

# Worksheet 2 - Subatomic Particles, Masses and Charges

Trimester school assessment - IB-style chemistry practice

**Suggested time:** 45 minutes

**Total marks:** 42

**HL:** Includes mass-to-charge reasoning.

## Learning focus

- Recall the relative masses and charges of protons, neutrons and electrons.
- Explain why most atomic mass is concentrated in the nucleus.
- Apply charge and mass ideas to atoms and simple ions.

## Section A - Multiple choice

**Q1.** Which subatomic particle has a relative charge of -1 and negligible relative mass?

- A proton
- B neutron
- C electron
- D nucleon

**Q2.** Which particles are collectively called nucleons?

- A protons and electrons
- B protons and neutrons
- C neutrons and electrons
- D ions and isotopes

**Q3.** Which row correctly compares relative mass and charge?

- A Proton: mass 1, charge +1
- B Neutron: mass 0, charge 0
- C Electron: mass 1, charge -1
- D Proton: mass 0.0005, charge +1

**Q4.** The mass of an atom is mostly due to:

- A electrons only
- B protons and neutrons
- C protons and electrons
- D empty space between particles

**Q5.** A neutral atom contains 11 protons. How many electrons does it contain?

- A 10
- B 11
- C 12
- D 22

**Q6.** Which particle determines the identity of an element?

- A electron
- B neutron
- C proton
- D positron

## Section B - Short answer

**Q7.** Complete the table for the three subatomic particles. [6]

Particle	Relative mass	Relative charge	Location
proton			
neutron			
electron			

**Q8.** Explain why an atom can be neutral even though it contains charged particles. [2]

**Q9.** Explain why the mass of electrons is often ignored when calculating mass number. [2]

**Q10.** State the force that attracts electrons to the nucleus in a simple atomic model. [1]

## Section C - Data response/case study

A set of particles and ions is described below.

Species	Protons	Neutrons	Electrons
A	12	12	12
B	12	13	10
C	17	18	18
D	18	22	18

**Q11.** Identify which species are neutral atoms and which are ions. Give the charge of each ion. **[4]**

**Q12.** Identify any pair of species that have the same number of electrons. State the term used for such species. **[2]**

**Q13.** For species B, calculate the mass number and write a suitable isotope-ion notation using the element symbol. **[3]**

### Section D - Extended response and HL extension

**Q14.** Explain how the relative masses and charges of subatomic particles account for the structure and overall neutrality of atoms. **[7]**

**Q15. HL:** In a mass spectrometer, singly charged positive ions are separated according to  $m/z$ . Explain why two singly charged ions with  $m/z$  values of 24 and 26 are separated in a magnetic field. **[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.

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

**Q7.** Proton: relative mass 1, charge +1, nucleus [2]; neutron: relative mass 1, charge 0, nucleus [2]; electron: relative mass about 0.0005/negligible, charge -1, outside nucleus [2].

**Q8.** The total positive charge from protons equals the total negative charge from electrons [1], so the charges cancel overall [1].

**Q9.** Electrons have a very small relative mass compared with protons/neutrons [1], so their contribution to the mass is negligible for ordinary mass-number calculations [1].

**Q10.** Electrostatic attraction between negative electrons and the positive nucleus. [1]

**Q11.** A: neutral atom, charge 0 [1]. B: 2+ ion because 12 p and 10 e [1]. C: 1- ion because 17 p and 18 e [1]. D: neutral atom, charge 0 [1].

**Q12.** B, C and D each have 18 electrons [1]. Species with the same number of electrons are isoelectronic [1].

**Q13.** Species B has  $p + n = 12 + 13 = 25$  [1]. Atomic number 12 is Mg [1]. Notation:  $^{25}_{12}\text{Mg}^{2+}$  or Mg-25 2+ [1].

**Q14.** Best-fit [7]: identifies protons, neutrons and electrons with correct charges [2]; nucleons in dense nucleus carry most mass [2]; electrons outside nucleus occupy most atomic volume [1]; neutral atoms have equal protons/electrons [1]; neutron role in mass/stability [1].

**Q15.** HL: Both ions have the same charge (+1), so  $m/z$  is determined mainly by mass [1]. The  $m/z$  24 ion is lighter and is deflected more strongly [1]. The  $m/z$  26 ion is heavier and is deflected less [1]. The detector records separate paths/peaks [1].