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Name :

DEYI SECONDARY SCHOOL
End-of-Year Examination 2021
Secondary Three Express
Science (Chemistry)**5076**
 05 October 2021
 1115 – 1300h
 1 hour 45 minutes

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST**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 OTAS.

Section B

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

Section C

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

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

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

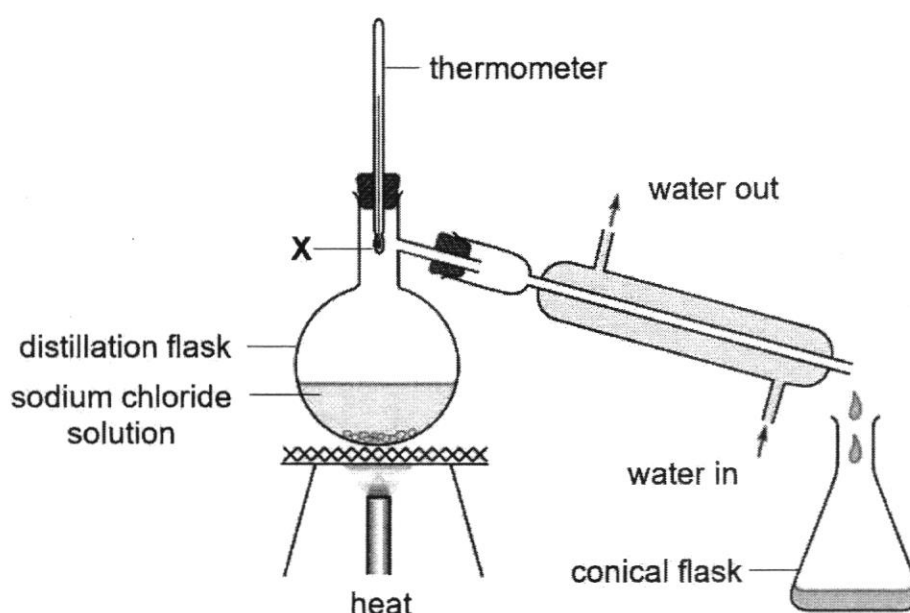
Section	Marks
A	/20
B	/45
C	/20
Total	/85

 This question paper consists of **21** printed pages

Section A (20 marks)

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

- 1 Which one of the following is likely to be a pure compound?
- A A brown solution.
 - B An oily liquid which gives two fractions when distilled.
 - C Blue crystals which melt over a range of $55^{\circ}\text{C} - 60^{\circ}\text{C}$.
 - D Colourless crystals which all melt at 58°C .
- 2 An aqueous solution of sodium chloride is heated in a distillation set-up.



What is the temperature shown at X, and what are found in the distillation flask and the conical flask at the end of distillation?

	temperature at X / $^{\circ}\text{C}$	contents in distillation flask	contents in conical flask
A	78	colourless liquid	white residue
B	100	colourless liquid	white residue
C	100	white residue	colourless liquid
D	105	white residue	colourless liquid

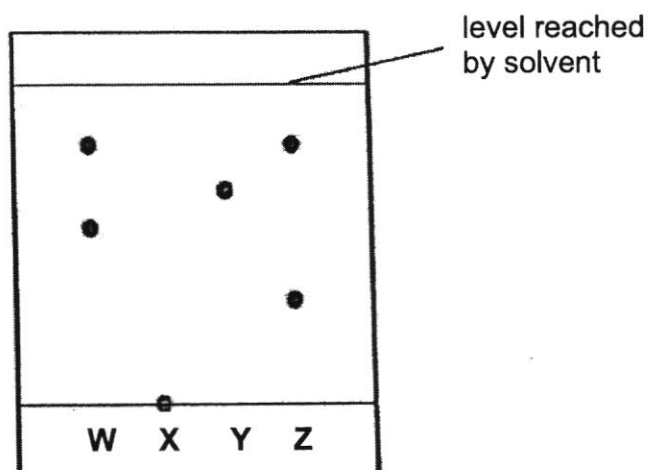
- 3 Which row shows the number of sub-atomic particles in an aluminium ion, Al^{3+} ?

	number of protons	number of neutrons	number of electrons
A	13	14	10
B	13	14	13
C	16	27	10
D	16	27	13

- 4 The table below shows the melting and boiling points of four substances **A**, **B**, **C** and **D**.
Which substance contains particles moving at high speeds at room temperature and pressure?

substance	melting point / °C	boiling point / °C
A	-114	5
B	-50	60
C	21	40
D	745	1445

- 5 The figure below shows a chromatogram used to compare present in four substances **W**, **X**, **Y** and **Z**.

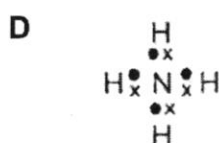
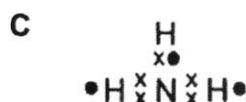
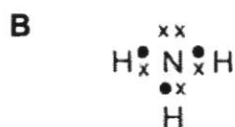
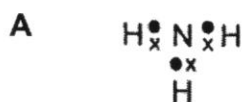


Which statement below is true?

- A** **W** is present in **Z**.
- B** **X** contains only 1 component.
- C** **Y** is pure.
- D** **Z** contains an insoluble component.

[Turn over

- 6 Which diagram shows the valence electron arrangement in a molecule of ammonia?



- 7 What is the relative molecular mass of sodium carbonate crystals, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$?

- A 106
B 124
C 142
D 286

- 8 Three elements, **X**, **Y** and **Z** have consecutive, increasing proton numbers. If element **X** is a noble gas, what will be the symbol for the ions of element **Z** in its compounds?

- A Z^+
B Z^{2+}
C Z^{3+}
D Z^{2-}

- 9 The elements **P** and **Q** form the compound P_2Q . What are the correct electronic configurations of the atoms of **P** and **Q**?

	atom of P	atom of Q
A	2, 1	2, 6
B	2, 2	2, 6
C	2, 1	2, 7
D	2, 2	2, 7

- 10 Photosynthesis by green plants can be represented by the equation below.



What are the values of x , y and z ?

	x	y	z
A	6	6	6
B	6	12	6
C	6	6	12
D	12	6	6

- 11 The results of the gases evolved in the reactions carried out on compound **Y** are shown.

reaction	result
dilute nitric acid added to compound Y	effervescence observed, gas formed white precipitate in limewater.
compound Y is warmed with aqueous sodium hydroxide	pungent gas produced, gas turned damp red litmus paper blue.

What is compound **Y**?

- A** ammonium carbonate
 - B** ammonium nitrate
 - C** calcium carbonate
 - D** calcium nitrate
- 12 Which statement about all acids is correct?
- A** They contain both hydrogen and oxygen.
 - B** They give ammonia with an ammonium salt.
 - C** They have a pH value below 7.
 - D** They react with all metals to form hydrogen gas.

[Turn over

13 Which compound is an amphoteric oxide?

- A aluminium oxide
- B carbon monoxide
- C nitric oxide
- D potassium oxide

14 Metal **M** is in Group I of the Periodic Table. Which statement is correct?

- A It forms an acidic oxide.
- B It forms an insoluble carbonate.
- C It forms a neutral oxide.
- D It reacts vigorously with cold water.

15 The table shows the colours of various indicators and the pH at which the colour changes.

indicator	colour change	pH at which the colour changes
bromothymol blue	yellow → blue	7
litmus	red → blue	7
methyl orange	red → yellow	4
screened methyl orange	violet → green	4

Which indicators would show the same colour in aqueous sodium hydroxide?

- A bromothymol blue and litmus
- B bromothymol blue and methyl orange
- C litmus and methyl orange
- D methyl orange and screened methyl orange

16 Which reaction produces a precipitate?

- A $\text{K}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{KCl} + \text{CO}_2 + \text{H}_2\text{O}$
- B $\text{ZnO} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2\text{O}$
- C $\text{NH}_4\text{OH} + \text{HCl} \rightarrow \text{NH}_4\text{Cl} + \text{H}_2\text{O}$
- D $\text{AgNO}_3 + \text{HCl} \rightarrow \text{AgCl} + \text{HNO}_3$

- 17 Magnesium blocks are attached to the base of a boat made from iron to prevent rusting of the boat.
How does the magnesium stop the iron from rusting?

A Magnesium forms an alloy with the iron.
 B Magnesium reacts to form a protective coating of magnesium oxide on the iron.
 C Magnesium reacts in preference to the iron as magnesium is more reactive than iron.
 D Magnesium stops oxygen in the water from getting to the iron.

- 18 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.
Which waste gas will **not** be removed by powdered calcium carbonate?

A carbon dioxide
 B carbon monoxide
 C nitrogen dioxide
 D phosphorus (V) oxide

- 19 When three unknown halogens, X_2 , Y_2 and Z_2 , are reacted with halide solutions, their results are shown in the table below.

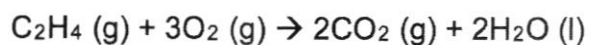
halogen added	halide solution		
	X^-	Y^-	Z^-
X_2	--	no reaction	Z_2 displaced
Y_2	X_2 displaced	--	Z_2 displaced
Z_2	no reaction	no reaction	--

Which row shows the halogens arranged in increasing order of reactivity?

A $X_2 < Y_2 < Z_2$
 B $Y_2 < X_2 < Z_2$
 C $Z_2 < X_2 < Y_2$
 D $Z_2 < Y_2 < X_2$

[Turn over

- 20 20 cm³ of ethene are reacted with 60 cm³ of oxygen.
The equation for the reaction is shown.



All volumes are measured at r.t.p.

What is the volume of carbon dioxide produced at the end of the reaction?

- A 40 cm³
- B 50 cm³
- C 80 cm³
- D 90 cm³

Section B (45 marks)

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

- 1 The boxes below show the descriptions of four different substances **V**, **W**, **X**, **Y**.

A white solid, **V**, which can be separated into two different substances by adding water and filtering.

A solid, **W**, with a fixed melting and boiling point.

A solid, **X**, which melts into a silvery liquid that cannot be made into a simpler substance.

Heat and light are produced when a substance is burnt in air to form a white solid, **Y**.

Deduce whether each substance should be classified as an element, a compound, a mixture or either an element or a compound. Place a tick (✓) in the correct box for each substance in the table below.

substance	element	compound	mixture	either an element or a compound
V				
W				
X				
Y				

[4]

- 2 Name the pieces of apparatus best used to carry out the following procedures.

(a) Measuring the boiling point of pure water. _____ [1]

(b) Adding 31.0 cm³ of nitric acid into a conical flask. _____ [1]

(c) Collecting and measuring the volume of a water-soluble gas. _____ [1]

(d) Adding 20.0 cm³ of sodium hydroxide to a beaker. _____ [1]

[Turn over]

- 3 The table below shows the electronic structures of five elements, **A** to **F**, in the Periodic Table. The letters are not the real symbols of the elements. They may be used once, more than once or not at all in the questions that follow.

element	A	B	C	D	E	F
electronic structure	2	2, 2	2, 7	2, 8	2, 8, 3	2, 8, 8, 2

From the information in the table above **only**, give the letter(s) of

- (a) all element(s) which is/are a noble gas _____ [1]
- (b) all element(s) which is/are a non-metal _____ [1]
- (c) all element(s) in the same Period _____ [1]
- (d) a pair of elements which form an ionic compound _____ [1]

- 4 The table below shows the composition of air in two cities **P** and **Q**.

city	gas X %	gas Y %	carbon dioxide %	sulfur dioxide %	other gases %
P	19.0	79.7	0.2	1.0	0.1
Q	18.8	79.7	0.9	0.5	0.1

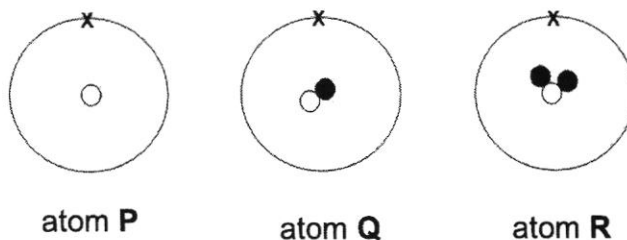
- (a) Name gas **X** and gas **Y**. _____ [1]

- (b) Sulfur dioxide is an air pollutant found in both cities. Give a source of sulfur dioxide and describe one problem that it can cause.

source: _____

problem: _____ [2]

- 5 Atoms **P**, **Q** and **R** are isotopes of one another. Their atomic structures are shown below.



- (a) Complete the table below.

[3]

symbol	sub-atomic particle	charge	mass
●			
○			
X			

- (b) Explain why atoms **P**, **Q** and **R** are isotopes of each other.

_____ [1]

- (c) Explain why atoms **P**, **Q** and **R** have similar chemical properties.

_____ [1]

- 6 Copper(II) sulfate crystals can be prepared by following the instructions below.

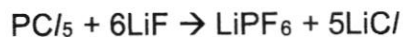
Add one spatula of copper(II) oxide to 50.0 cm³ of dilute sulfuric acid, and then stir. Continue adding copper(II) oxide until no more will dissolve. Filter the mixture. Evaporate the filtrate to about half its volume. Allow the filtrate to cool. Filter off the crystals. Dry them using filter paper. Do not heat the crystals.

Explain the importance of the underlined instructions or phrases in the table.

[4]

	instruction / phrase	explanation
(a)	until no more will dissolve	
(b)	filter the mixture	
(c)	filtrate to cool	
(d)	not heat the crystals	

- 7 PCl_5 reacts with lithium fluoride, LiF to form LiPF_6 .
The chemical equation of the reaction is shown below.



In a reaction, 3.04 g of LiPF_6 is formed.

- (a) Calculate the number of moles of LiPF_6 formed.

number of moles of LiPF_6 = _____ [1]

- (b) Calculate the mass of LiF reacted.

mass of LiF = _____ g [2]

[Turn over

- 8 (a) The table below shows information about solutions of an acid and an alkali. Complete the table by filling in the empty boxes. [4]

solution	colour change when mixed with Universal Indicator solution	chemical symbol of ion that causes this colour change
hydrochloric acid		
potassium hydroxide		

- (b) Dilute hydrochloric acid reacts with potassium hydroxide to form a salt and one other product.

- (i) Name the type of reaction between hydrochloric acid and potassium hydroxide.

[1]

- (ii) Write a chemical equation, including state symbols for the above reaction.

[2]

- 9 A student wanted to carry out some experiments in the laboratory. He was provided with the following chemicals.

copper	sodium hydroxide	magnesium	hydrochloric acid
sodium	calcium carbonate	copper(II) oxide	ammonium chloride

- (a) (i) Select two suitable substances from the list that will produce hydrogen gas. [1]

- (ii) Name the other product formed when the two substances in (a)(i) react. [1]

- (b) Describe a test that could be carried out to show the presence of hydrogen gas.

test: _____

result: _____ [2]

- 10 (a) Iron is extracted by heating iron ore with limestone and coke in a blast furnace.

- (i) Name an ore of iron.

[1]

- (ii) Write a balanced chemical equation for the decomposition of limestone

[1]

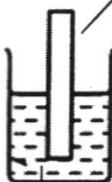
- (iii) Write a balanced chemical equation for the production of carbon monoxide in the blast furnace.

[1]

[Turn over

- (b) Three experiments were carried out to find the order of reactivity of three metals.

The metals used were zinc, tin and unknown metal **Q**.

experiment	colour of metal		colour of solution	
	start	end	start	end
 zinc tin(II) chloride	silver - grey	silver-grey with crystals formed on surface	colourless	colourless
 tin metal Q sulfate	silver - grey	reddish-brown coating on surface	blue	light blue
 metal Q zinc sulfate	reddish-brown		colourless	

- (i) Suggest the name of metal **Q**.

[1]

- (ii) Complete the table to show the colour of the metal and the solution at the end of the experiment between metal **Q** and zinc sulfate. [1]

- (iii) List the three metals in the order of increasing reactivity.

[1]

- (iv) Write a chemical equation for the reaction involving zinc and tin(II) chloride.

[1]

Section C (20 marks)

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

- 1 (a) The Periodic Table contains an element with proton number 9 and another element with proton number 17.

- (i) Identify and name these two elements and the group of the Periodic Table in which they are positioned.

[2]

- (ii) Explain why both elements appear in the same group of the Periodic Table.

[1]

- (iii) Elements with proton numbers 9, 17 and 35 are in the same group of the Periodic Table.
For these three elements, suggest **one** similarity in their properties and **one** trend in their properties.

[2]

[Turn over

- (b) The physical properties of some Group I elements are shown in the table.

element	melting point/ °C	boiling point/ °C	density/ g/cm ³
lithium	180	1330	0.53
sodium	98	890	0.97
potassium	64	760	0.86

- (i) State two other physical properties of Group I elements, other than those shown in the table above.

.....

.....

.....

[2]

- (ii) Rubidium, Rb, is found below potassium in the Periodic Table. Predict if the melting point of rubidium will be higher or lower than that of potassium.

.....

[1]

- (iii) Lithium reacts quickly with water. Effervescence is observed until no more lithium is left in the water. Describe and explain how the reaction of potassium with water will differ from lithium.

.....

.....

.....

[2]

- 2** Magnesium sulfide, MgS reacts with nitric acid to produce aqueous magnesium nitrate and hydrogen sulfide gas, H_2S .

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

[2]

(b) Showing only the valence electrons, draw 'dot and cross' diagrams to represent the bonding in

(i) magnesium sulfide, MgS ,

[2]

(ii) hydrogen sulfide, H_2S .

[2]

[Turn over

- (c) Explain why, at room temperature and pressure, magnesium sulfide is a solid and hydrogen sulfide is a gas.

[4]

- End of Paper -

Deyi Secondary School
EOY Examination 2021
Science Chemistry (5076)
Sec 3 Express

ANSWERS

Section A (20m)

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

Section B (45m)

Question 1

Qn.	Answer					Marks	Remarks
	subst ance	element	compound	mixture	either an element or a compound	4	
	V			✓			
	W				✓		
	X	✓					
	Y		✓				
	Total					4	

Question 2

Qn.	Answer	Marks	Remarks
(a)	thermometer	1	
(b)	burette	1	
(c)	gas syringe [do not accept syringe]	1	
(d)	pipette	1	
	Total	4	

Question 3

Qn.	Answer	Marks	Remarks
(a)	A & D	1	
(b)	A, C & D	1	
(c)	B, C & D	1	
(d)	B & C or E & C or F & C If multiple pairs of answers are given, mark only the first pair as question ask for <u>only a pair of elements</u> that form ionic compound.	1	
Total		4	

Question 4

Qn.	Answer	Marks	Remarks
(a)	gas X: oxygen; gas Y: nitrogen	1	
(b)	Any one of the following source and problem Source: - Volcanic activity - Combustion of fossil fuels or sulfur-containing substances Problem: - Dissolve in rainwater to form acid rain, affecting building, plants and aquatic life - Irritate eyes and lungs, causes breathing difficulties	1 1	
Total		3	

Question 5

Qn.	Answer					Marks	Remarks
(a)	symbol	sub-atomic particle	charge	mass		3	
	●	neutron	0	1			
	○	proton	+1	1			
	X	electron	−1	1/1840			
(b)	The three atoms have the same number of protons and different number of neutrons, thus they are isotopes of each other.					1	
(c)	The three atoms have the same number of valence electron / one valence electron therefore they will have similar chemical properties.					1	
	Total					5	

Question 6

Qn.	Answer			Marks	Remarks
		Instruction / Phrase	Explanation	4	
	(a)	until no more will dissolve	ensure all sulfuric acid is reacted		
	(b)	filter the mixture	remove the unreacted copper(II) oxide		
	(c)	filtrate to cool	Solubility of copper(II) sulfate will decrease, salt will crystallise		
	(d)	not heat the crystals	heating will decompose the crystal / heating will removed the water of crystallisation		
	Total			4	

Question 7

Qn.	Answer	Marks	Remarks
(a)	Number of moles of LiPF_6 = mass / molar mass = $3.04 / (7+31+19 \times 6)$ = 0.02 [working must be shown]	1	
(b)	Number of moles of LiF = 0.02×6 = 0.12	1	
	Mass of LiF = number of moles x molar mass = $0.12 \times (7+19)$ = 3.12g [working must be shown]	1	
	Total	3	

Question 8

Qn.	Answer				Marks	Remarks
(a)		solution	colour change when mixed with Universal Indicator solution	Chemical symbol of ion that causes this colour change	4	
		hydrochloric acid	from green to red	H ⁺		
		potassium hydroxide	from green to blue	OH ⁻		
(b)	Neutralisation reaction				1	
(c)	KOH (aq) + HCl (aq) → KCl (aq) + H ₂ O (l) [1 m for correct state symbols. 1 m for correct formula of reactants and products and correct balancing.]				2	Chemical formula must be correct in order to be awarded the mark for state symbol
	Total				7	

Question 9

Qn.	Answer	Marks	Remarks
(a)(i)	Magnesium and hydrochloric acid [mark will only be awarded if both answers are correct]	1	
(a)(ii)	Magnesium chloride	1	
(b)	Test: Place a lighted splint near the gas	1	
	Result: Lighted splint extinguished with a 'pop' sound.	1	
Total		4	

Question 10

Qn.	Answer	Marks	Remarks
(a)(i)	Haematite	1	
(a)(ii)	CaCO ₃ → CaO + CO ₂	1	
(a)(iii)	CO ₂ + C → 2CO	1	
(b)(i)	copper	1	
(b)(ii)	colour of metal (end): reddish- brown	0.5	
	colour of solution (end): colourless	0.5	
(b)(iii)	copper (metal Q), tin, zinc	1	
(b)(iv)	Zn + SnCl ₂ → ZnCl ₂ + Sn	1	
Total		7	

Section C (20m)**Question 1**

Qn.	Answer	Marks	Remarks
(a)(i)	Proton number 9: fluorine	0.5	
	Proton number 17: chlorine	0.5	
	Group name: halogen or Group VII	1	
(a)(ii)	Both elements have the same number of valence electrons or 7 valence electrons.	1	
(a)(iii)	Any one of the following similarities in properties: • Coloured substances • Form ions of charge -1	1	
	Any one of the following trend in properties: • Colour intensity increases down the group • Melting and boiling points increase down the group	1	
(b)(i)	Any two of the following: • soft and can be cut with a knife • good conductor of heat • good conductor of electricity	2	
(b)(ii)	The melting points of rubidium should be lower than that of potassium.	1	
(b)(iii)	Potassium reacts more vigorously/explosively/violently with water.	1	
	Potassium is more reactive than Lithium or Reactivity of Group I metals increases down the group.	1	
	Total	10	

Question 2

Qn.	Answer	Marks	Remarks
(a)	$\text{MgS} (\text{s}) + 2\text{HNO}_3 (\text{aq}) \rightarrow \text{Mg}(\text{NO}_3)_2 (\text{aq}) + \text{H}_2\text{S} (\text{g})$ [1 m for correct state symbols. 1 m for correct formula of reactants and products and correct balancing.]	2	
(b)(i)	 [1 m – cation] [1m – anion, 0 m if wrong charge or electron transfer]	2	
(b)(ii)	 [1 m – correct number of H atoms and S atom] [1m – correct number of electrons shared]	2	
(c)	Magnesium sulfide is an <u>ionic</u> compound with <u>giant lattice structure</u>. It has <u>strong electrostatic forces of attraction between oppositely charged ions</u>. A <u>large amount of energy is required to overcome these strong electrostatic forces of attraction</u>, hence the melting point is high and magnesium sulfide is a solid. Hydrogen sulfide is a <u>covalent</u> substance with a <u>simple molecular structure</u>. It has <u>weak intermolecular forces of attraction between molecules</u>. A <u>small amount of energy is required to overcome these weak intermolecular forces of attraction</u>, hence, hydrogen sulfide has a low melting point and boiling point, and it exists as a gas. [0.5 mark for each underlined statement]	2 2	
Total		10	

The End