South Pasadena • AP Chemistry

Name Grover
Period ___ Date ___/___/___

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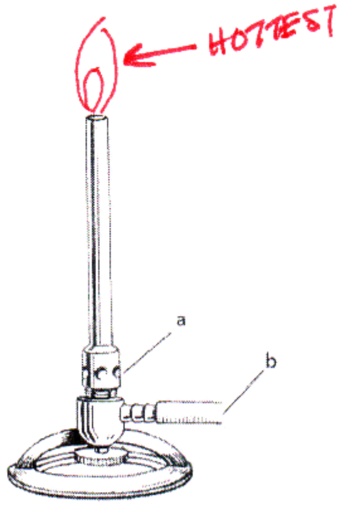
Station 1 – BURNERS AND FLAME TESTS

Metal Ion	Flame Test Color
sodium, Na	Yellow (orange)
strontium, Sr	Red
copper, Cu	Green/Blue
barium, Ba	Pale Green



During a flame test, light is emitted (absorbed/emitted) as an electron moves to a lower (higher/lower) energy level.

For the Bunsen burner:

a) AIR is added to the flame.

b) GAS is added to the flame.

Draw a well adjusted flame above the burner.
Indicate the hottest part of the flame. at the tip of the inner cone

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Station 2 – VIEWING SPECTRA

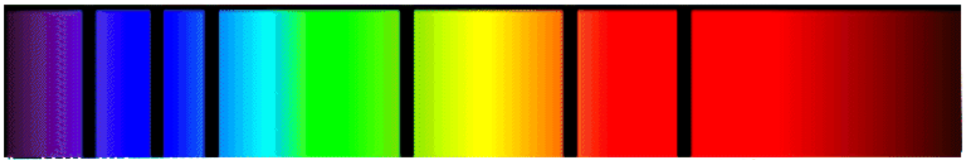
Using the triangular spectrometers, look at the provided light source.
The wavelength of light viewed ranges from 400 nm to 700 nm.

answers will vary

What is the wavelength of the GREEN light? 560 nm $= 560 \times 10^{-9}\,m = 5.6 \times 10^{-7}\,m$

Calculate the frequency of the green light. $\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\,m \cdot s^{-1}}{5.6 \times 10^{-7}\,m} = 5.357 \times 10^{14}\,s^{-1} = \boxed{5.4 \times 10^{14}\,Hz}$

Consider the spectrum below. It is an absorption (emission/absorption) spectrum.



Explain what the electrons are doing to produce the black lines:

The electrons ABSORB energy as they move from lower to higher energy levels.

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Station 3 – ENERGY CALCULATIONS

H-O-O-H

The energy required to break the O - O bond in hydrogen peroxide, $H_2O_{2(g)}$, is 139 kJ mol^{-1}.
How much energy is needed to break one peroxide bond (in Joules)? (Show work)

$$\frac{139\ \cancel{kJ}}{\cancel{\text{mole of bonds}}} \times \frac{1000\ J}{1\ \cancel{kJ}} \times \frac{\cancel{1\ \text{mole bonds}}}{6.02\times10^{23}\ \text{bonds}} = \boxed{2.31\times10^{-19}\ J}$$

Blue light has a wavelength of about 475 nm. Does this light have enough energy to break the bond? yes
Justify your answer with calculations.

$$\lambda = 475\ nm = 475\times10^{-9}\ m = 4.75\times10^{-7}\ m$$

$$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34}\ J\cdot\cancel{s})(3.00\times10^{8}\ \cancel{m}\cdot\cancel{s^{-1}})}{4.75\times10^{-7}\ \cancel{m}} = \boxed{4.18\times10^{-19}\ J}$$

$$4.18\times10^{-19} > 2.31\times10^{-19}\ J$$

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Station 4 – SHELLS, SUBSHELLS & ORBITALS

Circle the subshells that do NOT exist: *4p* [✓ *1p*] [✓ *2f*] *5s* *3d* *7p* [✓ *2d*] *3s*

5 The number of **orbitals** in a ***4d*** **subshell**. ALL "d" subshells contain 5 orbitals

4 The number of **orbitals** in the *n*=2 **shell**. n^2 orbitals; 2s $2p_x$ $2p_y$ $2p_z$

5 The number of **subshells** in the *n* =5 **shell**. n, 5s, 5p, 5d, 5f, 5g

7 The number of **orbitals** in a ***4f*** **subshell**. ALL "f" subshells contain 7 orbitals

3 The number of **subshells** in the *n* =3 **shell**. n 3s, 3p, 3d

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Station 5 – WAVE CALCULATIONS

$c = 2.998 \times 10^8$ m/s $h = 6.626 \times 10^{-34}$ J·s

The color orange (school colors) has a wavelength of 615 nm. $= 615 \times 10^{-9} m = 6.15 \times 10^{-7} m$

Calculate the frequency of this light.

Calculate the energy of a photon this light.

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ m \cdot s^{-1}}{6.15 \times 10^{-7}\ m} = \boxed{4.88 \times 10^{14}\ s^{-1}}$$

$$E = h\nu = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot \cancel{s})(3.00 \times 10^{8}\ \cancel{m} \cdot \cancel{s^{-1}})}{6.15 \times 10^{-7}\ \cancel{m}} = \boxed{3.23 \times 10^{-19}\ J}$$

A radio station broadcasts at a frequency of 590 KHz (590×10^3 ~~Hz~~ s^{-1}).

What is the wavelength of the radio waves?

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^{8}\ m \cdot \cancel{s^{-1}}}{590 \times 10^{3}\ \cancel{s^{-1}}} = 508\ m$$

$$\boxed{510\ m}$$

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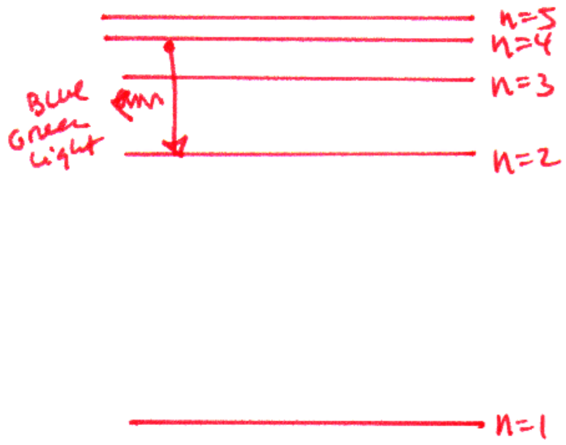
Station 6 – THE BOHR ATOM

$c = 2.998 \times 10^8$ m/s $h = 6.626 \times 10^{-34}$ J·s $Rhc = 2.18 \times 10^{-18}$ J $R = 1.0974 \times 10^7\ m^{-1}$

Sketch the Bohr atom from levels n=1 to n=5.



Show the transition that would give off **blue-green** light. $n=4 \rightarrow n=2$

Calculate the energy of level n=4.

$$E_n = -\frac{2.18 \times 10^{-18} J}{4^2} = 1.36 \times 10^{-19} J$$

Calculate the energy change of an electron that drops from level 4 to level 2.

$$E_2 = \frac{-2.18 \times 10^{-18} J}{4} = 5.45 \times 10^{-19}$$

$$E_2 - E_4 = \boxed{4.09 \times 10^{-19} J}$$

An electron that moves from n=1 to n=5 would gain (gain / lose) energy and produce an absorption (absorption / emission) spectrum.

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Station 7 – DE BROGLIE WAVELENGTH

SPEED OF LIGHT

$c = 2.998 \times 10^{8}$ m/s $h = 6.626 \times 10^{-34}$ J·s $Rhc = 2.18 \times 10^{-18}$ J $R = 1.0974 \times 10^{7}$ m^{-1}

Write the equation for the De Broglie wavelength of a particle:

$$\lambda = \frac{h}{mv}$$

Joule is the same as a unit containing "kg". What is it?

$$J \approx kg \cdot m^2 \cdot s^{-2} \quad \text{or} \quad kg\frac{m^2}{s^2}$$

An electron has a mass of 9.10956×10^{-31} kg. What is the wavelength of an electron traveling at 75.0% the speed of light?

$$\lambda = \frac{6.626 \times 10^{-34}\ J \cdot s}{(9.10956 \times 10^{-31} kg)(.750)(2.998 \times 10^{8} m \cdot s^{-1})}$$

$$= \boxed{3.23 \times 10^{-12}\ m}$$

NOTE: an atom is about 10^{-10} m

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Station 8 – QUANTUM NUMBERS

When n = 3, the possible values of ℓ are: [✓ 0] [✓ 1] [✓ 2] 3 4 5 (Circle your answers.)

For a *3d* orbital, the value of ℓ is 2.

When n = 5, the possible values of ℓ are: [✓ 0] [✓ 1] [✓ 2] [✓ 3] [✓ 4] 5 (Circle your answers.)

For a *5p* orbital, the value of ℓ is 1.

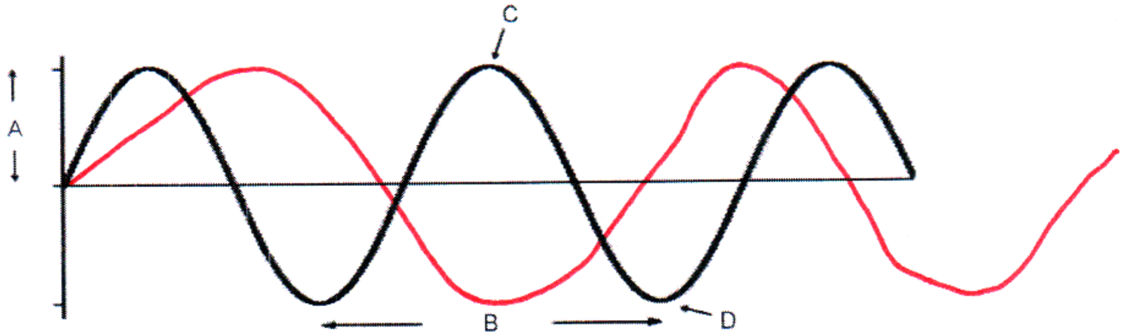
There are three different *4p* orbitals.
Write the three quantum numbers that describe these orbitals:

n	ℓ	m_ℓ
4	1	-1
4	1	0
4	1	+1

Is this set of quantum numbers possible? yes (a 3d orbital)

3	**2**	**-2**

Station 9 – WAVE FACTS



A = amplitude B = wavelength, λ C = crest D = trough

If this is a wave of YELLOW light, **sketch** what a wave of RED light would look like. less energetic
longer wavelength

The red light would have a Lower (higher/lower) frequency, a Longer (longer/shorter) wavelength, and Less (more/less) energy.

If this were a picture of a **standing wave**, how many antinodes are shown? 5