Name :	Class	Index no.

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

[Turn over

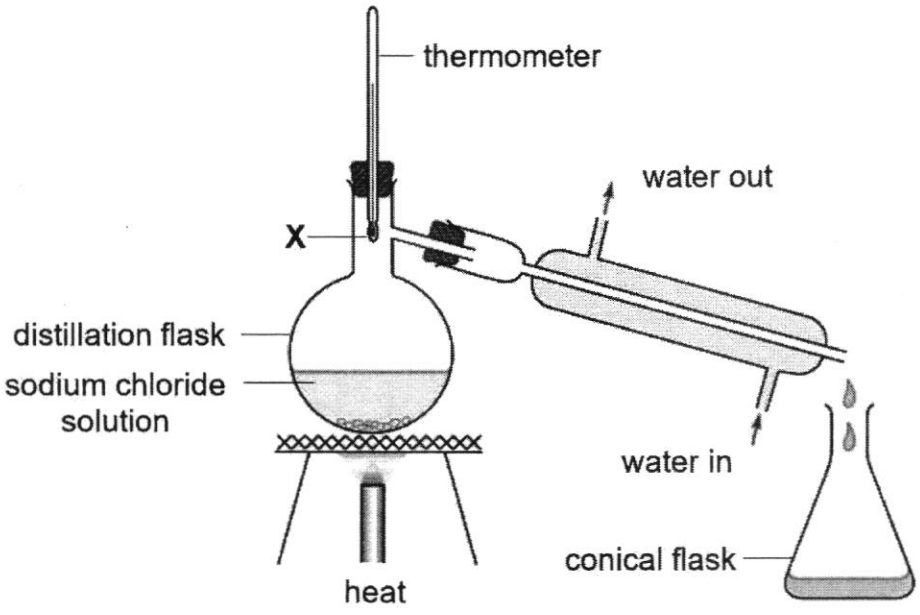
Section A (20 marks)

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°C – 60°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** / °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

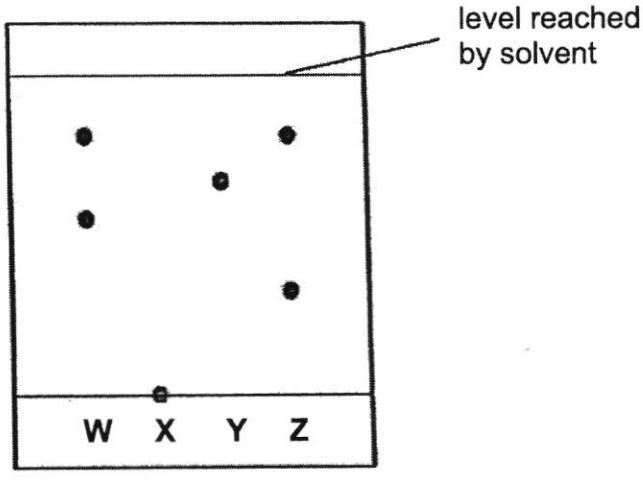
3 Which row shows the number of sub-atomic particles in an aluminium ion, Al^{3+}?

	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**.

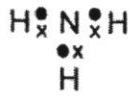


Which statement below is true?

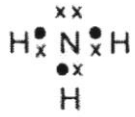
A **W** is present in **Z**.
B **X** contains only 1 component.
C **Y** is pure.
D **Z** contains an insoluble component.

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

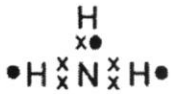
A



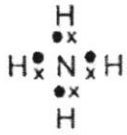
B



C



D



7 What is the relative molecular mass of sodium carbonate crystals, $Na_2CO_3.10H_2O$?

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.

$$x CO_2 + 6H_2O \rightarrow C_6H_yO_z + 6O_2$$

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.

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 $K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O$
B $ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$
C $NH_4OH + HCl \rightarrow NH_4Cl + H_2O$
D $AgNO_3 + HCl \rightarrow AgCl + HNO_3$

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 $Z_2 < Y_2 < X_2$

20 20 cm^3 of ethene are reacted with 60 cm^3 of oxygen.
The equation for the reaction is shown.

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

All volumes are measured at r.t.p.
What is the volume of carbon dioxide produced at the end of the reaction?

A 40 cm^3
B 50 cm^3
C 80 cm^3
D 90 cm^3

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 cm^3 of nitric acid into a conical flask. _____ [1]

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

(d) Adding 20.0 cm^3 of sodium hydroxide to a beaker. _____ [1]

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.

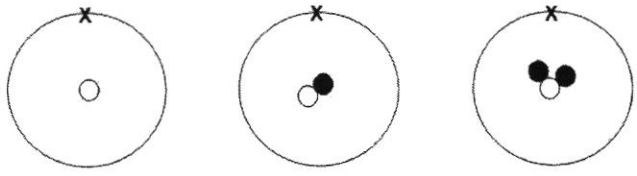
source: ---

problem: ---

[2]

---

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



atom **P** atom **Q** atom **R**

(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 cm^3 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.

$$PCl_5 + 6LiF \rightarrow LiPF_6 + 5LiCl$$

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]

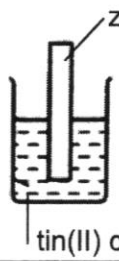
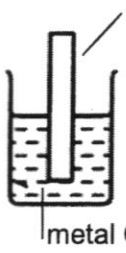
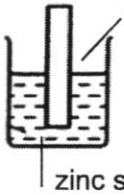
_____

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

[1]

_____

(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
	silver - grey	silver-grey with crystals formed on surface	colourless	colourless
	silver – grey	reddish-brown coating on surface	blue	light blue
	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]

(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]

(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
	substance / element / compound / mixture / either an element or a compound V / / / ✓ / W / / / / ✓ X / ✓ / / / Y / / ✓ / /	4	
	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 only a pair of elements 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)	<table><tr><th>symbol</th><th>sub-atomic particle</th><th>charge</th><th>mass</th></tr><tr><td>●</td><td>neutron</td><td>0</td><td>1</td></tr><tr><td>○</td><td>proton</td><td>+1</td><td>1</td></tr><tr><td>**X**</td><td>electron</td><td>−1</td><td>1/1840</td></tr></table>	3	
(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
	<table><tr><th></th><th>Instruction / Phrase</th><th>Explanation</th></tr><tr><td>(a)</td><td>until no more will dissolve</td><td>ensure all sulfuric acid is reacted</td></tr><tr><td>(b)</td><td>filter the mixture</td><td>remove the unreacted copper(II) oxide</td></tr><tr><td>(c)</td><td>filtrate to cool</td><td>Solubility of copper(II) sulfate will decrease, salt will crystallise</td></tr><tr><td>(d)</td><td>not heat the crystals</td><td>heating will decompose the crystal / heating will removed the water of crystallisation</td></tr></table>	4	
	Total	**4**	

Question 7

Qn.	Answer	Marks	Remarks
(a)	Number of moles of $LiPF_6$ = mass / molar mass = 3.04 / (7+31+19x6) = **0.02** [working must be shown]	1	
(b)	Number of moles of LiF = 0.02 x 6 = **0.12** Mass of LiF = number of moles x molar mass = 0.12 x (7+19) = **3.12g** [working must be shown]	1 1	
	Total	**3**	

Question 8

Qn.	Answer	Marks	Remarks
(a)	<table><tr><th>solution</th><th>colour change when mixed with Universal Indicator solution</th><th>Chemical symbol of ion that causes this colour change</th></tr><tr><td>hydrochloric acid</td><td>from green to red</td><td>H^+</td></tr><tr><td>potassium hydroxide</td><td>from green to blue</td><td>OH^-</td></tr></table>	4	
(b)	Neutralisation reaction	1	
(c)	$KOH\ (aq) + HCl\ (aq) \rightarrow KCl\ (aq) + H_2O\ (l)$ [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 Result: Lighted splint extinguished with a 'pop' sound.	1 1	
	Total	4	

Question 10

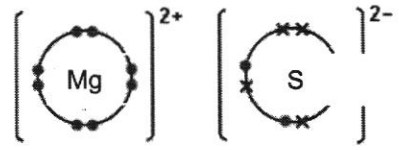
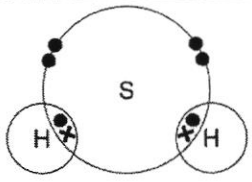
Qn.	Answer	Marks	Remarks
(a)(i)	Haematite	1	
(a)(ii)	$CaCO_3 \rightarrow CaO + CO_2$	1	
(a)(iii)	$CO_2 + C \rightarrow 2CO$	1	
(b)(i)	copper	1	
(b)(ii)	colour of metal (end): reddish- brown colour of solution (end): colourless	0.5 0.5	
(b)(iii)	copper (metal **Q**), tin, zinc	1	
(b)(iv)	$Zn + SnCl_2 \rightarrow ZnCl_2 + Sn$	1	
	Total	7	

Section C (20m)

Question 1

Qn.	Answer	Marks	Remarks
(a)(i)	Proton number 9: fluorine Proton number 17: chlorine Group name: halogen or Group VII	0.5 0.5 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 Any one of the following trend in properties: • Colour intensity increases down the group • Melting and boiling points increase down the group	1 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 vigourously/explosively/violently with water. Potassium is more reactive than Lithium or Reactivity of Group I metals increases down the group.	1 1	
	Total	**10**	

Question 2

Qn.	Answer	Marks	Remarks
(a)	$MgS\ (s) + 2HNO_3\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + H_2S\ (g)$ [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