

Periodic Table and Atomic Structure: Secret Agent

Student Advanced Version

This lab explores the structure of atoms and elements as well as simple ionic bonds. Students use colored beads and the periodic table to model and identify different elements. Students also assemble a periodic table of secret agents, and try to identify the missing agent, based on trends and patterns.

Key Concepts:

- An **atom** is the smallest particle any given molecule can be broken down to.
- A **proton** is a positively charged particle in an atom.
- An **electron** is a negatively charged particle in an atom.
- A **neutron** is a neutral (neither negative nor positive) particle in an atom.
- The **atomic number** is the number of protons in an atom.
- **Primary energy levels**, also called **electron shells**, are regions that electrons move in within the atom. The innermost of the energy levels surrounds the nucleus of the atom and has a maximum electron-holding capacity of two.
- Each energy level after the first one fills up with 8 electrons.
- **Ions** are charged atoms formed by losing or gaining electrons.

Information on the Periodic Table of Elements: An Example

The elements are ordered in consecutive order according to their **Atomic Number**. In most periodic tables, this number is found at the top (30). It represents the number of protons, which equals the number of electrons, so the positive and negative charges cancel, and give the element's atom an overall neutral charge. An abbreviated form of

23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.93	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39
41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41
73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59
105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]

30 Zn Zinc 65.39

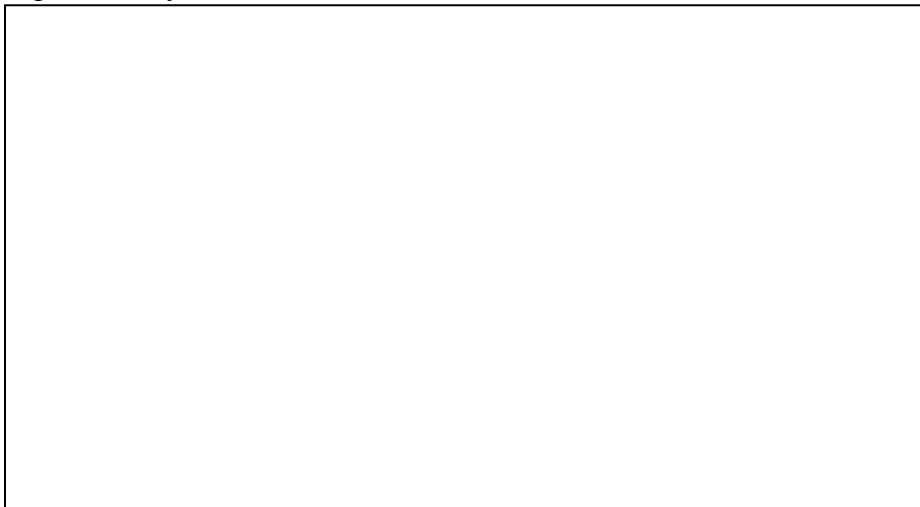
referring to the element is through its **Atomic Symbol** (Zn), though the actual name of the element is always given (Zinc). The only other number besides the Atomic Number in an element box is the **Atomic Mass**. It can be a rounded number, or a decimal (65.39). The Atomic Mass is approximately the number of protons plus the number of neutrons (in this case, there are 35 neutrons).

Part 1 – Atoms & Elements

Procedure:

Use the Atom Template to model the following atoms and elements.

1. Place 22 yellow beads in the central grey area marked with 0 (neutral) charge. *What part of the atom are you now modeling?* _____
2. Place 18 green beads in the central grey area marked with + (positive) charge. *What part of the atom are you now modeling?* _____
3. *What part of the atom do the three concentric ovals represent?* _____
4. Place 2 red beads, one in each of the boxes in the first (inner) circle, then 8 red beads in the boxes the second, and finally 8 red beads in the third circle boxes. *What do red beads represent?* _____
5. Draw a picture of your atom model:



Q1. Using a Periodic Table of the Elements, fill in the following for your atom:

Atomic number:

Atomic mass:

Chemical symbol:

Chemical name:

Overall charge:

1. Place 12 yellow beads in the neutral oval and 12 green beads in the positive oval.
2. On the first circle place 2 red beads. Continue placing red beads (total number of electrons is equal to the number of protons) onto the next energy levels until you run out of beads (make sure they don't exceed 8 beads per orbit!).
3. Draw a picture of this new model.



Q2. What is your atom's Atomic number: Atomic mass: Chemical symbol:

Chemical name:

Overall charge:

1. Look at the Periodic Table of the Elements and locate Chlorine.
2. Create a model of the chlorine atom on your template, then draw it here:

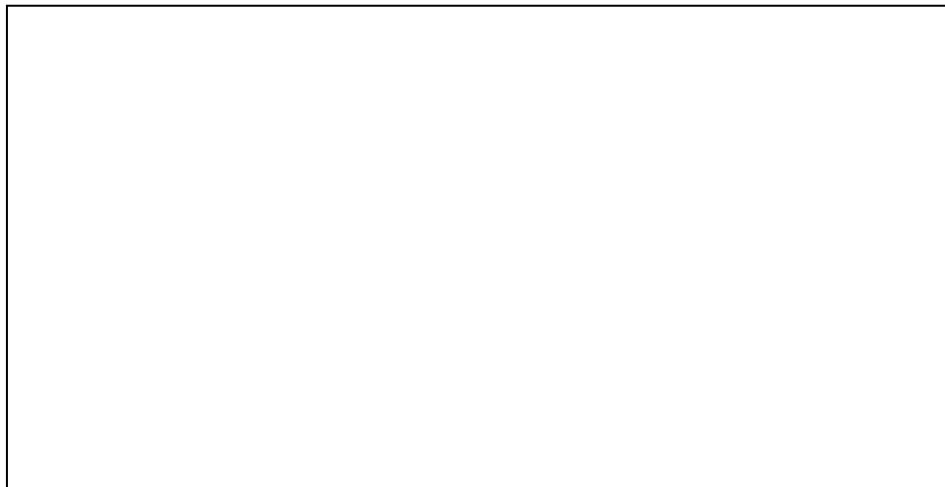


Q3. What is chlorine's Atomic number: Atomic mass: Chemical symbol:

Number of neutrons:

Overall charge:

1. Look at the Periodic Table of the Elements and locate Boron.
2. Create a model of the boron atom on your template (if necessary), then draw it here:



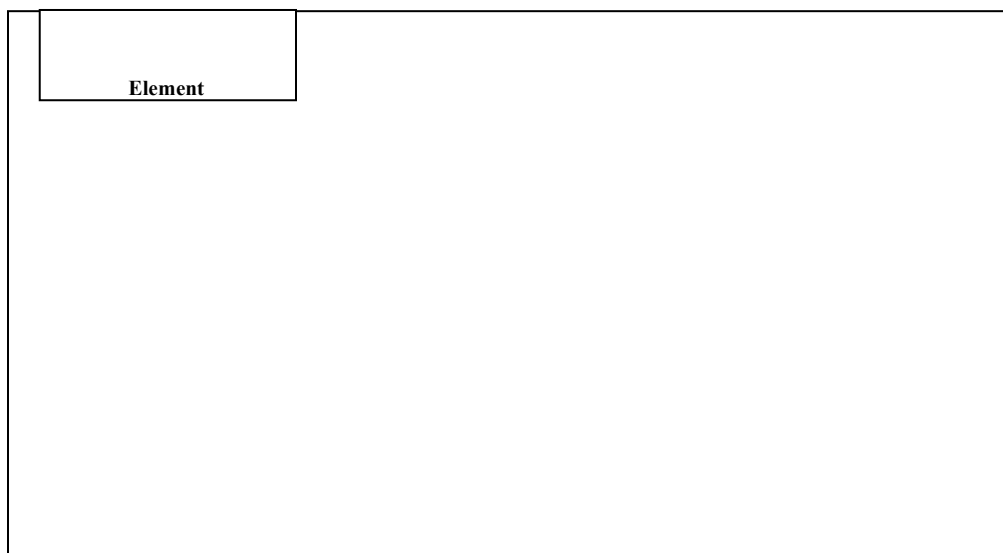
Q4. What is boron's Atomic number: Atomic mass: Chemical symbol:

Number of neutrons: Overall charge:

Part 2 – Introducing Ions & Ionic Bonding

Procedure:

1. Draw a model of an atom that has 11 protons, 12 neutrons, and 11 electrons. (Use the Atom Template first if necessary) What element is this?

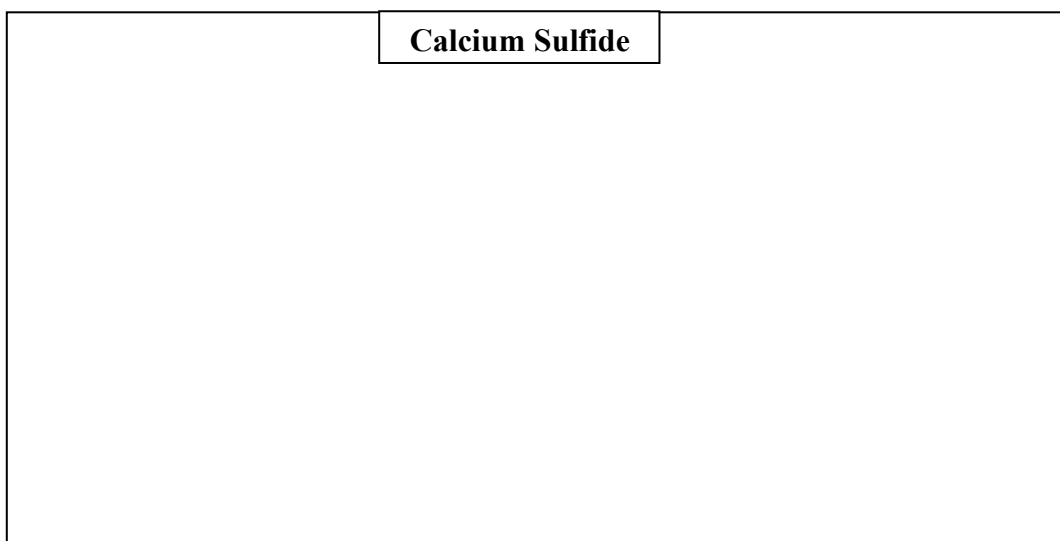


2. Draw your atom next to a chlorine atom. Show how 1 electron in the third shell leaves the atom, but joins the outermost shell of a chlorine atom (which has 7 electrons):



Q5. After the electron transfer, what is sodium's atomic number, atomic mass, chemical symbol, chemical name, and overall charge?

3. Draw a model showing the ionic bonding of Calcium and Sulfur. What does the electron transfer look like if these two atoms come together?



Q6. After the electron transfer occurs between calcium and sulfur, what are the sulfur atom's atomic number, atomic mass, chemical symbol, and overall charge?

Part 3 – Secret Agent Activity

Introduction (“The Mission”):

Based on your expertise in problem solving, your mission, should you accept it, is to work with the “photographs” of the suspicious characters on the attached Secret Agent sheet. They are part of a family of Secret Agents, but the deadliest agent of all has never been photographed, thus his “true” identity remains a mystery. Ultimately, your job is to arrange the photographs in a specific pattern that provides enough information enabling you to sketch the identity of the missing secret agent. Then you will create a “family portrait” of all the characters on poster paper as well as answering a few post-activity questions.

Procedure:

1. You should begin by cutting out all 17 photographs of the Secret Agents as well as the three blank squares.
2. **Note: You only need one blank to sketch the identity of the missing agent, but three blank squares are provided in case you make mistakes and need to start over.**
3. Arrange the photographs of the known Secret Agents by what they share in common, perhaps by choosing one or two shared characteristics at first to separate the Secret Agents into smaller piles.
4. Once you have several distinct piles focusing on one or two shared characteristics, now try looking at the big picture and combine the agents into one large family portrait.
5. If you have compiled the Secret Agents into the correct arrangement, there will be one empty spot in the family portrait.
6. **This missing spot is where the missing Secret Agent belongs in the family portrait.**
7. You should be able to sketch his exact identity by looking at the characteristic of those agents closest to him in the family portrait.
8. Once you have determined the identity of the missing Secret Agent *and* have the correct arrangement for the family portrait, look closely! Describe what you see:
9. Obtain one piece of large construction or presentation paper and a glue stick or tape.
10. Paste or tape all 18 Secret Agents onto the piece of construction paper in the correct arrangement.
11. Give the family portrait a creative family name of your choosing.
12. Give your missing Secret Agent a creative name (other than what it’s really called).
13. If time is available, decorate your family portrait in a creative and artistic fashion.

Concept Questions:

Q7. List all relationships observed in the characters as you look down a column.

Q8. List all relationships observed in the characters as you look across a row.

Q9. What is the actual identity of the missing secret agent? In other words, what chemical name do we call this “character” when it’s found on the Periodic Table of Elements?

Q10. What information from the Periodic Table of Elements does the character fingers represent?

Q11. What information from the Periodic Table of Elements does the character arms represent?

Q12. What information from the Periodic Table of Elements does the character hair represent?

Q13. What information from the Periodic Table of Elements does an increase in character body size represent?

Q14. What information from the Periodic Table of Elements does the character facial expression represent?