	Class Period:
Lab Partner	Lab Partner

Lab # 5 Observing Bright Line Spectra

PROBLEM

What evidence indicates that electrons move around the nucleus in definite pathways?

INTRODUCTION

The quantum model of the atom, proposed by Niels Bohr in 1913, suggests that electrons move around the nucleus of the atom in definite pathways. The further the electron's path is from the nucleus, the more energy the electron has. The electrons path is called an energy level.

Electrons can move to higher energy levels if they pick up enough energy, but they cannot be found between energy levels. Bohr reached this conclusion by examining the light given off by electrons as they fell from high energy levels back to their natural ground state. In his lab electrons are excited by passing an electric current through a gaseous sample in a discharge tube. When the gas is excited the tube will glow brightly. This glow is produced when excited electrons emit radiant energy as they return to their ground state. White, light can be separated into different colors as in a rainbow. Different colors of light have different energies. A rainbow has all the colors or energies of light in the visible spectrum.

In this laboratory exercise, you will use a spectroscope to examine the light given off by several tubes of gas, each containing the vapor of a pure element. An emission spectrum or bright line spectrum will be produced in which you will see spectral lines. Each element has its own unique bright line spectrum by which it can be identified. This consists of bright lines at a definite wavelength. Each wavelength can be mathematically related to a definite quantity of energy produced by the movement of an electron form one discrete energy level to another using Planck's formula, $E = hf$ and the formula relating wavelength and frequency, $f = c/\lambda$ Therefore, bright line spectra prove that electrons exist at definite and distinctive energy levels in the atom

MATERIALS (per group)

Gas tubes; power supply; spectroscope

PROCEDURE

1. Examine a source of white light through a spectroscope. Look around in the spectroscope until you find the spectrum (a rainbow of colors).

Turn your slide so the spectrum extends to both sides of the light source rather than above and below.

2. Your teacher will put gas tubes into the power supply and turn them on for you. Use the spectroscope to examine the spectrum emitted by the gas.

3. In the space provided on the next page, write the name of the gas. Then draw lines representing the line spectra you observed. Put the lines in the order - Red, Orange, Yellow, Green, Blue, Indigo, and Violet.

4. Repeat the procedure in steps 2 and 3 for each tube of gas.

OBSERVATIONS

Name of Gas _____ R O Y G B I V	Name of Gas _____ R O Y G B I V
Name of Gas _____ R O Y G B I V	Name of Gas _____ R O Y G B I V

Questions for Discussion

1. Do the electrons of the elements you examined give off all the colors of light in the visible spectrum? Why or why not?

2. What evidence indicates that electrons move around the nucleus in definite pathways?

3. Each element has its own characteristic bright line spectra (the arrangement of lines you saw as opposed to the complete spectrum). Why do you think this is so?

4. How might emission spectra be used in studying the composition of unknown chemicals?

Honors Only:

Calculate the energies of the assigned lines.

Use E = hc/ λ

$h = 6.63 \times 10^{-34}$ J-s ,

$c = 3.00 \times 10^{8}$ m/s

λ = wavelength in meters

Hint: (1 nm = 1×10^{-9} m) convert from nm to m

Show all work for the following wavelengths of light

Sodium (Yellow) = 589 nm

Neon (orange) = 620 nm

Multiple Choice (Regents & Honors)

1) In which shell are the valence electrons of the elements in Period 2 found?
A) 1 B) 2 C) 3 D) 4

2) The modern model of the atom shows that electrons are
A) found in regions called orbitals
B) located in a solid sphere covering the nucleus
C) orbiting the nucleus in fixed paths
D) combined with neutrons in the nucleus

3) Which electron configuration represents an atom in an excited state?
A) 2-7 B) 2-7-1 C) 2-8-2 D) 2-8-1

4) Given the electron configuration of an atom in the ground state: 2-8-6

This element is found in the Periodic Table in
A) Period 4 and Group 16
B) Period 3 and Group 14
C) Period 3 and Group 16
D) Period 4 and Group 14

5) What is the total number of electrons in the outermost shell of a phosphorus atom in the ground state?
A) 1 B) 2 C) 3 D) 5

6) In the modern model of the atom, each atom is composed of three major subatomic (or fundamental) particles.

State the charge associated with each type of subatomic particle contained in the nucleus of the atom.

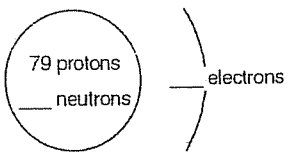
7) Subatomic particles can usually pass undeflected through an atom because the volume of an atom is composed of
A) an uncharged nucleus
B) neutrons
C) largely empty space
D) protons

8) Compared to an atom of hydrogen in the ground state, an atom of hydrogen in the excited state has
A) neither released nor absorbed energy
B) absorbed energy, only
C) released energy, only
D) both released and absorbed energy

9) Which of the following is the electron configuraton of a calcium atom in the excited state?
A) 2-8-7-3 B) 2-3-1 C) 2-4 D) 2-8-8-2

10) What is the electron configuration of a sulfur atom in the ground state?
A) 2-6 B) 2-8-4 C) 2-4 D) 2-8-6

11) In the early 1900's, evidence was discovered that atoms were not "hard spheres." It was shown that atoms themselves had an internal structure. One experiment involved gold metal foil.



(a) In the diagram above, complete the simple model for an atom of gold-197 by placing the correct numbers in the two blanks.

(b) In the gold-foil experiment, alpha particles were directed toward the foil. Most of the alpha particles passed directly through the foil with no effect. This result did not agree with the "hard spheres model" for the atom. What conclusion about the internal structure of the atom did this evidence show?

(c) In the same experiment, some of the alpha particles returned toward the source. What does this evidence indicate about the charge of the atom's nucleus?