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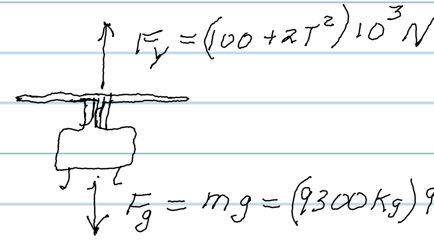
CH. 14 SECTION 14-1/2 FORCES IN STRAIGHT LINE MOTION

NEWTON'S SECOND LAW

FBD



$\Sigma \vec{F} = m\vec{a}$ ← COM (CENTER OF MASS)

INERTIAL REFERENCE FRAME $a = 0$

GOOD NEWS: NOTHING NEW

$$\Sigma F = m a \Rightarrow a(T) = \frac{\Sigma F(T)}{m}$$

EXAMPLE 14-3 GIVEN $m = 9300 Kg$, $F_y = T = (100 + 2T^2)10^3$ (N)

FIND: $V_y(3) = ?$, $S(3) = ?$

SOLUTION: $\Sigma F_y = m a_y$

$$10^5 + 2 \cdot 10^3 T^2 - m(9.8) = m a_y$$

$$\frac{dv}{dT} = a_y = \frac{10^5}{9300 Kg} + \frac{2000}{9300 kg} T^2 - \frac{9300(9.8)}{9300} =$$

$$\int_0^V dv = \int a_y dT = \int_0^T \frac{10^5}{9300} + \frac{2000}{9300} T^2 - 9300(9.8) \, dT$$

$$V(T) = 10.75T + .0717T^3 - 9.8T \Rightarrow V(3) = 4.8 \frac{m}{s}$$

$$S(T) = 5.38T^2 + .0179T^4 - 4.9T^2$$

$$S(3) = 48.4 + 1.45 - 44.1 = 5.7 m$$

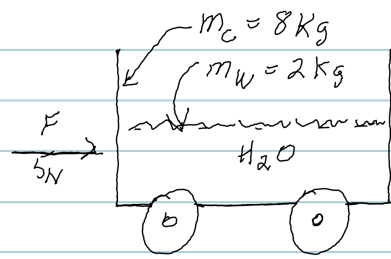
14-16 EXAMPLE

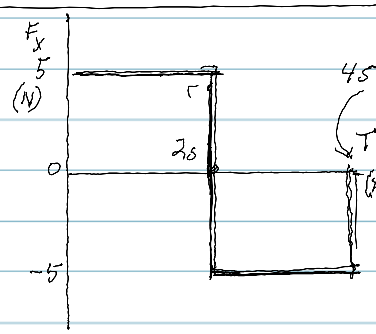
a) NO, COM ONLY

b) YES, $a = \frac{\Sigma F}{m_T} = \frac{5N}{8+2 Kg}$

$a = +0.5 \frac{m}{s^2}, -0.5 \frac{m}{s^2}, 0$

c) $X_{com} = 0$, BUT!





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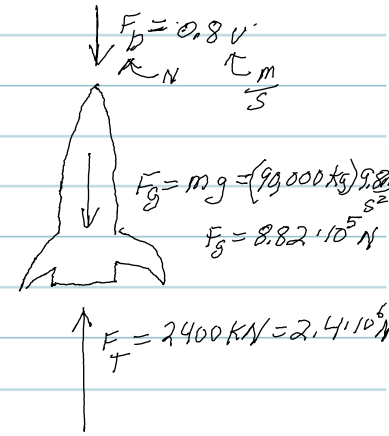
CH. 14 HOMEWORK EXAMPLE 14-15

14-15 GIVEN: $V(0) = 100\ \frac{m}{s}$, $m = 90{,}000\ kg$

FIND: $V(T=?) = 200\ \frac{m}{s}$



SOLUTION: $\Sigma F_y = m a_y$

$$+2.4 \cdot 10^6\ N - 8.82 \cdot 10^5\ N - 0.8V^2 = (90{,}000\ kg)\, a_y$$

$$a_y(T) = \frac{1.518 \cdot 10^6\ N - .8V^2}{90{,}000\ kg} = 16.87 - 8.889 \cdot 10^{-6}\, V^2$$

RULE → 105 pg.

RULE IIa

$$\frac{dV}{a(V)} = dT \Rightarrow \int_0^T dT = \int \frac{dV}{a(V)} = \int_{100}^{200} \frac{dV}{(16.87 - .8889 \cdot 10^{-6}\, V^2)}$$

FOR "MATHCAD" - UNDER "HELP" "RESOURCE CTR" "QUICKSHEET" "CALCULUS + DE"
"SYMBOLIC INTEGRATION" $f(V) = \frac{1}{(16.87 - .8889 \cdot 10^{-6} V^2)}$

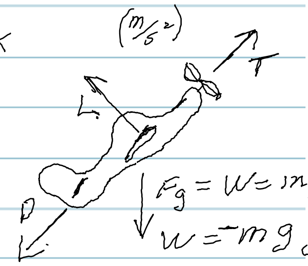
$$T = \int \frac{1}{16.87 - 8.889 \cdot 10^{-6}\, V^2} = 81.666\ a\mathrm{Tanh}(7.258 \cdot 10^{-4} \cdot V)\Big|_{100}^{200}$$

$$T = 11.94 - 5.938 = 6.00\ \text{sec}$$

14-23: GIVEN: $x(T) = 20T - 1.63T^2$ $\quad y = 35T - .15T^3$ $\quad z = -20T + 1.38T^2$ (m)

$V(T) \Rightarrow \dot{x} = 20 - 3.26T$ $\quad \dot{y} = 35 - .45T^2$ $\quad \dot{z} = -20 + 2.76T$ (m/s)

$a(T) \Rightarrow \ddot{x} = -3.26\ i$ $\quad \ddot{y} = -.9T\ j$ $\quad \ddot{z} = 2.76\ k$ (m/s²)



FIND: $T + L + D = ?$

SOLUTION: $\Sigma F = ma$

$$(T + L + D) - W = ma \Rightarrow T + L + D = ma - W = ma - (-mg\,j)$$

$$(T + L + D) = m(a + mg\,j) = 360\,kg\left[(-3.26\,i - .9T\,j + 2.76\,k) + g\,j\right]$$

$$T_{4\,sec} + L + D = 360\left[-3.26\,i - 3.6\,j + 9.8\,j + 2.76\,k\right] = 360\left[-3.26\,i + 6.2\,j + 2.76\,k\right]$$

$$(T + L + D) = (-1174\,i + 2236\,j + 994\,k)\ N$$

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SECTION 14-3 APPLICATIONS - NORMAL + TANGENTIAL COMPONENTS

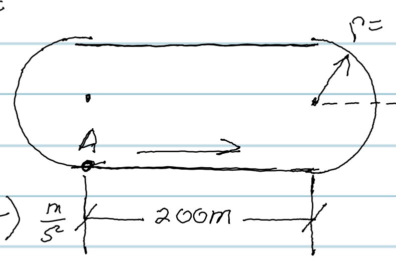
NOTE: $r =$ CONSTANT

NOTES:

$$\Sigma F_T = m a_T = m \frac{dv}{dT} \qquad \Sigma F_n = m a_n = m \frac{V^2}{r} = m \cdot r \cdot \omega^2$$

14-68 GIVEN: $m = 100\,Kg$, $F_T = 20 + 1.2T$ (N) ← sec

FIND: $V(40s) = ?$ $F_N(40) = ?$



SOLUTION: $\Sigma F_T = m a_T$

$$20 + 1.2T = (100\,kg)\, a_T \Rightarrow a_T = (.2 + .012T)\ \frac{m}{s^2}$$

$$\frac{dV}{dT} = a_T \Rightarrow \int_0^V dV = \int_0^T a_T\, dT = \int_0^T (.2 + .012T)\, dT$$

$$V(T) = .2T + .006T^2 \Rightarrow V(40) = .2(40) + .006(40)^2 = \underline{\underline{17.6\ \frac{m}{s}}}$$

$$\frac{dS}{dT} = V(T) \Rightarrow \int_0^S dS = \int V(T)\, dT = \int_0^{40\,sec} (.2T + .006T^2)\, dT$$

$$S = .1T^2 + .002T^3 \Rightarrow S(40) = .1(40)^2 + .002(40)^3 = \underline{\underline{288\ m}}$$

b) $F_N(40s) = ?$

SOLUTION:

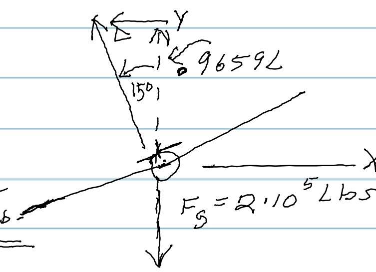
$$F_N = m\frac{V^2}{r} \Rightarrow F(40) = m\frac{(V(40))^2}{r} = \frac{(100\,kg)(17.6\,\frac{m}{s})^2}{50m} = \underline{\underline{620\ N}}$$

14-80 GIVEN: $W = 200{,}000\,Lbs$, $V = 600\ \frac{ft}{s}$

a) FIND: $L = ?$

SOLUTION: $\Sigma F_y = m a_y = 0 \Rightarrow +0.9659L - 2\cdot 10^5\,Lbs = 0$

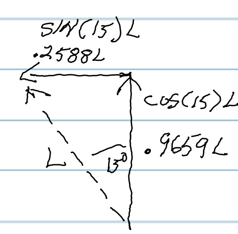
$$L = \frac{2\cdot 10^5}{.9659} = \underline{\underline{2.071\cdot 10^5\,Lb}}$$



b) FIND: $r = ?$

SOLUTION: $\Sigma F_x = m\frac{V^2}{r} \Rightarrow .2588L = \frac{mV^2}{r}$

$$r = \frac{mV^2}{.2588L} = \frac{\left(\frac{2\cdot 10^5\,Lb}{32.2\,\frac{ft}{s^2}}\right)(600\,\frac{ft}{s})^2}{.2588(2.071\cdot 10^5\,Lb)} = \frac{2.236\cdot 10^9}{5.359\cdot 10^4} = \underline{\underline{41{,}700.\ ft}}$$



SR-71 BLACKHAWK

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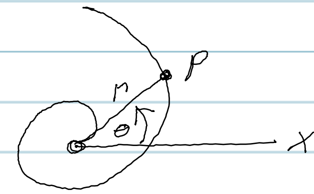
SECTION 14-4 NOTES - APPLICATIONS POLAR + CYLINDRICAL COORDINATES

WHEN $r(t, \theta)$ = CHANGE



$$\Sigma F_r = m a_r = m\left(\frac{d^2 r}{dt^2} - r\omega^2\right) = m\left(\ddot{r} - r\dot{\theta}^2\right)$$

$v = r\omega$

$$\Sigma F_\theta = m a_\theta = m\left(r\alpha + 2\frac{dr}{dt}\omega\right) = m\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)$$

$$\Sigma F_z = m a_z = m\frac{dv_z}{dt} = m\frac{d^2 z}{dt^2} = m\ddot{s}_z$$

14-97 GIVEN: $W = 50$ Lbs, $r(\theta) = 0.1\,\theta$ (ft) ← rad, $\theta = 2t$ (rad) ← sec

FIND: $F_r(4) = ?$, $F_\theta(4) = ?$

$r = .1(2t) = .2t$ $\qquad \dot{\theta} = 2.\ \frac{rad}{s}$

$\dot{r} = .2\ \frac{ft}{s}$ $\qquad \ddot{\theta} = 0$

$\ddot{r} = 0$

SOLUTION:

$$F_r = m\left(\ddot{r} - r\dot{\theta}^2\right)$$

$$F_r(4) = 1.553\,sl\left(0 - (.8\,ft)\left(2\ \frac{rad}{s}\right)^2\right)$$

$$F_r = 1.553 \cdot [-3.2] = -4.97\ \text{Lbs}$$

$r(4s) = .2(4) = 0.8$ ft

$\dot{r}(4) = 0.2$ ft/s

$\ddot{r} = 0$

$\theta(4) = 2(4) = 8$ rad

$\dot{\theta}(4) = 2.\ \frac{rad}{s}$

$\ddot{\theta}(4) = 0$

b) $F_\theta = ? = m\left[r\ddot{\theta} + 2\dot{r}\dot{\theta}\right]$

$$F_\theta(4) = 1.553\,sl\left[(0.8\,ft)\,0^2 + 2\left(.2\ \frac{ft}{s}\right)\left(2\ \frac{rad}{s}\right)\right]$$

$$m = \frac{W}{g} = \frac{F_g}{g} = \frac{50\ \text{Lbs}}{32.2\ \frac{ft}{s^2}} = 1.553\ \text{SL}$$

$$F_\theta(4) = 1.553\,sl\,[.8] = 1.24\ \text{Lbs}$$