Answer on Question #42900 – Physics – Other

23. In an elastic collision, a neutron collides with carbon. How much energy (in percentage) of neutron is transferred to carbon?

Solution.

Let particle 1 be neutron and particle 2 – carbon. Then

$$\frac{m_2}{m_1} = 12$$

Two conservation laws: energy and linear momentum (one dimension):

$$\frac{m_1 V_{1i}^2}{2} = \frac{m_1 V_{1f}^2}{2} + \frac{m_2 V_{2f}^2}{2}$$

$$m_1 V_{1i} = m_1 V_{1f} + m_2 V_{2f}$$

V_{1i}, V_{1f}, V_{2f} are **projections** and can be negative.

Then

$$V_{2f} = \frac{m_1}{m_2}(V_{1i} - V_{1f})$$

$$V_{1i}^2 - V_{1f}^2 = (V_{1i} - V_{1f})(V_{1i} + V_{1f}) = \frac{m_2}{m_1} V_{2f}^2 = (from\ above)$$
$$= \frac{m_2}{m_1}\left(\frac{m_1}{m_2}(V_{1i} - V_{1f})\right)^2 = \frac{m_1}{m_2}(V_{1i} - V_{1f})^2$$

Thus from last relation:

$$m_2(V_{1i} + V_{1f}) = m_1(V_{1i} - V_{1f})$$

$$V_{1f} = \frac{m_1 - m_2}{m_2 + m_1} V_{1i}$$

Kinetic energy of neutron after collision:

$$E_{1f} = \frac{m_1 V_{1f}^2}{2} = \left(\frac{m_1 - m_2}{m_2 + m_1}\right)^2 * \frac{m_1 V_{1i}^2}{2} = \left(\frac{m_1 - m_2}{m_2 + m_1}\right)^2 E_{1i}$$

Numerically:

$$E_{1f} = \left(\frac{11}{13}\right)^2 E_{1i} \approx 0.72 E_{1i}$$

$0.28E_{1i}$ or 28% is transferred to carbon

Answer: (c) 28%

24. A block of mass 1.0 kg moving on a horizontal surface with speed 2 m/s enter the rough surface. The retarding force on the block is given …

The kinetic energy of the block at x = 100 m is:

Solution.

The final kinetic energy is the sum of initial kinetic energy and work of the external force:

$$E_{Kf} = E_{Ki} + A$$

$$E_{Ki} = \frac{mV_0^2}{2}$$

$$A = \int_{x_1}^{x_2} F(x)dx$$

From relation for retarding force:

$$x_1 = 10m; x_2 = 100m; F(x) = -\frac{k}{x}; k = 0.5J$$

So

$$A = \int_{x_1}^{x_2} -\frac{k}{x}dx = -k\ln\frac{x_2}{x_1}$$

Finally:

$$E_{Kf} = \frac{mV_0^2}{2} - k\ln\frac{x_2}{x_1}$$

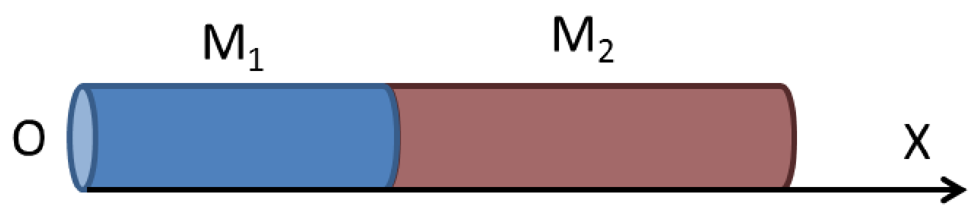
Numerically:

$E_{Kf} \approx 0.85J$ The nearest answer is (c) 0.5 J

Answer: (c) 0.5 J

25. The uniform rods of different materials M_1 and M_2 have lengths 2m and 3m, respectively. The mass per unit length of rods M_1 and M_2 are 1 kg and 2 kg, respectively. If the rods are arranged, as shown, the position of c.m. relative to point O is:

Solution.



Relation for center of mass:

$$x_{CM} = \frac{x_{CM1}M_1 + x_{CM2}M_2}{M_1 + M_2}$$

$$M = \rho L;\ x_{CM1} = \frac{L_1}{2};\ x_{CM2} = L_1 + \frac{L_2}{2}$$

Thus:

$$x_{CM} = \frac{x_{CM1}\rho_1 L_1 + x_{CM2}\rho_2 L_2}{\rho_1 L_1 + \rho_2 L_2} = \frac{\frac{\rho_1 L_1^2}{2} + \rho_2 L_2\left(L_1 + \frac{L_2}{2}\right)}{\rho_1 L_1 + \rho_2 L_2}$$
$$= \frac{L_1^2 + \frac{\rho_2}{\rho_1}L_2(2L_1 + L_2)}{2\left(L_1 + \frac{\rho_2}{\rho_1}L_2\right)}$$

$$\frac{\rho_2}{\rho_1} = 2$$

Numerically:

$$x_{CM} \approx 2.9m$$

Answer: (c) 2.9 m