SOLUTIONS OF PHYSICS PROBLEMS
11 GRADE

(1) $m = 64\,kg$

$\ell = 1{,}6\,m$

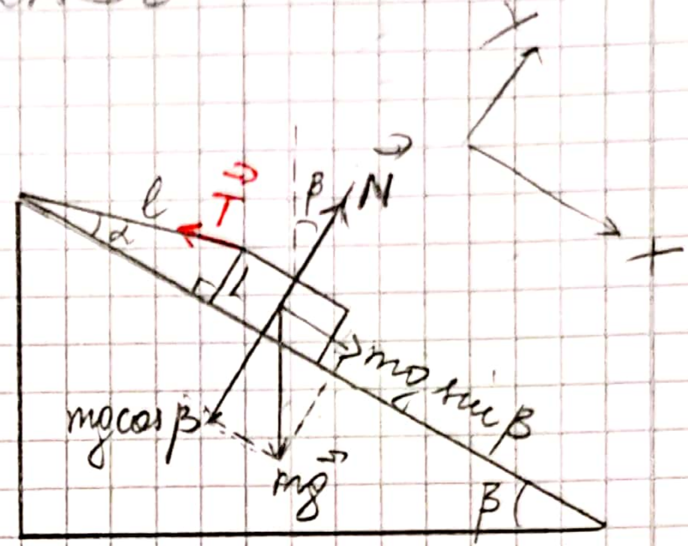
$L = 0{,}4\,m$

(p.s. it should be length of box side)

$\beta = 26°$

$g = 10\,m/s^2$

$T - ?$



From right triangle

$$\alpha = \sin^{-1}\left(\frac{L}{\ell}\right)$$

Applying 2nd Newton law x axis:

$$T\cos\alpha - mg\sin\beta = 0$$

$$T = \frac{mg\sin\beta}{\cos\alpha} = \frac{mg\sin\beta}{\cos\left(\sin^{-1}\frac{L}{\ell}\right)}$$

For any angle: $\cos\theta = \sqrt{1-\sin^2\theta}$

Tension

$$T = \frac{mg\sin\beta}{\sqrt{1-\left(\frac{L}{\ell}\right)^2}}$$

$$T = \frac{64 \cdot 10 \cdot \sin(26°)}{\sqrt{1-\left(\frac{0{,}4}{1{,}6}\right)^2}} = \underline{280{,}65\,N}$$

Scanned with CamScanner

(2) $m_A = 6$ kg

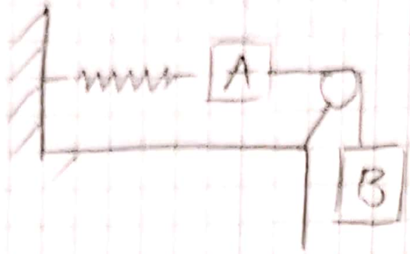
$m_B = 12$ kg

$k = 250$ N/m

$g = 10$ m/s^2

x_m - ?

v - ? if $x = \frac{x_m}{2}$



At maximum extension in the spring $v_A = v_B = 0$ (momentarily). Therefore, applying conservation of mechanical energy decrease in gravitational P.E of block B = increase in elastic P.E of spring

$$m_B g x_m = \frac{1}{2} k x_m^2$$

$$2 m_A g x_m = \frac{1}{2} k x_m^2$$

$$x_m = \frac{4 m_A g}{k}$$

$$x_m = \frac{4 \cdot 6 \cdot 10}{250} = \underline{0,96 \text{ m}}$$

At $x = \frac{x_m}{2} = \frac{2 m_A g}{k}$

Let say $v = v_B = v_A$

Decrease in gravitational P.E of block B = increase in elastic P.E of spring plus increase in K.E. of both blocks

$$m_B g x = \frac{1}{2} k x^2 + \frac{1}{2}(m_A + m_B) v^2$$

$$2 m_A g \frac{2 m_A g}{k} = \frac{1}{2} k \left(\frac{2 m_A g}{k}\right)^2 + \frac{1}{2}(m_A + 2m_A) v^2$$

$$\frac{4 m_A^2 g^2}{k} = \frac{1}{2} k \frac{4 m_A^2 g^2}{k^2} + \frac{1}{2} 3 m_A v^2$$

$$\frac{4 m_A^2 g^2}{k} - \frac{2 m_A^2 g^2}{k} = \frac{3}{2} m_A v^2$$

$\Rightarrow$

Scanned with CamScanner

$$\Rightarrow \frac{2m_A^2 g^2}{k} = \frac{3}{2} m_A v^2$$

$$v^2 = \frac{4 m_A g^2}{3k}$$

$$v = 2g\sqrt{\frac{m_A}{3k}}$$

Substituting numerical values

$$v = 2\cdot 10\sqrt{\frac{6}{3\cdot 250}} = 1{,}789\, m/s$$

Scanned with CamScanner

(3) $T = 27°C = 300\,K$

$V = 12\,V$

$L = 2{,}5\,m$

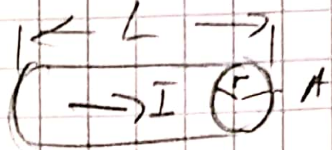
$t - ?$

$\rho_{cu} = 1{,}72 \cdot 10^{-8}\,\Omega m$

$c_{cu} = 386\,J/kg\,K$

$\rho = 8690\,kg/m^3$

$T_m = 1359\,K$



In order for copper cable to start melting its t-re must be increased to a melting point t-re.

The cable is insulated.

This means the energy dissipated by the cable is used to increase its temperature.

Resistance $R = \rho_{cu} \dfrac{L}{A}$

Energy dissipated by the cable

$$E = Pt = \frac{V^2}{R} t = \frac{V^2 A}{\rho_{cu} L} t$$

Energy must be equal to amount of heat required to increase t-re

$$E = Q$$

$$\frac{V^2 A}{\rho_{cu} L} t = mc\Delta T$$

Scanned with CamScanner

$$\frac{V^2 A}{\rho_{cu} L} t = \rho A L c \Delta T$$

Time :

$$t = \frac{c \Delta T \rho L^2 \rho_{cu}}{V^2}$$

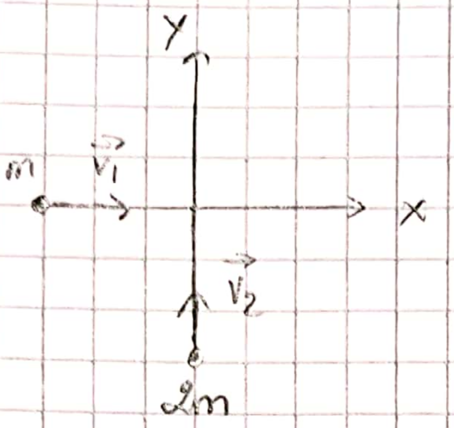
Substituting numerical values

$$t = \frac{386 (1359 - 300) 8690 \cdot 2{,}5^2 \cdot 1{,}72 \cdot 10^{-8}}{12^2}$$

$$t = 2{,}652\ s$$

Scanned with CamScanner

(4)



energy loss % - ?

If v' is velocity of the system after collision, then according to the principle of conservation of linear momentum

for x axis

$$p_{xi} = p_{xf}$$

$$m2v = 3mv_x$$

$$v_x = \frac{2}{3}v$$

for y axis

$$p_{yi} = p_{yf}$$

$$2mv = 3mv_y$$

$$v_y = \frac{2}{3}v$$

$$v^2 = v_x^2 + v_y^2$$

Initial energy of system

$$E_i' = \frac{1}{2}m(2v)^2 + \frac{1}{2}(2m)v^2 = 3mv^2$$

Final energy

$$E_f = \frac{1}{2}(m+2m)(v')^2 = \frac{1}{2}3m(v')^2$$

$$E_f = \frac{1}{2}3m\left(\frac{4}{3}v^2 + \frac{4}{3}v^2\right) = \frac{4}{3}mv^2$$

Energy loss in %

$$= \frac{E_i - E_f}{E_i} \times 100\%$$

$$= \frac{3mv^2 - \frac{4}{3}mv^2}{3mv^2} = \frac{5}{9} \text{ or } \underline{55,6\%}$$

Scanned with CamScanner