Answer on Question #45632, Physics, Mechanics | Kinematics | Dynamics

Question:

A 500g rubber ball is dropped from a height of 10 m and undergoes a perfectly elastic collision with the earth.

A) What is the earth's velocity after the collision? Assume the earth was at the rest just before collision.

B) How many years would it take the earth to move 1.00 mm at this speed?

Answer:

A) The law of conservation of energy:

$$\frac{mv_0^2}{2} = mhg$$

where v_0 speed of the ball before collision.

$$v_0 = \sqrt{2gh}$$

The law of conservation of momentum:

$$mv_0 = Mu + mv$$

$$m(v_0 - v) = Mu$$

where m is mass of the ball, M is mass of the Earth, u is speed of the Earth after collision.

The law of conservation of energy:

$$\frac{mv_0^2}{2} = \frac{mv^2}{2} + \frac{Mu^2}{2}$$

$$m(v_0 + v)(v_0 - v) = Mu^2$$

Dividing these equations:

$$v + v_0 = u \quad => \quad v = u - v_0$$

$$m(v_0 - (u - v_0)) = Mu$$

$$2mv_0 = (M + m)u$$

$$u = \frac{2m}{M+m} v_0 \approx \frac{2m}{M} v_0 = \frac{2m}{M} \sqrt{2gh} \cong 2.3 \cdot 10^{-24} \frac{m}{s}$$

Answer: $2.3 \cdot 10^{-24} \frac{m}{s}$

B) Time equals:

$$t = \frac{l}{v} = \frac{1mm}{2.3 \cdot 10^{-24} \frac{m}{s}} = 4.3 \cdot 10^{20} s = 1.36 * 10^{13}\ years$$

Answer: $1.36 * 10^{13}\ years$