

Bonding and structure

1. The formulae of some ions are shown.

positive ions	negative ions
Al^{3+}	Br^{-}
Ca^{2+}	CO_3^{2-}
Cu^{2+}	NO_3^{-}
Fe^{3+}	S^{2-}
K^{+}	SO_4^{2-}

In which row is the formula **not** correct?

	compound	formula
A	aluminium sulfate	$Al_2(SO_4)_3$ ✓
B	calcium nitrate	$Ca(NO_3)_2$ ✓
C	iron(III) bromide	Fe_3Br ✗ $FeBr_3$
D	potassium sulfide	K_2S ✓

2. Diamond and silicon(IV) oxide both have giant structures.

Which statements are correct?

- Both substances are compounds. ✗
- There are strong covalent bonds in diamond. ✓
- Silicon(IV) oxide is bonded ionically. ✗
- Both substances have very high melting points. ✓

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

3. Which statement about metals is correct?

- Layers of positive ions can slide over each other making metals malleable. ✓
- Metallic bonding consists of a lattice of negative ions in a sea of delocalised electrons. ✗
- Metallic bonding consists of a lattice of positive ions in a sea of delocalised negative ions. ✗
- Metals conduct electricity because positive ions are free to move. ✗

4. Sodium reacts with chlorine to form sodium chloride.

Which statements describe what happens to the sodium atoms in this reaction?

- 1 Sodium atoms form positive ions. ✓
- 2 Sodium atoms form negative ions.
- 3 Sodium atoms gain electrons.
- 4 Sodium atoms lose electrons. ✓

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

5. Diamond is extremely hard and does not conduct electricity.

Which statement explains these properties?

- A It has a lattice of positive carbon ions in a 'sea of electrons'. ~~✗~~
- B It has delocalised ~~✗~~ electrons and each carbon atom forms three ~~✗~~ covalent bonds with other carbon atoms.
- C** It has no delocalised electrons and each carbon atom forms four covalent bonds with other carbon atoms.
- D It has strong ionic ~~✗~~ bonds between each carbon atom.

6. Which statement about metals is **not** correct?

- A Metals are malleable because ✓ the metal ions can slide over one another.
- B Metals conduct electricity because electrons ✓ can move through the lattice.
- C Metals consist of a giant lattice of metal ions in a 'sea of electrons'. ✓
- D** Metals have high melting points because of the strong attraction between the metal ions. ~~✗~~

7. Which element does **not** form a stable ion with the same electronic structure as argon?

- A** aluminium 13e 18e⁻
- B chlorine 17e
- C phosphorus 15e⁻
- D potassium 19e⁻

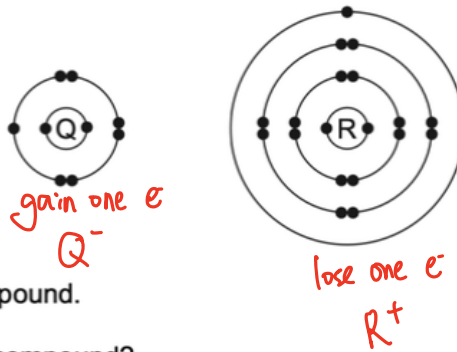
8. Graphite and diamond are both forms of the element carbon.

Which row shows the number of other carbon atoms that each carbon atom is covalently bonded to in graphite and diamond?

	graphite	diamond
A	3 ✓	3
B	3 ✓	4 ✓
C	4	3
D	4	4

9. Which statement describes metallic bonding?
- A The attraction between a lattice of negative ions and delocalised protons.
 - B** The attraction between a lattice of positive ions and delocalised electrons.
 - C The attraction between delocalised protons and electrons.
 - D The attraction between oppositely charged ions.

10. The electronic structures of atoms Q and R are shown.



Q and R form an ionic compound.

What is the formula of the compound?

- A QR_7
- B Q_2R_4
- C** QR
- D Q_7R

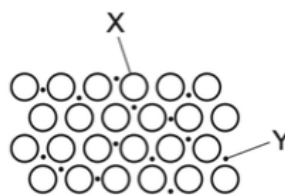
11. Which substance is a macromolecule?

- A ammonia
- B carbon dioxide
- C** diamond
- D water

giant covalent structure

↓ giant covalent structure.

12. The diagram shows metallic bonding.



Which labels are correct?

	X	Y
A	atomic nucleus	outer electron
B	metal atom	mobile electron
C	metal ion ✓	mobile electron ✓
D	positive ion ✓	negative ion

13. Two statements about silicon(IV) oxide are given.

- 1 It is a hard substance. ✓
- 2 It has a macromolecular structure with strong covalent bonds. ✓

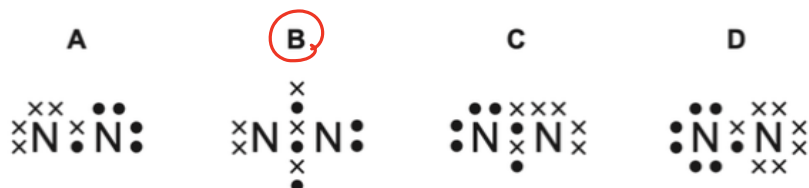
Which is correct?

- A** Both statements are correct and statement 2 explains statement 1.
- B Both statements are correct but statement 2 does not explain statement 1.
- C Statement 1 is correct but statement 2 is not correct.
- D Statement 2 is correct but statement 1 is not correct.

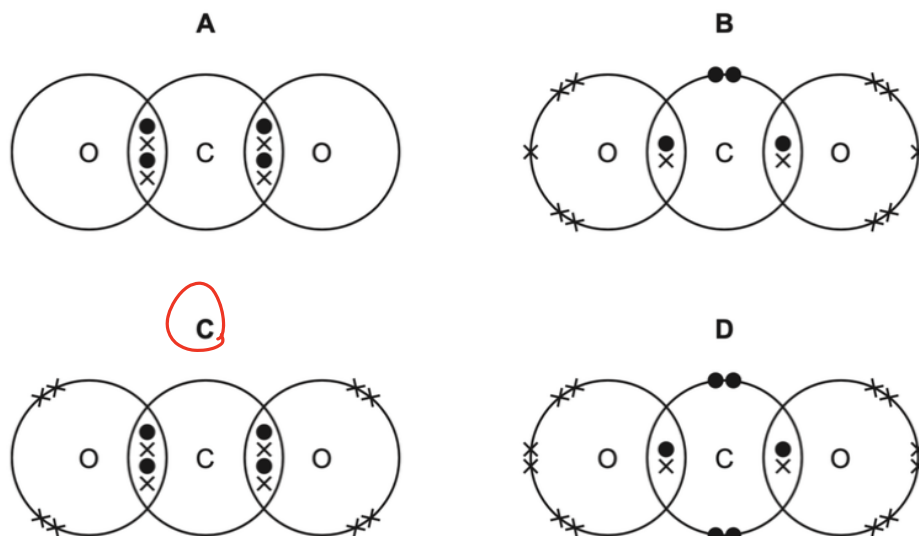
14. Which statement explains why isotopes of the same element have the same chemical properties?

- A They have a different number of neutrons in the nucleus.
- B They have the same number of neutrons in the nucleus.
- C** They have the same number of outer shell electrons.
- D They have the same number of protons as neutrons.

15. Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of nitrogen?



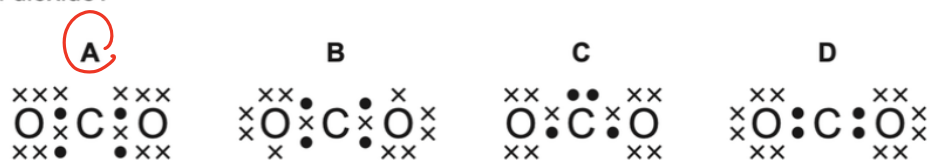
16. Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of carbon dioxide?



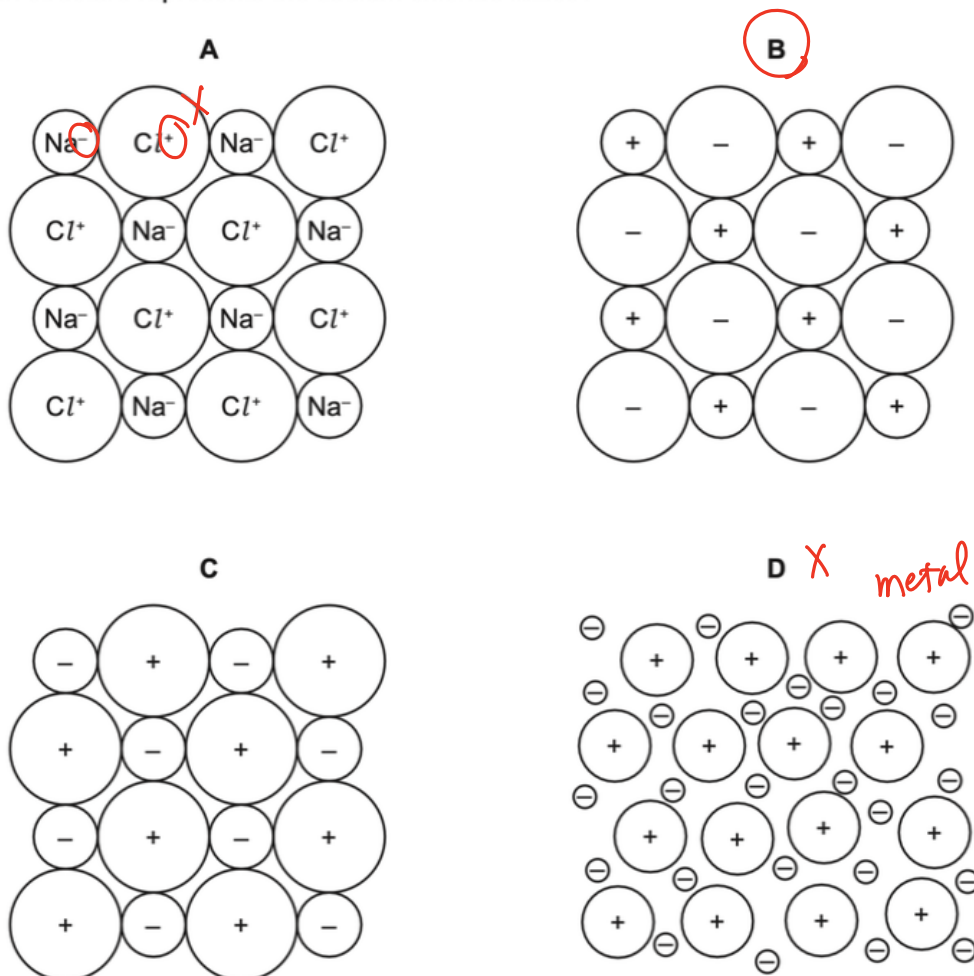
17. Which molecule contains only single covalent bonds?

- A** Cl₂
- B CO₂
- C N₂
- D O₂

18. Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of carbon dioxide?



19. Which structure represents the sodium chloride lattice?



*Na⁺ 10e⁻
Cl⁻ 18e⁻
→ 28e⁻*

20. Magnesium nitride is formed when magnesium burns in air. Magnesium nitride is an ionic compound.

What is the formula of magnesium nitride?

- A** MgN₂ **B** Mg₂N₂ **C** Mg₂N₃ **D** Mg₃N₂

21. Metals consist of a lattice of positive ions in a 'sea of electrons'.

Why is aluminium malleable?

- A** Its ions are attracted to the 'sea of electrons'.
B Its ions are tightly packed together.
C Its ions repel each other.
D Its layers of ions can slide over each other.

22. The table shows the electronic structure of four atoms.

atom	electronic structure
W	2,8,1
X	2,8,4 →
Y	2,8,7 →
Z	2,8,8

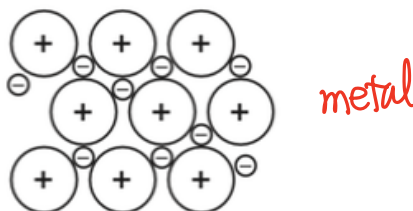
Which two atoms combine to form a covalent compound?

- A W and X B W and Y **C X and Y** D X and Z

23. Which statement describes the attractive forces between molecules (intermolecular forces)?

- A They are strong covalent bonds which hold molecules together.
B They are strong ionic bonds which hold molecules together.
C They are weak forces formed between covalently-bonded molecules.
D They are weak forces which hold ions together in a lattice.

24. The diagram represents the general structure of a solid Z.



What is Z?

- A aluminium**
B iodine
C silicon dioxide
D sulfur

25. Which substance exists as a lattice of positive ions in a 'sea of electrons'?

- A liquid potassium chloride
B solid graphite
C solid magnesium
D solid silicon(IV) oxide

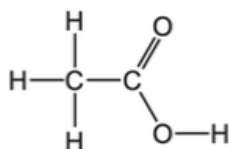
e^-

26. Metal P reacts with non-metal Q to form a compound.

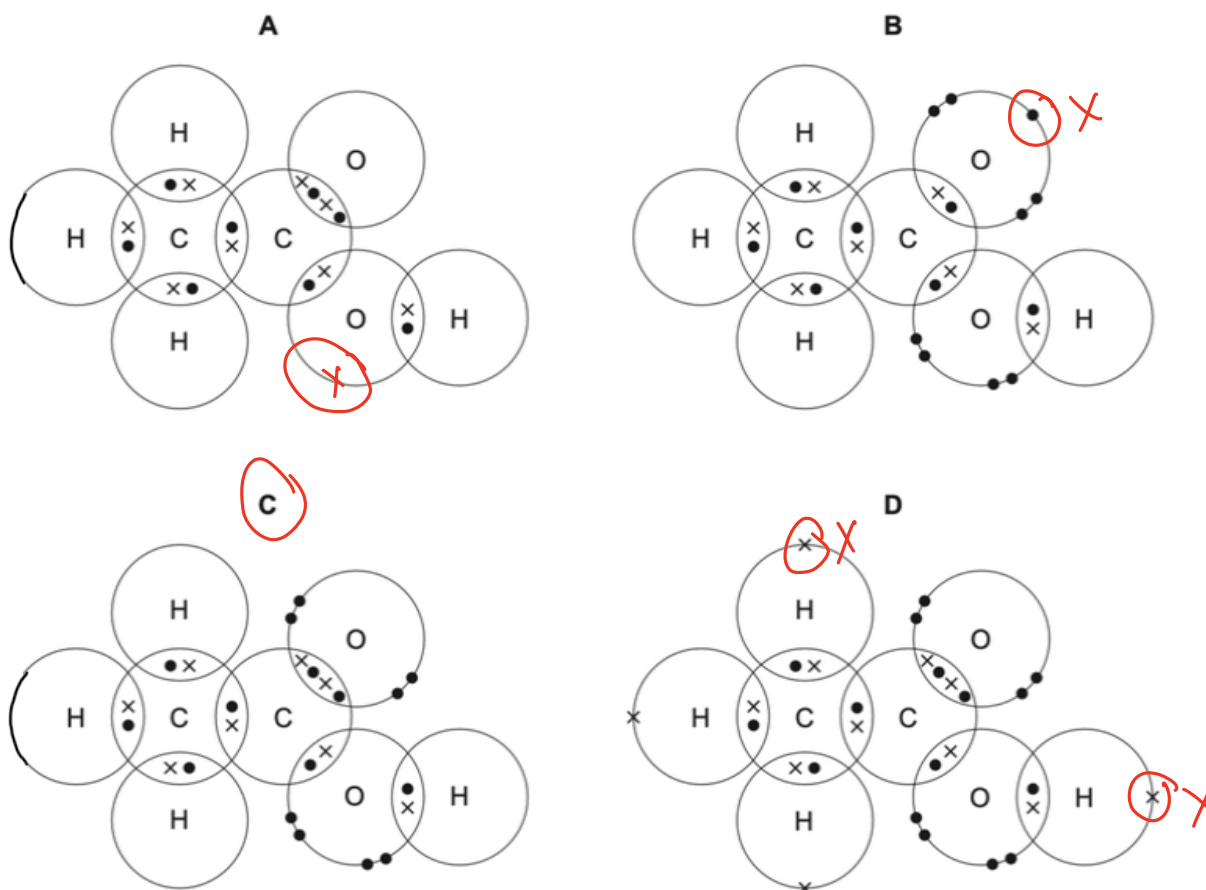
Which process takes place and which type of compound is formed?

	process	type of compound
A	electrons are transferred from P to Q ✓	covalent
B	electrons are transferred from P to Q ✓	ionic ✓
C	electrons are transferred from Q to P	covalent
D	electrons are transferred from Q to P	ionic

27. The structure of ethanoic acid is shown.



Which diagram shows the arrangement of outer shell electrons in a molecule of ethanoic acid?



28. X is a solid at room temperature.

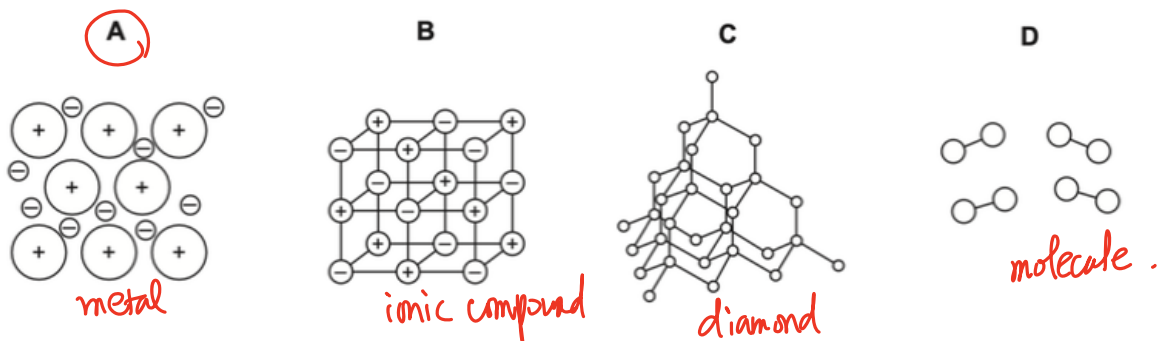
X has a high melting point.

Solid X conducts electricity.

} metal

其实有 graphite 的, 也是对的

Which diagram shows how the particles are arranged in solid X?



29. Which substance is an ionic compound?

	volatility	electrical conductivity when molten	solubility in water
A	high	good ✓	soluble
B	high	poor	insoluble
C	low ✓	good ✓	soluble ✓
D	low ✓	poor	insoluble

30. Covalent bonds are formed when electrons are1.....

Most covalent compounds have2..... electrical conductivity.

Which words correctly complete gaps 1 and 2?

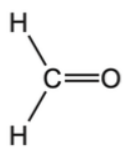
	1	2
A	shared ✓	high
B	shared ✓	low ✓
C	transferred	high
D	transferred	low

31. In which compounds are pairs of electrons shared between atoms?

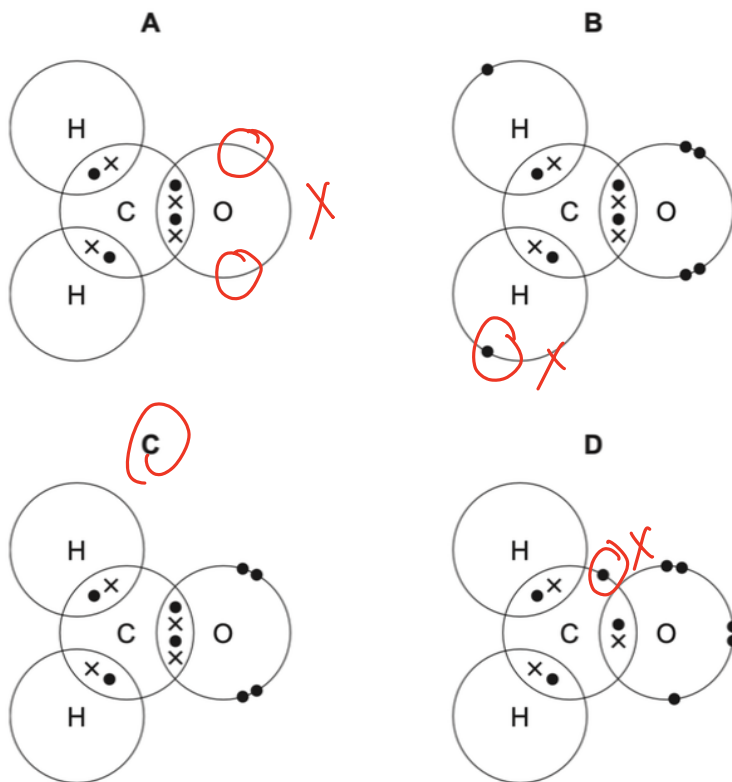
- 1 methane ✓
- 2 lead bromide ionic
- 3 sodium chloride ionic

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

32. The structure of methanal is shown.



Which diagram shows the arrangement of outer shell electrons in a molecule of methanal?



33. Iron is a metal. Its structure consists of a giant lattice of positive ions in a 'sea of electrons'.

Which statements about solid iron are correct?

- 1 Iron conducts electricity because the electrons are free to move. ✓
- 2 Iron conducts heat because the positive ions are free to move. ✗
- 3 Iron has a high melting point due to the strong covalent bonds. ✗
- 4 Iron is malleable because the layers of ions can slide over one another. ✓

A 1 and 3

B 1 and 4

C 1 only

D 2, 3 and 4

34. Ethanol is a liquid at room temperature and boils at 78 °C.

Sodium chloride is a solid at room temperature.

Which statement about the bonding in ethanol and sodium chloride is **not** correct?

- A** Each ethanol molecule is held together by weak covalent bonds. ✗
- B The ethanol molecules are held together by weak attractive forces. ✓
- C The sodium ions and chloride ions are held together by strong attractive forces. ✓
- D The sodium ions and chloride ions are held together in a giant lattice. ✓

35. The molecules N_2 , C_2H_4 , CO_2 and CH_3OH all have covalent bonds.

These bonds consist of shared pairs of electrons.

Which row gives the total number of shared pairs of electrons in the molecules shown?

	molecule	total number of shared pairs of electrons
A	N_2	2 X 3
B	C_2H_4 $C=C$	6 ✓
C	CO_2 $O=C=O$	2 X 4
D	CH_3OH $C-O-H$	4 X 5

36. Metals are malleable.

Which statement explains why metals are malleable?

- A Metallic bonding is very strong.
- B Metals are good conductors of electricity.
- C Positive metal ions are arranged in a regular lattice structure.
- D** The layers of positive metal ions can slide over each other.

37. Iron is a metal. The structure of iron is described as a lattice of positive ions in a sea of electrons.

Which of the following statements about iron are correct?

- 1 iron conducts electricity because the electrons are free to move ✓
- 2 iron has a high melting point due to the strong covalent bonds
- 3 iron is an alloy ✗
- 4 iron is malleable because the layers of atoms can slide over one another ✓

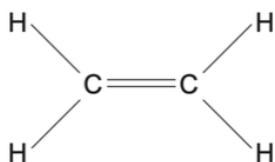
- A 1 only
- B 1 and 3
- C** 1 and 4
- D 2, 3 and 4

38. Which two elements react together to form an ionic compound?

element	electronic structure
R	2,4
T	2,8
X	2,8,1 } 2,8,7 }
Z	2,8,7 }

- A R and T
- B T and X
- C** X and Z
- D Z and R

39. Ethene is an unsaturated hydrocarbon.



Which description of the bonding in ethene is correct?

- A** ~~All atoms~~ in the molecule have a share of eight electrons. H不是
- B** Each carbon atom shares two of its electrons with hydrogen atoms and two of its electrons with a carbon atom.
- C** Each carbon atom shares ~~two~~ of its electrons with hydrogen atoms and one of its electrons with a carbon atom.
- D** The two carbon atoms share a total of ~~six~~ electrons with other atoms.

40. Rescuers are drilling through fallen rock in order to rescue some men trapped in a cave. The drill needs lubricating from time to time.

The following statements were made about the materials used for the drill tip and the lubricant and the reasons for their use.

- 1 Diamond was used for the drill tip as it does not conduct electricity.
- 2 Diamond was used for the drill tip as it is very hard. ✓
- 3 Graphite was used as the lubricant as it conducts electricity.
- 4 Graphite was used as the lubricant as it is soft and flaky. ✓

Which statements are correct?

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

41. Graphite is a form of carbon.

Why can graphite be used as a lubricant?

- A** Graphite contains delocalised electrons which move throughout the structure.
- B** Graphite contains weak covalent bonds so the atoms move easily.
- C** Graphite has a low melting point so it easily turns into a liquid.
- D** Graphite has weak forces of attraction between layers so they can move.

42. In which compounds are pairs of electrons shared between atoms?

- 1 methane ✓
- 2 lead bromide
- 3 sodium chloride

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

43. Diamond and graphite are both macromolecules.

Which statement is **not** correct?

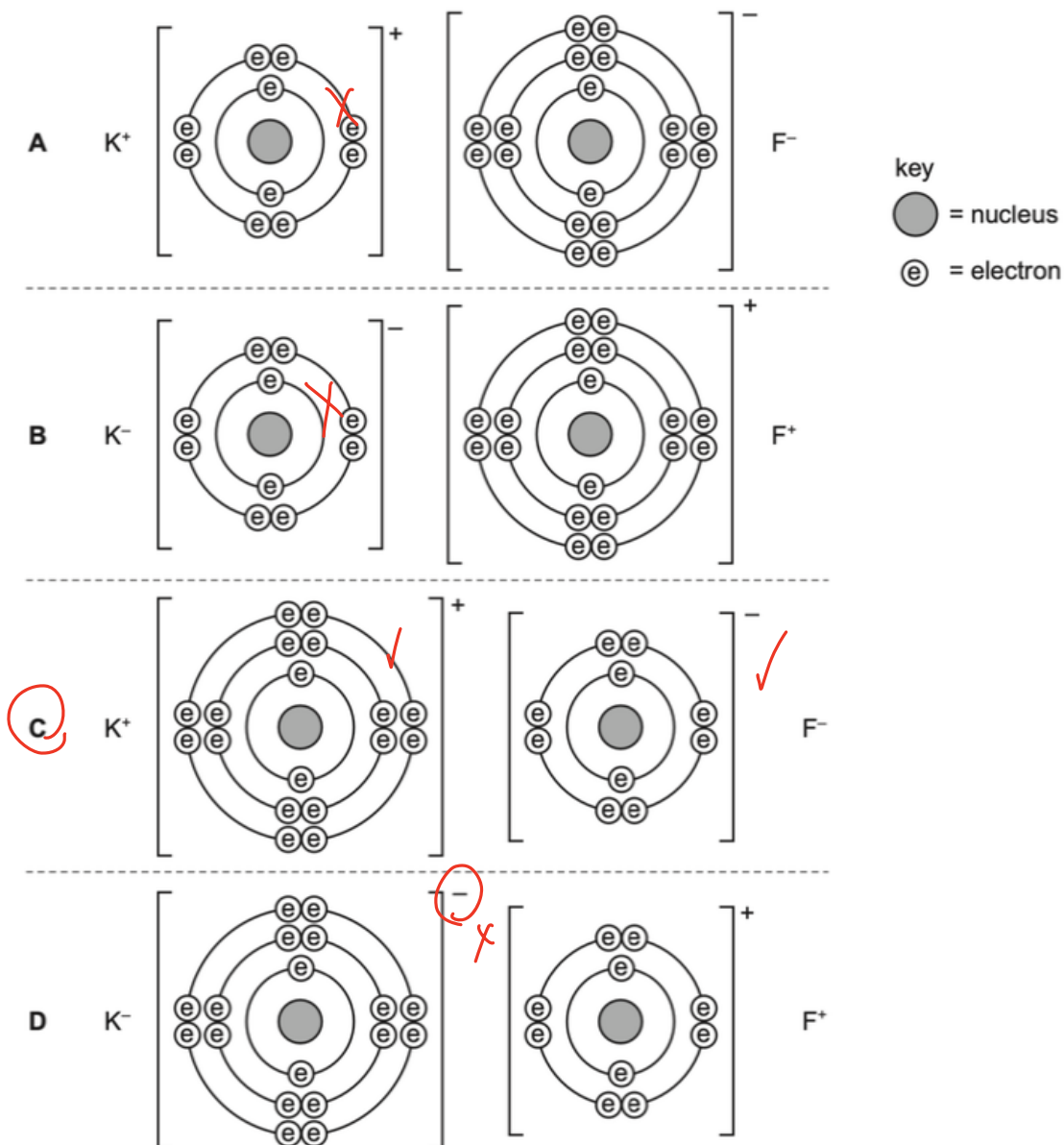
- A Diamond and graphite contain carbon atoms only. ✓
- B** Diamond and graphite contain charged ions. ✗
- C Diamond and graphite have high melting points. ✓
- D The atoms in diamond and graphite are held together by covalent bonds. ✓

44. In which compounds are pairs of electrons shared between atoms?

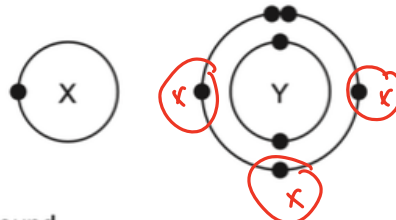
- 1 methane
- 2 lead bromide
- 3 sodium chloride

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

45. Which diagram correctly shows the ions present in the compound potassium fluoride?



46. The electronic structures of atoms X and Y are shown.



X and Y form a covalent compound.

What is its formula?

- A XY_5 B XY_3 C XY **D** X_3Y

X₃Y

47. Two atoms of magnesium, Mg, react with one molecule of oxygen, O_2 .

What is the formula of the product?

- A** MgO B MgO_2 C Mg_2O D Mg_2O_2

48. Compound X melts at $801^\circ C$ and is a good electrical conductor when dissolved in water. *ionic*

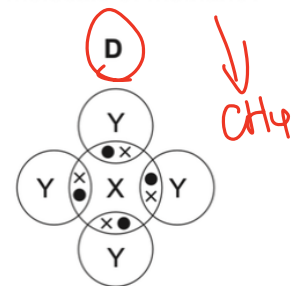
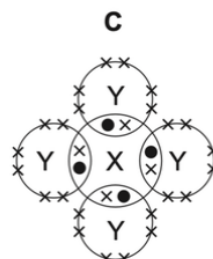
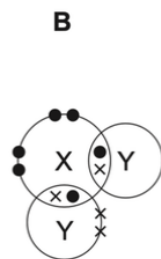
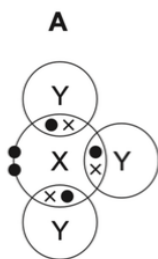
Compound Y boils at $77^\circ C$, is insoluble in water and is a non-conductor of electricity.

Which type of bonding is present in X and in Y?

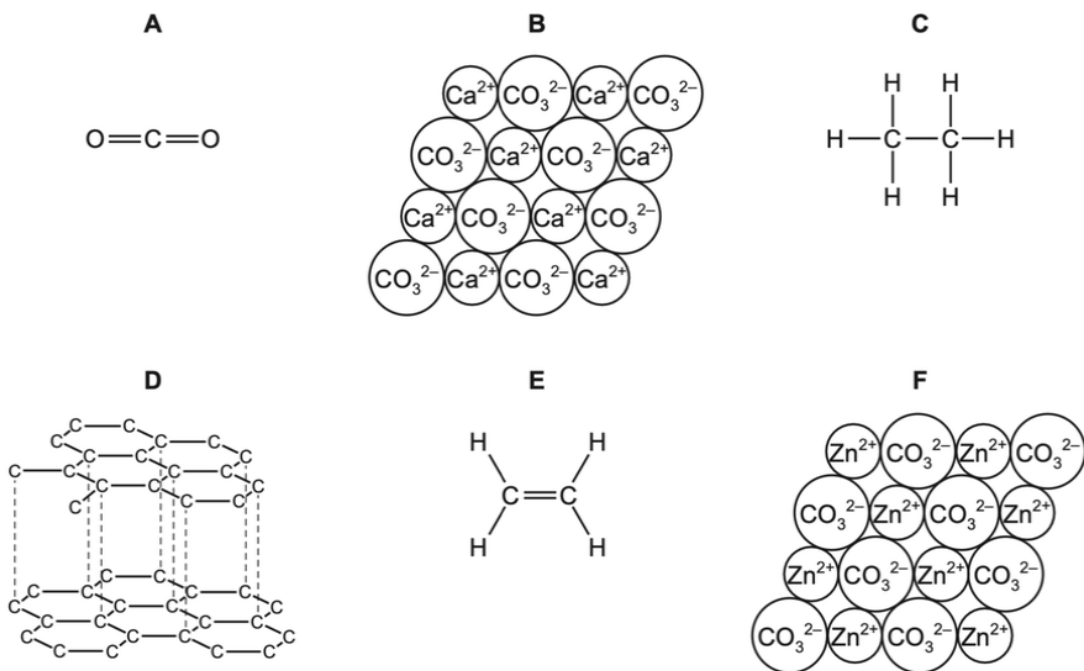
	X	Y
A	covalent	covalent
B	covalent	ionic
C	ionic ✓	covalent ✓
D	ionic ✓	ionic

49. In the following diagrams, X and Y are atoms of different elements.

Which diagram correctly shows the arrangement of outer electrons in a molecule of methane?



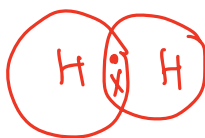
50. The structures of six substances containing carbon are shown below.



Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

- (a) Which substance, **A, B, C, D, E** or **F**,
- | | | |
|--|----------------------|-----|
| (i) is an element, | D | [1] |
| (ii) is a saturated hydrocarbon, | C | [1] |
| (iii) is added to the blast furnace to help in the extraction of iron, | B | [1] |
| (iv) has a giant covalent structure, | D | [1] |
| (v) is a product of respiration, | A | [1] |
| (vi) contains a metal ion with 20 protons? | B | [1] |

(c) (i) Draw a diagram to show the electron arrangement in a molecule of hydrogen.



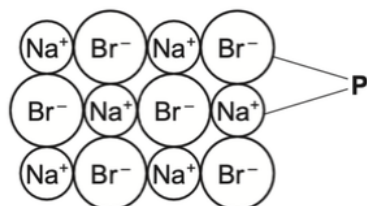
[1]

(ii) What type of bonding is present in a hydrogen molecule?

..... **covalent bonding**

[1]

5). (d) The diagram below shows the arrangement of the particles in sodium bromide at room temperature.



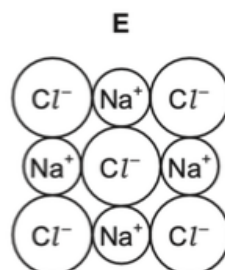
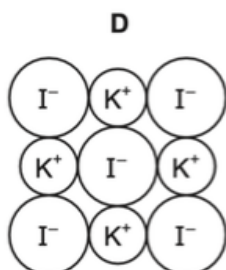
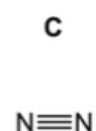
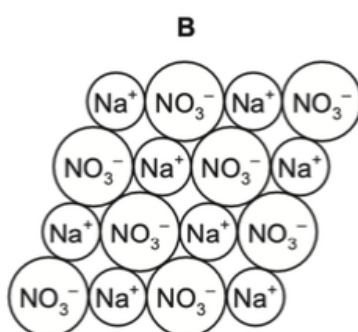
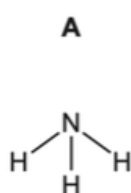
(i) Give the name of the type of particles, **P**, present in sodium bromide.

..... ion [1]

(ii) What is the state of sodium bromide at room temperature?
Use the information in the diagram to explain your answer.

..... solid
..... stronger ionic bonding between Na⁺ and Br⁻
..... high m.p. [2]

52. The structures of five substances are shown below.



Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

- (a) Which substance, **A**, **B**, **C**, **D** or **E**,
- (i) is an element, **C** [1]
 - (ii) turns damp red litmus paper blue, **A** [1]
 - (iii) is a salt which contains atoms of three different elements, **B** [1]
 - (iv) is a compound, whose aqueous solution gives a white precipitate on addition of aqueous silver nitrate, **E** [1]
 - (v) is an ionic compound, whose aqueous solution gives off ammonia when warmed with aluminium powder and aqueous sodium hydroxide? **B** [1]

(b) (i) Give the name of compound **B**.
..... **Sodium nitrate** [1]

(ii) Complete the following sentences about compounds **A** and **E** using words from the list below.

atoms gas giant ions liquid molecular polymer solid

Compound **A** is a **gas** at room temperature. It does not conduct electricity because it has a simple **molecular** structure. Compound **E** does not conduct electricity when it is **solid** because its **ions** cannot move. [4]

[Total: 10]

53. The table shows the melting points, boiling points and electrical properties of five substances, A to E.

substance	melting point /°C	boiling point /°C	electrical conductivity of solid	electrical conductivity of liquid
A	-7	59	poor	poor
B	1083	2567	good	good
C	755	1387	poor	good
D	43	181	poor	poor
E	1607	2227	poor	poor

Choose a substance from the table above to match each of the following descriptions. A substance may be used once, more than once or not at all. Justify each choice with evidence from the table.

One has been completed as an example.

This substance is covalent and is a solid at room temperature (25°C). **D**.....
 evidence *Its melting point is above room temperature. It has a low melting point and it does not conduct as a liquid, so it is covalent.*

(a) This substance has a giant covalent structure. **E**.....
 evidence *high m.p. & b.p. poor electrical conductivity as solid & liquid state* [3]

(b) This substance is a metal. **B**.....
 evidence *high m.p. & b.p. good electrical conductivity as solid & liquid state* [2]

(c) This substance is a liquid at room temperature (25°C). **A**.....
 evidence *m.p. (-7°C) < 25°C < b.p. (59°C)* [3]

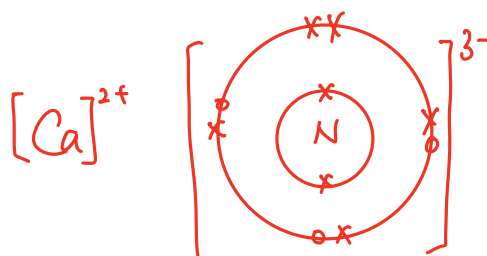
(d) This substance is an ionic solid. **C**.....
 evidence *poor conductivity in solid good .. in liquid* [3]

[Total: 11]

54. Calcium reacts with nitrogen to form the ionic compound calcium nitride, Ca_3N_2 .

- (a) Draw a diagram, based on the correct formula, which shows the charges on the ions and the arrangement of the electrons around the negative ion.

Use o to represent an electron from a calcium atom.
Use x to represent an electron from a nitrogen atom.



[3]

- (b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3:2.

- (i) What is meant by the term *lattice*?

..... alternative cation and anion are arranged regularly

[2]

- (ii) In terms of ionic charges, explain why the ratio of ions is 3:2.

..... for ionic compound, total charge = 0,

..... Ca^{2+} $(2+) \times 3 = 6+$ N^{3-} $(3-) \times 2 = 6-$ just neutralized

[2]

55. Use your copy of the Periodic Table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) aluminium fluoride AlF_3 [1]

(ii) arsenic oxide As_2O_5 [1]

(iii) silicon bromide $SiBr_4$ [1]

(b) Deduce the formula of each of the following ions.

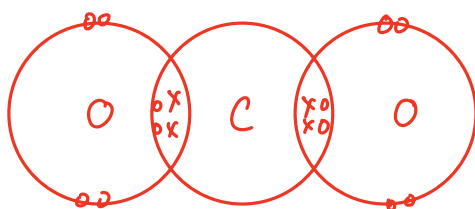
(i) phosphide P^{3-} [1]

(ii) barium Ba^{2+} [1]

(iii) francium Fr^+ [1]

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.

Use x to represent an electron from a carbon atom.
Use o to represent an electron from an oxygen atom.



[3]

56. Carbon and silicon are elements in Group IV. They both form oxides of the type XO_2 .

(a) Silicon(IV) oxide, SiO_2 , has a macromolecular structure.

(i) Describe the structure of silicon(IV) oxide.

giant covalent structure
each silicon is covalently bonded to four Oxygen.
each oxygen is covalently bonded to two silicon.

[3]

(ii) State **three** properties which silicon(IV) oxide and diamond have in common.

high m.p.
hard
cannot conduct electricity

[3]

(b) Explain why the physical properties of carbon dioxide are different from those of diamond and silicon(IV) oxide.

Carbon dioxide is simple molecule.

[1]

57. The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

element	Na	Mg	Al	Si	P	S	Cl	Ar
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4/-4	-3	-2	-1	0
melting point/°C	98	650	660	1414	317	115	-101	-189

- (a) Describe and explain the variation in oxidation state across the period.

..... from positive to negative (positive ↑, negative ↓)
 ↓ metals lose e⁻ nonmetals gain e⁻
 more e⁻ lost ⇒ greater positive charge more e⁻ gained ⇒ greater negative charge [3]

- (b) The first three elements, Na, Mg and Al, are metals.

Describe the structure of a typical metal.

..... giant metallic lattice
 the strong attractive force between the lattice of metal
 cation & sea of delocalized e⁻. [3]

- (c) Explain why Na, Mg and Al are good conductors of electricity.

..... free-moving delocalized e⁻ [1]

- (d) Which element exists as diatomic molecules of the type X₂?

..... Cl [1]

- (e) Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.

..... giant covalent structure
 more energy required to break structure [2]

58. Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

(a) Solid lithium bromide is a poor conductor of electricity. The ions cannot move to the electrodes, they are held in an ionic lattice by strong forces.

(i) Describe the motion of the ions in the solid state.

..... vibration [1]

(ii) Define the term *ionic bonding*.

..... strong attractive force between cation and anion [2]

(iii) What is meant by the term *ionic lattice*?

..... alternative cation and anion are regularly arranged. [2]

59. Carbon dioxide and silicon(IV) oxide are oxides of Group IV elements.

(a) Complete the following table.

	carbon dioxide	silicon(IV) oxide
formula	CO_2	SiO_2
melting point/ $^{\circ}C$	-56	1610
physical state at $25^{\circ}C$	gas	solid
conduction of electricity	non-conductor	non-conductor
structure	simple molecule	macromolecular

(of giant covalent structure) [4]

(b) (i) Name the type of bonds that exist between the atoms in silicon(IV) oxide.

..... covalent bond [1]

(ii) Explain why silicon(IV) oxide has a very high melting point.

..... more energy required to break
..... giant covalent structure [1]

(iii) Explain, in terms of attractive forces between particles, why carbon dioxide has a very low melting point.

..... weak intermolecular force [1]

(iv) Explain, in terms of particles, why carbon dioxide is a non-conductor of electricity.

..... molecules are neutral charge [1]

60. (d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

..... *covalent bonding* [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

..... *high m.p.*
..... *poor electricity conductivity* [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-} .

(i) What is ionic bonding?

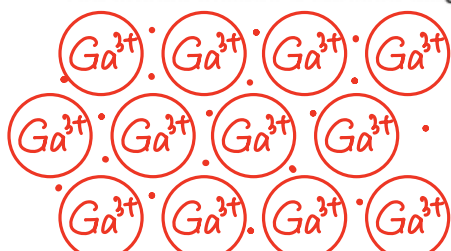
..... *strong attractive force between cation and anion* [2]

(ii) Deduce the formula of calcium phosphate.

..... *$\text{Ca}_3(\text{PO}_4)_2$* [1]

Gallium is a metallic element in Group III. It has similar properties to aluminium.

(a) (i) Describe the structure and bonding in a metallic element. You should include a labelled diagram in your answer.


..... *strong attractive force between*
..... *the lattice of metal cation and sea of delocalized e⁻* [3]

(ii) Explain why metallic elements such as gallium are good conductors of electricity.

..... *free-moving delocalized e⁻* [1]

(b) Give the formula of

gallium(III) chloride, *GaCl_3*

gallium(III) sulfate, *$\text{Ga}_2(\text{SO}_4)_3$* [2]

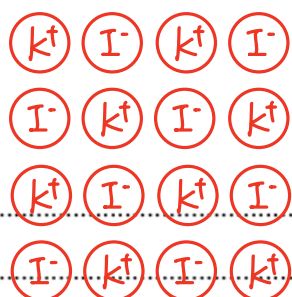
61. (a) Potassium iodide is an ionic compound.

- (i) Describe what happens, in terms of electron loss and gain, when a potassium atom reacts with an iodine atom.

potassium atom loses one electron to form K^+ .
iodine atom gains this electron to form I^- .

[2]

- (ii) Describe the structure of solid potassium iodide. You may draw a diagram.



giant ionic lattice
alternative cation & anion are
arranged regularly

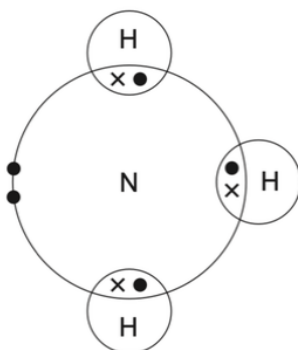
[2]

- (iii) Explain why potassium iodide has a high melting point.

strong ionic bonding between K^+ and I^- .

[2]

62. (c) The diagram shows the electron arrangement in a molecule of ammonia, showing only outer shell electrons.

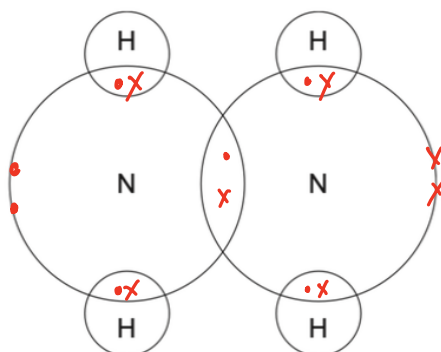


(i) State the type of bonding in ammonia.

..... *covalent bonding* [1]

(ii) Hydrazine, N_2H_4 , is another compound of nitrogen and hydrogen.

Complete the diagram to show the electron arrangement in a molecule of hydrazine, showing only outer shell electrons.



[3]

63. Beryllium is a metallic element in Group II.

(a) Give the electronic structure of a beryllium atom.

..... 2,2 [1]

(b) Give the formula of beryllium oxide.

..... BeO [1]

(c) (i) Describe the bonding in a metallic element such as beryllium. Include a labelled diagram and any appropriate charges in your answer.



.....
a strong attractive force between the lattice of Be^{2+} and the sea of delocalized electrons. [3]

(ii) Explain why metallic elements, such as beryllium, are good conductors of electricity.

..... free-moving delocalized e^- [1]

64. Silicon(IV) oxide and sodium chloride have different types of bonding and structure.

(a) Name the type of bonding present in

silicon(IV) oxide, *covalent bonding*

sodium chloride. *ionic bonding* [2]

(b) Name the type of structure present in silicon(IV) oxide.

..... *giant covalent structure.* [1]

(c) (i) Silicon(IV) oxide has a high melting point. Explain why.

..... *huge amount of energy required to*
..... *break giant covalent structure.* [2]

(ii) Silicon(IV) oxide is a poor conductor of electricity. Explain why.

..... *no free-moving ions or electrons in the structure* [1]

(d) Solid sodium chloride does not conduct electricity. However, it conducts electricity when molten.

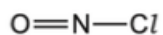
Explain why solid sodium chloride does **not** conduct electricity, whereas molten sodium chloride does conduct electricity.

..... *in solid, all ions are fixed on lattice.*

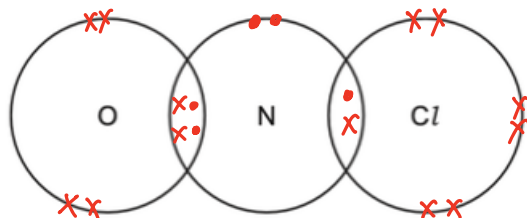
..... *in molten / aq, free-moving ions.*

..... [3]

65. (e) Nitrosyl chloride, NOCl, is a gas at room temperature. It has the structure shown.



- (i) Complete the dot-and-cross diagram to show the arrangement of the outer shell electrons in nitrosyl chloride.



[2]

- (ii) Nitrosyl chloride has a boiling point of -6°C .

Explain why nitrosyl chloride has a low boiling point.

..... weaker intermolecular forces

.....

..... [2]

6b. Magnesium is a metal.

(a) Describe the structure and bonding in magnesium.

lattice structure
metallic bonding is a strong attractive force between
the lattice of Mg^{2+} ions and the sea of delocalised e^- .

[3]

(b) Why can magnesium conduct electricity when solid?

free-moving delocalised e^-

[2]

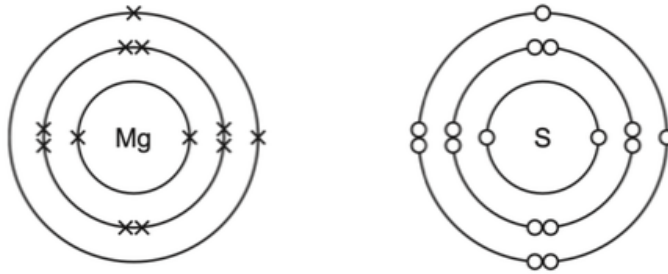
(c) Why is magnesium malleable?

the layers of cation can slide
without breaking metallic bond.

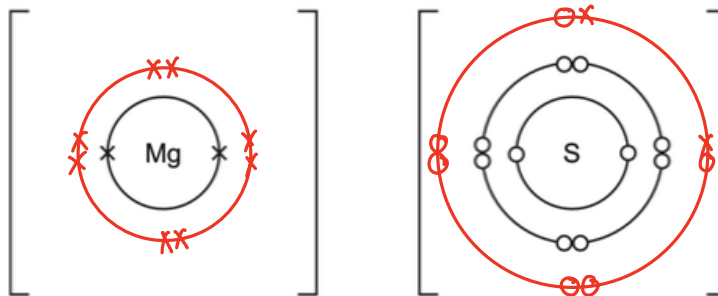
[2]

67. (d) Magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS.

The diagrams show the electronic structures of atoms of magnesium and sulfur.



(i) Complete the diagrams to show the electronic structures of the ions in magnesium sulfide. Show the charges on the ions.



[3]

(ii) Ionic compounds, such as magnesium sulfide, do **not** conduct electricity when solid. Magnesium sulfide does **not** dissolve in water. Magnesium sulfide **does** conduct electricity under certain conditions.

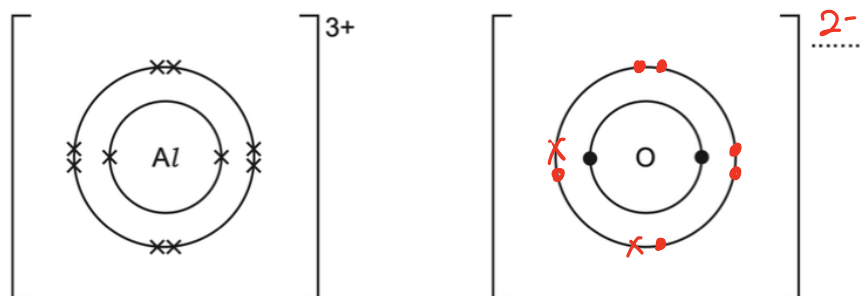
State the conditions needed for magnesium sulfide to conduct electricity. Explain why magnesium sulfide conducts electricity under these conditions.

..... molten state or aqueous solution
 free-moving ions

[2]

68.(b) Aluminium oxide is an ionic compound with a high melting point.

- (i) Complete the dot-and-cross diagram to show the electron arrangement in **one** of the oxide ions present in aluminium oxide. Include the charge on the oxide ion. One of the aluminium ions is shown.



[2]

- (ii) The melting point of aluminium oxide is above 2000 °C.

Explain why aluminium oxide has a high melting point.

..... strong ionic bonding between Al^{3+} and O^{2-}

.....

..... [2]

69. (a) Complete the table to show the electronic structure of the atoms and ions.

	electronic structure
F	2,7
Si	2, 8, 4
Ca ²⁺	2, 8, 8
N ³⁻	2, 8

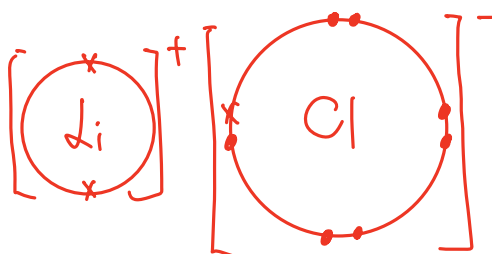
[3]

(b) Predict the formula of the compound formed between Ca²⁺ and N³⁻.

..... Ca₃N₂ [1]

(c) Draw a dot-and-cross diagram to show the electron arrangements in the **two** ions present in lithium chloride, LiCl.

Show outer shell electrons only. Include the charges on the ions.

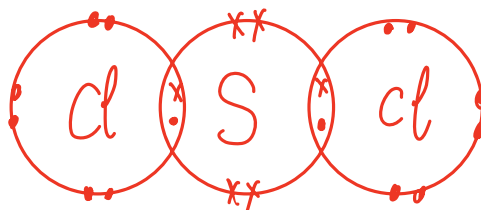


[3]

(d) Sulfur dichloride, SCl₂, is a covalent compound. It has the structure Cl-S-Cl.

Draw a dot-and-cross diagram to show the electron arrangement in a molecule of sulfur dichloride.

Show outer shell electrons only.



[3]

(e) In terms of attractive forces, explain why LiCl has a higher melting point than SCl₂.

LiCl has stronger ionic bonding between Li⁺ and Cl⁻.

SCl₂ has weak intermolecular force.

..... [3]

(f) Suggest the identity of a **covalent compound** with a higher melting point than LiCl

SiO₂ (giant covalent structure) [1]