Answer on Question#38525- Physics – Other

1.A dwarf drops from a tree and when it hits the ground it crouched down a distance of 0.4 m. If the dwarf dropped down from a height of 3.0 m what was the average force it absorbed over the crouching distance of 0.4 m?

Solution.

$m = x\ \ kg,$

$h = 3\ \ m,$

$d = 0.4\ \ m,$

$g = 9.8\ \ m/s^2.$

Potential energy of dwarf:

$E = mgh$

Work to overcome the force

$W = Fd$

Potential energy is equal to work

$E = W$

$mgh = Fd$

$$F = mg\frac{h}{d}$$

You must have a mass of dwarf m

Answer. $F = mg\frac{h}{d} = m \cdot 9.8 \cdot \frac{3}{0.4}$

2. Initially the goblin and the dwarf have the same velocity, but the dwarf has asthma and begins to slow down. He slows his pace at a constant rate of -0.6m/s^2 but the goblin maintains his velocity at 8 m/s. If the distance is 15m between the dwarf and the goblin when the dwarf began to slow down how long would it take for the dwarf to catch up?

Solution.

v=8 m/s – goblin's velocity,

a=0.6 m/s^2 – dwarf's acceleration

x_0=15 m.

Equations of motion:

for goblin: $x = vt = 8t$

for dwarf: $x = x_0 + vt + \frac{at^2}{2} = 15 + 8t - 0.3t^2$

The ways of dwarf and goblin are equal

$8t = 15 + 8t - 0.3t^2$

$0 = 15 - 0.3t^2$

$$t = \sqrt{\frac{2x_0}{-a}} = \sqrt{\frac{2 \cdot 15}{0.6}} = \sqrt{50} = 7.071\ \text{ s.}$$

Answer. t = 7.071 s.

3. The goblins fists cut through the air and connects with the dwarfs face in an elastic collision. The goblins fists each weigh 2kg and the dwarfs head weighs 5kg. What is the kinetic energy imparted to the dwarfs face by the goblins fists if the goblins fists had an initial velocity of 5m/s?

Solution.

An elastic collision is an encounter between two bodies in which the total kinetic energy of the two bodies after the encounter is equal to their total kinetic energy before the encounter.

m_1=2 kg – mass of goblins fist,

m_2=5 kg – mass of dwarfs head,

v_0=5 m/s – initial velocity of the goblins fists.

The conservation of the total momentum demands that the total momentum before the collision is the same as the total momentum after the collision, and is expressed by the equation

$$m_1 v_0 = m_1 u_1 + m_2 u_2,$$

u_1 and u_2 the velocities of goblins fists and dwarfs head after collision.

Likewise, the conservation of the total kinetic energy is expressed by the equation

$$\frac{m_1 v_0^2}{2} = \frac{m_1 u_1^2}{2} + \frac{m_2 u_2^2}{2}.$$

These equations may be solved directly to find u_1 and u_2

$$\begin{cases} m_1 v_0 = m_1 u_1 + m_2 u_2 \\ m_1 v_0^2 = m_1 u_1^2 + m_2 u_2^2 \end{cases}$$

$$\begin{cases} m_1 (v_0 - u_1) = m_2 u_2 \\ m_1 (v_0^2 - u_1^2) = m_2 u_2^2 \end{cases}$$

$$\begin{cases} m_1 (v_0 - u_1) = m_2 u_2 \\ m_1 (v_0 - u_1)(v_0 + u_1) = m_2 u_2^2 \end{cases}$$

Divide equations term by term

$$v_0 + u_1 = u_2$$

Together with the first equation $m_1 v_0 = m_1 u_1 + m_2 u_2$

$$u_1 = u_2 - v_0$$

$$m_1 v_0 = m_1 (u_2 - v_0) + m_2 u_2$$

$$2 m_1 v_0 = u_2 (m_1 + m_2)$$

$$u_2 = \frac{2 m_1 v_0}{m_1 + m_2} = \frac{2 \cdot 2 \cdot 5}{7} = 2.86 \text{ m/s.}$$

Kinetic energy imparted to the dwarfs face by the **one** goblins fist

$$E_{K2} = \frac{m_2 u_2^2}{2} = \frac{5 \cdot 20^2}{2 \cdot 7^2} = 20.41 \text{ J.}$$

Answer. $E_{K2} = \frac{m_2 u_2^2}{2} = \frac{5 \cdot 20^2}{2 \cdot 7^2} = 20.41$ J.