Tareas 5 Tópicos de la Física Moderna

29 de Septiembre 2020

1. What is the wavelength of (a) a photon that has an energy of 10 eV, (b) an electron that has a kinetic energy of 6 MeV, (c) a neutron that has a momentum of 1 keV/c, and (d) a neutrino that has an energy of 1 GeV?

2. A particle with a mass m and charge e is accelerated through a potential difference V. What is the wavelength of the particle?

3. Electrons, neutrons, and photons each have wavelengths of 0.01 nm. Calculate their kinetic energies.

4. (a) Estimate the wavelength of a nitrogen molecule at room temperature. (b) Make a comparison of the wavelength with the average distance between molecules at STP.

5. Calculate the wavelength of an electron that has a kinetic energy of (a) 10 eV, (b) 10 keV, (c) 0.5 MeV, (d) 1 GeV, (e) 50 GeV. Where are electrons with such energies found in nature?

6. In the Davisson-Germer experiment, the scattering angle (ϕ) from nickel is measured to be 30 degrees when the electron kinetic energy is 83 eV (see book for angle definition). Determine the scattering angle if the energy of the electrons is doubled.

7. A two-slit experiment is performed using light as the incident particle. The distance between the slits is 1 mm and the photon detector is placed at a distance of 1 m from the slits. Estimate the distance between the maxima in the resulting interference pattern. Does the light source need to be monochromatic?

8. The following is taken from the AIP Physics News Update from 19Oct1999. Follow up by reading the article in Nature. Goto to *www.aip.org* if you like to subscribe to this free weekly service:

   WAVE PROPERTIES OF BUCKYBALLS have been observed in an experiment at the University of Vienna. Physical objects from quarks to planets have wavelike attributes. The quantum nature of a bowling bowl, unfortunately, is not manifest since its equivalent quantum (or de Broglie) wavelength is so tiny that interference effects (for example, the left part of the ball negating the right part of the ball) cannot be detected in a practical experiment. However, the wave properties of some composite entities, such as atoms and even small molecules, have previously been demonstrated. Now Anton Zeilinger at the University of Vienna (zeilinger-office@exp.uniwire.ac.at) has been able to perform the same feat for fullerenes, the largest objects (by a factor of ten) for which wavelike behavior has been seen. The researchers send a beam of the soccerball-shaped C-60 molecules (with velocities of around 200 m/sec) through a system of baffles and a grating (with slits 50 nm wide,100 nm apart) which yields a striking interference pattern characteristic of quantum behavior. Ironically the pattern indicating wave behavior is built up from an ensemble of individual sightings, each of which depends upon a buckyball's particle-like ability to make itself felt in an electrode. The interference is not negated thereby since it is not known by which path the C-60 came to be at the electrode.(Arndt et al., Nature, 14 October 1999.)

9. Consider the experiment of Jönsson, where a 50 keV electrons were directed through a slit of width equal to 50 μm. Use the uncertainty principle to estimate the spread of the diffracted beam at a distance of 0.35 m from the slit.

10. Why is good mass resolution important in the search for a new long-lived particle?

11. The tau lepton has a mass of about 1.8 GeV and a lifetime of about 0.3 ps. What is the fractional width ($\Delta m/m$) of the tau particle?

12. The width of the Δ particle is measured to be 115 MeV. What is the lifetime of the Δ?

13. A recent paper about determining the width of a particle is V. Molchanov et al.: *Radiative decay width of the $a_2(1320)^-$ meson*, Physics Letters B 521 (2001) 171-180, arXiv:hep–ex/0109016.

14. Another recent paper about determining the width of a particle is V.M. Abazov, et al.: *Determination of the width of the top quark*, Phys.Rev.Lett.106:022001,2011, arXiv:1009.5686 [hep-ex].