

The Periodic Table

Answer key with explanations

A. Structure of the table

1. Periods and groups.

(a) A **period** is a horizontal row; a **group** is a vertical column of elements with similar properties. (b) Increasing **atomic number** (number of protons).

2. Elements.

(a) **lithium**, alkali metal (b) **bromine**, halogen (c) **argon**, noble gas (d) **calcium**, alkaline earth metal (e) **copper**, transition metal

B. Metals, non-metals and metalloids

3. Classify.

(a) **metal** (b) **non-metal** (c) **metalloid** (d) **metal** (e) **non-metal**. Metals are shiny, conduct heat and electricity, and are malleable and ductile (any two).

C. Valence electrons and ions

4. Valence electrons and ions.

(a) 2, Ca^{2+} (b) 3, Al^{3+} (c) 6, O^{2-} (d) 7, F^- (e) 5, N^{3-}

5. Formulas.

(a) Na^+ , O^{2-} : $2(+1) + (-2) = 0$, so Na_2O
(b) Ca^{2+} , Cl^- : $(+2) + 2(-1) = 0$, so CaCl_2
(c) Al^{3+} , S^{2-} : $2(+3) + 3(-2) = 0$, so Al_2S_3
(d) Mg^{2+} , N^{3-} : $3(+2) + 2(-3) = 0$, so Mg_3N_2

D. Blocks

6. Blocks.

(a) **s** (b) **d** (c) **p** (d) **f**. The block is the type of subshell (s, p, d or f) that the element's outermost electrons are filling.

E. History and patterns

7. Mendeleev.

(a) Atomic mass:

$$\frac{72 - 72.63}{72.63} \times 100\% = -\mathbf{0.87\%}$$

Density:

$$\begin{aligned} & \frac{5.5 \text{ g/cm}^3 - 5.32 \text{ g/cm}^3}{5.32 \text{ g/cm}^3} \times 100\% \\ &= +\mathbf{3.4\%} \end{aligned}$$

(b) He trusted the **pattern** of properties more than the list of known elements, and his predictions could be proved wrong. When gallium, scandium and germanium were discovered with the predicted properties, the periodic table was widely accepted.

F. Challenge

8. Reactivity down a group.

Down **group 1**, the outer electron is in a shell further from the nucleus and more shielded, so it is held less tightly and **lost more easily**: reactivity increases. Down **group 17**, the atoms are larger, so the nucleus attracts an incoming electron **less strongly**: the halogens gain electrons less easily and reactivity decreases.