2.1/2.2 Sub-atomic particles and structure of an atom

Understandings:

Atoms contain a positively charged dense nucleus composed of protons and neutrons (nucleons). Negatively charged electrons occupy the space outside the nucleus.

The main energy level or shell is given an integer number, *n*, and can hold a maximum number of electrons, $2n^2$, up to n = 4, where it remains at 32 for all following values of n.

A more detailed model of the atom describes the division of the main energy level into s, p, d and f sub-levels of successively higher energies.

Summary:

Protons and Neutrons are located in the nucleus of an atom, while electrons surround the nucleus in energy levels. Each energy level can hold a number of electrons equal to $2n^2$, where n is the energy level.

2.1 Atomic number and mass number

Applications and skills: Use of the nuclear symbol notation to deduce the number of protons, neutrons and electrons in atoms and ions.

Summary: Atomic number is equal to the number of protons. The mass number is equal to the number of protons plus the number of neutrons. The number of electrons is equal to the atomic number minus the charge.

2.1 Isotopes

Definition and properties of isotopes

Summary: Isotopes are atoms of the same element that have the same number of protons(same atomic number) but different numbers of neutrons(different mass numbers).

This alteration in neutron numbers can change the chemical properties of certain elements.

2.1 Calculating relative atomic mass

Understandings:

The mass spectrometer is used to determine the relative atomic mass of an element from its isotopic composition.

Applications and skills:

Calculations involving non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.

Summary:

Relative atomic mass is calculated by multiplying the percent abundance of each isotope of an element by its mass, then adding them together and dividing by 100.

2.2 Atomic orbitals

Understandings:

Sub-levels contain a fixed number of orbitals, regions of space where there is a high probability of finding an electron.

Applications and skills:

Recognition of the shape of an s atomic orbital and the px, py and pz atomic orbitals.

Summary:

Atomic orbitals represent a region of space where there is a high probability of finding an electron. Due to heisenberg's uncertainty principle, it is impossible to know exactly where an electron is at one period in time. S orbitals are spherical and can hold 2 elections. P orbitals are dumbbell shaped and can hold 6 electrons.

2.2 The Aufbau principle

Understandings:

Each orbital has a defined energy state for a given electronic configuration and chemical environment and can hold two electrons of opposite spin.

Applications and skills:

Application of the Aufbau principle, Hund's rule and the Pauli exclusion principle to write electron configurations for atoms and ions up to Z = 36.

Guidance:

Orbital diagrams should be used to represent the character and relative energy of orbitals.

Summary:

The Aufbau principle states that electrons fill lower energy orbitals before filling higher energy orbitals. The pauli-exclusion principle states that an atomic orbital can fit two electrons with opposite spins. Hund's rule states that degenerate orbitals in a sub-level are each filled once before they can be filled doubly.

2.2 Electron configurations

Applications and skills:

Application of the Aufbau principle, Hund's rule and the Pauli exclusion principle to write electron configurations for atoms and ions up to Z = 36.

Guidance:

Orbital diagrams should be used to represent the character and relative energy of orbitals.
The electron configurations of Cr and Cu as exceptions should be covered.

Summary:

Electron configuration is used to notate the the orbitals which the atom/ion's electrons are located. For example, $1s^2$ means that the **s sublevel** of the **1^{st} energy level** has **2 electrons**. As well, noble gases in brackets before the electron configuration is an abbreviation for the electron configuration of the noble gas.

2.2 Electromagnetic spectrum

Applications and skills:

Description of the relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum.

Summary:

The Electromagnetic spectrum displays all the wavelengths and frequencies of energy particles. Long wavelengths are a result of low frequency, and a high frequency results n short wavelengths. The speed of light (c) = Wavelength * Frequency.

2.2 Line Spectra

Applications and skills:

Distinction between a continuous spectrum and a line spectrum.

Summary:

A continuous spectrum displays all the wavelengths of visible light. An absorption line spectrum shows black lines on a colored background, and an emission line spectrum shows colored lines on a black background.

2.2 Hydrogen emission spectrum

Understandings:

Emission spectra are produced when photons are emitted from atoms as excited electrons return to a lower energy level.

The line emission spectrum of hydrogen provides evidence for the existence of electrons in discrete energy levels, which converge at higher energies.

Applications and skills:

Description of the emission spectrum of the hydrogen atom, including the relationships between the lines and energy transitions to the first, second and third energy levels.

Summary:

Electrons can only exist at discrete energy levels, and when they transition between these energy levels, they absorb or emit protons of specific energy levels, and thus wavelengths. These patterns of photons, with specific wavelengths, that are either absorbed or emitted make up the absorption and emission. The larger the transition, the higher the energy of the photons, and the lower the wavelength.

2.2 Exceptions to the Aufbau principle

This video covers exceptions to the Aufbau principle (Cu and Cr) as well as writing abbreviated electron configurations.

Summary:

Two exceptions to the Aufbau principle are Cu and Cr, which have one less electron in the 4s orbital and one more electron in the 3d orbital.

Abbreviated electron configuration uses a noble gas to abbreviate lower orbitals that are completely filled.

When notating ions in the 3d block, they lose their 4s electrons first.

2.2 Orbital diagrams

Understandings:

Each orbital has a defined energy state for a given electronic configuration and chemical environment and can hold two electrons of opposite spin.

Guidance:

Orbital diagrams should be used to represent the character and relative energy of orbitals.

Summary:

You can turn the electron configuration of an atom or an ion into an orbital diagram, which is a series of boxes representing the orbitals with arrows inside them representing electrons with different spins, by using the Pauli Exclusion Principle, the Aufbau Principle, and Hund's rule.

Questions: