

Solutions

2.1 17 protons; $37 - 17 = 20$ neutrons; 17 electrons.

2.2 (a) Filtration; (b) fractional distillation – different boiling points.

2.3 A compound has its elements chemically combined in fixed proportions; a mixture's substances are not combined and keep their own properties. A compound needs a chemical reaction to separate; a mixture separates by physical processes.

3.1 The plum pudding model was replaced by the nuclear model: most of the mass and all positive charge concentrated in a tiny nucleus at the centre; most of the atom is empty space, since most alpha particles passed straight through; the few deflected showed the nucleus repelled positive charges.

3.2 $\text{Ar} = (24 \times 79 + 26 \times 21) \div 100 = (1896 + 546) \div 100 = 2442 \div 100 = 24.42$.

3.3 Add water and stir to dissolve the salt; filter – the sand is insoluble and stays on the paper; the filtrate is salt solution; evaporate most of the water, then leave to crystallise; dry the crystals on filter paper/in a warm oven.

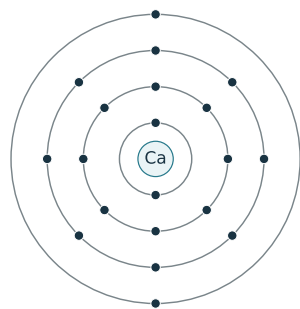
3.4 O_2 contains only oxygen atoms, whereas H_2O contains two chemically combined elements in a fixed ratio. $3\text{H}_2\text{O}$ contains 6 H and 3 O atoms. $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$. Changing subscripts changes the substance.

3.5 Ca^{2+} : 20 p, 20 n, 18 e; Cl^- : 17 p, 20 n, 18 e. Proton number is unchanged; only electrons change. A positive charge means fewer electrons, not added protons.

3.6 $0.1 \text{ nm} = 1 \times 10^{-10} \text{ m}$. Diameter $= 2 \times 10^{-10} \text{ m}$; count $= (1 \times 10^{-3}) / (2 \times 10^{-10}) = 5 \times 10^6$. Enlarged nucleus radius is less than $1/10000 \text{ m} = 0.1 \text{ mm}$; this is an upper comparison, not exact equality.

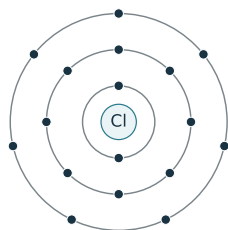
3.7 Chlorine: three shells with 2,8,7 electrons. Calcium: four shells with 2,8,8,2. Count every electron; the first-twenty model applies.

Calcium: 20 electrons



2,8,8,2

Chlorine: 17 electrons



2,8,7

Neutral atoms • dots are electrons • shell sizes are schematic, not to scale

3.8 Filter to collect insoluble powder; wash with a suitable small amount of solvent and dry it. Fractionally distil the filtrate using the liquids' different boiling points; lower-boiling fraction is collected first. Both dissolved/miscible liquid components pass through

filter paper, so filtration cannot separate them. Accept appropriate practical detail without assuming perfect purity from one reading.

3.9 Oxidation: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$. Reduction: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$.

Combined ionic equation: $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$. Sulfate is unchanged and omitted as spectator; total charge is +2 on each side and atoms are conserved.