

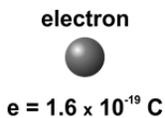
1. What is the energy of an electromagnetic wave with a frequency of 3.0×10^{14} hertz? The speed of light in a vacuum is 3.0×10^8 meters/sec. Planck's constant is 6.62×10^{-34} joules-seconds.

- (A) 1.99×10^{-19} joules
- (B) 2.2×10^{-48} joules
- (C) 4.51×10^{-47} joules
- (D) 9.62×10^{-20} joules
- (E) 3.62×10^{-20} joules

2. A steadily moving electron generates a magnetic field, but an accelerating electron generates an electromagnetic wave.

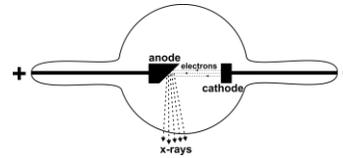
What is the frequency of the electromagnetic wave generated by an electron accelerated through 10,000 volts?

A single electron carries an electrical charge of 1.6×10^{-19} coulombs.



- (A) 1.6×10^{19} Hz
- (B) 6.63×10^{34} Hz
- (C) 1.6×10^{15} Hz
- (D) 2.41×10^{24} Hz
- (E) 2.41×10^{18} Hz

3. If an x-ray tube produces x-rays with a wavelength of 2×10^{-11} meters, how much voltage will be needed to run the x-ray tube?



- (A) 2.4×10^4 volts
- (B) 1.8×10^3 volts
- (C) 6.2×10^4 volts
- (D) 6.6×10^5 volts
- (E) 9.2×10^5 volts

4. How many electron volts of kinetic energy does an electron have if it speeding through space at 10^7 meters per second? The electrical charge on a single electron is 1.6×10^{-19} coulombs. The mass of an electron is 9.1×10^{-31} kg.

- (A) 284 eV
- (B) 160 eV
- (C) 455 eV
- (D) 728 eV
- (E) 146 eV

5. If a 100 watt light bulb emits light with a wavelength of 5.7×10^{-7} meters, how many photons per second does it emit?



- (A) 4.5×10^{17} photons
- (B) 1.8×10^{18} photons
- (C) 7.9×10^{19} photons
- (D) 2.6×10^{20} photons
- (E) 5.2×10^{21} photons

6. A fluorescent light bulb works by shooting electrons inside the bulb. Which of the following statements is true?



(A) The electrons strike atoms of mercury inside the tube, and boost mercury's electrons to a higher level. The mercury electrons drop back to different lower levels, giving off a mixture of electromagnetic radiation that our eyes merge into visible white light.

(B) The electrons strike atoms of mercury inside the tube, and boost mercury's electrons to a higher level. The mercury electrons drop back to different lower levels, giving off invisible ultraviolet photons. The ultraviolet photons strike atoms coating the inside of the bulb, and elevate their electrons to higher orbits. When those electrons drop back to a lower level, they give off visible light.

(C) The electrons knock electrons off atoms of inert argon gas. Those electrons strike atoms of mercury inside the bulb, boosting mercury's electrons into a higher orbit. When the electrons drop back to a lower orbit, they give off photons of visible light.

(D) The electrons strike atoms of phosphorescent material coating the inside of the bulb and boost the atoms' electrons to a higher orbit. When those electrons drop back to a lower level, they give off visible light.

(E) The accelerated electrons give off invisible ultraviolet photons. The ultraviolet photons strike atoms coating the inside of the bulb, and elevate their electrons to higher orbits. When those electrons drop back to a lower level, they give off visible light.

7. A star emits a light that on earth has a wavelength of 500.1 nanometers, but through the spectroscope has a wavelength of 499.9 nanometers. This star appears to be _____.

- (A) moving toward us
- (B) moving away from us
- (C) slowing its fusion of hydrogen
- (D) increasing its fusion of hydrogen

8. Snell's law says that the index of refraction of the incoming medium times the incoming light's angle of incidence with the vertical equals the index of refraction of the outgoing medium times the outgoing angle of refraction with the vertical.

What is the angle of refraction for underwater light rays striking the surface of the water at a 30 degree angle with the vertical and emerging into the air? Water has an index of refraction of $\frac{4}{3}$.

- (A) 41.8°
- (B) 48.6°
- (C) 49.2°
- (D) 51.1°
- (E) 52.7°

9. Light emerging from underwater at a 30 degree angle from the vertical bends to an angle of 41.8 degrees from the vertical. At what angle does light coming up through the water reflect back into the water?

- (A) 41.8°
- (B) 48.6°
- (C) 49.2°
- (D) 51.1°
- (E) 52.7°

10. An electron struck by a photon with exactly the right amount of energy to boost the electron from level 1 to level 2 is most likely going to _____.

- (A) be struck by a second photon, causing it to drop back to level 1
- (B) be struck by a second photon, causing it jump to a still higher level
- (C) remain at level 2 with the absorbed energy
- (D) fall back to level 1 without being struck by a second photon

11. Polarized sunglasses are better than non-polarized sunglasses at cutting down on glare from reflected light. Why?



- (A) because polarized sunglasses filter more light than non-polarized sunglasses.
- (B) because polarized sunglasses filter out more high energy blue light than non-polarized sunglasses.
- (C) because polarized sunglasses absorb high energy ultraviolet light.
- (D) because polarized sunglasses filter out horizontally polarized reflected light.
- (E) because polarized sunglasses filter out vertically polarized reflected light.