IMPORTANT TERMS:

- **Electromagnetic spectrum**
- **Electromagnetic wave**
- **Infrared**
- **Light-year**
- **Opaque**
- **Penumbra**
- **Photon**
- **Polarization**
- **Ray**
- **Shadow**
- **Transparent**
- **ultraviolet**
- **umbra**

EQUATIONS:

$$v = \lambda f$$

$$v = \frac{d}{t}$$

$$T = 2\Pi\sqrt{\frac{L}{g}}$$

$$f = \frac{1}{T}$$

$$T = \frac{1}{f}$$

UNIT IV: SOUND AND LIGHT
Chapter 25-31

Chapter 27: Light

I. Early Concepts of Light (27,1)

A. Light studied for thousands of years

1. Up until Newton and beyond, most philosophers though light consisted of _____

2. One Greek, Empedocles taught light traveled in _____

3. **Wave theory** accepted theory in **nineteenth century**

B. **Einstein** published theory explaining photoelectric effect in 1905. Said light consists of **particles** (later called _____)

C. Scientist now agree that light has a **dual nature**, **part** _____ **and part** _____**.**

II. The Speed of Light (27.2)

A. It was not known whether light traveled instantaneously or with finite speed.

1. Danish astronomer Olaus Roemer (1675) measured the _____ of Jupiter's moons.

a. Measured period of innermost moon (Io)

b. **Periods** longer when Earth moving _____ from Jupiter and _____ when Earth moving toward Jupiter

2. Albert Michelson (late 1880's) conducted most famous experiment

a. Bounced light off _____ arrangement

b. Calculated the speed of light to be **299,920 m/s** (which we rounded to **300,000 m/s**) He received Nobel prize for this

B. We know **speed of light** in a _____ is a **universal constant**

1. Light takes ___ **minutes** to travel from **Sun to Earth**

2. Distance light travels in one year called _____

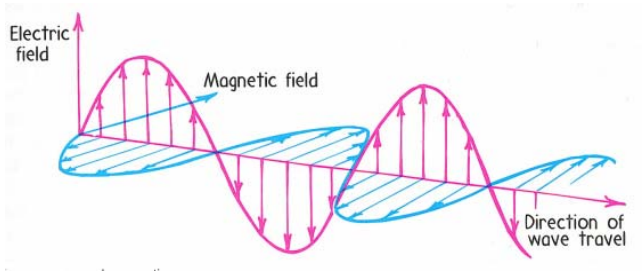
3. Our galaxy is 100,000 light years in diameter

III. Electromagnetic Waves (27.3)

A. **Light** is <u>energy</u> emitted by **accelerating** _____ **charges**

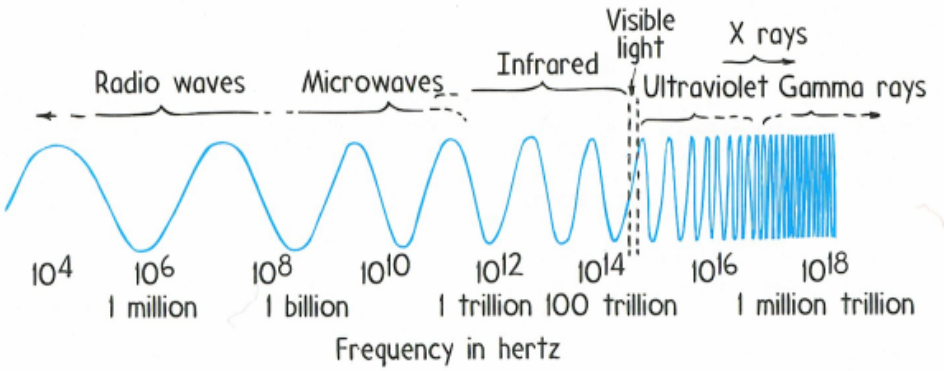
1. The energy travels in a **wave** that is partly _____ and partly _____

2. This is called an _____ **wave**



B. Light is small portion of broad family of electromagnetic waves.

1. The range of electromagnetic waves shown in _____ _____



2. **Lowest** frequency of light we can see with our eyes is _____

3. **Highest** frequency we can see appears _____

4. Frequencies **lower than red** are infrared (heat lamps give off _____)

5. **Higher** than violet called _____ (causes _____)

IV. Light and Transparent Materials (27.4)

A. **Light is energy carried in an electromagnetic wave that is generated by _____ electric charges.**

1. Vibrations in an **emitter** are transferred to vibrations in _____

2. Visible light vibrates at very high rate (100 trillion

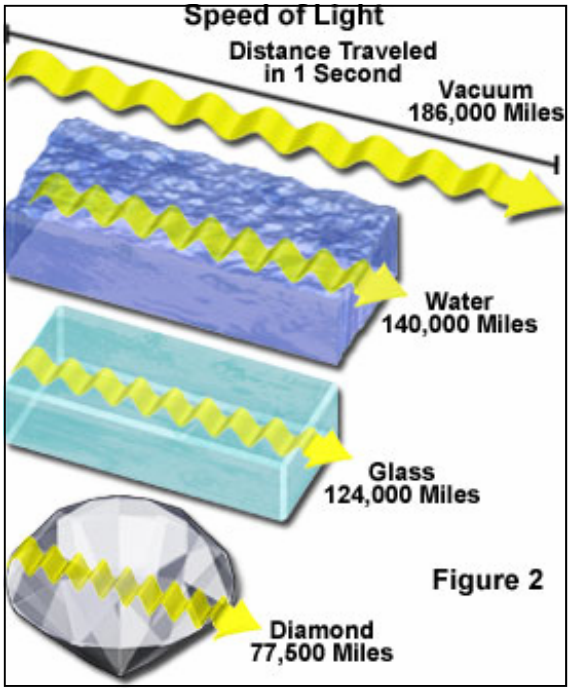
times per second. **10^{14} Hertz**)

B. **Transparent** materials (like glass and water)

1. Allows light to _____ through

2. Visible light sets up **vibrations** in atoms the produce a **chain of** _____ and _____ that pass the light energy through the material and out the other side

3. There is a **time delay** when light passes through a **transparent material**.



a. Light travels at different _____ in different _____

b. In **water** light travels at ____% the speed of light or _____**c**

c. In **glass** it travels _____**c**

d. In **diamond** is travels at _____**c**

C. **Glass** blocks both _____ and _____, but is transparent to _____ **light**

1. **Ultraviolet** light creates _____ in glass and atoms hold onto energy for quite a long time and gives up **energy as** _____

2. **Infrared** vibrate not only the electrons, but also the **entire structure** of the glass. This vibration **increases internal energy and makes it** _____

V. Opaque Materials (27.5)

A. Most materials **absorb light** without _____ and allow **no** light through them (they are _____)

1. vibrations given by light to atoms and molecules turned into **random** _____ **energy** (into _____ **energy)**

2. The materials become slightly _____

B. Metals have _____ **electrons** that are <u>not</u> bound to any particular atom

1. Makes metals **good conductors** of _____ and _____

2. Light shines on metals causes outer electrons to vibrate, but energy does <u>not</u> "**spring**" from atom to atom but is **reemitted** as visible light (_____)

C. Our atmosphere is <u>transparent</u> to _____ light and some _____, but almost <u>opaque</u> to high-frequency _____ waves

VI. Shadows (27.6)

A. A **thin beam of light** is called a _____

1. Any beam of light-no matter how wide-can be thought of as made of a _____ of rays

2. When light shines on object, some rays may be stopped where others pass on in a **straight-line path**

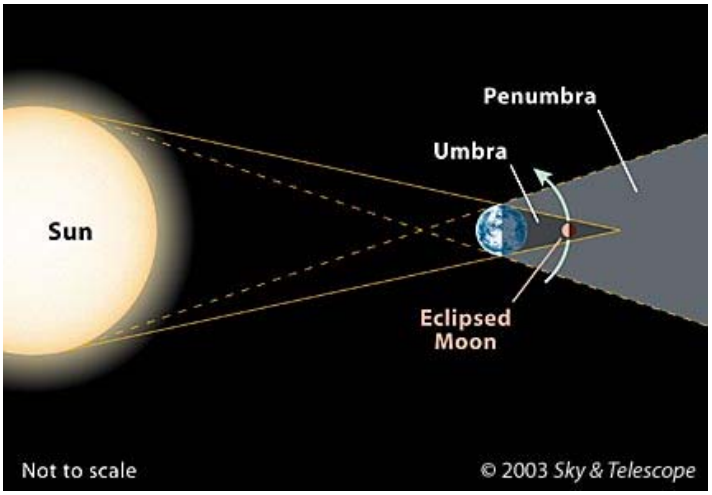
3. A _____ is formed where light rays cannot reach

B. **Sharp shadows** are produced by _____ **light source** <u>nearby</u> or by _____ **source** <u>farther away</u>

C. Most shadows are somewhat blurry

1. Total shadow called the _____

2. partial shadow called _____

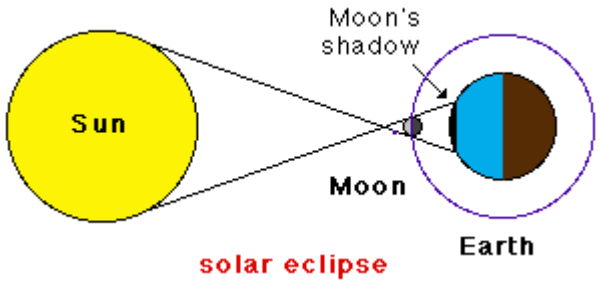


a. A penumbra appears where some light is blocked, but other light fill in

b. Occurs where light from a _____ source

is only _____ **blocked**

c. Can be seen during **solar eclipse** (when moon passes between Earth and Sun)



d. **Lunar eclipse**- when Earth passes between Sun and the moon.

D. Shadows can be created when light is _____ passing through _____ materials.

1. **Light** travels at slightly <u>different speeds</u> in _____ and in _____ water.

2. The difference _____ the light (that's why stars "twinkle" in the night sky)

VII. Polarization (27.7)

A, **Light travels in** _____ (**transverse** waves)

1. Demonstrated by phenomenon of _____

2.**Transverse** waves have **vibrations** <u>back</u> and <u>forth</u> in one direction (wave said to be _____)

B. Vibrating electrons can be vertical, horizontal or random

1. Creates vertical and horizontal polarized light

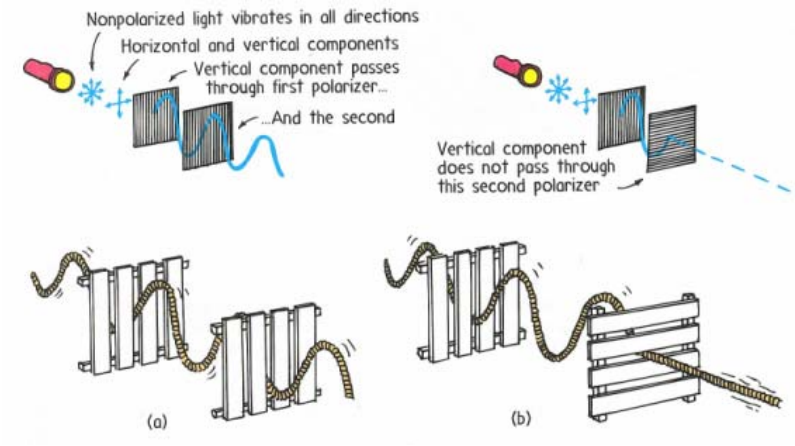
2. Candle light, light bulbs, and sun emit light that is _____ **polarized** (random vibration of electrons)

C. **Polarized filter**

1. Polarized sunglasses block out horizontal vibrating light

2. Light that reflects from nonmetallic surfaces such as glass, water, or roads, vibrates mainly in **plane** of the **reflecting surfaces**

3. So glare from a horizontal source is horizontally polarized (that's why polarized sunglasses block glare from horizontal surfaces)



VIII. Polarized Light and 3-D Viewing (27.8)

A. Vision in **three dimensions** depends on fact that both eyes give impressions simultaneously, each eye viewing a scene from slightly different _____

1. View by each eye is _____

2. Combination of views in eye-brain gives _____

B. A pair of photographs or movie frames taken a short distance apart (about average eye spacing) can be seen in 3-D

1. When left eye sees only the left view and right eye sees only the right view

2. Accomplish this with by projecting the **pair of views** through **polarization** _____ onto a screen.

a. **Polarization axes** are at _____ **angles** to each other

b. Overlapping pictures look _____ to the naked eye

c. Viewer wears polarized eyeglasses with the lens axes also at right angles (each eye sees a separate picture)

d. **Brain** interprets the two pictures as a single picture with a feeling of _____.

C. _____- use this technique also