WS 4.1 *Name:*_____*p.*_____

Formulas and numbers to know by heart

$c = \lambda\nu$ $c = 3.00 \times 10^{8}$ m/s 1 m $= 10^{9}$ nm (or 1 nm $= 10^{-9}$ m)

$E = h\nu$ Hz $= s^{-1}$ = cycles per second

Formulas and numbers that would be given on a test/quiz:

M = Mega $= 10^{6}$ k = kilo $= 10^{3}$ h $= 6.63 \times 10^{-34}$ J-s

1a. List the types of electromagnetic radiation in order from lowest energy to highest energy:

_____

b. Which type of EM radiation has the longest wavelength?_____

c. Which has the highest frequency?_____

2. Fill in the blanks with "directly" or "inversely" for electromagnetic radiation.

Energy of electromagnetic radiation is _____ related to frequency.

Frequency of electromagnetic radiation is _____ related to wavelength.

Energy of electromagnetic radiation is _____ related to wavelength.

_____**3.** Radio waves travel at _____ visible light waves.

a. a faster speed than b. a slower speed than c. the same speed as

_____**4.** Radio waves travel at _____ sound waves.

a. a faster speed than b. a slower speed than c. the same speed as

5. For each pair of photons below, circle the photon with higher energy.

a. a photon with a wavelength of 10^{-7} m or a photon with a wavelength of 10^{-10} meters.

b. a photon with a frequency of 102.3 MHz or a photon with a frequency of 105.5 MHz.

c. an X-ray or a radio wave

e. a photon with a frequency of 1.7×10^{15} Hz or a photon with a frequency of 7.1×10^{14} Hz.

f. a photon of yellow light or a photon of green light

g. a photon with a wavelength of 480 nm or a photon with a wavelength of 1200 nm

6. Determine the wavelength (in m and nm), the frequency (in Hz), the photon energy, and the type of EM radiation (part of the spectrum) for each problem, below. (You will need the chart on WS 13.0)

a. Electromagnetic radiation emitted by a laser pen, with a wavelength of 410. nm

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

b. EM radiation with a frequency of 104.7 MHz (MegaHertz)

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

c. A photon absorbed by a H_2O molecule in a microwave oven, with an energy of 1.62×10^{-24} J .

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum__microwave____*

* this would be "radio" according to the chart on 4.0… but many charts for EM radiation show an overlap of microwaves with the higher energy radio waves., and would classify this as a microwave.

d. EM radiation emitted when a C=O bond in carbon dioxide (O=C=O) vibrates, with a wavelength of 5200 nm.

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

e. EM radiation absorbed by sunscreen, with a photon energy of 6.4×10^{-19} J.

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

6f. EM radiation absorbed by a chlorophyll molecule in a leaf, with a frequency of 4.53×10^{14} Hz.

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

g. EM radiation emitted from the nucleus of a potassium-40 isotope, during a nuclear reaction, with a wavelength of 8.50×10^{-13} meters.

λ = _____

λ = _____

ν = _____

E = _____

Part of spectrum_____

7. For each pair, circle the photon with the higher energy. (Show work on any problems with a "*" next to the letter.)

a. A photon with a frequency of 6.8×10^{14} Hz, or a photon with a frequency of 5.8×10^{15} Hz.

b. A photon with a wavelength of 2200 nm, and one with a wavelength of 15 nm.

*c. A photon with a wavelength of 685 nm, and one with a frequency of 5.2×10^{14} Hz.

d. A photon with a wavelength of 440 nm, and a photon of yellow light.

*e. A photon with an energy of 2.2×10^{-19} J, and one with a frequency of 5.2×10^{14} Hz.

*f. A photon with a frequency of 9.3×10^{14} Hz, and a photon of blue light.

<u>There will be an OPTIONAL Quiz on Electromagnetic Radiation (wavelength, frequency, energy).</u>
Study WS 4.00, 4.0, 4.1, and the practice quiz (below).

Possible QUIZ times: Beginning of lunch on Weds, Nov 13.
Beginning of lunch on Thursday, Nov. 14
After school on Thursday, Nov. 14.
Beginning of lunch on Friday, Nov 15.

I will only enter the quiz into your grade if it brings your grade UP.

Quiz Topics!

Know the value for c, including the units. ($c = 3.00 \times 10^{8}$ m/s)

Know the formulas for wavelength, frequency, and energy, and how to use them.
($h = 6.63 \times 10^{-34}$ J·s will be given)

Be able to convert between meters and nanometers. (the conversion will not be given).
Wavelength, frequency, and energy – which are related directly? Inversely? What does this mean?

Know the order of the electromagnetic spectrum (For example, can you list them, in order, from highest to lowest energy, or from highest to lowest frequency, or from shortest to longest wavelength, etc)

Practice Quiz: (Report wavelength answers in meters and nanometers.)

1. Find the photon energy of EM radiation with a wavelength of 45 nm.

2. Find the wavelength of EM radiation with a frequency of 2.37×10^{15} Hz.

3. Find the wavelength of EM radiation with a photon energy of 2.2×10^{-20} J

4. Find the frequency of EM radiation with a wavelength of 1242 nm.

5. Find the photon energy of EM radiation with a wavelength of 6.8×10^{-5} m. \

6. Find the energy of EM radiation with a frequency of 94.2 MegaHertz.

7. Find the frequency of EM radiation with a photon energy of 9.7×10^{-13} J.

8. Find the energy of EM radiation with a wavelength of 1111 nm.

9. For each pair, determine which has more energy.
a. blue light or infrared
b. EM radiation with a wavelength of 166 nm or EM radiation with a wavelength of 55 nm
c. microwaves or Infrared
d. green or orange
e. Radiation with a frequency of 1.5×10^{15} Hz or Radiation with a frequency of 6.7×10^{14} Hz.

10. Which of these has a longer wavelength?
a. X-rays or ultraviolet
b. Light with a photon energy of 6×10^{-18} J, or one with an energy of 5×10^{-18} J.
c. Light with a frequency of 10 MHz (MegaHertz) or light with a frequency of 500 kHz (kiloHertz).
d. yellow light or green light

Answers: **1.** 4.4×10^{-18} J **2.** 1.27×10^{-7} m or 127 nm. **3.** 9.0×10^{-6} m or 9.0×10^{3} nm

4. 2.42×10^{14} Hz **5.** 2.9×10^{-21} J **6.** 6.25×10^{-26} J **7.** 1.5×10^{21} Hz **8.** 1.79×10^{-19} J

9. blue, 55 nm, IR, green, 1.5×10^{15} Hz. **10.** uv, 5×10^{-18} J, 500 kHz, yellow