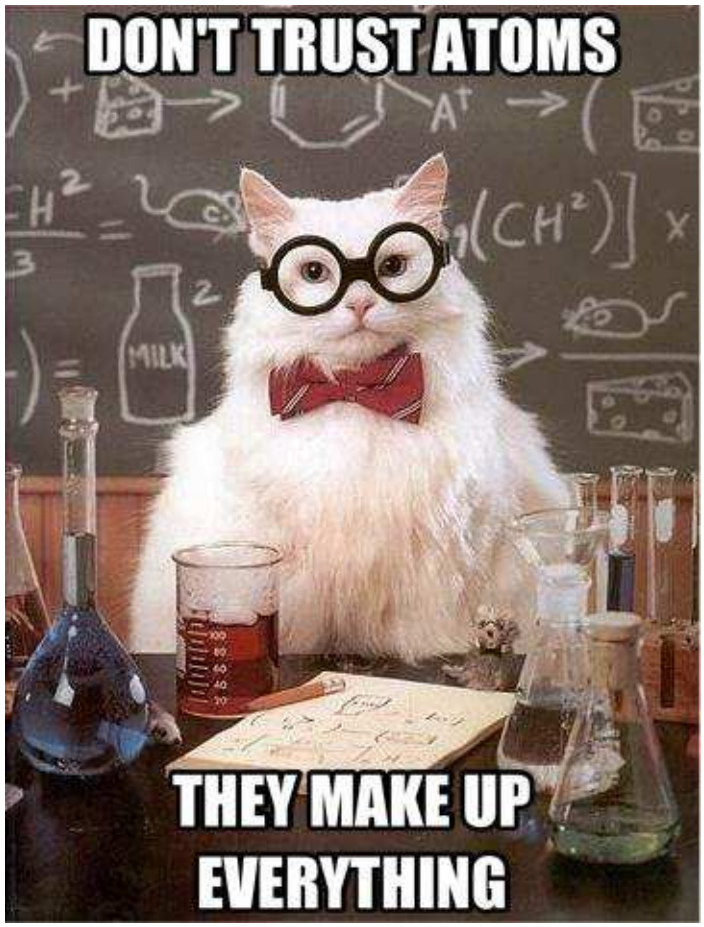
Name:

Regents Chemistry: Mr. Palermo

Notes: Unit 3: Atomic Concepts



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Vocabulary:

1. alpha particle
2. anion
3. atom
4. atomic mass
5. atomic mass unit (amu)
6. atomic number
7. atomic structure/subatomic particles
8. bright-line spectrum
9. cation
10. deflected
11. electron
12. element
13. excited-state electron configuration
14. Gold foil experiment
15. ground-state electron configuration
16. ion
17. isotope
18. isotopic notation
19. mass number
20. neutral
21. neutron
22. nuclear charge
23. nucleons
24. nucleus
25. orbital
26. percent abundance
27. proton
28. valence electron
29. wave-mechanical model

Unit Objectives: When you complete this unit you *will be able to do* the following...

1. Describe how the modern model of the atom has evolved over a long period of time through the work of many scientists
2. Relate experimental evidence to models of the atom
3. Describe in detail Rutherford's Experiment and the conclusions he made
4. Determine the number of protons, neutrons, and electrons in an ion
5. Identify the subatomic particles of an atom (proton, neutron, and electron)
6. Determine the number of protons, neutrons, electrons, nucleons and nuclear charge in a neutral atom
7. Differentiate between atomic number, mass number, and (average) atomic mass
8. Calculate the (average) atomic mass for all isotopes of an element
9. Calculate the number of neutrons in an isotope
10. Construct Bohr diagrams for atoms and ions
11. Construct Lewis dot diagrams for atoms and ions
12. Differentiate between excited and ground state
13. Explain how light is produced
14. Identify substances based upon their bright line spectra

Unit 3 Atomic Concepts:
Lesson 1- Atomic Theory

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Objective:

- Describe how the modern model of the atom has evolved over a long period of time through the work of many scientists
- Relate experimental evidence to models of the atom
- Describe in detail Rutherford's Experiment and the conclusions he made

Democritus (460-370 B.C.) –

His Model of the Atom:

-Atom is smallest piece that any substance can be broken down into.

Dalton (1808)-

His Model of the Atom

¨All elements composed of tiny particles called **ATOMS**

¨Atoms of same element are **identical**; atoms of different elements are **different**

J. J. Thompson (1897)- Discovered _____ using a cathode ray tube.

His Model of the Atom:

_____ model

¨Atom is positively charged with negative electrons "stuck" in it.

Cathode Ray Tube (CRT)- A Vacuum tube where a beam of electrons pass through from left to right.

Thomson used it to discover electrons,

Concluded they are negatively charged

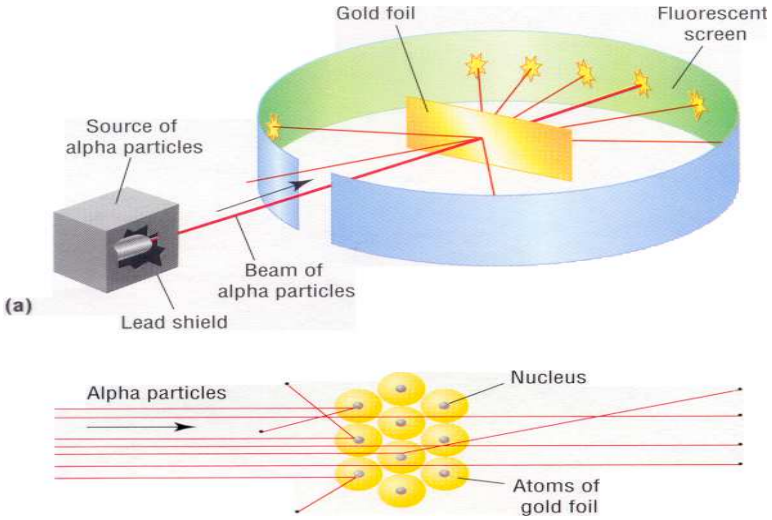
Ernest Rutherford (1911)- Discovered the _____

His Model of the Atom:

¨Small dense positive nucleus

¨Atom is mostly empty space

Rutherford's Experiment :



Rutherford's Conclusions:

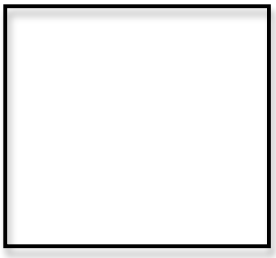
1.)

2.)

MODERN THEORIES

Niels Bohr (1913)-

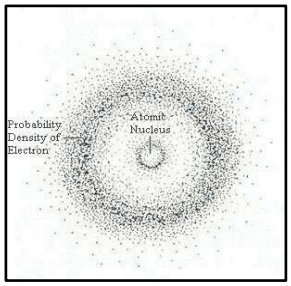
His Model of the Atom:



Electrons travel around the nucleus in well-defined paths called _____ (like planets in a solar system)

Electrons in different orbits possess different amounts of _____

Wave Mechanical Model (current model)-



Discovery: Can only determine the probability of finding an electron

Model of the Atom: **Electrons found in _____**

PRACTICE:

When alpha particles are used to bombard gold foil, most of the alpha particles pass through undeflected. This result indicates that most of the volume of a gold atom consists of _____.

1. a nucleus

2. neutrons

3. protons

4. unoccupied space

CHECK YOUR UNDERSTANDING:

How did Rutherford conclude that the nucleus was positively charged?

Unit 2 Atomic Concepts:
Lesson 3: Ions

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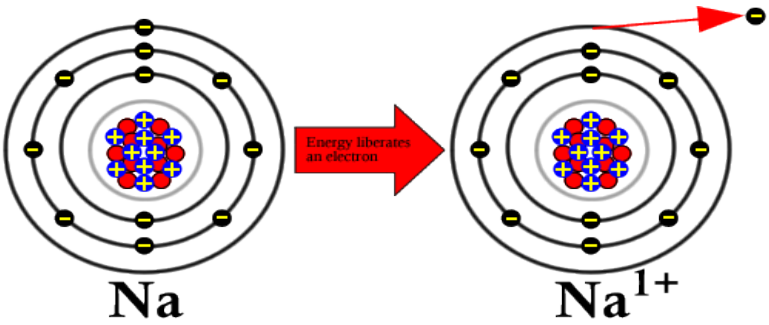
Objective:

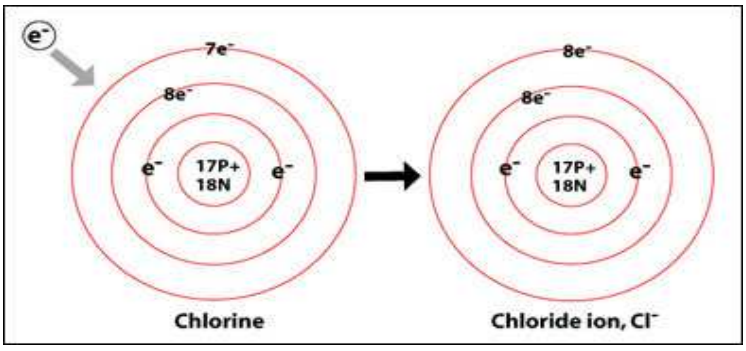
- Determine the number of protons, neutrons, and electrons in an ion

IONS:

CATION:



ANION:



PRACTICE:

Element	Atomic #	Mass #	p	n	e
Fe					
Fe^{3+}					

CHECK YOUR UNDERSTANDING:

Element	Atomic #	Mass #	p	n	e
Ca					
Ca^{2+}					
F					
F^{-}					

Objective:

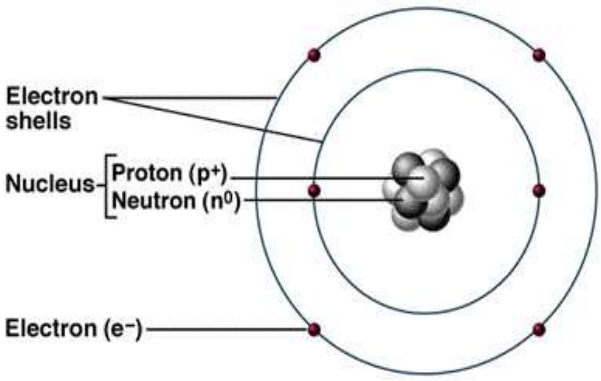
- Identify the subatomic particles of an atom (proton, neutron, and electron)
- Determine the number of protons, neutrons, electrons, nucleons and nuclear charge in a neutral atom

SUBATOMIC PARTICLES:

Name:	Symbol	Charge	Mass
Proton *(located in the nucleus)*	p^+	+1	1amu
Neutron *(located in the nucleus)*	n^0	0	1amu
Electron *(located outside the nucleus)*	e^-	-1	1/1836 amu

amu = _____

NUCLEONS:



ATOMIC NUMBER:

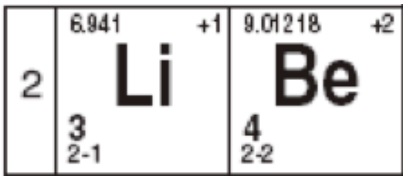
MASS NUMBER:

FINDING THE NUMBER OF SUBATOMIC PARTICLES

To find the # of PROTONS:

look up atomic number on Periodic Table

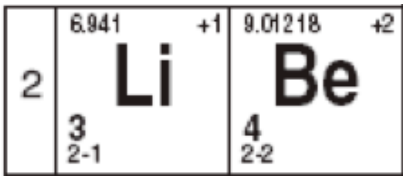
Ex. Lithium has 3 protons



To find the # of ELECTRONS:

Equal to the # of protons in a neutral atom

Ex. Lithium has 3 electrons

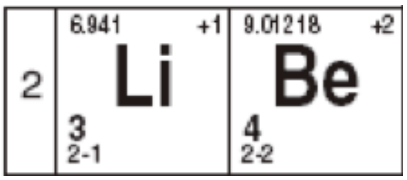


To find the # of NEUTRONS:

Protons + Neutrons = Mass

# of neutrons = mass number – number of protons

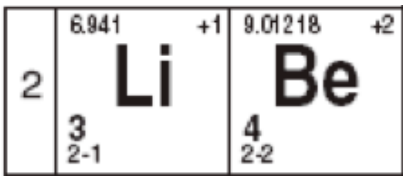
Ex. Lithium has 4 neutrons (7 – 3) = 4



To find the NUCLEAR CHARGE:

Equal to the number of protons

Ex. Lithium has a +3 nuclear charge



PRACTICE: Fill in the table

Element	Atomic #	Mass #	# of protons	# of neutrons	# of electrons
Carbon (C)					

CHECK YOUR UNDERSTANDING: Fill in the table

Element	Atomic #	Mass #	# of protons	# of neutrons	# of electrons
Ca					
Mg					
Na					
He					

Unit 3 Atomic Concepts:
Lesson 4- Isotopes & Average Atomic Mass

247
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Objective:

- Differentiate between atomic number, mass number, and (average) atomic mass
- Calculate the (average) atomic mass for all isotopes of an element
- Calculate the number of neutrons in an isotope

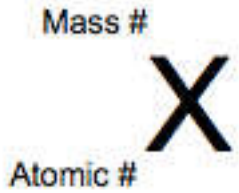
ISOTOPES: Elements that have the _____ but _____ (different # of neutrons)

Isotope Symbols:

Show the mass of isotope

Same atomic #, different mass #

Ex. isotope symbol of element X

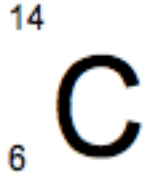


Common Isotopes of Hydrogen:

Name	Symbol	#p	#e	#n	Mass
Protium	H	1	1	0	1
Deuterium	H	1	1	1	2
Tritium	H	1	1	2	3

EXAMPLE: The isotope symbol for of Carbon-14

How many neutrons does it have?



PRACTICE: Write the isotope symbol for oxygen-17.

How many neutrons does it have?

CHECK YOUR UNDERSTANDING: Write the isotpe symbol for chlorine-37.

How many neutrons does it have?

CALCULATING AVERAGE ATOMIC MASS

AVERAGE ATOMIC MASS:

The atomic mass on the periodic table is a weighted average of the isotopes of the elements.

The weighted atomic mass takes into account the *relative abundances (amounts)* of all the naturally occurring isotopes.

Example: Determine avg atomic mass

Boron-10	19.78%	10.013 amu
Boron-11	80.22%	11.009 amu

Step 1: Multiply the mass of each isotope by its percent abundance in DECIMAL FORM (move decimal 2 places to left)

10.013 x (0.1978) = 1.981

11.009 x (0.8022) = 8.831

Step 2: Add up the products from step 1

1.981 + 8.831 = 10.812 amu

PRACTICE: Determine weighted atomic mass

Potassium-39 93.12% 38.964 amu

Potassium-41 6.88% 40.962 amu

CHECK YOUR UNDERSTANDING 2:

An element has two isotopes. 90% of the isotopes have a mass number of 20 amu, while 10% have a mass number of 22 amu. Calculate the atomic mass of the element.

247
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Objective:

- ***Construct Bohr diagrams for atoms and ions***

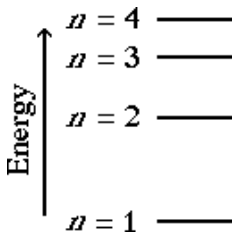
Bohr Models

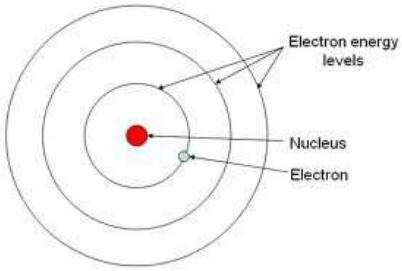
How do electrons "orbit" the nucleus? _____.

- Each principal energy level:
  - ☐ is a fixed distance from the nucleus
  - ☐ can hold a specific number of electrons
  - ☐ has a definite amount of energy

The **greater the distance** from the nucleus… _____
_____.

The **ORBITS** are called _____.





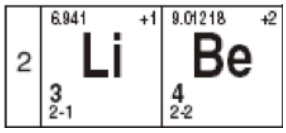
How many electrons can each shell hold? _____

n= _____

Ex. Max # of electrons in 1st?

Drawing Bohr Diagrams

1. Look up electron configuration on Periodic table *(if it's an ion add/subtract the e- from the outermost energy level)*
2. Draw a circle for nucleus and notate # of protons and neutrons in it.
3. Draw in energy levels and notate the # of electrons in each shell



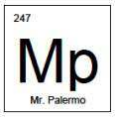
EXAMPLE: Draw the Bohr diagram of Li

EXAMPLE: Draw the Bohr diagram of Mg^{+2}

PRACTICE: Draw the Bohr diagram of Na

PRACTICE: Draw the Bohr diagram of H

CHECK YOUR UNDERSTANDING: Draw the Bohr diagram of Na^{+}



Objective:

- ***Construct Lewis dot diagrams for atoms and ions***

Lewis Dot Diagrams (electron dot diagrams)

LEWIS DOT DIAGRAMS only show _____.

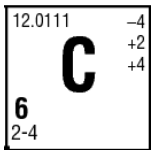
VALENCE SHELL: _____

VALENCE ELECTRONS: _____
_____.

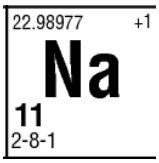
Steps for drawing dot diagrams:

1. Draw the elements symbol
2. Locate valence electron # (last number of electron configuration)
3. Pair the first 2 electrons they deal out any remaining one at a time to other 3 sides.

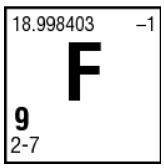
EXAMPLE: Draw dot diagram for Carbon



PRACTICE: Draw the dot diagram for Na



PRACTICE: Draw the dot diagram for F



Drawing Lewis Diagrams for IONS

1. Draw brackets around the element symbol
2. Write charge of ion outside bracket on top right corner of symbol
3. Positive ions no dots
4. Negative ions 8 dots

EXAMPLE: K^{+}

Remove 1 electron from the valence shell of K

EXAMPLE: S^{-2}

Add 2 electrons to the 6 that S normally has in its valence shell

PRACTICE: Draw dot diagram for Mg^{+2}

PRACTICE: Draw dot diagram for O^{-2}

CHECK YOUR UNDERSTANDING: Draw the dot diagram for N and N^{-3}

Unit 3: Atomic Concepts
Lesson 7: Ground vs Excited State and Bright Line Spectrum

247
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Objective:

- ***Differentiate between excited and ground state***
- ***Explain how light is produced***
- ***Identify substances based upon their bright line spectra***

GROUND STATE- When electrons occupy the _____ available _____. (This is the configuration on the **periodic table**)

EXCITED STATE- Electrons _____occupy the lowest available energy levels (different than electron configuration)

Example: Possible excited state for Na

Na (ground state)	Na (possible excited state)	Na (another possible excited state)	Na (another possible excited state)
2-8-1	**2-7-2**	**2-6-3**	**2-5-4**

How do you tell if the configuration is ground or excited state?

Add up total # of electrons in configuration

Determine element

If it **matches** element configuration on periodic table **=** _____

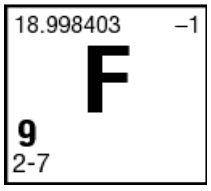
If it **doesn't match =**_____

EXAMPLE: Identify the electron configuration as being ground state or excited state: 2-6-1

2+6+1 = 9

Fluorine

Excited State



MORE EXAMPLES:

Given Shell Configuration	Add Up The Electrons	Which Element Is It?	What is the Shell Configuration on the Periodic Table For this Element?	Does it match your given configuration?	Ground state or excited state?
2-8-8-3	21	Sc	2-8-8-3	YES	Ground
2-7-2	11	Na	2-8-1	NO	Excited
2-8-3-1	14	Si	2-8-4	NO	Excited
2-8-15-2	27	Co	2-8-15-2	YES	Ground

*****Remember when in excited state the total # of electrons DOES NOT change**

PRACTICE: Identify the electron configuration as being ground state or excited state: 2-7-3

CHECK YOUR UNDERSTANDING: Give a possible electron configuration of Ca in the excited state.

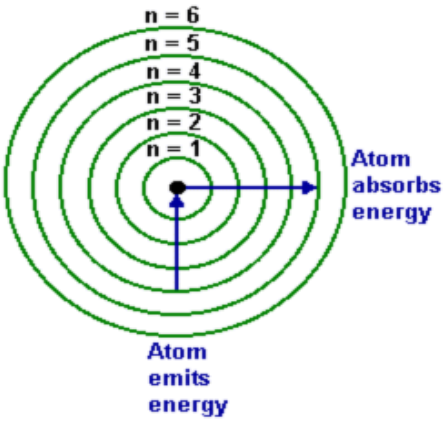
BRIGHT LINE SPECTRA

ABSORPTION:

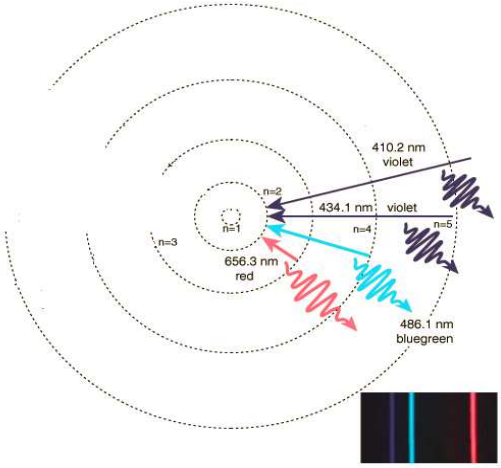
Electrons _____ energy as they move to
_____energy levels (excited state)

This excited state is _____.

EMISSION: Electrons are negatively charged and therefore attracted to positive nucleus so eventually they fall back to ground state and give off the energy they absorbed as light energy

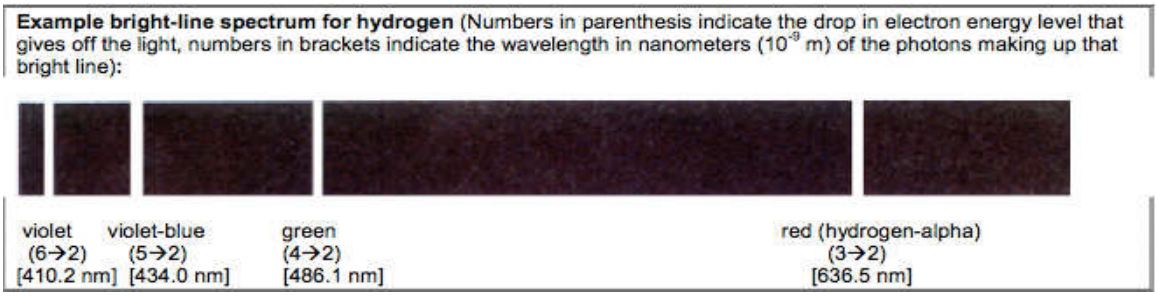


LIGHT: The _____ is determined by the amount of _____ by the electron when it drops back to the ground state.



EXAMPLE: Possible Ways an electron can fall back to ground state from 4th energy level

1. From the 4th to the 1st energy level
2. From the 4th to the 3rd to the 1st energy level
3. From the 4th to the 2nd to the 1st energy level.
4. From the 4th to the 3rd to the 2nd to the 1st energy level.

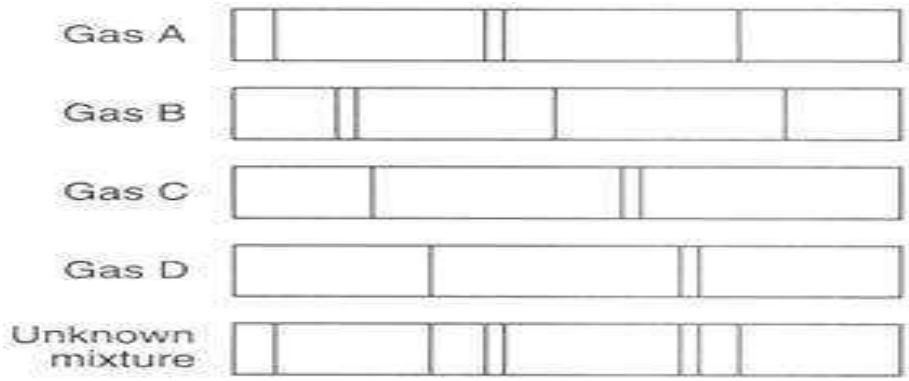


BRIGHT LINE SPECTRA:

Each element has its own bright line spectra that is unique. (like a fingerprint)

Can be used to identify an unknown mixture of gases.

PRACTICE: What Gases Comprise the Unknown?



CHECK YOUR UNDERSTANDING 2:

Each line on the visible light spectrum represents

a) electrons jumping to the same excited state or energy level.

b) electrons falling back down to their ground state from the same energy level.

c) electrons jumping to multiple excited states or energy levels.

d) electrons falling back down to their ground state from multiple energy levels.

CHECK YOUR UNDERSTANDING 3: The unknown gas is a mixture of what gases?