Name: _____

Period: _____

Electromagnetic Spectrum

Light is a Wave

Light is refracted in lenses. Light diffracting around two fingers (look close) causes lines of darkness: destructive interference.
Light must be a wave!

Light is a Particle

Light can travel through the vacuum of space, but waves can't travel in a vacuum. So ***light must be a particle!***

Light is Both

This contradiction perplexed scientists for many, many years, but the evidence must be believed: **light is both a wave and a particle.**

Packets of light we call photons.

Speed of Light: 3 x 10^8 m/sec

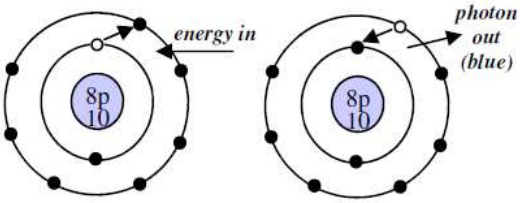
Sound is fast: 340 m/sec, but **light is faster:** 3 x 10^8 m/sec! That's 3 with 8 zeroes or 300,000,000 m/sec. Light can circle the earth 27 times in one second!

Scientists now believe that **nothing can go faster than light**.

The speed of light is the ultimate speed limit.

Origins of Light and Color

Photons (light) come from electrons falling from high electron orbits to low orbits.
These orbits are also called ***energy levels***.



Energy can raise an electron to a higher energy level.

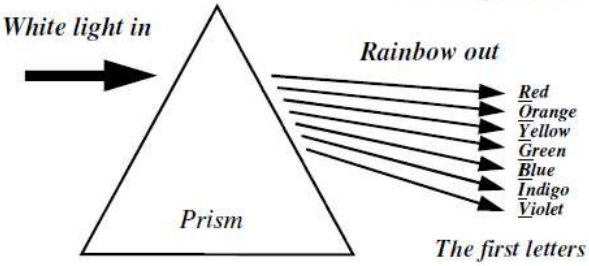
When the electron falls back, a photon is given off: light!

Because each element has a different number of protons, **each element** has slightly different electron energy levels and **gives off different colors.** From their colors we can tell the chemical makeup of stars.

The sky is blue because oxygen atoms give off blue photons.

Visible Light

What we call "visible light" is made up of many different colors. Each color has a different wavelength and a different frequency.



A prism uses refraction to separate the different wavelengths (colors) of visible light.

The first letters spell: ROY – G – BIV

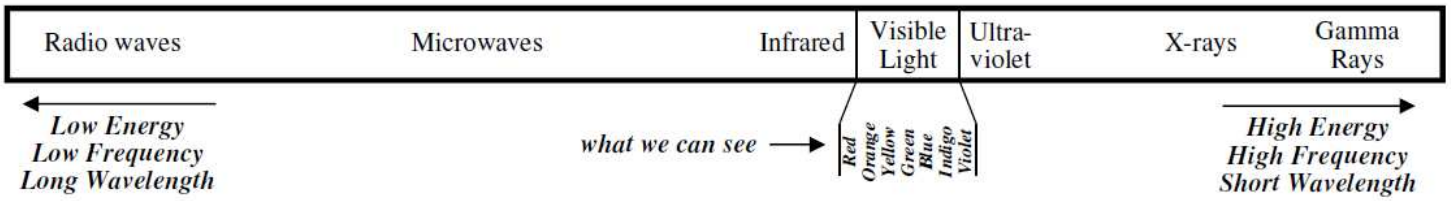
Colors have Different Energies

You know that different color flames give off different amounts of heat. Red flames are the coolest and blue flames are the hottest. ***As you move from Red to Blue, light GAINS energy.***

White light is made up of all colors. That is why a white flame is the hottest!

EM Spectrum

Visible Light is a *very* small part of the entire Electromagnetic (EM) Spectrum.



Radio waves – used to transmit radio and television signals. Wavelengths range from hundreds of meters to less than a centimeter. This is why radio towers have to be so tall.

Microwaves – used to cook food and by cell phones. Wavelengths range from 30 cm to 1 mm.

Infrared – (invisible heat) 1 mm to 700 nanometers (700 billionths of a meter).

Visible (white) light – from 700 to 400 nanometers.

Ultraviolet light – invisible wavelengths from 400 nanometers to 10 nanometers. Part of sunlight burns your skin and can cause cancer. The ozone layer protects us from most of the sun's ultraviolet light.

X-rays – Used in medicine and industry. Wavelengths are from 10 nanometers to .01 nanometers (10 trillionth of a meter).

Gamma rays – the most powerful and dangerous form of radiation. Wavelengths—less than .01 nanometers. Emitted by nuclear reactions, they can break chemical and nuclear bonds.

1. Photon	A. The fastest speed in the universe: the speed of light.
2. 3×10^8 m/sec	B. An orbit of electrons. To move from low to high requires energy.
3. Prism	C. All light: visible and invisible.
4. Light	D. Used to separate white light into its colors.
5. EM Spectrum	E. A single particle or packet of light.
6. Energy Level	F. A wave that can travel through a vacuum.

1. Radio waves	A. Electromagnetic waves we feel as heat.
2. Infrared	B. Dangerous EM waves that have very high energy and come from nuclear reactions.
3. Ultraviolet	C. EM waves that have very low energy and long wavelengths.
4. X-rays	D. EM waves that can pass through skin and have short wavelengths.
5. Gamma rays	E. EM waves with more energy than visible light and can cause sunburns.
6. Microwaves	F. Long wavelengths; used in cell phones.

Is light a wave or a particle. Prove your answer:

Put these three in order from slowest to fastest:

Light waves; sound waves; water waves.

_____

Where does light come from?

Put these from shortest to longest wavelengths

Radio waves Ultraviolet X-rays Visible Microwaves

_____

Indicate whether there is positive (+) or negative (-) work being done on the object.

_____ a. An eastward-moving **car** skids to a stop across dry pavement.

_____ b. A freshman stands on his toes and lifts a **World Civilization book** to the top shelf of his locker.

_____ c. At Great America, **a roller coaster car** is lifted to the peak of the first hill on the Shock Wave.

_____ d. A catcher puts out his mitt and catches the **baseball**.

_____ e. A falling **parachutist** opens the chute and slows down.

Read each of the following statements and identify them as having to do with kinetic energy (KE), potential energy (PE) or both (B).

KE, PE or B?	Statement:
_____	1. If an object is at rest, it certainly does NOT possess this form of energy.
_____	2. Depends upon object mass and object height.
_____	3. The energy an object possesses due to its motion.
_____	4. The amount is expressed using the unit joule (abbreviated J).
_____	5. The energy stored in an object due to its position (or height).
_____	6. The amount depends upon the arbitrarily assigned *zero level*.
_____	7. Depends upon object mass and object speed.
_____	8. If an object is at rest on the ground (zero height), it certainly does NOT possess this form of energy.

Read the following descriptions and indicate whether the objects' KE, PE and TME increases, decreases or remains the same (=). If it is impossible to tell, then answer ???.

a. A marble begins at an elevated position on top of an inclined ruler and rolls down to the bottom of the ruler.

KE: ↑ ↓ = ??? **PE:** ↑ ↓ = ??? **TME:** ↑ ↓ = ???

b. A marble is rolling along a level table when it hits a note card and slides to a stop.

KE: ↑ ↓ = ??? **PE:** ↑ ↓ = ??? **TME:** ↑ ↓ = ???

c. A cart is pulled from the bottom of an incline to the top of the incline at a constant speed.

KE: ↑ ↓ = ??? **PE:** ↑ ↓ = ??? **TME:** ↑ ↓ = ???

d. A physics student runs up a staircase at a constant speed.

KE: ↑ ↓ = ??? **PE:** ↑ ↓ = ??? **TME:** ↑ ↓ = ???

e. A force is applied to a root beer mug to accelerate it from rest across a level countertop.

KE: ↑ ↓ = ??? **PE:** ↑ ↓ = ??? **TME:** ↑ ↓ = ???