E

GAN ENG SENG SCHOOL
Mid-Year Examination 2019

CANDIDATE NAME

CLASS **INDEX NUMBER**

CHEMISTRY
Paper 1 Multiple Choice

6092/01
16 May 2019
1 hour

Sec 3 Express

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the OTAS.

There are forty questions in 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 choice in soft pencil on the separate OTAS.

Read the instructions on the OTAS very carefully.

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 found on page 14.

Total Marks
40

1 Water is added to a sample of purple powder in a test-tube. The contents of the test-tube are shaken, then filtered. A blue solid is left on the filter paper. After evaporating the filtrate, red crystals are left. Which of the following can be deduced from this analysis?

A The blue solid is an element.
B The red crystals are a mixture.
C The purple powder is a mixture.
D The purple powder is a compound.

2 Which of the following statements is true about ions?

A Positively charged ions have gained protons.
B Negatively charged ions have gained electrons.
C Atoms lose electrons to become negatively charged ions.
D Atoms lose protons to become positively charged ions.

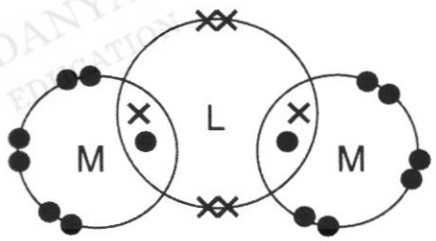
3 The table shows details of four particles.

Atoms/ ions	Number of neutrons	Number of electrons
W^-	17	18
X	16	16
Y^{2+}	20	18
Z	20	17

Which of the following atoms is an isotope of W?

A X
B Y
C Z
D None of the above

4 The diagram below shows the arrangement of electrons in the outer shells of the atoms in the compound $\mathbf{LM_2}$.

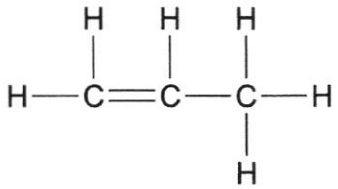


✕: Electrons of **L**
●: Electrons of **M**

Which pair of elements could be **L** and **M**?

	L	**M**
A	Calcium	Fluorine
B	Carbon	Sulfur
C	Oxygen	Hydrogen
D	Sulfur	Chlorine

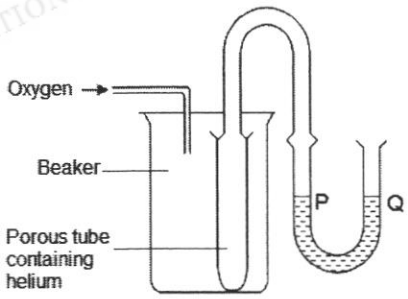
5 An organic molecule has the structural formula shown.



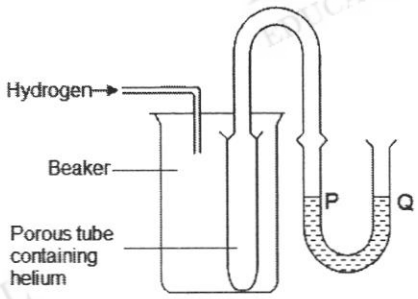
How many electrons are not used for bonding?

A 3
B 4
C 6
D 8

6 Two experiments, Experiment **1** and **2**, are set up to demonstrate the diffusion of gases. What would happen to the water levels at **P** and **Q** in both experiments?



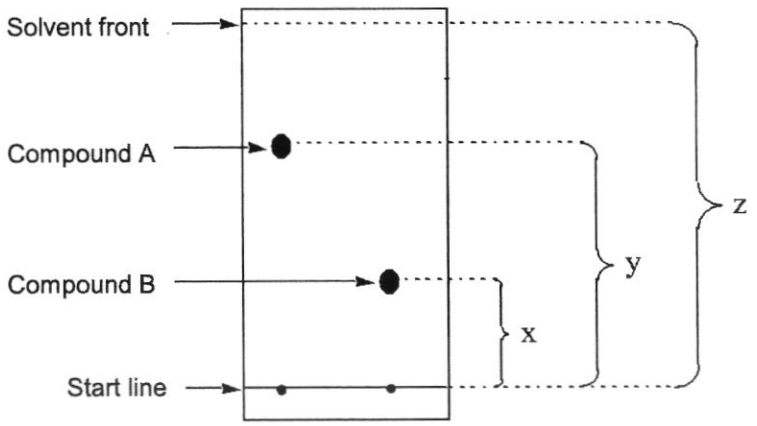
Experiment 1



Experiment 2

	Experiment 1	Experiment 2
A	**P** and **Q** remain the same	**P** and **Q** remain the same
B	**P** and **Q** remain the same	**P** is higher than **Q**
C	**P** is higher than **Q**	**P** is higher than **Q**
D	**P** is higher than **Q**	**Q** is higher than **P**

7 A paper chromatogram of two compounds **A** and **B** is shown in the diagram below:



Which statement regarding the paper chromatogram is correct?

A Compound **A** has a lower R_f value than compound **B**.
B Compound **A** is less soluble in the solvent than compound **B**.
C The R_f value of **A** is $\frac{y}{z}$.
D The solvent level is placed above the starting line.

8 Which mixture of gases would **not** change the colour of damp red litmus paper?

A Carbon dioxide and chlorine
B Sulfur dioxide and hydrogen
C Hydrogen and ammonia
D Neon and chlorine

9 Which element is most likely to be carbon in the form of graphite?

	Melting point/ °C	Electrical conductivity
A	30	Good
B	119	Poor
C	2600	Good
D	3500	Poor

10 The pH value of 0.1 mol/dm^3 of ethanoic acid is 3.7 whereas the pH value of 0.1 mol/dm^3 of nitric acid is 1.

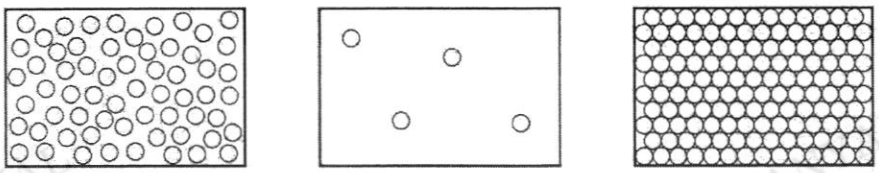
Which statement explains the difference in pH values?

A Ethanoic acid is a stronger acid than nitric acid.
B Ethanoic acid produces more hydrogen ions in water.
C Nitric acid dissociates completely in water.
D Nitric acid has fewer hydrogen atoms than ethanoic acid.

11 A mixture may be separated by evaporation. Which of the following is a disadvantage of this method?

A The solute recovered may contain impurities.
B It always required heating.
C The substances must have close boiling points.
D It cannot be used for a solid with a low melting point.

12 The diagrams show the arrangement of particles in three different physical states of substance **X**.



state 1 state 2 state 3

Which statement about the physical states of substance **X** is correct?

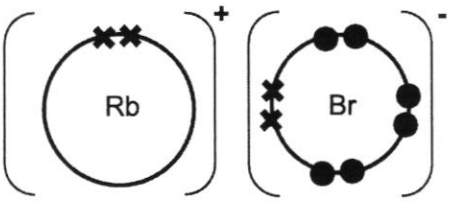
A The substance in state 3 has a fixed volume.
B State 1 changes to state 2 by diffusion.
C Particles in state 1 vibrate about fixed positions.
D State 2 changes directly to state 3 by condensation.

13 What happens when a hydrogen atom becomes a hydride ion in the ionic compound sodium hydride, NaH?

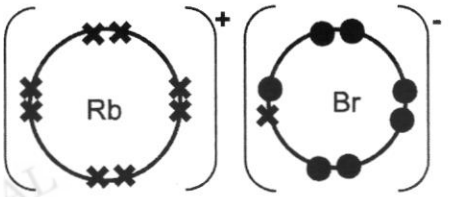
A The hydrogen atom gains an electron.
B The hydrogen atom gains a positive charge.
C The atomic mass of the hydrogen atom increases.
D The number of electrons of the hydrogen atom remains the same.

14 Which of the following diagrams is the correct representation of the bonding in rubidium bromide?

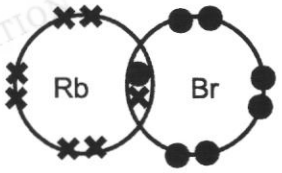
A



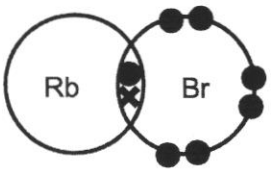
B



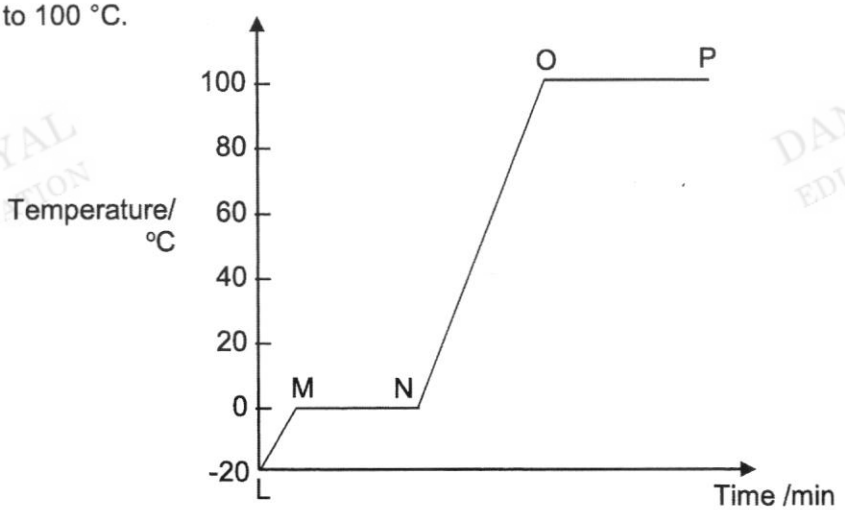
C



D



15 The graph shows the change in temperature with time when ice at -20 °C is heated to 100 °C.



Which of the following can be deduced from the graph?

A Between L and M, the average energy of particles remains constant.
B Between M and N, ice is melting.
C Between N and O, volume of steam is increasing.
D Between O and P, only steam is present.

16 The formulae of some oxides are shown below.

Na_2O MgO Al_2O_3 SO_2 CO

Which of the following gives the correct number of each type of oxide?

	Number of each type of oxide		
	Acidic	**Amphoteric**	**Basic**
A	1	1	2
B	2	0	3
C	2	1	2
D	1	1	3

17 Which statement explains why sodium chloride, NaCl, has a lower melting point than magnesium oxide, MgO?

A Sodium chloride contains weak covalent bond but magnesium oxide contains strong covalent bond.
B Sodium is more reactive than magnesium.
C The electrostatic attraction between Na^+ and Cl^- is weaker than that between Mg^{2+} and O^{2-}.
D The melting point of sodium is lower than that of magnesium.

18 An element **P** exists in three isotopic forms as shown below:

Isotope	^{150}**P**	^{155}**P**	^{157}**P**
Isotopic abundance	50%	25%	25%

What is the relative atomic mass of element **P**?

A 150
B 152
C 153
D 156

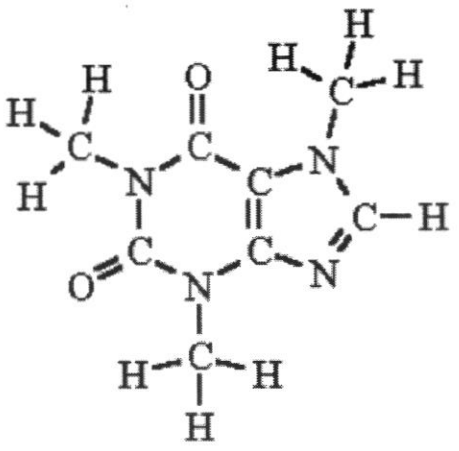
19 Which of the following salts is **incorrectly** matched with its method of preparation?

	Salts	**Method of preparation**
A	Silver nitrate	Add excess silver to warm dilute nitric acid
B	Lead(II) chloride	Mix aqueous lead(II) nitrate with dilute hydrochloric acid
C	Ammonium nitrate	Titrate aqueous ammonium carbonate with dilute nitric acid
D	Copper(II) sulfate	Add excess copper(II) carbonate to warm dilute sulfuric acid

20 Element **P** has proton number n. It is virtually unreactive under most conditions. Another element **Q** has proton number (n+2). What is the formula of the oxide of **Q**?

A QO
B QO_2
C Q_2O_3
D QO_3

21 The structural formula of caffeine is represented by



What is the total number of electrons shared in all the double bonds shown?

A 2
B 4
C 8
D 16

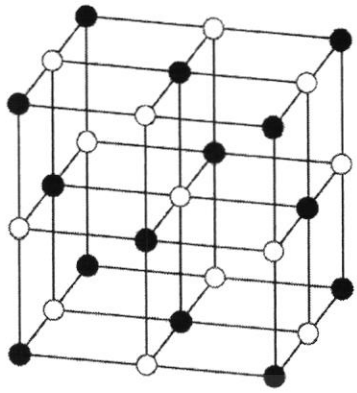
22 Which of the following oxides dissolves in water to form an acidic solution?

A SO_2
B SiO_2
C MgO
D ZnO

23 Phenylhydrazine has the formula $NH_2NHC_6H_5$. It has similar properties to ammonia. Which property will phenylhydrazine have?

A It turns moist red litmus paper blue when dissolved in an organic solvent.
B It reacts with ammonium salt to produce ammonia gas.
C It reacts with alkali to produce salt and water.
D It dissolves in water to give hydrogen ions.

24 The diagram shows the arrangement of ions in an ionic crystal.



Which compound **cannot** have this arrangement of its ions?

A Calcium oxide, CaO
B Copper (II) sulfate, $CuSO_4$
C Magnesium chloride, $MgCl_2$
D Sodium chloride, $NaCl$

25 An element **R** has *p* protons and *n* neutrons in its nucleus.

Which row gives the correct number of protons, neutrons and electrons in a negative ion of an isotope of **R**?

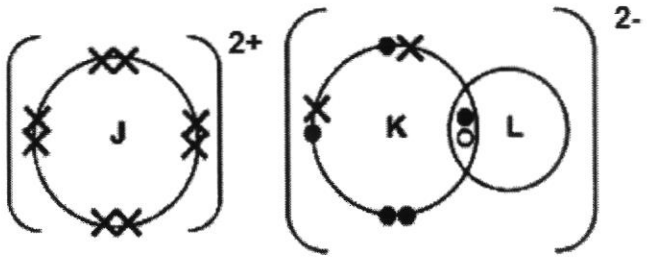
	protons	neutrons	electrons
A	*p*	*n+1*	*p+1*
B	*p*	*n*	*p-1*
C	*p+1*	*n*	*p+1*
D	*p+1*	*n+1*	*p-1*

26 Which of the following shows the correct property and explanation for graphite?

	Property	**Explanation**
A	Can conduct electricity	Each carbon atom only uses 4 electrons in its bonding and has 1 valence electron delocalised.
B	Hard	Atoms are held by strong covalent bonds.
C	High melting and boiling points	A large amount of energy is required to break the strong covalent bonds between the layers of carbon atoms.
D	Soft and slippery	The layers of carbon atoms have weak forces of attraction.

27 **J**, **K** and **L** are three different elements in the Periodic Table.

The dot and cross diagram below shows the bonding present in the compound formed between **J**, **K** and **L**. Only the valence electrons were shown.



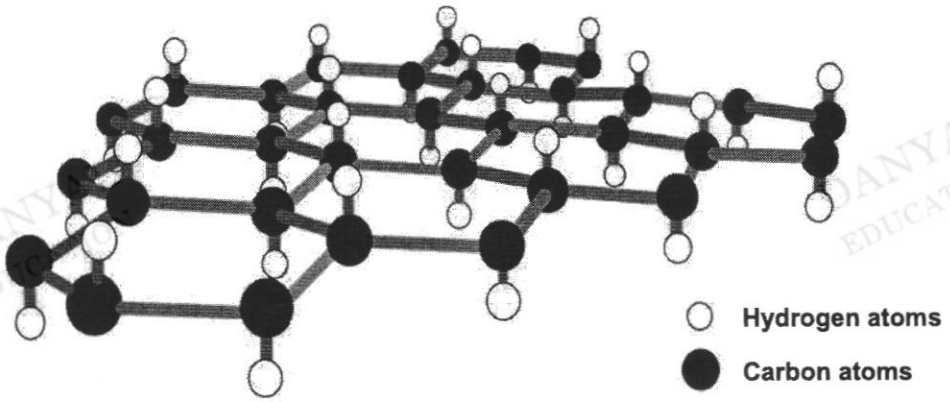
A student wrote three statements about the compound shown above.

I Element **L** is hydrogen.
II Element **J** belongs to Group II of the Periodic Table.
III Elements **J**, **K** and **L** are bonded together by ionic bonds only.

Which of the statements shown above is/are correct?

A **III** only
B **I** and **II** only
C **II** and **III** only
D All of the above

28 Since the discovery of *graphene*, scientists have been able to convert it to another material known as *graphane* (shown below) by attaching one hydrogen atom to each carbon atom as shown below:



Graphane has the same honeycomb structure as *graphene*, and retains most of its properties too.

Which property of *graphene* is not likely to be shared by *graphane*?

A It is insoluble in water.
B It is very strong and rigid.
C It has a high melting point.
D It is an electrical conductor.

29 **Y** and **Z** are elements belonging to Group I and VII respectively.

Which of the following describes the compound formed by **Y** and **Z**?

A An ionic compound with formula **YZ**.
B An ionic compound with formula $\mathbf{YZ_7}$.
C A covalent compound with formula **YZ**.
D A covalent compound with formula $\mathbf{Y_7Z}$.

30 Which statement is **not** true for all alkalis?

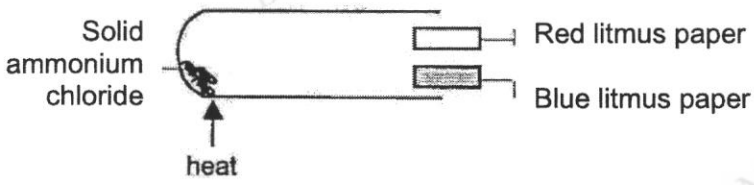
A They can act as electrolytes.
B They turn universal indicator purple.
C They form precipitate with salt solutions.
D They react with ammonium salt to give ammonia gas.

31 To reduce atmospheric pollution, powdered calcium carbonate is used to remove acidic waste gases from a coal-burning power station.

Which waste gas will **not** be removed by the powdered calcium carbonate?

A Carbon monoxide, CO
B Nitrogen dioxide, NO_2
C Sulfur dioxide, SO_2
D Sulfur trioxide, SO_3

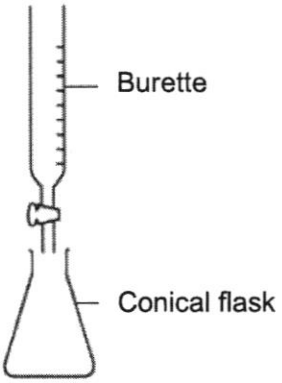
32 A student heats some solid ammonium chloride in a test tube as shown in the figure below.



What will be the colour change(es) observed?

A Moist blue litmus paper turns red and no further change is observed.
B Moist blue litmus paper turns red first before both litmus turn blue.
C Moist red litmus paper turns blue and no further change is observed.
D Moist red litmus paper turns blue first before both litmus turn red.

33 Which pair of reagents **can** be used in the setup shown below to prepare a salt?



A Dilute hydrochloric acid and silver chloride
B Dilute sulfuric acid and sodium hydroxide
C Dilute magnesium hydroxide and aqueous ammonia
D Dilute calcium oxide and aqueous ammonia

34 Which of the following equations best represents the ionic equation for the reaction between aqueous lithium carbonate and aqueous silver nitrate?

A $Li^+ + NO_3^- \rightarrow LiNO_3$
B $Li + Ag^+ \rightarrow Li^+ + Ag$
C $CO_3^{2-} + 2Ag^+ \rightarrow Ag_2CO_3$
D $CO_3^{2-} + 4Ag^+ \rightarrow 4Ag + CO_2 + O^{2-}$

Refer to the following information to answer questions **35** and **36**.

Mercury can form a crystalline salt with chlorine. The ionic compound has the formula Hg_2Cl_2.

35 What is the formula of the mercury cation in the compound?

A Hg_2^+
B Hg^{2+}
C Hg_2^{2+}
D Hg^{4+}

36 What is the total number of electrons in the mercury cation in the compound?

A 158
B 159
C 160
D 162

37 An element **X** reacts with iron to form two different compounds with the formulae Fe**X** and $Fe_2\mathbf{X}_3$.

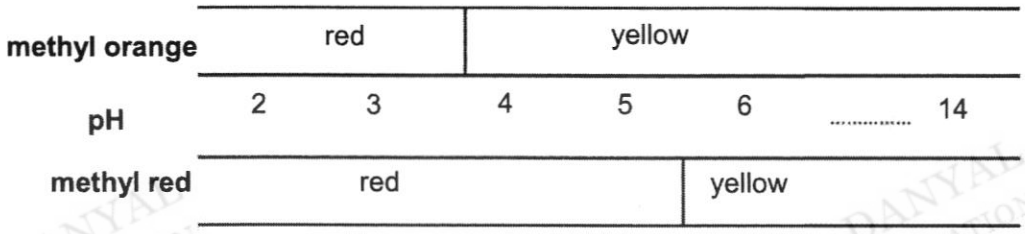
What is the proton number of **X** likely to be?

A 5
B 7
C 8
D 9

38 Calcium reacts with water to form calcium hydroxide and hydrogen gas. Which of the following shows the chemical equation for this reaction?

A $Ca + H_2O \rightarrow CaH + OH$
B $Ca + H_2O \rightarrow CaOH + H$
C $Ca + (H_2O)_2 \rightarrow Ca(OH)_2 + 2H$
D $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

39 The diagram shows the pH at which a change in colour occurs for the indicators methyl orange and methyl red.



Which pair of solution can likely be distinguished using methyl orange and methyl red?

A Aqueous ammonia and aqueous sodium hydroxide
B Aqueous calcium hydroxide and water
C Dilute hydrochloric acid and dilute ethanoic acid
D Dilute nitric acid and dilute sulfuric acid

40 Hydrogen chloride was bubbled into hexane, an organic solvent. This mixture was added to magnesium metal. However, no visible reaction took place. What is a likely explanation for this?

A A coating of insoluble magnesium chloride formed around the metal.
B Hydrogen chloride did not ionise in hexane.
C Hydrogen chloride is insoluble in hexane.
D Magnesium is not a reactive metal.

END OF PAPER

E

GAN ENG SENG SCHOOL
Mid-Year Examination 2019

CANDIDATE NAME _____

CLASS _____ **INDEX NUMBER** _____

CHEMISTRY
Paper 2

6092/02

8 May 2019
1 hour 45 minutes

Sec 3 Express

Candidates answer on the Question Paper.

Calculators are allowed in the examination.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 10 has a choice of parts to answer.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is found on page 18.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

Section A [50 marks]

*Answer **ALL** the questions in the spaces provided.*

A1 Table below gives some properties of five substances **A** to **E**.

Substance	Density (g/cm^3)	Melting point / °C	Boiling point / °C	Electrical conductivity	
				Solid	Molten
A	3.22	1083	3570	Yes	Yes
B	2.15	98	881	Yes	Yes
C	2.89	2852	3600	No	Yes
D	0.88	-80	-60	No	No
E	2.03	1610	2230	No	No

Using any letter once, more than once or not at all, state the letter of a substance which

(a) is a metal. .....

(b) could be magnesium oxide. .....

(c) could be silicon dioxide. .....

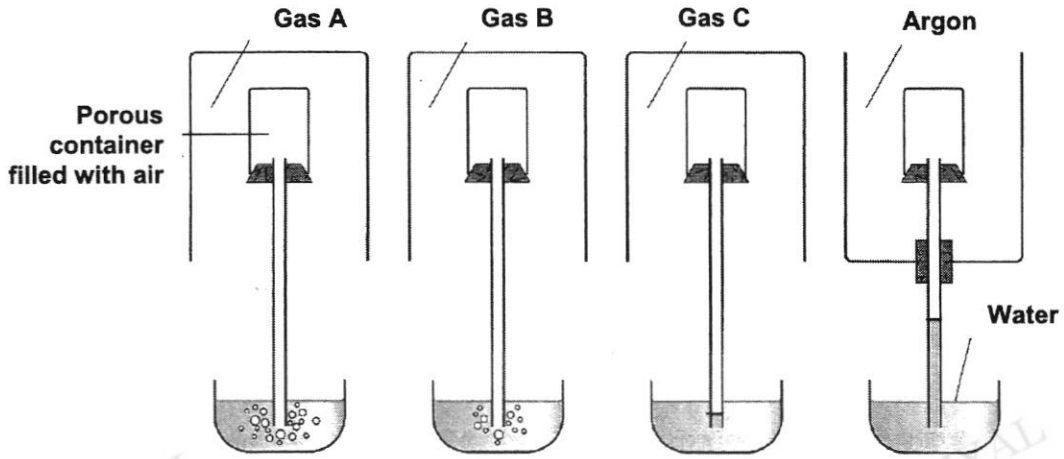
(d) has a simple molecular structure. .....

(e) consists of widely-spaced particles at room temperature and pressure. .....

(f) exists as a liquid at 2500 °C. .....

[Total: 6]

A2 (a) A student set up the apparatus below to investigate the relative molecular mass of three unknown gases, **A**, **B**, **C** and Argon as compared to air.



(i) Which gas has the smallest molecular mass?

..... [1]

(ii) Which gas is likely to be nitrogen?

..... [1]

(iii) Explain the presence of effervescence in the set-up using gas **A** and gas **B**.

.....

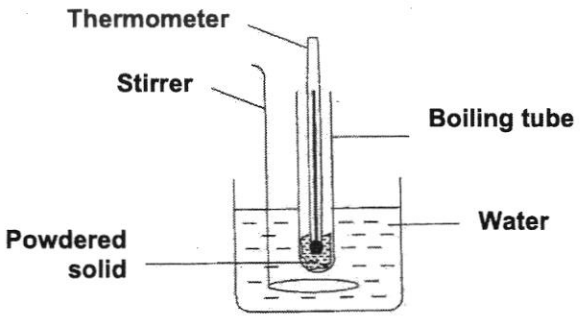
..... [2]

(iv) Why did the student place the container of argon the opposite way compared to the others?

.....

..... [2]

(b) The diagram below shows a method used to determine the melting point of a powdered solid, which melts between 50 °C and 80 °C.



(i) Explain why the water must be stirred continuously?

..... [1]

(ii) What observation could be made about the thermometer reading when the solid is melting?

.....

..... [1]

(iii) Explain why this experiment could not be used to determine the melting point of a solid, which is between 120 °C and 130 °C? Suggest how the experiment could be modified for this purpose.

.....

.....

..... [2]

[Total: 10]

A3 A pure substance **Z** has a melting point of 120 °C and a boiling point of 190 °C. It was cooled in an enclosed container where heat was drawn away at a constant rate.

(a) If the starting temperature was 200 °C and the ending temperature was 100 °C, sketch the cooling curve, showing how the **Temperature/ °C** of substance **Z** changes with **Time/ min**.

Indicate clearly on the graph below, the starting temperature, ending temperature, melting and boiling points clearly.

[3]

(b) Mark on the graph, the regions **solid**, **liquid** and **gas** where the substance exists in only one physical state. [2]

(c) Mark on the graph the regions **P** and **Q** where there are two physical states of matter co-existing. [1]

(d) Name the states present in region **P** and **Q**.

P: ..... & .....

Q: ..... & ..... [2]

(e) Draw the particle arrangement of substance **Z** at 191 °C and 120 °C.

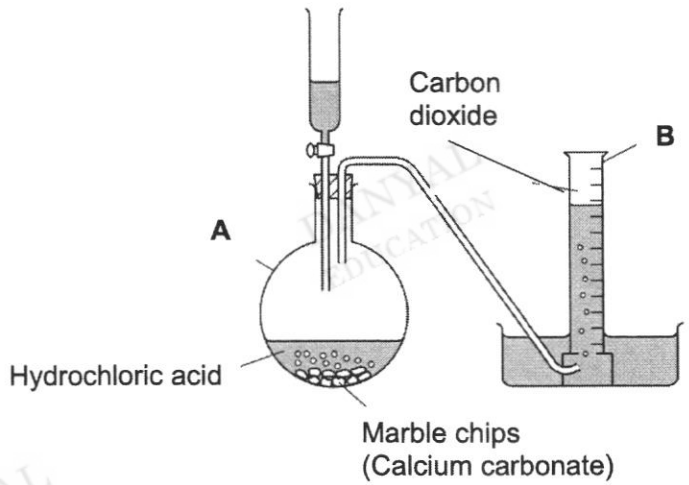
191 °C

120 °C

[2]

[Total: 10]

A4 Carbon dioxide can be prepared in the laboratory using the apparatus shown below.



(a) State the name of the pieces of apparatus labelled **A** and **B**.

.....

..... [2]

(b) State and explain whether the volume of carbon dioxide collected in **B** is lower, higher or the same as expected.

.....

..... [2]

[Total: 4]

A5 Aspirin is a form of an acid. Although its formula is complicated, it can be represented by H^+A^-, where A^- is the anion and H^+ is the cation. Aspirin is not very soluble but its sodium salt, NaA, is. Addition of dilute hydrochloric acid to this soluble sodium salt, NaA, will cause the aspirin to precipitate.

(a) **(i)** Write an equation, with state symbols, to show the precipitation of aspirin when hydrochloric acid acts on the soluble sodium salt of aspirin.

.....

..... [2]

(ii) Explain what the low solubility of aspirin tells you about its strength as an acid.

.....

..... [2]

(iii) When a person takes the soluble sodium salt of aspirin, the precipitation only occurs in the stomach. Suggest why.

..... [1]

(b) An antioxidant is a substance that prevents oxidation from taking place. Ascorbic acid, $C_6H_8O_6$, is a common antioxidant used in the food industry to prevent food from oxidising. When ascorbic acid acts as an antioxidant, it is changed to a new chemical called dehydroascorbic acid with a formula $C_6H_6O_6$.

(i) Which atoms are lost when ascorbic acid acts as an antioxidant?

..... [1]

(ii) Oxidation happens when a substance reacts with oxygen and water in the air. Suggest how ascorbic acid is able to act as an antioxidant to prevent food from being oxidised.

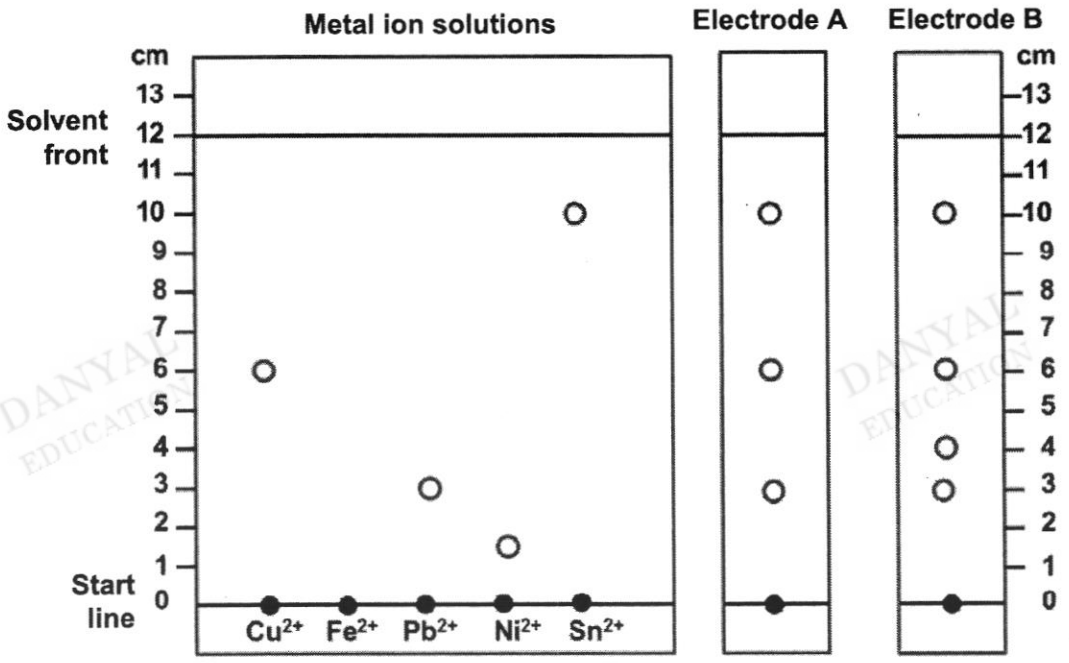
.....

..... [1]

[Total: 7]

A6 Electrodes **A** and **B** from 2 lead-acid batteries are tested to see if they are from the same manufacturer. In order to compare the impurities present in the electrodes, samples from the electrodes were dissolved in a suitable acid and the resulting solutions were chromatographed, together with solutions containing five known metal ions.

After treating with a locating agent, the chromatograms were as shown below.



(a) Based on the above chromatograms, provide a reason why the two electrodes are from different manufacturers.

.....

..... [1]

(b) **(i)** Calculate the R_f value for Cu^{2+}.

[1]

(ii) Add to the diagram above the "spot" for Fe^{2+}, which carries an **R_f value of 0.75**. [1]

[Total:3]

A7 Table 7.1 below gives some information of six gases. All the volumes are measured at room temperature and pressure.

Name of gas	Molecular formula	Relative molecular mass	Volume occupied by 1 g of gas /cm^3
Oxygen	O_2	32	750
Sulfur dioxide	SO_2	64	375
Carbon dioxide	CO_2	44	550
Hydrogen bromide	HBr	81	300
Methane	CH_4	16	1500
Argon	Ar	40	600

Table 7.1

(a) **(i)** Which of the gases in the above table would diffuse the fastest? Give a reason for your answer.

.....

..... [2]

(ii) Describe a test to confirm the presence of sulfur dioxide gas.

.....

..... [2]

(iii) Hydrogen bromide is a gas at room temperature and pressure. It dissolves in water to form hydrobromic acid. Describe the bonding in hydrogen bromide and deduce its boiling point.

.....

.....

..... [3]

(b) Phosphorus is in the same Group of the Periodic Table as nitrogen.

Phosphorus trichloride, PCl_3, is a liquid with a boiling point of 76°C. It can be prepared by passing pure, dry chlorine over heated phosphorus. Phosphorus trichloride reacts vigorously with water producing phosphoric acid, H_3PO_3, and hydrogen chloride.

For the reaction of phosphorus with dry chlorine, it is carried out in a fume cupboard.

(i) Give a reason why it is necessary to use dry chlorine.

.....

..... [1]

(ii) Suggest a reason why the experiment has to be carried out in the fume cupboard.

.....

..... [1]

(iii) Describe what you would observe when phosphorous trichloride is added to a blue litmus solution.

.....

..... [1]

[Total: 10]

SECTION B [30 marks]

Answer **three** questions from this section.

The last question is in the form either/ or and only **one** of the alternatives should be attempted.

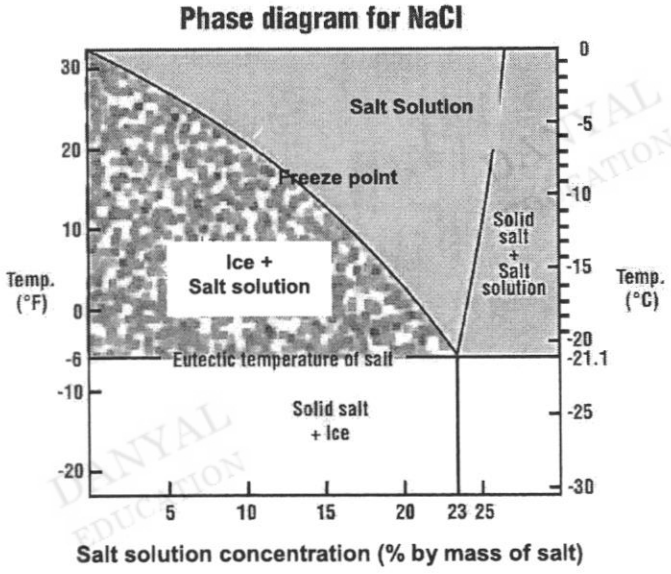
B8 Read the following article about freezing point depression and salting roads during extreme cold weather.

Salting Roads to Save Lives

Adding salt to water lowers the freezing point below zero. This phenomenon is known as freezing point depression.

During extreme cold weather in some countries, workers spread salt on the roads. As snowflakes melt, the salt dissolves in the liquid water. This produces a solution of 'salty water', which has a lower freezing point than pure snow. As a result, the additional snow might cool the road, but the temperature will not be cold enough to freeze the salt solution.

Salting is also effective when ice has already formed on roads. The salt causes salt solution to form on the surface of the ice. Although this is slow in the beginning, the growing solution continues to dissolve more salt and melt more ice. Passing vehicles also help to speed up this process. Salting allows drivers to be able to travel more safely on roads during extreme cold weathers.



The eutectic temperature is the lowest temperature at which at least part of the mixture can stay liquefied. For NaCl and water, the eutectic temperature is -21.1°C.

The effective melt temperature is the lowest temperature at which a salt solution is able to lower the freezing point of ice.

The phase diagram above shows how the salt solution concentration affects the freezing point of water. Table 8.1 shows the effective temperatures for three commonly used salts.

Salt	Effective melt temperature (°C)	Eutectic temperature (°C)
NaCl	–10	–21.1
$CaCl_2$	–32	–56
$MgCl_2$	–15	–33

Table 8.1

Adapted from 'Salting Roads', ChemMatters

11

(a) The phase diagram helps workers determine the mass of salt to be added onto roads.

(i) Describe how the freeze point of water is related to the salt solution concentration.

.....

..... [1]

(ii) Use the phase diagram to determine the freeze point (in °C) of a salt solution that has a concentration of 15% by mass of salt.

.....

..... [1]

(b) In one sample of salt solution, the concentration was found to be 20% by mass of salt. Draw in the box below to show how the particles are arranged at a temperature of –5°C.

Water particle

Salt particle

[1]

(c) In some parts of Alaska, temperatures may drop to –20°C. Name the salt that can be used to salt the roads effectively.

..... [1]

(d) Is salting effective in prolonged periods of cold weather? Explain your answer.

.....

..... [2]

(e) The instructions for preparing hydrated crystals of magnesium sulfate are given below:

Add one spatula full of magnesium carbonate to 50 cm^3 of dilute sulfuric acid. When it has reacted, add further amounts until no more magnesium carbonate will dissolve. Then filter the mixture. Evaporate the filtrate to about half its volume. Allow the filtrate to cool. Filter off the crystals. Dry them on filter paper.

Explain the importance of the four instructions that are underlined.

.....

.....

.....

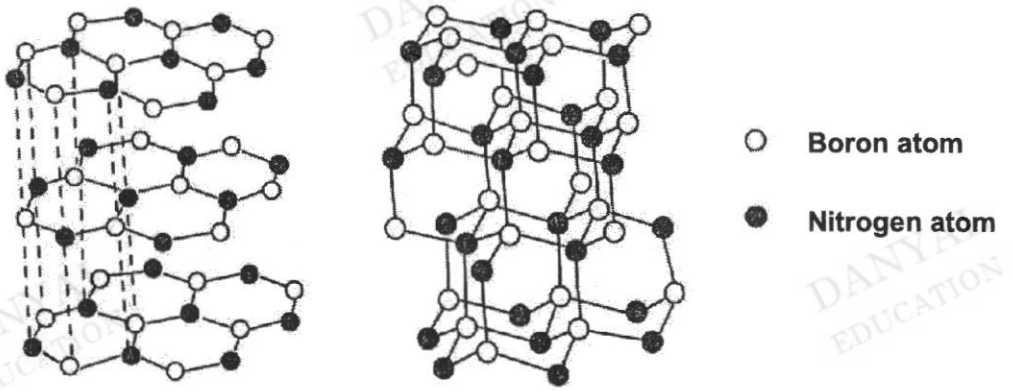
.....

.....

..... [4]

[Total: 10]

B9 Boron nitride is found to exist in two possible forms, hexagonal boron nitride and cubic boron nitride as shown below.



Hexagonal boron nitride **Cubic boron nitride**

(a) Carbon can also be found in two different forms (allotropes).

Name the allotropes of carbon which has a similar structure as

(i) hexagonal boron nitride

.....

..... [1]

(ii) cubic boron nitride

.....

..... [1]

(b) Based on the structures shown, explain the difference in **one** physical property of hexagonal and cubic boron nitride other than electrical conductivity.

.....

.....

.....

.....

..... [3]

(c) The melting points of hexagonal boron nitride and two other compounds of nitrogen are given below.

Compound	Melting point / °C
Hexagonal boron nitride	2973
Aluminium nitride (AlN)	2200
Hydrazine (N_2H_4)	2

(i) Draw the 'dot and cross' diagram to represent the bonding in aluminium nitride. Show only the valence electrons.

[2]

(ii) Both hexagonal boron nitride and aluminium nitride have very high melting points. Explain why, in terms of the bonding and structures, are present in both substances.

.....

.....

.....

.....

[3]

[Total: 10]

Either

B10 Camphor is a white solid used in some skin ointments. An impure sample of camphor is found to be contaminated with traces of carbon, iron and iron(III) oxide. The effects of three solvents on four substances are shown in Table 10.1 below.

Substance	Solubility in ethanol	Solubility in water	Solubility in dilute sulfuric acid
Camphor	Dissolves to give a colourless solution	Insoluble	Insoluble
Carbon	Insoluble	Insoluble	Insoluble
Iron	Insoluble	Insoluble	Reacts to give a green solution and a colourless gas
Iron(III) oxide	Insoluble	Insoluble	Reacts to give a brown solution

(a) Use the information in Table 10.1 to explain how to obtain a pure and dry sample of camphor from the impure sample.

.....

.....

.....

.....

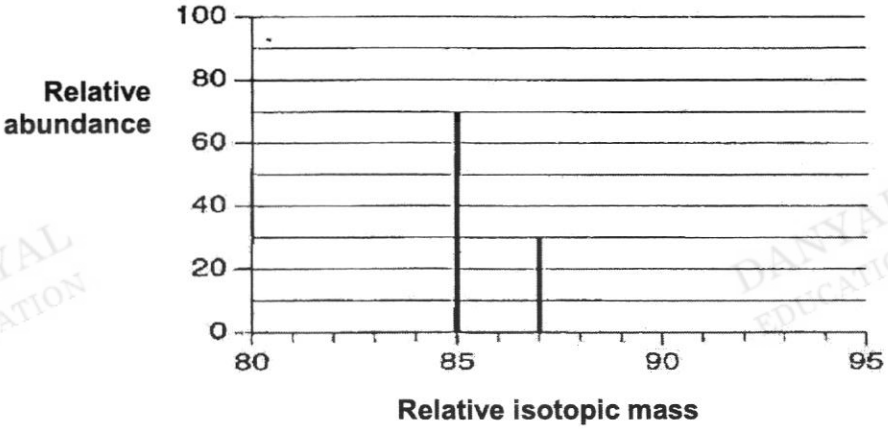
.....

.....

..... [4]

(b) A mass spectrometer determines the mass of a molecule by measuring the mass-to-charge ratio (m/z) of its ions. Ions are generated by either losing or gaining a charge from a neutral species. Once ions are formed, they are directed into a mass analyser where they are separated according to m/z and finally detected. The result is a mass spectrum that can provide molecular mass and even structural information.

In 1861, Bunsen and Kirchoff found that rubidium has two naturally occurring isotopes, rubidium-85 and rubidium-87. Figure 10.1 below shows the percentage abundance of the different isotopes of rubidium from a mass spectrum of an analysed rubidium sample.



(i) State one similarity and one difference between the compositions of the nuclei of the two isotopes of rubidium.

Similarity

.....

.....

Difference

.....

..... [2]

(ii) Calculate the relative atomic mass of rubidium.

Relative atomic mass: ..... [2]

(iii) Isotopes have different physical properties. State and explain how the density of rubidium-87 differs from rubidium-85.

.....

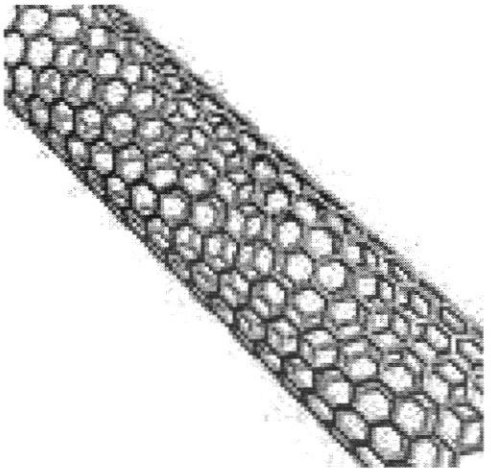
..... [2]

[Total: 10]

OR

B10

(a) In 1991 a Japanese chemist discovered that a layer of graphite could be rolled into a tube. These tubes, 50,000 times thinner than a human hair, are called carbon nanotubes, as shown below.



Carbon nanotubes are extremely lightweight and strong. They can conduct electricity much better than metals. Due to these properties, chemists believe that nanotubes will have important future uses.

(i) Explain, in terms of structure and bonding, the physical state of carbon nanotubes at room temperature.

.....

.....

..... [2]

(ii) State one similarity and one difference in the structures between graphite and carbon nanotube.

Similarity

.....

.....

Difference

.....

..... [2]

(iii) Explain, in terms of structure and bonding, if carbon nanotubes are good conductors of electricity.

.....

.....

..... [2]

(b) Covalent substances, such as carbon nanotubes and graphite, have giant structures. Metals too have giant structures.

With the help of a labelled diagram, explain how the bonding and structure in sodium allow it to conduct electricity.

.....

.....

.....

..... [4]

[Total: 10]

END OF PAPER

Marking Scheme for Paper 1

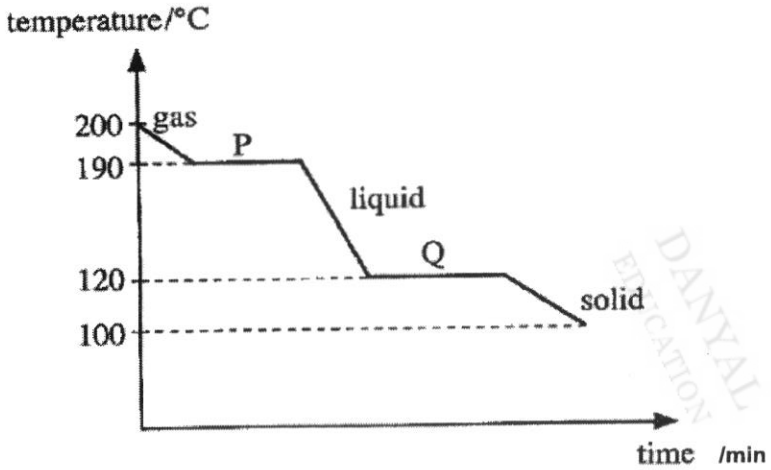
1	C It consists of a mixture of blue solid and red crystal.	**11**	A Evaporation involved not just heating, but occur at any temperature.	**21**	D One bond shows 2 electrons being shared. There are total 4 pairs double bonds → (4x2) x 2 = 16 electrons	**31**	A Carbon monoxide is a neutral oxide which will not react with acid and alkali.
2	B E.g. Oxygen has an electronic configuration of 2.8.6. It takes in (gains) 2 more electrons to form a stable octet configuration, forming a negatively charged ion, O^{2-}.	**12**	A State 3 shows particles in solid state, packed closely to one another, hence it has a fixed volume.	**22**	A Sulfur dioxide when mixes with rain, produce sulfuric acid which is acidic in nature.	**32**	D Ammonium chloride decomposes readily when heated, but condenses in the cooler area at the top of the test tube. Thermally decomposes into a mixture of two colourless gases ammonia and hydrogen chloride. NH_3: Turn red litmus blue first (Mr = 17) Lower Mr, travels faster. HCl: (Mr = 36.5) Higher slower and will turn both red eventually.
3	C Isotopes have the same number of protons and different number of neutrons. W^-: 17p ; Z: 17p	**13**	A Hydride ion has a formula of H^-, which means the hydrogen atom takes in (gains) an electron to form H^-.	**23**	B Ammonia is an alkali. It reacts with ammonium salt to produce ammonia gas, salt and water. It dissolves in water to produce OH^-.	**33**	B Titration → acid and alkali (soluble base) Knowledge question.

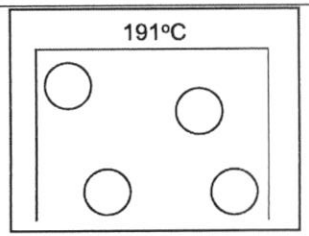
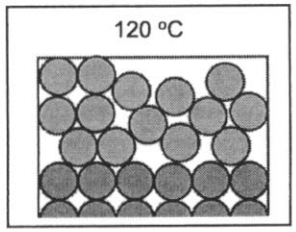
4	D Valence electrons show the Group which the atom is in. L: 6 valence electrons M: 7 valence electrons	**14**	B Rubidium bromide is an ionic compound. Rb is in Group I (gives out one electron to form a positive charge) and Br is in Group VII (takes in one electron to form negative charge ion)	**24**	C The diagram only shows one atom bonded to one atom. $MgCl_2$ shows one Mg bonded to 2 Cl atoms.	**34**	C Chemical equation $Li_2CO_3(aq) + 2\ AgNO_3 \rightarrow Ag_2CO_3(s) + 2\ LiNO_3(aq)$ Ionic equation $CO_3^{2-}(aq) + 2Ag^+(aq) \rightarrow Ag_2CO_3(s)$
5	C 2 electrons each from the inner shell of a carbon atom is not used for bonding. Therefore, 2 x 3 = 6 electrons	**15**	B Region M-N and O-P show a phase change of at least 2 states present. Hence at M-N, it is where melting occurs. It is a heating curve.	**25**	A Isotopes have same number of protons, different number of neutrons. Negative ion of R: p protons, p+1 electron, n+1 neutrons	**35**	C Mercury forms two ions; the mercuric ion, Hg++, and the mercurous ion that would be expected to be Hg+, but is [Hg-Hg]++.
6	D Lower Mr/Ar diffuse faster. Expt 1: He has lower Ar than O_2. Hence it diffuse out of porous pot, increase level of P. Expt 2: H has lower Ar than He. Diffuse into the porous pot, increasing the pressure, pushing the level at P downwards.	**16**	A Acidic oxide → non metal oxide [SO_2] Basic oxide → metal oxide [Na_2O, MgO] Amphoteric oxide → Zinc oxide, Aluminium oxide and Lead(II) oxide [Al_2O_3] *Note: CO is a neutral oxide*	**26**	D Knowledge question. Graphite has layers of carbon atoms arranged, held by weak intermolecular forces of attraction, hence making it soft and slippery.	**36**	A (80 x 2) – 2 = 158
7	C Rf = dist travelled by solute/dist travelled by solvent. Rf = y/z	**17**	C Both are ionic compound. NaCl, where Na has a charge of +1 MgO, where Mg has a charge of +2.	**27**	B L: Shows 1 electron used for bonding (Hydrogen) J: Shows 2 electrons given out for bonding, Group II J, K and L are not bonded by Ionic bonds only. Covalent bonding occurs between K and L.	**37**	C X must be in Group VI as it gains 2 electrons.

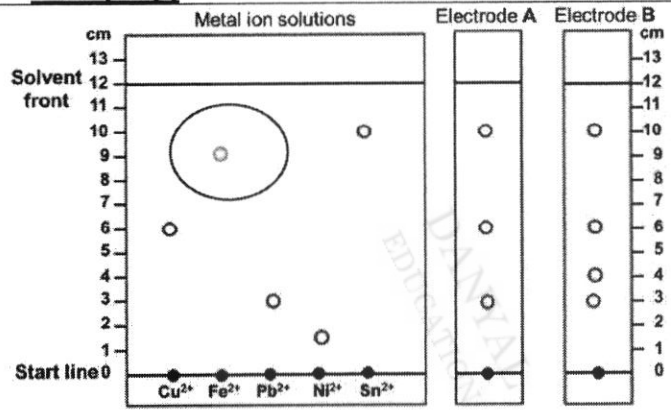
8	B Sulfur dioxide is an acidic oxide which turn red litmus red. Hydrogen gas is acidic in nature.	**18**	C [50/100*150]+[25/100*155]+[25/100*157] = 153	**28**	D There is no valence electrons used to conduct electricity.	**38**	D Knowledge question. Students are required to know the formula for calcium hydroxide.
9	C Graphite has strong covalent bond/strong intramolecular forces of attraction → high mpt It has one valence electron not used for bonding, delocalized and hence able to conduct electricity	**19**	A Silver nitrate is a soluble salt. Method of preparation shows Acid + metal However, silver is not a reactive metal. It cannot react with acid. Likewise for Cu.	**29**	A Y: Group I shows that it is a metal, losing 1 electron. Z: Group VII shows that is a non meta, gaining 1 electron. Ionic bonding → between a metal and non metal.	**39**	C The change of colour to yellow when methyl orange is used is at pH near 4. It shows that it is still acidic, but at a higher pH value. Ethanoic acid is a weak acid as it **dissociate partially** to produce **a low concentration of H^+.**
10	C A stronger acid can dissociate completely in water, with a lower pH.	**20**	A P → noble gas. Q → n+2, shows it is in Group II Formula with oxide (O^{2-}) → **QO**	**30**	B Note: precipitate is an insoluble solid formed in a reaction. NOT all alkalis turn universal indicator purple as some alkalis are have a pH which is lower.	**40**	B A reaction occur when acid reacts with metal. In the observation, no acid is being used as no visible reaction took place. H^+ ions must be present to show its acidic properties. Hence, in the set up, the HCl did not ionize / dissociate to produce H^+ ions.

Marking Scheme for Paper 2

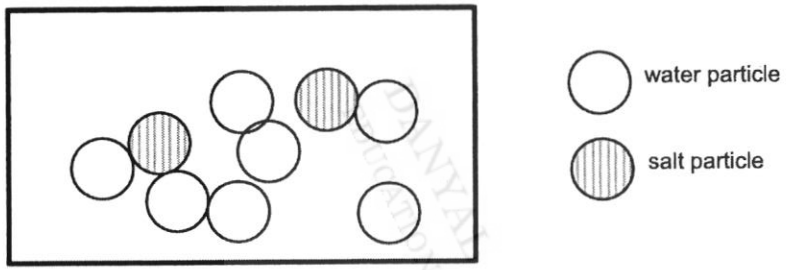
Qn	Possible answers	Mark	Markers' comments
A1	(a) Either A or B (either A or B is accepted) (b) C (c) E (d) D (e) D (f) A	**6**	**Most students are able to answer this question correctly.**
A2 (a) (i)	Gas A	**1**	
(ii)	Gas C	**1**	
(iii)	Both gases A and B have **lower relative molecular masses than air**; the **gases diffuse faster** into the container filled with air than the **air diffuses out**. [1] The **excess** gas molecules then **escape** into the container of water **as gas bubbles** / **Pushes the gas** into the water **creating bubbles**. [1]	**2**	**Some student have difficulty understanding the porous pot experiment.** **A lower Mr allow the molecules to diffuse faster which will cause the change in the level of the water.**
(iv)	Argon is **denser** than air / Argon has a **greater relative atomic mass** than air. [1] This is to **prevent** argon **from escaping** downwards instead of diffusing into the container. [1]	**2**	**Students are not able to see that argon is denser than air due to its Ar.**
(b) (i)	To ensure that **heat** is **uniformly distributed** during the experiment / **Temperature** of the water remain **constant**.	**1**	
(ii)	The temperature **reading** would **remain constant** during melting.	**1**	

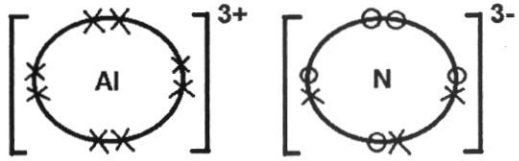
(iii)	The **boiling point of water is 100 °C** and would be **unable to reach 120 °C or higher**. [1] **Replace** water **with** a **liquid** whose **boiling point** is **higher than 130 °C**. [1]	**2**	**R: Add salt, solution (as both of these are a mixture which will affect the bpt)** **Accept: Solvent, liquid**
A3 (a)	 [1] – Labelling of temperatures (200, 190, 120 and 100) [1] – Labelling of x and y-axes [1] – General shape of cooling curve **[any mistake - 1 mark]**	**[3]**	**Some students gave different kinds of curve and wrongly label the states as well as P and Q.** **R: axis without units** **When drawing the graph, some students did not label the temperatures on the y-axis.**
(b)	[2] – labelling regions of solid, liquid and gas correctly	**2**	
(c)	[1] – labelling regions of P and Q correctly	**1**	

(d)	**P**: **gas** and **liquid [1]** **Q**: **liquid** and **solid [1]**	**2**	**Marks are given to this question if students name the states according to what they have labelled in part (a)**
(e)	 Gaseous  solid & liquid	**2**	**Many variations of drawing were seen in this questions which are not acceptable.** **R: Particles with different sizes, overlapping one another.**
A4 (a)	A **Round bottomed / bottom flask** [1] B **Measuring cylinder** [1]	**2**	**Some students did not label A and B. No marks given if they did not label and indicate the correct apparatus.** **Accept: Round bottom flask/round bottomed flask**
(b)	**Lower** than expected. [1] Carbon dioxide is an **acidic oxide,** can **dissolve in water to form acidic solution.** [1]	**2**	**Poorly done.** **Students are not able to relate carbon dioxide to acidic oxides and their properties in the question.**
A5 (a)(i)	$NaA(aq) + HCl(aq) \rightarrow NaCl(aq) + HA(s)$ *[1m – balanced equation; 1m – state symbols]*	**2**	**Chemical equation should not have present of ions seen. E.g. H^+A^-**

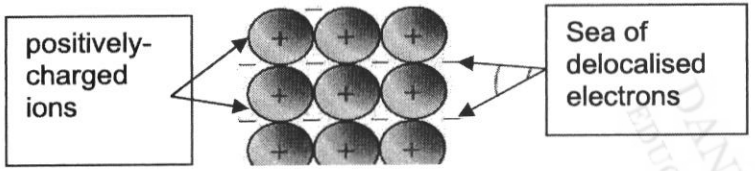
(a)(ii)	It is a **weak acid**. [1] It can only **produce very few hydrogen ions / low concentration of H^+ ions** in water due to **partial dissociation / partially dissociated** in water. [1]	2	**Missing of the word "*produce low concentration of H+ ions*" while answering the question.**
(iii)	Stomach has **hydrochloric acid** which is soluble.	1	**Students are able to identify HCl present in the stomach that causes a reaction.**
(b)(i)	Hydrogen atoms	1	**Well done**
(ii)	The hydrogen atoms from ascorbic acid **react (combine) with oxygen (in the air) to form water**, thus preventing food from being oxidised.	1	**Students did not answer the question on how it prevents oxidation from happening.**
A6 (a)	Chromatogram for electrode B has an **additional dot** which indicates the presence of other impurities; hence they are not from the same manufacturer.	1	**Students are required to draw a comparison between the 2 electrodes used.**
(b)(i)	Rf = 6/12 **= 0.5 (2d.p)**	1	**Well done**
(ii)		1	**Students understood the questions and drew the correct position for Iron(II)** **Marks awarded if student drew another column to show Iron(II).**

A7(a)(i)	**Methane** will diffuse fastest [1] It has the **lowest relative molecular mass** [1]	2	Lower Ar/Mr = Higher rate of diffusion
(ii)	Sulfur dioxide gas is tested by **bubbling it into acidfied aq potassium manganate(VII)** [1] Purple acidified potassium manganate (VII) is **decolourised to form a colourless** solution./ turn from **purple to colourless** [1]	2	Question removed.
(iii)	Hydrogen bromide has a **simple molecular structure** with **strong covalent bonds** between hydrogen and bromine atoms [1] Between the hydrogen bromide molecules, **weak intermolecular forces of attraction** exist. Hence **low amount of energy** is required to overcome the forces of attraction. [1] It has a boiling point of -66ºC (ACCEPT **Bpt lower**) as the weak intermolecular forces of attraction are overcome.	3	Students used the term intermolecular forces of attraction and strong intramolecular forces (Strong covalent bonds) of attraction wrongly.
(b)(i)	If chlorine is not dry, phosphorous trichloride formed will **react vigourously with water** to form phosphoric acid and hydrogen chloride.	1	Students who answered this question wrongly because they did not read the question carefully and gave vague answers.
(ii)	Phosphorous trichloride is toxic and corrosive / pungent.	1	
(iii)	Blue litmus solution turns red.	1	Well done.
B8(a)(i)	As **salt solution concentration increases** from 0 – 23%, the **freeze point decrease.**	1	Students are able to describe the trend shown in the data.
(ii)	Accept anything between -10.5°C to -11.5°C	1	

(b)	 *[ratio of water particles to salt particles is roughly 8:2]* *[particles are of the same size as in the legend]* *[some particles are touching each other but some are not]*	**1**	
(c)	Calcium chloride	**1**	**R: Chemical formula.** **Question is asking the Name of the compound.**
(d)	No. As more snow falls onto the roads and melts, the **salt solution concentration will decrease. [1]** This causes the **freeze point of the mixture to rise**, causing salting to be ineffective.[1]	**2**	**Poorly done.**
(e)	until no more magnesium carbonate will dissolve – to **ensure that all the acid have reacted [1]** filter the mixture – to **remove the excess magnesium carbonates** [1] about half its volume – to **saturate** the filtrate [1] filtrate to cool - to **allow for crystallizations** to take place [1]	**4**	**Not well done.** **Students are unable to use the correct key words/ concepts to reason the purpose for each steps.**

B9(a)(i)	Graphite / Silicon dioxide	**1**	**Knowledge based question.**
(ii)	Diamond	**1**	
(b)	Hexagonal boron nitride (HBN) is **soft** while cubic boron nitride (CBN) is very **hard** / **Slippery [1].** The atoms in HBN is held by **weak van der Waals' forces / intermolecular F.O.A** while the atoms in CBN are held by **strong covalent bonds in tetrahedral arrangement [1].** A **small amount of energy required to overcome the weak intermolecular forces of attraction, allow it to slide over one another**. [1]	**3**	**Poorly answer.** **Unable to identify covalent molecules and ionic compound. Gave wrong description for the type of bonding involved.**
(c)(i)	 1m – correct number of electrons in each ion 1m – correct charge for each ion	**2**	**No marks given if students DID NOT show the electrons equally shared.** **e.g. Students drew the 2 electrons transferred together as a pair. (not accepted)**
(ii)	Hexagonal boron nitride requires a **very large amount of heat energy** to break the **strong covalent bonds** between atoms in [1] the **giant molecular structure** .[1] While aluminium nitride requires a **very large amount of heat energy to overcome the strong electrostatic forces of attraction between oppositely charged ions** in the giant ionic lattice structure [1].	**3**	**Poorly answer.** **Unable to identify covalent molecules, ionic compound respectively.** **R: They are both covalent compound / They are both ionic compound. They required a large amount of energy to overcome the force of attraction.**

Either **B10 (a)**	**Add ethanol and stir to dissolve** camphor. [1] **Filter** the mixture and collect camphor dissolved in ethanol as the **filtrate** and impurities (carbon, iron, iron(III) oxide) as the **residue.** [1] **Heat** the camphor to obtain **a saturated solution**. **Cool** the camphor solution to obtain **camphor crystals.** [1] **Filter** the camphor crystals, **Wash** with distilled water and **dry** between sheets of filter paper. [1]	**4**	
(b)(i)	Isotopes have **same number of protons [1]** **and different number of neutrons. [1]**	**2**	**Knowledge based question**
(ii)	Relative atomic mass = $\frac{85(70)+87(30)}{100}$ [1] = **85.6** [1]	**2**	**Well done.**
(iii)	Density of rubidium-87 is **higher** than rubidium-85. [1] Density = mass/volume. Since **the mass of rubidium-87 is greater** than rubidium- 85, the density of rubidium-87 would be higher for the same volume. [1]	**2**	**Most students are able to mention the density but unable to relate the mass to the density.**
OR **B10** **(a)(i)**	Solid **Strong covalent bonds** between carbon atoms throughout the **giant molecular** structure [1] **A lot of heat energy** is needed to overcome these strong covalent bonds. [1]	**2**	

(a)(ii)	Similarity: they comprised carbon atoms arranged in a **giant molecular structure/hexagonal rings/each carbon atom is bonded to 3 carbon atoms/ free moving electrons**. [1] Difference: Carbon nanotubes are **cylinder – tube shaped** while ordinary graphite consists of **layers of carbon atoms.** [1]	2	**Students are required to make references from the diagram shown to describe the structure of the substances.**
(a)(iii)	Carbon nanotubes are good conductors of electricity. **One carbon is bonded to 3 other carbon atoms**. Each carbon atom has **one valence electron not used** to form covalent bonds/ not used for bonding. [1] The electrons are **delocalized** and can act as mobile charged carriers. [1]	2	**Well done.**
(b)	 **[1] – drawing** **[1] - labelling** It has a **giant lattice structure, with strong electrostatic forces of attraction between metal cations and sea of delocalized electrons. [1]** **Delocalised electrons/ "sea of electrons" are able to move freely [1]** within the metal lattice to conduct electricity,	4	**Must show the correct number of delocalized electron that each positive ion discharge in the drawing.**