Worksheet 3.1

Ionisation energy and atomic orbitals

Ionisation energy

1 **a** Define the following terms:
- **i** 1st ionisation energy [3]
- **ii** 3rd ionisation energy. [3]

b Write equations which describe:
- **i** the 1st ionisation of magnesium [2]
- **ii** the 3rd ionisation of magnesium. [2]

c Which ionisation energy is represented by each equation below?
- **i** $Mg^{3+}(g) \rightarrow Mg^{4+}(g) + e^-$ [1]
- **ii** $Al^{5+}(g) \rightarrow Al^{6+}(g) + e^-$ [1]

Hint: The number of the ionisation energy is the charge on the ion produced by the ionisation.

2 **a** The table below shows the first five ionisation energies for five elements (A to E). State which group each of these elements belongs to. [5]

Element	Ionisation energy / kJ mol^{-1}				
	1st	2nd	3rd	4th	5th
A	786	1580	3230	4360	16 090
B	418	3070	4600	5860	7975
C	1090	2350	4610	6220	37 830
D	548	1060	4120	5440	6908
E	577	1980	2960	6190	8200

b Explain the reasoning behind your answer for element C. [2]

c Draw a sketch graph to show how $\log_{10}$ ionisation energy for chlorine (atomic number 17) varies when plotted against the number of electrons removed. [7]

Atomic orbitals

3 What is meant by the term atomic **orbital**? [2]

4 Draw the shapes and the relative directions in space of all the atomic orbitals at energy level $n = 2$. [4]

5 State the maximum number of electrons that each of the following orbitals can hold.
- **a** A 4s orbital. [1]
- **b** All the orbitals at the third energy level together. [1]
- **c** A 4d orbital. [1]

6 What is the meaning of the term **degenerate orbitals**? [2]

7 Why are degenerate orbitals singly occupied at first? [4]