

Worksheet 3 - Nuclear Symbols, Atoms and Ions

Trimester school assessment - IB-style chemistry practice

Suggested time: 50 minutes

Total marks: 46

HL: Includes one HL ion notation and m/z challenge.

Learning focus

- Use nuclear symbols to deduce protons, neutrons and electrons.
- Calculate charges of ions from protons and electrons.
- Write isotope and ion notation from subatomic composition.

Section A - Multiple choice

Q1. In the notation A_ZX , what does Z represent?

- A mass number
- B number of neutrons
- C atomic number
- D charge

Q2. How many neutrons are in ${}^{27}_{13}\text{Al}$?

- A 13
- B 14
- C 27
- D 40

Q3. How many electrons are in ${}^{16}_8\text{O}^{2-}$?

- A 6
- B 8
- C 10
- D 16

Q4. A particle has 19 protons and 18 electrons. Its charge is:

- A 1+
- B 1-
- C 18+
- D 37+

Q5. Which species contains 20 protons, 20 neutrons and 18 electrons?

- A ${}^{40}_{20}\text{Ca}^{2+}$
- B ${}^{40}_{18}\text{Ar}^{2-}$
- C ${}^{38}_{20}\text{Ca}$
- D ${}^{20}_{40}\text{Ca}^{2+}$

Q6. The mass number of an atom is equal to:

- A protons + electrons
- B neutrons + electrons
- C protons + neutrons
- D protons only

Section B - Short answer

Q7. Complete the table. [10]

Species	Protons	Neutrons	Electrons	Charge
${}^7_3\text{Li}$				
${}^{14}_6\text{C}$				
${}^{19}_9\text{F}^-$				
${}^{56}_{26}\text{Fe}^{3+}$				
${}^{31}_{15}\text{P}^{3-}$				

Q8. Write nuclear symbols for the following: (i) 8 protons, 10 neutrons, 10 electrons; (ii) 11 protons, 12 neutrons, 10 electrons. [4]

Q9. Explain why the atomic number is a better identifier of an element than mass number. [2]

Section C - Data response/case study

A forensic laboratory compares particles found in a mineral sample.

Particle	Protons	Neutrons	Electrons
P	29	34	29
Q	29	36	27
R	30	34	28
S	29	34	28

Q10. Identify which particles are atoms of the same element. Justify your answer. **[3]**

Q11. For each particle, state the charge. **[4]**

Q12. Write complete notation for Q and S. **[4]**

Q13. Identify any isotopic relationship in the table. **[2]**

Section D - Extended response and HL extension

Q14. Describe a general method for deducing the number of protons, neutrons and electrons from a nuclear symbol for both neutral atoms and ions. **[7]**

Q15. HL: A mass spectrum shows a peak at m/z 63 for a $1+$ copper ion and a small peak at m/z 31.5. Suggest the origin of the smaller peak. **[4]**

Answer key and marking guidance

Award marks for chemically correct ideas. Accept alternative wording when the same scientific meaning is clear. For extended responses, use the marking guidance as a best-fit rubric.

Q1-6. C, B, C, A, A, C. MC: 1 mark each.

Q7. Li-7: p3 n4 e3 charge 0 [2]; C-14: p6 n8 e6 charge 0 [2]; F-19 1-: p9 n10 e10 charge -1 [2]; Fe-56 3+: p26 n30 e23 charge +3 [2]; P-31 3-: p15 n16 e18 charge -3 [2].

Q8. (i) $^{18}_{8}\text{O}^{2-}$ [2]; (ii) $^{23}_{11}\text{Na}^{+}$ [2]. Accept equivalent notation.

Q9. Atomic number equals the number of protons [1], which defines the element and does not change in chemical reactions; mass number can vary between isotopes [1].

Q10. P, Q and S are the same element because all have 29 protons [2]. R has 30 protons and is a different element [1].

Q11. P: 0; Q: 2+; R: 2+; S: 1+. [4]

Q12. Q: mass number 65, Z=29, Cu, charge 2+ \rightarrow $^{65}_{29}\text{Cu}^{2+}$ [2]. S: mass number 63, Z=29, Cu, charge 1+ \rightarrow $^{63}_{29}\text{Cu}^{+}$ [2].

Q13. P and Q are isotopes of copper because they have the same proton number but different neutron numbers/mass numbers. [2]

Q14. Best-fit [7]: Z gives protons [1]; A - Z gives neutrons [1]; neutral atom has electrons = protons [1]; positive charge means electrons lost/subtract charge [1]; negative charge means electrons gained/add magnitude of charge [1]; includes one worked example [1]; uses notation accurately [1].

Q15. HL: A peak at half the m/z can be caused by a 2+ ion of the same isotope [2]. If ^{63}Cu forms Cu^{2+} , $m/z = 63/2 = 31.5$ [1]. It has a smaller abundance/intensity because fewer 2+ ions are formed [1].