NAME: ______________________________ (   ) **CLASS: 3E1**

HOUGANG SECONDARY SCHOOL

SEMESTRAL EXAMINATION 2 / 2019

CHEMISTRY 6092/01

Paper 1 Multiple Choice

SECONDARY THREE EXPRESS

Tuesday, 8 October 2019

Total duration for Paper 1 and Paper 2: **2 hours**

MAKE THE DIFFERENCE RESPECT OURSELVES RESPECT OTHERS MAKE THE DIFFERENCE RESPECT OURSELVES RESPECT OTHERS MAKE THE DIFFERENCE
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READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and register number on both the question paper and the Answer Sheet (OTAS) provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your answer in **soft pencil** on the OTAS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 12.
The use of an approved scientific calculator is expected, where appropriate.

Hand in Paper 1, Paper 2 and OTAS separately.

This document consists of 12 printed pages (including this cover page).

[Turn over

1 In which one of the following substances are the particles closest together?

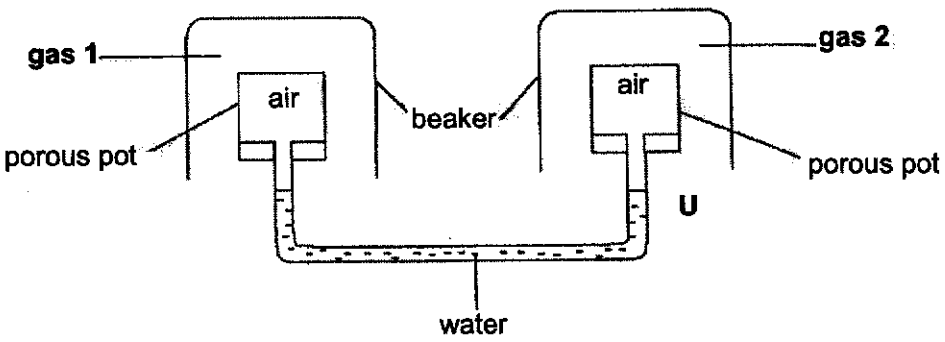
A dry ice

B hydrogen gas

C lithium fluoride solution

D molten iron

2 The apparatus in an experiment is set up using different gases in the two inverted beakers as shown.



Which pair of gases would cause an upward movement of the water level at **U**?

	gas 1	gas 2
A	CO_2	H_2
B	CO_2	N_2
C	H_2	CO_2
D	N_2	H_2

3 Which apparatus is most suitable for measuring 24.10 cm^3 of dilute sulfuric acid accurately?

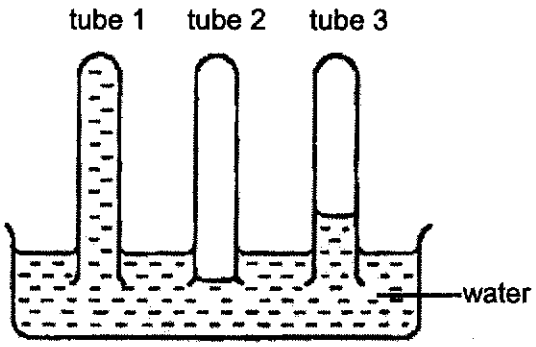
A beaker

B burette

C measuring cylinder

D pipette

4 Three test-tubes were filled with different gases and placed in a trough of water. After a period of time, the water had risen in two of the tubes as shown in the diagram.



Which of the following gases are in the tubes?

	tube 1	tube 2	tube 3
A	ammonia	carbon dioxide	hydrogen
B	ammonia	hydrogen	carbon dioxide
C	carbon dioxide	hydrogen	ammonia
D	carbon dioxide	ammonia	hydrogen

5 Heptene and water can be separated using a separating funnel.

What can be deduced about the two substances from this method of separation?

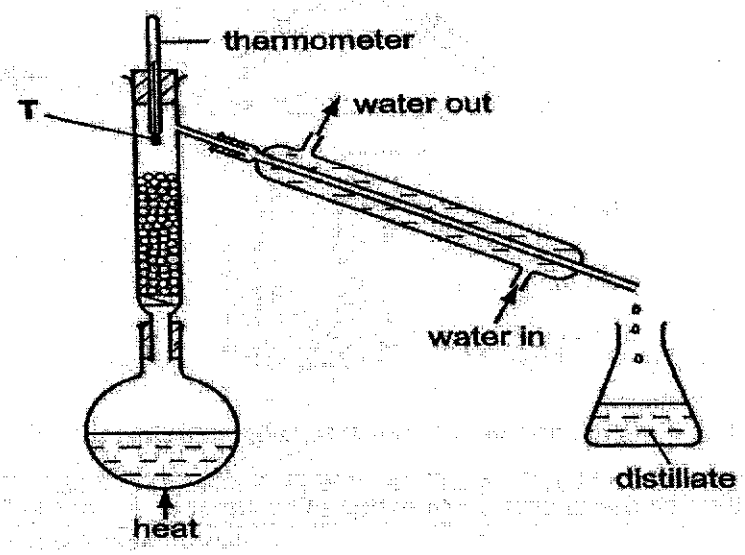
A Heptene and water have different boiling points.

B Heptene and water have different densities.

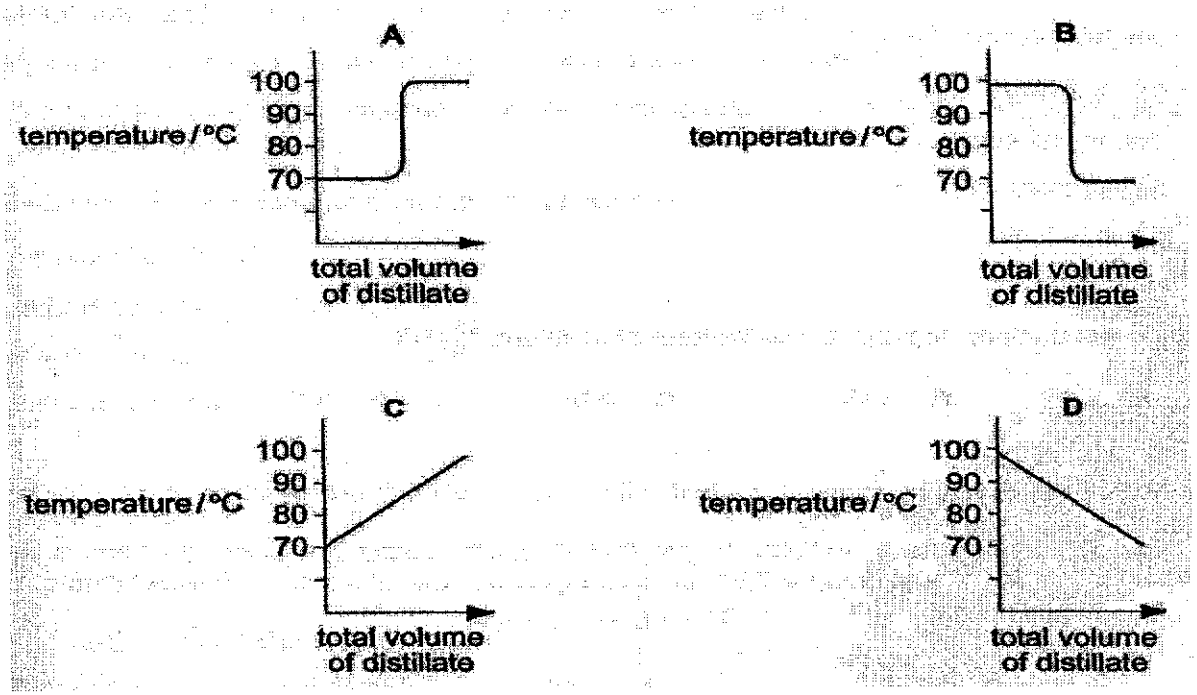
C Heptene and water have different relative molecular masses.

D Heptene is an insoluble gas and water is a liquid.

6 The diagram shows the apparatus used to separate hexane (boiling point of 70 °C) and heptane (boiling point of 98 °C).



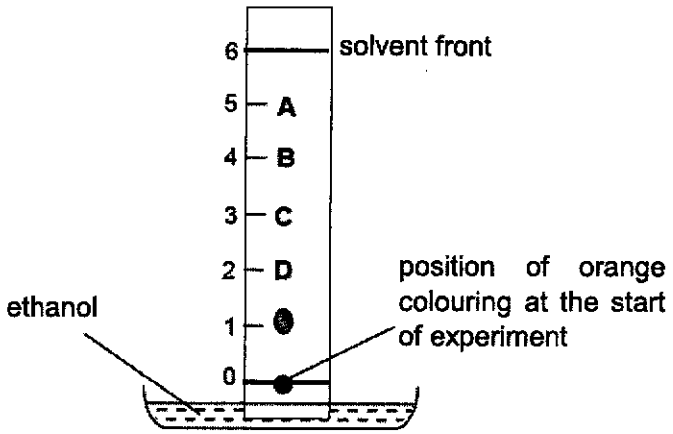
Which of the following graphs would be obtained if the temperature at point T was plotted against the total volume of distillate collected?



7 The purple colouring from a candy was extracted using a solvent and placed at the start line of a strip of filter paper dipped in ethanol. The colouring is known to contain two dyes with R_f values of 0.17 and 0.67.

One of the dyes is shown on the chromatogram.

What is the position of the other missing dye?



8 Which of the following is true of the substances in a mixture that are separated using paper chromatography?

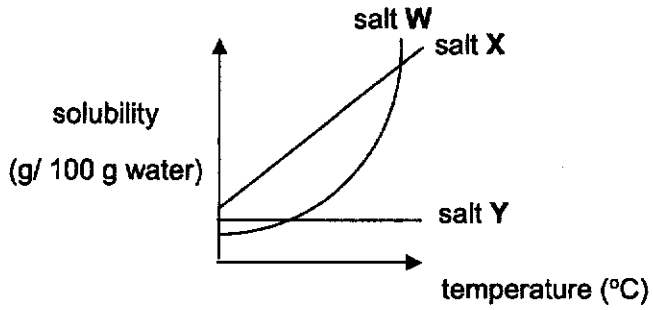
A The substances must be of different colours.

B The substances must be soluble in the solvent used.

C The substances must have different densities.

D The substances must have the same R_f values in the different solvents used.

9 From the solubility curves shown, which salt(s) can be prepared by crystallisation?



A **W** only

B **X** only

C **W** and **X** only

D **X** and **Y** only

10 Some brown solid is placed in a test tube and excess water was added to it. The test tube is shaken and the contents are filtered. A white solid is left on the filter paper. The filtrate are heated and orange crystals are formed.

What do these observations suggest?

A The brown solid is a compound.

B The brown solid is a mixture.

C The orange crystal is an element.

D The white solid is an element.

11 What are the similarity between the structure of $^{26}_{12}Mg$ and $^{28}_{14}Si$?

A They contain the same number of electrons.

B They contain the same number of neutrons.

C They have the same atomic number

D They have the same nucleon number.

12 Two particles **Q** and **R** have the composition shown in the table.

particle	number of electrons	number of neutrons	number of protons
Q	10	8	8
R	18	18	17

The particles **Q** and **R** are

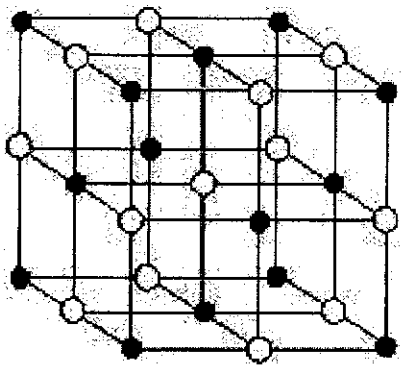
A metal atoms.

B non-metal atoms.

C negative ions.

D positive ions.

13 The diagram shows the lattice structure of an ionic compound made up of elements **Y** and **Z**.



● -atom of **Y**

O -atom of **Z**

What is the formula of the compound?

A **YZ** **B** Y_2Z **C** YZ_3 **D** Y_2Z_3

14 Which compound has both ionic and covalent bonds?

A ammonium fluoride

B ammonia

C carbon monoxide

D magnesium chloride

15 Which statement explains why magnesium oxide has a higher melting point as compared to sodium chloride?

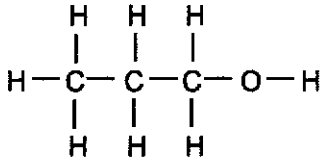
A Magnesium is more reactive than sodium.

B Magnesium oxide has a larger molecular size as compared to sodium chloride.

C Magnesium oxide is an ionic compound but sodium chloride is a covalent compound.

D The attraction between Na^+ and Cl^- is weaker than that between Mg^{2+} and O^{2-}.

16 The structure of propanol is shown.



How many of the electrons in a molecule of propanol are **not** involved in bonding?

A 0 **B** 4 **C** 10 **D** 12

17 Which pair of substances has a giant molecular structure?

A diamond, iodine

B diamond, silica

C methane, iodine

D methane, iron

18 Some information about oxide of **Q** are listed.

1 It has a high melting point and is insoluble in water.

2 It reacts with either hydrochloric acid or aqueous sodium hydroxide to give a salt and water.

3 Q can form a compound with chlorine with the formula QCl_2.

Deduce the identity of oxide of **Q**.

A Al_2O_3 **B** H_2O **C** MgO **D** ZnO

19 The table gives the electrical conductivity of three substances.

P	conducts when dissolved in water only
Q	conducts when solid and when molten
R	does not conduct under any condition

What could be the identity of **P**, **Q** and **R**?

	P	**Q**	**R**
A	ammonia	magnesium chloride	carbon
B	ammonia	zinc	chlorine
C	ethanol	ammonia	zinc
D	magnesium chloride	zinc	chlorine

20 Which of the following shows the correct relative formula mass of copper(II) nitrate crystals, $Cu(NO_3)_2.\ 3H_2O$?

A 121 **B** 144 **C** 242 **D** 618

21 The formula of an oxide of element **Y** is Y_2O.

17.4 g of Y_2O contains 14.2 g of **Y**.

How many moles of **Y** does 14.2 g of the element contain?

A (3.2 ÷ 16) x 2

B (3.2 ÷ 16) x (1 ÷ 2)

C (17.4 ÷16) x 2

D (17.4 ÷ 16) x (1 ÷ 2)

22 The complete combustion of ethane is represented by the following reaction:

$$C_2H_4\ (g) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 2H_2O\ (l)$$

20 cm^3 of ethane reacts with 100 cm^3 of oxygen in a closed container.

What is the total volume of gas collected at room temperature at the end of the reaction?

A 80 cm^3 **B** 100 cm^3 **C** 120 cm^3 **D** 140 cm^3

23 The pH of a dilute hydrochloric acid is 2.

What will be the pH of the acid after the addition of 15 g of sodium chloride?

A pH 1 **B** pH 2 **C** pH 7 **D** pH 10

24 Which of the following will react with aqueous ammonium chloride to produce an alkaline gas?

A calcium hydroxide

B magnesium sulfate

C sulfuric acid

D zinc chloride

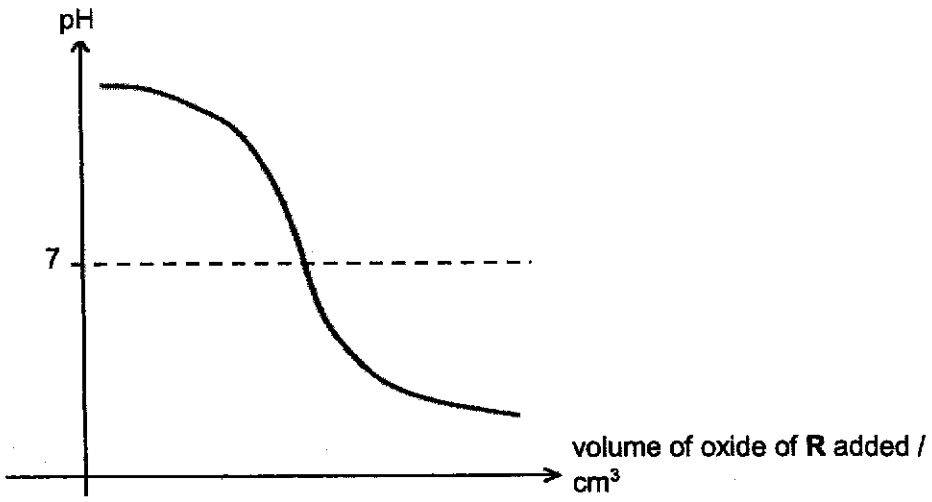
25 The table shows the information about three different indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
congo red	blue	5	red
phenolphthalein	colourless	10	red
thymol blue	red	3	yellow

Which of the following shows the correct observations when each indicator is added separately to a weak acid?

	congo red	**phenolphthalein**	**thymol blue**
A	blue	colourless	red
B	blue	red	yellow
C	colourless	red	red
D	red	colourless	yellow

26 Oxide of **R** is bubbled into a solution of oxide of **Q**. The graph shows the change in the pH during the reaction.



What could be oxide of **Q** and **R**?

	oxide of **Q**	oxide of **R**
A	carbon monoxide	zinc oxide
B	copper(II) oxide	carbon dioxide
C	nitrogen dioxide	potassium oxide
D	sodium oxide	sulfur dioxide

27 Element **Q** burns in air to give a product that dissolves in water to form an acidic solution.

What is element **Q**?

A carbon

B helium

C hydrogen

D iron

28 Which of the following is the best pair of reagents to prepare a pure sample of copper(II) sulfate crystals?

A copper and sulfuric acid

B copper(II) carbonate and calcium sulfate

C copper(II) nitrate and sulfuric acid

D copper(II) oxide and sulfuric acid

29 Which statement describes oxidation?

A Electrons are gained and the oxidation state decreases.

B Electrons are gained and the oxidation state increases.

C Electrons are lost and the oxidation state decreases.

D Electrons are lost and the oxidation state increases.

30 A carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals. When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.

$$CO\ (g) + PdCl_2\ (s) + H_2O\ (l) \rightarrow CO_2\ (g) + Pd\ (s) + 2HCl\ (aq)$$

Which element has its oxidation number increased?

A carbon

B chlorine

C oxygen

D palladium

End of Paper 1

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

NAME: ______________________________ (   )   **CLASS: 3E1**

HOUGANG SECONDARY SCHOOL

SEMESTRAL EXAMINATION 2 / 2019

CHEMISTRY 6092/02

Paper 2

SECONDARY THREE EXPRESS

Tuesday, 8 October 2019

Total duration for Paper 1 and Paper 2: **2 hours**

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READ THESE INSTRUCTIONS FIRST

Write your name and register number at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A (40 marks)
Answer **all** questions in the spaces provided.

Section B (20 marks)
Answer all **two** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 19.

The use of an approved scientific calculator is expected, where appropriate.

Hand in Paper 1, Paper 2 and OTAS separately.

For Examiner's Use	
Paper 1	/30
Paper 2 Section A	/40
Section B	/20
Total	**/90**

This document consists of **19** printed pages (including this cover page).

[Turn over

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 40.

A1 **(a)** Use the list of substances to answer the questions.

copper	helium	silver chloride
chlorine	air	steel
diamond	iron	silicon dioxide

(i) Which substance is ionic?

.....[1]

(ii) Which substance is a compound with a giant molecular structure?

.....[1]

(iii) Which substance is a mixture containing both elements and compounds?

.....[1]

(iv) Which substance can be prepared by precipitation method?

.....[1]

(b) Draw a 'dot-and-cross' diagram to show the bonding in the substance in **(a)(i)**.
Show the valence electrons only.

[2]

[Total: 6]

A2 Complete the table.

nuclide notation of particle	number of proton	number of neutron	number of electron
$^{39}_{19}K^{+}$			
	15	17	18

[3]

[Total: 3]

A3 The table shows the variation of atomic and ionic radius of elements across Period 3, excluding silicon and argon.

element	atomic radius/ nm	simple ion	ionic radius/ nm	number of electron shells in simple ion
Na	0.191	Na^{+}	0.102	2
Mg	0.160	Mg^{2+}	0.072	
Al	0.130	Al^{3+}	0.054	2
P	0.110	P^{3-}	0.212	
S	0.102	S^{2-}	0.184	3
Cl	0.099	Cl^{-}	0.181	3

(a) Complete the table to show the number of electron shells in the simple ions of elements Mg and P. [2]

(b) Use the information from the table to explain why the radii of cations are generally smaller than that of anions found in the same period.

.....

.....

.....[1]

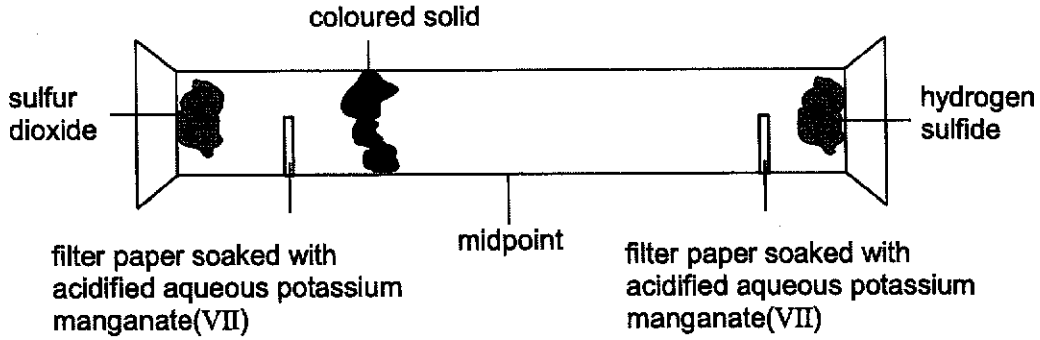
(c) Suggest why there is no value stated for the ionic radius of argon.

.....

.....[1]

[Total: 4]

A4 The diagram shows an experimental set-up in which sulfur is formed in the reaction between hydrogen sulfide and sulfur dioxide.



The equation for the reaction between hydrogen sulfide and sulfur dioxide is given below.

$$2H_2S\ (g) + SO_2\ (g) \rightarrow 3S\ (s) + 2H_2O\ (l)$$

(a) Draw a 'dot-and-cross' diagram to show the bonding in hydrogen sulfide. Show the valence electrons only.

[2]

(b) Explain why the coloured solid does not form at the midpoint of the tube.

.....

.....

.....

.....[2]

(c) Complete the table.

gaseous compound	hydrogen sulfide	sulfur dioxide
oxidation state of sulfur		

[2]

[Total: 6]

A5 Outline the preparation of a pure, dry sample of lead(II) nitrate crystals from a named acid and lead(II) carbonate.

.....

.....

.....

.....

.....

.....

.....

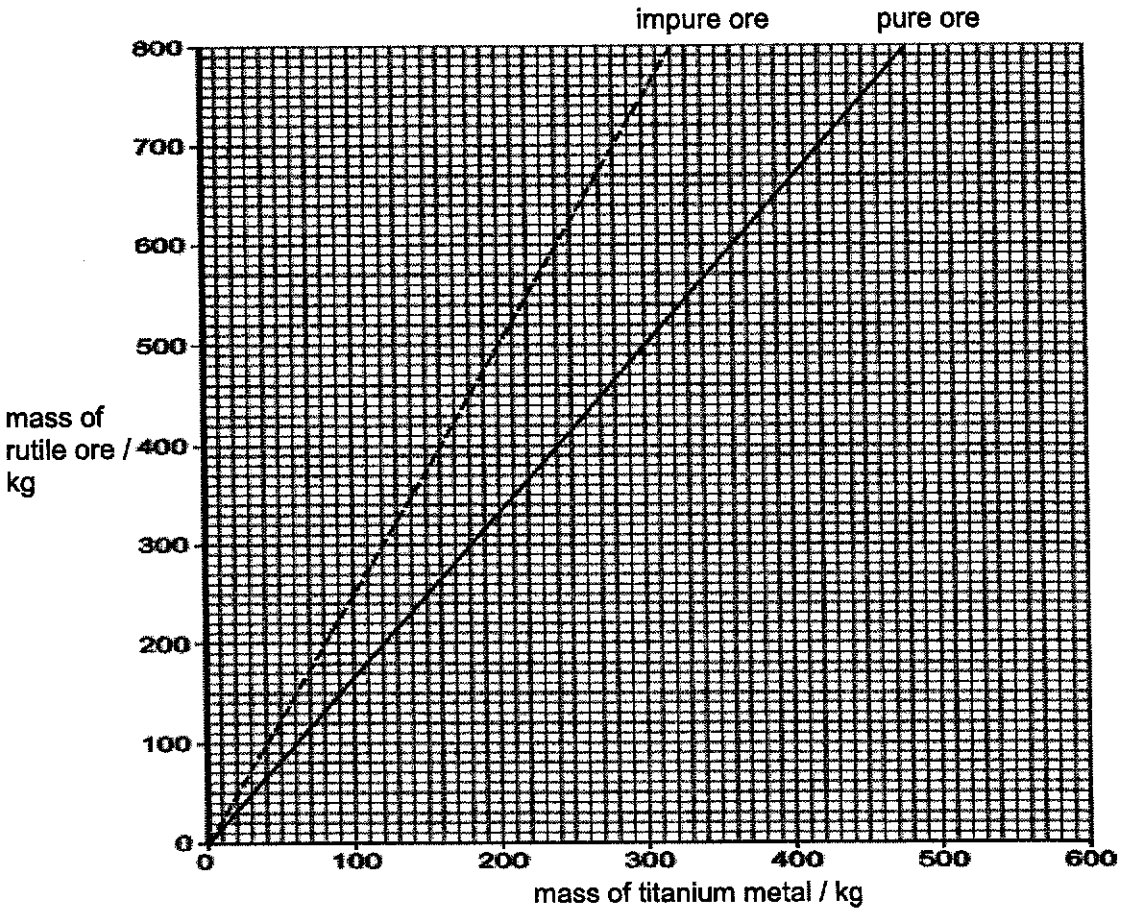
.....

.....

.....[4]

[Total: 4]

A6 Titanium can be extracted from its ore, rutile, mainly an oxide of titanium. The graph shows the mass of titanium metal that can be produced from pure and impure rutile.



(a) What is the mass of titanium that can be obtained from 500 kg of pure rutile?

.....[1]

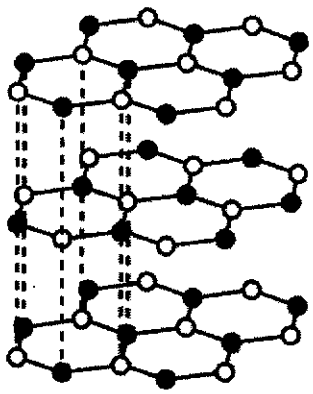
(b) Hence, calculate the empirical formula of rutile.

[3]

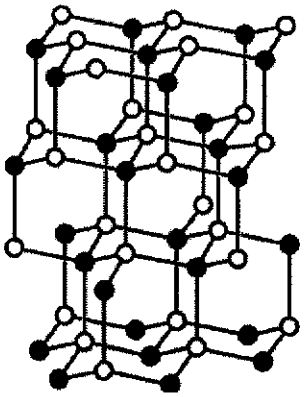
[Total: 4]

A7 Boron nitride, BN, exists in two physical forms. The structures of these forms are shown.

Key
- ● boron
- ○ nitrogen



structure **X**



structure **Y**

(a) Explain, in terms of structure and bonding, why boron nitride with structure **X** can be used as a lubricant.

.....

.....

.....

.....

.....

.....

.....[3]

(b) Suggest, with reasons, why boron nitride with structure **X** is unable to conduct electricity.

.....

.....

.....[2]

(c) Explain, in terms of structure and bonding, why boron nitride with structure **Y** is used in drill bits and cutting tools.

.....

.....

.....

.....

.....[2]

[Total: 7]

A8 Ammonia is used to make ammonium phosphate and ammonium nitrate.

(a) Ammonium phosphate contains ammonium ion, NH_4^+, and phosphate ion, PO_4^{3-}. What is the formula for ammonium phosphate?

.....[1]

(b) Phosphate ions are present in the waste water from the factory making ammonium nitrate. One way of treating the water to remove these phosphate ions is by adding calcium ions. The calcium ions react with the phosphate ions to form a precipitate.

Write an ionic equation, with state symbols, for the precipitation reaction above.

.....[2]

(c) The waste water also contains nitrate ions.

Explain why nitrate ions cannot be removed by adding calcium ions.

.....

.....[2]

(d) The bags of ammonium nitrate fertiliser have the following warning label on them.

Do not add fertiliser to soil that has been recently treated with any lime-containing product.

The main lime-containing product used on farms is calcium hydroxide.

Why is it important **not** to add ammonium compounds to soils that have been treated recently?

.....

.....[1]

[Total: 6]

Section B

Answer **two** questions in this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B9 Instrumental techniques in analysis

Flame tests for Group I elements

Flame test were used in 1850s. Robert Bunsen developed the Bunsen burner and used it to show that many metals give characteristic colours when they are heated in the flame. The colour comes from light emitted by individual atoms when they become very hot. For example, sodium gives a very intense yellow-orange colour. The table shows the flame colours of Group I elements.

element	flame colour
lithium	red
sodium	yellow-orange
potassium	pale violet
rubidium	red-violet
caesium	blue-violet

Group I element emission spectra

Bunsen realised that, in practice, it was difficult to use flame tests to identify elements in mixtures. In the 1860s, Bunsen worked with fellow scientist, Gustav Kirchhoff. They used a spectroscope to split the colours of the flames into individual lines. They found that atoms of an element each give a characteristic pattern of lines which is known as an emission spectrum. Fig. 9.1 shows the emission spectra of some Group I elements.

Emission spectra from elements can be used as a reference. They can be compared with the emission spectrum of a mixture so that individual elements in the mixture can be identified. This technique is used today to analyse light from stars to work out which elements are present in the star.

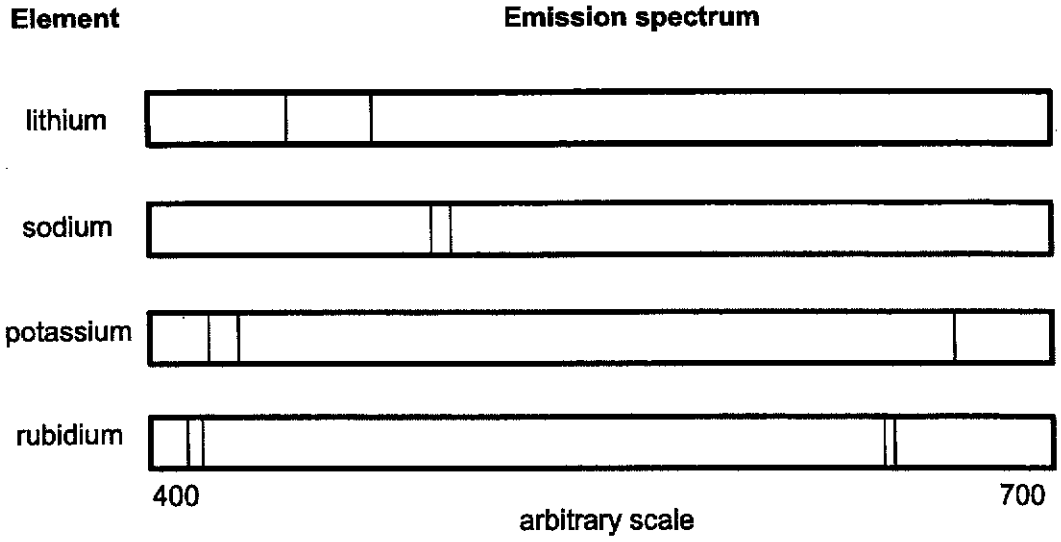


Fig. 9.1

Ion chromatography of a sample of water

In the 1950s, ion chromatography was developed. This techniques involves passing a sample through a chromatography column, Different ions travel through the column at different speeds. A detector is attached to the end of the column. The results are printed out as a graph.

The **retention time** is the time it takes each ion to travel through the column. Ions can be identified by retention times. The position of the peaks show the retention time of each ion.

The **height** of each peak (relative intensity) is proportional to the **relative amount** of each ion in the sample.

Ion chromatography can be used to identify any ion, even those which contain multiple atoms, such as sulfate ion.

The ion chromatography analyses of a sample of water from a natural source are shown in Fig. 9.2 and Fig. 9.3.

Fig. 9.2 shows the ion chromatogram of positive ions in a sample of water.

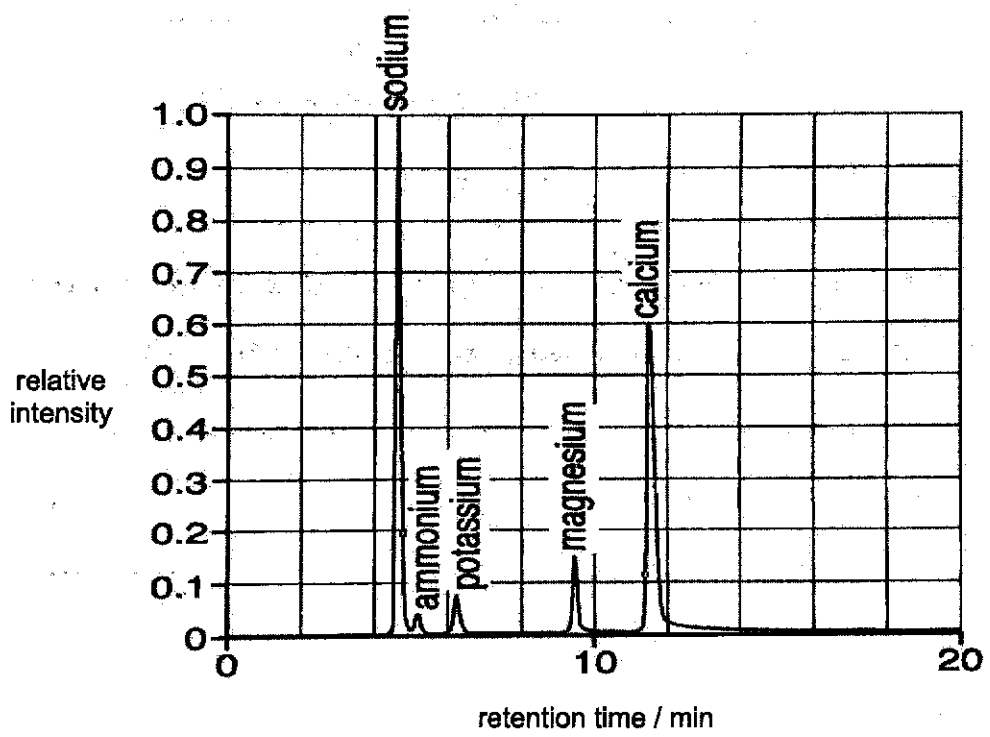


Fig. 9.2

Fig. 9.3 shows the ion chromatogram of negative ions in a sample of water.

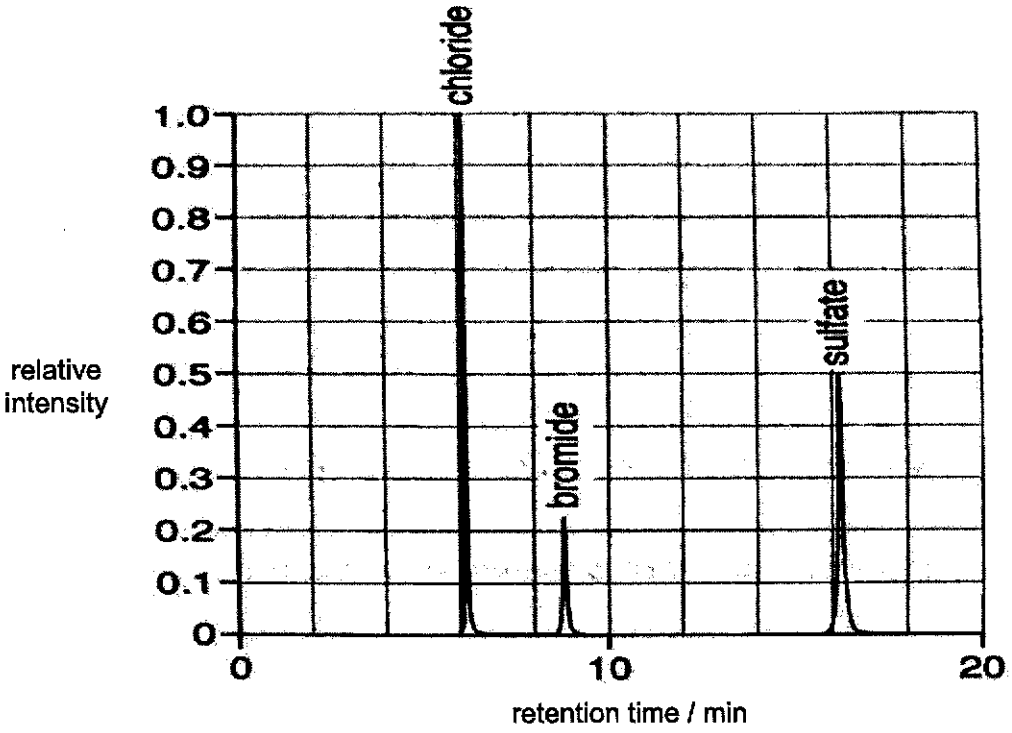


Fig. 9.3

(a) Bunsen said that it is difficult to use flame tests to identify elements in mixtures.

Explain why it is difficult to use flame tests to identify which Group I elements are in a mixture.

.....

.....

.....[2]

(b) This is the emission spectrum from a mixture.

arbitrary scale

(i) What conclusions can you make about which Group I elements this mixture does and does not contain?

Explain your reasoning.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) What additional information would you need so that you could use the spectrum to identify all the elements in the mixture?

.....

.....[1]

(c) Further analysis of the same sample of water that was tested by **ion chromatography** was done.

(i) The sample was analysed to find out the concentration of sodium ions.

The first stage was to crystallise solid salts from the water.

Give the formulae of three different sodium salts which could crystallise from the water sample.

salt 1 .....

salt 2 .....

salt 3 .....[2]

(ii) The concentration of calcium ions in the water is 0.00420 mol/dm^3.

Calculate the concentration of magnesium ions and the concentration of sodium ions in the water.

[2]

(d) A student comments that the ion chromatograms give more information about mixtures than the emission spectrum.

Give reasons to support his idea.

.....

.....

.....

.....[2]

[Total: 12]

EITHER

B10 A solution of a dibasic acid containing a polyatomic anion, **X**, with a concentration of 13.4 g/dm^3, is titrated against sodium hydroxide solution of 0.200 mol/dm^3. It is found that 15.2 cm^3 of this acid solution reacts exactly with 10.4 cm^3 of sodium hydroxide solution. The products of the reaction are Na_2X and water.

(a) Calculate the concentration of this acid in mol/dm^3.

[2]

(b) Calculate the relative molecular mass of the acid.

[2]

(c) Hence, deduce the identity of the acid and the salt produced.

.....

.....[2]

(d) Acid dissociation constant, K_a is a quantitative measure of the strength of an acid in solution. The table shows the K_a values of some common acids.

acid	K_a
citric acid	7.4×10^{-4}
ethanoic acid	1.8×10^{-5}
hydrochloric acid	1.3×10^{6}
sulfuric acid	1.0×10^{3}
phosphoric acid	6.9×10^{-3}

Using the information from the table, state and explain the relationship between the strength of an acid and its K_a value.

.....

.....

.....

.....

.....[2]

[Total: 8]

OR

B10 Lemons are known as citrus fruits as they contain an acid known as citric acid, $C_6H_8O_7$. Citric acid is a *weak tribasic acid*. In aqueous solution, the following reaction occurs.

$$C_6H_8O_7\,(aq) \rightleftharpoons C_6H_5O_7^{3-}\,(aq) + 3H^+\,(aq)$$

(a) Explain why citric acid is termed as a '*weak tribasic acid*'.

.....

.....

.....[2]

(b) Citric acid can be used to remove rust, iron(III) oxide. The equation for the reaction between rust and citric acid is shown.

$$2C_6H_8O_7 + Fe_2O_3 \rightarrow 2C_6H_5O_7Fe + 3H_2O$$

In a separate experiment, 19.2 g of critic acid and 1.6 g of iron(III) oxide were reacted together. At the end of the reaction, only 4.08 g of the salt was obtained.

(i) Identify the reactant in excess.

[2]

(ii) Hence, or otherwise, calculate the percentage yield of the salt.

[3]

(iii) A student decided to add critic acid powder into a dry kettle to remove rust. State and explain whether this method is effective for rust removal.

.....

.....[1]

[Total: 8]

End of Paper 2

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lantharum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

2019 HS 3E Chemistry SA1 Answer

Paper 1

1	2	3	4	5	6	7	8	9	10
A (E)	C	B (E)	B (M)	B (E)	A (H)	B	B	C (H)	B (E)

11	12	13	14	15	16	17	18	19	20
B (E)	C (E)	A (E)	A (E)	D (H)	D	B (E)	D	B	C (E)

21	22	23	24	25	26	27	28	29	30
A (H)	A (H)	B (E)	A (E)	D	D (H)	A	D (E)	D (E)	A (E)

	Easy	Hard
Mark	15	6
Percentage	50%	20%

Paper 2

A1ai	silver chloride	1	E
ii	silicon dioxide	1	
Iii	air	1	E
iv	silver chloride	1	E
b		1 – correct no. of electrons transfer and charges of ions 1- correct no. of valence electrons for all atoms (Ag+ ion must be represent ed by	E

		empty shell)	
		[6]	
A2	19 ; 20 [1] ; 18 [1] $^{32}_{15}P^{3-}$ [1]	1; 1 1	E; E
		[3]	
A3a	2 [1] ; 3 [1]	1 ; 1	E; E
b	**Cations** consist of **1 less electron shell** as compared to anions in the same period, thus, the radius of cations are generally smaller.	1	E
c	Argon atom has **fully filled electron shells** and thus do not form ion.	1	E
		[4]	
A4a		1 – correct no. of shared electrons 1- correct no. of valence electrons for all atoms	E E
b	**Hydrogen sulfide** (Mr = 34) has a **smaller relative molecular mass/ lower density** compared to sulfur dioxide (Mr = 64). Therefore, **hydrogen sulfide diffuses faster to the left** than **sulfur dioxide to the right** which resulted in the coloured solid forms nearer to sulfur dioxide.	1 1	E
c	-2 +4	1 1	E E
		[6]	
A5	Add **excess** lead(II) carbonate while stirring into a beaker of warm **dilute nitric acid** until no more can dissolve. **Filter** the mixture to remove the excess lead(II) carbonate and **collect the filtrate, lead(II) nitrate solution**. **Heat** the filtrate to evaporate the water until it is **saturated.** **Cool** the solution so that lead(II) nitrate **crystals** can be formed. **Filter** to collect the crystals and **wash** it with a small volume of cold **distilled water**. **Dry them between pieces of filter papers**.	**6 pts- 4 m** **4 – 5 pts-3m** **2 -3 pts- 2m** **1-2pts- 1m**	2m – E

<table>
<tr><td>A6a

A6b</td><td>300 kg of titanium

<table><tr><td>Element</td><td>Ti</td><td>O</td></tr><tr><td>Mass /g</td><td>300 000</td><td>200 000</td></tr><tr><td>No. of mole/ mol</td><td>300 000/ 48 = 6250</td><td>200 000 /16 = 125 00</td></tr><tr><td>Ratio</td><td>1</td><td>2</td></tr></table>
Empirical formula is TiO_2</td><td>1

1

1

1</td><td>

E

E

E</td></tr>
<tr><td></td><td></td><td>[4]</td><td></td></tr>
<tr><td>A7a</td><td>Boron nitride with structure X has a giant molecular structure where the boron and nitrogen atoms are <u>covalently bonded</u> to three other <u>atoms in layers</u> of hexagonal arrangement.

A <u>small amount</u> of energy/force is required to <u>overcome the weak intermolecular forces of attraction between</u> the layers of <u>atoms</u>.

Thus, the layers of atoms can <u>slide over each other easily</u> and this leads to boron nitride being slippery, to use as a lubricant.</td><td>1

1

1</td><td>

E

E</td></tr>
<tr><td>b</td><td>All <u>the valence electrons</u> in boron are <u>used for bonding</u>.

Thus, there are <u>no free moving electron</u> or ion to conduct electricity.</td><td>1

1</td><td>

E</td></tr>
<tr><td>c</td><td>It has a giant molecular structure with an <u>extensive network / millions / tetrahedral arrangement of</u> boron and nitrogen <u>atoms are bonded by strong covalent bonds</u>.

A <u>large amount of energy/force</u> is required to overcome the strong covalent bonds between the atoms in boron nitride with structure Y, making diamond hard.</td><td>1

1</td><td>

E</td></tr>
<tr><td></td><td></td><td>[7]</td><td></td></tr>
<tr><td>A8a</td><td>$(NH_4)_3\ PO_4$</td><td>1</td><td>E</td></tr>
<tr><td>b</td><td>$2\ PO_4^{3-}\ (aq) + 3\ Ca^{2+}\ (aq) \rightarrow Ca_3(PO_4)_2\ (s)$</td><td>1 – correct formulae of ions and balanced

1 – state symbols</td><td>

E</td></tr>
<tr><td>c</td><td>The compound, <u>calcium nitrate</u> formed is a <u>soluble salt</u>,

thus <u>unable to remove by filtration</u> method.</td><td>1

1</td><td>E

H</td></tr>
</table>

d	Ammonium compounds react with calcium hydroxide to **release ammonia** to the atmosphere. The **nitrogen** element in fertiliser is **lost** in the process.	1	H
		[6]	
B9a	**Flame colours** of some metals are **quite similar**, e.g. Lithium is red and rubidium is red-violet OR potassium is pale violet, rubidium is red-violet and caesium is blue-violet [As long as the **similar colour schemes are compared**]	1	H
	The **very intense yellow orange of sodium** may **affect or mask** the observation of **other colours**, such as the **pale violet** of potassium.	1	H
bi	**Rubidium and sodium are present** in the mixture while **potassium and lithium are not.**		
	The **2 double lines** on **the emission spectrum of rubidium** can be found on the given spectrum at **around 400 and 650 of the arbitrary scale**.	1	H
	The **1 double lines** on the **emission spectrum of sodium** can be found on the given spectrum at **around 500 of the arbitrary scale**.	1	H
	However, the given **emission spectrum** of potassium and lithium **do not match the 3 unknown lines (550 -600)** on the given spectrum.	1	H
bii	I will need **the emission spectra of all Group I elements** on the Periodic Table with **lines in the 550 – 600** regions.	1	E
ci)	NaCl NaBr Na_2SO_4	1 1 (all three 2m)	E E
cii)	Concentration of Mg ions = 0.00420 / 0.6 x 0.15 = 0.00105 mol/dm^3 Concentration of Na ion = 0.00420 / 0.6 x 1.0 = 0.007 mol/dm^3	[1] [1]	
d	**Ion chromatogram** provides more information because it can be used to **identify more types of ions, even polyatomic** like sulfate ions than using the **emission spectrum**.	1	H
	Ion chromatogram can also allow us to **know the relative amount of each ions in the mixture** based on the **height of each peak / relative intensity.**	1	H
		[12]	
EB10a	$C_{acid}V_{acid} / C_{NaOH}V_{NaOH}$ = 1/1 C_{acid} = 0.200 x 0.0104 / 0.0152 = 0.13684 = 0.137 mol/dm^3 (to 3 s.f.)	1 1	E

b	Molar mass = 13.4 / 0.13684 = 97.924 = 97.9 g/mol Thus the relative molecular mass of the acid is 97.9.	1 1	E
c	The acid is **dilute sufuric acid** and the salt is **sodium sulfate**.	1 ; 1	
d	**Strong acids** have **larger Ka values** (positive power) while **weaker acids have lower Ka values** (negative power). Strong acids such as sulfuric acid have Ka values of **1.0×10^3 / hydrochloric acid 1.3×10^6** while weaker acids such as citric acid has Ka value of **7.4×10^{-4} / ethanoic acid of 1.8×10^{-5} / phosphoric acid 6.9×10^{-3}**. *Must quote 1 corresponding values for a **strong** and a **weak acid** to have the second mark.	1 1	E H
		[8]	
O10 a	A weak tribasic acid is a weak acid which **partially ionised when dissolved in water,** to give **3 moles of hydrogen ions for every 1 mole of the acid**.	1 1	E
bi	No of moles of $C_6H_8O_7$ = 19.2 / (6 x 12 + 8 x 1 + 7 x 16) = 0.1 mol No of moles of Fe_2O_3 = 1.6 / (56 x 2 + 16 x 3) = 0.01 mol Mole ratio of $C_6H_8O_7$: Fe_2O_3 = 2:1 = 0.1 mol: 0.05 mol. (more than given 0.01mol) Citric acid is in excess.	 1 1	 H
bii	Mole ratio of $C_6H_5O_7Fe$: Fe_2O_3 = 2:1 No of moles of of $C_6H_5O_7Fe$ = 0.01 x 2 = 0.02 mol Mass of $C_6H_5O_7Fe$ = 0.02 x (12 x 6 + 1 x 5 + 16 x 7 + 56) = 4.9 g % yield of $C_6H_5O_7Fe$ = 4.08 / 4.9 x 100% = 83.265% = 83.3 % (to 3s.f.)	 1 1 1	 E H
d	No, **without the presence of water**, the powdered citric acid **do not have hydrogen ions** to react with the iron(III) oxide in the kettle.	1	E
		[8]	

	Easy	Hard
Mark	36	12
Percentage	51%	17%