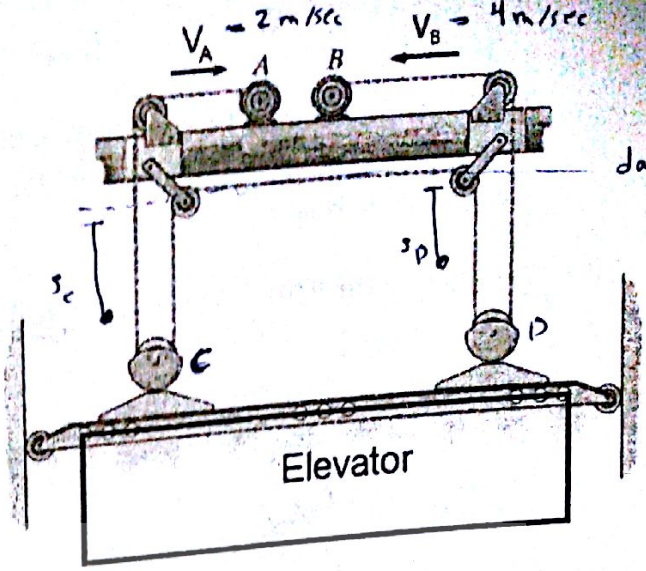
Problem 1: The crane is used to hoist an elevator. If the motors at A and B are drawing in the cable at a speed of 2 m/s and 4 m/s, respectively. The speed of the elevator (in m/s) is:

(a) 1.5 (b) 3 (c) 6 (d) 0.75 (e) 9



$2s_C + 2s_D =$

$2s_C + 2s_D$

$2s_A + 2s_B = L$

$2v_A + 2v_B = 0$

$2s_C + 2s_D + s_A + s_B = L$

$2v_C + 2v_D + v_A + v_B = 0$

$2v_C + 2v_D - 2 - 4 = 0$ $\quad v_1 = 15$ m/sec $\quad v_2 = 0$, $x = 10$ m

$2v_C + 2v_D = 6$ = speed of elevator

Problem 2: A truck is travelling at 15 m/s when the brakes are applied, causing it to skid for a distance 10 m before coming to rest. If the mass of the boat and trailer is 1Mg, the horizontal force in the coupling C (in kN) is:

(a) 17.45 (b) 11.25 (c) 19.13 (d) 21.38 (e) 9.25

$T = 1000\,(a)$

$= 1000 \times 11.25$ (N)

$= 11.25$ kN.

$v_2^2 = v_1^2 + 2a(10)$

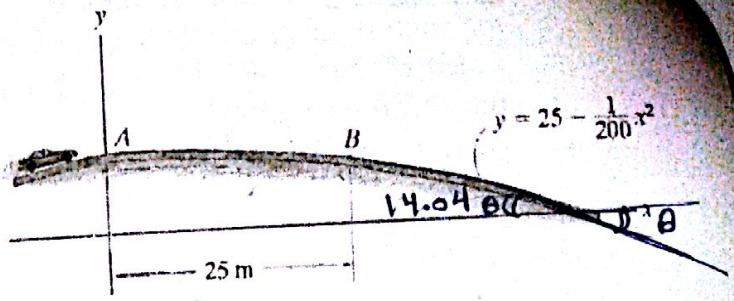
$0 = 15^2 + 20a$

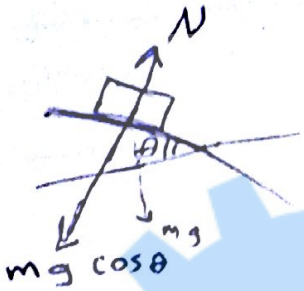
$a = -11.25$ m/sec^2

$v = 25$ m/sec

Problem 3: The 800-kg car travels in the vertical plane at a constant speed of 25 m/s. The normal force (in Newton's) on the car at point B is:

(a) 5337 (b) 4191 (c) 6477 (d) 3048 (e) 2056





$mg\cos\theta - N = ma_n$

$N = 3048$

$v_0 = 0 \quad s_0 = 0$

$a_n = \frac{v^2}{\rho}$

$= \frac{25^2}{109.52}$

$a_n = 5.71$ m/sec^2

$\tan^{-1} y' = \theta$

$\theta = 14.04^\circ$

$y' = -\frac{2}{200}x = -0.01x$

$y'' = \frac{-2}{200} = -0.01$

$y' = -0.01x$

$y'' = -0.01$

$\rho| = \frac{[1 + y'^2]^{3/2}}{y''}$

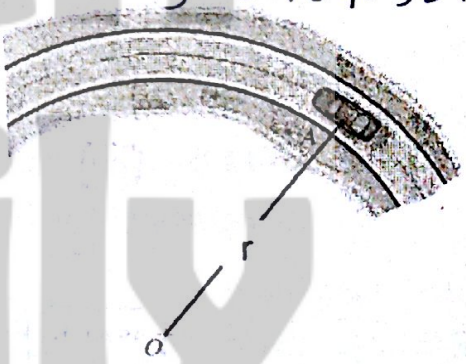
$x = 25$

$= \frac{[1 + 0.0625]^{3/2}}{0.01}$

$\rho = 109.52$ m

Problem 4: A car (starting from rest at S= 0) travels along a circular path of $r = 17$ m, such that its speed is increased by $a_t = 2S$ m/s^2, where S is in meters. The magnitude of its acceleration (in m/s^2) after the car has traveled a distance of S=18 m is:

(a) 43.83 (b) 49.13 (c) 45.73 (d) 52.43 (e) 33.63



$a_t = 2S$

$v\frac{dv}{ds} = 2S$

$\int_0^v v\,dv = \int_0^{18} 2S\,ds$

$\frac{v^2}{2} = S^2\Big|_0^{18}$

$\frac{v^2}{2} = 324$

$v = 25.46$ m/s

$a_t = 2 \times 18$

$= 36$

$a = \sqrt{36^2 + 38.13^2}$

$= 52.43$

$a_n = \frac{v^2}{\rho}$

$= \frac{25.46^2}{17}$

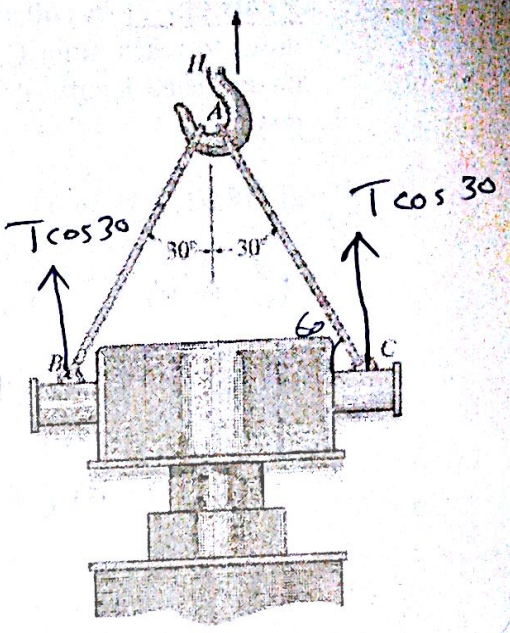
$= 38.13$

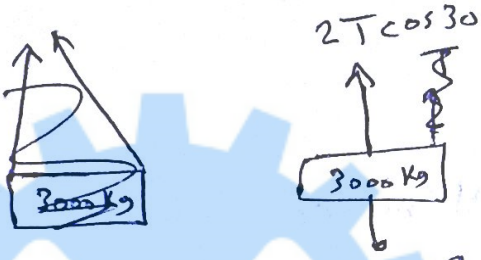
$a = \frac{0.2}{0.3} = 0.67 \text{ m/sec}^2$

$V_0 = 0$

Problem 5: The 3-Mg casting, suspended in the vertical position and initially at rest, is given an upward speed of 0.2 m/s in 0.3 sec. Assuming constant acceleration, the tension in cables AB and AC (in kN) is:

(a) 18.15 (b) 24.25 (c) 30.25 (d) 36.35 (e) 15.25





$3000 * 9.81$

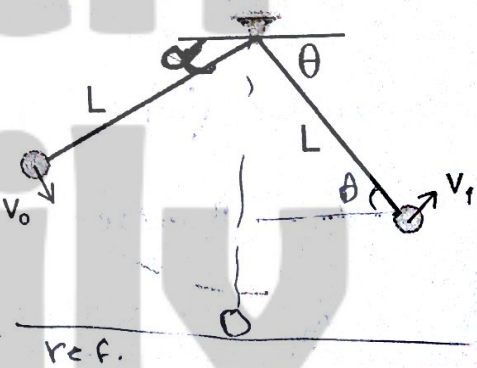
$2T\cos 30 - 3000 * 9.81 = 3000 * 0.67$

$T = 18151.9 \text{ N}$

$= 18.15 \text{ kN}$

Problem 6: A simple pendulum starts moving downward with a velocity $V_0 = 2$ m/s and $\alpha = 30°$. On the opposite side, it reaches a velocity $V_f = 4$ m/s and $\theta = 60°$. The cable length L of the pendulum [in meters] is:

a) 2.67 b) 1.17 c) 1.67 d) 3.67 e) 2.00



$T_1 + V_1 = T_2 + V_2$

$\frac{1}{2} m (2)^2 + m * 9.81 * (L - L\sin 30)$

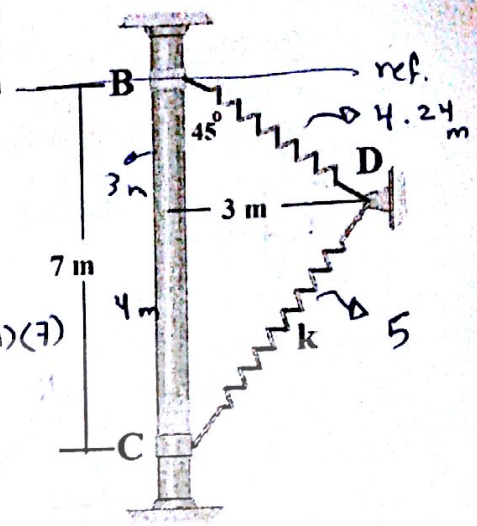
$= \frac{1}{2} m (4)^2 + m * 9.81 * (L - L\sin 60)$

$2 + 4.905 L = 8 + 1.31 L$

$L = 1.67 \text{ m}$

Problem 7: A collar 8 kg starts to move from rest from point B and falls down to reach point C. If the spring has a stiffness of $k = 50$ N/m and an un-stretched length of 3m. The collar velocity while reaching point C (in m/s) is:

a) 18.02 b) 16.03 c) 12.05 d) 14.07 e) 11.04



$T_1 + V_1 = T_2 + V_2$

$0 + \frac{1}{2}(50)(4.24-3)^2 = \frac{1}{2}(8)(V_2)^2 - (8)(9.81)(7)$

$+ \frac{1}{2}(50)(5-3)^2$

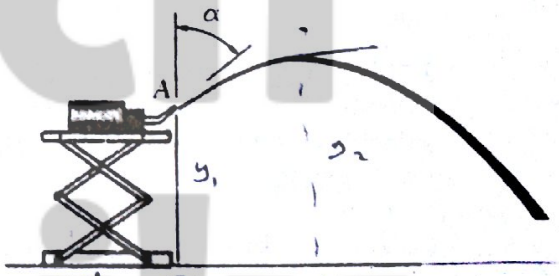
$V_2 = 11.04$ m/sec

$\sin 45 = \frac{3}{x}$

$x = 4.24$ m

Problem 8: A nozzle discharges a stream of water in the direction of $\alpha=40^\circ$ with an initial velocity of 8 m/s. The radius of curvature (in meters) of the stream as it will be at its **maximum** height is:

(a) 4.38 (b) 2.70 (c) 2.15 (d) ∞ (e) 3.24



$V_i = 8$ m/sec $\quad V_x = 8\sin 40$

$V_x = 5.14$ m/sec

$V_{y_i} = 8\cos 40$

$V_{y_i} = 6.13$ m/sec

$\rho = \frac{V^2}{a_n}$

$y =$

$\Delta y = 6.13t - \frac{1}{2}(9.81)t^2$

$x_2 = 5.14t \Rightarrow t = \frac{x_2}{5.14}$

at max. height.

$V_2^2 = V_i^2 - 2(9.81)\Delta y$

$0 = 6.13^2 - 19.62\Delta y$

$\Delta y = 1.91$

$1.91 = 1.19x - 0.19x^2$

$x = 3.13$

$y = 6.13\left(\frac{x}{5.14}\right) - \frac{4.91x^2}{(5.14)^2}$

$y_2 = 1.19x - 0.19x^2 + y_1$

$y' = 1.19 - 0.38x$

$y'' = -0.38$

$\rho = \frac{(1+y'^2)^{3/2}}{y''}$