

Period 3 trends in radius, energy and melting

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

Name: _____ Date: _____ Class: _____

These 20 problems train you to describe and explain the trends across period 3: atomic radius, first ionisation energy, structure, bonding, conductivity and melting point. They start with recall and unit work, then move to data analysis and extended explanations.

The level suits A Level, IB Chemistry SL, CBSE Class 11-12 and WAEC/NECO senior students. Always name the structure or the electron configuration before you give an explanation.

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

Problem 1 Period 3 roll call (easy)

Aarav in Pune is revising period 3.

1. Write the symbols of the eight period 3 elements in order.
2. Write the full electron configuration of sodium and of chlorine.
3. Explain why argon is the last element of the period.

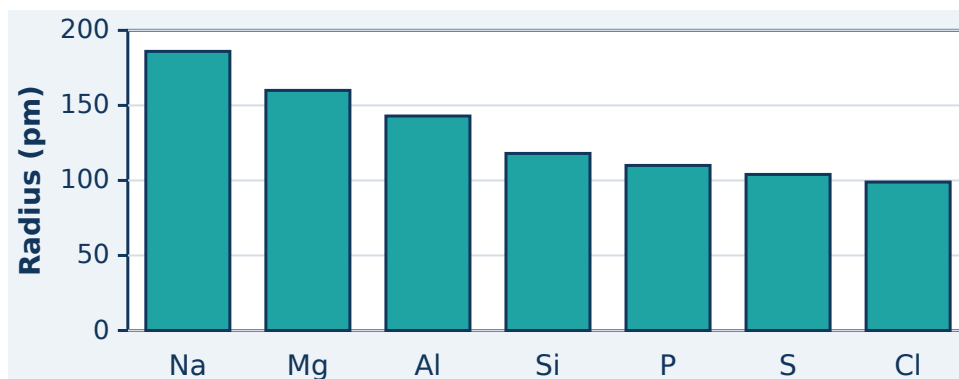
Problem 2 Which way does it go? (easy)

Chiamaka sorts property cards for sodium to chlorine. State whether each property increases, decreases or stays the same.

1. Nuclear charge
2. Number of occupied electron shells
3. Atomic radius
4. Number of outer electrons

Problem 3 Reading the radius chart (easy)

The chart shows atomic radii of sodium to chlorine.



Atomic radii of sodium to chlorine (pm).

1. Read the radii of sodium and chlorine.
2. Calculate the decrease and the percentage decrease.
3. Calculate the mean decrease per step across the six steps.

Problem 4 Pull of the nucleus (easy)

A simple model says effective nuclear charge = nuclear charge – number of inner-shell electrons (ignoring shielding inside the shell).

1. Calculate it for sodium and chlorine (10 inner electrons each).
2. Calculate how many times larger the value is for chlorine.
3. Explain what this predicts about atomic radius.

Problem 5 Ionisation data (easy)

First ionisation energies (kJ/mol) for period 3: Na 496, Mg 738, Al 578, Si 789, P 1012, S 1000, Cl 1251, Ar 1521.

1. Name the elements with the highest and the lowest value.
2. Calculate the fall from Mg to Al and from P to S.
3. Write the equation for the first ionisation of aluminium, with state symbols.

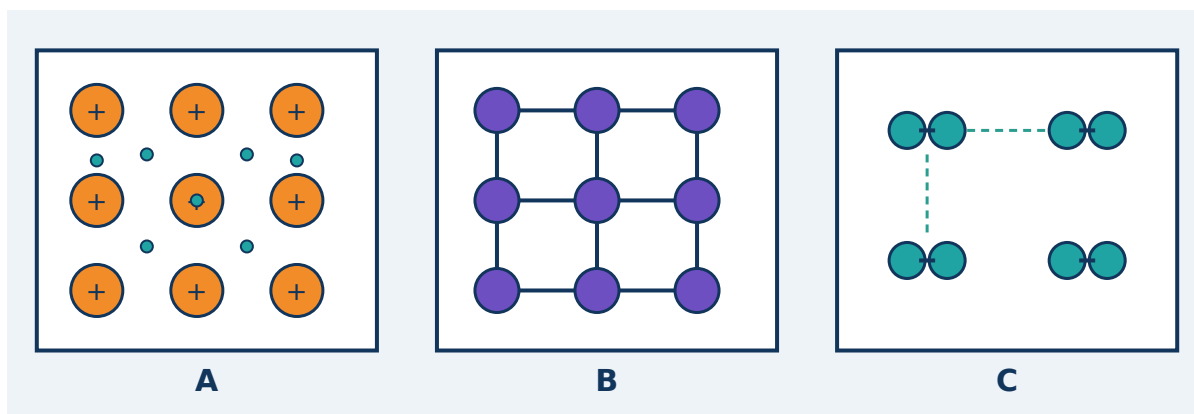
Problem 6 Kelvin conversions (easy)

Kwame in Accra records melting points in °C: Na 98, Mg 650, Al 660, Si 1410.

1. Convert each to kelvin (add 273).
2. Calculate the difference in melting point between Mg and Na, and between Al and Mg, in K.

Problem 7 Match structure to element (medium)

Emma in Leeds draws three structures.



Three structure types A, B and C.

1. Name the structure type shown in A, B and C.
2. Match magnesium, silicon and sulfur (S_8) to A, B and C.
3. State what is overcome when each substance melts.

Problem 8 Conductors and insulators (medium)

Wanjiru in Nairobi tests period 3 elements: magnesium conducts well, silicon conducts poorly, sulfur and argon do not conduct.

1. Explain why magnesium conducts electricity.
2. Explain why sulfur does not conduct.
3. Predict, with a reason, whether liquid chlorine conducts.

Problem 9 Charge on the metal ions (medium)

Melting points (K): Na 371, Mg 923, Al 933.

1. State the charge on each cation and the number of delocalised electrons per atom.
2. Explain why the melting point rises from sodium to aluminium.
3. Predict, with a reason, whether potassium melts above or below 371 K.

Problem 10 Phosphorus and sulfur (medium)

White phosphorus exists as P_4 molecules and sulfur as S_8 molecules.

1. Calculate the number of electrons in one P_4 molecule and one S_8 molecule.
2. Explain why sulfur has the higher melting point.
3. Name the force overcome on melting.

Problem 11 Ranking molecular elements (medium)

Diego in Texas must rank four elements by melting point: P_4 , S_8 , Cl_2 and Ar.

1. Calculate the number of electrons per particle.
2. Rank the elements from highest to lowest melting point.
3. Justify your ranking.

Problem 12 Why silicon is hard to melt (medium)

Silicon melts at 1683 K but white phosphorus at 317 K.

1. State what is broken when silicon melts.
2. Explain the large difference.
3. Calculate how many times higher silicon's melting point is (in K).

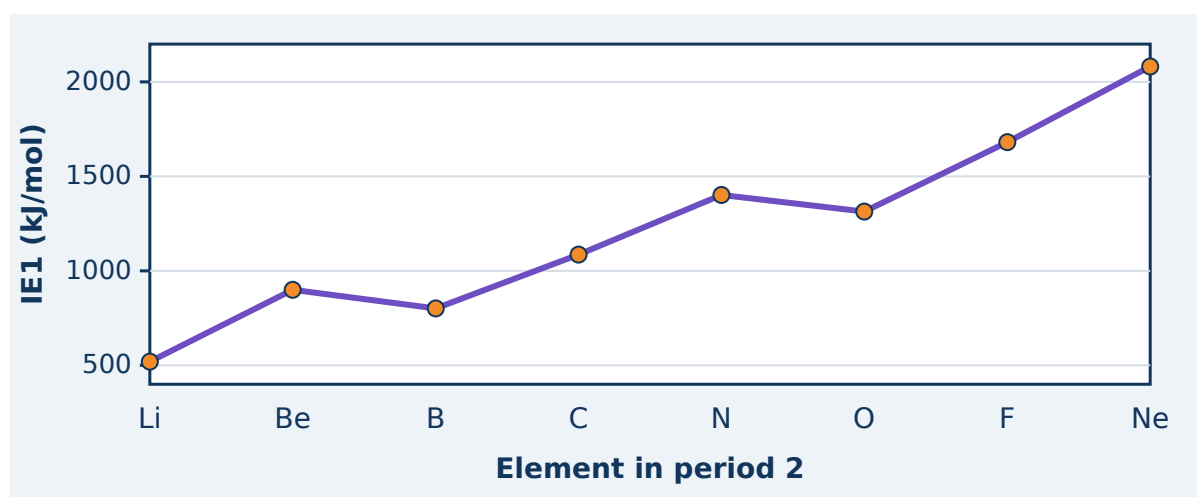
Problem 13 Argon versus sodium (medium)

IE1 of argon is 1521 kJ/mol and of sodium 496 kJ/mol.

1. Calculate how many times larger the argon value is.
2. Compare nuclear charge and number of shells for the two atoms.
3. Explain the difference.

Problem 14 Period 2 dips (medium)

Look at the first ionisation energies across period 2.



First ionisation energies across period 2.

1. Read the values for Be, B, N and O.
2. Calculate the fall from Be to B and from N to O.
3. Explain both falls.

Problem 15 Interpolating silicon (medium)

Aluminium has a radius of 143 pm and phosphorus 110 pm.

1. Estimate the radius of silicon as the mean of its neighbours.
2. Compare with the measured value of 118 pm and calculate the percentage error.
3. Suggest why the estimate is not exact.

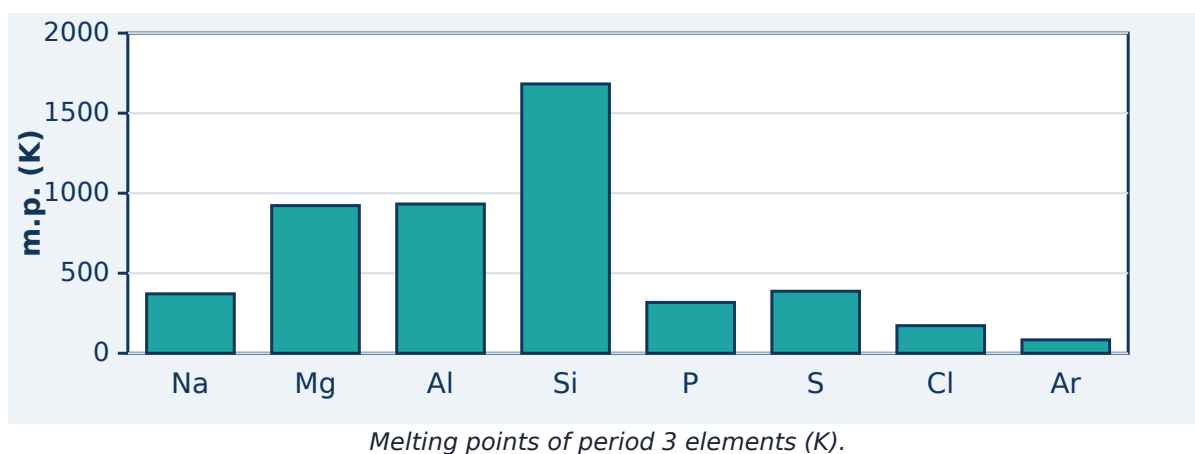
Problem 16 Identify the element (hard)

Identify each period 3 element from its clues and give one piece of reasoning.

1. A conducting solid with three delocalised electrons per atom and a melting point of 933 K.
2. A monatomic gas with the highest first ionisation energy in the period.
3. A solid of P₄ molecules with five outer electrons.
4. A metal with two outer electrons, IE1 of 738 kJ/mol and radius 160 pm.

Problem 17 Shape of the melting point graph (hard)

Mei in Singapore plots melting point against atomic number for period 3.



1. Explain why the melting point rises from Na to Al.
2. Explain the maximum at silicon.
3. Explain the sharp fall from silicon to phosphorus and the low value for argon.

Problem 18 Charge density (hard)

The ionic radii are Na⁺ 102 pm and Mg²⁺ 72 pm. Define charge density here as ion charge divided by radius.

1. Calculate the charge density of each ion in units of e per pm.
2. Calculate how many times larger the Mg²⁺ value is.
3. Use your answer to explain the difference in melting point between sodium and magnesium.

Problem 19 Evaluate a claim (hard)

Bilal in Lahore claims that sulfur has a lower first ionisation energy than phosphorus because its outer electrons are further from the nucleus.

1. Use the radii (P 110 pm, S 104 pm) to test the claim.
2. Give the correct explanation for the lower value.
3. Predict, with a reason, whether chlorine's IE1 is higher or lower than sulfur's.

Problem 20 Spot the errors (hard)

Each statement contains one error. Find it and correct it.

1. Atomic radius increases across period 3 because more electrons are added.

2. Magnesium has a higher IE1 than aluminium because magnesium is a larger atom.
3. Silicon melts at a high temperature because of strong London forces.
4. When sulfur melts, the S-S covalent bonds break.