近代物理期中考

Oct 2024

1. If the temperature of a blackbody tripled (it means: 3 times), by what factor will the wavelength of the maximum emission change? By what factor will the total emission energy per unit time change? (15)

解答：.

1. Consider an electron emitting a photon, ie. . are respectively the momenta of the initial electron (mass and the final electron while that of the photon (mass . Due to momentum and energy conservation, this process cannot occur.

To prove this fact, it is easiest to work in the rest frame of the initial electron so that: . Show if momentum conservation is true, energy conservation cannot be satisfied. (20)

提示：Use the formula :. For a massless photon:

解答：Use .

, *.* We use momentum conservation here.

Energy conservation would say:

There is no solution. The first term on the right hand side is larger than the left hand side: *,* while the second term on the right hand side *is* positive. So if momentum conservation is true, energy conservation cannot be satisfied.

1. In a photoelectric effect experiment, we can measure the stopping voltage of the photoelectrons versus the frequencies of the light applied. Assume that at frequency , the stopping voltage is measured to be .
2. Calculate the stopping voltage corresponding to the frequency 2. The answer can be expressed in terms of . (15)
3. What is the electron wave wavelength of the photoelectron emitted when , expressed in terms of ? (5)

A graph of a function

Description automatically generated

解答：

1. , ，兩式相減：。
2. is the kinetic energy of the photoelectron. So its momentum is:

Hence

1. In a Compton Scattering Event, a photon of frequency collides with an electron at rest. It is scattered through into a photon of frequency . Assume that the angle between the scattered electron and the incoming photon is (as in the diagram). What is in terms of ? Hint: For photons, . (15)

A diagram of a mathematical equation

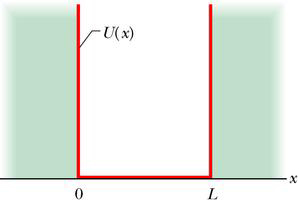
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解答：Due to momentum conservation, the x-y components of the final electron equals respectively the momenta of the incoming photon and the negative momentum of the outgoing photon.

1. Consider the wavefunction of an electron at a certain moment:

This is the stationary state wavefunction of an electron located within an infinite potential box, with boundaries at and :

(The potential is and . We will discuss this wavefunction in details in class later.)



1. Prove that it is normalized: .(15)
2. Calculate the Probability of finding the electron between (15)

Hint: You might need this formula: .

解答：