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HW 7.1 Light

Per _____ Name Key

1. Identify which portions of the electromagnetic spectrum are used in each of the following devices:

microwave oven
visible light, microwaves
television set
visible light, infrared, (radio)
disposable 35 mm camera
visible light, infrared

2. If an electromagnetic wave has a frequency of 7.57 E 14 Hz, what is its wavelength? To what part of the spectrum does it belong?

$f = 7.57 \times 10^{14}$ Hz, $\lambda = ?$, $v = 3 \times 10^8$ m/s, $v = f \cdot \lambda$, $\lambda = \frac{v}{f}$, $\lambda = \frac{3E8}{7.57E14}$

| 3.96E-7 m |
|---|
| UV |

3. Galileo performed an experiment to measure the speed of light by timing how long it took light to travel from a lamp he was holding to an assistant about 1.5 km away and back again. Why was Galileo unable to conclude that light had a finite speed?

$\Delta x = 3000$ m, $v = 3E8$ m/s, $t = ?$, $t = \frac{\Delta x}{v} = \frac{3000}{3E8} = 1 \times 10^{-5}$ s $= 0.00001$ s

Galileo couldn't time this

4. Which portion of the electromagnetic spectrum has the lowest frequency? The shortest wavelength?

| radio |
|---|
| Gamma |

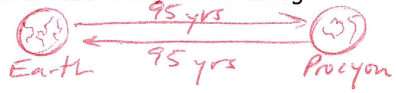
5. Which of the following waves has the highest frequency?

radio (UV) blue light IR

6. Why can light be used to measure distances accurately? What must be known in order to make distance measurements?

light isn't affected by change in temperature of air and has a relatively constant velocity in air

7. Suppose an intelligent society capable of receiving and transmitting radio signals lives on a planet orbiting Procyon, a star 95 light-years away from the earth. If a signal were sent toward Procyon in 1999, what is the earliest year that Earth could expect to receive a return message?




1999 + 95 + 95 = 2189

| 2189 |
|---|

8. How fast do X-rays travel in a vacuum?

| 3E8 m/s |
|---|

9. Why do astronomers observing distant galaxies talk about looking backward in time?

the light we see has often been traveling for millions of years, meaning that if you could focus on specific events, they would have happened millions of years ago

10. The compound eyes of bees and other insects are highly sensitive to light in the UV portion of the spectrum, particularly light with frequencies between 7.5 E 14 Hz and 1 E 15 Hz. To what wavelengths do these frequencies correspond?

$f_1 = 7.5 \times 10^{14}$ Hz, $f_2 = 1 \times 10^{15}$ Hz, $\lambda_{1,2} = ?$, $v = 3E8$ m/s, $v = f \cdot \lambda$, $\lambda = \frac{v}{f}$

$\lambda_1 = \frac{3E8}{7.5E14} = 4E-7$ m, $\lambda_2 = \frac{3E8}{1E15} = 3E-7$ m

| 4x10^-7 m |
|---|
| 3x10^-7 m |

11. The brightest light detected from the star Antares has a frequency of about 3 E 14 Hz. What is the wavelength of this light?

$v = 3 \times 10^8$ m/s, $f = 3 \times 10^{14}$ Hz, $\lambda = ?$, $v = f \cdot \lambda$, $\lambda = \frac{v}{f} = \frac{3 \times 10^8}{3 \times 10^{14}}$

| 1x10^-6 m |
|---|

12. What is the wavelength of a radar signal that has a frequency of 33 GHz?

$v = 3 \times 10^8$ m/s, $\lambda = ?$, $f = 33 \times 10^9$ Hz, $\lambda = \frac{v}{f} = \frac{3E8}{33E9} = 0.00909$

| 9.09x10^-3 m |
|---|

HW 7.2 Particle Properties Period _____ Name Key

1. What is meant by the term quantum?

Quantum just signifies quantity, or value. A quantum number simply identifies what position or state an electron is in, or the amount of energy a photon has

2. Describe the photoelectric effect.

This occurs when an electron absorbs a photon of light and is caused to leave the atom

3. Describe how light can be both a wave and a particle. Gives examples of both.

Light behaves like both a wave and a particle. It exhibits key behaviors of waves (reflection, refraction, interference) and can still travel through a vacuum and collide with particles (electrons - the photoelectric effect)

4. What is the relationship between a joule (J) and an electron volt (eV)?

Both are units of energy. An eV is the change in energy an electron experiences when it goes through a change in voltage of 1 Volt. $1eV = 1.6 \times 10^{-19} J$.

5. According to the photon theory of light what does the frequency of light determine?

The frequency of light determines the amount of energy the photon has, and the wavelength

6. According to the photon theory of light what does the intensity of light effect?

The number of photons present. Higher intensity means more photons bombarding.

7. Which has more energy, a photon of violet light or a photon of green light?

Violet light - it has a shorter wavelength and therefore higher frequency. Higher frequency means higher energy.

8. A photon has 3.62 E -19 J of energy. What is the frequency of this photon? What is the color of this photon?

$E = 3.62E-19\ J$ $\quad E = h \cdot f$

$f = ?$ $\quad f = \frac{E}{h}$

$h = 6.626E-34\ J \cdot s$

$v = 3E8\ m/s$ $\quad f = \frac{3.62E-19}{6.626E-34} = 5.46 \times 10^{14}\ Hz$

green

$\lambda = \frac{v}{f} = \frac{3E8}{5.46E14} = 5.49E-7\ m$

$= 549\ nm$

9. A photon of blue light has a wavelength of 444 nm. Find:

a. The frequency of this photon.

$v = 3E8\ m/s$
$\lambda = 444 \times 10^{-9}\ m$
$f = ?$

$v = f \cdot \lambda$

$f = \frac{v}{\lambda} = \frac{3E8}{444E-9} = \boxed{6.76 \times 10^{14}\ Hz}$

b. The energy of this photon.

$E = h \cdot f = \frac{h \cdot v}{\lambda} = \frac{(6.626 \times 10^{-34})(3 \times 10^{8})}{444 \times 10^{-9}} = \boxed{4.48 \times 10^{-19}\ J}$

$h = 6.626 \times 10^{-34}\ J \cdot s$

10. Describe emission lines.

emission lines represent the discreet wavelengths that a type of atom can emit when its electrons drop quantum levels

11. Describe absorption lines.

Absorption lines are the opposite of emission lines. They represent the (same) wavelengths absorbed by specific atoms as their electrons jump up energy levels.

12. Describe a continuous spectrum.

A continuous spectrum is all colors/wavelengths of visible light

13. What is a photon?

A photon is a discreet particle of 'light' - electromagnetic radiation

14. What is the energy of a light wave with a wavelength of $6.5 \times 10^{-7}$ meters?

$E = ?$
$\lambda = 6.5 \times 10^{-7}\ m$
$h = 6.626 \times 10^{-34}\ J \cdot s$
$v = 3 \times 10^{8}\ m/s$

$E = h \cdot f \qquad f = \frac{v}{\lambda}$

$E = \frac{h \cdot v}{\lambda}$

$= \frac{(6.626 \times 10^{-34})(3 \times 10^{8})}{(6.5 \times 10^{-7})}$

$\frac{(J \cdot s)(m/s)}{m}$

$= \boxed{3.06 \times 10^{-19}\ J}$

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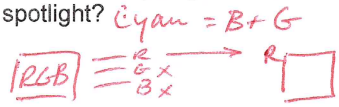
HW 7.3 Light and Color

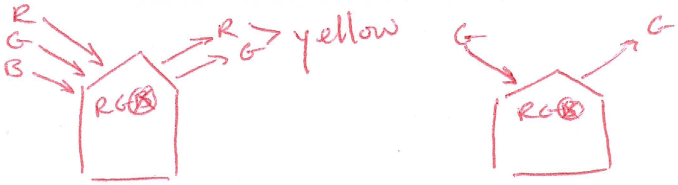
Per _____ Name Key

1. A lens for a spotlight is coated so that it does not transmit cyan light. If the light source is white what color is the spotlight? Cyan = B + G



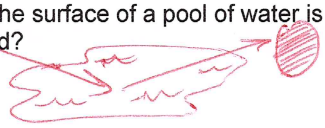

| Red |
|---|

2. A house is painted with pigments that reflect red and green light but absorb all other colors. What color does the house appear to be when it is illuminated by white light? What color does it appear to be under green light?




| yellow |
|---|
| green |

3. The light reflected from the surface of a pool of water is observed through a polarizer. How can you tell if the reflected light is polarized?



if you turn the polarizer and it blocks light at specific angles, the light is polarized

4. Explain what could happen when you mix the following:
   a. Magenta (R+B) and yellow (G) pigment absorbs green & blue light = red
   b. Blue and yellow light you get B + R + G = White light

5. What color would an opaque cyan shirt appear to be under the following colors of light?
   a. White G+B = cyan
   b. Red black
   c. Magenta ~~R~~ + B = blue
   d. Green green
   e. Yellow ~~R~~ + G = green


6. A substance is known to reflect green and blue light. What color would it appear to be when it is illuminated by white light? By blue light?


| cyan |
|---|
| blue |

7. Why would sunglasses with polarizing lenses remove the glare from your view of the hood of your car or a distant body of water, but not from a tall metal tank used for storing liquids?

Horizontal surfaces (car hood and water) reflect horizontally polarized light. A metal tank has vertical surfaces which vertically polarize light. Polarizing sunglasses block horizontally polarized light, so they let in vertically polarized light.

8. Is light from the sky polarized?

No!