Photon Formulas   Name _____

Photon Formulas: Introduction:
All light, plus many other important things, are electromagnetic waves.
Three things make each electromagnetic wave operate the way it does: wavelength,
frequency, and photon energy. Each of these things is related by precise mathematical
formulas. Thus, a wave with a specific wavelength has a very specific frequency and photon
energy that go with it!

All electromagnetic waves have different wavelength, frequency, and photon energy.
However, one quantity is the same for all electromagnetic waves: their speed! All
electromagnetic waves have a speed of precisely 3.0×10^8 m/s.

Even though these formulas are pretty simple, one mathematical challenge exists: units.
Whenever we use formulas, we must use SI units: Joules for energy, hertz for frequency,
and meters for wavelength. But these units create awkward scientific notation numbers. To
counter this, these quantities are typically presented in different units: electron Volts for
energy, terahertz for frequency, and nanometers for wavelength. To both properly use our
formulas and elegantly present out data, we need to constantly be doing unit conversions!

Color	Wavelength
Red	700 – 635 nanometers (nm)
Orange	635 – 590 nm
Yellow	590 – 560 nm
Green	560 – 520 nm
Blue	490 – 450 nm
Violet	450 – 400 nm
Ultraviolet (not visible)	Less than 400 nanometers

Name _____

Photons
Al light (electromagnetic energy) comes in tiny packets of energy called photons.
Frequency and Wavelength
Every photon has a frequency and a wavelength, which determine the color of the photon for visible light.
Photon energy
Every photon has a very specific amount of energy
Speed of light
Every photon moves at the speed of light c = 3.0 x 10⁸ m/s.

$$E = h\nu$$
$$\nu\lambda = c$$

Symbol	Quantity	Units	
E	Energy (of a photon)	Joules or electron volts (eV)	Even though it is not an SI Unit, we often represent the energy of a photon in electron volts.
h	Planks constant $h = 6.626 \times 10^{-34}$ m² kg /s	Joule -Seconds	
ν	Frequency	Hertz (1 /s) or Terahertz	The Greek letter nu, can also be represented by *f*
λ	Wavelength	Meters or nanometers	
c	Speed of light $c = 3.0 \times 10^8$ m/s	m/s	

Greek Alphabet:
ν = nu (frequency)
λ = lambda (wavelength)

nano = 10^{-9}
tera = 10^{12}

1 Joule = 6.24 x 10¹⁸ electron volts.

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1. A photon of red light has a wavelength of about 700. nm. Find:
A – the wavelength in meters in scientific notation

B – the frequency of the light in Hertz.

Looking For	Formula
Already Know	
Answer with *unit* and *three significant figures*:	

C – the energy of the red lightphoton in Joules.

Looking For	Formula
Already Know	
Answer with *unit* and *three significant figures*:	

D – the energy of the red light in electron volts.

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2. A photon of green light has a wavelength of 550 nm. Find:
A – the wavelength in meters in scientific notation

B – the frequency of the light in Hertz.

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

C – the energy of the green light in Joules.

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

D – the energy of the green light in electron volts.

3. A photon of violet light has a wavelenght of 410 nm.
A – the wavelength in meters in scientific notation

B – the frequency of the light in Hertz.

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

C – the energy of the violet light in Joules.

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

D – the energy of the violet light in electron volts.

4. Now we are goign to go the other direction. With a specific energy, find the wavelength and color of that light. A hydrogen atom emits a photon which has an energy of 13.6 electron volts. Find:

A – The energy of this photon in Joules:

B- The frequency of the photon:

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

C – The wavelength of the photon in meters:

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

D – The wavelength of the photon in nanometers.

E – What color is this photon? [Look at page 1]

5. Now, we are going to go the other direction! A hydrogen atom emits a photon with a energy of 1.90 eV. Find:

A – The energy of this photon in Joules:

B- The frequency of the photon:

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

C – The wavelength of the photon in meters:

Looking For	Formula	
Already Know		
Answer with *unit* and *three significant figures*:		

D – The wavelength of the photon in nanometers.

E – What color is this photon? [Look at Page 1]

History of Science Fact:
Each element emits very specific colors of light, called its emission spectrum. By understanding this spectrum, and relating the colors (wavelengths) of light to the energy of the photons that were emitted, scientists were abel to posit that electrons are contained in energy levels within an atom.

Answers:

1. 1.77 eV
2. 2.26 eV
3. 3.03 eV
4. 91.2 nanometers --- ultraviolet
5. 653 nanometers --- Red