SUBJECT: Science

UNIT: Fundamentals: Atoms

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Lesson 1: Density

1. How is the density of a regularly shaped object found?
2. How is the density of an irregularly shaped object found?

Lesson 2: Changes of State

1. What is the arrangement of particles in a solid?
2. What is the arrangement of particles in a liquid?
3. What is the arrangement of particles in a gas?
4. What are the four main changes of state?

Lesson 3: Structure of the Atom

1. What is the size of an atom?
2. What is the structure of an atom?
   How can electrons move between energy levels?

Lesson 4: Mass Number and Atomic Number

1. How is the number of protons identified?
2. How is the number of neutrons identified?
3. How is the number of electrons identified?
4. What is an isotope?

Lesson 5: Development of the Atom

1. What is the plum pudding model?
2. What is the nuclear model?
3. What did Chadwick discover?

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Key Equations

Density

$$\rho = \frac{m}{V}$$

Specific Latent Heat

$$E = m\ x\ L$$

Pressure

$$P\ x\ V = constant$$

Quantities and units

ρ = Density (kg/m^3)
m = Mass (kg)
V = Volume (m^3)
E = Energy (J)
L = Specific Latent Heat (J/kg)
P = Pressure (Pa)

Particles

Solids – regular arrangement, particles close together in fixed position, strong forces, low energy and can only vibrate.
Liquids – irregular arrangement, close together, free to move, weaker forces, more energy.
Gases – irregular arrangement, particles separate, very weak forces, lots of energy, move randomly.

Ambitious Vocabulary

Isotope, mass number, atomic number

Density

Regularly shaped object:
Measure all three sides, multiply together to find the volume. Place on a balance to find the mass. Divide the mass by the volume to find the density.
Irregularly shaped object:
Fill a eureka can to just below the spout, place the object in and collect water from the spout in a measuring cylinder – this is the volume. Place the object on a balance to find the mass. Divide the mass by the volume to find the density.

Changing State

The process of changing between a solid and a liquid is melting (solid to liquid) or freezing (liquid to solid). The process of changing between a liquid and a gas is evaporating, boiling (liquid to gas), or condensing (gas to liquid). When a substance changes state there is no chemical change, only physical. No new substance is formed and the substance can return to its original state. The number of particles remains the same and the mass is conserved.

The structure of an atom

Atoms are very small, having a radius of about 1 × 10-10 metres. The basic structure of an atom is a positively charged nucleus composed of both protons and neutrons surrounded by negatively charged electrons. The radius of a nucleus is less than 1/10 000 of the radius of an atom. Most of the mass of an atom is concentrated in the nucleus. The electrons are arranged at different distances from the nucleus (different energy levels). The electron arrangements may change with the absorption of electromagnetic radiation (move further from the nucleus; a higher energy level) or by the emission of electromagnetic radiation (move closer to the nucleus; a lower energy level).

Mass number, atomic number and isotopes

In an atom the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge. All atoms of a particular element have the same number of protons. The number of protons in an atom of an element is called its atomic number. The total number of protons and neutrons in an atom is called its mass number. Atoms can be represented as shown in this example:

(mass number) 23
Na
(Atomic Number) 11

Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element. Atoms turn into positive ions if they

The development of the model of the atom

New experimental evidence may lead to a scientific model being changed or replaced. Before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided. The discovery of the electron led to the plum pudding model of the atom. The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it. The results from the alpha particle scattering experiment led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This nuclear model replaced the plum pudding model. Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations. Later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles, each particle having the same amount of positive charge. The name proton was given to these particles. The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea.