Ch 39. 상대론

1. A Klingon spacecraft moves away from the Earth at a speed of 0.800*c* (Fig. P39.26). The starship *Enterprise* pursues at a speed of 0.900*c* relative to the Earth. Observers on the Earth see the *Enterprise* overtaking the Klingon craft at a relative speed of 0.100*c*. With what speed is the *Enterprise* overtaking the Klingon craft as seen by the crew of the *Enterprise*?

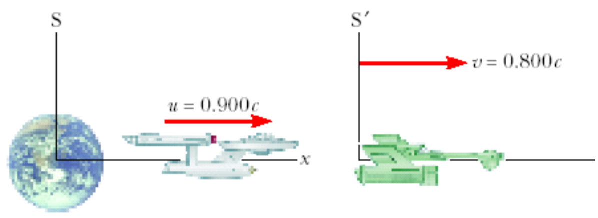

Figure P39.26

2. A golf ball travels with a speed of 90.0 m/s. By what fraction does its relativistic momentum magnitude *p* differ from its classical value *mu*? That is, find the ratio $(p - mu)/mu$.

3. A proton in a high-energy accelerator moves with a speed of *c*/2. Use the work–kinetic energy theorem to find the work required to increase its speed to (a) 0.750*c* and (b) 0.995*c*.

Ch. 40. 양자물리학

1. Two light sources are used in a photoelectric experiment to determine the work function for a particular metal surface. When green light from a mercury lamp (λ = 546.1 nm) is used, a stopping potential of 0.376 V reduces the photocurrent to zero. (a) Based on this measurement, what is the work function for this metal? (b) What stopping potential would be observed when using the yellow light from a helium discharge tube (λ = 587.5 nm)?

2. A 0.700-MeV photon scatters off a free electron such that the scattering angle of the photon is twice the scattering angle of the electron (Fig. P40.28). Determine (a) the scattering angle for the electron and (b) the final speed of the electron.

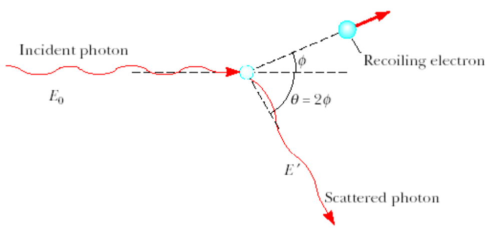

Figure P40.28

3. An electron ($m_e = 9.11 \times 10^{-31}$ kg) and a bullet (m = 0.020 0 kg) each have a velocity of magnitude of 500 m/s, accurate to within 0.010 0%. Within what limits could we determine the position of the objects along the direction of the velocity?

Ch. 41. 양자역학

1. The wave function for a particle is

$$\psi(x)=\sqrt{\frac{a}{\pi\left(x^2+a^2\right)}}$$

for $a > 0$ and $-\infty < x < +\infty$. Determine the probability that the particle is located somewhere between $x = -a$ and $x = +a$.

2. An electron in an infinitely deep square well has a wave function that is given by

$$\psi_2(x)=\sqrt{\frac{2}{L}}\sin\left(\frac{2\pi x}{L}\right)$$

for $0 \le x \le L$ and is zero otherwise. What are the most probable positions of the electron?

3. A particle of mass m moves in a potential well of length $2L$. Its potential energy is infinite for $x < -L$ and for $x > +L$. Inside the region $-L < x < L$, its potential energy is given by

$$U(x)=\frac{-\hbar^2 x^2}{mL^2\left(L^2-x^2\right)}$$

In addition, the particle is in a stationary state that is described by the wave function $\psi(x) = A(1 - x^2/L^2)$ for $-L < x < +L$, and by $\psi(x) = 0$ elsewhere. (a) Determine the energy of the particle in terms of $\hbar$, m, and L. (*Suggestion:* Use the Schrödinger equation, Eq. 41.13.) (b) Show that $A = (15/16L)^{1/2}$. (c) Determine the probability that the particle is located between $x = -L/3$ and $x = +L/3$.

4. The normalized wave functions for the ground state, $\psi_0(x)$, and the first excited state, $\psi_1(x)$, of a quantum harmonic oscillator are

$$\psi_0(x)=\left(\frac{a}{\pi}\right)^{1/4}e^{-ax^2/2}$$

$$\psi_1(x)=\left(\frac{4a^3}{\pi}\right)^{1/4}xe^{-ax^2/2}$$

where $a = m\omega/\hbar$. A mixed state, $\psi_{01}(x)$, is constructed from these states:

$$\psi_{01}(x)=\frac{1}{\sqrt{2}}\left[\psi_0(x)+\psi_1(x)\right]$$

The symbol $\langle q\rangle_s$ denotes the expectation value of the quantity q for the state $\psi_s(x)$. Calculate the following expectation values: (a) $\langle x\rangle_0$ (b) $\langle x\rangle_1$ (c) $\langle x\rangle_{01}$.