Name _____ Date _____ Class _____

Note-taking Worksheet

Waves

Section 1 The Nature of Waves

A. **Wave**—a repeating disturbance or movement that transfers _____ through matter or space

1. Molecules pass energy on to _____ molecules.
2. Waves carry energy without transporting _____.
3. All waves are produced by something that _____.
4. **Medium**—a _____ through which a wave travels.
   a. May be solid, liquid, or _____
   b. Not all waves need a medium to travel through; example: _____

B. Mechanical waves—waves that can travel only through _____

1. **Transverse waves**—matter in the medium moves back and forth _____ the direction that the wave travels; example: _____
2. **Compressional waves**—matter in the medium moves _____ that the wave travels; example: _____
3. Combinations—not purely transverse or compressional; examples: water waves, _____ waves

Section 2 Wave Properties

A. Ways waves differ

1. How much _____ they carry
2. How _____ they travel
3. How they look
   a. _____ waves have **crests**—the highest points, and **troughs**—the lowest points.
   b. Compressional waves have dense regions called _____ and less dense regions called _____.

B. **Wavelength**—the distance between one point in the wave and _____

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Note-taking Worksheet (continued)

C. **Frequency**—how many _____ pass a fixed point each second

1. Expressed in _____
2. As frequency increases, wavelength _____.
3. The frequency of a wave equals the rate of _____ of the source that creates it.

D. Wave _____, or v, describes how fast the wave moves forward.

1. _____ = wavelength × _____, or $v = \lambda \times f$.
2. Light waves travel _____ than sound waves.
3. Sound waves travel faster in _____ and _____ than in gas.
4. Light waves travel faster in _____ and _____ than in liquids and solids.

E. **Amplitude**—a measure of the _____ in a wave

1. The more energy a wave carries, the _____ its amplitude.
2. Amplitude of _____ waves is related to how tightly the medium is pushed together at the compression.
   a. The _____ the compressions, the larger the amplitude is and the more energy the wave carries.
   b. The less dense the rarefactions, the _____ the amplitude and the more energy the wave carries.
3. Amplitude of _____ waves
   a. The distance from the crest or trough of a wave to the _____of the medium
   b. Example: how high an ocean wave appears above the water level

Section 3 The Behavior of Waves

A. Reflection occurs when a wave strikes an object and _____ of it.

1. _____ types of waves can be reflected.
2. The angle of incidence of a wave is always equal to the angle of _____.
   a. Normal—an imaginary line _____ to a reflective surface
   b. Angle of _____—the angle formed by the wave striking the surface and the normal
   c. Angle of _____—the angle formed by the reflected wave and the normal

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Note-taking Worksheet (continued)

B. Refraction—the _____ of a wave caused by a change in its speed as it moves from one medium to another

1. The greater the change in speed is, the _____ the wave bends.
2. When a wave passes into a material that slows it down, the wave is bent _____ the normal.
3. When a wave passes into a material that speeds it up, the wave is bent _____ the normal.

C. Diffraction—an object causes a wave to change direction and _____ around it

1. If the obstacle is _____ than the wavelength, the wave diffracts a lot.
2. If the obstacle is much _____ than the wavelength, the wave does not diffract much.
3. The larger the obstacle is compared to the wavelength, the _____ the waves will diffract.

D. Interference—the ability of two or more waves to _____ and form a new wave

1. Waves pass right through each other and continue in _____.
2. New wave exists only while the two original waves continue to _____.
3. Constructive interference—waves _____ together
4. Destructive interference—waves _____ from each other

E. Standing waves—a wave pattern that stays in _____

1. Form when waves of equal _____ and amplitude that are traveling in _____ directions continuously interfere with each other
2. Nodes—the places where two waves _____ cancel each other

F. Resonance—the ability of an object to _____ by absorbing energy at its natural frequency

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Electromagnetic Waves

Section 1 What are electromagnetic waves?

A. **Electromagnetic waves** are made by vibrating electric charges and can travel through _____.

B. Electric and magnetic fields—related _____ that operate even in empty space

1. A _____ electric charge creates a magnetic field.
2. _____ magnetic fields create changing electric fields and vice versa.

C. Electromagnetic waves are produced when an electric charge is _____.

1. Vibrating electric charges are _____ by vibrating electric and magnetic fields.
2. Vibrating electric and magnetic fields travel _____ from the moving charge.

D. Properties of electromagnetic _____—carry **radiant energy**

1. **Frequency** and wavelength—as frequency _____, wavelength decreases
   a. Frequency is the number of _____ per second; measured in hertz.
   b. Wavelength is the _____ from one crest to another and is measured in meters.
2. Wave speed—in the vacuum of space, _____; electromagnetic waves slow as they travel through matter.

E. Waves and particles—_____ not clear

1. Light can behave as a particle, a _____, whose energy depends on frequency.
2. All _____ can behave like a wave

Section 2 The Electromagnetic Spectrum

A. The entire _____ of electromagnetic wave frequencies is called the electromagnetic spectrum.

B. _____ **waves**—low-frequency electromagnetic waves with wavelengths from less than a centimeter to about 1000 meters

1. **Microwaves**—radio wave lengths of about 1 to _____ cm
2. _____—radio waves bounced off an object to determine its speed and location

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Note-taking Worksheet (continued)

3. _____ (MRI)—radio waves produce an image of the inside of the body

C. **Infrared waves**—electromagnetic wave with a slightly _____ frequency than radio waves; people feel it as thermal energy or warmth

D. _____—has wavelengths between about 390 to 770 billionth of a meter; can be seen with the eye

E. _____—have frequencies slightly higher than visible light; can damage skin

1. Ultraviolet light can kill _____.
2. Ultraviolet light can be absorbed by some _____ materials and released as visible light.
3. _____ layer above Earth's surface absorbs most of the Sun's harmful ultraviolet waves.

F. _____ and **gamma rays**—ultra-high-frequency electromagnetic waves that can travel through matter, break molecular bonds, and damage cells

1. X rays are used to provide images of _____ and to examine suitcases at airports without opening them.
2. Radiation therapy is used to _____ diseased cells.

Section 3 Radio Communication

A. Radio _____—radio converts electromagnetic waves into sound waves

1. The _____ is the specific frequency of the radio wave to which a radio station is assigned.
2. AM radio stations broadcast electronic signals by varying the _____ of the carrier wave; frequencies range from 540 to 1,600 thousand vibrations per second.
3. FM radio stations transmit electronic signals by varying the _____ of the carrier wave; frequencies range from 88 million to 108 million vibrations per second.

Note-taking Worksheet (continued)

B. _____—sounds and images changed into electronic signals broadcast by carrier waves

1. Audio sent by _____ radio waves.
2. Video sent by _____ signals.
3. A sealed vacuum chamber called a **cathode-ray tube** has a coated screen that receives _____ to provide images.

C. Telephones—microphone converts _____ into electrical signal

1. _____—electrical signal creates a radio wave that is transmitted to and from a microwave tower
2. _____—uses a **transceiver** to send one radio signal and receive another at a different frequency from a base unit
3. _____—a radio receiver on which a message is left

D. Communication satellites—high frequency _____ signal is transmitted to a satellite, which amplifies it and returns it to Earth at a different frequency

1. Satellite telephone systems—_____ phones transmit radio signals to a satellite, which relays them back to a ground station that passes the call into the telephone network
2. Television satellites—uses _____ rather than longer-wavelength radio wave; ground receiver dish focuses the microwave beam onto an antenna

E. _____ **system**—system of satellites, ground stations, and receivers that provide information about the receiver's location on or above the Earth's surface

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Note-taking Worksheet

Light

Section 1 The Behavior of Light

A. Light and matter—objects must _____ light to be seen.

1. _____ materials do not allow light to pass through them; they only absorb and reflect light.
2. Some light passes through _____ materials.
3. _____ materials allow almost all light to pass through them; only a little light is absorbed and reflected.

B. Reflection of light—a light wave strikes an object and _____

1. _____—the angle at which light strikes a surface is the same as the angle at which it is reflected
2. _____ reflection—reflection of light waves from a smooth surface
3. _____ reflection—reflection of light waves from a rough surface

C. _____—change in the speed of a light wave when it passes from one material to another

1. _____—indicates how much a material reduces the speed of light; the more light is slowed, the _____ the index of refraction
2. _____—separate white light into visible spectrum based on light wavelengths
3. _____—caused by water droplets refracting wavelengths of sunlight
4. Refraction of light through air layers of different densities can result in a(n) _____.

Section 2 Light and Color

A. _____—determined by wavelength of light an object reflects

1. Objects appear to be _____ because they reflect all colors of visible light.
2. Objects appear to be _____ because they absorb, rather than reflect, all colors of visible light.
3. Filter—transparent material that _____ all colors except the color or colors it transmits
4. _____ can make objects appear to be different colors.

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Note-taking Worksheet (continued)

B. Seeing color—light enters the eye and is focused on the _____.

1. Retina—made up of two types of _____ that absorb light
   a. _____—distinguish colors and detailed shapes; most effective in daytime vision
   b. _____—sensitive to dim light; most effective in nighttime vision
2. _____ results when one or more sets of cones do not function properly.

C. Mixing colors

1. _____—colored material that absorbs some colors and reflects others
2. Primary colors of light—red, green, and _____
3. Primary colors of _____—magenta, cyan, and _____
4. Primary colors of light are _____ colors—combine to form white
5. Primary colors of pigments are _____ colors—combine to form black, the absence of reflected light

Section 3 Producing Light

A. _____ **lights**—hot tungsten wire glows; gives off light and heat

B. _____ **lights**—electrons collide with gas atoms, releasing ultraviolet radiation absorbed by phosphors lining the bulb; gives off light

1. Use _____ energy than incandescent bulbs
2. Last _____ than incandescent bulbs

C. _____ lights—tubes filled with gas (usually neon) produce light from electron collisions; different colors can be made by adding different gases

D. _____ lights—heated neon gas glows and warmth turns sodium into a vapor, producing a yellow-orange glow; used for _____ lighting

E. _____ lights—have a filament and gas enclosed in a glass bulb to produce intensely bright light

F. _____—light beam produced when identical atoms send off identical light waves; can be made from gases, liquids, or solids

1. Lasers produce _____—waves of same wavelength are aligned, and travel same direction

Note-taking Worksheet (continued)

2. _____—waves of multiple wavelengths are not aligned, travel in many directions
3. Lasers are used in many areas such as industry, science, communication, _____, and _____.

Section 4 Using Light

A. _____—light waves vibrate in only one direction after passing through a polarizing filter.

B. _____—process used to create a three-dimensional photographic image of an object

1. Illuminating objects with laser light produces _____.
2. Holographic images are _____ to copy.

C. When laser light must travel long distances or to hard-to-reach places, _____ are used.

1. _____—light strikes a surface between two materials and is completely reflected back to the first material
2. Uses of optical fibers
   a. _____—send enormous numbers of messages in coded light beams
   b. _____—internally explore the body

D. _____—read intensities of reflected light and convert the information to digital signals

1. Used in stores to read price on pattern called _____
2. Used in U.S. Postal Service to _____ and keep track of deliveries
3. Used in office machines such as _____ machines and fax machines

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