

Period 3 trends in radius, energy and melting

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab answers

These model answers use the sample readings in the results table. Compare your own calculations and explanations with them, paying attention to the way structure and bonding explain each observation and to the uncertainty analysis.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.2.1

Question 1 Resistance of the samples

$R(\text{total}) = V / I$. Mg: $3.0 / 0.297 = 10.10 \, \Omega$, so sample = $10.10 - 10.0 = \mathbf{0.10 \, \Omega}$. Al: $3.0 / 0.296 = 10.14 \, \Omega$, so sample = $\mathbf{0.14 \, \Omega}$. Si: $3.0 / 0.0061 = 491.8 \, \Omega$, so sample = $491.8 - 10.0 = \mathbf{4.8 \times 10^2 \, \Omega}$.

Question 2 Purpose of the resistor

It limits the current so the cells are not short-circuited when a low-resistance metal is connected, keeps the current within the ammeter range and prevents the sample heating, which would change its resistance. **It protects the equipment and keeps the test fair.**

Question 3 Ranking by conductivity

Mg $\approx$ Al > Si > S. Magnesium and aluminium have giant metallic lattices with delocalised electrons that carry charge. Silicon has a giant covalent lattice in which almost all electrons are held in bonds. Sulfur consists of S_8 molecules with no mobile charge carriers.

Question 4 Why silicon is in the middle

A few electrons in silicon have enough energy to escape from bonds and move, so it is a semiconductor. Sulfur's electrons are firmly localised. Warming silicon frees more electrons, so the current **increases**, the opposite of a metal, whose resistance rises with temperature.

Question 5 Malleable or brittle

In a metal the layers of cations can slide past each other while the delocalised electrons keep the lattice bonded, so the metal **bends**. In silicon the directional covalent bonds are fixed and break along a plane when the lattice is deformed, so it **shatters**.

Question 6 Uncertainty

$\Delta R = 3.0 \times 0.001 / (0.297)^2 = 0.034 \, \Omega$, so Mg = $0.10 \pm 0.03 \, \Omega$ and Al (same method, $0.034 \, \Omega$) = $0.14 \pm 0.03 \, \Omega$. The ranges overlap, so **this experiment cannot separate**

magnesium from aluminium.

Question 7 Improving the method

Oxide layers on Mg and Al add resistance: **sand the surface just before the test**. Poor clip contact adds resistance: **use the same clamps at the same distance and add a voltmeter across the sample to measure its resistance directly**.

Question 8 Prediction

Sodium conducts because it has a giant metallic lattice with one delocalised electron per atom. **Liquid chlorine does not** because it contains neutral Cl_2 molecules and no mobile charges.