Exam Papers Practice

2.1 Atomic & Electronic Structure

Mark Schemes

Course	DP IB Chemistry
Section	2. Atomic Structure
Topic	2.1 Atomic & Electronic Structure
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

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The correct answer is **A** because:

- The **atomic number** of sodium is 11, so it has **11** protons
- Its **mass number** is 23, so it has 23 - 11 = **12** neutrons
- The Na^+ ion has a single **positive charge** meaning it has **lost** an electron, so it has 11 - 1 = **10** electrons

B is incorrect as ^{27}Al is an atom and therefore has the same number of protons and electrons, in this case, 13

C is incorrect as $^{19}F^-$ has 10 electrons and 10 neutrons

D is incorrect as $^{32}S^{2-}$ has 16 neutrons and 16 protons

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The correct answer is **B** because:

- Atoms are **electrically neutral** as the overall negative charge produced by the electrons is cancelled by the overall positive charge produced by the protons
- Since there are equal numbers of protons and electrons, then these particles must have an **equal** but **opposite** charge

A is incorrect as the difference in mass does not affect the charge

C is incorrect as neutrons are electrically neutral

D is incorrect as the position of each particle is irrelevant as long as they are part of the same atom

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The correct answer is **C** because:

- The bulk of the mass is concentrated **within** the nucleus which holds the protons and neutrons
- The negatively charged electrons are **outside** the nucleus moving around in shells

A, **B** & **D** are incorrect as statements 2 and 3 are correct. Statement 1 is incorrect as the electrons are moving in their respective shells which spreads the negative charge around the outside of the nucleus

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The correct answer is **D** because:

- The electronic configuration of chromium is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$
- There are 5 unpaired 3d electrons and 1 4s electron, giving a total of 6 unpaired electrons as shown in the electron box notation for chromium

A is incorrect as sulfur has 2 unpaired electrons in the 3p subshell:

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

B is incorrect as iron has 4 unpaired electrons in the 3d subshell:

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$

C is incorrect as carbon has 2 unpaired electrons in the 2p subshell: $1s^2\ 2s^2\ 2p^2$

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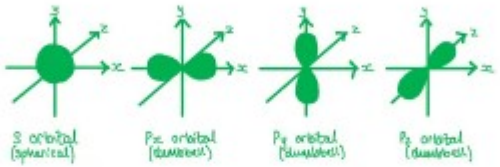
The correct answer is **D** because:

- The s orbital is **spherical** in shape and the p orbitals are **dumbbell-shaped**
- The p_x lies along the x-axis and the p_y lies along the y-axis



A, **B** & **C** are incorrect as these options do not correctly label each orbital.

You are required to know the shapes of s and p orbitals, but not d orbitals

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The correct answer is **B** because:

- With an **atomic number** (the number of protons) of 17, the element is chlorine
- In atoms, the number of protons equals the number of electrons
- The chloride ion, Cl^-, has a **single negative charge** and therefore has one more electron than the chlorine atom = **18 electrons**
- It's electronic configuration is thus the same as argon which is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

A, **C** & **D** are incorrect as these options do not provide the correct electronic configuration of the chloride ion

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The correct answer is **D** because:

- The electronic configuration of vanadium is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^3$
- The energy of each successive orbital is **higher** than the previous one
- Therefore in order of decreasing energy, the notation is written in reverse order which matches option **D**

Remember:

- The energy level of the "d" orbital is between the "s" and "p" orbitals of the next shell
- Therefore in **increasing** energy, it would be 4s, 3d, 4p
- Electrons fill orbitals with lower energy first, therefore the 3d subshell will be filled before the 4p
- **d** orbitals can hold up to **10 electrons**

A is incorrect as it places the orbitals in order of increasing energy

B & C are incorrect as the sequence does not place the orbitals in the correct order

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The correct answer is **A** because:

- The atomic number is 27 hence there are 27 protons in the nucleus so the relative charge of the nucleus is +27 as each proton has a +1 charge
- There are 60 - 27 = **33 neutrons**

B & **D** are incorrect as isotopes of the same element have the same number of protons but different numbers of neutrons

C is incorrect as statement 1 is also true

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The correct answer is **A** because:

- Relative atomic mass reflects the abundance and mass of the all the isotopes
- The spectrum shows the abundance of the isotope ^{70}X is greater than the abundance of the ^{72}X, so the average atomic mass must be below 71, but above 70

Answer **B** is incorrect as atoms are converted into **cations** before they are separated in the **mass spectrometer**

Answer **C** is incorrect as the most abundant isotope (which has the tallest peak) has mass 71, but that mass consists of neutrons and protons

Answer **D** is incorrect as the deflection of particles is related to their mass; smaller light particles are deflected more, so ^{72}X will be deflected the least

10

The correct answer is **B** because:

- The **atomic number** of Mg is 12, so the number protons is 12
- The number of neutrons in $^{26}Mg^{2+}$ must be 26–12 =14 neutrons
- The +2 charge means that the particle has lost two electrons
- The number of electrons is the same as the number of protons in a neutral atom
- The number of electrons is 12–2 = 10 electrons
- So there are 12 protons, 14 neutrons and 10 electrons

Remember to subtract electrons for positive ions and add electrons for negative ions