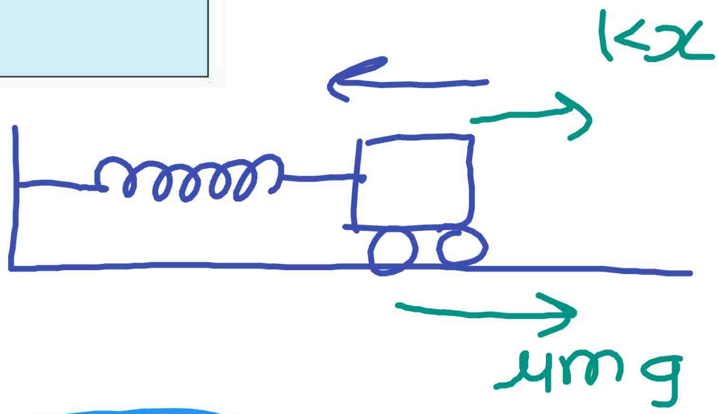
▶ **Example 6.9** Consider Example 6.8 taking the coefficient of friction, μ, to be 0.5 and calculate the maximum compression of the spring.



∴ W.E theorem:-

$$\Delta K = W_{ext}$$

$$\therefore K_f - K_i = W_{ext}$$

$$\therefore 0 - \frac{1}{2}mv^2 = -\frac{1}{2}kx_m^2 - (\mu_s N)x_m$$

spring — fric^n

$$\therefore \frac{1}{2}mv^2 = \frac{1}{2}kx_m^2 + \mu m g x_m$$

$$(\times 2)\quad \frac{2}{2}mv^2 = \frac{2}{2}kx_m^2 + 2\mu m g x_m$$

$$\therefore 0 = kx_m^2 + (2\mu m g)x_m - mv^2$$

a, b, c

compare with

$$ax^2 + bx + c = 0$$

$$a = k = 6.25\times10^3 \text{ N/m}.$$

$$b = 2\mu m g = 2(0.5)(1000)(10) = 2\left(\frac{1}{2}\right)\times10^4 = 10^4$$

$$c = -mv^2 = -(1000)(5) = -5000$$

$a = K \quad = 6.25\times10^3$ N/m.

$b = 2\mu mg = \cancel{2}(\cancel{0.5})(1000)(10) = 2\left(\frac{1}{2}\right)\times10^4$

$c = -mv^2 = -(1000)(5)^2 \quad = 25\times10^3$

$= -25000 \quad = 2.5\times10^4.$

$$x_m = \frac{-b \pm\sqrt{b^2-4ac}}{2a}$$

$$= \frac{-10^4 \pm \sqrt{10^8 - 4(6.25\times10^3)(2.5\times10^4)}}{2(6.25\times10^3)}$$

$$= \frac{-10^4 \pm \sqrt{10^8 + 625\times10^6}}{125\times10^2}.$$

$$= \frac{-10^4 \pm \sqrt{10^8 + 6.25\times10^8}}{1.25\times10^4}.$$

$$= \frac{-\cancel{10^4} \pm \sqrt{(1+6.25)\times\cancel{10^4}}}{1.25\times\cancel{10^4}}$$

$$= \frac{-1 \pm \sqrt{7.25}}{1.25}$$

$$= \frac{-1 \pm 2.69}{1.25}$$

$$= \frac{-1 \pm 2.69}{1.25}$$

$$\frac{-1 + 2.69}{1.25}$$

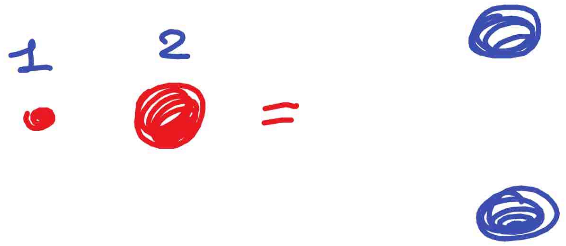
$$= 1.35\ \text{m} = x\ \text{m}$$

$$\frac{-1 - 2.69}{1.25}$$

−ve

not possible

Example 6.12 Slowing down of neutrons: In a nuclear reactor a neutron of high speed (typically 10^7 m s^{-1}) must be slowed to 10^3 m s^{-1} so that it can have a high probability of interacting with isotope ${}^{235}_{92}U$ and causing it to fission. Show that a neutron can lose most of its kinetic energy in an elastic collision with a light nuclei like deuterium or carbon which has a mass of only a few times the neutron mass. The material making up the light nuclei, usually heavy water (D_2O) or graphite, is called a moderator.



∴ Neutron

$$K_{1i} = \frac{1}{2} m_1 v_{1i}^2$$

$$K_{1f} = \frac{1}{2} m_1 (v_{1f})^2 \rightarrow = \frac{1}{2} m_1 \left[\frac{m_1 - m_2}{m_1 + m_2} v_{1i}\right]^2$$

∴ fraction of loss

$$f_1 = \frac{K_{1f}}{K_{1i}} = \frac{\text{output}}{\text{Input}}$$

$$= \frac{\frac{1}{2} m_1 \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 v_{1i}^2}{\frac{1}{2} m_1 v_{1i}^2}$$

$$f_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$

Energy absorbed by Moderator.

$$f_2 = 1 - f_1$$
$$= 1 - \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$
$$= 1 - \frac{[m_1^2 - 2m_1m_2 + m_2^2]}{[m_1^2 + 2m_1m_2 + m_2^2]}$$
$$= \frac{[m_1^2 + 2m_1m_2 + m_2^2] - [m_1^2 - 2m_1m_2 + m_2^2]}{[m_1^2 + 2m_1m_2 + m_2^2]}$$

$$f_2 = \frac{4m_1m_2}{(m + m_2)^2}.$$

fractional Energy Absorbed by moderator.

→ For Deutron :- (mass of D is 2 times of neutron)

$\therefore m_2 = 2m_1$

$$\therefore f_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \left(\frac{m_1 - 2m_1}{m_1 + 2m_1}\right)^2 = \left(\frac{-m_1}{3m_1}\right)^2 = \frac{1}{9}$$

$$f_2 = \frac{4m_1m_2}{(m_1 + m_2)^2} = \frac{4(m_1)(2m_1)}{(3m_1)^2} = \frac{8}{9}$$

($\because$ direct
$$f_2 = 1 - f_1$$
$$= 1 - \frac{1}{9} = 8/9)$$

f_2 = gained by deutron = 90%.

f_1 = loss by neutron = 10%

If (n) (c)

$f_1 = 71.6\%$ MCQ.
$f_2 : 28.4\%$

Tomorrow Morning