Atoms, Isotopes, and Ions

Teacher Information

science take-out just add students™

Summary

Students use chips and a periodic table to model the sub-atomic particles in atoms, isotopes, and ions.

Core Concepts

- Information in the periodic table can be used to determine the structure of atoms.
- Isotopes are atoms of the same element that have different numbers of neutrons.
- Ions are charged particles formed when atoms lose or gain electrons.

Time Required

Two 40-minute class periods

Kit contains

- **Reference Sheet** with periodic table of elements
- **Model Sheet**
- Cup (nucleus)
- Bag of colored chips to represent protons, neutrons, and electrons.
- Labels for chips

Teacher Suggestions

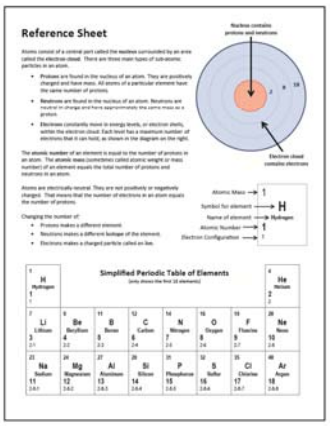
- Chips and model sheets may also be used to discuss valence electrons and bonding.
- Pages iii-iv (**Applying What You Learned about Atoms, Isotopes, and Ions**) may be used as an optional quiz or as homework. Students will need a copy of the simplified period table or the reference sheet.

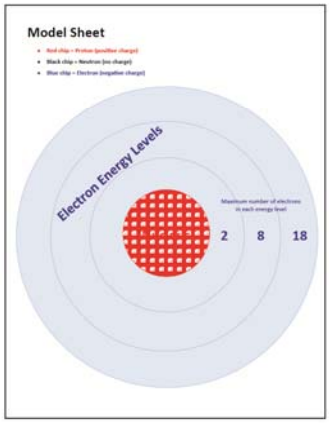
Reusing the kit

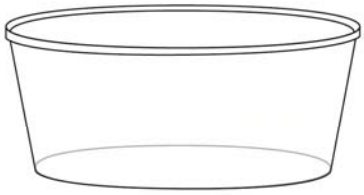
All parts of kit can be reused. Instruct students to save the colored chips.

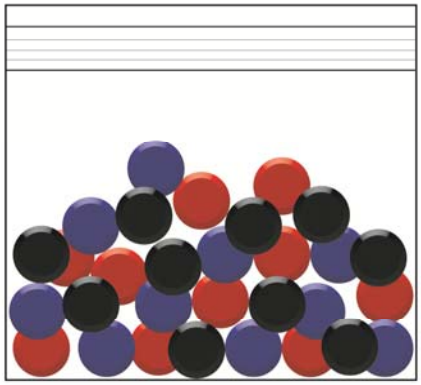
Warning: Choking Hazard
This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit components.

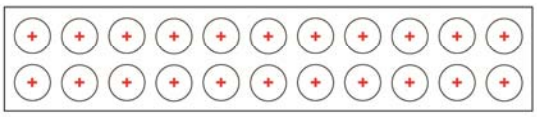
Kit Contents Quick Guide

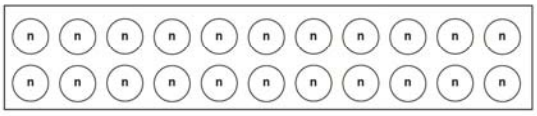


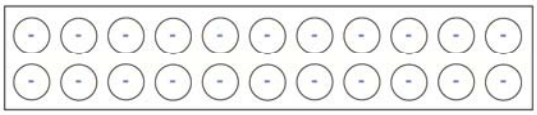








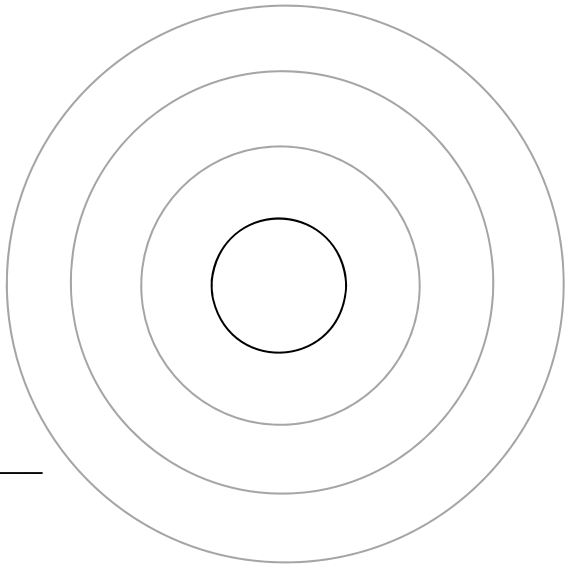




Applying What You Learned about Atoms, Isotopes, and Ions

You will need to refer to the information on a periodic table to complete this activity.

Base your answers to questions 1 through 5 on an element that has 15 protons and 16 neutrons. This element has 2 electrons in the innermost energy level, 8 electrons in the next energy level, and 5 electrons in the outermost energy level.



1. Complete the element's structure diagram on the right.
2. What is the element's atomic number? _____
3. What is the element's mass number? _____
4. What is the element's chemical symbol? _____
5. What is the element's chemical name? _____

Base your answers to questions 6 through 13 on the information below about elements A, B, C, and D.

A	B	C	D
12 protons 12 neutrons 12 electrons	12 protons 13 neutrons 12 electrons	12 protons 12 neutrons 11 electrons	11 protons 12 neutrons 11 electrons

6. What is the symbol for element A? _____
7. What is the name of element A? _____
8. What is the mass number for element A? _____
9. What is the atomic number for element A? _____
10. Which diagram (B, C, or D) is NOT the same element as element A? Explain your answer.

_____

11. Which diagram (B, C, or D) is an ion of element A? Explain your answer.

_____

12. What is the charge of the ion you selected in question #11? Explain your answer.

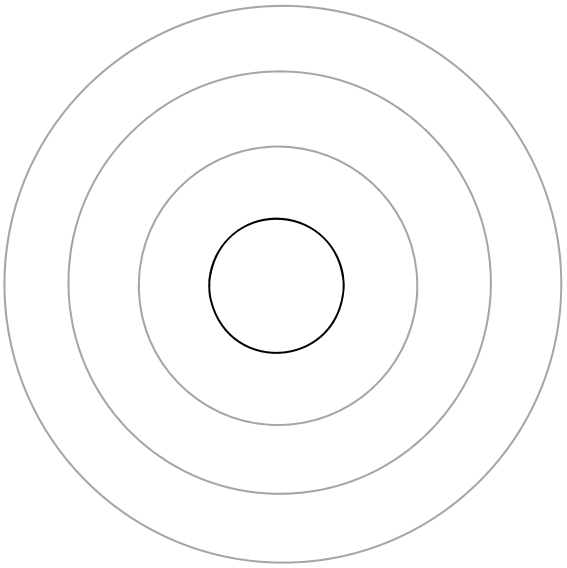
_____

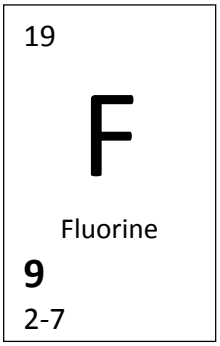
13. Which diagram (B, C, or D) is an isotope of element A? Explain your answer.

_____

Base your answers to questions 14 through 16 on the information about the element fluorine.

14. Complete the diagram below to show the sub-atomic particles in a fluorine atom. Include the appropriate numbers of neutrons, protons, and electrons.





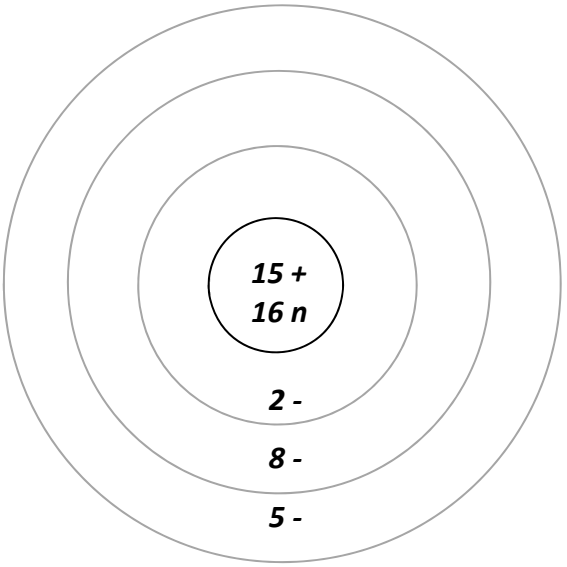
15. Explain how you should change the diagram to represent an <u>isotope</u> of fluorine.

_____

16. Explain how you should change the diagram to represent an **F** $^{1-}$ <u>ion</u>.

_____

Teacher Answer Key: Applying What You Learned about Atoms, Isotopes, and Ions



1. Complete the element's structure diagram on the right.
2. What is the element's atomic number? ___***15***___
3. What is the element's mass number? _____***31***___
4. What is the element's chemical symbol? ___***P***____
5. What is the element's chemical name? __***Phosphorous***_

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6. What is the symbol for element A? __***Mg***___
7. What is the name of element A? __***Magnesium***__
8. What is the mass number for element A? __***24***___
9. What is the atomic number for element A? __***12***___
10. Which diagram (B, C, or D) is NOT the same element as element A? Explain your answer.

    D because it has a different number of protons.

11. Which diagram (B, C, or D) is an ion of element A? Explain your answer.

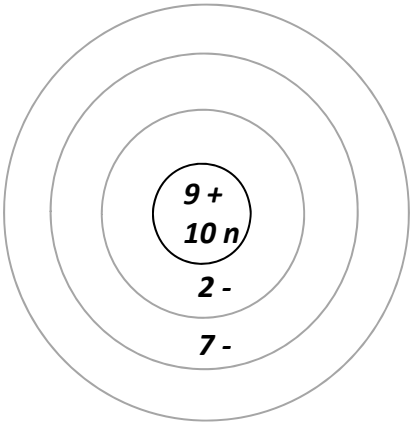
    C because it has a different number of electrons.

12. What is the charge of the ion you selected in question #11? Explain your answer.

    Positive charge or + 1 charge because it has one fewer electron than protons.

13. Which diagram (B, C, or D) is an isotope of element A? Explain your answer.

    B because it has an additional neutron.



14. Complete the diagram to show the sub-atomic particles in a fluorine atom.
15. Explain how you should change the diagram to represent an <u>isotope</u> of fluorine.

    Add 1 or more neutrons to the nucleus.

16. Explain how you should change the diagram to represent an **F** $^{1-}$ <u>ion</u>.

    Add one electron to the outer shell.

Atoms, Isotopes, and Ions - *Teacher Answer Key*

In this laboratory activity, you will use chips and the information in a Reference Sheet to make models of atoms, isotopes, and ions of various elements.

Part 1: Modeling Atoms

1. Use the information on the **Reference Sheet** to complete the chart below.

Sub-atomic Particle	Chip Color used to represent	Charge of particle	Location of particle	Change in number results in _____
Proton	Red	**+**	***Nucleus***	***A different element***
Neutron	Black	***0 or neutral***	***Nucleus***	***Isotopes***
Electron	Blue	**-**	***Electron cloud or Energy Levels or Electron Shells***	***Ions***

2. According to the **Reference Sheet**:

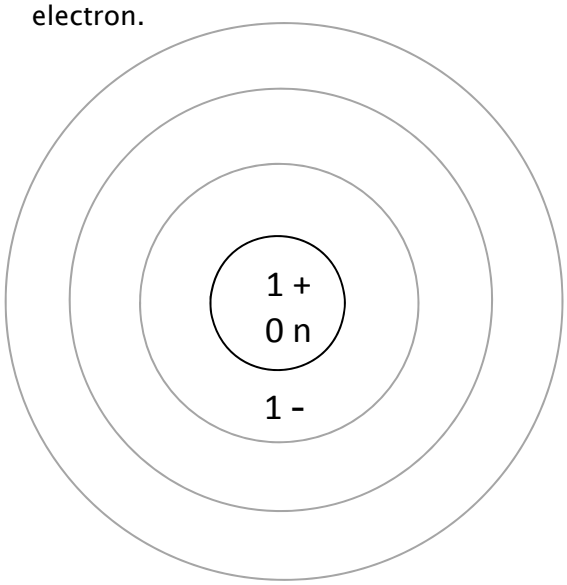
   - The atomic number is equal to the number of ___***Protons***___.
   - The mass number is equal to the number of ____***Protons***___ plus the number of ____***Neutrons***____.
   - The number of protons in an atom is equal to the number of _____***Electrons***___ in a neutral (uncharged) atom.

Before you continue with this activity, you will need to apply the stickers in your kit to the colored chips in your kit.

- Apply the red + stickers to the red chips. These chips represent protons.
- Apply the blue – stickers to the blue chips. These chips represent electrons.
- Apply the black **n** stickers to the black chips. These chips represent neutrons that have no charge.

3. Make a model of one atom of **hydrogen** on the **Model Sheet** in your kit.
   - Place the small cup on the nucleus of the Model Sheet.
   - Place 1 proton (red chip) in the nucleus cup on the Model Sheet.
   - Place 1 electron (blue chip) in the inner electron level.
   - The hydrogen atom does not have any neutrons.

   The diagram below shows how you should draw the model that you made. Note that the diagram uses a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Hydrogen

What is the atomic number? ***1***

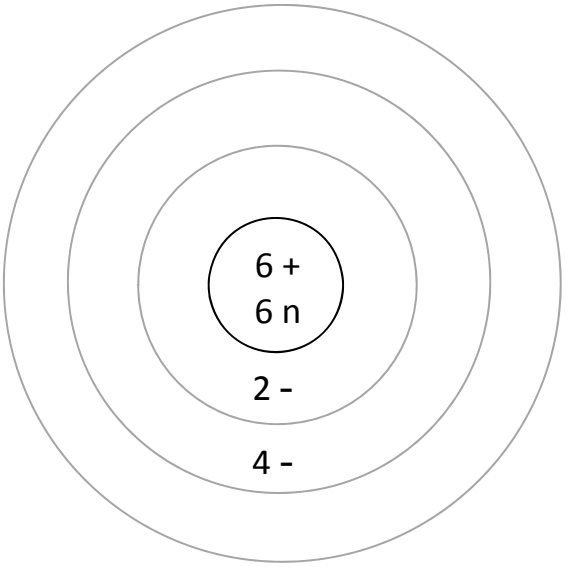
What is the mass number? ***1***

What is the chemical symbol? ***H***

What is the electron configuration? ***1***

What is the net charge of the atom? ***0***

4. Make a model of one atom of **carbon**. Place 6 protons (red chips) and 6 neutrons (black chips) in the nucleus (small cup). Place 2 blue chips in the inner electron level and 4 electrons in the outer electron level. Draw your model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Carbon

What is the atomic number? ***6***

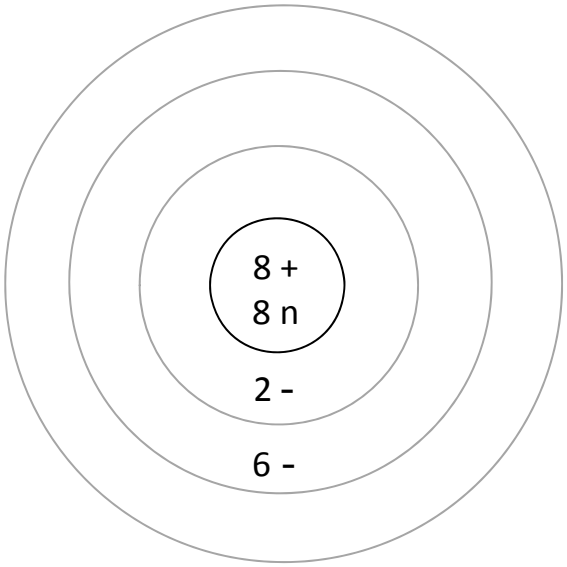
What is the mass number? ***12***

What is the chemical symbol? ***C***

What is the electron configuration? ***2-4***

What is the net charge of the atom? ***0***

5. Make a model of one atom of **oxygen**. Place 8 protons (red chips) and 8 neutrons (black chips) in the nucleus. Place 2 electrons (blue chips) in the inner electron level and 6 electrons in the outer electron level. Draw your model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Oxygen

What is the atomic number? ***8***

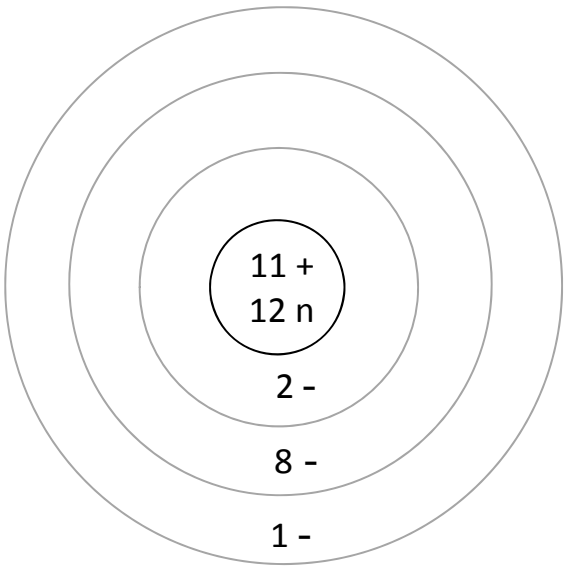
What is the mass number? ***16***

What is the chemical symbol? ***O***

What is the electron configuration? ***2-6***

What is the net charge of the atom? ***0***

6. Make a model of one atom of **sodium**. Place 11 protons (red chips) and 12 neutrons (black chips) in the nucleus. Place 2 electrons (blue chips) in the inner electron level, 8 electrons in the next electron level, and 1 electron in the outer energy level. Draw your model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Sodium

What is the atomic number? ***11***

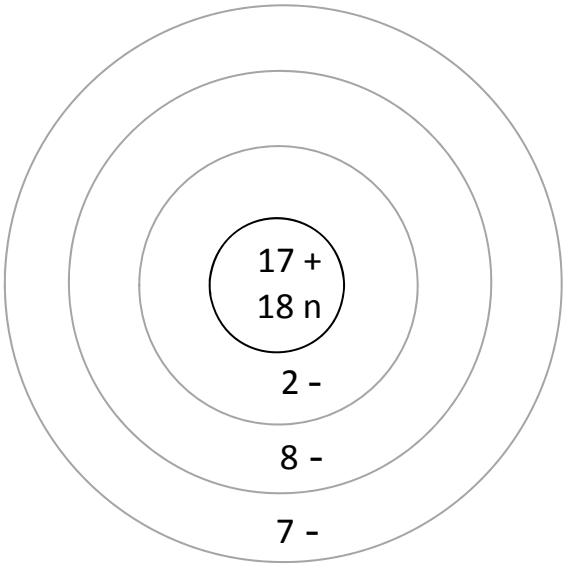
What is the mass number? ***23***

What is the chemical symbol? ***Na***

What is the electron configuration? ***2-8-1***

What is the net charge of the atom? ***0***

7. Use information from the periodic table to make a model of a **chlorine** atom. Draw your model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Chlorine

What is the atomic number? ***17***

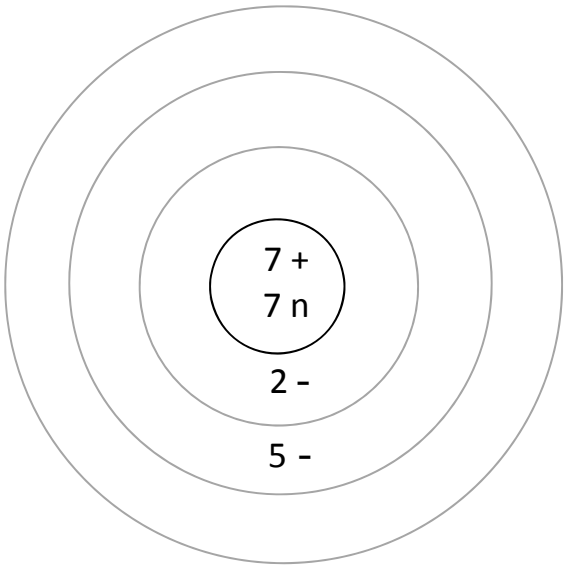
What is the mass number? ***35***

What is the chemical symbol? ***Cl***

What is the electron configuration? ***2-8-7***

What is the net charge of the atom? ***0***

8. Use information from the periodic table to make a model of a **nitrogen** atom. Draw your model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron).



Nitrogen

What is the atomic number? ***7***

What is the mass number? ***14***

What is the chemical symbol? ***N***

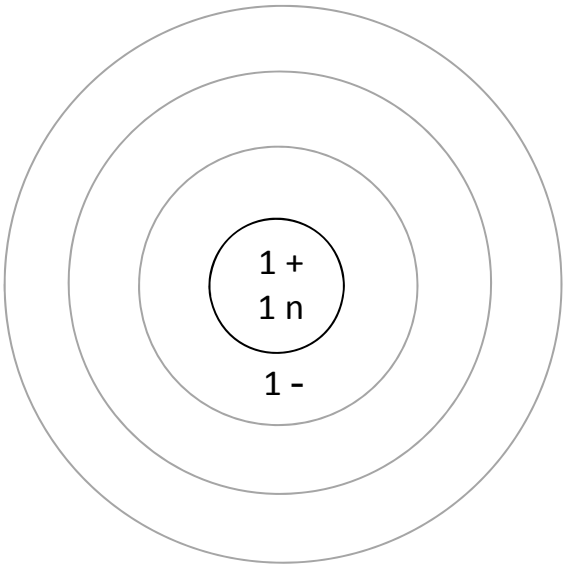
What is the electron configuration? ***2-5***

What is the charge of the atom? ***0***

Part 2: Modeling Isotopes

Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons.

1. Use the information on the periodic table to make a model of a hydrogen atom. Change the model to an isotope of hydrogen by adding a neutron (black chip) to the model. Draw your isotope model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Isotope of Hydrogen

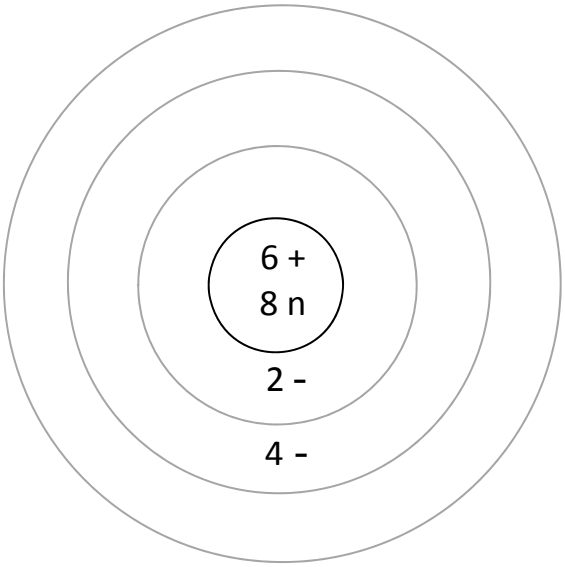
What is the atomic number? ***1***

What is the mass number? ***2***

What is the chemical symbol? ***H***

What is the net charge of the isotope? ***0***

2. Use the information on the periodic table to make a model of a "normal" carbon atom (called Carbon-12). Change the model to an isotope of carbon (Carbon-14) by adding two neutrons (black chips) to the model. Draw your isotope model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Isotope of Carbon (Carbon-14)

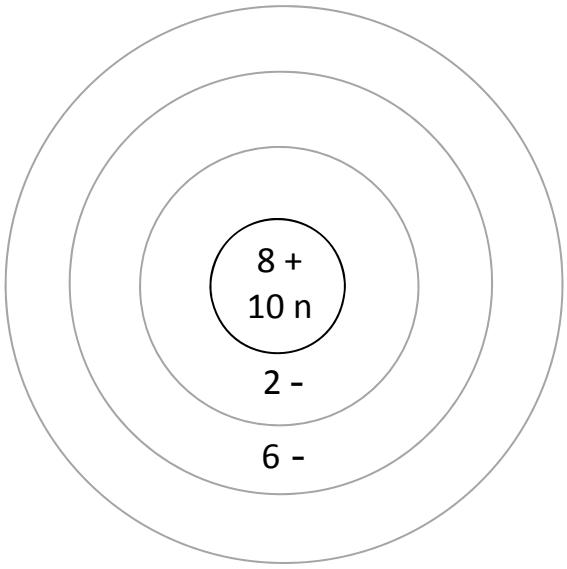
What is the atomic number? ***6***

What is the mass number? ***14***

What is the chemical symbol? ***C***

What is the net charge of the isotope? ***0***

3. Use the information on the periodic table to make a model of a "normal" oxygen atom (called oxygen-16). Change the model to an isotope of oxygen (called oxygen-18). Draw your isotope model. Use a "+" sign for each proton, an "**n**" for each neutron and a "**-**" sign for each electron.



Isotope of Oxygen (Oxygen-18)

What is the atomic number? ***8***

What is the mass number? ***18***

What is the chemical symbol? ***O***

What is the net charge of the isotope? ***0***

Part 3: Modeling Ions

Ions are particles that are formed when atoms lose or gain electrons. Ions are charged particles because the number of electrons is not equal to the number of protons. To calculate the charge of an ion, subtract the number of electrons from the number of protons.

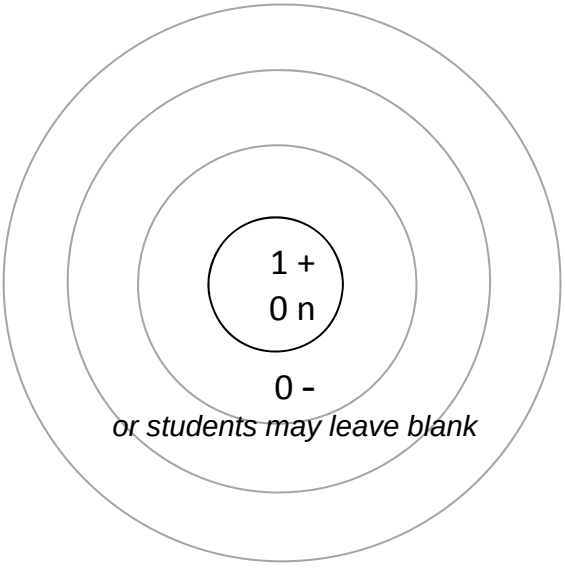
- If an ion has more protons than electrons, the ion will have a positive charge.
- If an ion has more electrons than protons the ion will have a negative charge.

To write the symbol for an ion, you write the charge of the ion as a **superscript** after the symbol. A superscript is written on the upper right-hand side of the element symbol.

Cl^{-1} ← **-1** superscript represents an ion formed when an atom has gained one electron.

Ca^{+2} ← **+2** superscript represents an ion formed when an atom has lost two electrons.

1. Use the information on the periodic table to make a model of a hydrogen atom. Then make a hydrogen ion by removing the electron (blue chip) from the model. Draw your ion model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Hydrogen Ion

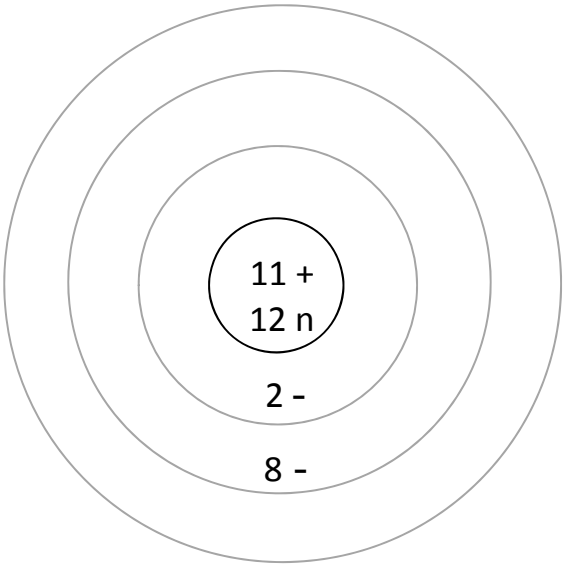
How many protons does the ion have? ***1***

How many electrons does the ion have? ***0***

What is the net charge of the ion? ***+1***

Write the symbol for the hydrogen ion? ***H^{+} or H^{+1}***

2. Use the information on the periodic table to make a model of a sodium atom. Then make a sodium ion by removing an electron (blue chip) to the model. Draw your ion model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Sodium Ion

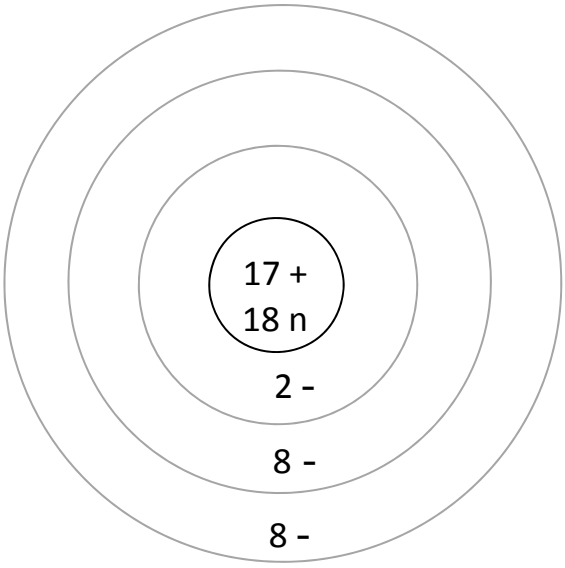
How many protons does the ion have? ***11***

How many electrons does the ion have? ***10***

What is the net charge of the ion? ***+1***

What is the chemical symbol for the ion? ***Na^+***

3. Use the information on the periodic table to make a model of a chlorine atom. Then make a **chloride** ion by adding one electron (blue chip) to the model. Draw your ion model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Chloride Ion

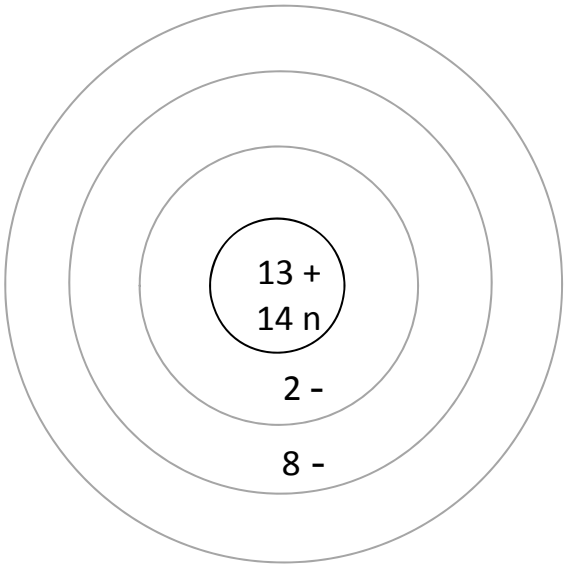
How many protons does the ion have? ***17***

How many electrons does the ion have? ***18***

What is the charge of the ion? ***-1***

What is the chemical symbol for the ion? ***Cl^-***

4. Use the information on the periodic table to make a model of an aluminum atom. Then remove three electrons to make an aluminum ion. Draw your ion model. Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Aluminum Ion

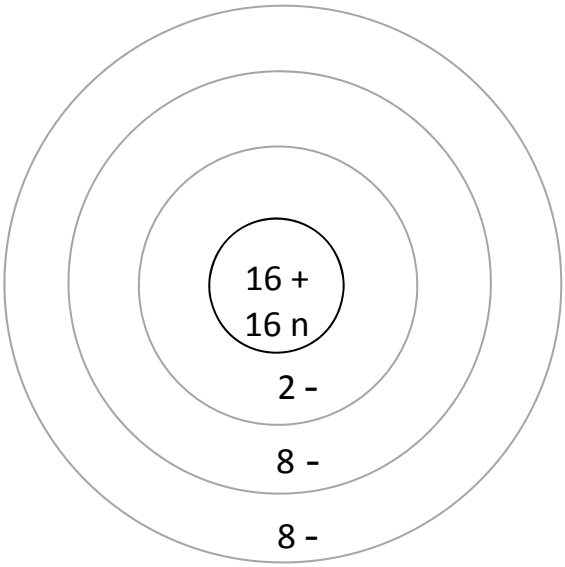
What is the chemical symbol for the ion? ***Al^{+3}***

What is the charge of the ion? ***+3***

How many protons does the ion have? ***13***

How many electrons does the ion have? ***10***

5. Make a model of a sulfur atom. Then make a sulfur ion (S^{2-}). Use a "+" sign for each proton, an "**n**" for each neutron and a "–" sign for each electron.



Sulfur Ion S^{2-}

What is the charge of the ion? ***-2***

What is the atomic number? ***16***

What is the atomic mass? ***32***

How many protons does the ion have? ***16***

How many electrons does the ion have? ***18***