Tareas 3 Tópicos de la Física Moderna

Martes, 14 de Septiembre 2020

1. Can a object glow *green* from thermal radiation? Why or why not?

2. Can you think of some objects that do not behave like a blackbody? Give an example of radiation that does not have a thermal spectrum.

3. A pottery maker places a small bowl and a large vase in a very hot oven. Which piece glows red first?

4. Make a rough estimate of the number of photons radiated per second by thermal radiation from the pencil or pen that you are holding in your hand as you write the solution to this problem.

5. A thermal light source has a temperature of 6000 K and a total radiated power of 100 W. (a) Calculate the power per area per μm ($dR/d\lambda$) at the peak of the spectrum. (b) Estimate the number of visible photons from the light source that enter a pupil of radius 2 mm at a distance of 1 km.

6. Consider a distant star with the same luminosity and surface temperature as the sun. A person can see the star if 250 visible photons per second pass through the pupil, which has a radius of 2 mm. What is the maximum distance at which the star is visible?

7. A dark room of size 3 m $\times$ 3 m $\times$ 3 m is shielded from external light. Estimate the number of visible photons in the room at any given time.

8. Suppose that the earth was formed as molten rock at some very high temperature. Estimate the time for the earth to cool to 300 K. Why is the results much smaller than the age of the earth? What is the age of the earth? How can it be determined?

9. Determine an algorithm to solve the equation for the maximum wavelength of the Planck distribution. Solve it with your calculator or with a computer program.

10. Use the Stefan-Boltzmann law to calculate the energy density of the cosmic radiation ($T = 2.74$K).

11. How many cosmic photons per second per square meter where incident on the antenna of Penzias and Wilson? What was the size of the antenna?

12. Estimate the typical energy of photons from (a) an FM radio station, (b) a microwave oven ($\lambda \approx 10$ cm), (c) the sun, (d) a piece of ceramic heated to $T = 1000$ K, and (e) the cosmic photons from the early universe ($T \approx 3$ K).

13. A helium-neon laser produces red light at a wavelength of 633 nm. The laser light shines on a can of beans in order to read the supermarket bar-code. If the laser output is 1 mW, what is the rate at which photons strike to can of beans?

14. A photon with an energy equal to the work function is absorbed by an electron and the electron is freed from the atom, but with zero kinetic energy. Where has the energy of the photon gone?

15. Photons with a wavelength of 410 nm are used to eject electrons from a metallic cathode by the photoelectric effect. The electrons are prevented from reaching the anode by applying a stopping potential of 0.88 V. What is the work function of the cathode material?

16. Electromagnetic radiation with a frequency f is incident on a metal, causing the photoelectric effect to occur. When the frequency of the radiation is doubled, the maximum kinetic energy of the ejected electrons is tripled. What is the minimum radiation frequency for initiating the photoelectric effect in the metal?

17. Light from a thermal sources ($T = 6000\,\mathrm{K}$) is filtered so that only photons in the visible region are allowed to strike to photocathode, which has a work function of 2.0 eV. When the intensity of the light that reaches the photocathode is 1 mW, a current of 1 μA is observed in a circuit that detects the photoelectrons. Estimate the quantum efficiency of the photocathode.

18. What is the minimum wavelength of a photon that can be emitted by a hydrogen atom?

19. In the Bohr model, what is the largest speed that an electron can have in a hydrogen atom? What is the smallest speed?

20. (a) Calculate the wavelength of the emitted radiation in the $n = 3$ to $n = 2$ transition in hydrogen. (b) In singly ionized helium, which transition produces radiation of a wavelength closest to that of the $3 \to 2$ transition in hydrogen?

21. (a) Use the Bohr model to calculate the size of the hydrogen atom if gravity were the force responsible for holding the atom together. (b) Calculate the ground state energy of the atom. (c) Calculate the speed of the electron in the ground state.

22. Which has greater energy, a K_α or a K_β x ray from the same element?

23. Estimate the energy of a K_α x ray from the element lead.

24. Which element has an L_α x ray that is closest in wavelength to the K_α x ray from the element manganese ($Z = 25$)?

25. Read about the Nobel Price in Physics of 2006. What was the achievement? Is there a newer and more precise experiment of the same type today?