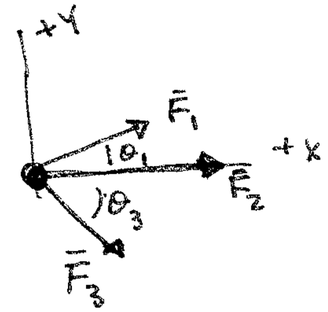
5.5



$m = 120\,kg$

$F_1 = 32 \quad \theta_1 = 30^\circ$

$F_2 = 55$

$F_3 = 41$ Newtons $\quad \theta_3 = 60^\circ$

$$m\vec{a} = \sum \vec{F}_s$$

$$\bar{F}_1 = 32\cos 30^\circ\,\hat{i} + 32\sin 30^\circ\,\hat{j}$$

$$\bar{F}_2 = 55\,\hat{i} + 0\,\hat{j}$$

$$\vec{F}_3 = 41\cos 60^\circ\,\hat{i} - 41\sin 60^\circ\,\hat{j}$$

$$\vec{F}_1 = 27.71\,\hat{i} + 16.0\,\hat{j}$$

$$\bar{F}_2 = 55\,\hat{i} + 0\,\hat{j}$$

$$\bar{F}_3 = 20.50\,\hat{i} - 35.51\,\hat{j}$$

$$\bar{F}_{TOT} = 103.2\,\hat{i} - 19.51\,\hat{j}$$

Then

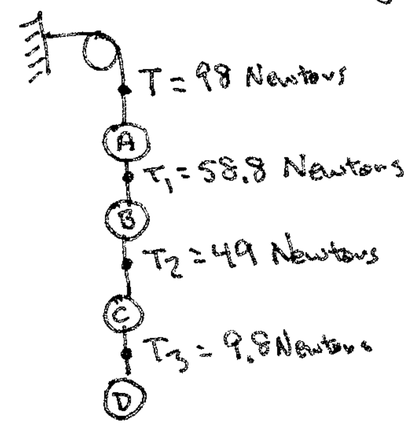
$$\vec{a} = \frac{1}{m}\bar{F}_{TOT} = 0.86\,\hat{i} - 0.163\,\hat{j}$$

$$|\bar{a}| = \sqrt{0.86^2 + (-0.163)^2} = 0.875\ m/s^2$$

$$\tan\theta = \frac{-0.163}{0.86} \rightarrow \theta = -10.7^\circ$$

5.13

4 objects $\Rightarrow$ 4 fbd



call up the y-axis

do $ma_y = \sum F_y$'s for each fbd

Note that each acceleration is = zero

fbd-D

fbd-C

fbd-B

fbd-A

$m_A \cancelto{0}{a} = T - T_1 - m_A g$

So that

$m_A g = T - T_1$

$m_A(9.8) = 98 - 58.8$

$m_A = 4\ kg$

$m_C \cancelto{0}{a} = T_2 - T_3 - m_C g$

$m_C g = T_2 - T_3$

$m_C(9.8) = 49 - 9.8$

$m_C = 4\ kg$

$m_D \cancelto{0}{a} = T_3 - m_D g$

$m_D g = T_3$

$m_D(9.8) = 9.8$

$m_D = 1\ kg$

$m_B \cancelto{0}{a} = T_1 - T_2 - m_B g$

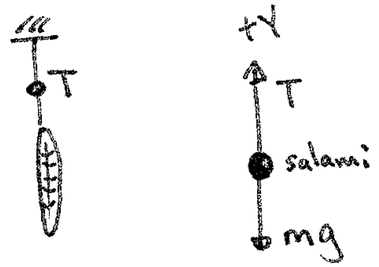
$m_B g = T_1 - T_2$

$m_B(9.8) = 58.8 - 49$

$m_B = 1\ kg$

5.15 Ignore the scale, it is just a tension indicator device.
Pulleys just redirect ropes & Tensions

a)

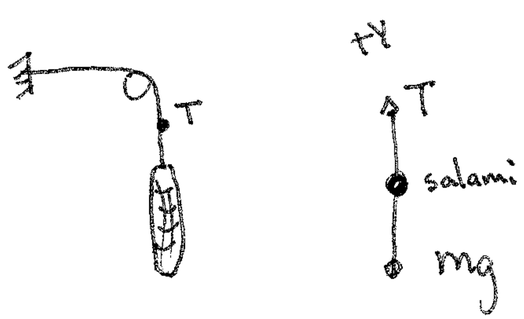


$ma_y = \Sigma F_y$'s

$m\cancelto{0}{a_y} = T - mg$

$T = mg = 11(9.8)$
$= 107.8$ Newtons

b)

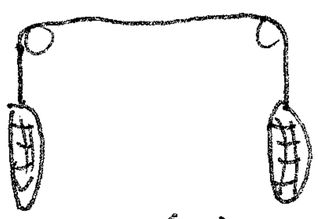


$ma_y = \Sigma F_y$'s

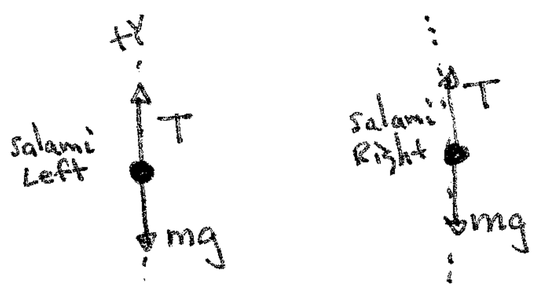
$m\cancelto{0}{a_y} = T - mg$

$T = mg = 11(9.8)$
$= 107.8$ Newtons

c)



two masses
∴ two fbd's



$m\cancelto{0}{a_y} = T - mg$

$T = mg = 11(9.8)$
$= 107.8$ Newtons

don't need to analyze this fbd right for salami

5.26

Weight = 85 Newtons
$mg = 85$
$m(9.8) = 85$
$m = 8.67$ kg

Assume fish was originally drifting to the left and was stopped in 11 cm if originally moving at 2.8 m/s. The (de) acceleration vector will point toward Right.

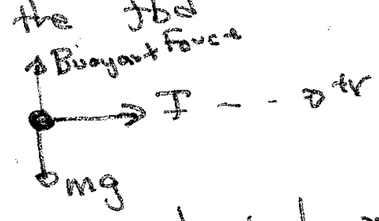
The easiest method to get the magnitude of acceleration is to use the 3rd kinematic formula

$v_f^2 - v_i^2 = 2a\,\Delta x$

$0^2 - 2.8^2 = 2a(-0.11)$

$a = 35.6$ m/s^2

Then for the fbd



Only worry about horizontal directions

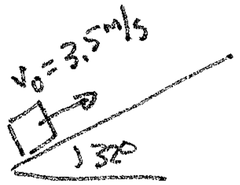
$ma_x = \Sigma F_x$'s

$8.67(35.6) = T$

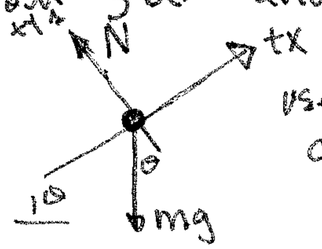
$T = 309$ Newtons

≈ 70 lb fishing line

5.31



Can get the (de)acceleration from fbd analysis



use a tilted coordinate system

$ma_x = \sum F_x$'s $\qquad ma_y = \sum F_y$'s

$ma_x = -mg\sin\theta \qquad m\cancelto{0}{a_y} = N - mg\cos\theta$

we just need the a_x

$ma_x = -mg\sin\theta$

$a_x = -g\sin\theta = -9.8\sin 32^\circ$

$= -5.19\ m/s^2$

a) Use the short cut equation

$v_f^2 - v_i^2 = 2a_x\Delta x$

$0^2 - (3.5)^2 = 2(-5.19)\Delta x$

$\Delta x = 1.18\ m$

b) How long at stop

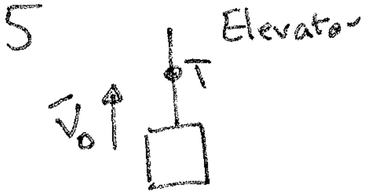
$v_x(t) = v_{0x} + a_x t$

$0 = 3.5 + (-5.19)t$

$t = 0.674$ sec

c) Since there's no friction, it will be moving at 3.5 m/s

5.45



weight = 27.8 kN

mg = 27.8 kN

m(9.8) = 27800

m = 2837 kg

$ma_y = \sum F_y$'s

$ma_y = T - mg$

a) accel vector points up $\vec{a}\uparrow$

$a_y = +1.22$ m/s

$ma_y = T - mg$

$2837(+1.22) = T - 2837(9.8)$

$T = 31.19$ kiloNewtons

b) accel vector points down $\vec{a}\downarrow$

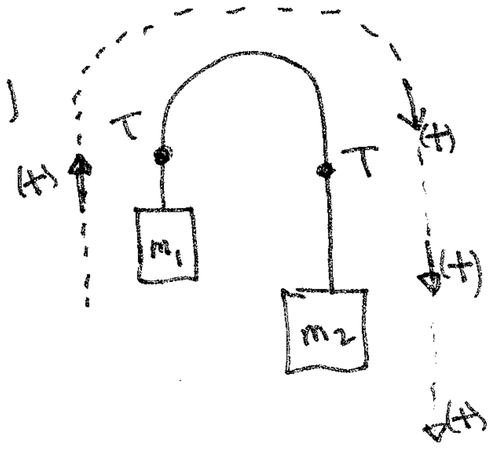
$a_y = -1.22$ m/s

$ma_y = T - mg$

$2837(-1.22) = T - 2837(9.8)$

$T = 24.34$ kiloNewtons

5.51



IDEAL pulleys will adjust and turn until the tension is the same on both sides.

We also need a bent coordinate system because #1 moving up implies #2 moving down.

$m_1 = 1.30$ kg

$m_2 = 2.80$ kg

block 1

$m_1 a = T - m_1 g$

block 2

$m_2 a = m_2 g - T$

Add equations

$$m_1 a = T - m_1 g$$
$$m_2 a = m_2 g - T$$

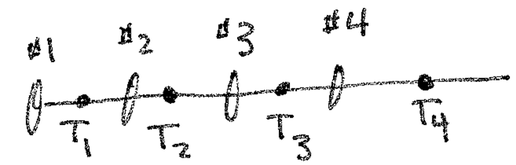
$$(m_1 + m_2)\, a = m_2 g - m_1 g$$

$$a = \frac{(m_2 - m_1)\, g}{m_1 + m_2} = \frac{2.8 - 1.3}{1.3 + 2.8}(9.8) = 3.59 \text{ m/s}^2$$

Then

$$m_1 a = T - m_1 g$$
$$1.3\,(3.59) = T - 1.3\,(9.8)$$
$$T = 17.4 \text{ Newtons}$$

5.54

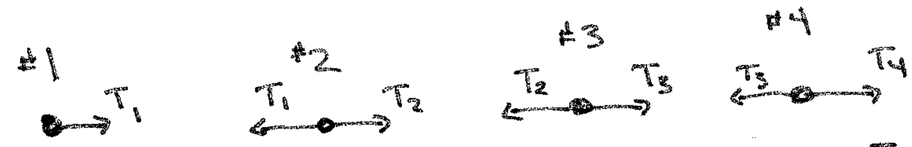


4 objects

All accel the same

$m_1 = 12$ $\quad m_2 = ?$ $\quad m_3 = 15$ $\quad m_4 = 20$

$T_2 = 111$ $\quad T_4 = 222$



$m_1 a = T_1$ $\quad m_2 a = T_2 - T_1$ $\quad m_3 a = T_3 - T_2$ $\quad m_4 a = T_4 - T_3$

$12a = T_1$ $\quad m_2 a = 111 - T_1$ $\quad 15a = T_3 - 111$ $\quad 20a = 222 - T_3$

solve together

ADD: $35a = 222 - 111$

$a = 3.17 \text{ m/s}^2$

$12\,(3.17) = T_1$

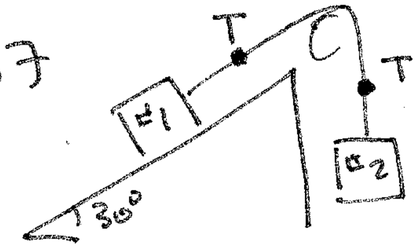
$T_1 = 38.0$ Newtons

$m_2 a = 111 - T_1$

$m_2\,(3.17) = 111 - 38$

$m_2 = 23.0$ kg

5.57



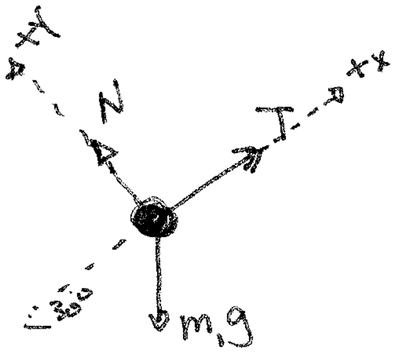
2 objects

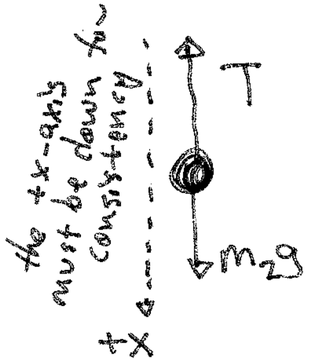
$m_1 = 3.7$ kg

$m_2 = 2.3$ kg

$\theta = 30°$

The accelerations are the same.
Use a bent coordinate system.





$m_1 a_x = \sum F_{x's}$ $\quad$ $m_1 a_y = \sum F_{y's}$ $\quad$ $m_2 a_x = \sum F_{x's}$

$m_1 a_x = T - mg\sin\theta$ $\quad$ $m_1 \cancelto{0}{a_y} = N - mg\cos\theta$ $\quad$ $m_2 a_x = m_2 g - T$

$N = mg\cos\theta$

ADD

$(m_1 + m_2) a_x = m_2 g - m_1 g \sin\theta$

$$a_x = \frac{m_2 g - m_1 g \sin\theta}{m_1 + m_2} = \frac{2.3(9.8) - 3.7(9.8)\sin 30°}{(3.7+2.3)} = \frac{40.67}{6}$$

$a_x = 6.68$ m/s

therefore block #2 accelerates down.

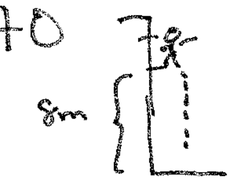
To get Tension plug in

$m_2 a_x = m_2 g - T$

$2.3(6.68) = 2.3(9.8) - T$

$T = 7.18$ Newtons

5.70



mass = 80 kg

First need speed just as he hits ground

$y(t) = y_0 + v_{0y} t + \frac{1}{2} a_y t^2$

$y_0 = 8$

$v_{0y} = 0$

$a_y = -9.8$

$y = 8 + \frac{1}{2}(-9.8)t^2$

on ground when $y = 0$

$y = 0 = 8 + (-4.9)t^2$

$t = 1.28$ sec

$v_y(t) = v_{0y} + a_y t$

$v_y = 0 + (-9.8)t$

$v_y = -9.8(1.28)$

$= -12.5$ m/s

Second, estimate his (de)acceleration as he comes to rest.

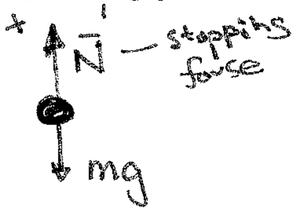
It's easiest to use: $\Delta y = 2$cm

$v_f^2 - v_i^2 = 2 a_y \Delta y$

$0^2 - (12.5)^2 = 2 a_y (0.02\text{m})$

$a_y = 3.91 \times 10^3$ m/s^2

Third, estimate forces while stopping



$m a_y = \sum F_y$

$m a_y = N - mg$

$80(3.91 \times 10^3) = N - 80(9.8)$

$N = 3.13 \times 10^5$ Newtons

$\sim 7 \times 10^4$ lbs