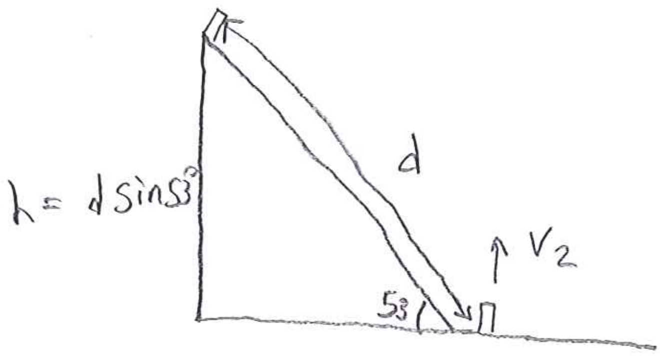
(56)

$m = 1500\ Kg$

$V_2 = 50\ m/s$

$F = 2000\ N$

$f = 500\ N$



If we apply conservation of energy:

$$K_1 + U_1 + W_{ot.} = K_2 + U_2$$

$K_1 = 0$ (No initial velocity)

$U_2 = 0$ (We choose ground as reference)

$U_1 = mgh = mgd\sin 53°$

$W_{ot.} = F_{tot} \cdot d = (F - f)d$ (Note that F_{Tot} is constant)

$K_2 = \frac{1}{2} m V_2^2$

Thus:

$$mgd\sin 53° + (F-f)d = \frac{1}{2} m V_2^2$$

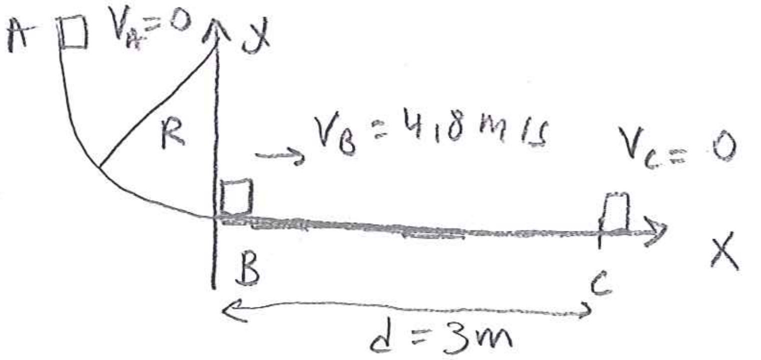
$$d(mg\sin 53° + F - f) = \frac{1}{2} m v^2$$

$$d = \frac{m v^2}{2(mg\sin 53° + F - f)}$$

$$d = \frac{(1500\ Kg)\cdot(50\ m/s^2)^2}{2((1500\ kg)\cdot(9{,}8\ m/s^2)\sin 53° + (2000\ N) - (500\ N))}$$

$$d = 142\ m$$

(65)



$y_A = R$
$y_B = y_c = 0$
$m = 0{,}2\ kg$
$R = 1{,}6\ m$
$d = 3\ m$

a) From conservation of energy we have:

$$K_B + U_B + W_{ot.} = K_c + U_c$$

$$U_B = mgy_B = 0 \ ; \ K_B = \frac{1}{2}mv_B^2$$

$$U_c = mgy_c = 0 \ ; \ K_c = \frac{1}{2}mv_c^2 = 0$$

$$W_{ot.} = W_f = f_k(\cos\phi)d = \mu_k n(\cos 180^\circ)d = -\mu_k mgd$$

Thus:

$$\frac{1}{2}mv_B^2 - \mu_k mgd = 0 \Rightarrow \mu_k \cancel{m}gd = \frac{1}{2}\cancel{m}v_B^2 \Rightarrow$$

$$\mu_k = \frac{v_B^2}{2gd} = \frac{(4{,}8\ m/s)^2}{2\cdot(9.8\ m/s^2)\cdot 3m} = 0{,}392$$

b) Again from conservation of energy:

$$K_A + U_A + W_{ot.} = K_B + U_B$$

$$K_A = 0; \ U_A = mgy_A = mgR \ ; \ K_B = \frac{1}{2}mv_B^2 \ ; \ U_B = 0$$

$$W_{ot.} = W_f$$

Thus:

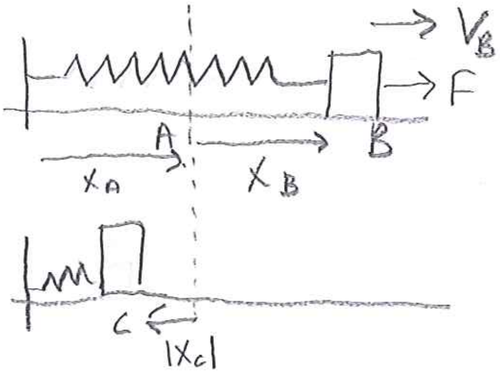
$$mgR + W_f = \frac{1}{2}mv_B^2 \Rightarrow$$

$$\Rightarrow W_f = \frac{1}{2}mv_B^2 - mgR$$

$$W_f = \frac{1}{2}\cdot(0{,}2kg)\cdot(4{,}8\ m/s)^2 - (0{,}2\ kg)(9{,}8\ m/s^2)(1{,}6m)$$

$$W_f = 2{,}304\ J - 3{,}136\ J = -0{,}83\ J$$

75



$k = 40\ N/m$

$m = 0{,}5\ kg$

$x_B = 0{,}25\ m$

$x_A = 0{,}6\ m$

$F = 20\ N$

a) From conservation of energy:

$$K_A + U_A + W_{ot} = K_B + U_B$$

$K_A = 0$; $U_A = 0$; $K_B = \frac{1}{2} m v_B^2$; $U_B = \frac{1}{2} k x_B^2$

$W_{ot.} = W_F = F x_B$

Thus conservation of energy expression becomes:

$$F x_B = \frac{1}{2} m v_B^2 + \frac{1}{2} k x_B^2 \Rightarrow \frac{1}{2} m v_B^2 = \left(\frac{1}{2} k x_B^2 - F x_B\right)$$

$$\Rightarrow V_B = \sqrt{\frac{2}{m}\left(\frac{1}{2} k x_B^2 - F x_B\right)} = \sqrt{\frac{2}{0{,}5kg}\left(\frac{1}{2}(40N/m \cdot (0{,}25m)^2 - (20N \cdot 0{,}25m)\right)}$$

$$V_B = 3{,}87\ m/s$$

b) $$K_B + U_B + W_{ot.} = K_C + U_C$$

$K_B = \frac{1}{2} m v_B^2$; $U_B = \frac{1}{2} k x_B^2$; $K_C = 0$; $U_C = \frac{1}{2} k x_C^2$; $W_{ot} = 0$

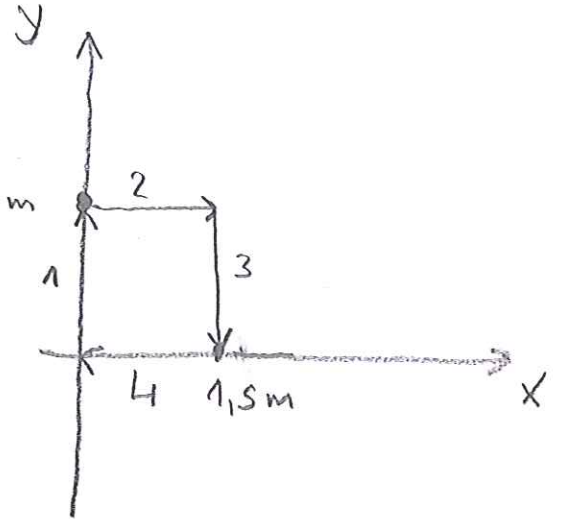
$$\cancel{\frac{1}{2}} m v_B^2 + \cancel{\frac{1}{2}} k x_B^2 = \cancel{\frac{1}{2}} k x_C^2$$

$$x_c = \sqrt{x_B^2 + \frac{m}{k} v_B^2}$$

$$x_c = \sqrt{(0{,}25m)^2 + \frac{0{,}5kg}{40\ N/m} \cdot (3{,}87\ m/s)^2}$$

$$x_c = 0{,}5\ m$$

85



$$\vec{F} = \alpha x y \hat{i}$$

$$\alpha = 2\ N/m^2$$

b)

- Work is defined as: $W = \int_{P_1}^{P_2} \vec{F} \cdot \vec{dl}$. Note that:

$$\vec{F} \cdot \vec{dl} = (\alpha x y \hat{i}) \cdot \vec{dl} = \alpha x y\, dx$$

- Along (1): $x = 0 \Rightarrow F = 0$ thus $W_1 = 0$.
- Along (2): $y = 1{,}5\ m$,

$$W_2 = \int_0^{1,5} \alpha x y\, dx = \alpha y \int_0^{1,5} x\, dx = \alpha y \left.\frac{x^2}{2}\right|_0^{1,5}$$

$$W_2 = 2\ N/m^2 \cdot (1{,}5\ m) \cdot \frac{(1{,}5 m)^2}{2} = 3{,}38\ J$$

- Along (3): $dx = 0 \Rightarrow \vec{F} \cdot \vec{dl} = 0 \Rightarrow W_3 = 0$
- Along (4): $y = 0 \Rightarrow F = 0 \Rightarrow W_4 = 0$

c) $W_T = W_1 + W_2 + W_3 + W_4 = 3{,}38\ J$

The work done in moving around the closed path is not zero. Thus force is not conservative.

(86) Look figure P 7.86 at your book. (Pg. 239)

a) The slope of the U vs X curve is negative at point A. Since $F_x = -\frac{dU}{dX}$, F_x is positive at A.

b) The slope of the curve is positive at point B. Thus F_x is negative.

c) The kinetic energy is maximum, when potential is minimum. That is at around $X = 0{,}75$ in our figure.

d) The curve at point C looks pretty close to flat, so the force is zero.

e) The object had zero kinetic energy at point A, and in order to reach point with more potential energy than $U(A)$, the kinetic energy at that point must be negative. Kinetic energy cannot be negative. Thus object can never be at any point where the potential is higher than $U(A)$. On the graph, that looks to be at around $X = 2{,}2$.

f.) The point of minimum potential (found in part(c)) is stable point. As is the relative minimum near $X = 1{,}9$ m.

g) The only potential maximum, thus the only point of unstable equilibrium, is at point C.