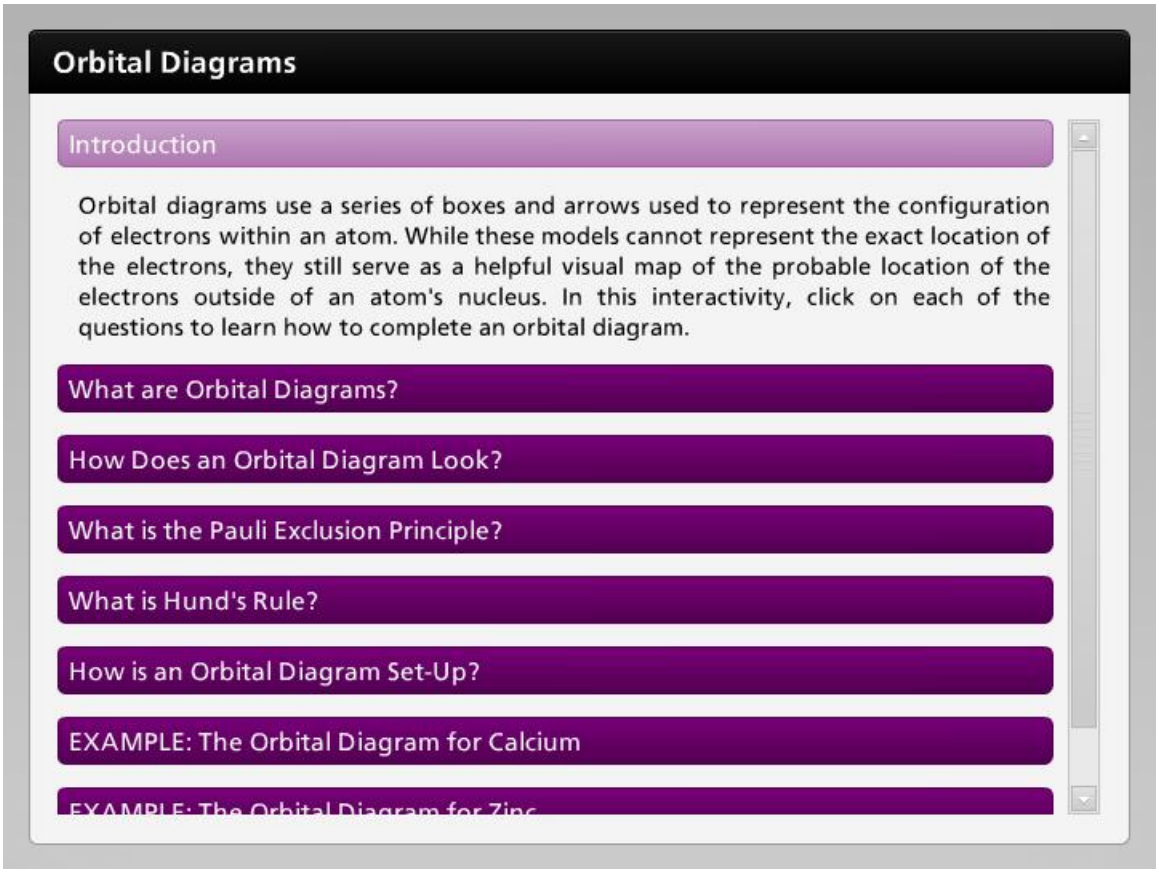
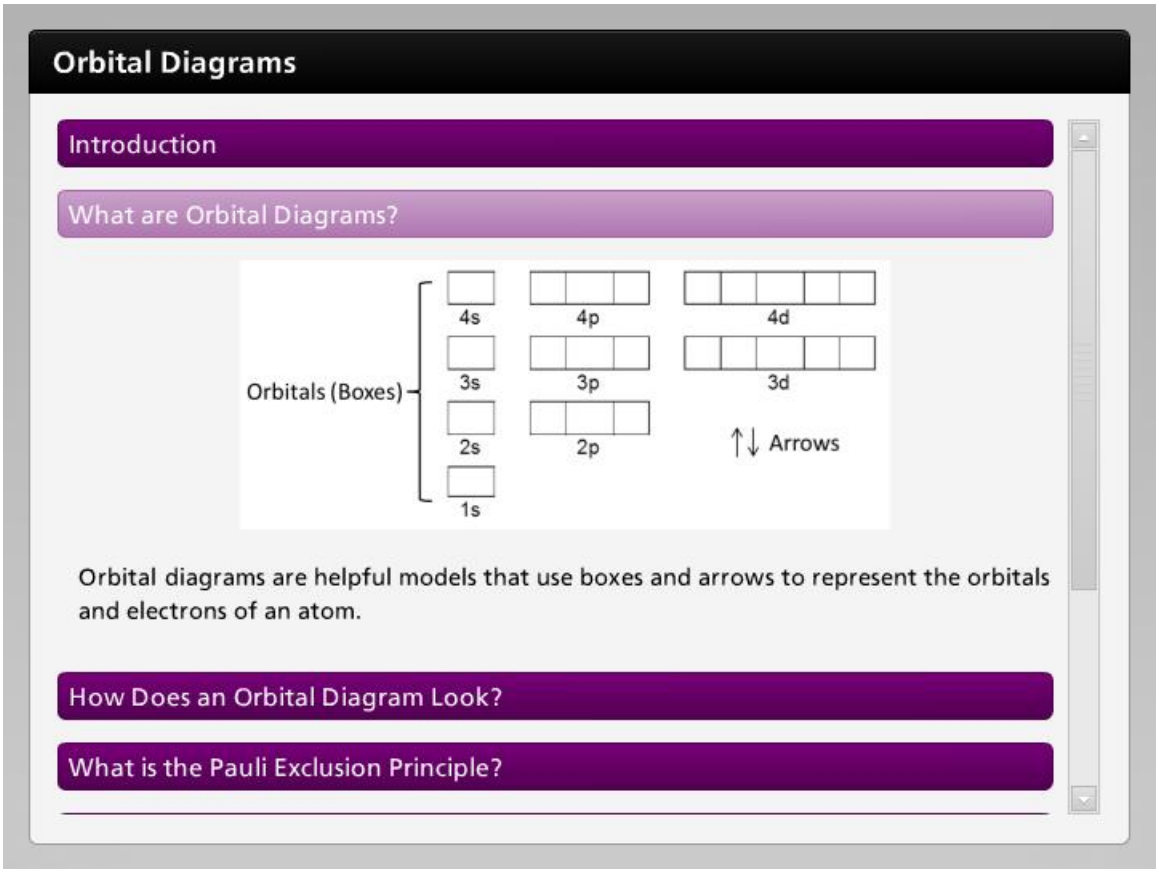
Module 3: Modern Atomic Theory, Electron Structure, and Periodicity
Topic 4 Content: Orbital Diagrams

Introduction



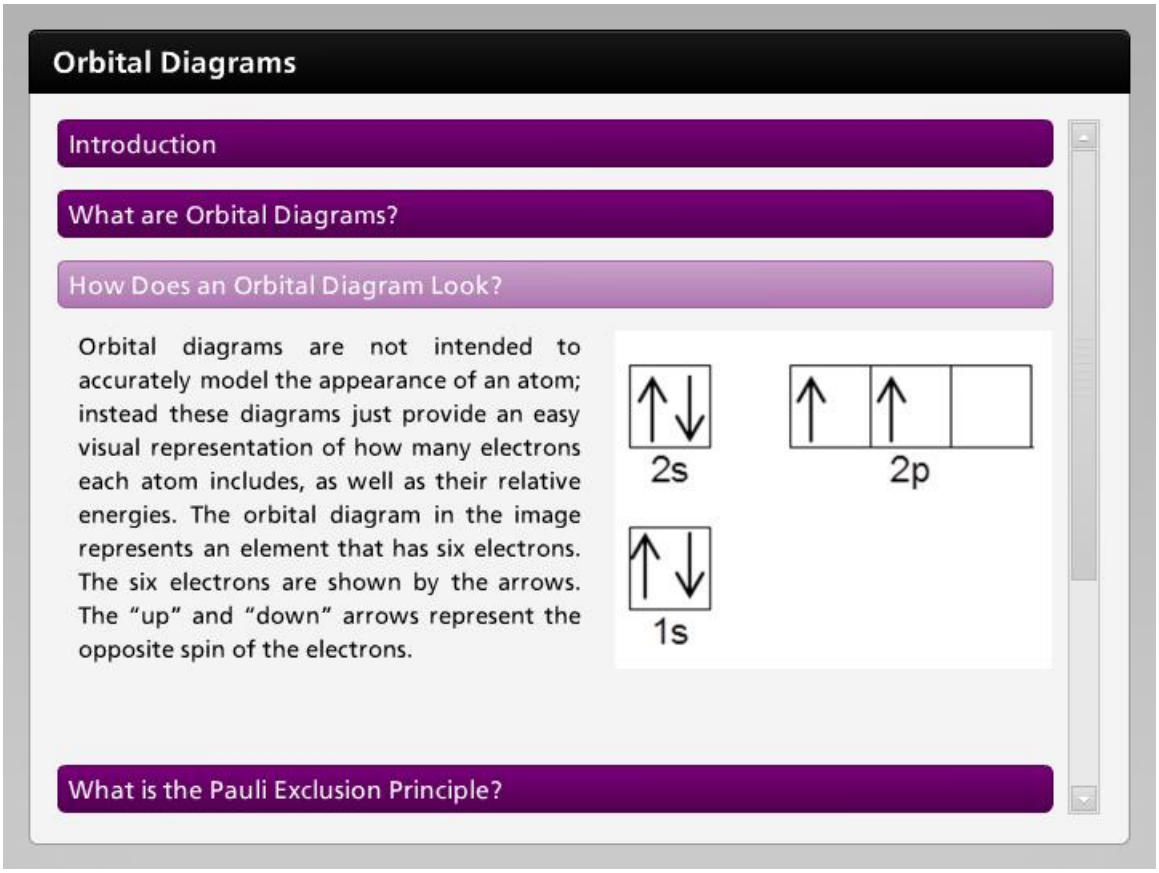
Orbital diagrams use a series of boxes and arrows used to represent the configuration of electrons within an atom. While these models cannot represent the exact location of the electrons, they still serve as a helpful visual map of the probable location of the electrons outside of an atom's nucleus. In this interactivity, click on each of the questions to learn how to complete an orbital diagram.

What are Orbital Diagrams?



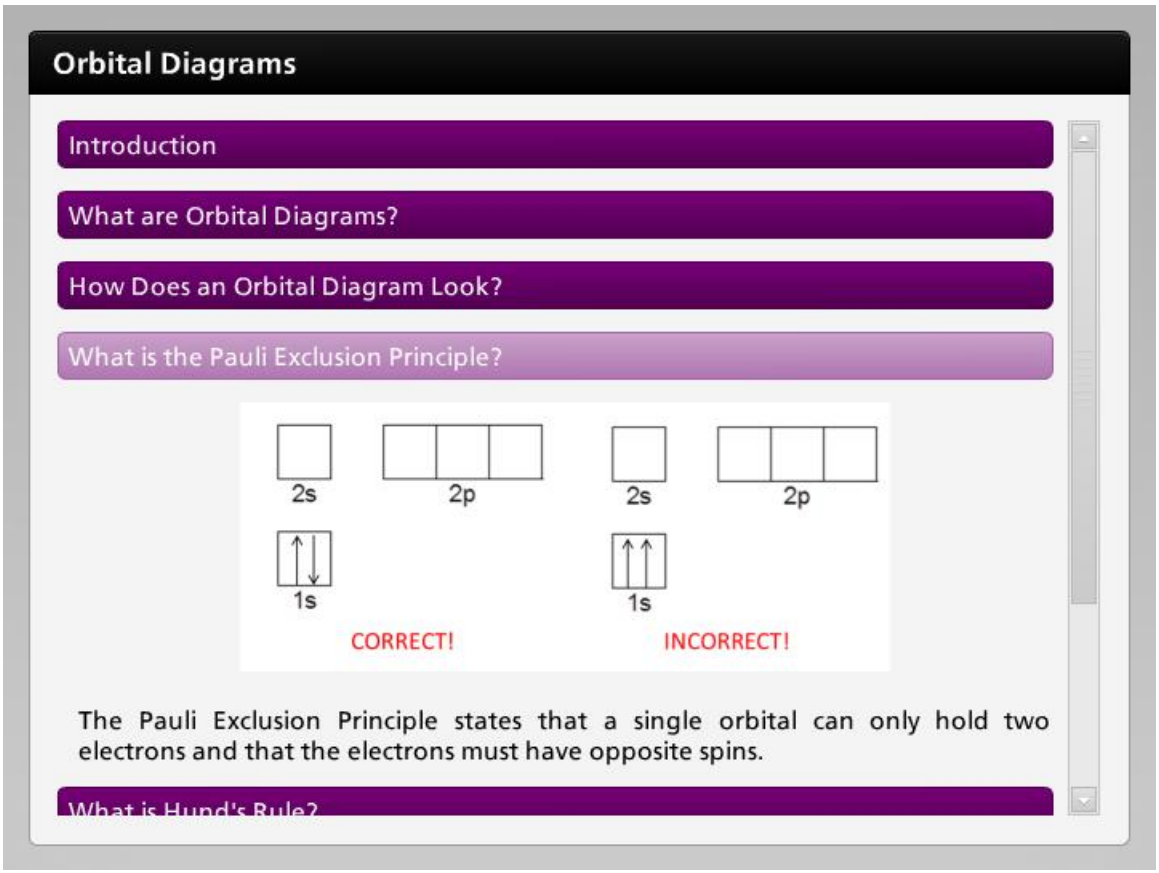
Orbital diagrams are helpful models that use boxes and arrows to represent the orbitals and electrons of an atom.

How Does an Orbital Diagram Look?



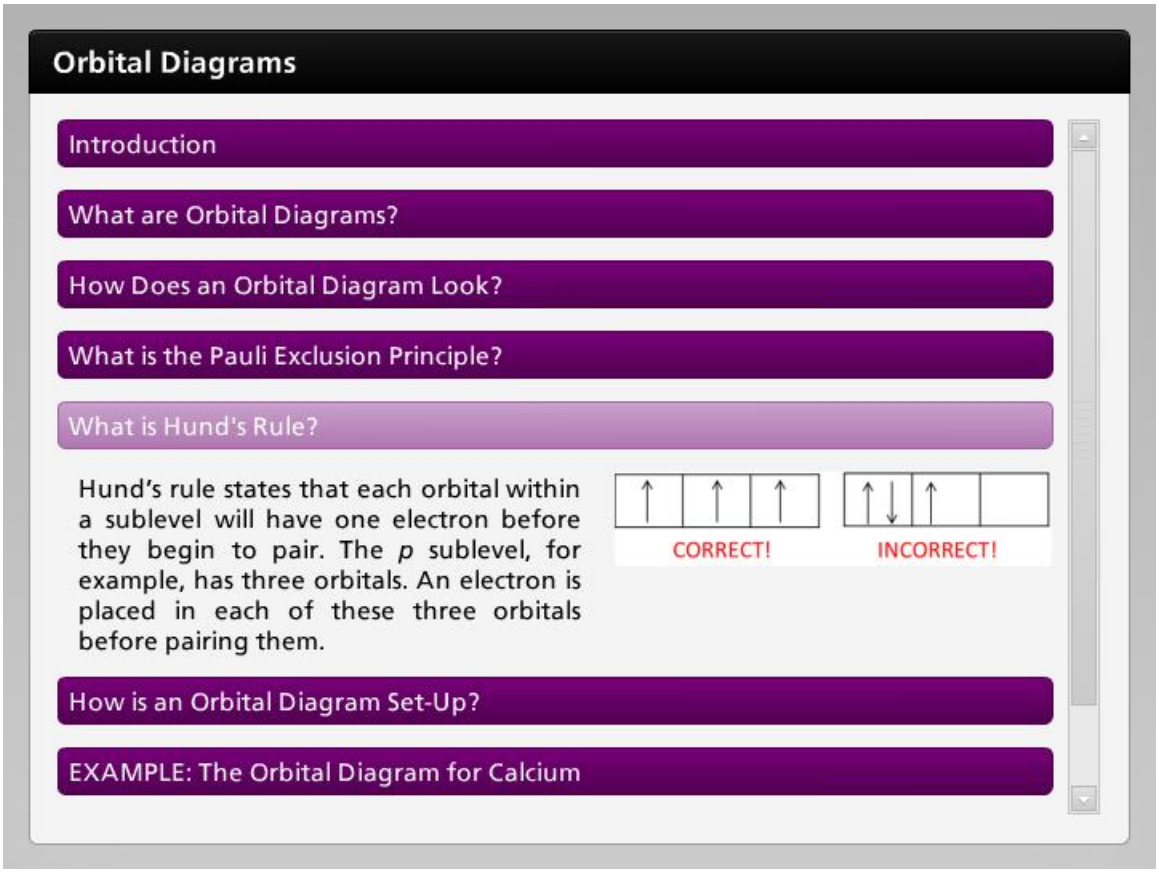
Orbital diagrams are not intended to accurately model the appearance of an atom; instead these diagrams just provide an easy visual representation of how many electrons each atom includes, as well as their relative energies. The orbital diagram in the image represents an element that has six electrons. The six electrons are shown by the arrows. The "up" and "down" arrows represent the opposite spin of the electrons.

What is the Pauli Exclusion Principle?



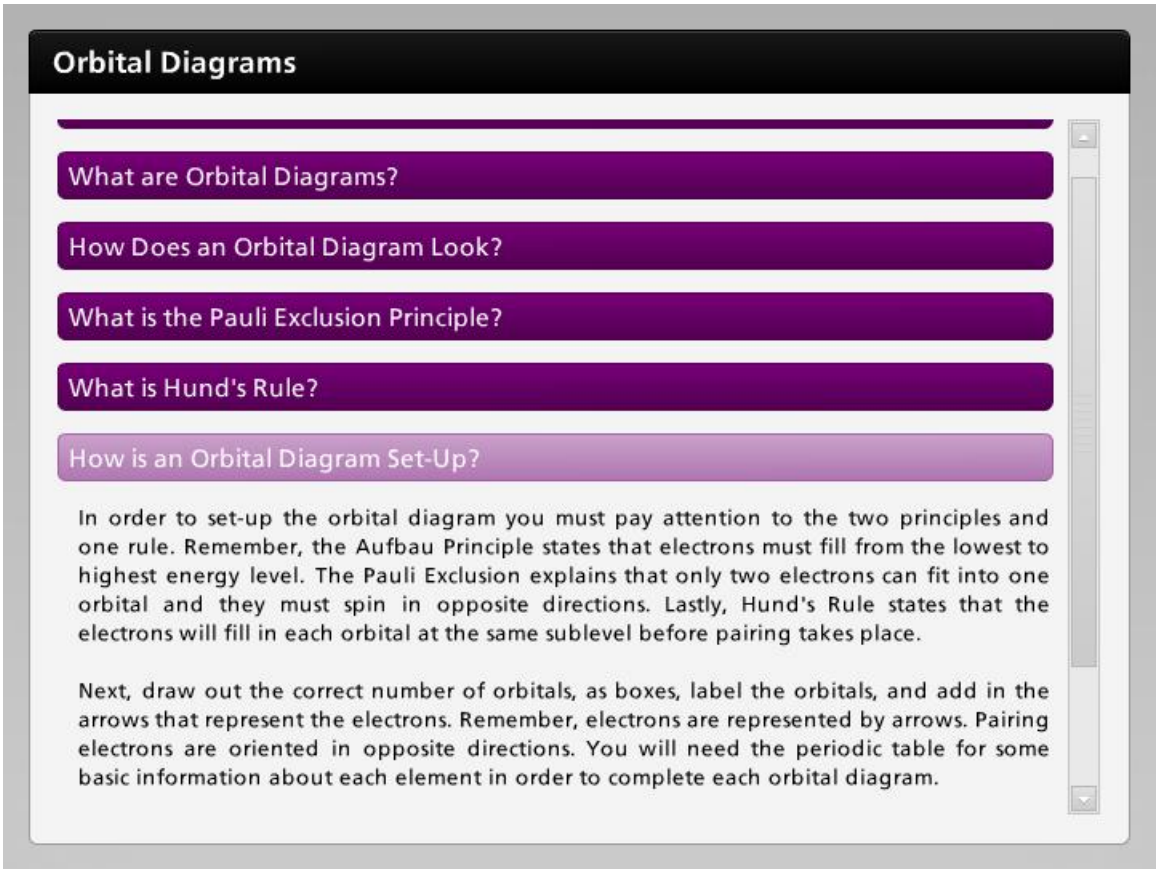
The Pauli Exclusion Principle states that a single orbital can only hold two electrons and that the electrons must have opposite spins.

What is Hund's Rule?



Hund's rule states that each orbital within a sublevel will have one electron before they begin to pair. The p sublevel, for example, has three orbitals. An electron is placed in each of these three orbitals before pairing them.

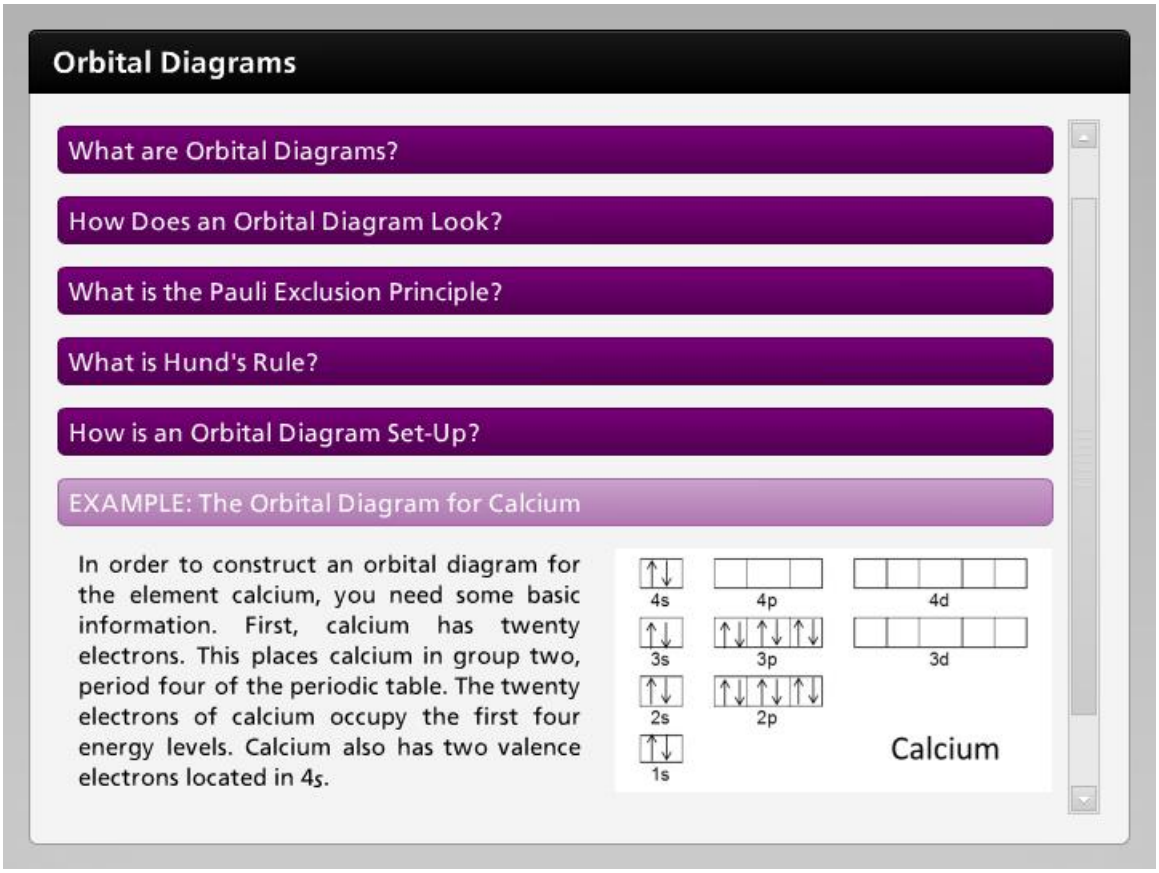
How is an Orbital Diagram Set-Up?



In order to set-up the orbital diagram you must pay attention to the two principles and one rule. Remember, the Aufbau Principle states that electrons must fill from the lowest to highest energy level. The Pauli Exclusion explains that only two electrons can fit into one orbital and they must spin in opposite directions. Lastly, Hund's Rule states that the electrons will fill in each orbital at the same sublevel before pairing takes place.

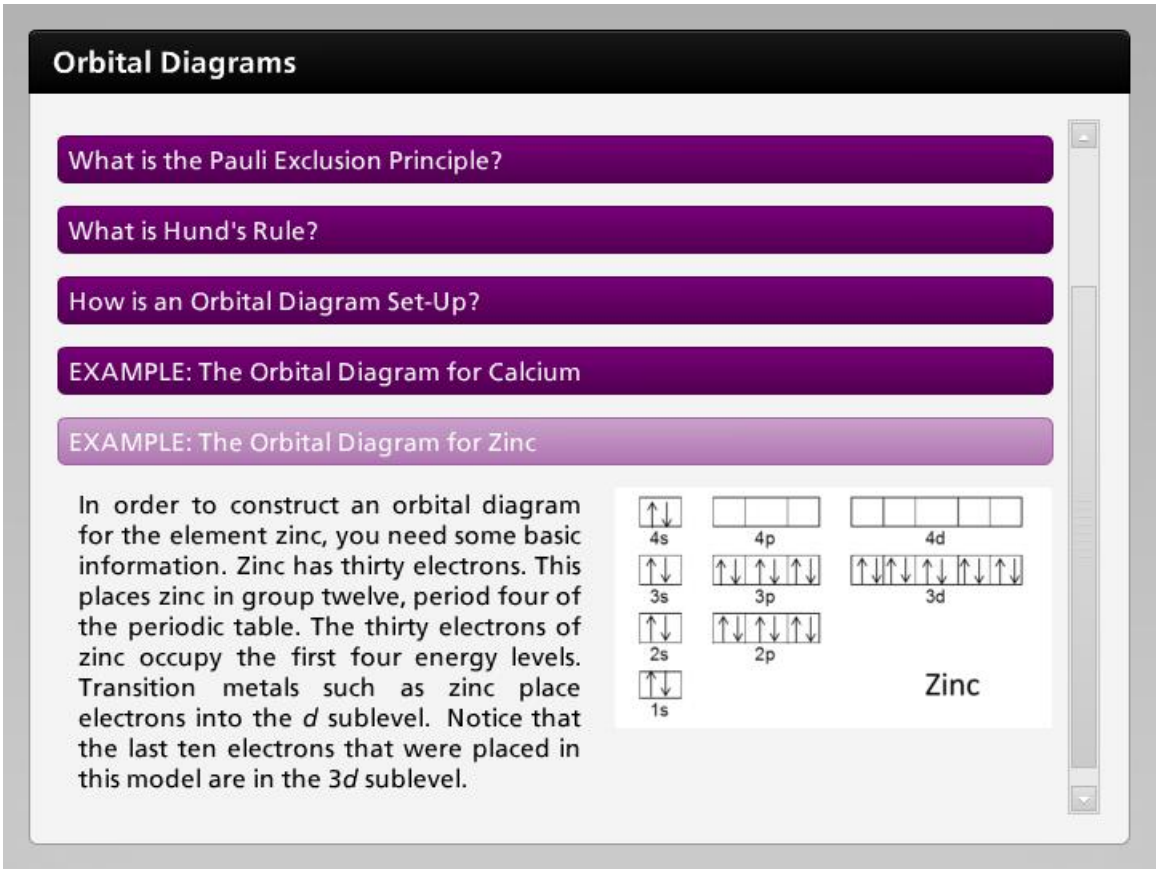
Next, draw out the correct number of orbitals, as boxes, label the orbitals, and add in the arrows that represent the electrons. Remember, electrons are represented by arrows. Pairing electrons are oriented in opposite directions. You will need the periodic table for some basic information about each element in order to complete each orbital diagram.

EXAMPLE: The Orbital Diagram for Calcium



In order to construct an orbital diagram for the element calcium, you need some basic information. First, calcium has twenty electrons. This places calcium in group two, period four of the periodic table. The twenty electrons of calcium occupy the first four energy levels. Calcium also has two valence electrons located in 4*s*.

EXAMPLE: The Orbital Diagram for Zinc



In order to construct an orbital diagram for the element zinc, you need some basic information. Zinc has thirty electrons. This places zinc in group twelve, period four of the periodic table. The thirty electrons of zinc occupy the first four energy levels. Transition metals such as zinc place electrons into the d sublevel. Notice that the last ten electrons that were placed in this model are in the 3*d* sublevel.