## EXERCISE 1.6

*MODULE 1 TOPIC 4, p. 41*
*Gr 10 Physical Sciences 3-in-1*

**QUESTION 1**

Study the table below and answer the questions that follow.

| Element/ ion | Number of protons | Number of neutrons | Number of electrons | Electron configuration |
|---|---|---|---|---|
| **P** | 3 | 4 | | $1s^2\ 2s^1$ |
| **Q** | 14 | 16 | 14 | |
| **R** | 16 | 16 | 18 | |
| **S** | 17 | 20 | | $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ |
| **T** | 19 | 20 | | $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ |

1.1 Define the term *atomic number*.

1.2 Write down the:

1.2.1 chemical symbol of element **Q** using the notation ${}^{A}_{Z}X$

1.2.2 sp-notation of element **Q**

1.2.3 chemical symbol of **R**

1.2.4 special name of the group to which element **S** belongs

1.3 Give only the LETTER(S) (**P** to **T**) of the element(s) that:

1.3.1 is an / are alkali metal(s)

1.3.2 has/have two core electrons

1.3.3 have the same group number

1.3.4 has/have a noble gas electron configuration

**QUESTION 2**

The first ionisation energies and electron affinity values of the period 3 elements are listed in the table below.

| Element | First ionisation energy ($kJ \cdot mol^{-1}$) | Electron affinity ($kJ \cdot mol^{-1}$) |
|---|---|---|
| **Sodium** | 496 | 53 |
| **Magnesium** | 738 | 0 |
| **Aluminium** | 578 | 44 |
| **Silicon** | 786 | 134 |
| **Phosphorous** | 1 012 | 72 |
| **Sulphur** | 1 000 | 200 |
| **Chlorine** | 1 251 | 349 |
| **Argon** | 1 521 | 0 |

2.1 Explain the difference between the terms *ionisation energy* and *electron affinity*.

2.2 What is meant by *periodicity*?

2.3 What is the tendency regarding the atomic radii of the period 3 elements, from sodium to argon?

2.4 Give a reason for the tendency in the first ionisation energy values as indicated in the table.

2.5 Use the information in the table and explain why metals do not easily form anions.

2.6 There is a decrease in the first ionisation energy from magnesium to aluminium.

2.6.1 Draw an Aufbau diagram for aluminium and explain this decrease in ionisation energy.

2.6.2 Give a reason why the first ionisation energy of argon is so high.

2.7 Calculate the energy that is needed to ionise 46 g of sodium.

# EXERCISE ANSWERS

**QUESTION 1**

1.1 The atomic number of an atom indicates the number of protons in the nucleus of the atom, i.e. the charge of the nucleus.

1.2.1 $^{30}_{14}Si$

NOTE
*Number of neutrons is indicated as 16, so this is the Si-30 isotope.*

1.2.2 $1s^2 2s^2 2p^6 3s^2 3p^2$ 1.2.3 $S^{2-}$ 1.2.4 halogens

1.3.1 P and T 1.3.2 P 1.3.3 P and T

1.3.4 R and S

NOTE
*R has gained two electrons and S has gained one electron, so both are anions with a filled valence shell.*

**QUESTION 2**

2.1 Ionisation energy is the amount of energy needed per mole to remove an electron(s) from an atom in the gaseous state, whereas electron affinity ($E_{aff}$) is the energy released when an electron is attached to an atom or molecule to form a negative ion.

2.2 Periodicity is the repetition of similar properties in chemical elements, as indicated by their positioning in the Periodic Table.

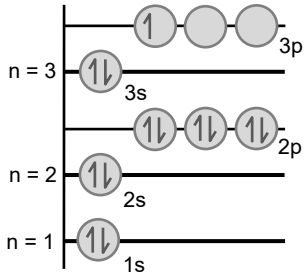
2.3 There is a decrease in the atomic radii of the period 3 elements from sodium to argon.

2.4 There is an increase in the ionisation energy from sodium to argon. This is due to is a decrease in the atomic radii, an increased net nuclear charge, a tighter electron configuration and a stronger attractive force exerted on the valence electrons.

2.5 ○ Metals (on the left) have larger atomic radii and their nuclei will exert a weaker force of attraction on a shared electron pair (lower EN values).

○ They are more inclined to lose electrons (valence electrons are further away from the nucleus; low first ionization energy) and therefore are less inclined to form anions.

2.6.1




$^{27}_{13}A\ell$ **atom**

The 3p-valence (outermost) electron of A$\ell$ has a higher energy than the 3s-valence electron of Mg and requires less energy to be removed.

2.6.2 Argon is noble gas with a completely filled valence energy level. This configuration is very stable and requires more energy to remove an electron than a half-filled energy level does. Therefore, argon has a very high first ionization energy.

2.7 $n(Na) = \frac{m}{M} = \frac{46}{23} = 2 \text{ mol}$

$E = 2 \times 496$

$= 992 \text{ kJ}$