Solutions

Each answer shows the steps, then the **result**.

2.1

(a)

- 6

(b)

- 10

2.2

- $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2$

2.3

- Six; a p sub-shell has three orbitals and each orbital holds at most two electrons, with opposite spins

2.4

- $[Ar]\,3d^5 4s^1$; a half-filled d sub-shell is more stable than the expected $3d^4 4s^2$

2.5

- The next electron is being removed from a shell closer to the nucleus, which is less shielded and more strongly attracted, so far more energy is needed

3.1 B

- 4s is slightly lower in energy than 3d, so it fills first

3.2 B

- A p orbital is a dumbbell (two lobes)

3.3

(a)

- $[Ar]\,3d^6\,4s^2$

(b)

- $[Ar]\,3d^5$; the 4s electrons are removed before the 3d electrons

3.4

- each electron is negative and they repel; occupying separate orbitals keeps them apart, lowering repulsion — the lowest-energy (most stable) arrangement

3.5

(a)

- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

(b)

- [Ar] $3d^2$; the two 4s electrons are lost first, then one 3d electron

(c)

- 4s shown as one box with two opposed arrows; 3d shown as five boxes with three single arrows all pointing the same way; Hund's rule — electrons occupy orbitals singly with parallel spins before pairing, because they repel

(d)

- Group IV; the large jump comes between the fourth and fifth ionisation energies, so four electrons are removed from the outer shell before the next must come from a shell closer to the nucleus

(e)

- Magnesium's outer electron is in a 3s orbital and aluminium's in a 3p orbital; the 3p sub-shell is slightly higher in energy and better shielded by the 3s electrons; that outweighs the extra proton, so less energy is needed to remove it