Checkpoint 1

1 State the number of protons, electrons and neutrons for the following particles:

Particles	Nucleon number	No. of protons	No. of neutrons	No. of electrons
$^{31}_{15}P$	31	15	16	15
$^{40}_{20}Ca^{2+}$	40	20	20	18
$^{32}_{16}S^{2-}$	32	16	16	18

Generally, **except for $^{1}_{1}H$, number of neutrons ≥ number of protons** for other elements.

2 Which of the ions has more electrons than protons and more protons than neutrons?

[Given: $^{4}_{2}$He, $^{1}_{1}$H, $^{16}_{8}$O, D = $^{2}_{1}$H]

A He^+ **B** OH^- **C** D_3O^+ **D** OD^-

	Nucleon number	No. of protons	No. of neutrons	No. of electrons
He^+	4	2	2	1
OH^-	17	9	8	10
D_3O^+	22	11	11	10
OD^-	18	9	9	10

3 Oxygen has two isotopes, ^{16}O and ^{18}O. An oxide ion, $^{x}_{8}O^{y-}$ has the same number of neutrons and electrons.

What could be the values of *x* and *y*?

	x	*y*
A	16	1
B	16	2
C	18	1
D	18	2

	x	*y*	No. of neutrons	No. of electrons
A	16	1	8	9
B	16	2	8	10
C	18	1	10	9
D	18	2	10	10

4 In 1999 Russian chemists claimed to be the first to identify atoms of a new element of proton number 114. This was produced by bombarding atoms of plutonium, Pu, with the atoms of an isotope of a group 2 element, **X**. The reaction taking place is as shown below.

$$^{244}_{94}Pu + \boldsymbol{X} \rightarrow {}^{\mathbf{289}}_{\mathbf{114}}[new\ element] + 3\ neutrons\ (^{1}_{0}n)$$

What is **X**?

A Mg **B** Ca **C** Sr **D** Ba

[N03/1/4]

Nucleon number and charge are always conserved. Proton number is also conserved since electrons are not involved in this nuclear reaction.
To identify X, determine its proton number.
proton number of 114 – 94 = 20.
∴ X is Ca.

Checkpoint 2

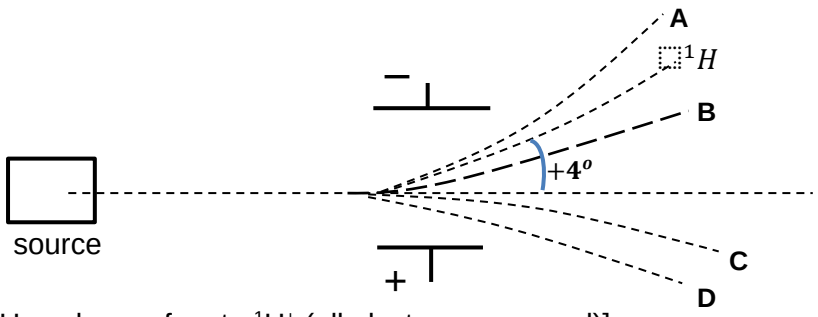
1 *Use of the Data Booklet is relevant to this question.*

Which of the ions will be deflected the **most** in an electric field?

A S^{2-} **B** Br^- **C** F^- **D** O^{2-}

The angle of deflection, θ, is proportional to the $\frac{\text{charge}}{\text{mass}}$ of the particles. The $\frac{\text{charge}}{\text{mass}}$ ratio of the O^{2-} ion is the highest amongst the four.
Hence O^{2-} will deflect the most

2 When passed through an electric field, the ^1H nucleus is deflected as shown below.



[**Note:** ^1H nucleus refers to $^1H^+$ (all electrons removed)]

Which of the above beams represents the deflection for an ion $^2X^{2-}$?

$$\theta = k \times \frac{\text{charge}}{\text{mass}}$$

for $^1H^+$,
$+4 = k \times \frac{+1}{1}$,
$k = 4$

for $^2X^{2-}$,
angle of deflection for $^2X^{2-} = 4 \times (\frac{-2}{2})$
$= -4^o$

3 A plasma is a gaseous mixture in which atoms have been completely stripped of their electrons, leaving bare nuclei. When passed through an electric field, the ^1H nucleus is deflected at an angle of +4°. What will be the angle of deflection for the ^3H nucleus in the same plasma?

A +0.75° **B** $+1.3^o$ **C** $+4^o$ **D** $+12^o$

Angle of deflection = $k \times \frac{\text{charge}}{\text{mass}}$

For the ^1H nucleus, $+4 = k \times \left(\frac{+1}{1}\right)$. Hence k = 4.

For the ^3H nucleus, angle = $4 \times \left(\frac{+1}{3}\right) = +1.3°$

4 The five isotopes of krypton occur in the following abundances:

Isotopic mass	% abundance
80	2
82	12
83	12
84	57
86	17

Use these data to calculate a value, to one decimal place, for the A_r of the atmospheric krypton.

$$A_r = \frac{2}{100} \times 80 + \frac{12}{100} \times 82 + \frac{12}{100} \times 83 + \frac{57}{100} \times 84 + \frac{17}{100} \times 86$$

= 83.9

5 The relative atomic mass of boron, which consists of the isotopes $^{10}_{5}B$ and $^{11}_{5}B$ is 10.8. What is the percentage of $^{11}_{5}B$ atoms in the isotopic mixture?

Let A be the fraction of $^{11}_{5}B$, thus the fraction of $^{10}_{5}B$ is (1-A).

11A + (1–A) 10 = 10.8

A = 0.8

% abundance = 0.8 x 100 = 80%

Checkpoint 3 (Think-pair-share) 

1 Discuss if each statement is true (T) or false (F). Provide an explanation for statement that false.

(a) **There are two 2s orbitals.** **T / F**

Explanation (if any): There is only one 2s orbital. All s subshells contain one s orbital.

(b) **1s subshell and 2s subshell are in the same principal quantum shell.** **T / F**

Explanation (if any): They are in different principal quantum shell.
1s subshell is in the 1st principal quantum shell, 2s subshell is in the 2nd principal quantum shell.

(c) **$3p_x$ orbital is at a higher energy level than $2p_x$ orbital.** **T / F**

Explanation (if any): The larger the principal quantum number, the higher the energy level, hence $3p_x$ is of a higher energy level than $2p_x$.

(d) **$3p_x$ orbital is at a higher energy level than $3p_y$ orbital.** **T / F**

Explanation (if any): All the three 3p orbitals are at same energy level (degenerate).

(e) **$2p_y$ and $3p_y$ orbitals have the same shape but different in size.** **T / F**

Explanation (if any): All p orbitals have dumbbell shapes and 3py orbital is bigger in size (electrons are more diffused).

(f) **3s, 3p and 3d orbitals are in the same subshell.** **T / F**

Explanation (if any): They are in the same principal quantum shell but different subshells.

(g) **Electrons orbit around the nucleus.** **T / F**

Explanation (if any): Electrons do not revolve around the nucleus at particular distance from the nucleus in one plane, instead they are found in atomic orbitals (region of 3-dimensional space where there is 95% chance of finding an electron).

Checkpoint 4(a)

1 Complete the table below with reference to the periodic table.

In terms of **s, p, d, f** notations	
	Full electronic configuration
$_{1}$H	$1s^1$
$_{2}$He	$1s^2$
$_{3}$Li	$1s^2\ 2s^1$
$_{4}$Be	$1s^2\ 2s^2$
$_{5}$B	$1s^2\ 2s^2\ 2p^1$
$_{6}$C	$1s^2\ 2s^2\ 2p^2$
$_{7}$N	$1s^2\ 2s^2\ 2p^3$
$_{8}$O	$1s^2\ 2s^2\ 2p^4$
$_{9}$F	$1s^2\ 2s^2\ 2p^5$
$_{10}$Ne	$1s^2\ 2s^2\ 2p^6$
$_{19}$K	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
$_{20}$Ca	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
$_{22}$Ti	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$
*$_{24}$Cr	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
*$_{29}$Cu	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$

electron-in-boxes representation																				
1s		2s		2p				3s		3p				3d						4s

Checkpoint 4(b)

1 Which atom has 2 unpaired electrons?

A Ba [Xe] $6s^2$ (0 unpaired e^-)

B Ge [Ar] $3d^{10}$ $4s^2$ $4p^2$ (2 unpaired e^- in 4p orbitals)

C Fe [Ar] $3d^6$ $4s^2$ (4 unpaired e^- in 3d orbitals)

D Sc [Ar] $3d^1$ $4s^2$ (1 unpaired e^- in 3d orbitals)

( )

2 Which atom has a half-filled set of 4p electrons?

A Al …$3p^1$

B P ….$3p^3$

C Ga ….$4p^1$

D As ….$4p^3$

( )

3 The table refers to the electron distribution in the second shell of an atom with eight protons. Which row is correct for this atom?

	Orbital shape 		Orbital shape 	
	Orbital type	Number of electrons	Orbital type	Number of electrons
A	p	2	s	4
B	p	4	s	2
C	s	2	p	4
D	s	4	p	2

( )

An atom with eight protons: oxygen → electronic configuration: $1s^2 2s^2 2p^4$
Second shell : $2s^2 2p^4$

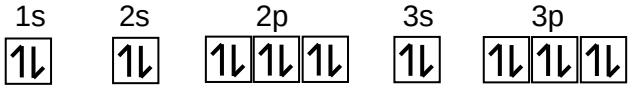
5 Using the ground state valence electronic configuration of atom given below, identify the elements with reference to the periodic table.

(i) $4s^2 4p^4$
(ii) $5s^2 5p^1$
Se and In

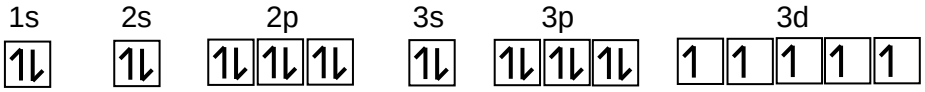
Checkpoint 5

1. Write the electronic configuration and draw the electron-in-boxes representation to represent the electronic configurations of each of the following species.

(a) $_{15}P^{3-}$ $1s^2 2s^2 2p^6 3s^2 3p^6$



(b) $_{24}Cr^{+}$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$



Checkpoint 6

Write the equations that represent the 1st and 2nd ionisation energies of C*l*.

1st I.E. : C*l* (g) → C*l*$^+$(g) + e$^-$

2nd I.E. : C*l*$^+$ (g) → C*l* $^{2+}$ (g) + e$^-$

Checkpoint 7

1 The first seven successive ionisation energies (in kJ mol^{-1}) of an element **J** are given below:

1020 1950 2730 4580 6020 12300 15400

Deduce which Group does element **J** belongs to? Write down the valence shell electronic configuration of element **J**.

Most significant increase in IE is between 6020 and 12300 (5th and 6th IE). 6th electron is removed from the inner principal quantum shell. Hence there are 5 valence electrons.

Hence element **J** is from Group 15.

Its valence shell electronic configuration is ns^2np^3.

Checkpoint 7 (Continued)

2 The table below shows the first 8 successive IEs (in kJ mol^{-1}) for elements **Y** and **Z**.

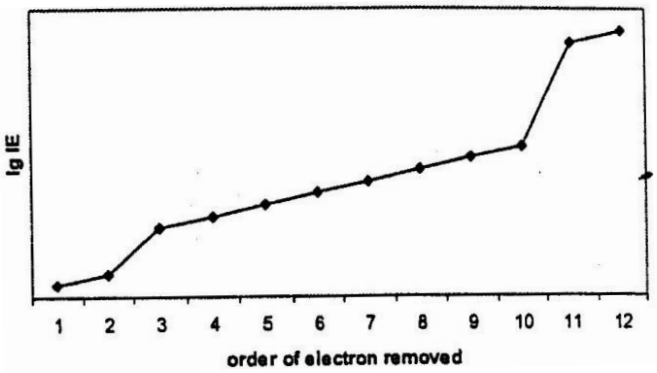
	1st	2nd	3rd	4th	5th	6th	7th	8th
Y	578	1817	2745	11577	14842	18379	23326	27465
Z	1012	1907	2914	4937	6274	21267	25431	29872

Deduce which groups in the Periodic Table does each element, **Y** and **Z,** belong to?

For **Y**, the significant increase in the IE is from the **3rd to 4th**, implying that the **4th** electron is removed from the inner principal quantum shell. Hence there are **3** valence electrons.
Y is in group **13**.

For **Z**, the significant increase in the IE is from the **5th to 6th**, implying that the **6th** electron is removed from the inner principal quantum shell. Hence there are **5** valence electrons.
Z is in group **15**.

3 The diagram below shows successive ionisation energy values of all electrons for an unknown element **Z**.



(a) Account for the large difference between the 2nd and 3rd ionisation energy values.

The 3rd electron from **Z** is removed from the inner principal quantum shell which is in a **much lower** energy level. The electron in inner principal quantum shell experience **much greater** nuclear attraction hence requires **much more** energy to overcome it.

(b) How many occupied principal quantum shells does **Z** have?

There are **2 sharp jumps** in successive I.E., indicating that there are 3 occupied principal quantum shells.

(c) Write the electronic configuration of **Z.**

Total number of electrons on the element = 12
Electronic configuration = **$1s^2\ 2s^2\ 2p^6\ 3s^2$**