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聖嬰中學

HOLY INNOCENTS' HIGH SCHOOL

Name of Student

Class

Index Number

100

END OF YEAR EXAMINATION 2016

SECONDARY 3 EXPRESS

CHEMISTRY

5073

Additional Materials: 1 Multiple Choice Answer sheet
2 sheets of writing paper
1 Periodic Table

Date: 10 OCT 2016

Duration: 2 HR 15 MIN

Time: 0800 - 1015

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use paper clips, glue or correction tape/fluid.

Section A

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 answer sheet.

Read very carefully the instructions on the answer sheet.

Section B

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

Section C

Answer **all** questions, the last question is in the form either/or.

Write your answers on the separate writing paper provided.

At the end of the examination, hand in the answer sheets to Sections A, B and C separately. Do not detach Section B from the Question Paper.

	For Examiner's use
Section A	
Section B	
Section C	
Total	

Information for Candidates

For Section A, each correct answer will score one mark.

For Sections B and C, the number of marks is given in brackets [] at the end of each question or part question.

Set by: Mrs Sheryl Mok

Vetted by: Mrs Cynthia Chan & Ms Tan Bee Tin

This document consists of 20 printed pages (including this cover page).

Section A (35 marks)
Answer all the questions in the MCQ Answer Sheet provided.

- 1 Which physical processes could be used to separate petrol and water?

- 1 distillation
- 2 filtration
- 3 sublimation
- 4 use of a separating funnel

- A 1, 2, 3 and 4
- B 1, 2 and 3 only
- C 1 and 2 only
- D 1 and 4 only

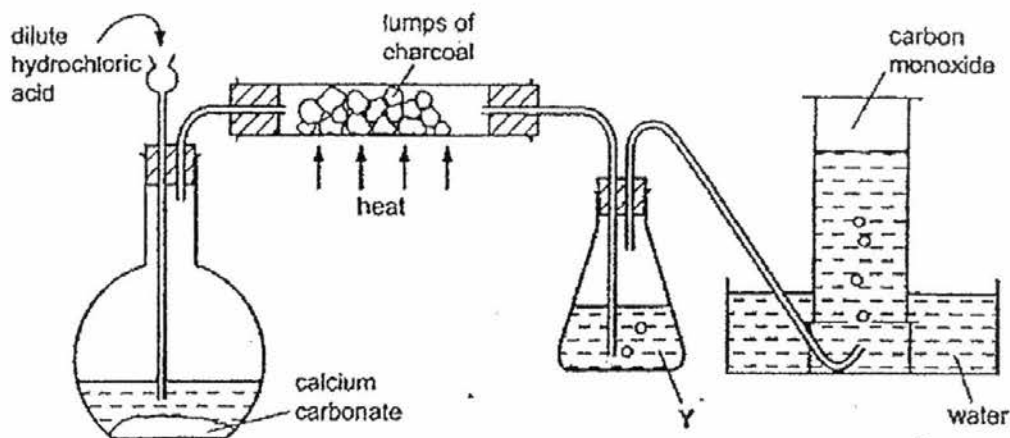
- 2 The table shows the colours and solubilities in water of four solids.

solid	colour	solubility in water
Q	blue	soluble
R	blue	insoluble
S	white	soluble
T	white	insoluble

A mixture containing two of the solids is added to excess water, stirred and filtered. A blue residue and a colourless filtrate are obtained. Which two solids are present in the mixture?

- A Q and R
- B Q and S
- C R and S
- D R and T

- 3 The diagram shows apparatus used to obtain carbon monoxide.



What is the main purpose of Y?

- A to dry the gas
- B to remove hydrogen chloride from the gas
- C to remove carbon dioxide from the gas
- D to prevent water from being sucked back on to the hot carbon

- 4 Two gases, M and N, were separately released in a laboratory on a cold day. The experiment was repeated on a hot day. The time taken for the gases to reach the opposite end of the laboratory was recorded for each experiment.

The relative molecular mass of gas M was 26 and the relative molecular mass of gas N was 74.

Which gas on which day would reach the end of the laboratory in the shortest time?

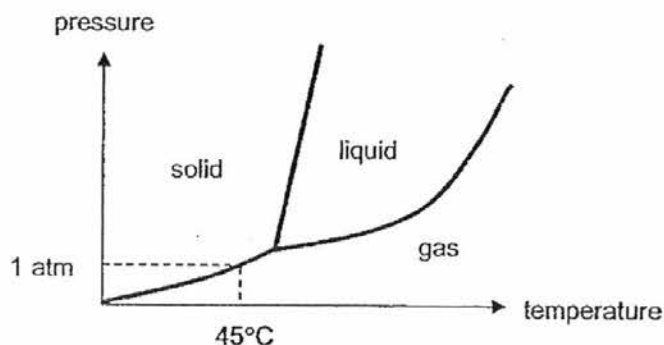
	gas	day
A	M	hot
B	M	cold
C	N	cold
D	N	hot

- 5 Magnesium perchlorate, $\text{Mg}(\text{ClO}_4)_2$, is a compound discovered on Mars. It has a melting point of -22°C .

Which of the following correctly describes the state of magnesium perchlorate on Mars in summer (-5°C) and in winter (-87°C)?

- A solid in both summer and winter
- B solid in summer and liquid in winter
- C liquid in summer and solid in winter
- D liquid in both summer and winter

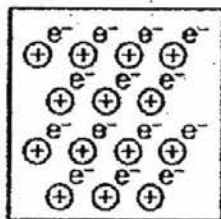
- 6 The diagram below shows the state of a pure substance W at different pressures (atm) and temperature ($^\circ\text{C}$). The conditions for room temperature and pressure are given as 25°C and 1 atm.



What is the change in state when W is heated from room temperature to 45°C at 1 atm?

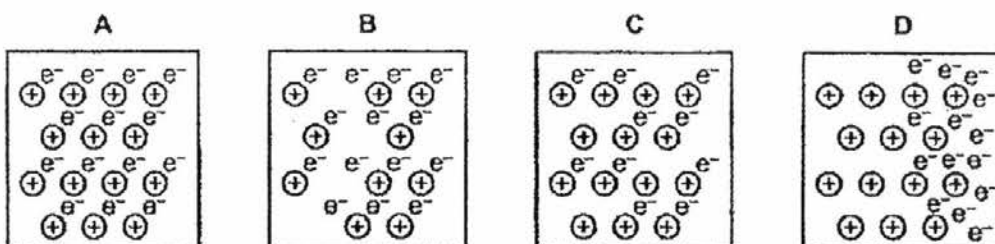
- A gas to solid
 - B gas to liquid
 - C liquid to gas
 - D solid to gas
- 7 At which temperature does a concentrated aqueous solution of sodium chloride begin to boil?
- A 94°C
 - B 99°C
 - C 100°C
 - D 104°C

- 8 A giant molecule is made up of a large amount of carbon, mainly isotopes ^{12}C and ^{13}C . It was found that the relative atomic mass of carbon in the molecule is 12.2. What is the ratio by mass of ^{12}C to ^{13}C ?
- A 4 : 1 B 1 : 4 C 3 : 4 D 3 : 1
- 9 The isotope cobalt-60 is used to destroy cancer cells in the human body. Which statement about an atom of cobalt-60 is **not** correct?
- A It contains 33 neutrons.
 B It has fewer electrons than the atoms of other isotopes of cobalt.
 C Its nucleus has a relative charge of 27+.
 D Its nucleus contains more than 99% of the mass of the atom.
- 10 Which of the following statements is true?
- A Ar has more electrons than Cl.
 B Cl^- has more electrons than K^+ .
 C Fe^{3+} has more electrons than Fe^{2+} .
 D K has more electrons than K^+ .
- 11 The diagram shows the arrangement of positive ions and electrons in a solid metal.



An electric current is passed through the metal for several minutes and then switched off.

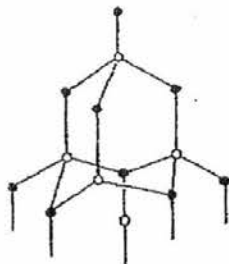
Which diagram shows the positive ions and electrons in the metal after the current has been switched off?



- 12 Elements S and T form a compound ST_3 . This compound exists as a solid at room temperature. Which of the following could be the electronic configurations of the atoms S and T?

	S	T
A	2.1	2.8.3
B	2.7	2.8.5
C	2.8.4	2.7
D	2.8.3	2.8.7

- 13 The diagram shows part of the structure of silicon carbide.

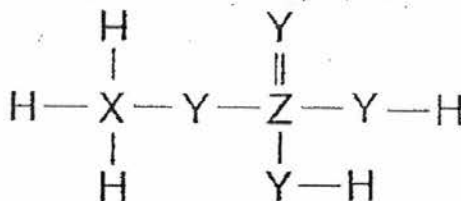


- carbon atom
○ silicon atom

Which set of properties is silicon carbide likely to have?

	when heated strongly in oxygen	physical state
A	burns, leaving no solid residue	soft slippery solid
B	melts at high temperature, no chemical change	soft slippery solid
C	burns easily, leaving no residue	hard solid
D	burns slowly, a solid residue and a colourless gas are formed	hard solid

- 14 The diagram shows the structure of a covalent compound containing the element hydrogen, H and the unknown elements, X, Y and Z.



To which groups of the Periodic Table do these three elements, X, Y and Z, belong?

	X	Y	Z
A	IV	II	V
B	IV	VI	V
C	IV	VI	III
D	V	II	III

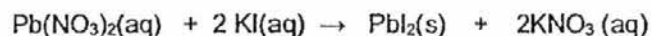
- 15 Which of the following correctly shows the particles that conduct electricity in the substance?

	substance	particles
A	PbCl ₂ (l)	ions and electrons
B	Fe (l)	ions and electrons
C	NaCl (s)	ions
D	HCl (aq)	ions

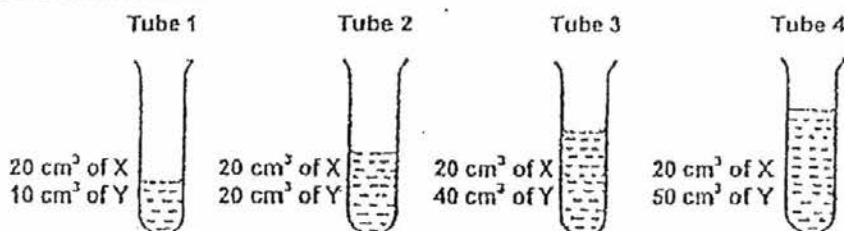
- 16 Which solution contains the greatest number of chloride ions?

- A 20 cm³ of 1 mol/dm³ of silver chloride
 B 10 cm³ of 1 mol/dm³ of barium chloride
 C 5 cm³ of 1 mol/dm³ of sodium chloride.
 D 5 cm³ of 2 mol/dm³ of hydrochloric acid

- 17 When solutions of lead(II) nitrate and potassium iodide are mixed, lead(II) iodide is precipitated as shown by the equation.

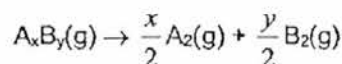


Different volumes of 1.00 mol/dm^3 aqueous potassium iodide (Y) are added to the same volume of 0.500 mol/dm^3 aqueous lead(II) nitrate (X) in each of the four test tubes as shown below.



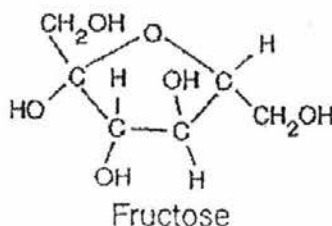
When the precipitate settles, it is found that the amount of precipitate

- A is the same in all four test tubes.
 B increases consecutively from tubes 1 to 4.
 C increases from tubes 1 to 2, but is the same in tubes 2 to 4.
 D increases from tubes 1 to 3, but is the same in tubes 3 and 4.
- 18 When 32.0 g of calcium reacts with excess dilute hydrochloric acid, 66.6 g of calcium chloride is produced. What is the percentage yield of calcium chloride?
- A 60.0 % B 66.6 % C 75.0 % D 88.8 %
- 19 25 g of impure calcium carbonate decomposed on heating to give 8.8 g of carbon dioxide gas. What is the percentage purity of the calcium carbonate? (Assume that none of the impurities produces carbon dioxide upon heating)
- A 15.0 % B 25.0 % C 60.0 % D 80.0 %
- 20 The equation for the decomposition of A_xB_y is given as:



If 30 cm^3 of A_xB_y decompose on heating to produce 15 cm^3 of A_2 and 45 cm^3 of B_2 , which of the following is the formula of A_xB_y ?

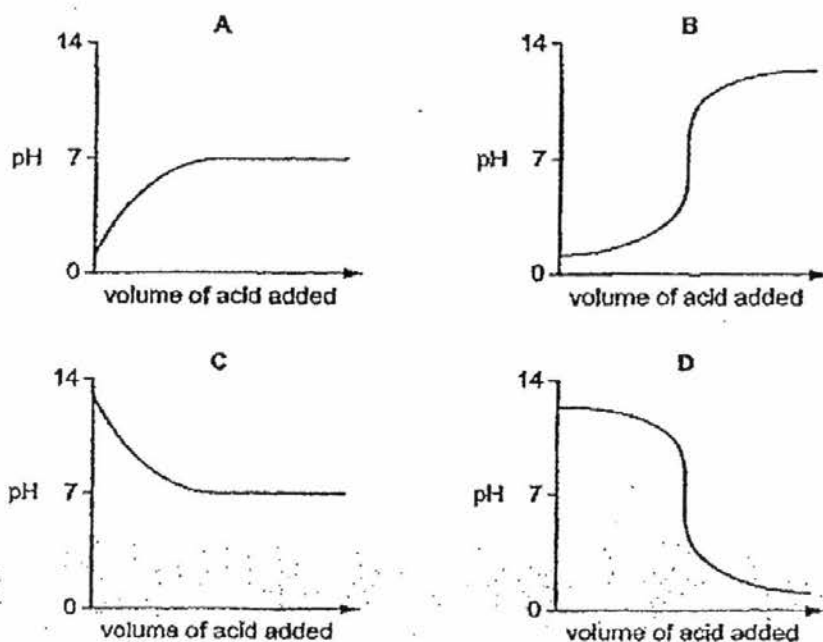
- A AB_3 B A_2B_3
 C A_3B D A_3B_2
- 21 Fructose has the following structural formula.



What is the empirical formula of fructose?

- A CH_2O B CHO
 C $\text{C}_6\text{H}_{12}\text{O}_6$ D $\text{C}_7\text{H}_{12}\text{O}_5$

- 27 Which graph shows the changes in pH as an excess of nitric acid is added to aqueous sodium hydroxide?

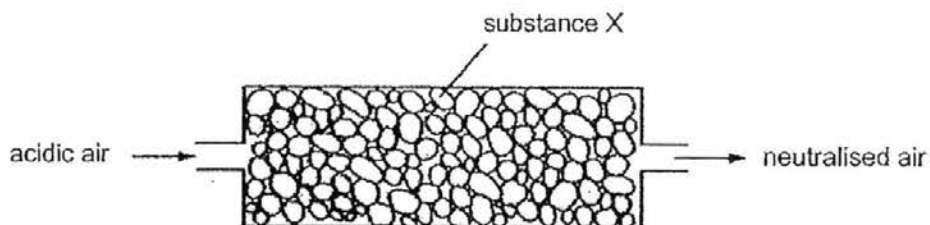


- 28 The global atmospheric concentration of carbon dioxide has increased in the last 200 years. What could be causing this increase?

- 1 emissions from motor vehicles
- 2 photosynthesis
- 3 power stations using coal and oil

- | | | | |
|----------|--------------|----------|--------------|
| A | 1 and 2 only | B | 1 and 3 only |
| C | 2 and 3 only | D | 1, 2 and 3 |

- 29 Air containing an acidic impurity was neutralised by passing it through a column containing substance X.

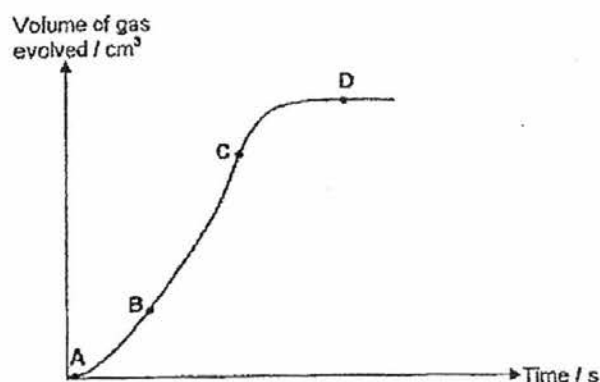


What is substance X?

- | | |
|----------|----------------------------|
| A | calcium oxide |
| B | sand |
| C | sodium chloride |
| D | concentrated sulfuric acid |
- 30 Which of the following gases is one of the main contributors to global warming?

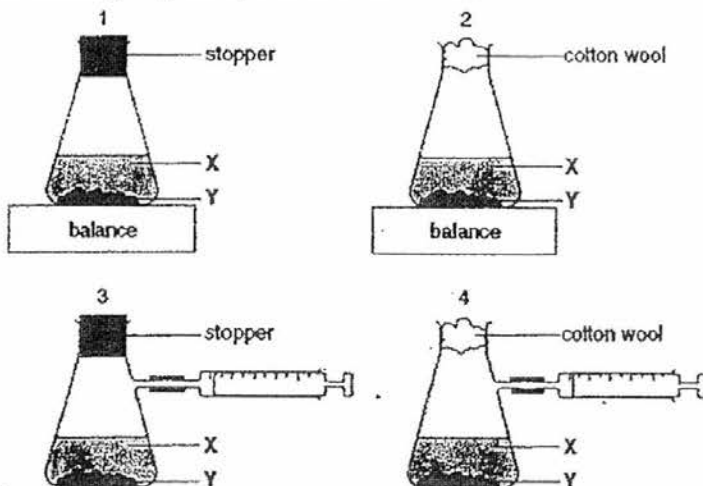
- | | |
|----------|---------------------|
| A | chlorofluorocarbons |
| B | methane |
| C | nitrogen dioxide |
| D | sulfur dioxide |

- 31 In an experiment, magnesium strips react with an excess of dilute hydrochloric acid. The graph below shows how the volume of gas evolved varies with time.



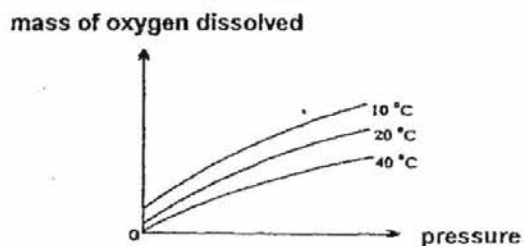
Which of the following statements **best** explains the rate of reaction at point A on the graph?

- A The reactants had not reached the activation energy level at A.
 - B The magnesium strip had a protective layer on them.
 - C The rate of chemical reaction is always the slowest at the start.
 - D The magnesium strips have to be converted to the aqueous state first.
- 32 In which reaction is the pressure least likely to affect the rate of reaction?
- A $\text{C(s)} + \text{CO}_2\text{(g)} \rightarrow 2\text{CO(g)}$
 - B $2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$
 - C $\text{N}_2\text{(g)} + 3\text{H}_2\text{(g)} \rightarrow 2\text{NH}_3\text{(g)}$
 - D $\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$
- 33 Liquid X reacts with solid Y to form a gas. Which two diagrams show suitable methods for investigating the speed of the reaction?



- A 1 and 3 B 1 and 4 C 2 and 3 D 2 and 4

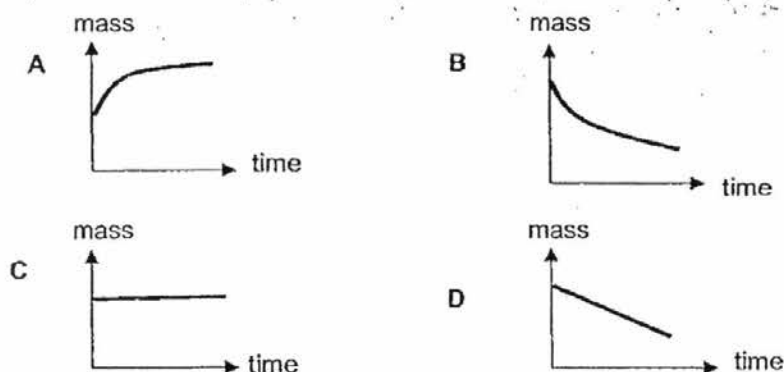
- 34 The graph below shows the solubility of oxygen in water at various temperatures and pressures.



Which one of the following correctly describes the effect of an increase in pressure and an increase in temperature on the solubility of oxygen in water?

	increase in pressure	increase in temperature
A	more soluble	more soluble
B	more soluble	less soluble
C	no effect	less soluble
D	less soluble	no effect

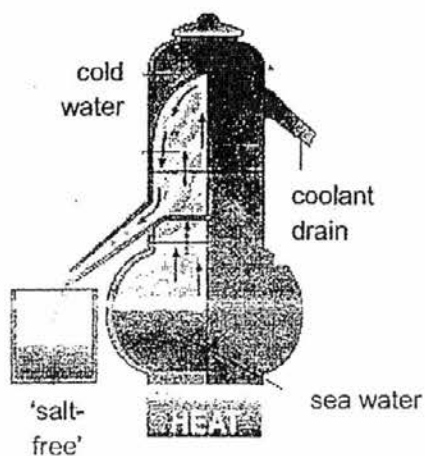
- 35 A conical flask containing hydrochloric acid is placed on a top-pan balance. Some marble chips are carefully added to the flask. Which of the following graphs represents the correct plot of the mass of the flask and its content against time?



Section B (35 marks)

Write your answers in the spaces provided.

- B1 Seawater can be converted into drinking water by the process of desalination. The older processes used a distillation method to desalinate the water, as shown in the diagram.



- (a) Explain how this process produces salt-free water.

[3]

- (b) The removal of salt is only one stage of the process of producing drinking water from sea water. Suggest another stage or process that is carried out to ensure the purity of drinking water and whether it should happen before or after distillation.

[2]

- (c) A newer process involves using a membrane to remove salt from the sea water. Cold sea water is pumped through the membrane under pressure. Suggest why this process has a lower energy demand than the distillation process.

[1]

- B2 The following procedure is an account of an experiment to prepare copper(II) chloride crystals.

Procedure :

1. A measuring cylinder was used to transfer 125 cm^3 of 2.00 mol/dm^3 hydrochloric acid to a beaker.
2. 12.0 g of copper(II) oxide was weighed out.
3. The acid was heated and the copper(II) oxide was added a little at a time, with stirring until the copper(II) oxide was present in excess.
4. The mixture was filtered and the filtrate was heated until the volume had been reduced to 50.0 cm^3 .
5. The solution was left to cool.
6. The crystals that was formed were filtered off and dried between pieces of filter paper.

The mass of crystals obtained was 5.00 g .

- (a) Write a balanced chemical equation, with state symbols, for the reaction.

[2]

- (b) State and explain which measurement was unnecessary.

[1]

- (c) Explain why crystals of copper(II) chloride were formed when the filtrate was cooled. [1]

.....
.....

- (d) Suggest one possible way to modify the experiment so as to obtain more than 5.00 g of copper(II) chloride crystals from 125 cm³ of 2.00 mol/dm³ of dilute hydrochloric acid. [1]

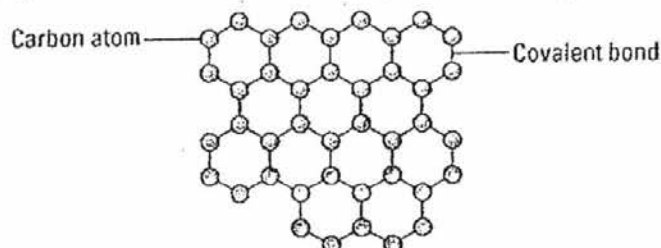
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- B3** Scientists have recently developed a method to produce large sheets of a substance called graphene. Graphene is made from carbon and is made of a single layer of graphite.

The properties of graphene include:

- it conducts electricity
- it is transparent as it has the thickness of a single layer of atoms
- it is strong and durable

The picture below shows the structure of graphene.



These properties make it suitable to overlay a monitor screen to make it a touchscreen.



- (a) Explain [1]
(i) why graphene is strong;

.....
.....

- (ii) why graphene is a good conductor of electricity. [2]

.....
.....

- (b) Suggest why a sheet of graphite, which is made up of large number of carbon layers, would not be suitable as a material for a touchscreen monitor. [1]

.....
.....

B4 A sample of air taken from around a power station that uses fossil fuels was found to contain many pollutants. Sulfur dioxide is one of the pollutants present in the sample.

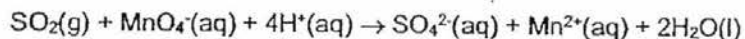
- (a) State a pollutant, other than sulfur dioxide, in the sample which causes acid rain. Explain how the pollutant enters the air and how the amount can be reduced. [3]

.....
.....
.....

- (b) Suggest why the levels of these pollutants in the atmosphere increase in winter time. [1]

.....

- (c) A sample of the polluted air can be treated for sulfur dioxide by bubbling it through acidified potassium manganate(VII). The equation is given below.



A solution contains 0.100 mol/dm³ of manganate(VII) ions. Given a 2.00 dm³ sample of polluted air which contains 3.4 % by volume of sulfur dioxide, measured at room temperature and pressure, calculate the minimum volume of this solution required to remove the sulfur dioxide. [4]

- (d) Explain why it is necessary to treat sulfur dioxide. [2]

.....
.....
.....

- B5** Lumps of calcium carbonate, of identical size, were treated with 100 cm³ of dilute acid and the volume of carbon dioxide gas evolved after 4 minutes was measured. The temperature rise was monitored at the same time. All other conditions remain the same. The results of the four experiments are tabulated in the table below.

experiment no.	dilute acid	volume of CO ₂ gas/cm ³	temperature rise/°C
1	0.10 mol/dm ³ HCl	11.0	0.10
2	0.20 mol/dm ³ HCl	22.0	0.30
3	0.40 mol/dm ³ HCl	44.0	0.60
4	0.20 mol/dm ³ HNO ₃	22.0	0.30

- (a) Explain why it is important that the pieces of calcium carbonate are the same size and the same shape. [2]

.....

.....

- (b) What deduction can be made about the rate of the reaction from the volumes of gas evolved over the 4 minute interval using the different concentrations of dilute hydrochloric acid? [1]

.....

.....

- (c) Using ideas from the collision theory, explain the deduction in (b). [2]

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- (d) Suggest why the volume of carbon dioxide gas produced is the same over the 4 minute interval for experiments 2 and 4. [1]

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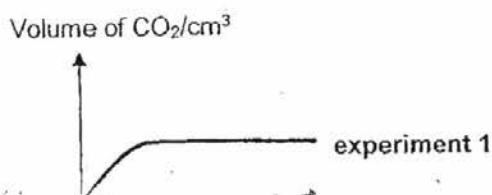
- (e) With reference to experiment 1, suggest how the temperature rise will change if the acid used is changed to ethanoic acid. Explain your reasoning. [2]

.....

.....

.....

- (f) The result for experiment 1 is shown in the graph below. Sketch, on the same diagram below, two graphs to show the results for experiment 3 and 4. Label your graphs experiment 3 and experiment 4. [2]



Section C (30 marks)

Answer all three questions from this section. The last question is in the form of either/or and only one of the alternative should be attempted.

C1(a) A molecule that is made up of more than two atoms usually has a central atom that all other atoms are bonded to.

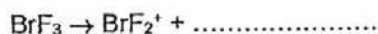
Central atom	Period that Central atom belongs to	Formula of molecule	Dot-and-cross diagram of molecule
C	2	CO	$\text{:C}\ddot{\text{O}}\text{:}$
		CO ₂	
N	2	NH ₃	$\begin{array}{c} \text{H}:\text{N}:\text{H} \\ \\ \text{H} \end{array}$
O	2	I ₂ O	$\begin{array}{c} \text{O} \\ / \quad \backslash \\ \text{I} \quad \text{I} \end{array}$
P	3	PCl ₃	$\begin{array}{c} \text{Cl} \\ \\ \text{Cl}-\text{P}-\text{Cl} \\ \\ \text{Cl} \end{array}$
		PCl ₅	$\begin{array}{c} \text{Cl} \\ \\ \text{Cl}-\text{P}-\text{Cl} \\ / \quad \backslash \\ \text{Cl} \quad \text{Cl} \end{array}$
S	3	SF ₄	$\begin{array}{c} \text{F} \\ \\ \text{F}-\text{S}-\text{F} \\ \\ \text{F} \end{array}$
		SF ₆	$\begin{array}{c} \text{F} \\ \\ \text{F}-\text{S}-\text{F} \\ / \quad \backslash \\ \text{F} \quad \text{F} \end{array}$

* Only valence electrons are shown

The table above shows information about some of these molecules with central atoms (except carbon monoxide) formed by elements in Periods 2 and 3 of the Periodic Table. Study the information carefully and answer the following questions.

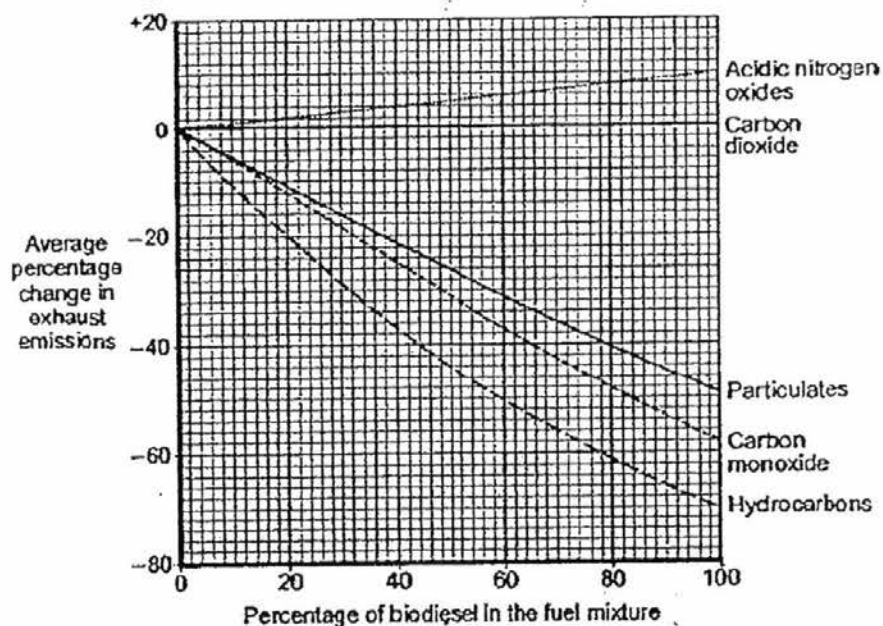
- (i) With reference to the table, draw a similar 'dot-and-cross' diagram of the carbon dioxide molecule. [1]
- (ii) Comment on the unusual bonding seen in the 'dot-and-cross' diagram in carbon monoxide and phosphorus pentachloride (PCl_5). [2]
- (iii) Interhalogen compounds are formed between atoms of different Group VII elements. BrF_5 is an example of an interhalogen compound. Using information given in the table, draw a similar 'dot-and-cross' diagram of BrF_5 . [1]
- (iv) Another interhalogen compound, BrF_3 , is a straw-coloured liquid with a pungent odour. It is able to conduct electricity and goes through partial self-ionization.

Copy and complete the equation below.



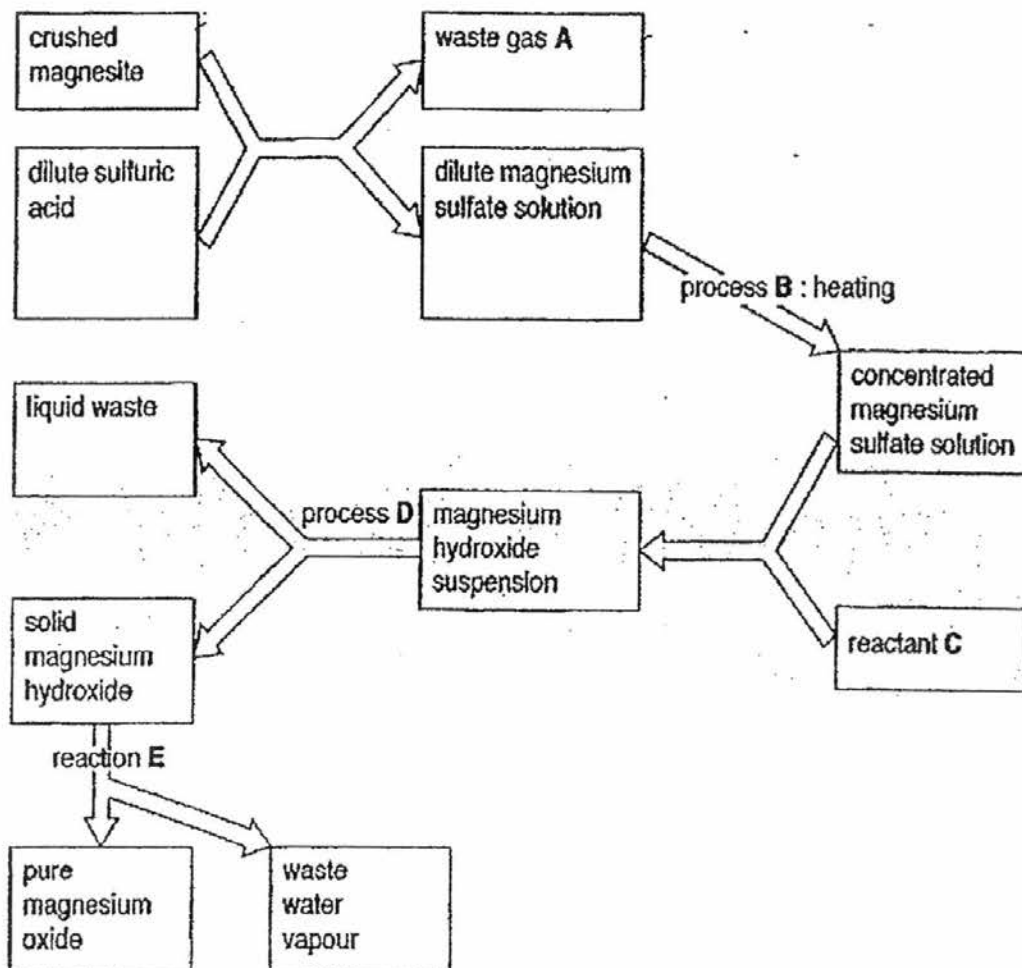
Explain why BrF_3 is a good conductor of electricity while bromine and fluorine are non-conductors of electricity. [3]

- (b) Carbon dioxide is one of the gases found in exhaust emissions. The graph below shows the average percentage change in exhaust emissions from vehicles using different mixtures of petroleum diesel and biodiesel. Biodiesels are fuels harvested from plants.

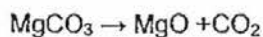


- (i) Describe how the percentage change in exhaust emission varies as the percentage of biodiesel in the fuel mixture increases. [1]
- (ii) The following claim was made by a scientist:
"I think that the net carbon dioxide emissions are lower for biodiesel than for petroleum diesel."
Do you agree with this claim? Explain your reasoning. [1]
- (iii) Suggest why one of the exhaust emissions increases with higher percentage of biodiesel in the fuel mixture. [1]

- C2 Magnesium oxide, MgO, is an important starting chemical in the making of many medicines. It is made from magnesite mineral, containing 75 % magnesium carbonate, by the process shown in the flow chart.



- (a)(i) Give the name of the main gas in waste gas A. [1]
- (ii) What method should be used to separate out the solid magnesium hydroxide in process D? [1]
- (iii) Write an equation for reaction E. [1]
- (b) Magnesium oxide can also be produced from magnesite mineral as shown in the equation:



Calculate the maximum mass of magnesium oxide that can be produced from 280 tonnes of magnesite mineral. [3]

- (c) Before heating the solution in process B, 400 dm³ of dilute solution has a concentration of 70 g/dm³. After process B, the concentrated solution has a concentration of 560 g/dm³. What is the volume of the concentrated solution? [2]

- (d) Solid magnesium oxide can be reacted with a dilute acid to form magnesium chloride, which is another important chemical in the making of medicines.

Draw a flow chart, similar to the one above, to show how to produce a concentrated solution of magnesium chloride from magnesium oxide. [2]

C3 EITHER

- (a) The electronic arrangement of the elements **A** and **B** are given in the table below.

Element	Electronic arrangement
P	2, 2
Q	2, 8, 7

- (i) Elements **P** and **Q** form a compound with formula **PQ₂**. **PQ₂** melts at 898 °C and boils at 1543 °C.

Comment on the electrical conductivity of **PQ₂**. [2]

- (ii) Explain, in terms of its structure, why **PQ₂** has a high boiling point. [2]

- (iii) Draw a 'dot-and-cross' diagram to show the bonding in **PQ₂**. Show the outer shell electrons only. [2]

- (b) The size of an atom can be determined by measuring the distance between the nuclei of two adjacent atoms. For example, the 'covalent radius' of the Cl atom is assumed to be half the distance between the nuclei in a Cl₂ molecule. Similarly, the 'metallic radius' is half of the distance between two adjacent metal atoms in its metallic lattice.

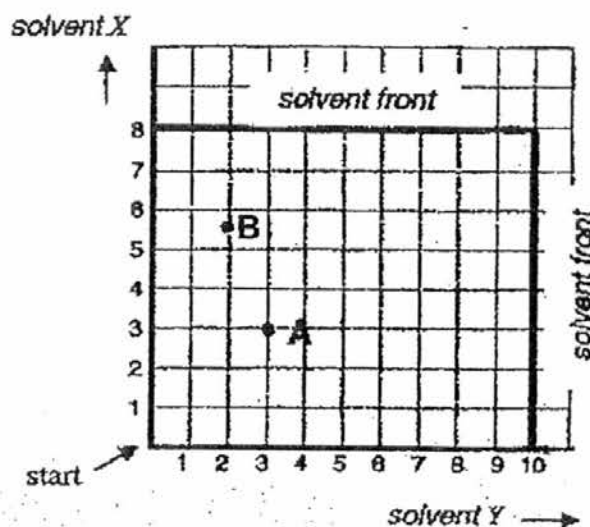
The table below shows the atomic radii for the elements of period 3 of the Periodic Table, **Na** to **Cl**, as well as the radii of the cations and anions formed by some of the Period 3 elements.

Element	Na	Mg	Al	Si	P	S	Cl
Atomic radius / 10 ⁻⁹ m	0.186	0.160	0.143	0.117	0.110	0.104	0.099
Ion	Na ⁺	Mg ²⁺	Al ³⁺	-	P ³⁻	S ²⁻	Cl ⁻
Radius of ion / 10 ⁻⁹ m	0.095	0.065	0.050	-	0.212	0.184	0.181

- (i) Describe the variation in atomic radius of these period 3 elements. [1]
- (ii) Suggest why it is **not** possible to use the same type of measurement to find the atomic radius of argon, Ar. [1]
- (iii) Explain why the radii of the cations are much smaller than the radii of their corresponding atoms. [2]

C3 OR

- (a) A mixture of amino acids is separated by two-way chromatography. The positions of spots A and B, after treating with a locating agent, are indicated in the chromatogram below.



The R_f value of an amino acid is defined as:

$$R_f \text{ value} = \frac{\text{Distance travelled by the 'spot' of amino acid}}{\text{Distance travelled by the solvent}}$$

Two of the spots can be identified with the help of the table below:

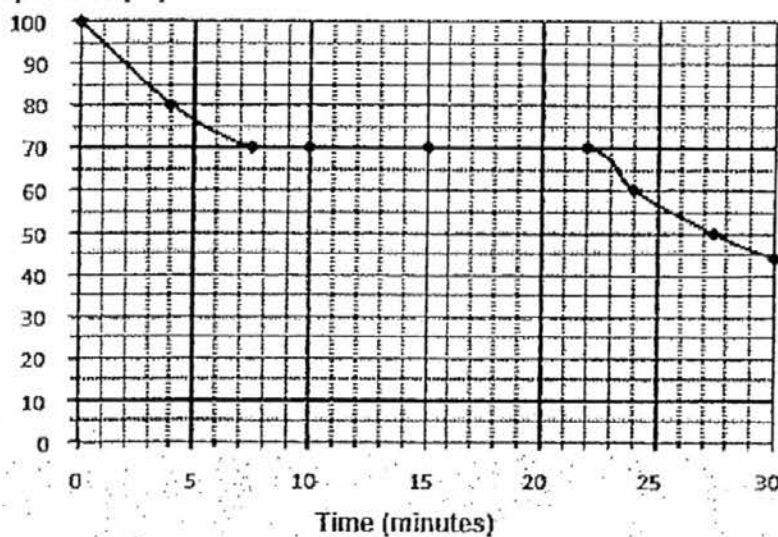
Amino acid	R_f value in solvent X	R_f value in solvent Y
Glutamic acid	0.38	0.30
Glycine	0.50	0.26
Arginine	0.70	0.20
Leucine	0.91	0.73

- (i) Using data from the table, name the two amino acids, A and B, present in the mixture. [2]
- (ii) Explain why a locating agent needs to be used. [1]
- (iii) The start line on the chromatogram was drawn using a pencil. Explain why this is important. [1]

- (b) Phenyl benzoate is a solid at room temperature and it has a boiling point of 298°C .

The graph shows the temperature of a sample of phenyl benzoate as it cools.

Temperature ($^{\circ}\text{C}$)



- (i) State the physical state(s) of phenyl benzoate at the 15th minute. [1]
- (ii) Describe the changes to the **arrangement** and **movement** of the particles of phenyl benzoate as it cools from the 5th to the 25th minute. [2]
- (iii) Using information from the graph, state the melting point of phenyl benzoate. [1]
- (iv) Explain why the temperature remains constant from the 7.5th minute to the 22nd minute. [2]

End of Paper

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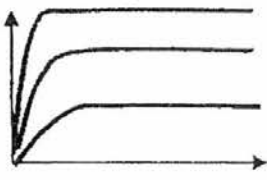
Section A (MCQ)

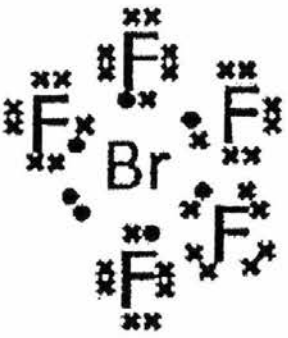
Q1	D
Q2	C
Q3	C
Q4	A
Q5	C
Q6	D
Q7	D
Q8	A
Q9	B
Q10	D
Q11	A
Q12	D
Q13	D
Q14	B
Q15	D
Q16	B
Q17	C
Q18	C
Q19	D
Q20	A

Q21	A
Q22	C
Q23	C
Q24	A
Q25	D
Q26	B
Q27	D
Q28	B
Q29	A
Q30	A
Q31	B
Q32	D
Q33	C
Q34	B
Q35	B

Section B & C (Structured & Long Qn)

Qn	Answers	Marks
B1a	Sea water consists of water and salt (sodium chloride). When heated, water boils and turns into steam at 100°C, leaving salt behind; The steam condenses when it reaches the cold surface and flows out of the distillation apparatus.	1 1 1
b	Filter the sea water by passing through a filter to remove large insoluble solids such as sand; Filtration should be carried out before distillation. OR Add substances (such as chlorine) to kill bacteria; It should be added after distillation.	1 1
c	Distillation needs more energy as heat has to be supplied to boil the water.	1
B2a	$\text{CuO(s)} + 2\text{HCl(aq)} \rightarrow \text{CuCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$	2
b	Weighing out 12.0 g of copper(II) oxide was unnecessary as the copper(II) oxide is needed to add to the acid in excess.	1
c	The solubility of copper(II) chloride is lower at a lower temperature; Thus, the amount of copper(II) chloride which is not able to dissolve at a lower temperature will appear as crystals.	1
d	Using greater volume of acid / higher concentration of acid.	1
B3ai	Graphene has many strong covalent bonds between carbon atoms.	1
ii	One carbon atom is bonded to only three other carbon atoms; One free-moving electron per carbon atom which acts as charge carrier.	1 1
b	Too many layers will reduce/ decrease the sensitivity of the touch screen.	1
B4a	Oxides of nitrogen; Internal combustion in engines of vehicles; Reduced by using platinum catalytic converters in car engine.	1 1 1
b	There is a need to burn more fuel for heaters.	1
c	Volume of SO_2 in 2.00 dm^3 of air = $3.4/100 \times 2 = 0.0680 \text{ dm}^3$ [1] No. of moles of SO_2 present in air = $0.0680/24 = 0.00283 \text{ mol}$ [1] No. of moles of MnO_4^- required = 0.00283 mol [1] Volume of solution needed = $0.00283/0.1 = 0.0283 \text{ dm}^3$ [1]	4

d	(Sulfur dioxide causes acid rain). Acid rain corrodes limestone buildings; and destroys aquatic life and vegetation.	1 1
B5a	It is to ensure that the surface area of solids remain constant throughout the various experiments for a fair comparison .	1 1
b	The higher the concentration of the acid, the faster the reaction rate.	1
c	Higher concentration, more reactant particles per unit volume ; thus frequency of effective collisions increases , increasing rate of reaction.	1 1
d	Both HCl and HNO ₃ are monobasic acids ; The number of moles of acid reacting with calcium carbonate is the same , thus volume of carbon dioxide produced is the same.	0.5 0.5
e	The temperature will be lower ; Ethanoic acid is a weak acid and it ionizes partially to give fewer hydrogen ions, hence less heat energy is released.	1 1
f	Volume of CO₂/cm³  Time/s	2
C1ai		1
ii	The carbon atom and the oxygen atom in CO do not share equal number of electrons to achieve the stable electronic structure. Oxygen atom shared 4 electrons while carbon atom shared only 2 electrons. OR For CO, one pair of electrons being shared comes solely from the oxygen atom instead of one electron each from the carbon and oxygen atom. The P atom has a total of 10 valence electrons in the outermost shell instead of the usual configuration of 8 valence electrons.	1 1

iii		1
iv	$\text{BrF}_3 \rightarrow \text{BrF}_2^+ + \text{F}^-$ BrF₃ goes through self-ionization and produces ions which are free moving in liquid state which act as charge carriers. Bromine and fluorine exists as simple covalent molecules and do not have free moving charged particles (ions or electrons) to act as charge carriers.	1 1 1
bi	Increase percentage change of nitrogen oxides AND Decrease percentage change of particulates, hydrocarbons and carbon monoxide.	1
ii	(Yes) Carbon dioxide produced by burning the biodiesels is reabsorbed by the plants which produced biodiesels during photosynthesis , thus the net emissions are lower.	1
iii	Biodiesel undergoes combust more readily, thus releases more heat . Nitrogen and oxygen in the air reacts at high temperature to give nitrogen oxides.	0.5 0.5
C2ai	Carbon-dioxide	1
ii	Filtration	1
iii	$\text{Mg}(\text{OH})_2 \rightarrow \text{MgO} + \text{H}_2\text{O}$	1
b	Mass of MgCO₃ in 280 tonnes of magnesite $= 75/100 \times 280 = 210$ tonnes [1] $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$ No. of moles of MgCO₃ $= 210 \times 10^6 / [24 + 12 + 3(16)] = 2\,500\,000$ moles [1] Since 1 MgCO₃ : 1 MgO No. of moles of MgO = 2 500 000 moles Maximum mass of MgO produced $= 2\,500\,000 \times (24 + 16) = 100\,000\,000\text{g} = 100$ tonnes [1]	3

c	Mass of $\text{MgSO}_4 = 70 \times 400 = 28\,000\text{g}$ [1] Since concentration = mass/volume Volume of concentrated solution = mass/concentration $= 28000 / 560 = 50\text{ dm}^3$ [1]	2
d	Solid magnesium oxide $\xrightarrow{\text{Dilute hydrochloric acid [1]}}$ dilute magnesium chloride solution $\rightarrow$ concentrated magnesium chloride solution <i>Note: arrows are essential to score</i>	2
C3ai Either	Conducts electricity in molten and aqueous states as ions are moving freely to carry current; Does not conduct electricity in solid state as ions are held in fixed positions and cannot move to act as charge carriers.	1 1
ii	Giant ionic lattice structure; Large amount of energy required to overcome the strong electrostatic forces of attraction between the cations and anions.	1 1
iii	Correct P ion Correct Q ion and number of Q ions	1 1
bi	Atomic radius decreases across the period.	1
ii	Argon does not form any bonds/ compounds/ molecules OR Argon exists as single atoms/ is monoatomic.	1
iii	Cations contain fewer electrons than protons/ the corresponding atoms; thus nucleus has a greater force of attraction on its electrons.	1 1

C3ai Or	A: Glutamic acid B: Arginine	1 1
ii	Locating agent is used to reveal the colourless amino acid spots on the chromatogram.	1
iii	Pencil lead is insoluble in the solvent . It will not dissolve and separate out , interfering with the results.	1
bi	solid AND liquid states	1
ii	arrangement: changes from less closely packed together in a disorderly manner to being closely packed in an orderly manner . movement: changes from sliding over each other and moving throughout the liquid to vibrating and rotating about their fixed position .	1 1
iii	70°C	1
iv	Heat energy is released as the particles slow down to take up their positions; Energy is used to compensate for the loss of heat energy to the surroundings .	1 1