

WORKSHEET

3.7

ENRICHMENT WORKSHEET

INTEGRATING

TECHNOLOGY

Seeing Atoms: the STM

Read the following paragraphs, and complete the exercises below.

The idea that everything is made up of small particles called atoms was first proposed by Greeks in the fifth century B.C. At that time, there was no experimental evidence to support this theory, and it did not gain much acceptance.

Much later, in the early 1800s, British scientist John Dalton made a convincing argument based on experimental evidence for the existence of atoms. Atoms are much too small to see, but Dalton found evidence for them in things he could observe, such as reactions between compounds. Because of the work of Dalton and others, the atomic theory soon became widely accepted by scientists.

How the STM sees atoms

Until recently, all evidence for the atomic theory was indirect. But an exciting development in 1981 made it possible to “see” atoms for the first time. This new technology, the scanning tunneling microscope (STM), uses an electric current to probe the surface of a material. The STM measures how electrons are distributed on the material’s surface. The results are used to create a computer-generated image of the atoms on the surface.

The first image created by an STM showed a layer of gold atoms. Since then, the atoms of many different substances have been observed with STMs, including silver, nickel, platinum, and silicon. At this time, imaging atoms is the primary use of STMs. STMs have also been used to move single atoms from one location to another, and other potential applications are being researched.

Exercises

1. What was one important difference between the Greek theory of atoms and Dalton’s atomic theory?

2. What is the significance of the invention of the STM?

3. Explain how an STM creates an image of the atoms on the surface of a material.

WORKSHEET

3.8**ENRICHMENT WORKSHEET****INTEGRATING****PHYSICS**

Atomic Fingerprints

Read the following paragraphs, and complete the exercises below.

In the Bohr model of the atom, electrons can be found only in certain energy levels. Electrons “jump” from one level to the next without passing through any of the regions in between. When an electron moves from one level to another, it gains or loses energy, depending on the direction of its jump.

Bohr’s model explained an unusual event. When electric current flows through a gaseous element, the gas produces a glowing light, like in a neon sign. If this light is passed through a prism, a pattern of lines appears, each line having a different color. The pattern depends on the element—neon has one pattern, and helium has another. What causes these lines, and why are they always the same for a given element?

Electrons release energy in certain quantities

In Bohr’s model, the lines are caused by electron jumps from higher to lower energy levels. Because only certain jumps are possible, electrons release energy only in certain quantities. These packets of energy produce the lines that are seen.

Because the energy levels in each element are different, each element has a unique set of lines—a sort of atomic fingerprint. These lines can be used to identify unknown elements. This method is often used to identify gases in a mixture, and it can be used to determine the chemical composition of stars and interstellar gases.

Exercises

1. What limitation is placed on electrons in the Bohr model of the atom?

2. When the light from a gas is passed through a prism, why is there only a certain number of lines rather than a continuous spectrum?

3. How is the series of lines emitted by a gas similar to a fingerprint?

4. Explain how scientists can use the pattern of lines from an unknown gas to identify what elements are contained in the gas.

Word Search: Elements

Directions: Write the correct word for each definition. As a check, find each vocabulary word in the puzzle below.

- an abbreviation for the name of an element _____
- a table that lists the elements in order of increasing atomic number (two words) _____
- a mixture of two or more metals _____
- a form of an element that has the same number of protons and electrons but a different number of neutrons _____
- elements on the right side of the periodic table that are not good conductors of heat and electricity _____
- the mass of an object divided by its volume _____
- a group of elements on the left side of the periodic table that are usually shiny and are good conductors of heat and electricity _____
- a group of gases that do not react with other substances under ordinary conditions (two words) _____
- a word that describes noble gases _____

Word Bank

Alloy

Inert

Noble Gas

Metals

Isotope

Periodic Table

Symbol

Density

Nonmetals

N K N O J Y E A N D V R C B H
 O T F K O D S L B S U H I Z S
 N B N E K F D L B Y B E S Y V
 M A O N P T H O E M D P O O E
 E A B K E Z H Y H B U O T M P
 T J L P R G U F G O I P O G G
 A Z E C I T S O A L D L P Z A
 L Y G D O I A Q Z L S L E Y V
 S P A N D N F B X O A T T V P
 Y A S M I E G P L T Z I D R K
 R G E E C R D W D E S W N B F
 X M S K H T B W S N W D Z U N
 E L Z X W K L M E H H P T H N
 M E T A L S H D X X M E N J D

Elements: Terms Review

Part A

Directions: Match each term in Column A with its meaning in Column B. Write the correct letter on the line.

Column A

- _____ 1. periodic table
- _____ 2. alloy
- _____ 3. nonmetals
- _____ 4. atomic mass
- _____ 5. deuterium
- _____ 6. isotope
- _____ 7. noble gases
- _____ 8. family

Column B

- a. A group of gases that do not react with other substances under ordinary conditions
- b. Form of an element; having the same number of protons and electrons but a different number of neutrons
- c. A group of elements with similar properties arranged in a column on the periodic table
- d. The average mass of all the isotopes of an element
- e. A table that lists the elements in order of increasing atomic number
- f. A mixture of two or more metals
- g. Elements found on the right side of the periodic table, which are not good conductors of heat or electricity
- h. A form of hydrogen

Part B

Directions: Unscramble the word or words in parentheses to complete each sentence below.

- 9. A _____ is an abbreviation for the name of an element.
(mobsly)
- 10. _____ are the elements placed on the left side of the periodic table.
(saltem) They are usually shiny and are good conductors of heat and electricity.
- 11. _____ gases will not combine with other substances under ordinary conditions.
(entir)
- 12. _____ is an isotope of hydrogen.
(riimutt)