

Academic Year 2021-22

Tutorial #09

PH100: Mechanics and Thermodynamics

1. What do you understand from Ultraviolet catastrophe?
2. An FM radio station of frequency 98.1 MHz puts out a signal of 50,000 W. How many photons/s are emitted?
3. How many photons/s are contained in a beam of electromagnetic radiation of total power 180 W if the source is (a) an AM radio station of 1100 kHz, (b) 8.0-nm x rays, and (c) 4.0-MeV gamma rays?
4. What is the threshold frequency for the photoelectric effect on lithium ($\phi = 2.93$ eV)? What is the stopping potential if the wavelength of the incident light is 380 nm?
5. What is the maximum wavelength of incident light that can produce photoelectrons from silver ($\phi = 4.64$ eV)? What will be the maximum kinetic energy of the photoelectrons if the wavelength is halved?
6. An experimenter finds that no photoelectrons are emitted from tungsten unless the wavelength of light is less than 270 nm. Her experiment will require photoelectrons of maximum kinetic energy 2.0 eV. What frequency of light should be used to illuminate the tungsten?
7. The human eye is sensitive to a pulse of light containing as few as 100 photons. For orange light of wavelength 610 nm, how much energy is contained in the pulse?
8. In a photoelectric experiment it is found that a stopping potential of 1.00 V is needed to stop all the electrons when incident light of wavelength 260 nm is used and 2.30 V is needed for light of wavelength 207 nm. From these data determine Planck's constant and the work function of the metal.
9. The phase velocity of ocean waves is $\sqrt{(g \lambda)/2 \pi}$, where g is the acceleration of gravity. Find the group velocity of ocean waves.
10. Find the de Broglie wavelength of a 1.0-mg grain of sand blown by the wind at a speed of 20 m/s.
11. Generating plants in some power systems drop 10% of their load when the AC frequency changes by 0.30 Hz from the standard of 60 Hz. How often must the reading be monitored in order for the automatic operating system to be able to take corrective action? Let the time between measurements be at least half that determined by the bandwidth relation.
12. Consider electrons of kinetic energy 6.0 eV and 600 keV. For each electron, find the de Broglie wavelength, particle speed, phase velocity (speed), and group velocity (speed).
13. Two waves are traveling simultaneously down a long Slinky. They can be represented by $\psi_1(x, t) = 0.0030 \sin(6.0x - 300t)$ and $\psi_2(x, t) = 0.0030 \sin(7.0x - 250t)$. Distances are measured in meters and time in seconds. (a) Write the expression for the resulting wave. (b) What are the phase and group velocities?