EXAM PAPERS PRACTICE

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Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Level: CIE AS and A Level (9701)
Subject: Chemistry
Topic: CIE Chemistry
Type: Mark Scheme

Chemistry CIE AS & A Level
To be used for all exam preparation for 2025+

CHEMISTRY AS and A

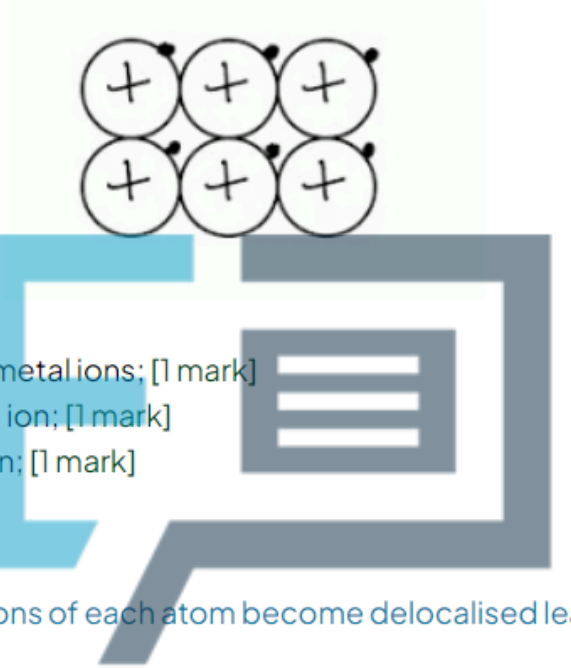
This to be used by all students studying CIE AS and A level Chemistry (9701) But students of other boards may find it useful

EXAM PAPERS PRACTICE

Mark Scheme

Answer 1.

a) A labelled diagram to show the arrangement of particles in a crystal of sodium is below:



- A regular arrangement of metal ions; [1 mark]
- + sign drawn in each metal ion; [1 mark]
- At least six electrons drawn; [1 mark]

[Total: 3 marks]

- In a metal the outer electrons of each atom become delocalised leaving them to form ions with a positive charge
- You therefore **must** show the positive charge in each ion
- The question specifically states to draw six ions, so if you have drawn less you will not score marking point 1
- Make sure you draw the ions in a regular arrangement to show that the ions can slide over each other with ease
- The electrons do not need to have a negative charge for you to score the mark

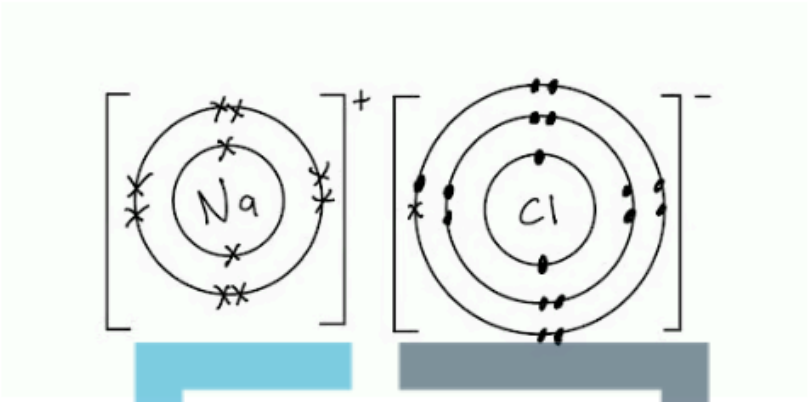
b) The definition of ionic bonding is:

- Electrostatic attraction between oppositely charged ions (in a lattice); [1 mark]

[Total: 1 mark]

- The metal loses electrons to form positively charged ions (cations)
- The non-metal gains electrons to form negatively charged ions (anions)
- The opposite charges are strongly attracted

c) The ions formed by sodium chloride are:



- Electronic configuration of sodium is 2,8
  AND
  Ion has a single positive charge; [1 mark]
- Electronic configuration of chloride ion is 2,8,8
  AND
  Ion has a single negative charge; [1 mark]

[Total: 2 marks]

- You must show all the electrons in ionic dot and cross diagrams
- **Remember:** Sodium will lose its outer electron to achieve a full outer shell
- It has one more proton than electron overall so the ion has a single positive charge
- Chlorine gains the one electron, meaning the chloride ion has one more electron than proton and therefore has a single negative charge
- It is good practice to use dots for electrons in one ion and the other with crosses however you would score the mark if you have done either as long as the number of them is correct

Answer 2.

a) The ions are held together in lithium and lithium chloride by:

- (Electrostatic) attraction / electrostatic forces between positive metal / lithium ions / Li^+ and (the sea of) delocalised electrons ; [1 mark]
- Electrostatic attraction / electrostatic forces between oppositely charged ions / Li^+ and Cl^-

  OR

  Electrostatic attraction / electrostatic forces between positive & negative ions; [1 mark]

[Total: 2 marks]

- This should be a straight forward question to answer as it covered at GCSE
- Correctly drawn diagrams would also score the marks
- The idea of attraction between ions with opposite charges must be clear

b) Explaining what can be deduced from the information in Table 4.1:

- The melting and boiling points of lithium chloride are higher than lithium
  OR
  The melting and boiling points of lithium are lower than lithium chloride
  OR
  The melting and boiling points of an ionic substance are higher than a metal

  OR

  The melting and boiling points of a metal are lower than an ionic substance; [1 mark]
- (Because) Ionic bonds (in lithium chloride) are stronger than metallic bonds (in lithium)
  OR
  Ionic bonds (or bonding) require more energy to break than metallic bonds
  OR
  Electrostatic attraction between oppositely charged ions (in lithium chloride) is stronger than electrostatic attraction between positive ions and delocalised electrons (in lithium metal); [1 mark]

[Total: 2 marks]

- Ionic bonds are stronger than metallic bonds and you are expected to know this for the exam
- In this question you have been asked to use the table, so you **must** use the table in your answer
- The more marks a question is worth, the more you will have to use the data and explain your answer in detail

c) State and explain whether Student A, Student B, or neither student is correct:

- Both Student **A** and Student **B** are incorrect (neither student is correct)
  OR
  Student B is incorrect and Student A is partly correct; [1 mark]
- Lithium will conduct electricity (at all times); [1 mark]
- Lithium has delocalised electrons which can flow through the (metal) structure and carry the charge / carrying the current; [1 mark]
- Lithium chloride will conduct electricity when molten / dissolved in solution, but will not conduct electricity when solid; [1 mark]
- When solid the (negative) ions are fixed in position and cannot move
  AND
  When molten / dissolved in solution the (negative) ions are mobile and can move, carrying the charge / carrying current ; [1 mark]

[Total: 5 marks]

- For a substance to conduct electricity, there must be a flow of negative charge
  - I.e., a flow of electrons or a flow of negative ions
- A metal has delocalised electrons which can flow at all times; this is why metals conduct electricity
- Ionic solids will only conduct electricity when **molten/dissolved** in solution
  - When solid, the ions are fixed in their position and cannot move, so the negative ions cannot flow
  - No movement of negative ions means no electrical conductivity
  - When molten/dissolved in solution the ions have been 'pulled apart' from their solid structure, and they are mobile (they can freely move around)
  - Because the ions are now able to flow, electricity can also flow

d) Explain, in terms of electrons, how CaF_2 is formed from its atoms:

- One calcium atom loses two electrons; [1 mark]
- Two fluorine atoms each gain one electron; [1 mark]
- Forming one calcium ion / one Ca^{2+} and two fluoride ions / two F^-; [1 mark]

[Total: 3 marks]

- This question is worth 3 marks, so it is reasonable to deduce that you will score one mark for describing the loss / gain of electrons for each atom and the third for describing the ions produced
- Calcium is in Group 2 so will lose two electrons to gain a full outer shell and form a positively charged ion
- The formula tells you that there are two fluoride ions present, each of which will gain one electron to form a negatively charged ion

Answer 3.

a) The term ionic bonding refers to:

- The strong force of attraction; [1 mark]
- Between + and – ions / oppositely charged ions; [1 mark]

[Total: 2 marks]

- You need to know this standard definition
  - An ionic bond is the strong electrostatic force of attraction between oppositely charged ions
  - Using the word particles instead of ions will sometimes get the second mark but this is not guaranteed

b) The information in which shows lithium bromide is an ionic compound is:

- Does not conduct electricity when solid but conducts when molten; [1 mark]
- Higher boiling point; [1 mark]

[Total: 2 marks]

- Ionic compounds cannot conduct electricity when they are solid as the ions are not able to move
  - Ionic compounds can conduct electricity when they are melted / molten or dissolved as the ions can now move
- The boiling point of ionic compounds is high as the strong (electrostatic) forces of attraction require a large amount of energy to overcome

c) A reason for the difference in solubility in organic solvents:

- The lithium ion is small and highly charged; [1 mark]
- Bromide ion is polarised; [1 mark]
- Therefore lithium bromide has covalent character; [1 mark]
- Potassium fluoride does not have covalent character / potassium ion does not polarise the fluoride ion; [1 mark]

[Total: 4 marks]

- The lithium ion is small compared to the potassium ion
- They also have the same charge
- Therefore the lithium ion can pull electron density from the large bromide ion towards itself and this creates covalent character which means it can interact with the organic solvent
- Any fully ionic compound can not interact with the organic solvent

Answer 4.

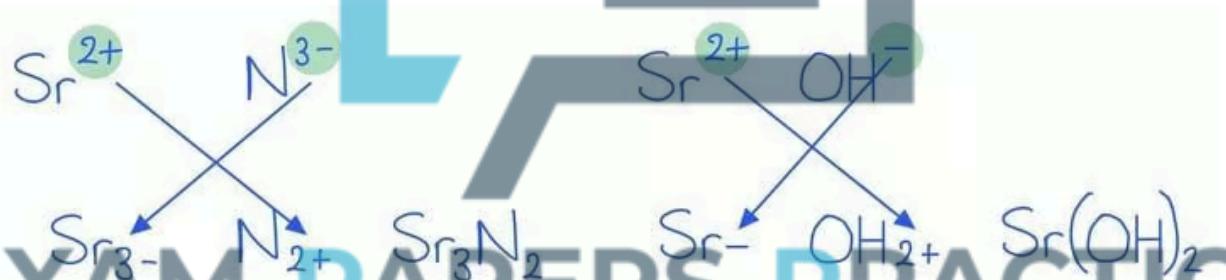
a) The balanced symbol equation is:

$$Sr_3N_2 + 6H_2O \rightarrow 3Sr(OH)_2 + 2NH_3$$

- Correct formula; [1 mark]
- Correct balancing; [1 mark]

[Total: 2 marks]

- For this question, you need to write the formulas for the ionic compounds and then balance the equation
- You can use the swap and drop method to help you do this:
  - Just make sure you remove the + and - charge in the final formula and include brackets if required



b)

i) The melting point is high because:

- Strong electrostatic forces of attraction between oppositely charged ions require a large amount of energy to overcome; [1 mark]

ii) Strontium nitride will act as a conductor when it is:

- Molten / liquid; [1 mark]
- Solution / aqueous; [1 mark]

Explanation:

- Ions are able to move when a potential difference is applied; [1 mark]

[Total: 4 marks]

- Make sure you know why ionic compounds generally have a high melting point as this is a common question
- Ionic compounds only conduct electricity when molten or in solution
  - When molten or in solution, the ions can freely move around and conduct electricity
  - As a solid, the ions are in a fixed position and unable to move around

c) The melting points are different because:

- Magnesium / Mg is a smaller ion than strontium / Sr; [1 mark]
- Electrostatic forces of attraction stronger between Mg^{2+} and N^{3-} ions than Sr^{2+} and N^{3-} ions; [1 mark]

[Total: 2 marks]

- Melting and boiling points increase with the charge density of the ions due to the greater electrostatic attraction of charges
- The ions can get closer together so it will take more energy to separate them