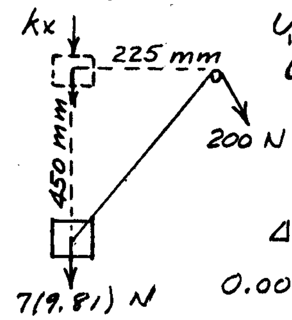
3/135 | For system of collar & cable



$U_{1-2} = \Delta T$

$U_{1-2} = 200\left[\sqrt{(0.450)^2 + (0.225)^2} - 0.225\right]$

$\quad - 7(9.81)(0.450) - \frac{1}{2}k(0.075)^2$

$\quad = 55.6 - 30.9 - 0.00281k$ J

$\Delta T = 0$ so

$0.00281k = 55.6 - 30.9$

$k = 8790$ N/m or $\underline{k = 8.79\text{ kN/m}}$

3/139 $(U_{1-2})_s = -\int_{x_1}^{x_2} (4x - 120x^3)\,dx$

$= (-2x^2 + 30x^4)\Big|_{x_1}^{x_2} = -2(x_2^2 - x_1^2) + 30(x_2^4 - x_1^4)$

With $x_1 = 0.1$ m & $x_2 = 0$, $(U_{1-2})_s = 0.017$ kN·m

or $(U_{1-2})_s = 17$ N·m $= 17$ J

$(U_{1-2})_f = -\mu_k mgd = -0.2(10)(9.81)(0.1) = -1.962$ J

$T_1 + U_{1-2} = T_2 : 0 + 17 - 1.962 = \frac{1}{2}(10)v^2$

$\underline{v = 1.734 \text{ m/s}}$

For the linear spring, $(U_{1-2})_s = 2(x_1^2 - x_2^2)$

$= 2(0.1)^2 = 0.02$ kN·m $= 20$ J, $\underline{v' = 1.899 \text{ m/s}}$

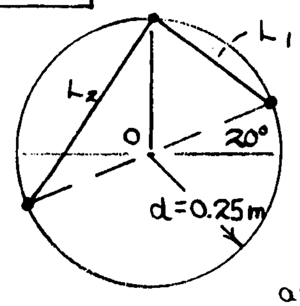
3/150 For the system, $U'_{1-2} = 0$ so $\Delta V_g = 0$

$$\Delta V_{g_{100}} = -100(7) = -700 \text{ ft-lb}$$

$$\Delta V_{g_W} = W\left[2(12\sqrt{2}) - 2\sqrt{5^2+12^2}\right] = 7.94W$$

Thus $7.94W - 700 = 0$, $\underline{W = 88.1 \text{ lb}}$

3/155



$$L_1 = 2d\sin(90^\circ-20^\circ)/2 = 0.287 \text{ m}$$

$$\delta_1 = 0.25\sqrt{2} - L_1 = 0.0668 \text{ m}$$

$$L_2 = 2d\sin\left(\frac{90^\circ+20^\circ}{2}\right) = 0.410 \text{ m}$$

$$\delta_2 = L_2 - 0.25\sqrt{2} = 0.0560 \text{ m}$$

We may ignore the equal and opposite potential energy changes associated with two of the masses,

$T_1 + V_1 = T_2 + V_2$, datum at O.

$$0 - mgd\cos 20^\circ + \tfrac{1}{2}k\delta_1^2 + \tfrac{1}{2}k\delta_2^2 = 3\left(\tfrac{1}{2}md^2\dot\theta^2\right) - mgd$$

$$0 - 3(9.81)(0.25)\cos 20^\circ + \tfrac{1}{2}1200(0.0668)^2$$
$$+ \tfrac{1}{2}1200(0.0560)^2 = \tfrac{3}{2}3(0.25)^2\dot\theta^2 - 3(9.81)(0.25)$$

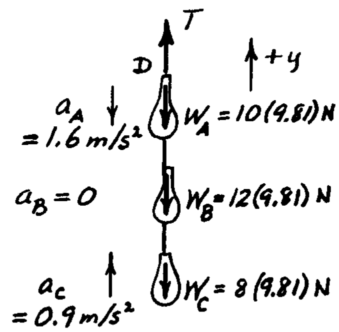
Solving, $\underline{\dot\theta = 4.22 \text{ rad/s}}$

4/2 For system $\Sigma F_y = \Sigma m_i a_i$

$T - 9.81(10+12+8)$

$= 10(-1.6) + 12(0) + 8(0.9)$

$T - 294 = -8.8$, $\underline{T = 286\ N}$

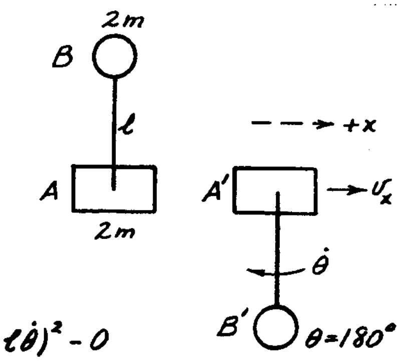


4/28 For entire system,

$$\int \Sigma F_x \, dt = \Delta G_x = G_{A'} + G_{B'} - 0$$

$$0 = 2mv_x + 2m(v_x - l\dot{\theta})$$

$$2v_x = l\dot{\theta} \quad ----(1)$$



For entire system,

$$U'_{1-2} = \Delta T + \Delta V_g$$

$$\Delta T = \frac{1}{2}(2m)v_x^2 + \frac{1}{2}(2m)(v_x - l\dot{\theta})^2 - 0$$

$$= m(2v_x^2 - 2l\dot{\theta}v_x + l^2\dot{\theta}^2)$$

$$\Delta V_g = -2mg(2l) = -4mgl$$

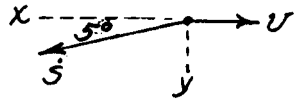
$$U'_{1-2} = 0 \text{ so } 0 = m(2v_x^2 - 2l\dot{\theta}v_x + l^2\dot{\theta}^2) - 4mgl$$

$$\text{or } 2v_x^2 - 2l\dot{\theta}v_x + l^2\dot{\theta}^2 = 4gl \quad ---(2)$$

Combine (1) & (2): $2v_x^2 - 4v_x^2 + 4v_x^2 = 4gl$, $v_x^2 = 2gl$, $\underline{v_x = \sqrt{2gl}}$

$$\dot{\theta} = 2v_x/l = 2\sqrt{2gl}/l = \underline{2\sqrt{\frac{2g}{l}}}$$

4/29 System is conservative so $\Delta T + \Delta V_g = 0$



Flatcar; $\Delta T = \frac{1}{2} m v^2 - 0$

$$= \frac{1}{2} \frac{50{,}000}{32.2} v^2$$

$$\Delta V_g = 0$$

Vehicle; $\Delta T = \frac{1}{2} m v^2 - 0 = \frac{1}{2} \frac{15000}{32.2}\left[(\dot{s}\cos 5° - v)^2 + (\dot{s}\sin 5°)^2\right] - 0$

$$\Delta V_g = -W\Delta h = -15{,}000\,(40 \sin 5°)$$

Thus $776.4\, v^2 + 232.9\left[(\dot{s}\cos 5° - v)^2 + (\dot{s}\sin 5°)^2\right] - 52290 = 0$ - - - - -(1)

Also for system, $\Sigma F_x = 0$ so $\Delta G_x = 0$

$$\frac{15{,}000}{32.2}(\dot{s}\cos 5° - v) - \frac{50{,}000}{32.2} v = 0$$

$\dot{s}\cos 5° - v = 3.33 v$ & $\dot{s}\sin 5° = 4.33 v \tan 5°$
$= 0.379 v$

Substitute into (1) & get

$$776.4 v^2 + 232.9\left[(3.33 v)^2 + (0.379 v)^2\right] - 52290 = 0$$

$$v^2(776.4 + 2588 + 33.5) = 52290$$

$v^2 = 15.39\ (ft/sec)^2$, $\underline{v = 3.92\ ft/sec}$