Protons, Electrons, and Neutrons

By the end of this lesson, I will be able to:

☑ Explain the following terms: proton, neutron, electron, subatomic particle, neutral atom, ion, cation, anion, atomic number, atomic mass, mass number.
☑ Differentiate between:
  - neutral atoms, cations, and anions.
  - atomic number, atomic mass, and mass number.
☑ Use atom symbols and the periodic table to determine the number of protons, electrons, and neutrons in an atom.
☑ Use atom symbols and the periodic table to create diagrams showing the location and correct number of protons, electrons, and neutrons in different atoms.

💡 Ask your teacher for the handout and card set that accompany this lesson.

You will also need a copy of a paper titled “Atom Data Sheet” and a paper titled “Task Card Answer Sheet”.

Subatomic Particles: particles that compose atoms.

- **Protons**
  - Located in the nucleus
  - Positive charge
- **Neutrons**
  - Located in the nucleus
  - No charge
- **Electrons**
  - Located in mostly empty space surrounding the nucleus
  - Negative charge
  - Very, very tiny
Open the envelope labeled “Atom Card Set”.

This card set contains ten cards:
- Five of the cards show illustrations of the subatomic particles in lithium atoms.
- Five of the cards show illustrations of the subatomic particles in nitrogen atoms.

The subatomic particles on each card are illustrated as shown below:

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Atom Card Key
Nucleus

Neutron (White) → Proton (Red)

Electron (Black)
```

Sort the cards into two groups based on whether they illustrate lithium or nitrogen atoms.

? Count the number of protons, neutrons, and electrons on each card and record your answers on the “Atom Data Sheet”.

**Part 1: Protons**

Use the information that you recorded on the “Atom Data Sheet” to answer the following questions.

? Which subatomic particle is present in the same amount in all of the lithium atoms?
? Which subatomic particle is present in the same amount in all of the nitrogen atoms?


? What do you think determines the identity of an atom - the number of protons, the number of neutrons, or the number of electrons?


Look at the atom symbol indicated for each atom on the cards and the “Atom Data Sheet”.

? Which part of the atom symbol do you think indicates the number of protons?


Look at the periodic table boxes for lithium and nitrogen.


? Which number in the periodic table boxes do you think indicates the number of protons?
The **Atomic Number:**
- is the whole number in the periodic table square.
- is the bottom, left number in an atom symbol.
- is always equal to the number of protons.
- is equal to the number of electrons in a neutral atom. (See Part 2: Electrons.)
- will tell you the identity of an atom, because each atom has a different atomic number.

Ask your teacher for a set of “Proton Task Cards” and get out the “Task Card Answer Sheet”.

? Answer each of the questions on the Proton Task Cards. Record your answers on your “Task Card Answer Sheet”.

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**Part 2: Electrons**

Look at the handout titled “Atoms and Charge”.

This handout illustrates the number of protons and electrons that can be found in lithium and nitrogen atoms.

Notice that:
- each proton adds one positive (+) charge to the atom.
- each electron adds one negative (-) charge to the atom.
- there are two versions of each atom, neutral and ion.
Neutral Atoms

Look at the neutral lithium and nitrogen atoms on the “Atoms and Charge” card.

What do you notice about the number of protons relative to the number of electrons in a neutral atom?

Look at the atom symbols below. They are the atom symbols for neutral lithium and neutral nitrogen atoms.

\[ ^7_3 \text{Li} \quad ^{14}_7 \text{N} \]

What part of the atom symbol can you use to determine the number of electrons in a neutral atom? (Hint: Think about your answer to the previous question and what you just learned about protons.)

Look again at the periodic table squares for lithium and nitrogen shown below.

\[ \begin{array}{c|c}
\text{Li} & \text{N} \\
3 & 7 \\
6.941 & 14.007 \\
\text{Lithium} & \text{Nitrogen} \\
\end{array} \]

Which number do you think indicates the number of electrons in a neutral atom, the atomic number or the atomic mass?
A **neutral atom** has the same number of electrons and protons.

The charge of a neutral atom is equal to zero.

**Ions**

Return to the handout titled “Atoms and Charge”.

Look at the lithium ion on the “Atoms and Charge” card.

What happens to the electrons of a neutral lithium atom when it becomes a lithium ion?

Look at the atom symbols below. They are the atom symbols for neutral lithium atoms and lithium ions.

\[ ^{7}_{3}\text{Li} \quad ^{7}_{3}\text{Li}^{1+} \]

What is the difference between the atom symbol for the neutral lithium atom and the atom symbol for the lithium ion?

Why does the lithium ion symbol have a positive charge? (Hint: Refer back to the “Atoms and Charge” card.)
? What do you think the small number “1” indicates in the lithium ion atom symbol? (Hint: Refer back to the “Atoms and Charge” card.)

? When an ion has a positive charge, it means that the atom has _________ (less or more) electrons than its neutral form.

Vocabulary!

An ion is an atom with a charge.

An ion with a positive charge is called a cation.

A cation is formed when a neutral atom loses electrons.

Return to the handout titled “Atoms and Charge”.

Look at the nitrogen ion on the “Atoms and Charge” card.

? What happens to the electrons of a neutral nitrogen atom when it becomes a nitrogen ion?
Look at the atom symbols below. They are the atom symbols for neutral nitrogen atoms and nitrogen ions.

\[ ^{14}_{7} \text{N} \quad ^{14}_{7} \text{N}^{3-} \]

? What is the difference between the atom symbol for the neutral nitrogen atom and the atom symbol for the nitrogen ion?

? Why does the nitrogen ion symbol have a negative charge? (Hint: Refer back to the “Atoms and Charge” card.)

? What do you think the small number “3” indicates in the nitrogen ion atom symbol? (Hint: Refer back to the “Atoms and Charge” card.)

? When an ion has a negative charge, it means that the atom has _________ (less or more) electrons than its neutral form.

Vocabulary!

An ion with a negative charge is called an **anion**.

An anion is formed when a neutral atom **gains electrons**.
Summary: How to determine the number of electrons.

**Neutral Atoms (No Charge)**

\[ ^{40}_{20}\text{Ca} \]
Number of electrons = bottom number

20 ⪯ Number of electrons = atomic number

Ca
40.078
Calcium

**Cations (Positive Charge)**

\[ ^{137}_{56}\text{Ba}^{2+} \]
Number of electrons =
bottom number - charge number

56 ⪯ Atomic Number

Ba
137.328
Barium

**Anions (Negative Charge)**

\[ ^{80}_{35}\text{Br}^- \]
Number of electrons =
bottom number + charge number

35 ⪯ Atomic Number

Br
79.904
Bromine
Ask your teacher for a set of “Electron Task Cards” and get out the “Task Card Answer Sheet”.

? Answer each of the questions on the Electron Task Cards. **Record your answers on your “Task Card Answer Sheet”**.

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**Part 3: Neutrons**

Return to the information that you recorded on your “Atom Data Sheet”.

Look at the three neutral lithium atoms.

? What are two differences between the three neutral lithium atoms?

The top number to the left of the atom symbol is called the **mass number**.

The mass number is equal to the sum of two of the subatomic particles.

? Use the information on your “Atom Data Sheet” to determine whether the mass number is equal to: the number of protons plus electrons, the number of protons plus neutrons, or the number of neutrons plus electrons.
How can you determine the number of neutrons in an atom? (Hint!: Refer back to your last answer and construct a mathematic equation.)

How can you use an atom symbol to determine the number of neutrons in an atom? (Hint: Remember, the top number is the mass number and the bottom number is the number of protons.)

Look again at the periodic squares for lithium and nitrogen below. The mass numbers for lithium and nitrogen are also shown.

Lithium
Mass Number = 7

Nitrogen
Mass Number = 14

Compare the atomic mass and mass number for lithium and nitrogen.

How is the mass number related to the atomic number?
How can you use the periodic table to determine the number of neutrons? (Hint: Remember, the atomic number is equal to the number of protons and the atomic mass (rounded) is equal to the mass number.)

The **Atomic Mass**:
- is equal to the average weighted mass of the different forms of the same type of atom.
- is usually written as a decimal in the periodic table.

The **Mass Number**:
- is equal to the mass of a particular form of an atom.
- is often written as the atomic mass rounded to a whole number.
- is the top, left number in an atom symbol.
- is equal to the # protons + # neutrons.

**Vocabulary!**

- **Ask your teacher for a set of “Neutron Task Cards” and get out the “Task Card Answer Sheet”**.

- Answer each of the questions on the Neutron Task Cards. **Record your answers on your “Task Card Answer Sheet”**.
Indicate the location and number of protons, electrons, and neutrons in each of the atoms shown below. The first one has been done for you.

\[ p = \text{protons} \]
\[ n = \text{neutrons} \]
\[ e = \text{electrons} \]

\begin{align*}
\text{11}_5^5\text{B} & : 5e, 5p, 6n \\
\text{16}_8^8\text{O}^2- & : 8e, 8n \\
\text{18}_7^7\text{Cl} & : 17e, 17n \\
\text{19}_9^9\text{F} & : 19e, 9n \\
\text{24}_12^{2+}\text{Mg} & : 10e, 12n \\
\text{18}_8^8\text{O} & : 8e, 8n \\
\text{136}_52\text{Ba} & : 52e, 86n \\
\text{40}_20\text{Ca}^{2+} & : 20e, 20n \\
\text{2}_1^1\text{H}^{1+} & : 1e, 1n
\end{align*}
**Protons, Electrons, and Neutrons**  
*Study Sheet – Page 1*

**Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subatomic Particle:</strong></td>
<td>particles smaller than an atom</td>
</tr>
<tr>
<td><strong>Proton:</strong></td>
<td>a positively charged subatomic particle located in the nucleus of an atom</td>
</tr>
<tr>
<td><strong>Electron:</strong></td>
<td>a tiny, negatively charged subatomic particle located in mostly empty space around the nucleus of an atom</td>
</tr>
<tr>
<td><strong>Neutron:</strong></td>
<td>a subatomic particle with no charge located in the nucleus of an atom</td>
</tr>
<tr>
<td><strong>Neutral Atom:</strong></td>
<td>an atom with the same number of protons and electrons</td>
</tr>
<tr>
<td><strong>Ion:</strong></td>
<td>an atom that has gained or lost electrons - creates a positive or negative charge on the atom</td>
</tr>
<tr>
<td><strong>Cation:</strong></td>
<td>an atom that has LOST one or more electrons - creates a positive charge on the atom</td>
</tr>
<tr>
<td><strong>Anion:</strong></td>
<td>an atom that has GAINED one or more electrons - creates a negative charge on the atom</td>
</tr>
<tr>
<td><strong>Atomic Number:</strong></td>
<td>indicates the number of protons; indicates the number of electrons in a neutral atom; is the whole number in periodic table blocks; is the bottom, left number in an atom symbol.</td>
</tr>
<tr>
<td><strong>Atomic Mass:</strong></td>
<td>is the average weighted mass of all of the forms of a particular type of atom; is the decimal number in the periodic table</td>
</tr>
<tr>
<td><strong>Mass Number:</strong></td>
<td>describes the mass of each form of an atom; can be equal to the atomic mass rounded to a whole number; is used in calculations to determine the number of neutrons; is the top, left number in an atom symbol</td>
</tr>
</tbody>
</table>
Protons, Electrons, and Neutrons
Study Sheet – Page 2

How to Find the Number of Protons, Electrons, and Neutrons from an Atom Symbol

How to Find the Number of Protons, Electrons, and Neutrons from the Periodic Table

**Round atomic mass numbers to a whole number!
## Atom Data Sheet

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Type of Atom</th>
<th># Protons</th>
<th># Electrons</th>
<th>#Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^6_{\text{Li}}$</td>
<td>lithium atom - neutral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^7_{\text{Li}}$</td>
<td>lithium atom - neutral</td>
<td></td>
<td></td>
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<tr>
<td>$^9_{\text{Li}}$</td>
<td>lithium atom - neutral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^6_{\text{Li}^{1+}}$</td>
<td>lithium ion (cation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^7_{\text{Li}^{1+}}$</td>
<td>lithium ion (cation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^{13}_{\text{N}}$</td>
<td>nitrogen atom - neutral</td>
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<td>$^{14}_{\text{N}}$</td>
<td>nitrogen atom - neutral</td>
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<td>$^{15}_{\text{N}}$</td>
<td>nitrogen atom - neutral</td>
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<td>$^{14}_{\text{N}^{3-}}$</td>
<td>nitrogen ion (anion)</td>
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## Task Card Answer Sheet

### Proton Task Card Answers

Card Color ________________

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<td>5</td>
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<td>7</td>
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</table>

### Electron Task Card Answers

Card Color ________________

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### Neutron Task Card Answers

Card Color ________________

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