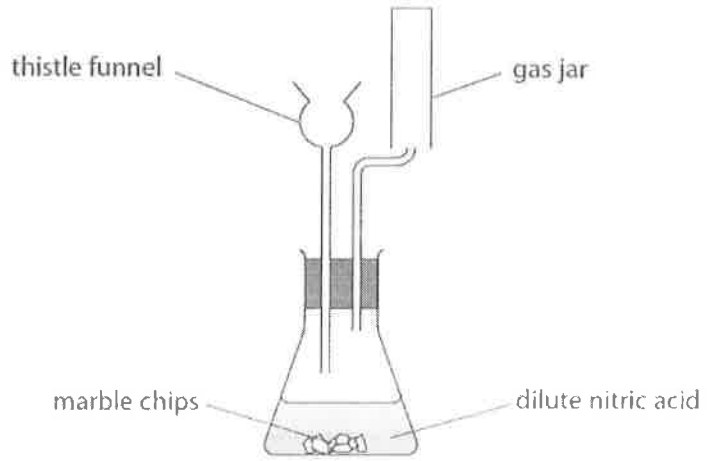
calcium carbonate + nitric acid → calcium nitrate + carbon dioxide + water

(a) Write a chemical equation for the reaction. Include state symbols.

(3)

.....

(b) A student needs to prepare and collect some carbon dioxide gas, using the reaction between marble chips and dilute nitric acid. The diagram shows how he sets up his apparatus.



(i) State two reasons why the student's set-up is not suitable for collecting carbon dioxide.

(2)

1 .....

.....

2 .....

.....

(ii) The student then sets up his apparatus correctly, but uses excess dilute sulfuric acid instead of dilute nitric acid.
The reaction produces calcium sulfate.
Explain why the reaction stops, even though there are still marble chips and unreacted sulfuric acid in the flask.

(2)

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.....

(Total for Question 8 = 7 marks)

TOTAL FOR PAPER = 60 MARKS

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Answer ALL questions.

Some questions must be answered with a cross in a box. If you change your mind about an answer, put a line through the box and then mark your new answer with a cross.

1. In this question the answer to each part is a number.

(a) Give the pH value of a neutral solution.

7 ✓ (1) (1)

(b) Give a pH value of a weakly acidic solution.

5 ✓ (1) (1)

(c) Give the number of the Group in the Periodic Table that contains the elements that do **not** readily react.

8 or 0 ✓ (1) (1)

(d) Give the number of different elements present in glucose, $C_6H_{12}O_6$.

3 ✓ (1) (1)

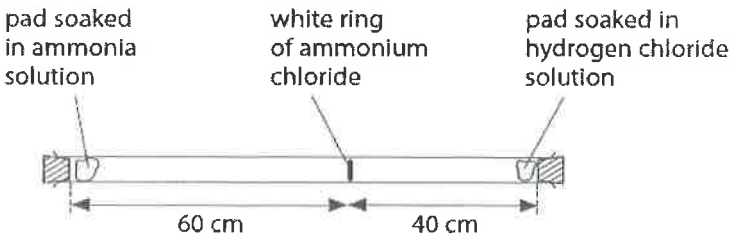
(Total for Question 1 = 4 marks)

2. When ammonia gas and hydrogen chloride gas mix, they react together to form a white solid called ammonium chloride.
The equation for the reaction is:

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

A cotton wool pad was soaked in ammonia solution and another was soaked in hydrogen chloride solution. The two pads were then put into opposite ends of a dry glass tube at the same time.

After five minutes, a white ring of solid ammonium chloride formed.



(a)(i) What name is given to the movement of the two gases?

Diffusion ✓ (1) (1)

(ii) Identify which gas is moving faster and give a reason for your choice.

Ammonia gas, as it diffused the longest distance within the same period of time (1) (1)

(b) The experiment was repeated at a higher temperature.
State and explain how this change would affect the time taken for the white ring to form.

Increasing the temperature increases the particles' kinetic energy (1) and therefore increases the rate at which the gases are diffusing, and reacting. (1)
As a result, it will take less than 5 minutes for the ring to form. (1) (3)

(c) Gas particles move at a speed of several hundred meters per second at room temperature. Suggest **one** reason why it took five minutes for the white ring to form.

It's the time taken for the particles to evaporate as solutions of ammonia and hydrogen chloride were used. (1)

(Total for Question 2 = 6 marks)

3. When water is added to a mixture of sand and cement, a reaction takes place between silicon dioxide in the sand and calcium oxide in the cement.
The reaction produces a salt called calcium silicate. The equation for the reaction is:

$$SiO_2 + CaO \rightarrow CaSiO_3$$

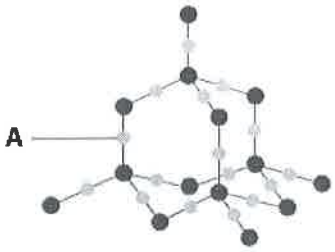
(a) Explain why silicon dioxide reacts with calcium oxide.

(2)

It's an acid - base reaction (1)

Metal oxide are basic while non-metal oxide are acidic. (1)

(b) Part of the structure of silicon dioxide is shown in the diagram.



(i) What does particle **A** represent? Give a reason for your answer.

(2)

It's oxygen (1)

Oxygen establishes 2 single covalent bonds. (1)

(ii) Explain, in terms of its bonding and structure, why silicon dioxide has a very high melting point.

(4)

Silicon dioxide has a giant covalent tetrahedral structure where the atoms of silicon and oxygen are covalently bonded. Huge amount of energy is needed to break these bonds which explains the high melting point. (4)

(Total for Question 3 = 8 marks)

4. When sodium is burned in air, one of the products is a pale yellow solid, **X**.

(a) A sample of solid **X** was found to contain 1.15 g of sodium and 0.80 g of oxygen.

(i) Show, by calculation, that the empirical formula of **X** is NaO.

(2)

Na	:	O
$\frac{1.15}{23}$		$\frac{0.80}{16}$
$\frac{0.05}{0.05}$		$\frac{0.05}{0.05}$ ✓
1	:	1 ✓

=> E.F : $(NaO)_x$ (2)

(ii) The relative formula mass of **X** is 78. Deduce the formula of **X**.

(2)

$x = \frac{78}{23+16} = 2$ ✓ (1)

Formula of **X** ..... Na_2O_2 ..... ✓ (1)

(b) Solid **X** reacts with water to form sodium hydroxide, NaOH, and hydrogen peroxide, H_2O_2

(i) Write a chemical equation to represent the reaction between **X** and water.

(2)

..... Na_2O_2 + $2H_2O$ ⟶ $2NaOH$ + H_2O_2 ..... (2)

(ii) The solution formed in the reaction between **X** and water turns red litmus blue.

Identify the ion that causes this change.

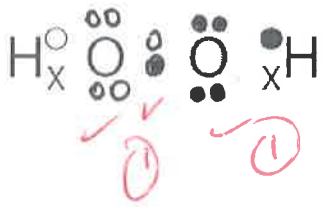
(1)

..... OH^- ✓ (1) .....

(iii) The displayed formula for hydrogen peroxide is H—O—O—H.

Complete the dot and cross diagram to show the arrangement of the outer shell (valence) electrons in a molecule of hydrogen peroxide.

(2)



✓ (1) ✓ (1)

(Total for Question 4 = 9 marks)

5. This question is about the insoluble salt, lead(II) bromide.
Lead(II) bromide can be made by a precipitation reaction. This is the equation for the reaction.

$$Pb(NO_3)_2(aq) + 2KBr(aq) \rightarrow PbBr_2(s) + 2KNO_3(aq)$$

(a) Describe how solutions of lead nitrate and potassium bromide can be used to make a pure, dry sample of lead(II) bromide.

(4)

At a ratio of 1 : 2, volumes of $Pb(NO_3)_2$ and KBr solutions, of equal concentrations, were placed in a beaker. ✓ (1)
The precipitate formed is allowed to settle. (1)
Using a conical funnel and a filter paper and a clean erlenmeyer, simple filtration is performed. ✓ (1)
The precipitate collected on filter paper is then rinsed with deionised water, dabbed with dry filter paper and (1)
placed in dessicator. ✓

(b) A solution containing 0.150 mol of lead(II) nitrate is reacted with an excess of potassium bromide solution.
A mass of 49.6 g of pure, dry lead(II) bromide is produced.
Show, by calculation, that the percentage yield of lead(II) bromide is 90.1%.
[$PbBr_2$, Mr = 367]

(2)

$n_{PbBr_2} = n_{Pb(NO_3)_2} = 0.150$ mol ✓

$\Rightarrow m_{PbBr_2} = 0.150 \times 367 = 55.05\,g$ ✓ (1)

$\%\ \text{yield} = \frac{49.6}{55.05} \times 100 = 90.09\%$ or 90.1% ✓ (1)

(Total for Question 5 = 6 marks)

6. A student is asked to find the concentration of a solution of nitric acid by doing a titration.

The student is provided with sodium hydroxide solution with a concentration of 0.350 mol/dm^3.

These are the first four steps in the student's method.

- use a pipette to add exactly 25.0 cm^3 of the nitric acid solution to a conical flask placed on a white tile
- add a few drops of indicator to the flask
- use a burette to add sodium hydroxide solution to the flask until the indicator has changed colour
- record the volume needed for the indicator to change colour

(a) Give the reason for using the white tile.

(1)

To better discernate the colour change at the endpoint ✓(1)

(b) Universal indicator is not a suitable indicator to use in a titration.
Complete the table to show the name of a suitable indicator and its final colour in this titration.

(2)

Indicator	Final colour in titration
litmus solution ✓(1)	indigo ✓(1)

(c) The student wants to obtain a reliable value for the volume of sodium hydroxide solution needed to neutralise the 25.0 cm^3 of nitric acid.
Describe all the further steps the student should take.

(5)

. Rinse the conical flask with deionised water. ✓ (1)

. Deliver 25 cm^3 of nitric acid, using a 25 cm^3 pipette, into the flask and add a pH indicator (few drops). ✓ (1)

. Add sodium hydroxide from the burette, slowly slowly, and around the endpoint, add it dropwise onto the flask while swirling. ✓ (1)

. Record the volume needed for the colour to change. Ensure to read at eye level ✓

. Repeat the process until concordant values of the titres are obtained. ✓ (1)

. Find the mean titre & use it to calculate the concentration of HNO_3. ✓ (1)

(d) This is a summary of the student's results.

volume of HNO_3 used = 25.0 cm^3
concentration of NaOH solution = 0.350 mol/dm^3
volume of NaOH solution needed for neutralisation = 18.80 cm^3

The equation for the reaction is

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

(i) Calculate the amount, in moles, of NaOH that reacts.

(1)

$n_{NaOH} = 18.80 \times 10^{-3} \times 0.350$ ✓

(1)

amount of NaOH = 6.58×10^{-3} mol

(ii) Determine the amount, in moles, of HNO_3 that reacts.

(1)

$n_{HNO_3} = n_{NaOH}$

✓ (1)

amount of HNO_3 = 6.58×10^{-3} mol

(iii) Calculate the concentration, in mol/dm^3, of HNO_3.

(1)

$$[HNO_3] = \frac{6.58 \times 10^{-3}}{25 \times 10^{-3}}$$ ✓

✓ (1)

concentration = 0.263 mol/dm^3

(Total for Question 6 = 11 marks)

7. A student investigates the solubility of potassium nitrate in water.
She measures the masses of potassium nitrate that dissolve in 25 cm^3 of water at different temperatures.
The table shows the student's results. One of the results is anomalous.

Temperature in °C	10	20	30	40	50	60	70
Mass of potassium nitrate in g	9.0	10.0	12.5	16.0	17.5	26.5	34.0

(a) (i) Plot the results on the grid.

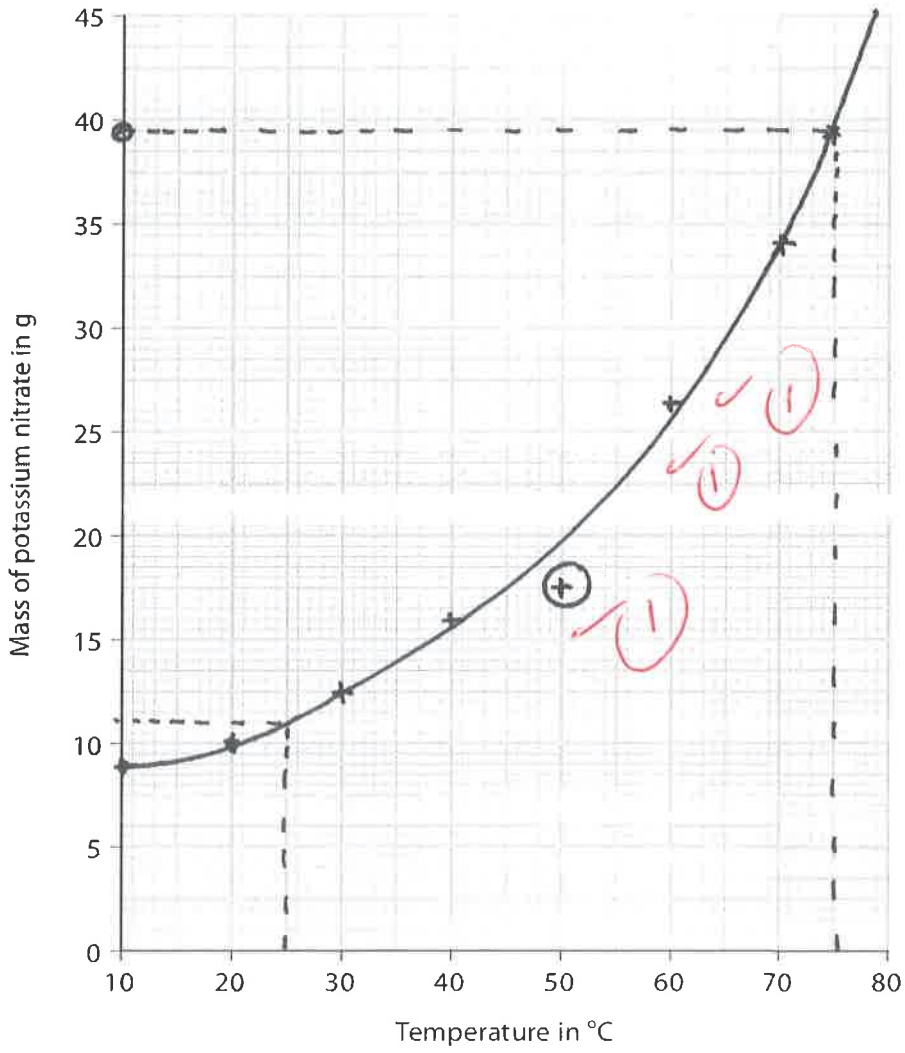
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Ignoring the anomalous result, draw a curve of best fit.

(1)



(b) Suggest **two** possible mistakes that could have caused the anomalous result.

(2)

1 Incorrect temperature / Temperature less than 50°C (1)

2 The dissolution of KNO_3 was incomplete (1)

(c) Use your graph to find the maximum mass of potassium nitrate that dissolves in 25 cm^3 of water at 75°C.
Show on your graph how you obtained your answer.

(2)

(2)

mass = 39.5 g

(d) Use your graph to calculate the solubility of potassium nitrate in g per 100 g of water at 25°C.
[1.0 cm^3 of water has a mass of 1.0 g]

(2)

@ 25°C , $S = \frac{11g}{25g} = \frac{x}{100}$ (1)

(1)

solubility = 44 g per 100 g of water

(Total for Question 7 = 9 marks)

8. Carbon dioxide gas forms when dilute nitric acid is added to marble chips.
The word equation for the reaction is

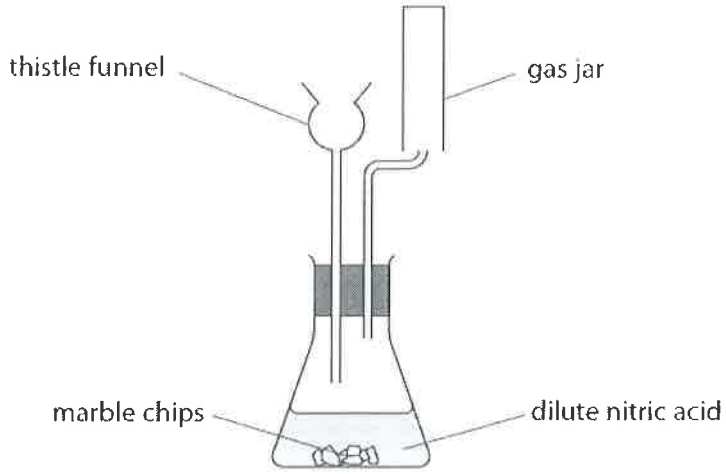
calcium carbonate + nitric acid → calcium nitrate + carbon dioxide + water

(a) Write a chemical equation for the reaction. Include state symbols.

(3)

$CaCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$ 3

(b) A student needs to prepare and collect some carbon dioxide gas, using the reaction between marble chips and dilute nitric acid. The diagram shows how he sets up his apparatus.



(i) State two reasons why the student's set-up is not suitable for collecting carbon dioxide.

(2)

1 The gas might escape through the thistle. (1)

2 CO_2 gas is a heavy gas and should be collected downward. (1)

(ii) The student then sets up his apparatus correctly, but uses excess dilute sulfuric acid instead of dilute nitric acid.
The reaction produces calcium sulfate.
Explain why the reaction stops, even though there are still marble chips and unreacted sulfuric acid in the flask.

(2)

The calcium sulfate produced is sparingly soluble (1). Thus it will form a layer on the marble chips and thus causing the reaction to stop. (1)

(Total for Question 8 = 7 marks)

TOTAL FOR PAPER = 60 MARKS

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.