Orbital Basics

A Level

P P P

Part A $5\mathrm{f}$ subshell

Give the number of f-orbitals that comprise the $5\mathrm{f}$ subshell.

Part B Number of electrons

Give the maximum number of electrons that can occupy a single orbital.

Part C Electrons in the second shell

Give the maximum number of electrons that can occupy the second shell.

Part D $3\mathrm{d}$ subshell

Give the maximum number of unpaired electrons that can occupy the $3\mathrm{d}$ subshell.

Part E Unpaired electrons

Give the number of unpaired electrons in the ground state of an oxygen atom.

Part F Paired electrons

Give the number of paired electrons in the ground state of the Na^{+} ion.

Based on questions D2.1 and D2.2 from Physical Chemistry book

Atomic Orbitals 3

A Level

Essential Pre-Uni Chemistry D2.3

Identify the subshell to which each of the orbitals below belongs.

Part A **(a)**

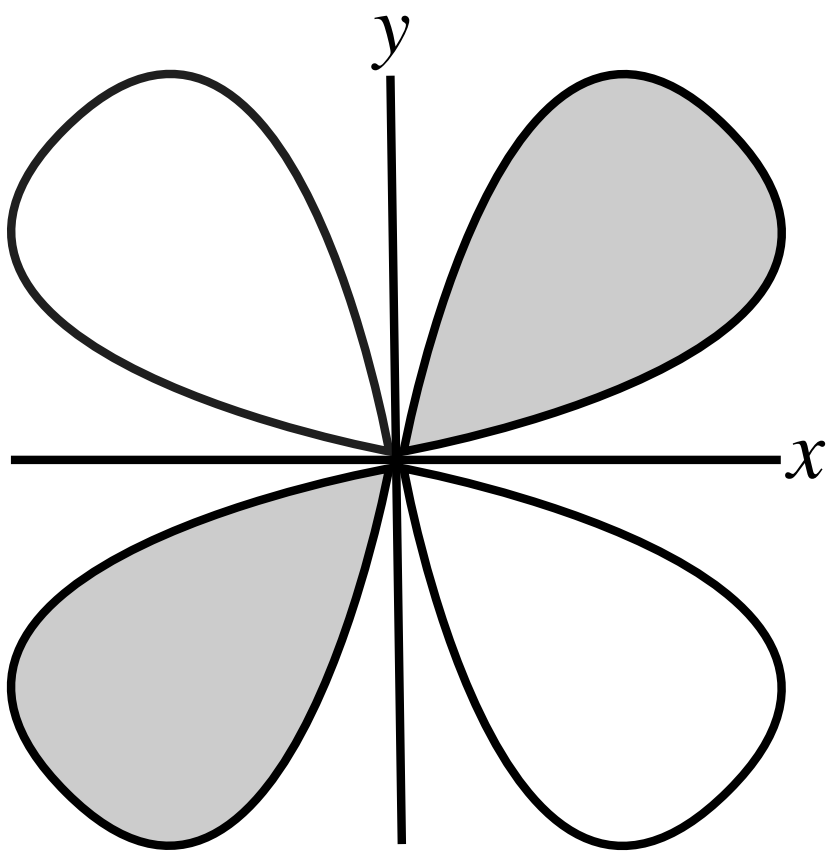

Figure 1: Unknown Orbital

What kind of orbital is depicted above?

- s
- p
- d
- f

Part B (b)

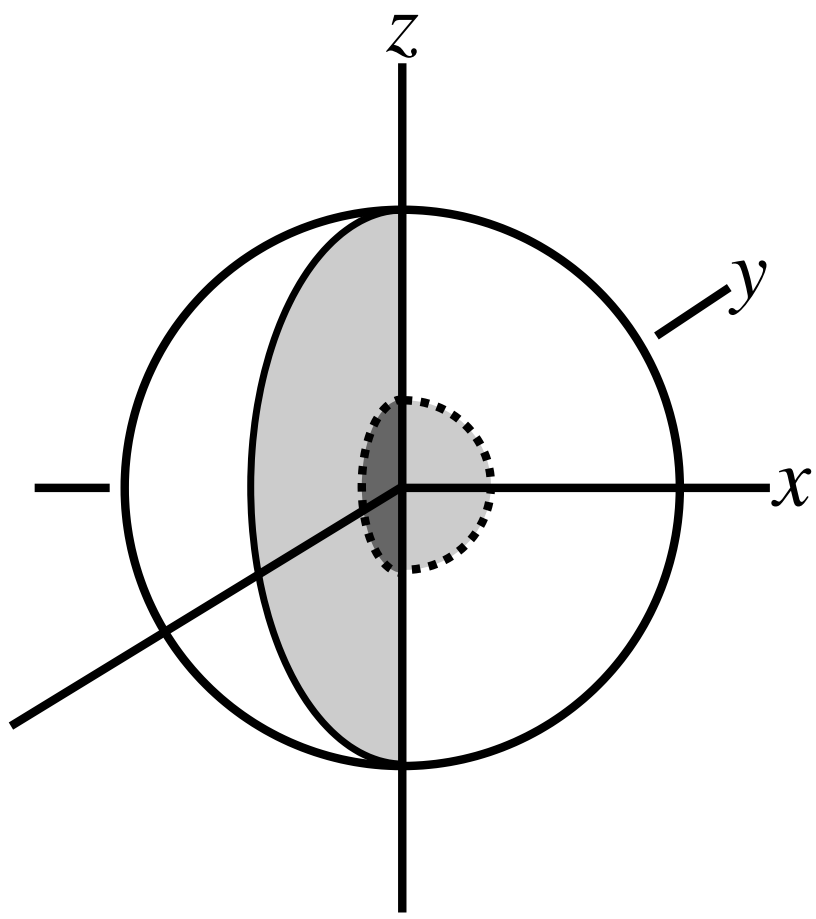

Figure 2: Unknown Orbital

What kind of orbital is depicted above?

- s
- p
- d
- f

Part C (c)

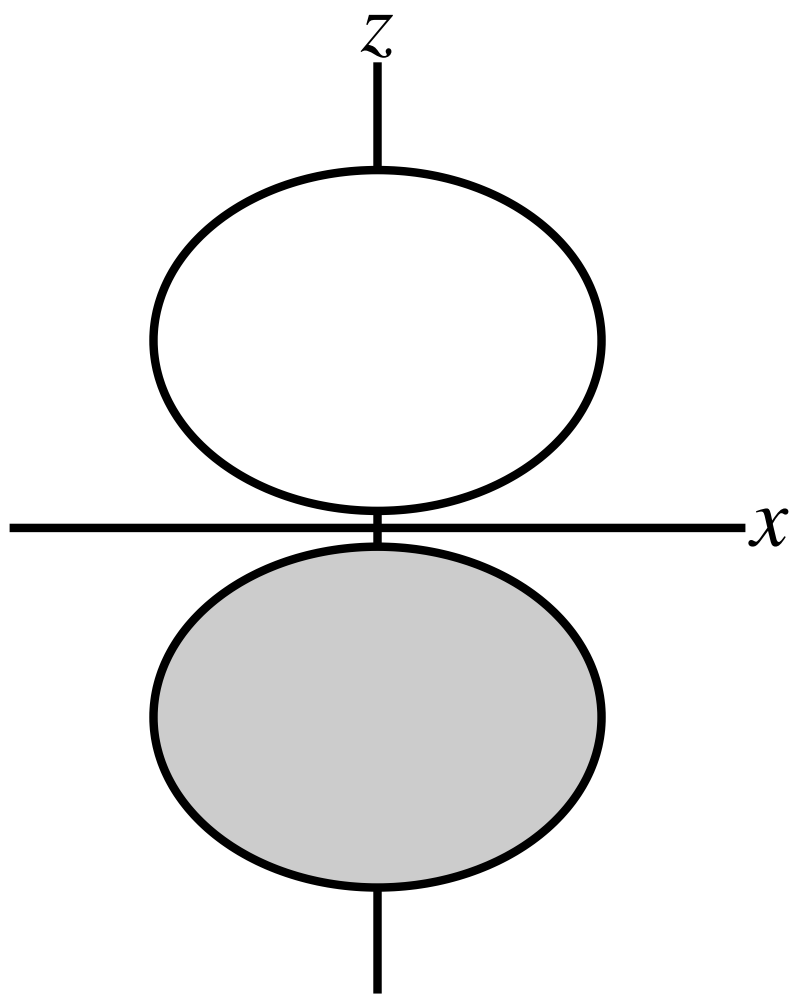

Figure 3: Unknown Orbital

What kind of orbital is depicted above?

- s
- p
- d
- f

Part D **(d)**

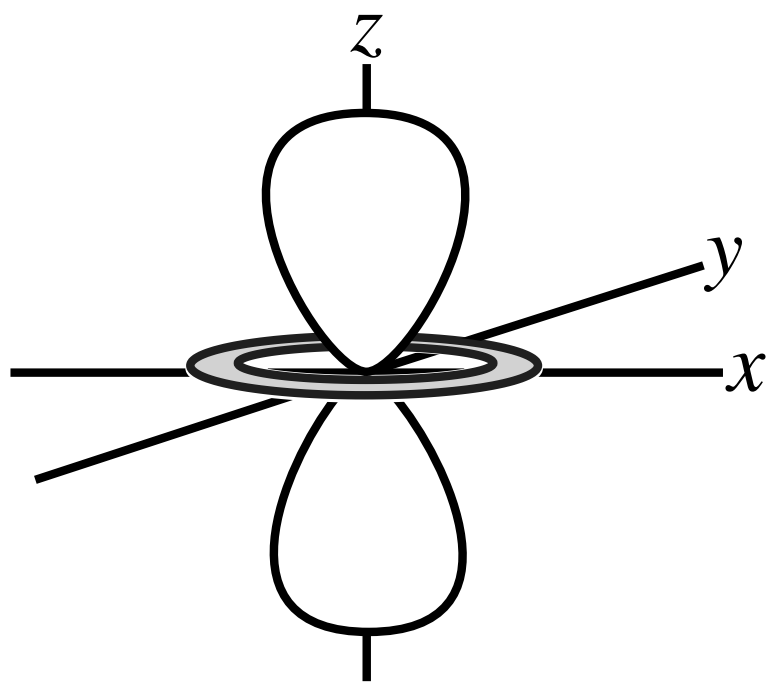

Figure 4: Unknown Orbital

What kind of orbital is depicted above?

- s
- p
- d
- f

Gameboard:

STEM SMART Chemistry Week 2

Orbitals and Subshells

A Level

Part A Vanadium

Give the number of occupied orbitals in the ground state of a vanadium atom.

Part B Titanium

Give the highest occupied subshell in the Ti^{4+} ion.

Part C Bismuth

Give the number of electrons in p-orbitals in the ground state of the Bi^{3+} ion.

Based on questions D2.4, D2.5 and D2.6 from the Physical Chemistry book

Gameboard:

STEM SMART Chemistry Week 2

Electron Configurations (D1.3)

A Level

Complete the following ground state electron configurations.

Part A K

What is the ground-state electron configuration of K?

[ ] [ ] [ ]

Items:

[Ar] [Kr] [Xe] 3s 4s 2p 4p 3d 1 2 6

Part B Sc

What is the ground-state electron configuration of Sc?

[Ar] 3d [ ] [ ] [ ]

Items:

3s 4s 3p 4p 1 2 3 4 5 6

Part C Cr

What is the ground-state electron configuration of Cr?

$[\mathrm{Ar}]\ 3\mathrm{d}$ [ ] [ ] [ ]

Items:

3s | 4s | 3p | 4p | 1 | 2 | 3 | 4 | 5 | 6

Part D Co

What is the ground-state electron configuration of Co?

$[\mathrm{Ar}]\ 3\mathrm{d}$ [ ] [ ] [ ]

Items:

3s | 4s | 4p | 1 | 2 | 3 | 5 | 6 | 7 | 8

Part E Cu

What is the ground-state electron configuration of Cu?

$1\mathrm{s}^2\ 2\mathrm{s}^2\ 2\mathrm{p}^6\ 3\mathrm{s}^2\ 3\mathrm{p}^6\ 3\mathrm{d}$ [ ] [ ] [ ]

Items:

4s | 4p | 1 | 2 | 3 | 4 | 7 | 8 | 9 | 10

Electron Configurations (D1.6)

A Level

Complete the following ground state electron configurations.

Part A Ti^{3+}

What is the ground-state electron configuration of Ti^{3+}?

Items:

[Ar] [Kr] 3s 4s 3p 3d 4d 1 2 3 4

Part B Fe^{2+}

What is the ground-state electron configuration of Fe^{2+}?

Items:

[Ar] [Kr] 3s 4s 3p 3d 4d 2 4 6 8

Part C Ni^{2+}

What is the ground-state electron configuration of Ni^{2+}?

[ ] [ ] [ ]

Items:

[Ar] [Kr] 3s 4s 3p 3d 4d 2 4 6 8 10

Part D Cu^{+}

What is the ground-state electron configuration of Cu^{+}?

[ ] [ ] [ ]

Items:

[Ar] [Kr] 3s 4s 3p 3d 4d 2 4 6 8 10

Part E Zn^{2+}

What is the ground-state electron configuration of Zn^{2+}?

$1s^2\ 2s^2\ 2p^6\ 3s^2$ [ ] [ ] [ ] [ ]

Items:

4s 3p 3d 4d 1 2 4 6 8 9 10

Atomic Structure 10

A Level

Essential Pre-Uni Chemistry D1.10

A 1^+ ion, in an excited state due to X-ray bombardment, is found to have an electron configuration $1s^2\ 2s^1\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2\ 4p^1$ in the gas phase.

Name the element whose ion this is.

Gameboard:

STEM SMART Chemistry Week 2

No Paired p-Electrons

A Level

Select which of the following elements has *no* paired p electrons in a single uncombined atom of the element:

- Oxygen
- Neon
- Silicon
- Magnesium
- Carbon

Adapted with permission from UCLES, A Level Chemistry, June 1990, Paper 1, Question 6

Gameboard:

STEM SMART Chemistry Week 2

First Configurations

A Level

P P P

Part A Unpaired electron

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has an unpaired electron in its ground-state configuration.

Part B Incomplete shell, no unpaired electrons

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has an incomplete shell, but no unpaired electrons in its ground-state configuration.

Part C Cation with unpaired electron

Specify the symbol of the element with the lowest atomic number that satisfies the following property: its singly-charged cation has an unpaired electron in its ground-state configuration.

Part D Full shell configuration $^{2-}$ anion

Specify the symbol of the element with the lowest atomic number that satisfies the following property: its doubly-charged anion has only full shells in its ground-state configuration.

Part E Cation and anion

Specify the symbol of the element with the lowest atomic number that satisfies the following property: both its singly-charged cation and its singly-charged anion have two unpaired electrons in their ground-state configurations.

Part F Partially-filled p-orbital

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has a partially-filled p-orbital in its ground-state configuration.

Part G Fully-filled p-orbital

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has a fully-filled p-orbital in its ground-state configuration.

Part H Six unpaired electrons

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has six unpaired electrons in its ground-state configuration.

Part I Fully-filled d-orbital

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has a fully-filled d-orbital in its ground-state configuration.

Part J Fully-filled d-subshell

Specify the symbol of the element with the lowest atomic number that satisfies the following property: it has a fully-filled d-subshell in its ground-state configuration.

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Gameboard:

STEM SMART Chemistry Week 2

Elements Reversal

A Level

C C C

Although the elements in Mendeleev's table are primarily arranged by atomic mass, this was not the case with tellurium (Te) and iodine (I). Mendeleev realised that the chemical properties of the elements meant that tellurium had to come before iodine, but the atomic masses did not support this order. He marked the mass of tellurium with a question mark to highlight its suspicious value.

The modern value for the relative atomic mass of tellurium is one of the least precise: 127.60 ± 0.03. The reason for the uncertainty is that naturally occurring tellurium is a mix of 8 different isotopes whose proportions can vary depending on the sample. In contrast, naturally occurring iodine consists of a single isotope – iodine 127 – and so its relative mass is known to a high degree of precision: 126.904472 ± 0.000003.

Part A Protons in iodide

State the number of protons in an iodide ion.

Part B Neutrons in iodide

State the number of neutrons in an iodide ion.

Part C Electrons in iodide

State the number of electrons in an iodide ion.

Part D Tellurium-130

The heaviest of the isotopes found in naturally occurring tellurium is tellurium-130 which has a relative mass of 129.906223. Technically, tellurium-130 is very slightly radioactive and if there were none in the naturally occurring element, the relative atomic mass of tellurium would be 126.412449 (which would make it less than iodine).

Calculate the percentage of tellurium-130 present in naturally-occurring tellurium to 4 significant figures.

Adapted with permission from the Cambridge Chemistry Challenge 2019, Question 1