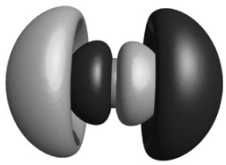
	Marks
• A schematic representation of a *p* orbital is shown below. The central sphere (mostly obscured) represents the atomic nucleus.	**2**



How many spherical and planar nodes does this orbital have? Label them on the diagram above.

Number of spherical nodes:	Number of planar nodes:

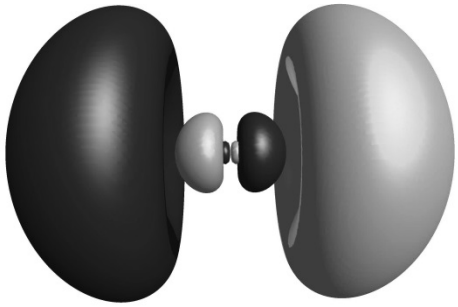
What is the principal quantum number, *n*, of this orbital? Explain your answer.

• Shielding is important in multi-electron atoms. Briefly explain the concept of shielding.	**3**

Give one example of a consequence of shielding.

Marks 3

- Consider the 4*p* orbital shown below. Note that, for clarity, the nucleus of the atom is not shown.



How many spherical and planar nodes does this orbital have?

Number of spherical nodes:	Number of planar nodes:

Complete the following table to give a set of quantum numbers that describes an electron in a 4*p* orbital.

Quantum number	*n*			
Value	4			

Marks 4

- Write down the ground state electron configurations for the following species.
  Na is given as an example.

Na	[Ne] $3s^1$
K	
As	
Sr	
C^+	

Name the elements described by the following configurations.

[Kr] $5s^2\ 4d^6$
[Xe] $6s^2\ 5d^1\ 4f^{11}$

- Name the element described by the following configuration. **Marks 1**

[Kr] $5s^2\ 4d^{10}$

- Write out the valence electron configuration of the following anions and in each case explain why the anion is less stable than the separated atom and electron. **4**

Ne^-

N^-

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

Marks 4

- The "Paschen" series of emission lines corresponds to emission from higher lying energy states to the $n = 3$ state in hydrogen-like atoms. Calculate the wavelength (in nm) of the lowest energy "Paschen" emission line in Li^{2+}.

Answer:

What are the possible l states for the $n = 4$ level of Li^{2+}?

Sketch the atomic orbital with $n = 3$ and the lowest value of l.

Marks 5

e) The oxygen atom in the reaction in part d) is formed in its ground electronic state. What is the ground state electronic configuration for O?

Draw an atomic orbital energy level diagram for the ground state O atom. Name the orbitals and show all electrons.

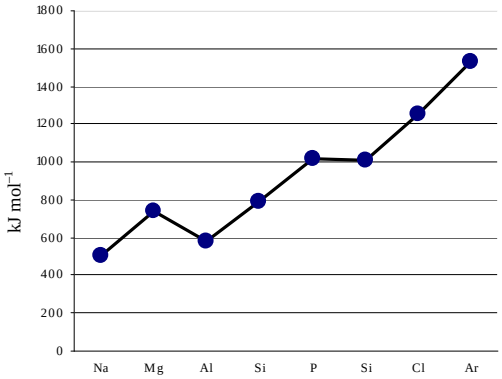
Name and sketch the atomic orbitals for the highest occupied atomic orbital and the lowest unoccupied atomic orbital in the ground state O atom. Make sure all nodes are clearly identified in your sketch.

sketch of highest occupied orbital	sketch of lowest unoccupied orbital
Name:	Name:

	Marks
• Consider the values of the electronic energy levels of an He atom. State which interactions would be expected to increase the energies of the electrons and which would decrease them.	**3**

Marks 4

- The graph shows the first ionisation energies for third row elements of the periodic table.



Explain the general trend and both anomalies.

Marks

- Moseley discovered experimentally in 1913 that the atomic number, *Z*, of an element is inversely proportional to the square root of the wavelength, λ, of fluorescent X-rays emitted when an electron drops from the $n = 2$ to the $n = 1$ shell.

$$i.e. \quad \frac{1}{\sqrt{\lambda}} = kZ$$

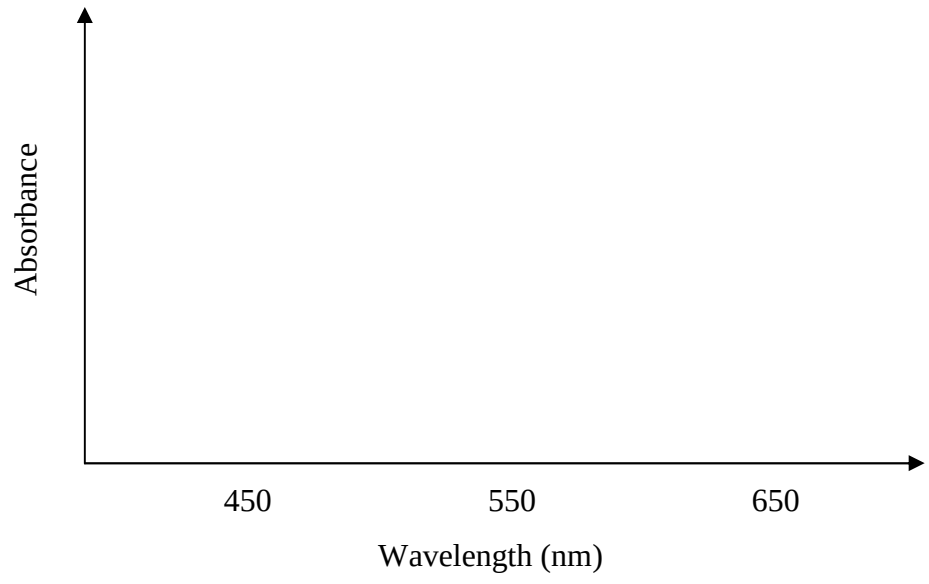
What element would emit such X-rays with a wavelength one-quarter that of zirconium?

3

Answer:

- Many plants are green due to their high chlorophyll content. Draw on the diagram below the absorption spectrum of a green pigment such as chlorophyll.

2



• Provide a brief explanation of each of the following terms. (You may include an equation or a diagram where appropriate).	**Marks 4**
(a) Pauli exclusion principle	
(b) the Bohr model of the atom	

• Write down the ground state electron configurations for the following elements. The configuration of lithium is given as an example.	**2**

Li	$1s^2\ 2s^1$
Ne	
Br	

• Sketch the following wave functions as lobe representations. Clearly mark all nodal surfaces and nuclear positions.	**4**

(a) a 2*p* orbital	(b) a π molecular orbital