1.4

Atoms, ions and isotopes

Name _____ Class _____ Mark _____ / 36

What you are practising

I can use symbol notation to work out the protons, neutrons and electrons in an atom or ion.

Worked example: $^{7}_{3}\mathrm{Li}$

Z = 3: 3 protons, so lithium.
Neutrons = A − Z = 7 − 3 = **4**.
Atom: **3** electrons, no charge.
Ion $^{7}_{3}\mathrm{Li}^{+}$: one electron lost, so **2** electrons, charge +1.

A (top left) = mass number
Z (bottom left) = atomic number = protons
A = protons + neutrons, so neutrons = A − Z
Atom: electrons = protons
Ion: charge = protons − electrons

Part 1 · Complete the table — work in every direction [8]

Work in pencil. Use a periodic table to name an element from its protons. Fill **every** empty cell.

Element	Z	A	Protons	Neutrons	Electrons
a Beryllium		9			
b	5	11			
c		19	9	10	
d Sodium		23			
e			12	12	
f Chlorine		35			
g	7	14			
h		40		20	

Who is right? [2]

Both students are working out the particles in $^{31}_{15}\mathrm{P}$.

Ana: "It has 15 protons and 31 − 15 = 16 neutrons."

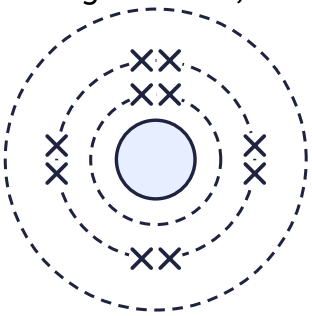
Ben: "The mass number is the bottom number, so A = 15 and Z = 31. Neutrons = Z − A = 31 − 15 = 16, and it has 31 protons."

Who is right? What has the other student done wrong?

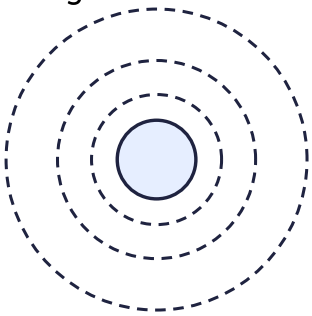
Part 2 · Complete the Bohr models [6]

The inner shells are drawn. Add the missing electrons, then write the arrangement underneath.

Carbon (Z = 6)



Silicon (Z = 14)



Argon (Z = 18) — all of it

Part 3 · Spot the pattern — isotopes and ions [8]

For each pair, write what is the **same** and what is **different**.

Pair	Same	Different
(a) $^{12}_{6}C$ and $^{14}_{6}C$		
(b) a sodium atom and Na^{+}		
(c) $^{35}_{17}Cl$ and $^{37}_{17}Cl$		
(d) an oxygen atom and O^{2-}		

Two marks for each pair: one for the same, one for the different.

Part 4 · What can you work out? [6]

For each, write down **everything** you can work out (protons, neutrons, electrons, charge, element, group …).

1. $^{39}_{19}K^{+}$ [2]

2. $^{27}_{13}Al$ [2]

3. An atom with 8 protons and 10 neutrons. [2]

Part 5 · Spaced retrieval – earlier topics (no notes) [6]

1. Elemental substance, compound substance or mixture? [2]

air		NaCl	
oxygen		sea water	

2. How many atoms in total in $(NH_4)_2SO_4$? [1]

3. An element has the arrangement **2, 8, 7**. Which **group** and **period** is it in? [1]

Group ____ Period ____

4. Going **down** Group 1, does reactivity increase or decrease? Explain in one line. [2]

Answers

Mark your own work in a different colour. Answers are in blue.

Part 1 · Complete the table [8]

Element	Z	A	Protons	Neutrons	Electrons
a Beryllium	4	9	4	5	4
b Boron	5	11	5	6	5
c Fluorine	9	19	9	10	9
d Sodium	11	23	11	12	11
e Magnesium	12	24	12	12	12
f Chlorine	17	35	17	18	17
g Nitrogen	7	14	7	7	7
h Calcium	20	40	20	20	20

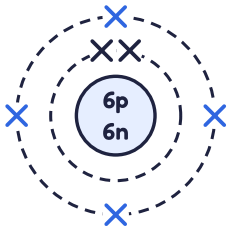
One mark for each row with every cell right. Row h: neutrons = A − Z, so Z = 40 − 20 = 20, which is calcium.

Who is right? [2]

Ana **(1)**. Ben has A and Z the wrong way round: A, the mass number, is top left and Z, the atomic number, is bottom left. Phosphorus has 15 protons, not 31; A must be the bigger number because A = protons + neutrons **(1)**.

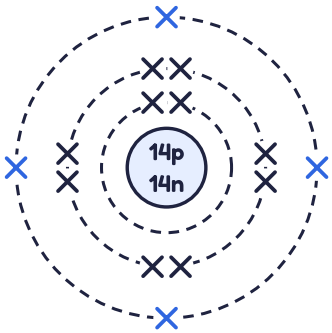
Part 2 · Complete the Bohr models [6]

One mark for each diagram, one mark for each arrangement. Shells fill from the inside; one cross in each N, E, S, W position before any pair up.



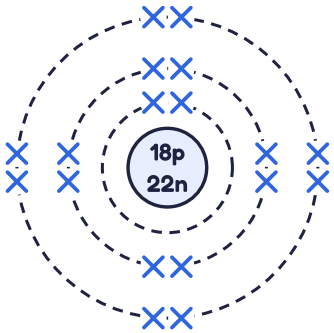
Carbon (Z = 6)

2, 4



Silicon (Z = 14)

2, 8, 4



Argon (Z = 18) — all of it

2, 8, 8

Nucleus shown for carbon-12, silicon-28 and argon-40, the most common atoms of each.

Page done? Tick it off ◌

Part 3 · Spot the pattern — isotopes and ions [8]

Pair	Same	Different
a $^{12}_{6}C$ and $^{14}_{6}C$	6 protons and 6 electrons; both carbon	neutrons: 6 and 8; mass number 12 and 14. They are isotopes.
b a sodium atom and Na^+	11 protons, same neutrons (same nucleus); both sodium	electrons: 11 and 10; charge 0 and +1
c $^{35}_{17}Cl$ and $^{37}_{17}Cl$	17 protons and 17 electrons; both chlorine	neutrons: 18 and 20; mass number 35 and 37. They are isotopes.
d an oxygen atom and O^{2-}	8 protons, same neutrons (same nucleus); both oxygen	electrons: 8 and 10; charge 0 and 2–

Pattern: isotopes differ only in neutrons; ions differ only in electrons. The protons never change, because they fix the element.

Part 4 · What can you work out? [6]

One mark for protons, neutrons and electrons all right; one mark for the charge and element (group and period are a bonus).

1 Potassium. 19 protons, 39 − 19 = 20 neutrons, 18 electrons (one lost), charge +1. Group 1, period 4.

2 Aluminium. 13 protons, 27 − 13 = 14 neutrons, 13 electrons, no charge (neutral atom). Arrangement 2, 8, 3: group 3, period 3.

3 Oxygen (Z = 8). A = 8 + 10 = 18, so $^{18}_{8}O$, an isotope of oxygen. 8 electrons, no charge. Arrangement 2, 6: group 6, period 2.

Part 5 · Spaced retrieval [6]

1 air: mixture NaCl: compound substance [2]
oxygen: elemental substance sea water: mixture
Two marks for all four, one mark for three.

2 2 × (1 + 4) + 1 + 4 = 15 atoms [1]

3 Group 7 (group 17), period 3. It is chlorine. [1]

4 Reactivity increases **(1)**. The outer electron is further from the nucleus, so the attraction is weaker and it is lost more easily **(1)**. [2]

How to revise this

Look at the rules box on page 1. Cover it. Write the rules for A, Z, neutrons and charge from memory. Check. Then redo only the rows and questions you got wrong.