 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

Photon Formulas 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 10^8 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 x 10^{-34} m^2 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 x 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 10^{18} electron volts.

Photon Formulas Name ___________________

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.

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

MATH: Photon Formulas Part 2 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.
Speed of light Every photon moves at the speed of light c = 3.0×10^8 m/s.

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

Symbol	**Quantity**	**Units**
E	Energy	Joules or electron volts (eV)
h	Planks constant h = 6.626×10^{-34} m^2 kg /s	
ν	Frequency	Hertz (1 /s) or Terahertz
λ	Wavelength	Meters or nanometers
c	Speed of light c = 3.0×10^8 m/s	m/s

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

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

1 Joule = 6.24×10^{18} electron volts.

MATH: Photon Formulas Part 2 Name ___________________

1. A photon of infrared light has a wavelength of about 300 μm. Find:
A – the wavelength in meters in scientific notation

B – the frequency of the inrafed light in Hertz.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

C – the energy of the infrared light in Joules.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

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

MATH: Photon Formulas Part 2 Name ___________________

2. A microwave photon of green light has a wavelength of 47 mm. Find:
A – the wavelength in meters.

B – the frequency of the microwave in Hertz.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

C – the energy of the microwave in Joules.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

D – the energy of the microwave in electron volts.

MATH: Photon Formulas Part 2 Name ___________________

3. A photon of yellow light has a wavelenght of 580 nm.
A – the wavelength in meters in scientific notation

B – the frequency of the yellow light in Hertz.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

C – the energy of the yellow light in Joules.

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

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

MATH: Photon Formulas Part 2 Name ___________________

4. A helium atom emits a photon which has a wavelength of 2.77 electron volts. Find:
A – The energy of this photon in Joules:

B- The frequency of the photon:

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

C – The wavelength of the photon in meters:

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

D – The wavelength of the photon in nanometers.

E – What color is this photon?

5. A helium atom emits a photon with a energy of 1.86 eV. Find:
A – The energy of this photon in Joules:

B- The frequency of the photon:

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

C – The wavelength of the photon in meters:

Looking for	
Already Know	
Formula	Answer in a complete sentence *with unit*:

D – The wavelength of the photon in nanometers.

E – What color is this photon?

MATH: Photon Formulas Part 2 Name ___________________

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. .0031 eV

2. 2.7×10^{-5} eV

3. 2.14 eV

4. 447 nm – blue

5. 667 nm – red