Physics 203 Lecture 1

Jun 24, 2013

1. An earthbound sibling observers her twin to depart from earth at a speed 60% the speed of light. After 10.0 years, the travelling twin returns having travelled 3.0 light-years and back. (a) Calculate the proper time the travelling twin was aboard the spaceship. (b) From the traveler's vantage point, the earth-bound twin's clocks tick slow. How much time does she observe to pass on earth? (c) During the moment of acceleration 3.0 light-years out, the clocks aboard ship go out of synch with those on earth. Calculate how far ahead the desynchronization put the clocks on the ship.

(a) 8.0 yr
(b) 6.4 yr
(c) 3.6 yr

2. Halley's comet has a highly elongated orbit. The eccentricity of its orbit is 0.967 with a distance of closest approach equal to 0.586 AU. (a) What is the maximum distance Halley's comet reaches before it turns around toward the sun? Express your answer in units of AU. (For reference, Neptune's average distance from the sun is 30 AU.) (b) When distances are measured in astronomical units (AU) and time is measured in years, Kepler's Third Law simplifies to $T^2 = a^3$ for orbits around the sun. Determine the period of Halley's comet in years. (Hint: Halley's original estimate was 76 years).

(a) 34.9 AU
(b) 74.8 yr

3. The pion used to be thought of as the particle that mediates the attractive interaction between nucleons. For example, a proton can convert into a neutron by absorbing a negative pion. Knowing that the quark content of the proton is uud and the neutron is udd, what must the quark content of the negative pion be? Justify your answer.

$\pi^- = \bar{u}d$

4. Figure **??** illustrates a possible elastic collision of two identical particles. They both have an initial speed of 100 m/s, but the final speeds are different. This shows that even if we could make the molecular speeds in an ideal gas the same, over time the internal elastic collisions will spread the speed distribution.

(a) $p_x = 0$ kg-m/s
(b) $p_y = 0.0684$ kg-m/s
(c) $KE = 10$ joules

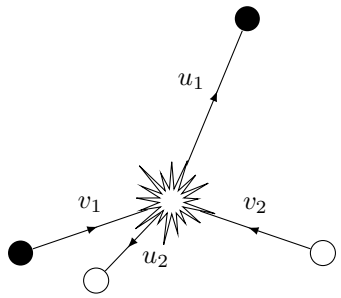

Figure 1: Elastic collision

In this example the initial velocity vectors are

$$v_1 = 100.0 \text{ at } 20^\circ \qquad v_2 = 100.0 \text{ at } 160^\circ$$

and the final velocity vectors are

$$u_1 = 66.6 \text{ at } 225^\circ \qquad u_2 = 124.8 \text{ at } 68^\circ$$

Confirm that this collision is elastic by showing that both momentum and kinetic energy are conserved. For your answer, assume each a mass is one gram.

5. An electron is travelling east at a speed of 100 m/s. It encounters a magnetic field pointing north. What magnitude of magnetic field is required to overcome the acceleration due to gravity effectively levitating the electron?

5.57×10^{-13} tesla