



**BEATTY SECONDARY SCHOOL  
PRELIMINARY EXAMINATION 2021**

**SUBJECT : SCIENCE  
(CHEMISTRY, BIOLOGY)**                      **LEVEL : Sec 4 Express**

**PAPER : 5078/01**                                      **DURATION : 1 hour**

**SETTERS : Ms Serena Tan  
Mr Yeo Chee Keong**                      **DATE : 1 September 2021**

<b>CLASS :</b>	<b>NAME :</b>	<b>REG NO :</b>
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**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Write your name, class and register number on the Optical Answer Sheet provided.

Do not use staples, paper clips, glue or correction fluid.

There are **forty** 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 choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet 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 Data Sheet is printed on page 20.

A copy of the Periodic Table is printed on page 21.

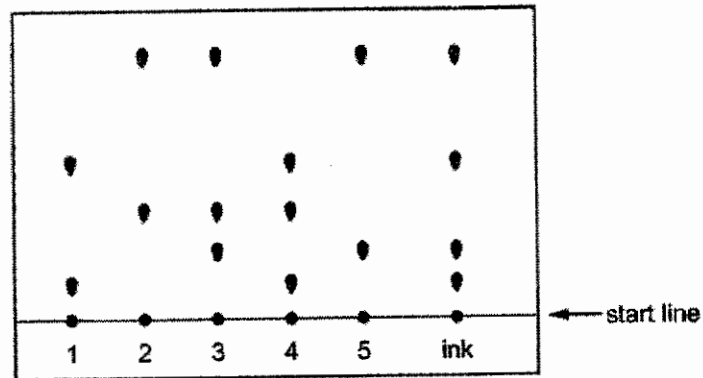
The use of an approved scientific calculator is expected, where appropriate.

This paper consists of **21** printed pages (including this cover page).

**[Turn over**

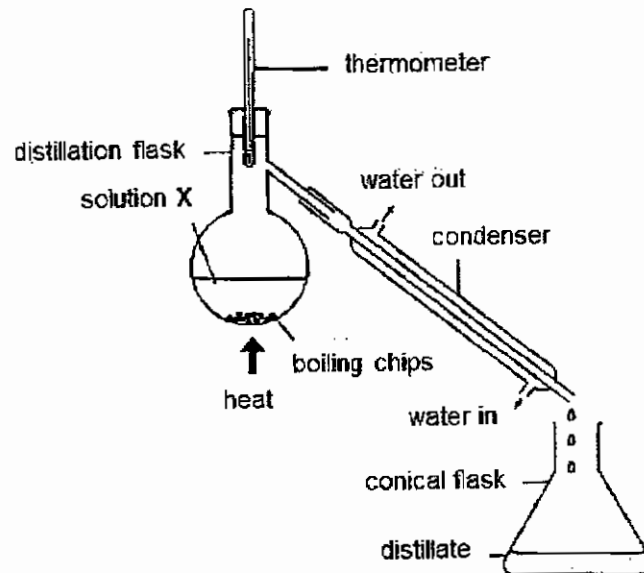
2

- 1 The diagram shows the results of a chromatography experiment to identify the dyes present in a sample of ink.



Which **two** dyes make up the ink sample?

- A 1 and 3  
 B 1 and 5  
 C 2 and 4  
 D 3 and 4
- 2 Solution X is a mixture of liquid Y and substance Z. It is known that liquid Y has a boiling point of  $80\text{ }^{\circ}\text{C}$  and substance Z has a boiling point of  $139\text{ }^{\circ}\text{C}$ . This solution is distilled in the setup as shown.



What is the temperature shown by the thermometer when the distillate is first collected?

- A  $25\text{ }^{\circ}\text{C}$   
 B  $80\text{ }^{\circ}\text{C}$   
 C  $100\text{ }^{\circ}\text{C}$   
 D  $139\text{ }^{\circ}\text{C}$

## 3

- 3 Jia Rui carried out some tests on two salt solutions, X and Y, to determine their actual identities.

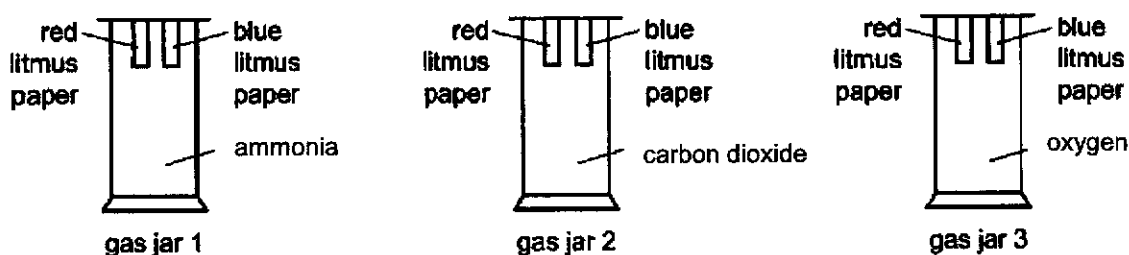
The table shows the results.

test	X	Y
a few drops of aqueous sodium hydroxide are added	green precipitate formed	red-brown precipitate formed
a few drops of dilute nitric acid and a few drops of barium nitrate are added	no visible change	white precipitate formed
a few drops of dilute nitric acid and a few drops of silver nitrate are added	white precipitate formed	no visible change

What are substances X and Y?

	X	Y
A	iron(II) chloride	iron(III) sulfate
B	iron(III) chloride	iron(III) sulfate
C	iron(II) sulfate	iron(III) chloride
D	iron(III) sulfate	iron(III) chloride

- 4 Pieces of damp red litmus paper and blue litmus paper are placed in three different gas jars.



In which gas jars does at least one piece of litmus paper change colour?

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

4

- 5 Diagram 1 shows the paper chromatogram of substance X.

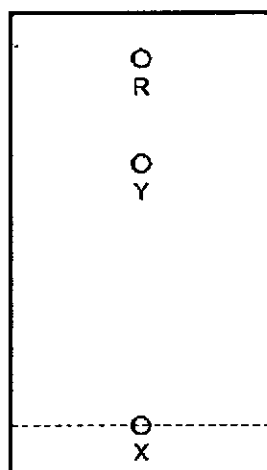


diagram 1

Diagram 2 shows the cooling curve for substance Y.

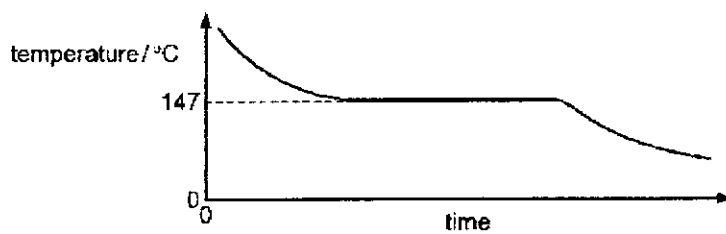


diagram 2

Which statement about X and Y is correct?

- A X and Y are mixtures.
- B X and Y are pure substances.
- C X is a mixture and Y is a pure substance.
- D X is a pure substance and Y is a mixture.

## 5

- 6 The melting points and boiling points of substances W, X and Y are shown.

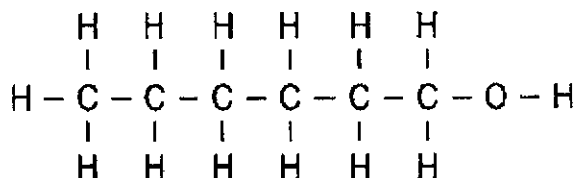
	W	X	Y
melting point / °C	-39	115	-101
boiling point / °C	357	445	-34

The substances are chlorine, mercury and sulfur.

Which row identifies W, X and Y?

	W	X	Y
<b>A</b>	chlorine	mercury	sulfur
<b>B</b>	sulfur	mercury	chlorine
<b>C</b>	sulfur	chlorine	mercury
<b>D</b>	mercury	sulfur	chlorine

- 7 Hexanol has the structural formula as shown.



What statement correctly explains a property of hexanol?

- A** It has a high melting point due to the strong covalent bonds between the atoms.  
**B** It is malleable due to the layers of atoms sliding past each other.  
**C** It is soluble in water due to the  $\text{OH}^-$  ions.  
**D** It is unable to conduct electricity due to the absence of mobile ions.
- 8 20 cm<sup>3</sup> of ethane, C<sub>2</sub>H<sub>6</sub>, are reacted with 80 cm<sup>3</sup> of oxygen. The equation for the reaction is as shown.



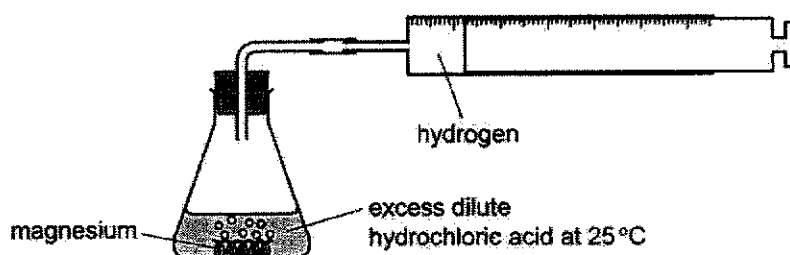
What is the **total** volume of gas remaining at the end of the reaction?  
 (all volumes are measured at room temperature and pressure)

- A** 40 cm<sup>3</sup>      **B** 50 cm<sup>3</sup>      **C** 80 cm<sup>3</sup>      **D** 100 cm<sup>3</sup>

- 9 An aqueous solution of  $0.200 \text{ mol/dm}^3$  of sodium hydroxide was prepared by adding  $4.00 \text{ g}$  of solid sodium hydroxide to a beaker of water.

What is the volume of water used to produce  $0.200 \text{ mol/dm}^3$  of sodium hydroxide?

- A  $0.5 \text{ cm}^3$       B  $20 \text{ cm}^3$       C  $500 \text{ cm}^3$       D  $2000 \text{ cm}^3$
- 10 Which process involves an energy change that is exothermic?
- A burning fossil fuels to generate electricity  
 B decomposition of silver salts used in photography  
 C melting of ice  
 D photosynthesis
- 11 The diagram shows an experiment to determine the rate of reaction.



Which row correctly describes how the conditions affect the rate of reaction?

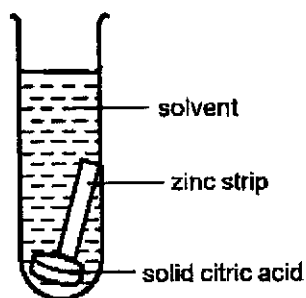
	increasing the pressure	increasing the temperature
A	decrease rate of reaction	increase rate of reaction
B	increase rate of reaction	decrease rate of reaction
C	no effect	increase rate of reaction
D	no effect	no effect

- 12 Separate samples of hydrogen peroxide are added to aqueous potassium iodide and to acidified potassium manganate(VII). The iodide ions are oxidised and the manganate(VII) ions are reduced.

What colour changes are seen?

	potassium iodide	acidified potassium manganate(VII)
A	brown to colourless	orange to green
B	brown to colourless	purple to colourless
C	colourless to brown	orange to green
D	colourless to brown	purple to colourless

- 13 Christina wishes to demonstrate to primary school students the wonders of Science, by showing them that bubbles can be produced from reactions.



Which solvent should she **not** use?

- A citric acid solution  
 B dilute hydrochloric acid  
 C hexane  
 D water
- 14 An element X forms an oxide with the following properties.
- reacts with calcium hydroxide
  - reacts with sulfur dioxide
  - insoluble in water
  - high melting and boiling points
- What is element X?
- A carbon  
 B nitrogen  
 C sodium  
 D zinc
- 15 Which row correctly states the method of preparation for sodium nitrate and the reagents used in the reaction?

	method	reagents used
A	adding excess solid	sodium and nitric acid
B	adding excess solid	sodium carbonate and silver nitrate
C	titration	sodium hydroxide and nitric acid
D	titration	sodium hydroxide and silver nitrate

- 16 Which statement best explains the reactivity of Group 0 elements?
- A Group 0 elements have eight electrons in the outermost shell.  
 B Group 0 elements have low melting and boiling points and exist as gases.  
 C Group 0 elements have sufficient electrons and they do not gain, lose or share electrons.  
 D Group 0 elements have the ability to remain as monatomic elements.

8

17 Seven properties of metals are listed as shown.

- good conductors of electricity
- good conductors of heat
- malleable
- high melting and boiling points
- high density
- soft and easily cut by a knife
- reacts moderately with dilute acids

How many of the properties listed are characteristics of Group 1 elements?

A 3  
C 5

B 4  
D 6

18 Molten iron from the blast furnace contains impurities.

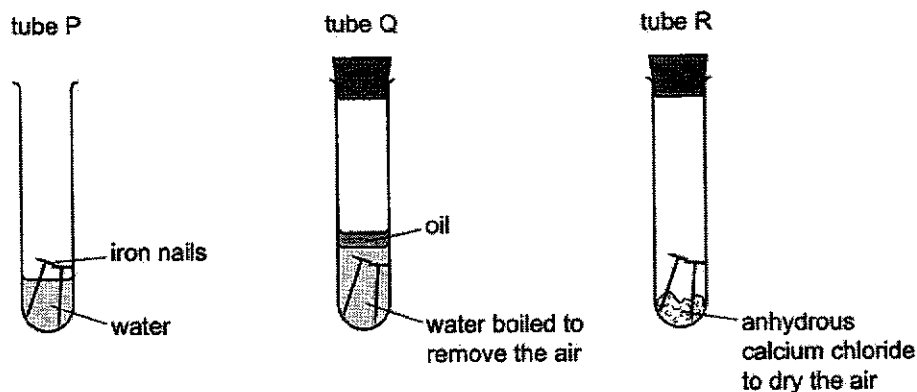
The process of turning the impure iron into steel involves blowing oxygen into the molten iron and adding calcium oxide.

Which row correctly explains the reason for blowing oxygen and adding calcium oxide?

	blowing in oxygen	adding calcium oxide
<b>A</b>	carbon is removed by reacting oxygen	reacts with acidic impurities making slag
<b>B</b>	carbon is removed by reacting oxygen	reacts with slag and so removes it
<b>C</b>	iron reacts with the oxygen	reacts with acidic impurities making slag
<b>D</b>	iron reacts with the oxygen	reacts with slag and so removes it



19 The diagrams show experiments involving the rusting of iron.



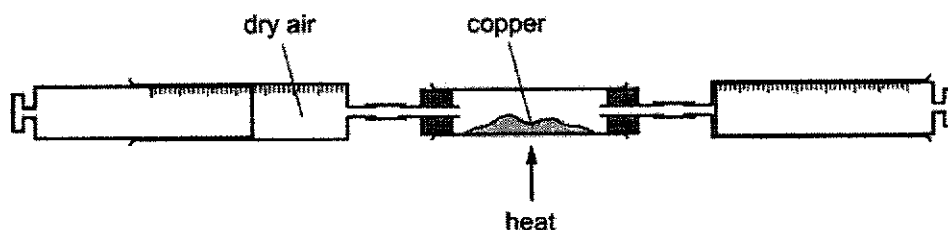
Four statements are made with respect to tubes P, Q and R.

- 1 The iron nails in tube P will not rust when a rubber stopper is placed over the tube.
- 2 The iron nails in tube P will rust faster with the addition of mineral salts to water.
- 3 The iron nails in tube Q will rust due to the dissolved oxygen trapped in the oil.
- 4 The iron nails in tube R will not rust due to the absence of water.

Which statements are correct?

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

20 Dry air is passed over copper until all the oxygen has reacted.



The volume of gas at the end of reaction is  $60 \text{ cm}^3$ .

What is the starting volume of dry air?

- A  $66 \text{ cm}^3$     B  $76 \text{ cm}^3$   
 C  $90 \text{ cm}^3$     D  $285 \text{ cm}^3$

21 A list of different components from different organisms are shown below.

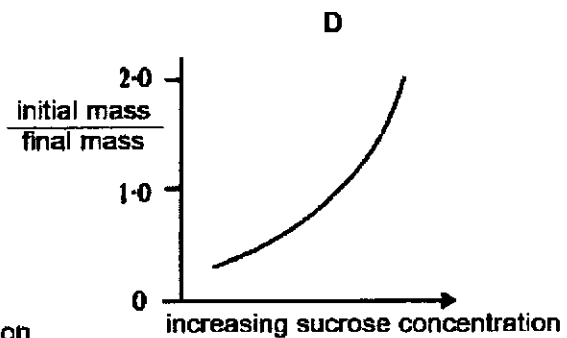
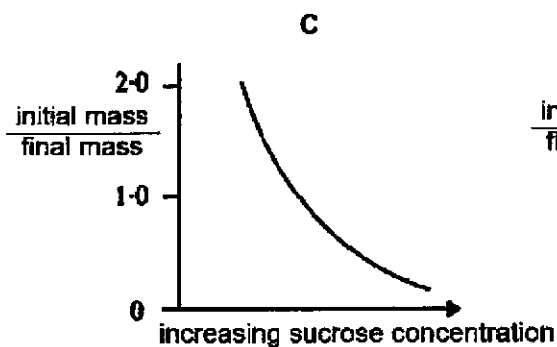
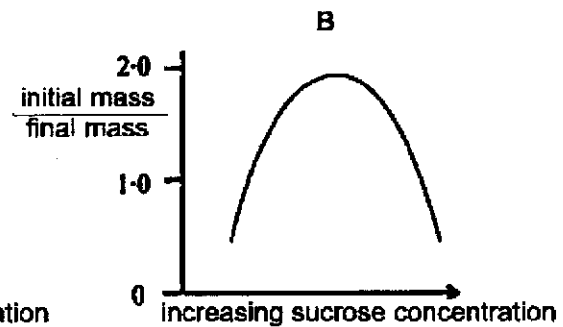
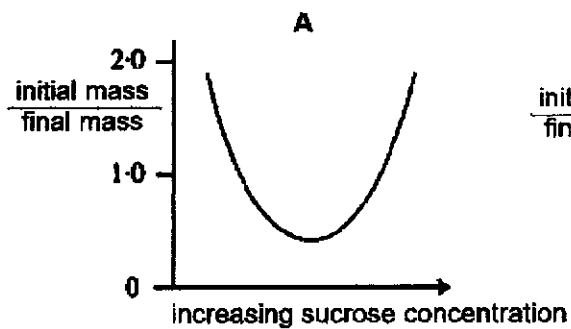
- 1 blood, blood vessels and heart
- 2 xylem
- 3 liver
- 4 lymphocyte

Which row correctly identifies these components?

	cell	tissue	organ	organ system
<b>A</b>	2	3	4	1
<b>B</b>	2	4	1	3
<b>C</b>	4	2	1	3
<b>D</b>	4	2	3	1

22 Agar cubes of equal sizes were weighed and then placed in different concentrations of sucrose. After 12 hours, the agar cubes were removed and reweighed. For each agar cube, the ratio of the initial mass over the final mass was calculated.

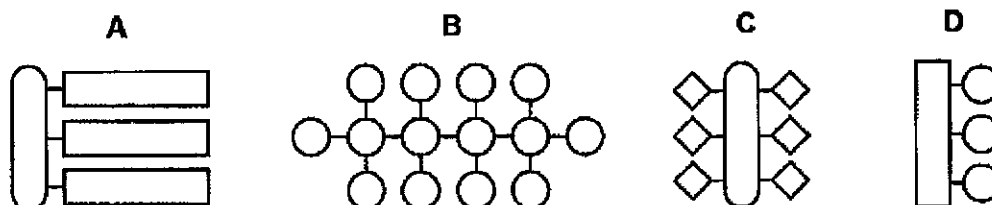
Which graph represents the change in the ratio of the initial mass over the final mass in the agar cube as concentration of sucrose increases?



- 23 The basic units of some molecules are represented as shown.



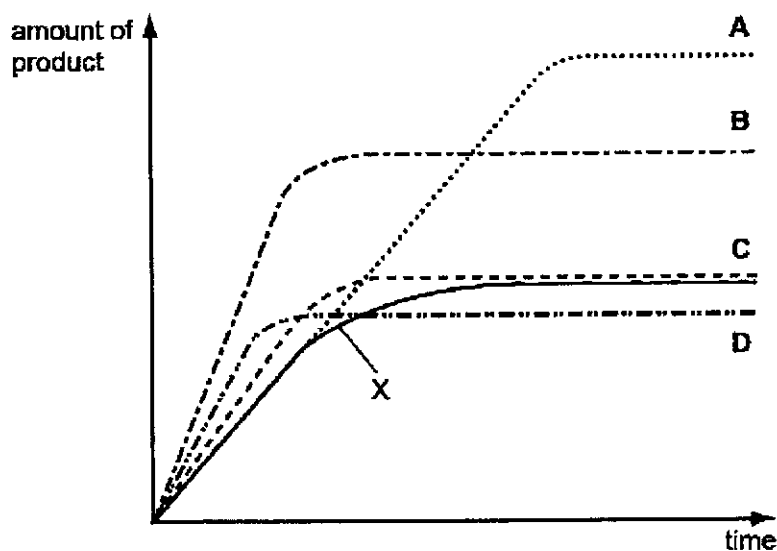
Which diagram represents a fat molecule?



- 24 Curve X shows the activity of a particular enzyme at 20 °C.

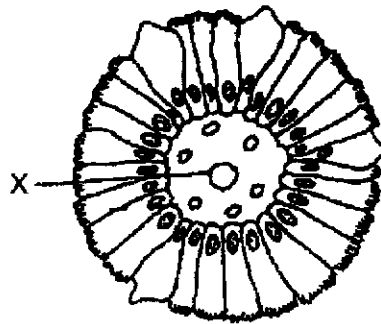
Curves A, B, C and D show the effect of different conditions on the activity of the same enzyme.

Which curve shows the effect of increasing the temperature by 10 °C and increasing substrate concentration?



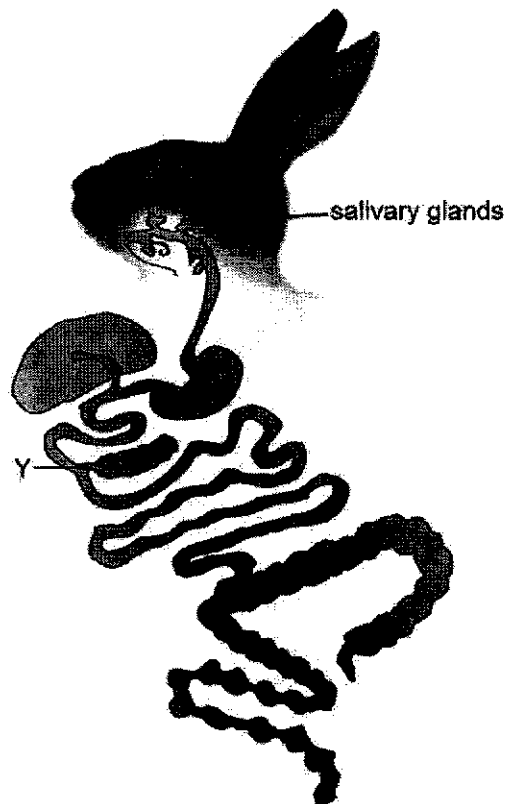
12

- 25 The diagram shows a cross section of an intestinal villus.



Which substance does structure X transport?

- A amino acids  
 B fats  
 C fatty acids  
 D glycerol
- 26 The diagram shows the alimentary canal of a rabbit. The alimentary canal resembles that of a human.

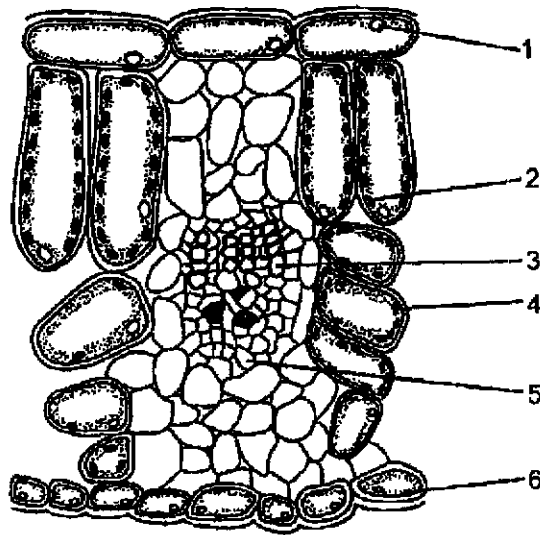


Which would be the consequence if the part labelled Y is blocked?

- A anaemia  
 B constipation  
 C diabetes  
 D poor digestion

13

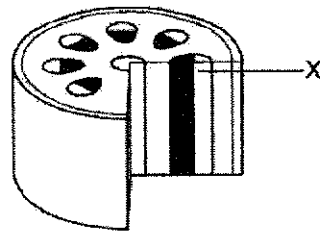
27 The diagram shows a cross-section of a leaf.



Which row correctly identifies the function of the labelled structures?

	converts light energy to chemical energy	transports water and dissolved mineral salts	involved in the transport of food substances
<b>A</b>	1, 2	3	5
<b>B</b>	1, 6	5	3
<b>C</b>	2, 4	3	5
<b>D</b>	2, 4	5	3

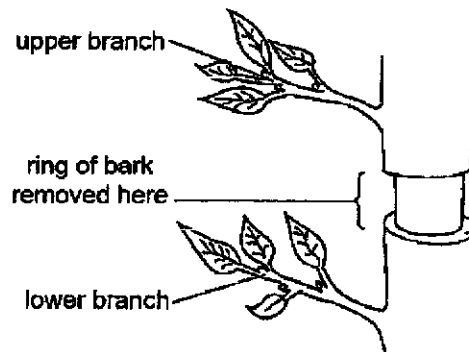
28 The diagram shows a section through a stem. Samples of the contents of structure X were tested.



Which row correctly shows the results of the food tests?

	biuret test	Benedict's test
<b>A</b>	negative	negative
<b>B</b>	negative	positive
<b>C</b>	positive	negative
<b>D</b>	positive	positive

- 29 The diagram shows part of the trunk of a small tree with a ring of bark removed. Removing the bark takes away some tissues in the trunk.

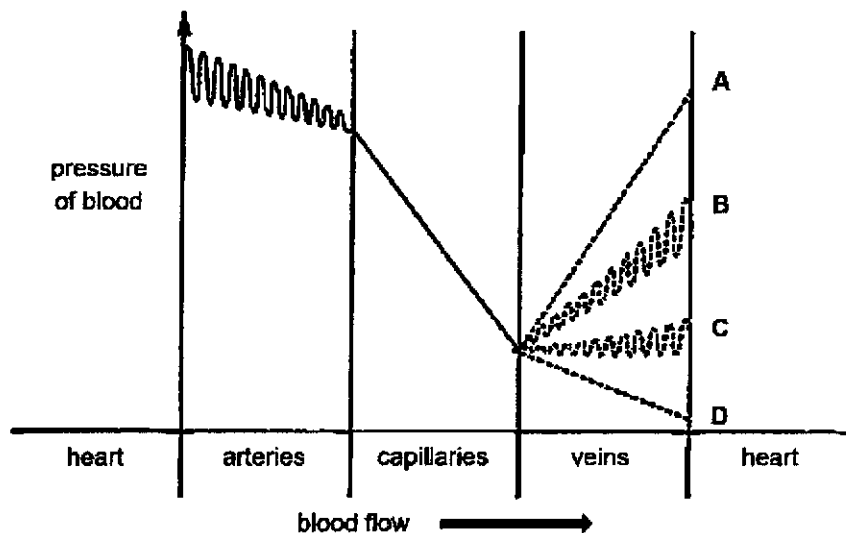


Which row correctly describes the effect of removing the bark on the growth and appearance of the leaves found on the two branches?

	upper branch		lower branch	
	growth	appearance	growth	appearance
<b>A</b>	normal	normal	normal	wilted
<b>B</b>	normal	wilted	normal	normal
<b>C</b>	normal	normal	normal	normal
<b>D</b>	reduced	wilted	reduced	wilted

- 30 The diagram shows the pressure of blood after it leaves the heart and passes through the various types of blood vessels.

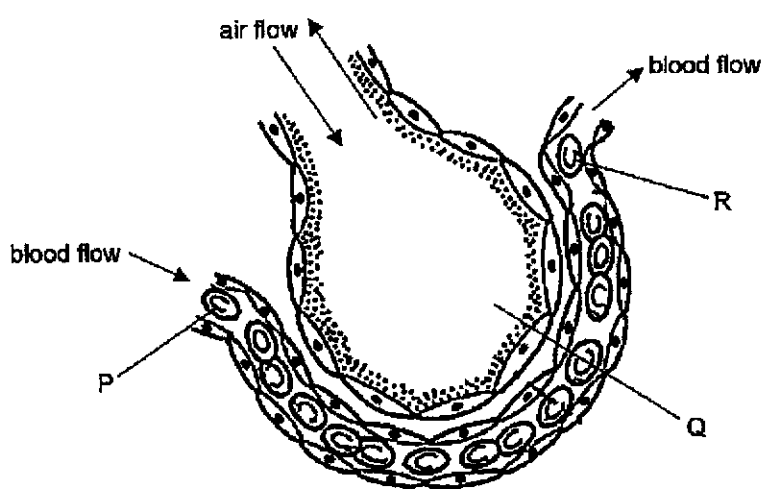
Which dotted line best shows the pressure of blood as it flows through veins before returning to the heart?



31 Which statement is true?

- A 70% of the volume of blood is made up of plasma.
- B Coronary heart disease is caused by the blockage of the hepatic artery.
- C Red blood cells are biconcave in shape to increase their surface area to volume ratio.
- D White blood cells are involved in the clotting of blood with the help of platelets.

32 The diagram shows a section of an alveolus in the lung of a mammal.

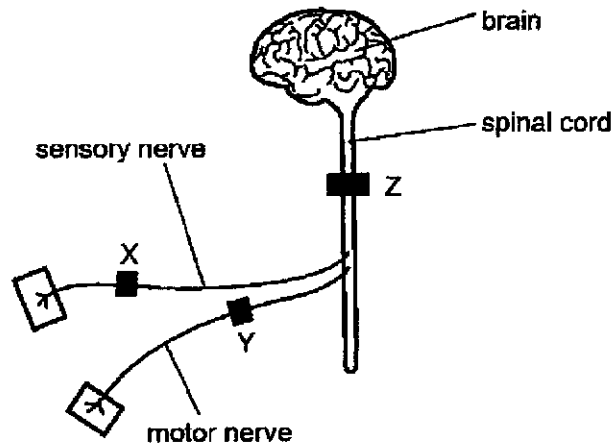


What are the relative oxygen concentrations in the three parts labelled P, Q and R?

	P	Q	R
<b>A</b>	high	high	low
<b>B</b>	high	low	low
<b>C</b>	low	high	high
<b>D</b>	low	low	high

16

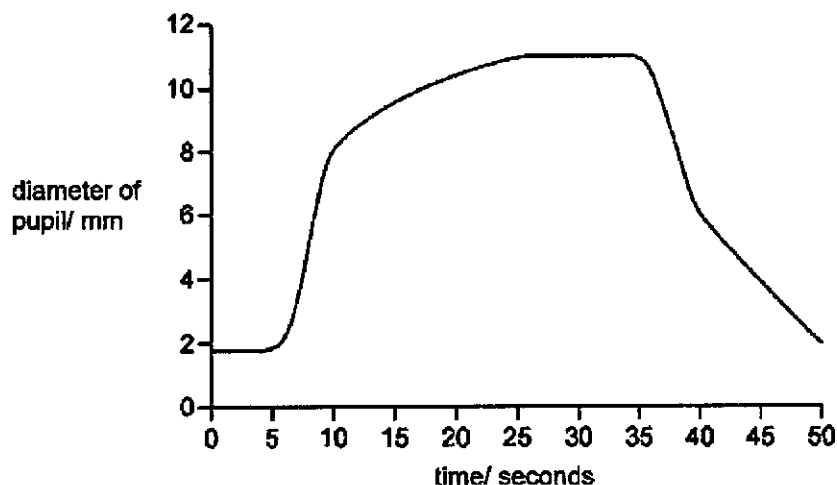
- 33 A local anaesthetic is a drug used to block the transmission of nerve impulses. The diagram represents part of the nervous system. X, Y and Z show sites where the anaesthetic can be injected.



A patient, who was administered the anaesthetic, is able to feel a hot object but not able to move his hand away.

At which point was the drug injected?

- A X  
B Y  
C Z  
D X and Y
- 34 The graph shows the changes in the size of the pupil of the eye as the light intensity of the surroundings is changed.



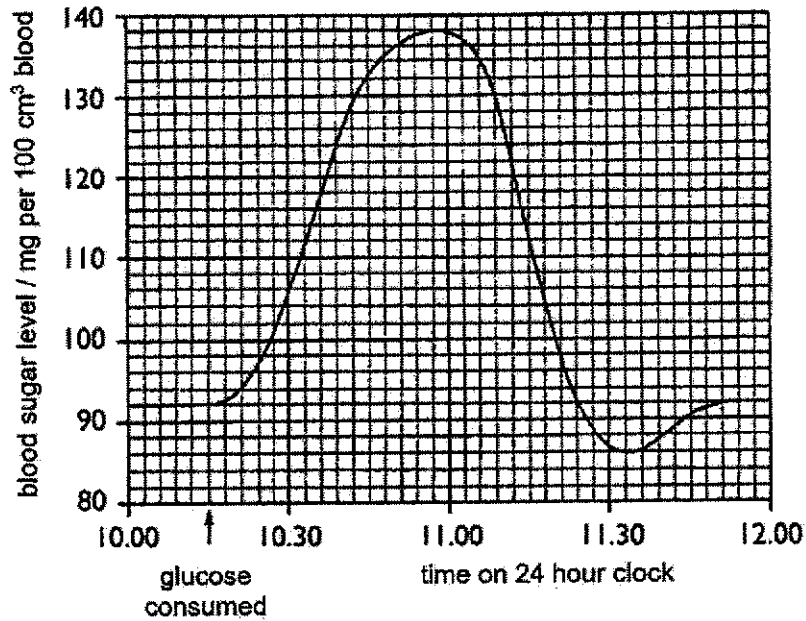
Which time period shows the light intensity increasing?

- A 5 to 10 seconds  
B 10 to 25 seconds  
C 25 to 35 seconds  
D 35 to 40 seconds



17

- 35 The graph shows the blood sugar level of a person who has consumed 50 g of glucose at the time indicated.



At which time would insulin and glucagon be produced, respectively?

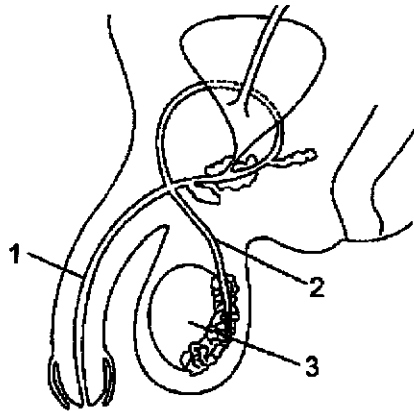
- A 10.00, 11.00                      B 10.45, 11.30  
 C 11.00, 10.30                      D 11.30, 11.00
- 36 Which row about hormones is correct?

	response	transported by	control
A	generally fast	neurones	voluntary
B	generally slow	blood	voluntary
C	generally fast	neurones	involuntary
D	generally slow	blood	involuntary

- 37 Which statement about flowering plants is correct?

- A Fertilisation and pollination must occur at the same time.  
 B Fertilisation can take place without pollination.  
 C Pollination and fertilisation are the same.  
 D Pollination can take place without fertilisation.

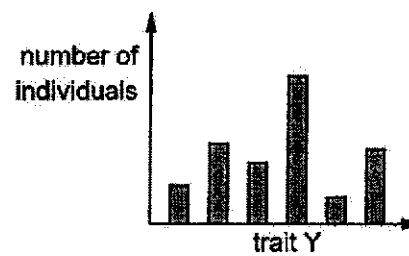
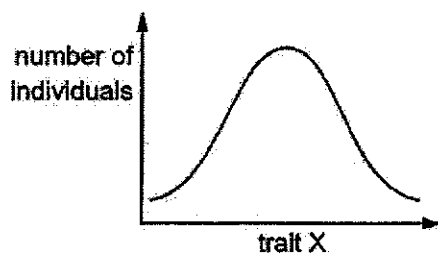
- 38 The diagram shows part of the human male reproductive system.



What are structures 1, 2 and 3?

	1	2	3
<b>A</b>	sperm duct	urethra	testis
<b>B</b>	sperm duct	testis	urethra
<b>C</b>	urethra	testis	sperm duct
<b>D</b>	urethra	sperm duct	testis

- 39 The diagram shows the two types of variation in humans.



Which traits could trait X and trait Y represent?

	trait X	trait Y
<b>A</b>	intelligence	eye colour
<b>B</b>	eye colour	hair colour
<b>C</b>	blood group	height
<b>D</b>	height	weight

- 40 The following table shows the base composition of the chromosomes in grasshoppers.

base composition / %			
adenine	P	Q	R
29.3	20.5	20.7	29.3

Which row correctly identifies the unknown bases?

	P	Q	R
<b>A</b>	cytosine	guanine	thymine
<b>B</b>	guanine	thymine	cytosine
<b>C</b>	thymine	cytosine	guanine
<b>D</b>	thymine	guanine	cytosine

**Data Sheet****Colours of Some Common Metal Hydroxides**

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

The Periodic Table of Elements

		Group																																	
		I		II		III		IV		V		VI		VII		0																			
3	Li lithium 7	4	Be beryllium 9	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 -	88-103	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 -	113	Nh nihonium -	114	Fl flerovium -	115	Mc moscovium -	116	Lv livermorium -	117	Ts tennessine -	118	Og oganeson -

**Key**  
proton (atomic) number  
atomic symbol  
name  
relative atomic mass

1  
H  
hydrogen  
1

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<sup>3</sup> at room temperature and pressure (r.t.p.).



## 2

## Section A

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

- 1 Table 1.1 shows some common ionic equations involving reactions.

Table 1.1

letter	ionic equation
A	$\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$
B	$\text{NH}_4^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l}) + \text{NH}_3 (\text{g})$
C	$\text{Fe}^{2+} (\text{aq}) + 2\text{OH}^- (\text{aq}) \rightarrow \text{Fe}(\text{OH})_2 (\text{s})$
D	$\text{Mg}^{2+} (\text{aq}) + \text{Ca} (\text{s}) \rightarrow \text{Mg} (\text{s}) + \text{Ca}^{2+} (\text{aq})$
E	$2\text{I}^- (\text{aq}) + \text{Br}_2 (\text{aq}) \rightarrow \text{I}_2 (\text{aq}) + 2\text{Br}^- (\text{aq})$
F	$\text{Na} (\text{s}) \rightarrow \text{Na}^+ (\text{aq}) + \text{e}^-$

Use the letter in Table 1.1 to state which ionic equation(s) best represent(s)

- (a) ammonium salts reacting with bases, .....
- (b) displacement, .....
- (c) ionisation, .....
- (d) neutralisation, .....
- (e) precipitation. ....

[5]

- 2 Tristan conducted an experiment to investigate the effects of temperature changes when solids are added to water. He added 0.5 g of ammonium sulfate into a beaker containing 30 cm<sup>3</sup> of water. He measures the temperature before and after the addition of solid as shown in Fig. 2.1.

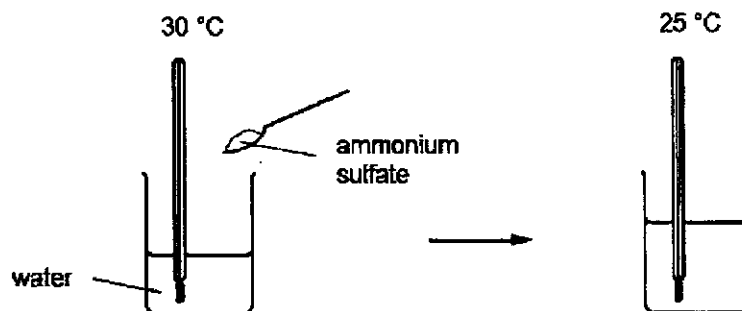


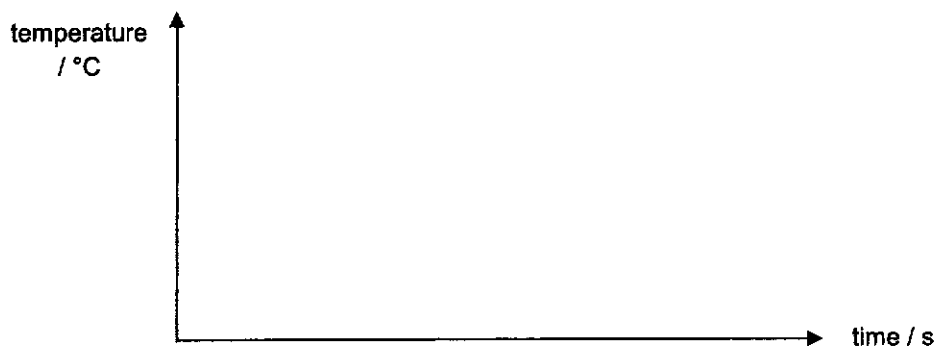
Fig. 2.1

3

(a) Explain how this experiment shows that the process is endothermic.

.....  
 .....[1]

(b) Sketch a temperature–time graph to show the changes in the temperature of the reaction.



[1]

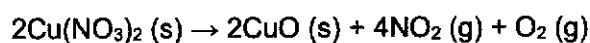
(c) Describe a test that Tristan can carry out to test for the positive ion present in the reaction mixture.

test .....

results .....

.....[2]

3 Copper(II) nitrate thermally decomposes into solid copper(II) oxide and two gases – oxygen and nitrogen dioxide in the equation as shown.



A sample of copper(II) nitrate was decomposed using the apparatus shown in Fig. 3.1.

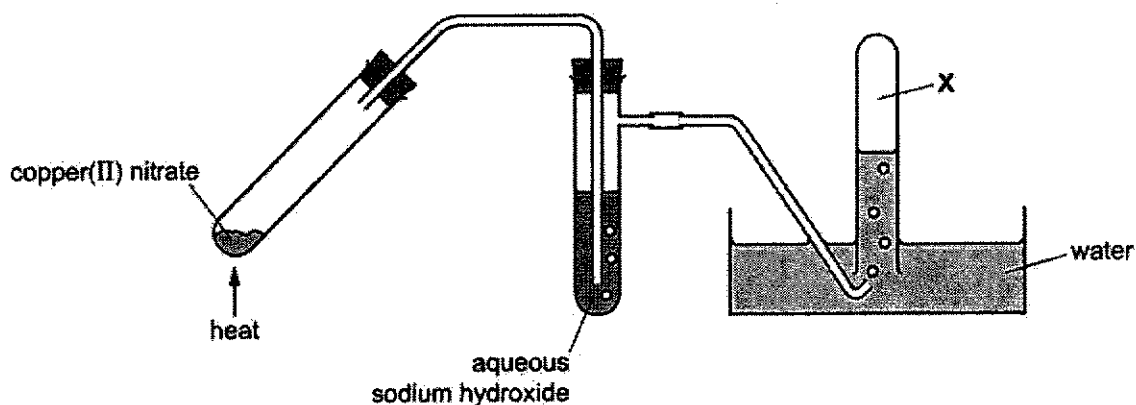


Fig. 3.1



4

- (a) (i) Only one gas was collected at X. Identify the gas collected and explain why the other gas was **not** collected at X.

gas collected .....

explanation for the other gas .....

.....[2]

- (ii) Name the method of gas collection shown in Fig. 3.1.

.....[1]

- (b) In a separate experiment, Vidhun heated 0.188 g of copper(II) nitrate. Calculate the maximum volume of nitrogen dioxide gas (in  $\text{dm}^3$ ) that could be collected using a gas syringe.

volume of nitrogen dioxide .....  $\text{dm}^3$  [2]

- (c) (i) Nitrogen dioxide can also be formed in car engines. Explain how nitrogen dioxide is formed in car engines.

.....

.....[2]

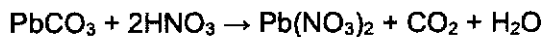
- (ii) State the impact of nitrogen dioxide on human health.

.....[1]

## 5

- 4 A class of Chemistry students discussed the preparation of two salts, lead(II) nitrate and lead(II) sulfate.

Mandy prepared crystals of lead(II) nitrate, by adding an excess of solid lead(II) carbonate to 50 cm<sup>3</sup> of 2 mol/dm<sup>3</sup> nitric acid in the equation as shown.



She proceeded to filter the mixture and then rinsed the residue, before performing crystallisation on the filtrate to obtain pure crystals of lead(II) nitrate.

- (a) Explain why Mandy added an excess of lead(II) carbonate.

.....[1]

- (b) Explain why Mandy rinsed the residue.

.....[1]

- (c) Calculate the mass of lead(II) carbonate that reacted with nitric acid.

mass of lead(II) carbonate ..... g [2]

- (d) Another student, Jia Liang prepared lead(II) sulfate, by adding an excess of lead(II) carbonate to 50 cm<sup>3</sup> of 2 mol/dm<sup>3</sup> sulfuric acid. Shortly after the addition of the carbonate, the reaction stopped.

- (i) Suggest why the reaction stopped.

.....  
 .....[2]

- (ii) Name one substance that Jia Liang should have used in place of lead(II) carbonate as the starting material to prepare lead(II) sulfate salt.

.....[1]

## 6

- 5 Zinc is an important metal that is used to make useful substances like brass and zinc fluoride. Zinc can be extracted from zinc blende, ZnS from a two-step process.

Step 1:  $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$

Step 2: reaction of zinc oxide with coke to form zinc and carbon monoxide in the blast furnace

(a) After Step 2, the liquid zinc is then distilled off and collected.

- (i) Name a **metal ore** that could be used in the extraction of a pure metal similar to zinc.

.....[1]

- (ii) Construct the equation for the extraction of zinc in Step 2.

.....[1]

- (iii) Explain why the process in Step 2 is considered a redox reaction.

.....

.....

.....[2]

- (b) The purified zinc can either be mixed with copper to form brass, or reacted with fluorine to form zinc fluoride. The melting points of both substances are shown in Table 5.1.

**Table 5.1**

substance	melting point / °C
brass	900 – 940
zinc fluoride	870

- (i) Using brass and zinc fluoride as examples, describe **two other differences** between a mixture and a compound.

.....

.....

.....

.....

.....[2]

- (ii) Draw a 'dot and cross' diagram to show the arrangement of the **outer shell electrons** in zinc fluoride.

[2]

- (iii) Both brass and zinc fluoride have high melting points. However, their electrical conductivity varies. Brass can conduct electricity in any state, but this is not the case for zinc fluoride.

With reference to its structure and bonding, explain the difference in electrical conductivity of zinc fluoride at room temperature and at 880 °C respectively.

.....  
 .....  
 .....  
 .....[2]

- (c) (i) Copper can be recycled from scrapped brass. One way of separating the copper metal from brass is to use fractional distillation on the molten brass. Suggest why this method of obtaining copper is **not** widely used in industries.

.....  
 .....[1]

- (ii) In the laboratory, pure copper metal may be obtained from a sample of brass by a chemical method. Briefly describe how this can be done.

.....  
 .....  
 .....  
 .....  
 .....[2]

- 6 Samyuhktha conducted an experiment to investigate the speed of reaction between magnesium ribbon and excess  $0.1 \text{ mol/dm}^3$  hydrochloric acid. She measured the volume of hydrogen gas produced over regular time intervals and plotted her results as shown in Fig. 6.1.

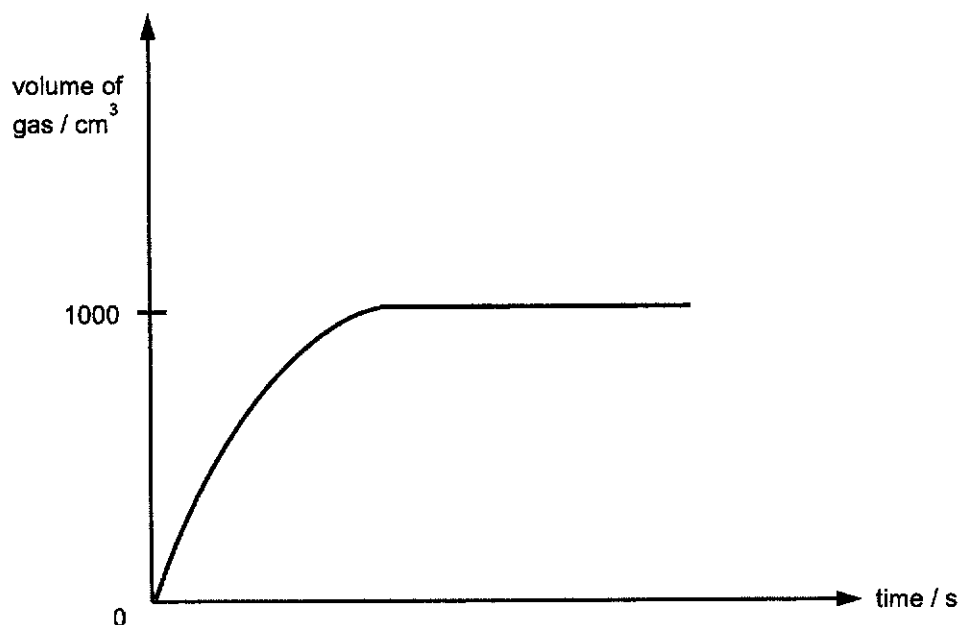


Fig. 6.1

- (a) Samyuhktha repeated her experiment twice with two separate modifications – experiment 6A and experiment 6B.

In experiment 6A, the magnesium ribbon was replaced with the same mass of magnesium powder.

In experiment 6B, the concentration of hydrochloric acid was changed to  $0.2 \text{ mol/dm}^3$ .

- (i) Add to Fig. 6.1, the graph Samyuhktha would have obtained for experiment 6A.

[1]

- (ii) Use your knowledge of reacting particles to explain how the modification in experiment 6B affected the speed of reaction.

.....  
 .....  
 .....[2]

- (b) Nathanael decided to use Samyuhktha's experimental setup to determine the reactivity order of four metals, silver, magnesium, X and Y
- (i) In his investigation, Nathanael used the same number of moles of each of the four metals to react with excess hydrochloric acid. He then recorded the volume of hydrogen gas collected in the first 30 seconds, before the reaction hits completion. Nathanael's results are shown in Table 6.2.

Table 6.2

metal	volume of hydrogen collected in the first 30 seconds / cm <sup>3</sup>
silver	0
magnesium	100
X	350
Y	70

With reference to Table 6.2, arrange the four metals in order of reactivity starting from the most reactive.

.....[1]

- (ii) Another student, Mukesh, claimed that the reactivity order of the metals can also be determined by recording the time taken for the reaction to collect 100 cm<sup>3</sup> of hydrogen gas. Explain why his method is also feasible and include the expected results in your answer.

.....  
 .....  
 .....  
 .....[2]

- (c) Briefly describe another experiment that can be carried out to confirm the order of reactivity of the four metals in Table 6.2. Include the expected observations.

.....  
 .....  
 .....  
 .....  
 .....[2]

## Section B

Answer **all** questions in this section.

Write your answers in the spaces provided.

- 7 The Periodic Table lists the elements in order of atomic number and classifies them into Periods and Groups. On moving across the Periods, the character of the element changes from metallic to non-metallic character. A trend could also be observed moving down the Groups. These trends can be used to explain the physical and chemical properties of the elements.

- (a) Describe and explain how the character of the elements changes moving down Group IV, from carbon to lead.

.....  
 .....  
 .....  
 .....[3]

- (b) Mizuno conducted an experiment by placing excess sodium metal in an enclosed jar of chlorine gas to form sodium chloride.

- (i) Write a balanced chemical equation for the formation of sodium chloride.

.....[1]

- (ii) Marvin suspects that the reaction is incomplete and that chlorine has **not** fully reacted. Describe how Marvin can prove that he is correct.

.....  
 .....[2]

- (iii) The experiment demonstrated the oxidising ability of chlorine. Explain why chlorine is considered an oxidising agent in the reaction in (b)(i).

.....  
 .....  
 .....[2]

- (c) Dexter repeated the experiment by placing excess sodium metal in an enclosed jar of fluorine gas to form sodium fluoride.

Predict and explain how the speed of reaction changes when fluorine is used instead of chlorine.

.....  
 .....[2]

8 Sulfur is commonly used in black gunpowders and as pesticides to keep snakes and rats away. Of the 25 isotopes of sulfur discovered,  $^{32}\text{S}$  and  $^{34}\text{S}$  are the most stable known forms.

(a) With reference to **both** isotopes, describe how they are the same and how they are different in terms of the number of protons, neutrons and electrons present in each form.

.....  
 .....  
 .....[2]

(b) Explain why the two isotopes have similar chemical properties.

.....  
 .....[1]

(c) The relative atomic mass of sulfur is 32.06.

Define the term *relative atomic mass* and explain why this value differs from the nucleon number of  $^{32}\text{S}$ .

.....  
 .....  
 .....  
 .....[3]

(d) Sulfur reacts with carbon to form a compound carbon disulfide.

(i) Draw a 'dot and cross' diagram to show the arrangement of **all** electrons in carbon disulfide.

[2]

(ii) Explain why carbon disulfide containing the  $^{34}\text{S}$  isotope has a higher melting point than the one containing the  $^{32}\text{S}$  isotope.

.....  
 .....  
 .....[2]



**Data Sheet****Colours of Some Common Metal Hydroxides**

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white



# The Periodic Table of Elements

		Group																																																																											
I	II	III	IV	V	VI	VII	0																																																																						
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	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 -	113 Nh nihonium -	114 Fl flerovium -	115 Lv livermorium -	116 Ts tennessium -	117 Og oganeson -	118 Uu unbinilium -	119 Uue unbinilium -	120 Uuo unbinilium -

**Key**  
 proton (atomic) number  
 atomic symbol  
 name  
 relative atomic mass

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
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 -

lanthanoids

actinoids

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



5076/5078 Science (Chemistry) Sec 4E/5NA Preliminary Examinations 2021 – Marking Scheme

Paper 1: MCQ Answers [20 marks]

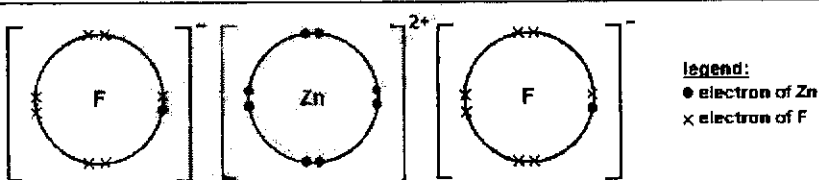
1	2	3	4	5	6	7	8	9	10
B	B	A	A	C	D	D	B	C	A
11	12	13	14	15	16	17	18	19	20
C	D	C	D	C	C	B	A	D	B

Paper 3:

Section A [45 marks]

<b>1</b>		<b>Total = 5</b>
a	B	1
b	D, E	1
c	F	1
d	A	1
e	C	1
<b>2</b>		<b>Total = 4</b>
a	There is a <u>decrease / drop in temperature</u> (from 30 °C to 25 °C), indicating that <u>heat energy is absorbed from the surroundings</u> .	1
b		1
c	test: add equal volume of sodium hydroxide and warm [1]  results: moist/damp red litmus paper turns blue showing the evolution of ammonia [1]	2

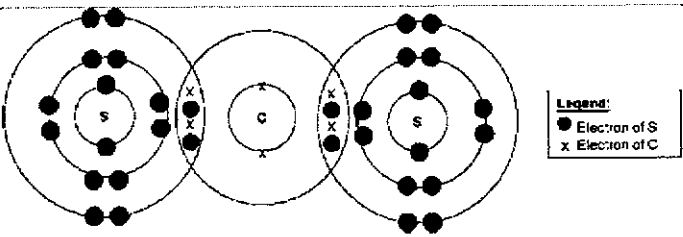
3		Total = 8
ai	gas collected: <u>oxygen</u> [1]  explanation for the other gas: <u>acidic nitrogen dioxide reacts / dissolves / neutralised by aqueous sodium hydroxide</u> [1]	2
aii	displacement of water	1
b	No. of mol of $\text{Cu}(\text{NO}_3)_2 = \frac{0.188}{188} = \underline{0.001 \text{ mol}}$ [1] Compare mole ratio: $\begin{array}{ccc} \text{Cu}(\text{NO}_3)_2 & : & \text{NO}_2 \\ 2 & : & 4 \\ 0.001 & : & 0.002 \end{array}$  Volume of $\text{NO}_2 = 0.002 \times 24 = \underline{0.048 \text{ dm}^3}$ [1]	2
ci	<u>Nitrogen</u> reacts with <u>oxygen</u> in the air [1] at <u>high temperatures</u> [1] to form nitrogen dioxide.	2
cii	gas causes <u>breathing difficulties</u>	1
4		Total = 7
a	To prevent acid from contaminating the salt solution / Ensure all the acid is fully reacted	1
b	It is to ensure the complete transfer of the lead(II) nitrate trapped in the residue / to ensure maximum yield of lead(II) nitrate is obtained	1
c	No. of mol of $\text{HNO}_3 = \frac{50}{1000} \times 2 = \underline{0.1 \text{ mol}}$ [1] Compare mole ratio: $\begin{array}{ccc} \text{HNO}_3 & : & \text{PbCO}_3 \\ 2 & : & 1 \\ 0.1 & : & 0.05 \end{array}$  mass of lead(II) carbonate = $0.05 \times (207 + 12 + 48) = \underline{13.35 \text{ g} / 13.4 \text{ g}}$ [1]	2
di	Sulfuric acid reacts with lead(II) carbonate to form an <u>insoluble salt, lead(II) sulfate</u> [1]. The <u>insoluble layer</u> of lead(II) sulfate then <u>coats</u> around the lead(II) carbonate and <u>prevents further reaction</u> [1] between lead(II) carbonate and sulfuric acid.	2
dii	lead(II) nitrate	1

5		Total = 10																		
ai	Haematite	1																		
aii	$\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$	1																		
aiii	Zinc oxide is reduced and coke/carbon is oxidised at the same time [1 mk pt].  Zinc oxide loses oxygen atom to form zinc [1 mk pt], while coke/carbon gains oxygen atom to form carbon monoxide [1 mk pt]  or  Oxidation state of zinc decreases from +2 in ZnO to 0 in Zn [1 mk pt], while oxidation state of C increases from 0 in C to +2 in CO [1 mk pt].  <i>Accept electron transfer explanations</i> 3 mk pt – [2] 1-2 mk pt – [1]	2																		
bi	<table border="1"> <thead> <tr> <th></th> <th>compound</th> <th>mixture</th> </tr> </thead> <tbody> <tr> <td>composition</td> <td>has <u>fixed</u> composition by mass</td> <td>has <u>variable</u> composition by mass</td> </tr> <tr> <td>properties</td> <td>has physical and chemical properties that are <u>different</u> from those of its <u>constituent</u> elements</td> <td><del>has</del> <u>chemical</u> properties that are the <u>same</u> as those of its <u>constituents</u></td> </tr> <tr> <td>method of separation</td> <td>is separated into its constituents by <u>chemical methods</u>, like the application of heat or electricity</td> <td>is separated into its constituents by <u>physical methods</u>, like magnetic separation, filtration or distillation</td> </tr> <tr> <td>energy changes</td> <td>chemical reaction occurs during its formation – overall heat is released (exothermic) or absorbed (endothermic)</td> <td>no chemical reaction occurs when it is made – <u>little or no energy change</u></td> </tr> <tr> <td>-</td> <td>compound is pure</td> <td>mixture is impure</td> </tr> </tbody> </table> <p>Any 2 differences – [1] each</p>		compound	mixture	composition	has <u>fixed</u> composition by mass	has <u>variable</u> composition by mass	properties	has physical and chemical properties that are <u>different</u> from those of its <u>constituent</u> elements	<del>has</del> <u>chemical</u> properties that are the <u>same</u> as those of its <u>constituents</u>	method of separation	is separated into its constituents by <u>chemical methods</u> , like the application of heat or electricity	is separated into its constituents by <u>physical methods</u> , like magnetic separation, filtration or distillation	energy changes	chemical reaction occurs during its formation – overall heat is released (exothermic) or absorbed (endothermic)	no chemical reaction occurs when it is made – <u>little or no energy change</u>	-	compound is pure	mixture is impure	2
	compound	mixture																		
composition	has <u>fixed</u> composition by mass	has <u>variable</u> composition by mass																		
properties	has physical and chemical properties that are <u>different</u> from those of its <u>constituent</u> elements	<del>has</del> <u>chemical</u> properties that are the <u>same</u> as those of its <u>constituents</u>																		
method of separation	is separated into its constituents by <u>chemical methods</u> , like the application of heat or electricity	is separated into its constituents by <u>physical methods</u> , like magnetic separation, filtration or distillation																		
energy changes	chemical reaction occurs during its formation – overall heat is released (exothermic) or absorbed (endothermic)	no chemical reaction occurs when it is made – <u>little or no energy change</u>																		
-	compound is pure	mixture is impure																		
bii	 <p>correct ratio of <math>\text{Zn}^{2+}</math> and <math>\text{F}^-</math> ions – [1] correct number of valence electrons showing the electron transferred and charge – [1]</p>	2																		
biii	In the solid state, <u>the ions are held in fixed position</u> [1] strong electrostatic forces of attraction, hence there are no mobile ions to function as charged carriers to conduct electricity.  At 880 °C, the giant ionic structure is broken down and there are <u>mobile ions</u> [1] to function as charge carriers to conduct electricity.	2																		

ci	Melting point of the metals are high, hence the cost of using electricity to melt the solid would be <u>expensive</u> .	1
cii	1. Add excess dilute acid (nitric/hydrochloric/sulfuric acid) to completely react zinc. 2. Filter the mixture to obtain copper as the residue 3. Rinse the copper residue with cold deionised water to remove any soluble impurities  3 mk pt – [2] 1-2 mk pt – [1]	2
<b>6</b>		<b>Total = 8</b>
ai		1
aii	As the concentration of the hydrochloric acid <u>increases</u> , the number of reacting particles <u>per unit volume</u> of solution [1] increases. As such, the particles collide more frequently and the <u>frequency of effective collisions increases</u> , <u>increasing the rate of reaction</u> [1].	2
bi	X, magnesium, Y, silver	1
bii	The <u>more reactive the metal</u> , <u>the faster the metal reacts with the acid</u> [1] to produce hydrogen gas. As such, the <u>time taken</u> for the most reactive metal to first collect 100 cm <sup>3</sup> would be the <u>shortest</u> [1].	2
c	React each of the four metals with <u>steam</u> [1] and record the observations.  Metal X will react <u>vigorously</u> with steam while the magnesium reacts <u>moderately / readily with steam</u> . Metal Y should <u>react slowly</u> with steam while silver <u>does not react</u> with steam [1].	2



## Section B [20 marks]

7		Total = 10
a	On moving down Group IV, the character of the element changes <u>from non-metallic to metallic</u> [1].  Moving down Group IV, the tendency for the elements to <u>lose electrons more readily increases</u> [1]. This is because the <u>electrons are further away (and less strongly attracted) to the nucleus</u> [1], resulting in a weaker forces of attraction.	3
bi	$2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$	1
bii	Place a piece of <u>moist blue litmus paper</u> at the mouth of the jar [1]. If gas produced <u>turns moist/damp blue litmus paper red and then bleaches it</u> [1]	2
biii	Chlorine is an oxidising agent because it <u>oxidises sodium while itself getting reduced</u> [1]. Explanation [1]: Oxidation state of sodium increases from <u>0 in Na to +1 in NaCl</u> / Oxidation state of chlorine decreases from <u>0 in Cl<sub>2</sub> to -1 in NaCl</u> / Sodium loses (1) electron to form NaCl / Chlorine gains electrons to form NaCl	2
c	The <u>speed of reaction increases</u> when fluorine is used [1]. This is because <u>fluorine is more reactive than chlorine</u> [1].	2
8		Total = 10
a	Both <sup>32</sup> S and <sup>34</sup> S have the same number of 16 protons and 16 electrons [1] However, the difference is that <sup>32</sup> S have 16 neutrons but <sup>34</sup> S have 18 neutrons [1]	2
b	Chemical properties are dependent on valence electrons. Since both isotopes have the <u>same number of valence electrons</u> , they have similar chemical properties.	1
c	Relative atomic mass, A <sub>r</sub> , is the <u>average mass</u> of an <u>atom</u> of the <u>element</u> [1] when <u>compared</u> with the mass of $\frac{1}{12}$ of an atom of the <u>carbon-12 atom</u> , <sup>12</sup> <sub>6</sub> C [1]  The nucleon number of <sup>32</sup> S measures the <u>number of protons and neutrons from 1 isotope</u> , but relative atomic mass measures the <u>average number of protons and neutrons from all the isotopes available</u> [1].	3
d	  correct number of bonding electrons – [1] correct number of electrons in all shells – [1]	2
dii	Carbon disulfide containing the <sup>34</sup> S isotope has a <u>larger molecular mass</u> [1] than carbon disulfide containing the <sup>32</sup> S isotope. Hence the <u>forces of attraction</u> between the molecules containing <sup>34</sup> S would be <u>stronger</u> , leading to a <u>larger amount to energy</u> to melt it [1].	2

