Example 1

The mass of a regulation tennis ball is 57 g, and tests have shown that the ball is in contact with the tennis racket for 30 ms. The fastest-known served tennis ball was served by "Big Billy" Tilden in 1931, and its speed was measured to be 73.14 m/s.

a) What impulse and what force did Big Billy exert on the tennis ball in his record serve?

b) If Big Bill's opponent returned his serve with a speed of 55 m/s, what force and what impulse did he exert on the ball, assuming only horizontal motion.

Example 2

To warm up for a match, a tennis player hits the 57.0-g ball vertically with her racket. If the ball is stationary just before it is hit and goes 5.50 m high, what impulse did she impart?

Example 3

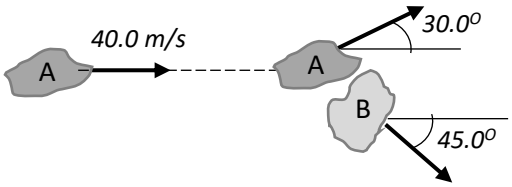
Two identical 1.50-kg masses are pressed against opposite ends of a light spring of force constant 1.75 N/cm, compressing the spring by 20.0 cm from its normal length. Find the speed of each mass when it has moved free of the spring on a frictionless horizontal table.

Example 4

Two asteroids of eqaul mass in the astroid belt between Mars and Jupiter collide with a glancing blow. Asteroid A, which was initially traveling at 40.0 m/s, is deflected 30.0^{O} from its original direction, while asteroid B, which was initially at rest, traveled at 45.0^{O} to the original direction of A.

a) Find the speed of each asteroid after the collision.

b) What fraction of the original kinetic energy of asteroid A dissipated during this collision?

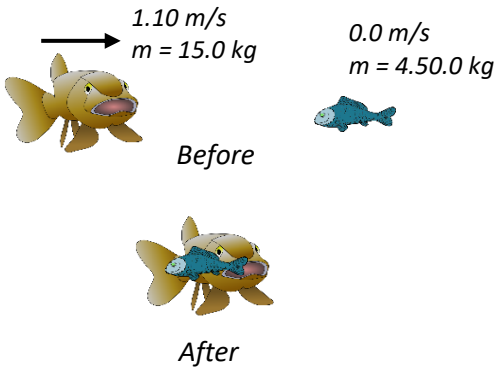


Example 5

A 15.0-kg fish swimming at 1.10 m/s suddenly gobbled up a 4.50-kg fish that is initially stationary. Neglect any drag effects of water:

a) Find the speed of the larger fish after it eats the small one.

b) How much mechanical energy was dissipated during this meal?



Example 6

A small wooden block with mass 1.00 kg is suspended from the lower end of a light cord that is 1.50 m long. The block is initially at rest. A bullet with mass 20.0 gr is fired at the block with a horizontal velocity v_o. The bullet stikes the block and become embeded in it. After the collision the combined object swings on the end of the cord. When the block has risen a vertical height of 0.500 m, the tension in the cord is 8.13 N. What was the initial speed v_o of the bullet?

Example 7

Block A (mass 2.00 kg) and B (mass 10.00 kg) move on a frictionless, horizontal surface. Initially, block B is at rest and block A is moving toward it at 2.00 m/s. The blocks are equipped with ideal spring bumpers. The collision is head-on, so all motion before and after the collision is along a straight line.

a) Find the maximum energy stored in the spring bumpers and the velocity of each block at that time.

b) Find the velocity of each block after they moved apart.

Example 8

You are at the controls of a particle accelerator, sending a beam of 1.50 x 10^7m/s protons (mass m) at a gas target of an unkown element. Your detector tells you that some protons bounce straight back after a collision with one of the nuclei of the unkown element. All such protons rebound with a speed of 1.20 x 10^7 m/s. Assume that the initial speed of the target nucleus is negligible and the collision is elastic:

a) Find the mass of one nucleus of the unknown element. Express your answer in term of the proton mass *m* .

b) What is the speed of the unknown nucleus immediately after such collision?

Example 9

Pluto's diameter is approximately 2370 km, and the diameter of its satellite Charon is 1250 km. Although the distance varies, they are often about 19,700 km apart, center to center. Assuming that both Pluto and Charon have the same composition and hence same average density, find the location of the center of mass of this system relative to the center of Pluto.

Example 10

A system consists of two particles. At t= 0 one particle is at rest at the origin; the other which has a mass of 0.50 kg, is on the y-axis at y = 6.0 m. At t = 0 the center of mass of the system is on the y-axis at y = 2.40 m. The velocity of the center of mass is given by (0.75 m/s^3) $t^2\underline{\boldsymbol{i}}$.

a) Find the acceleration of the center of mass at any time t.

b) Find the net external force acting on the system at t = 3.0 s