Topic C1 — Atomic Structure and the Periodic Table

Pages 34-36— Atoms, Elements, Compounds and Mixtures

1.1 Relative atomic mass (A_r)
= (sum of (isotope abundance × isotope mass number)) ÷ sum of abundances of all the isotopes
= ((24 × 79) + (25 × 10) + (26 × 11)) ÷ (79 + 10 + 11)
= 2432 ÷ 100 = 24.32 = **24.3** to 1 d.p.
[1 mark for correct values from x-axis, 1 mark for correct values from y-axis, 1 mark for correct calculation, 1 mark for correct answer to one decimal place]
Name = magnesium ***[1 mark]***

1.2 X = Mg, which has 12 electrons. In $MgCl_2$, Mg exists as the ion Mg^{2+}, which has 12 – 2 = 10 electrons ***[1 mark]***.
So electronic structure = 2, 8 ***[1 mark]***

1.3 1.5×10^2 m ***[1 mark]***

1.5 cm = 0.015 m. The radius of the nucleus is about 1/10 000 of the atom's radius. So the atom's radius = 0.015 × 10 000 = 1.5×10^2 m.

2 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: A brief description of both atomic models is given. There is little discussion of the experimental results, or why the model changed. ***[1 to 2 marks]***

Level 2: The models are clearly described. The experimental results, and why the model changed, are discussed but some detail is missing. ***[3 to 4 marks]***

Level 3: Both atomic models, and the expected results based on the previous model, are clearly described. The reason for why the model was changed is coherent and refers clearly to the role of evidence. ***[5 to 6 marks]***

Here are some points your answer may include:

Atomic models

The previous model was the plum pudding model — this had a ball of positive charge with electrons embedded throughout.
The updated model was the (Rutherford) nuclear model — it had a positive nucleus at the centre, and electrons orbiting the nucleus.

Change of models

Data/evidence from experiments did not fit the plum pudding model.
Plum pudding model was rejected as it didn't explain the new data/evidence.
The nuclear model was developed, which explained all the known data/evidence (at the time).

Expected results

It was observed that most alpha particles passed straight through the gold sheet, a few were deflected by small angles and a very small amount were deflected by very large angles.
This didn't fit the plum pudding model, which predicted that the alpha particles should pass through the gold sheet or be slightly deflected at most.
No deflection was expected because, within the plum pudding model, positive charge is evenly distributed.
The nuclear model could explain the results from 1911.
It proposed that positive charge is concentrated in a very small volume, so most alpha particles don't pass near the nuclei and aren't deflected. A few pass close enough to be deflected. A very small amount approach the nucleus almost head-on and their trajectory is reversed (they are deflected backwards).
This nuclear model fitted the observed behaviour.
A suitably annotated diagram can be credited in this section.

3.1 Relative formula mass = (3 × 40) + (2 × 31) + (8 × 16) ***[1 mark]*** = **310** ***[1 mark]***

3.2 $6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$ ***[1 mark for CaO formula, 1 mark for correct balancing]***

4.1 Technique 1: Filtration ***[1 mark]***
Explanation: Copper sulfate will dissolve in the water, silicon dioxide won't. Filtering separates the silicon dioxide from the solution ***[1 mark]***.
Technique 2: Crystallisation ***[1 mark]***
Explanation: Crystals of copper sulfate will form as water evaporates ***[1 mark]***.

4.2 The boiling points are too close together for simple distillation to be used ***[1 mark]***. Fractional distillation allows substances with close boiling points to be separated ***[1 mark]*** because it provides a temperature gradient/is hot at the bottom and cool at the top ***[1 mark]***, so only substances with a specific boiling point can reach the top (and be separated off) without condensing and running back into the flask ***[1 mark]***.

4.3 Chromatography ***[1 mark]***. Unlike distillation, this doesn't involve heating the mixture which would lead to unwanted reactions ***[1 mark]***.

Pages 37-40 — Groups and the Periodic Table

1.1 E.g. Mendeleev produced a model that explained the known data ***[1 mark]***. Mendeleev made predictions based on the model ***[1 mark]***. Experiments verified his predictions ***[1 mark]*** allowing his model to be accepted ***[1 mark]***.

You'll also get marks if you've discussed peer review in your answer.

1.2 The electronic structure of aluminium is 2, 8, 3 ***[1 mark]***.
The number of shells is equal to the period number/three occupied electron shells/energy levels means aluminium is in the third period ***[1 mark]***. The number of electrons in the outer shell is equal to the group number/three electrons in the outer shell means aluminium is in the third group ***[1 mark]***.

1.3 Caesium chloride ***[1 mark]***
Caesium is more reactive than sodium ***[1 mark]*** and chlorine is more reactive than iodine ***[1 mark]*** so the reaction between them would give out the most heat ***[1 mark]***.

2.1 Prediction: simple molecular (diatomic) covalent molecules ***[1 mark]***.
Explanation: astatine atoms have 7 electrons in their outer shell/energy level ***[1 mark]*** so form one single covalent bond ***[1 mark]***.

2.2 NaAt ***[1 mark]***. Sodium forms 1+ ions and astatine forms 1– ions when they react ***[1 mark]***.

2.3 There will be no reaction ***[1 mark]***. Astatine is less reactive than chlorine, so cannot displace chloride from a salt solution ***[1 mark]***.

2.4 The outer shell/energy level of rubidium atoms is far from the nucleus so the electrons are weakly held ***[1 mark]***.
Therefore little energy is required to remove the electrons, and so the element is highly reactive ***[1 mark]***.
The outer shell/energy level of iodine atoms is far from the nucleus ***[1 mark]*** and so there is little attractive force to gain electrons, hence low reactivity ***[1 mark]***.

2.5 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of the similarities and differences between the reactions of lithium and potassium with water, but no explanation of these observations. ***[1 to 2 marks]***

Level 2: There is a detailed comparison of the similarities and differences between the reactions of lithium and potassium with water, and some explanation of the observations. ***[3 to 4 marks]***

Level 3: There is a detailed comparison of the similarities and differences between the reactions of lithium and potassium with water, and a good explanation of the observations. ***[5 to 6 marks]***

Here are some points your answer may include:
A vigorous reaction would be observed with both metals.
Both metals will float/fizz on the surface of the water, because they are less dense than water.
The reaction between potassium and water would be more vigorous than the reaction between lithium and water.
Both metals produce hydrogen in a reaction with water, so bubbles would be observed.
Both metals also produce a hydroxide (lithium hydroxide and potassium hydroxide).
They both have one electron in the outer electron shell/energy level.
The outer shell/energy level of potassium atoms is further from the nucleus than in lithium, so is more easily lost.
Therefore potassium is more reactive and produces more bubbles.
The reaction with potassium gives out more energy (to the extent that potassium and hydrogen can ignite/catch fire).

3.1 Iodine forms an ionic compound with sodium ***[1 mark]***. Iodine forms a covalent compound with chlorine ***[1 mark]***.

3.2 The solution would become darker ***[1 mark]*** because iodine would be produced ***[1 mark]*** as chlorine displaces iodine from solution ***[1 mark]***.

More reactive halogens can displace less reactive halogens from their salts.

4.1 Any value from –185 °C to –109 °C ***[1 mark]***.
Down Group 0 the size of the atoms/number of electrons increases ***[1 mark]*** so the strength of the intermolecular forces increases ***[1 mark]*** and therefore more energy is required to separate the atoms ***[1 mark]***. Krypton is between argon and xenon in size, so has a higher boiling point than argon, but a lower boiling point than xenon ***[1 mark]***.

4.2 Until 1962, Group 0 elements were considered unreactive due to the full outer electron shell/energy level ***[1 mark]***. The experiments provided new evidence that the existing theory couldn't explain ***[1 mark]*** therefore the theory was modified to include the new data ***[1 mark]***.

5.1 $Cl_{2(g)} + H_{2(g)} \rightarrow 2HCl_{(g)}$
[1 mark for state symbols, 1 mark for balancing equation.]

5.2 When halogens react, electrons are gained in the outer electron shell ***[1 mark]***. The further the outer shell is from the nucleus, the less strongly electrons are attracted ***[1 mark]***. Iodine atoms are bigger than chlorine atoms/have a larger atomic radius/the outer shell of iodine is further from the nucleus than chlorine ***[1 mark]***. Therefore iodine is less reactive than chlorine ***[1 mark]***.

5.3 A purple vapour will form over the solution ***[1 mark]*** as iodine evaporates ***[1 mark]***. Purple/grey crystals will form on the lid ***[1 mark]*** as iodine crystallises/solidifies/deposits ***[1 mark]***.

6 Fluorine exists as a simple covalent molecule ***[1 mark]*** in which two fluorine atoms are covalently bonded/share two electrons in order to complete their outer shells ***[1 mark]***. When fluorine reacts with a Group 1 element, an ionic compound is formed ***[1 mark]***. This is because the Group 1 atoms easily donate their outer electrons to become positively charged/1+ ions, and the fluorine atoms easily accept the electrons to become negatively charged fluorine/fluoride/F^- ions ***[1 mark]***.

Topic C2 — Bonding, Structure ar
Properties of Matter

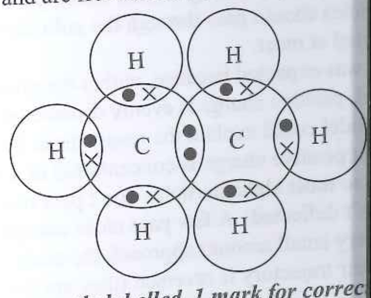
Pages 41-44 — Types of Bonding

1 How to grade your answer:
Level 0: There is no relevant informatio
Level 1: There is a brief description of t and some of the properties of tl ***[1 to 2 marks]***
Level 2: There is some comparison of tl and properties of both substanc attempt to explain how the stru the properties of the materials, are missing or lacking in detail
Level 3: There is a clear and detailed c the structures and properties o The properties of both substan described in detail, with a clea how the structures relate to th ***[5 to 6 marks]***

Here are some points your answer may inc
Both are giant structures.
Graphite consists of hexagonal layers, wit between atoms within the layers. There a between the layers.
Metals consist of layers of metal atoms/io arrangement.
Both conduct electricity.
Both conduct thermal energy.
In graphite, each carbon atom has one de which is free to move and carry charge/tr energy.
In metals, the outer electrons from each a and free to move through the structure a transfer thermal energy.
Both have high melting and boiling poin
Graphite has many strong covalent bond energy to break.
Metals have strong metallic bonds that r to break.
Graphite is soft and slippery. This is be between the layers means that the layers other.
Metals are malleable (and ductile). Thi of atoms/ions can slide over each other.

2 Solid: the light bulb won't light up *[1 m* in a solid ionic compound, the ions are conduct electricity ***[1 mark]***.
Liquid: the light bulb will light up *[1 m* in a liquid ionic compound, the ions ar carry an electric charge ***[1 mark]***.
Aqueous: the light bulb will light up *[1* because, in solution, the ions from the and are free to move and carry an elec

3.1



correctly labelled, 1 mark for correc

3.2 E.g. ethane is a smaller molecule tha carbon atoms ***[1 mark]***, so the interm ethane molecules will be weaker *[1* energy is required to overcome them