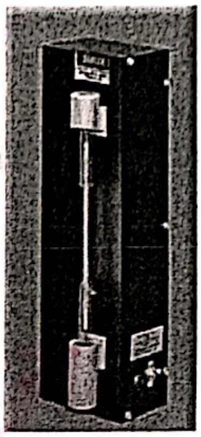
Emission Spectra and Energy Levels Practice

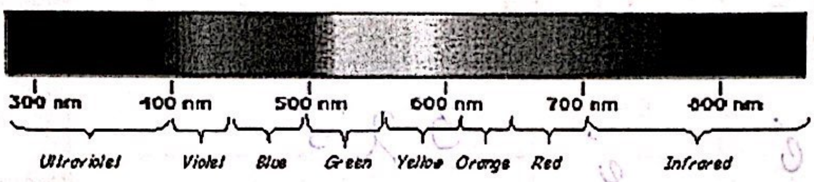
Name: Key Honors Period:_____ Date:_____

Discussion:

One convenient method of exciting atoms of an element is to pass an electric current through a gas sample of the element. This is the principle behind the spectrum tubes in the demonstration. A spectrum tube contains a small sample of an element in the vapor phase. An electric discharge through the tube will cause the vapor to glow brightly. The glow is produced when excited electrons emit visible light energy as they return to their original levels.



When visible light energy from a spectrum tube is passed through a diffraction grating, a bright line spectrum, or *line-emission spectrum* is produced. Each element has its own unique emission spectrum by which it can be identified, analogous to a fingerprint. Such a spectrum consists of a series of bright lines of definite wavelength. Each wavelength can be mathematically related to a definite quantity of energy produced by the movement of an electron from one discrete energy level to another. Thus, emission spectra are experimental proof that electrons exist in definite, distinctive energy levels in an atom.



Questions:

1. Look at the spectrum and determine the colors of the following four lines – described by their wavelength. These are the four emission lines in the visible part of the spectrum for hydrogen.

   410 nm Violet

   432 nm Violet/Blue

   486 nm Blue

   656 nm Red

2. Which color of *visible* light has…
   a. the shortest wavelength? Violet
   b. the longest wavelength? Red
   c. the least amount of energy? Red
   d. the greatest amount of energy? Violet

3. The color of the emitted light is dependent on the wavelength of the light.

4. According to the modern theory of the atom, how are the ~~atoms~~ electrons arranged around the nucleus?

   Atom
   → Energy Levels
   → Sublevels
   → Orbitals

5. How do electrons become "excited"?

gaining energy

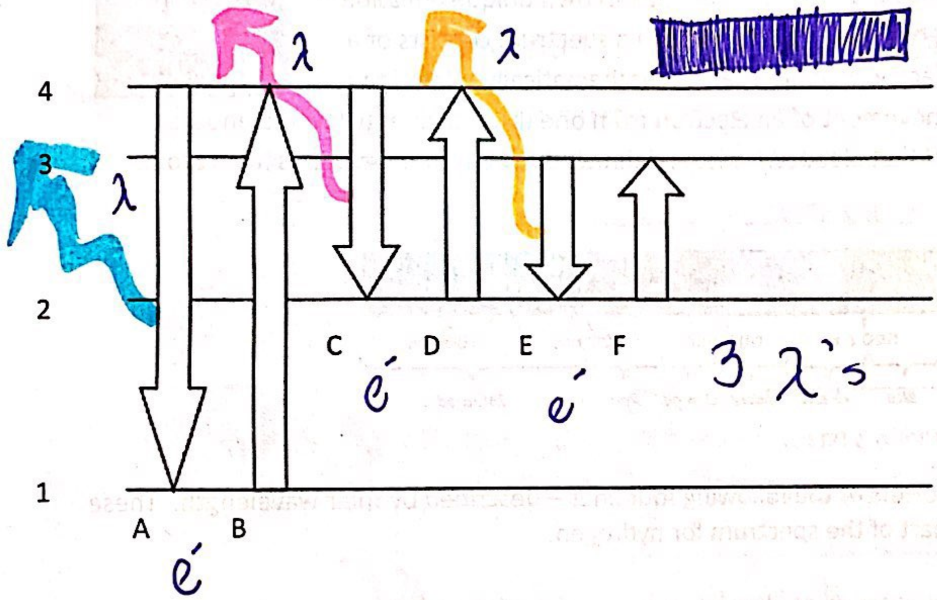
6. What form of energy accompanies the return of excited electrons to the ground state? Is this energy always visible to the human eye? Why or why not?

Electromagnetic radiation

No

Depends on λ

7. The quantum level occupied by an electron in an atom depends on the energy of the electron. Changes in quantum level are related to absorption or emission of energy. The figure below represents the four lowest energy levels of an atom. (n = 1 to 4). The six, lettered arrows represent changes in the energy level of an electron.



"And anyone who thinks they can talk about quantum theory without feeling dizzy hasn't yet understood the first thing about it."
– Niels Bohr

8. Why do these energy levels mean that the atom will show an emission spectrum of individual lines rather than a continuous spectrum of emitted light?

1B

Because there are only 3 λ's released

9. Which three of the lettered energy changes involve **absorption** of energy by the atom?

B, D, F

10. Which three of the lettered energy changes involve **emission** of light energy by the atom?

A, C, E

11. How does a hydrogen atom, which has only one electron, have so many lines in it's spectrum?

The one electron can transition between multiple energy levels (ex: n=1 → n=2, n=1 → n=4, etc.

Worksheet: Energy Levels, Sublevels, Orbitals Name____________________

Energy Level *n*	E Sublevel (type of orbital)	# of Orbitals in Sublevel	# of e^- in Sublevel	Total # of e^- in E level ($2n^2$)
1	s	1	2	2
2	s	1	2	8
	p	3	6	
3	s	1	2	18
	p	3	6	
	d	5	10	
4	s	1	2	32
	p	3	6	
	d	5	10	
	f	7	14	

Worksheet Part A: Atomic Spectra Name: ____________

Answer the following questions using your notes.

1. Compare the energy of an electron in the ground state and an electron in the excited state.

Gr < Ex

2. When an electron *absorbs* energy and moves from ground state to a higher energy level, what do we see with our spectroscope or diffraction glasses?

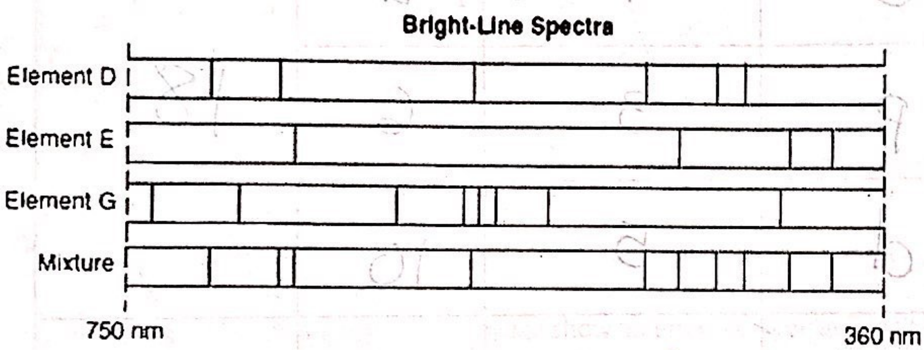
Nothing!

3. When an electron falls from a higher energy level to a lower energy level, how is the energy released?

Photon of EM radiation

4. The further the electron is from the nucleus, the __more__ energy the electron has.

Use the diagram below to answer the next question:



5. What elements are present in the mixture? D + E
Explain how you know?

b/c the atomic spectra match up!

6. A(n) __orbital__ is often thought of as a region of space in which there is a high probability of finding an electron.

7. How are s orbitals different from p orbitals? s (sphere) p (dumbell) – shape

8. How many electrons can each of the following orbitals hold?
   a. a. 2s = 2 b. 6d = 10 c. 3p = 6 d. 4p = 6
   b. e. 5f = 14 f. 3d = 10 g. 3s = 2 h. 7s = 2

9. How many "p" orbitals can there be in any energy level? 3

10. What is the *maximum* number of electrons in the 3[rd] energy level? __18__

Name ______________________ Date ____________ Class ____________

TEACHING TRANSPARENCY WORKSHEET 16

Atomic Orbitals

1. What is the shape of an s orbital?

sphere

2. What is the relationship between the size of an s orbital and the principal energy level in which it is found?

direct relationship

3. What is the shape of a p orbital? How many p orbitals are there in a sublevel?

dumbell max of 3

4. How many electrons can each orbital hold?

$2e^-$

5. Look at the diagrams of the p orbitals. What do *x*, *y*, and *z* refer to?

planes that the orbitals occupy

6. How many d orbitals are there in a given sublevel? How many total electrons can the d orbitals in a sublevel hold?

5 10

7. Which d orbitals have the same shape?

all except dz^2

8. What point in each diagram represents an atom's nucleus?

the center

9. How likely is it that an electron occupying a p or a d orbital would be found very near an atom's nucleus? What part of the diagram supports your conclusion?

unlikely b/c near the nucleus the orbital is tiny, therefore stating that it's uncommon