**Topic 2: Atomic structure (4 hours)**

## 2.1 The atom

**1 hour**

**TOK:** What is the significance of the model of the atom in the different areas of knowledge? Are the models and theories that scientists create accurate descriptions of the natural world, or are they primarily useful interpretations for prediction, explanation and control of the natural world?

| | Assessment statement | Obj | Teacher's notes |
|---|---|---|---|
| 2.1.1 | State the position of protons, neutrons and electrons in the atom. | 1 | **TOK:** None of these particles can be (or will be) directly observed. Which ways of knowing do we use to interpret indirect evidence gained through the use of technology? Do we believe or know of their existence? |
| 2.1.2 | State the relative masses and relative charges of protons, neutrons and electrons. | 1 | The accepted values are:<br>rel. mass / rel. charge<br>proton: 1, +1<br>neutron: 1, 0<br>electron: $5\times10^{-4}$, –1 |
| 2.1.3 | Define the terms *mass number* (*A*), *atomic number* (*Z*) and *isotopes of an element.* | 1 | |
| 2.1.4 | Deduce the symbol for an isotope given its mass number and atomic number. | 3 | The following notation should be used: ${}^{A}_{Z}X$, for example, ${}^{12}_{6}C$. |
| 2.1.5 | Calculate the number of protons, neutrons and electrons in atoms and ions from the mass number, atomic number and charge. | 2 | |
| 2.1.6 | Compare the properties of the isotopes of an element. | 3 | |
| 2.1.7 | Discuss the uses of radioisotopes | 3 | Examples should include $^{14}C$ in radiocarbon dating, $^{60}Co$ in radiotherapy, and $^{131}I$ and $^{125}I$ as medical tracers.<br>**Aim 8:** Students should be aware of the dangers to living things of radioisotopes but also justify their usefulness with the examples above. |

## 2.2 The mass spectrometer

**1 hour**

| | Assessment statement | Obj | Teacher's notes |
|---|---|---|---|
| 2.2.1 | Describe and explain the operation of a mass spectrometer. | 3 | A simple diagram of a single beam mass spectrometer is required. The following stages of operation should be considered: vaporization, ionization, acceleration, deflection and detection. **Aim 7:** Simulations can be used to illustrate the operation of a mass spectrometer. |
| 2.2.2 | Describe how the mass spectrometer may be used to determine relative atomic mass using the $^{12}C$ scale. | 2 | |
| 2.2.3 | Calculate non-integer relative atomic masses and abundance of isotopes from given data. | 2 | |

## 2.3 Electron arrangement

**2 hours**

| | Assessment statement | Obj | Teacher's notes |
|---|---|---|---|
| 2.3.1 | Describe the electromagnetic spectrum. | 2 | Students should be able to identify the ultraviolet, visible and infrared regions, and to describe the variation in wavelength, frequency and energy across the spectrum. **TOK:** Infrared and ultraviolet spectroscopy are dependent on technology for their existence. What are the knowledge implications of this? |
| 2.3.2 | Distinguish between a *continuous spectrum* and a *line spectrum*. | 2 | |
| 2.3.3 | Explain how the lines in the emission spectrum of hydrogen are related to electron energy levels. | 3 | Students should be able to draw an energy level diagram, show transitions between different energy levels and recognize that the lines in a line spectrum are directly related to these differences. An understanding of convergence is expected. Series should be considered in the ultraviolet, visible and infrared regions of the spectrum. Calculations, knowledge of quantum numbers and historical references will not be assessed. **Aim 7:** Interactive simulations modelling the behaviour of electrons in the hydrogen atom can be used. |
| 2.3.4 | Deduce the electron | 3 | For example, 2.8.7 or 2,8,7 for $Z = 17$. |

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| | arrangement for atoms and ions up to $Z = 20$. | | **TOK:** In drawing an atom, we have an image of an invisible world. Which ways of knowing allow us access to the microscopic world? |