Exploring the Building Blocks of Matter

Teacher's Guide

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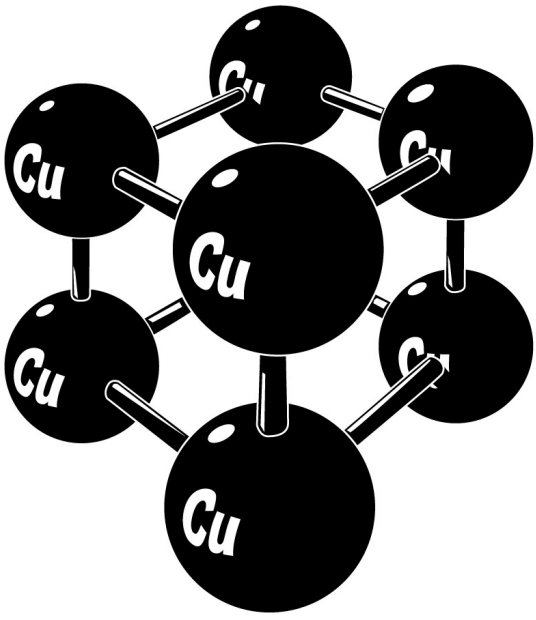

Elementary Science

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National Standards Correlations

Benchmarks for Science Literacy

(Project 2061 – AAAS) Grades 3–5

The Physical Setting – The Structure of Matter (4D)

By the end of the 8th grade, students should know that:

- All matter is made up of atoms, which are far too small to see directly through a microscope. The atoms of any element are alike but are different from atoms of other elements. Atoms may stick together in well-defined molecules or may be packed together in large arrays. Different arrangements of atoms into groups compose all substances.

- Scientific ideas about elements were borrowed from some Greek philosophers of 2,000 years earlier, who believed that everything was made from four basic substances: air, earth, fire, and water. It was the combinations of these "elements" in different proportions that gave other substances their observable properties. The Greeks were wrong about those four, but now over 100 different elements have been identified, some rare and some plentiful, out of which everything is made. Because most elements tend to combine with others, few elements are found in their pure form.

National Science Education Standards

(Content Standards: K–4, National Academy of Sciences)

Properties of Objects and Materials – Content Standard B

As a result of their activities in grades K-4, all students should develop an understanding of:

- Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

Properties and Changes of Properties in Matter - Content Standard B

As a result of their activities in grades 5-8, all students should develop an understanding of:

- Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group.

- Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.

Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students will be able to do the following:

- Understand that the quest to better understand the building blocks of matter has transpired over the past several thousand years.

- State the following components of Dalton's early atomic theory:
  - all elements are made of atoms.
  - atoms are indivisible and cannot be destroyed.
  - atoms of the same element are exactly alike, and atoms of different elements are different from each other.
  - compounds are formed when the atoms of two or more elements combine.

- Appreciate and understand the very small size of atoms.

- Explain that atoms are made up of smaller particles of matter referred to as subatomic particles.

- List the three major types of subatomic particles: protons, neutrons, and electrons.

- Describe some of the characteristics of protons, neutrons, and electrons.

- Create a simple diagram of an atom labeling the following structures: protons, neutrons, electrons, and nucleus.

- Understand that electrons travel in orbit paths, but they travel at such high speeds the space in which they travel is referred to as an electron cloud.

- State that the atomic number is the number of protons found in an atom.

- Explain that the periodic table of elements is a chart containing the known elements organized by increasing atomic number.

Assessment

Preliminary Test (p. 14–15):

The Preliminary Test is an assessment tool designed to gain an understanding of students' preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Post-Test (p. 16–17):

The Post-Test can be utilized as an assessment tool following student completion of the program and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Video Review (p. 18):

The Video Review can be used as an assessment tool or as a student activity. There are two sections. The first part contains questions displayed during the program. The second part consists of a five-question video quiz to be answered at the end of the video.

Introducing the Program

Before showing the video program to your students, give each one of them a scrap piece of paper. Explain to them that the paper is an example of a piece of matter. Write the term “Matter” on the board. Next, ask students what they think makes up matter. Write down some of their suggestions.

Now instruct students to tear the piece of paper in half. Then tell them to take one of the halves and tear it in half. Instruct the students to continue to tear each half of paper in half to the tiniest piece of paper they can make. Then ask students how tiny might the smallest piece of paper be. Tell them that it would be a molecule of paper - made up of several smaller atoms bonded together. Explain that all matter is made up of atoms - the building blocks of matter. Tell students to pay close attention to the video to learn more about atoms.

Program Viewing Suggestions

The student master “Video Review” (p.18) is provided for distribution to students. You may choose to have your students complete this master while viewing the program or do so upon its conclusion.

The program is approximately 14 minutes in length and includes a five-question video quiz. Answers are not provided to the Video Quiz in the video, but are included in this guide on page 12. You may choose to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.

Video Script

1. Take a few seconds to look around.
2. What do you see? Maybe you see furniture, walls, people, books, or other objects.
3. Have you ever thought about what makes up these things?
4. Everything we see contains matter.
5. But, what makes up matter?
6. What do we call tiny pieces of matter, and what are their characteristics?
7. During the next few minutes we are going to investigate these questions and others…
8. …as we explore the building blocks of matter.
9. **Graphic Transition – Early Ideas about Matter**
10. For thousands of years people have wondered what makes up matter?
11. Nearly 2,500 years ago the Greek philosopher Democritus believed,…
12. …that if you continued to "cut" up an object such as a coin, you would eventually end up with a tiny "uncuttable" complete piece of matter.
13. He called this particle an atom. The word atom is from the Greek word atomos, meaning indivisible.
14. While Democritus, and other people of his time, had no way of actually seeing atoms, they believed that atoms were small, hard particles, all made of the same material, but in different shapes and sizes.
15. They also believed atoms were always moving and capable of joining together.
16. While Democritus and others were on the right track, their ideas about matter and atoms were largely ignored for over 2000 years.
17. **Graphic Transition – The Modern Atomic Theory**
18. In the early 1800s a British chemist by the name of John Dalton performed many experiments with different substances.
19. Among other things, he found that elements were made up of specific types of atoms with specific characteristics.
20. Atoms are the smallest complete part of an element.
21. Dalton published a very important explanation about the building blocks of matter called the atomic theory.
22. The atomic theory proposed that all elements are made of atoms. It stated that atoms are indivisible and cannot be destroyed.
23. Both of these atoms are from the element carbon.
24. **You Compare!** Do they look the same or different from each other?
25. That's right, they look the same.
26. Dalton's atomic theory proposed that atoms of the same element are exactly alike,...
27. ...and atoms of different elements are different from each other.
28. He also stated that compounds are formed when the atoms of two or more elements combine.
29. Over time as new information has been learned, scientists have developed and expanded a more modern theory, which describes atoms as we know them today.

Video Script

30. Graphic Transition – How Small are Atoms?
31. It's amazing that we have learned so much about something that can't be seen with the naked eye.
32. Microscopes can't even see atoms.
33. So, just how small are they?
34. To give you an idea of how small atoms are, take a look at the thickness of this piece of paper.
35. Even though it is very thin, it still takes 10,000 atoms to make it this thick!
36. This small coin contains 20 thousand billion atoms of copper and zinc. This gives you an idea of how small atoms really are.
37. In some cases atoms join together. When two or more atoms join, they create a molecule.
38. A molecule of water, for instance, consists of two hydrogen atoms joined to one atom of oxygen.
39. A single drop of water contains trillions of molecules of water.
40. Just imagine how many molecules of water there are in this lake!
41. Graphic Transition – Inside the Atom
42. When you think of how small an atom is, it's hard to believe that they are made up of even smaller pieces of matter generally referred to as sub-atomic particles.
43. While there are many different kinds of subatomic particles, the three main ones are protons, neutrons, and electrons.
44. Protons and neutrons are subatomic particles located in the center of the atom called the nucleus.
45. Even though the nucleus makes up 99.9% of the mass of an atom, it is a hundred thousand times smaller than the entire atom!
46. If we let this marble represent the nucleus of an atom at one end of the soccer field – the outer limits of the atom would be at the other end of the field! Amazing!
47. Protons are positively charged subatomic particles located in the nucleus.
48. Sometimes a plus sign is used to indicate the positive charge of a proton.
49. Neutrons, another type of sub-atomic particle in the nucleus, do not have a plus sign.
50. You Decide! What type of charge do neutrons possess?
51. Neutrons do not have a charge. In other words, they have a neutral charge.
52. Electrons are the third type of subatomic particle.
53. They have a negative charge, symbolized by a minus sign.
54. Electrons have a tiny mass compared to protons and neutrons. In fact, it takes 1,800 electrons to equal the mass of a single proton.
55. Electrons are not found in the nucleus but instead orbit at very high speeds around the outside of the atom.
56. They orbit in paths but they travel at such high speeds, that the space in which they travel is referred to as an electron cloud.

Video Script

57. Think of an electron cloud kind of like a swarm of bees around their hive.
58. Except unlike bees, electrons travel at incredibly high speeds whirling about the nucleus billions of times in a second.
59. You have heard the old phrase “opposites attract”. Well, negatively charged electrons are held in orbit by a force of attraction with positively charged protons in the nucleus.
60. **Graphic Transition – Comparing Different Types of Atoms**
61. **You Decide!** If all atoms contain the same subatomic particles, are all atoms the same?
62. No, all atoms are not the same. The number of protons, neutrons, and electrons varies between atoms causing them to be different from each other.
63. There are over 100 different elements each of which are made up of different atoms and have different combinations of subatomic particles.
64. Let’s take a look at two different elements: helium and aluminum. Helium is a gas often used to fill balloons.
65. The element, Aluminum, is a metal. It is used to make cars, soda cans, and many other things.
66. These elements are very different from one another.
67. That’s because each is made up of different atoms.
68. This is a model of an aluminum atom. It has 13 protons in its nucleus.
69. The number of protons in the nucleus of an atom is called the atomic number.
70. The aluminum atom also has 14 neutrons in its nucleus.
71. And orbiting the nucleus are 13 electrons.
72. Helium, on the other hand, is a much different element with a vastly different atomic structure.
73. **You Observe!** What is the atomic number of Helium?
74. Inside its nucleus a helium atom has two protons and therefore its atomic number is two.
75. It also has two neutrons in its nucleus. Two electrons orbit the nucleus.
76. So, as you can see aluminum and helium are two very different elements as is reflected in their atomic structure.
77. **Graphic Transition – Organizing the Elements**
78. Imagine the frustration of working in a kitchen and not being able to find anything because all the plates, bowls, cups, eating utensils, and cooking tools were so disorganized.
79. Scientists felt a similar frustration concerning the organization of the many different elements until...
80. ...they were arranged in an orderly chart called the Modern Periodic Table of Elements seen here.
81. It includes over 100 elements.
82. The periodic table is arranged according to increasing atomic number.

Video Script

83. The atomic number of 5 of the element boron is highlighted here.
84. Notice how the atomic number increases as we go from left to right in the table.
85. Also, notice how elements in the periodic table have one or two letters that represent them. We call this an elements' chemical symbol.
86. The Modern Periodic Table of Elements contains a lot of information, and serves as a very valuable tool for scientists helping them to organize and study elements.
87. **Graphic Transition – Summing Up**
88. During the past few minutes we have explored many of the fascinating features of atoms – the building blocks of matter.
89. We began by exploring some of the early ideas about the structure of matter.
90. The various parts of the atomic theory were outlined.
91. We then took an in depth look at subatomic particles – specifically protons, neutrons, and electrons.
92. The structure of different types of atoms was investigated, emphasizing how structure influences the characteristics of atoms and elements.
93. Last we briefly discussed how elements are organized in the Modern Periodic Table of Elements.
94. So, the next time you wonder what makes up the matter around you,...
95. ...or if you wonder about the millions of atoms found in simple everyday objects,...
96. ...think about some of the things we discussed during the past few minutes.
97. You just might think about the building blocks of matter a little differently.
98. **Graphic Transition – Video Assessment**

Fill in the correct word to complete the sentence. Good luck and let's get started.

1. All elements are made of ___.
2. _____ are formed when two or more elements combine.
3. The ____ of an atom is made up of protons and neutrons.
4. Negatively charged _____ swirl around the nucleus.
5. This chart is called the Modern ____ Table of Elements.

Answer Key to Student Assessments

Pre-Test (p. 14-15)

1. a - atom
2. d - atomic theory
3. b - exactly alike
4. a - compounds
5. c - protons and neutrons
6. c - negative
7. d - nucleus
8. a - atomic number
9. b - Modern Periodic Table of Elements
10. b - chemical symbols
11. true
12. false
13. true
14. false
15. false
16. An atom is the smallest complete part of an element.
17. Different elements are made up of different kinds of atoms.
18. Protons, neutrons, and electrons are the three major types of subatomic particles.
19. Neutrons and protons are found in the nucleus of most atoms.
20. Electrons orbit the nucleus at high speeds in energy levels in a region referred to as an electron cloud.

Post-Test (p. 16-17)

1. c - negative
2. b - Modern Periodic Table of Elements
3. a - atom
4. a - atomic number
5. d - atomic theory
6. b - chemical symbols
7. a - compounds
8. d - nucleus
9. c - protons and neutrons
10. b - exactly alike
11. false
12. false
13. true
14. false
15. true
16. Different elements are made up of different kinds of atoms.
17. Neutrons and protons are found in the nucleus of most atoms.
18. An atom is the smallest complete part of an element.
19. Electrons orbit the nucleus at high speeds in energy levels in a region referred to as an electron cloud.
20. Protons, neutrons, and electrons are the three major types of subatomic particles.

Video Review (p. 18)

1. The two atoms from the element carbon look the same.
2. Neutrons do not have a charge. In other words, they have a neutral charge.
3. No, all atoms are not the same.
4. The atomic number of helium is two because it has two protons inside its nucleus.

1. All elements are made of ***atoms***.
2. ***Compounds*** are formed when two or more elements combine.
3. The ***nucleus*** of an atom is made up of protons and neutrons.
4. Negatively charged ***electrons*** swirl around the nucleus.
5. This chart is called the Modern ***Periodic*** Table of Elements.

Answer Key to Student Activities

Vocabulary (p. 19)

1. atom
2. atomic theory
3. subatomic particles
4. protons
5. electrons
6. neutrons
7. nucleus
8. electron cloud
9. atomic number
10. Periodic Table of Elements

Writing Activity (p. 20)

For thousands of years people have tried to gain a better understanding of what makes up ***matter***. In the early 1800s, the British chemist, John Dalton, published a very important explanation about the building blocks of matter called the ***atomic theory***. The atomic theory proposes all ***elements*** are made of ***atoms***. It also states that atoms are ***indivisible*** and cannot be destroyed. Dalton's theory proposed that atoms of the same element are exactly ***alike***. ***Compounds*** are formed when the atoms of two or more elements combine. Today we know that atoms are made up of smaller pieces of matter referred to as ***subatomic particles***. Examples of these small pieces of matter include neutrons, protons, and ***electrons***. Neutrally charged neutrons, and positively charged protons are massive particles located in the nucleus of most atoms. Negatively charged electrons orbit the nucleus at high speeds in a region referred to as an ***electron cloud***.

In Your Own Words (p. 20)

1. The atomic theory is an explanation concerning the nature of atoms. It states that all matter is made up of atoms, and that elements are made up of atoms. Atoms are indivisible and can't be destroyed. The atoms of the same element are exactly alike. Compounds are formed when the atoms of two or more elements combine.
2. Atoms are made up of smaller pieces of matter called subatomic particles. The three main types of subatomic particles include protons, neutrons, and electrons.
3. The periodic table of elements consists of all the known elements. It is organized based on the increasing atomic number of elements.

Early Ideas About Atoms (p. 21–22)

1. Advances in technology have helped atomic research advance. People working hard, and working together have also advanced scientific knowledge.
2. The plum pudding model was developed by J.J. Thomson.
3. The scientist who researched ways to use radioactivity in medicine was Marie Curie.

Structure of an Atom (p. 23)

Labels on Diagram:
A. electron
B. electron cloud
C. nucleus
D. neutron
E. proton

1. The nucleus is the center, or core, of an atom.
2. An electron cloud is the space in which electrons orbit the nucleus of an atom.
3. No, not all atoms are the same. Each element has its own unique atoms.

Making Atoms (p. 24–25)

1. The atoms the students make will have the nucleus in the center of the atom with the neutrons and protons. The electrons of the atom will be located in a spherical pattern around the nucleus.
2. The atomic number is the number of protons in the nucleus of the atom.
3. Protons, neutrons, and electrons are subatomic particles. Protons and neutrons are located in the nucleus of an atom whereas, electrons orbit around the nucleus. Protons and neutrons account for about 99% of an atom's mass. Electrons are 1/2000 of the size of protons and neutrons.
4. Protons have a positive charge, neutrons have a neutral charge, and electrons have a negative charge.

Pre-Test

Name _____

Circle the best answer for each of the following questions.

1. The smallest complete part of an element is a(n):

   a. atom ***b. electron*** ***c. particle*** ***d. compound***

2. John Dalton developed many important ideas about matter and atoms that are summarized in the:

   a. theory of relativity ***b. master theory*** ***c. quantum theory*** ***d. atomic theory***

3. Atoms of the same element are:

   a. very different ***b. exactly alike*** ***c. nothing alike*** ***d. opposites***

4. The following are formed when the atoms of two or more elements combine:

   a. compounds ***b. nuclei*** ***c. more atoms*** ***d. cells***

5. Subatomic particles located in the nucleus include:

   a. electrons ***b. energy levels*** ***c. protons and neutrons*** ***d. electron clouds***

6. Electrons orbiting the nucleus have the following charge:

   a. positive ***b. neutral*** ***c. negative*** ***d. none***

7. About 99% of an atom's mass is located in its:

   a. electron cloud ***b. proton shell*** ***c. energy levels*** ***d. nucleus***

8. The number of protons in the nucleus of an atom is called:

   a. atomic number ***b. proton number*** ***c. atomic weight*** ***d. neutral weight***

9. The chart containing all the elements organized by increasing atomic number is called the:

   a. Newton Chart ***b. Modern Periodic Table of Elements*** ***c. Hertzberg chart*** ***d. Element organizer***

10. Letters that represent an element are referred to as:

    a. equation ***b. chemical symbols*** ***c. equations*** ***d. icons***

Pre-Test

Name _____

Write true or false next to each statement.

11. _____ Atoms of the same element are exactly alike.

12. _____ Subatomic particles are larger than the atom itself.

13. _____ The nucleus in an atom takes up little space, but has great mass.

14. _____ Neutrons are subatomic particles with a negative charge.

15. _____ All atoms are the same.

Write a short answer for each of the following.

16. What is an atom?

_____

_____

17. What makes elements different from each other?

_____

_____

18. List two of the three major types of subatomic particles.

_____

_____

19. What subatomic particles are found in the nucleus of most atoms?

_____

_____

20. Where are electrons located in the atom?

_____

_____

Post-Test

Name _____

Circle the best answer for each of the following questions.

1. Electrons orbiting the nucleus have the following charge:

   a. positive ***b. neutral*** ***c. negative*** ***d. none***

2. The chart containing all the elements organized by increasing atomic number is called the:

   a. Newton Chart ***b. Modern Periodic Table of Elements*** ***c. Hertzberg chart*** ***d. Element Organizer***

3. The smallest complete part of an element is a(n):

   a. atom ***b. electron*** ***c. particle*** ***d. compound***

4. The number of protons in the nucleus of an atom is called:

   a. atomic number ***b. proton number*** ***c. atomic weight*** ***d. neutral weight***

5. John Dalton developed many important ideas about matter and atoms that are summarized in the:

   a. theory of relativity ***b. master theory*** ***c. quantum theory*** ***d. atomic theory***

6. Letters that represent an element are referred to as:

   a. equation ***b. chemical symbols*** ***c. equations*** ***d. icons***

7. The following are formed when the atoms of two or more elements combine:

   a. compounds ***b. nuclei*** ***c. more atoms*** ***d. cells***

8. About 99% of an atom's mass is located in its:

   a. electron cloud ***b. proton shell*** ***c. energy levels*** ***d. nucleus***

9. Subatomic particles located in the nucleus include:

   a. electrons ***b. energy levels*** ***c. protons and neutrons*** ***d. electron clouds***

10. Atoms of the same element are:

    a. very different ***b. exactly alike*** ***c. nothing alike*** ***d. opposites***

Post-Test

Name _____

Write true or false next to each statement.

11. _____ Subatomic particles are larger than the atom itself.

12. _____ Neutrons are subatomic particles with a negative charge.

13. _____ Atoms of the same element are exactly alike.

14. _____ All atoms are the same.

15. _____ The nucleus in an atom takes up little space, but has great mass.

Write a short answer for each of the following.

16. What makes elements different from each other?

_____

_____

17. What subatomic particles are found in the nucleus of most atoms?

_____

_____

18. What is an atom?

_____

_____

19. Where are electrons located in the atom?

_____

_____

20. List two of the three major types of subatomic particles.

_____

_____

Video Review

Name _____

While you watch the video, answer these questions:

You Compare!

1. Do they look the same or different from each other?

_____

_____

_____

You Decide!

2. What type of charge do neutrons possess?

_____

_____

_____

You Decide!

3. If all atoms contain the same subatomic particles, are all atoms the same?

_____

_____

_____

You Observe!

4. What is the atomic number of helium?

_____

_____

_____

After you watch the video, test your knowledge with these questions.

1. All elements are made of _____.
2. _____ are formed when two or more elements combine.
3. The _____ of an atom is made up of protons and neutrons.
4. Negatively charged _____ swirl around the nucleus.
5. This chart is called the Modern _____ Table of Elements.

Vocabulary

Name _____

Use these words to fill in the blanks next to the sentences below.

Words

electrons | periodic table of elements | neutrons | atomic theory | atomic number
electron cloud | atom | protons | nucleus | subatomic particles

1. _____ The smallest complete part of an element.

2. _____ Includes several ideas that describe the nature of atoms.

3. _____ Smaller pieces of matter that make up atoms; examples include protons, neutrons, and electrons.

4. _____ Positively charged subatomic particles located in the nucleus.

5. _____ Negatively charged subatomic particles that orbit the nucleus.

6. _____ Neutrally charged subatomic particles located in the nucleus.

7. _____ The center, or core, of the atom that contains neutrons and protons in most atoms.

8. _____ The space in which electrons orbit at very high speeds around the nucleus.

9. _____ The number of protons in the nucleus of an atom.

10. _____ A chart containing all the elements organized by increasing atomic number.

Writing Activity

Name _____

Words					
atoms	subatomic particles	atomic theory	compounds	elements	
electron cloud	electrons	alike	matter	indivisible	

Use the correct word from above to complete the sentences in the following paragraph.

For thousands of years people have tried to gain a better understanding of what makes up _____. In the early 1800s, the British chemist, John Dalton, published a very important explanation about the building blocks of matter called the _____ _____. The atomic theory proposes all _____ are made of _____. It also states that atoms are _____ and cannot be destroyed. Dalton's theory proposed that atoms of the same element are exactly _____. _____ are formed when the atoms of two or more elements combine. Today we know that atoms are made up of smaller pieces of matter referred to as _____ _____. Examples of these small pieces of matter include neutrons, protons, and _____. Neutrally charged neutrons, and positively charged protons are massive particles located in the nucleus of most atoms. Negatively charged electrons orbit the nucleus at high speeds in a region referred to as an _____ _____.

In Your Own Words

1. What is the atomic theory?

_____

_____

_____

2. What makes up an atom?

_____

_____

_____

3. What is the periodic table of elements and how is it organized?

_____

_____

_____

Early Ideas About Atoms

Name _____

J.J. Thomson, chemist

Background: Over 2,000 years ago the Greek philosopher Democritus pondered whether matter could be divided into smaller and smaller pieces forever. He theorized that eventually the smallest piece of matter could be obtained. He called these particles “atomos”, which means “not to be cut” or “indivisible”. Today we call such particles atoms.

Since the time of Democritus, our understanding of atoms has greatly increased. Dozens of women and men have devoted their lives to atomic research. Through their creative energies, hard work, and advances in technology, we now know a tremendous amount about atoms.

In this activity you will read about some of the significant advances in understanding the atom and about the people behind those advances. You will then record these events on a timeline.

Materials: ruler, long piece of paper (at least 1 meter in length), colored pens and pencils

Directions:

1. Carefully read the information on the following page that outlines some of the major advances in understanding atoms.
2. Obtain a long piece of paper, pens, pencils, and a ruler from your teacher.
3. Use a ruler to measure the length of the piece of paper. Make a timeline which starts at 100 B.C. and continues through present day. This spans over 2,100 years. Your teacher will explain how to develop a scale for your timeline.
4. Once you have figured out your scale, write 100 A.D. in the bottom left hand part of the piece of paper, and then put this year’s date in the bottom right. Draw a straight line between these two dates along the bottom of the page. Label dates along the line using the scale that you figured out.
5. Summarize the key discoveries and place them at the appropriate points on the timeline. Use different colored pens and pencils to make your timeline more colorful.
6. After completing the timeline, answer the questions below:

Questions:

1. What factors helped atomic research advance?

2. Who developed the plum pudding model?

3. Which scientist researched ways to use radioactivity in medicine?

Early Ideas About Atoms

Name _____

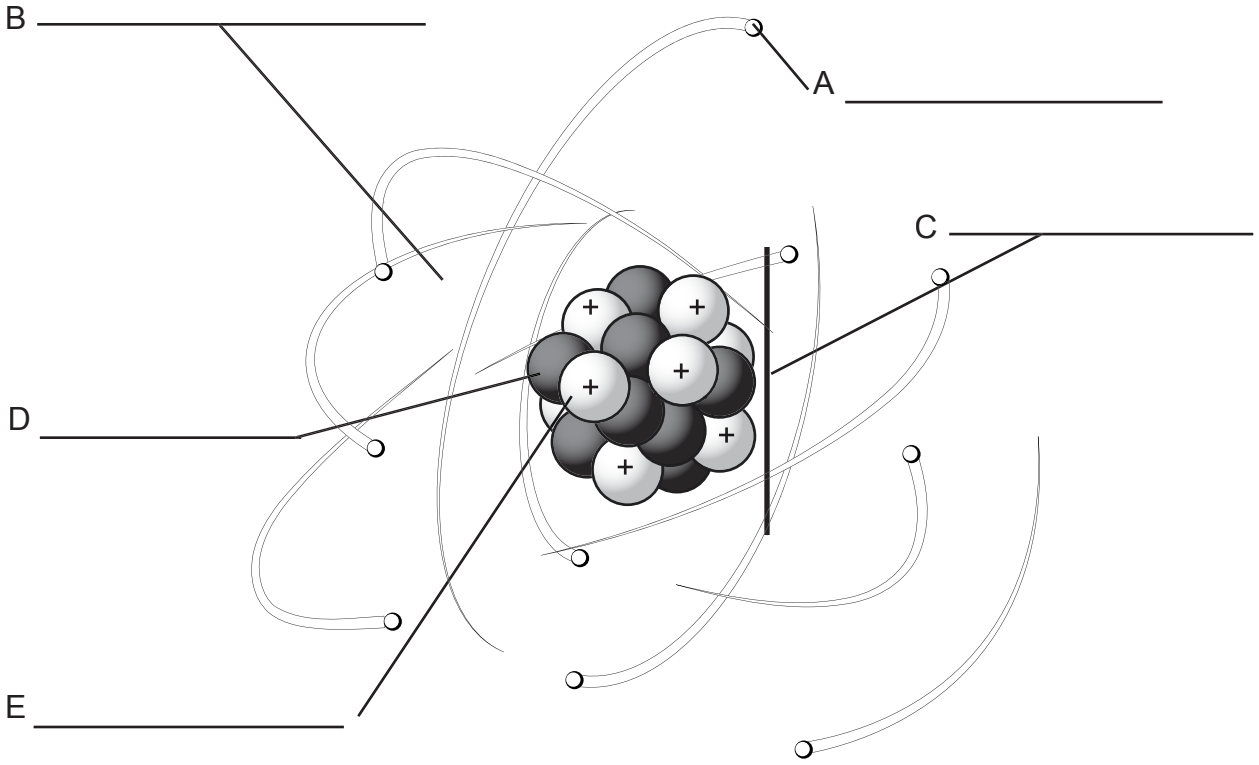
- 100 B.C. - Democritus suggested that matter was made up of small indivisible particles he called atoms. There were some other Greek philosophers, called atomists, who supported his idea. Not many people believed in Democritus' idea, and since atoms couldn't be seen, there wasn't any way to prove it was true. Therefore, his idea was largely ignored for about 2,000 years.
- 1803-1807 - John Dalton proposed his atomic theory of matter. In his theory, he stated that:
  - all matter is made up of atoms, which are indivisible and indestructible particles.
  - all atoms of an element are exactly alike.
  - different elements have different kinds of atoms.
  - by joining two or more atoms, compounds can be formed.
- 1897 - J.J. Thomson performed experiments which led him to believe that atoms are made up of smaller particles. He developed a model of the atom called the plum pudding model in which atoms are made up of positively charged material with negatively charged electrons scattered throughout.
- 1896 - Henri Becquerel discovered radioactivity accidentally when he left some uranium salt on a photographic plate and returned to find that the film had been exposed in places where it was in contact with the uranium salt. He thought that the uranium had given off invisible energy, which he called radiation.
- 1898 - Marie and Pierre Curie discovered the radioactive elements polonium and radium, the elements that make up uranium salt. Henri Becquerel had suggested that they research the uranium salt that had exposed his film two years earlier.
- 1911 - Marie Curie won the Nobel Prize for chemistry for her work with radium and polonium. She went on to research ways in which radioactivity could be used in medicine.
- 1911 - Ernest Rutherford developed the idea that atoms were made up mostly of empty space in which electrons orbited, and he hypothesized that atoms had a small, central, positively charged nucleus.
- 1913 - A Danish scientist named Niels Bohr improved upon Rutherford's idea of atomic structure by developing a new atomic model. His model of the atom had a central nucleus with electrons orbiting in a specific energy levels. In this model, there is one orbit per electron.
- 1939 - Lise Meitner published a paper that she had written with her cousin Otto Frisch describing nuclear fission, which she had just discovered. Nuclear fission is the splitting of atoms which creates large amounts of energy.
- 1942-1946 - The Manhattan Project focused on developing the atomic bomb. The Manhattan Project was led by a team of some of the world's top scientists. The atomic bomb that was developed used nuclear fission to create an enormous amount of energy and radiation. Fortunately many non-military uses for nuclear energy were indirectly developed as a result of the knowledge gained in the project.

Structure of an Atom

Name _____

Background: An atom is the smallest complete part of an element that still has the same properties of that element. The atoms of one element are different than atoms of another element. The difference is the way the atoms are arranged and the number of subatomic particles they contain. Atoms are made up of smaller pieces of matter called subatomic particles. There are three major types of subatomic particles: neutrons, protons, and electrons. Neutrons are neutrally charged subatomic particles located in the nucleus of the atom. The nucleus is the center, or core of the atom, and makes up about 99% of the atom's mass. Protons are positively charged subatomic particles also located in the nucleus of the atom. Electrons are negatively charged subatomic particles that orbit the nucleus at very high speeds. The space in which they travel is referred to as an electron cloud.

Directions: Label each part of the atom illustrated below and then answer the questions.



Questions:

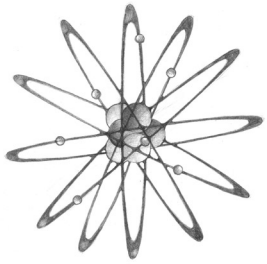
1. What is the nucleus of an atom?

2. What is an electron cloud?

3. Are all atoms the same?

Making Atoms

Name _____



Background: What would happen if you were able to continually cut a piece of an aluminum can in half? Eventually you would end up with the smallest piece of aluminum possible. This piece of matter is called an atom. Aluminum, and other substances such as copper, oxygen, gold, and carbon are all examples of elements. An element is a pure substance made up of just one kind of atom. There are over 100 known elements on Earth.

Have you ever thought about what makes up elements? Elements are made up of a single kind of atom. The atoms of one element are different than the atoms of another kind of element. The way an atom is arranged gives it unique properties that make it different from other atoms.

While atoms are extremely small, they are made up of yet smaller particles called subatomic particles. There are three types of subatomic particles: protons, neutrons, and electrons. The nucleus is the center of the atom and it contains protons and neutrons. These two types of subatomic particles in the nucleus account for over 99% of an atom's mass. Protons have a positive charge, and neutrons have a neutral charge. Electrons are negatively charged subatomic particles that are only about 1/2000 the size of protons and neutrons. Electrons move at very high speeds orbiting around the nucleus.

Each element has a different number of protons, neutrons, and electrons. In this activity you will create models of atoms.

Materials: red and green modeling clay or play dough, circular paper cut-outs from a hole punch, pieces of paper containing the name of an atom as well as its number of protons, neutrons, and electrons

Directions:

1. Your teacher will write the names of atoms on pieces of paper along with the numbers of protons, neutrons and electrons in that particular atom. Obtain one of these pieces of paper from your teacher.

2. Obtain some red and some green modelling clay (or play dough). The red will symbolize the protons and the green will symbolize the neutrons.

3. Create the protons by forming small balls of modeling clay (or play dough) about the size of a pea. Create the number of protons as stated for your atom.

Making Atoms

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4. Next, make your neutrons with green modeling clay (or play dough). Create the number of neutrons as stated for your atom.

5. After making both your protons and neutrons you are ready to form the nucleus of your atom. Carefully create a sphere of neutrons and protons. Try to prevent protons from sitting next to other protons.

6. Next, you will add electrons to your atom. In reality, an electron is 1/2000 the size of a proton or neutron and the orbiting electrons would be tens of meters away from the nucleus with the scale of this model. But, for the sake of this exercise, use the paper cut-outs provided by your teacher to represent electrons.

7. Count out the number of electrons as stated for your atom. Space the electrons out evenly in a circular pattern around the nucleus.

8. Compare the structure of your atom to other atoms in the classroom. Then answer the following questions.

9. If time remains, create models of several different atoms.

Questions:

1. Describe the atom you created.

2. What is its atomic number?

3. What kind of particles are protons, neutrons, and electrons? How are they different from each other?

4. What kinds of charges do protons, neutrons, and electrons possess?