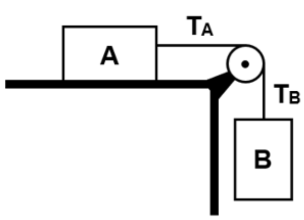
Forces Practice Problems

1. A 3 kg box is pulled horizontally across a frictionless floor by a force of 80 N. What is the box's acceleration? What is the box's velocity after 10 seconds if it starts from rest?

2. Jenny pulls her suitcase with a force of 150 N at an angle of 60°. Her suitcase weighs 400 N. What is its acceleration? What is the Normal Force?

3. A cardboard box slides down a ramp angled at 24.5°. If the box initially isn't moving and the ramp is 3.2 meters high, what is the box's speed at the bottom?

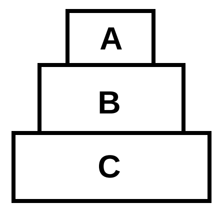
4. In the figure below, box A is 4 kg and box B is 2 kg. What is the acceleration of box A? What is the tension in each rope (T_A and T_B)?



5. Mr. Smilges brings a bathroom scale onto an elevator. Before the elevator starts moving, his weight is 76.4 N. When the elevator is accelerating upwards at 2.3 m/s^2, what will the reading on the scale be (in Newtons)?

6. A stack of books is pulled across a wood floor with friction. The total mass of the books is 20 kg. The coefficient of kinetic friction between the books and the floor is 0.3. If a 300 N force is applied to the books horizontally, how far will they move after 5 seconds? (the books start from rest)

7. Three blocks are stacked on top of each other (as shown in the figure below). What is the force of Block B on Block A and Block B on Block C?

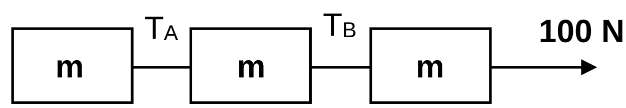


$M_A = 3$ kg

$M_B = 6$ kg

$M_C = 9$ kg

8. Three masses (25 kg each) are pulled with a force of 100 N. What is the tension between each mass (T_A and T_B)?

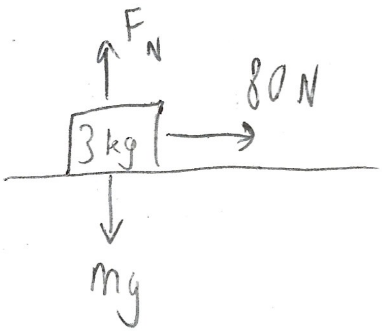


9. A box remains stationary on a shallow ramp due to friction. If the angle of the ramp is 6° and the box weighs 87 N, what is the magnitude of the Static Friction Force?

10. A boy pushes a rocking horse with *just enough* force to get it moving. If the boy pushes with 80 N of force and the mass of the rocking horse is 15 kg, what is the coefficient of static friction between the rocking horse and the floor?

11. A 170-gram hockey puck slowly slides to a stop on an ice rink. If the coefficient of friction between the puck and the ice is 0.02 and the puck was initially moving at 1 m/s, how far will the puck travel before it stops?

1.



$F_{net,x} = 80 = ma_x$

$80 = 3(a)$

$a = 26.7\ m/s^2$

Use kinematics to find velocity

$V_i = 0$

$V_f = ?$

$a = 26.7$

$t = 10$

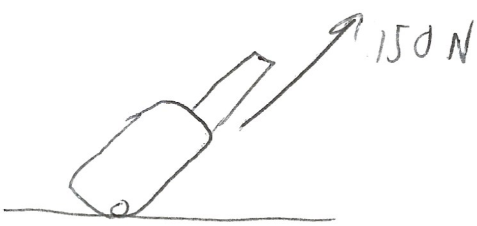
Δx

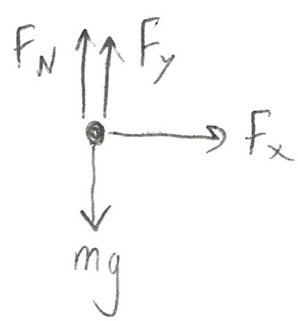
$V_f = V_i + at$

$V_f = 0 + 26.7(10)$

$V_f = 267\ m/s$

2.



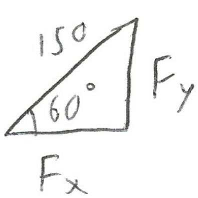


weight = 400 N

$mg = 400$

$m = \frac{400}{g} = \frac{400}{9.8}$

$m = 40.8\ kg$



$F_y = 150 \sin 60°$

$F_y = 130\ N$

$F_x = 150 \cos 60°$

$F_x = 75\ N$

$F_{net,x} = F_x = ma_x$

$75 = 40.8\ a$

$a = 1.84\ m/s^2$

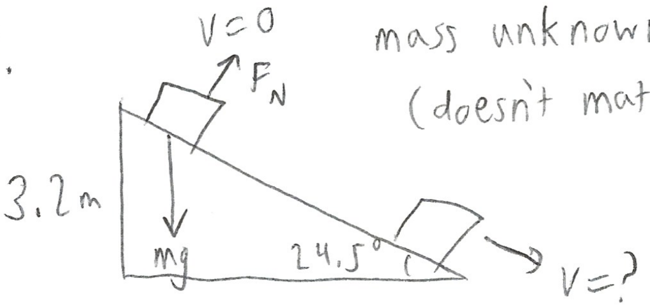
$F_{net,y} = F_N + F_y - mg = m\cancel{a_y}^{\,0}$

(not moving in y direction)

$F_N + 130 - 400 = 0$

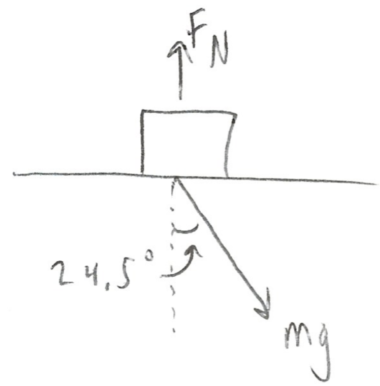
$F_N = 270\ N$ Normal force

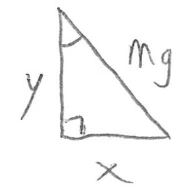
3.



mass unknown (doesn't matter)

Tilt diagram





$x = mg\sin 24.5°$

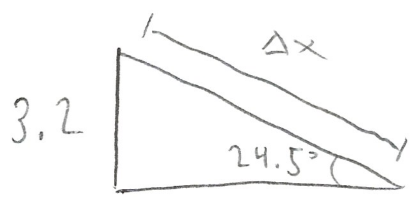
$y = mg\cos 24.5°$

$F_{net,x} = \cancel{m}g\sin 24.5° = \cancel{m}a_x$

mass cancels

$a = 9.8(\sin 24.5°)$

$a = 4.06\ m/s^2$



$\sin 24.5° = \frac{3.2}{\Delta x}$

$\Delta x = \frac{3.2}{\sin 24.5°}$

$\Delta x = 7.72m$

$V_i = 0$

$V_f = ?$

$a = 4.06$

t

$\Delta x = 7.72$

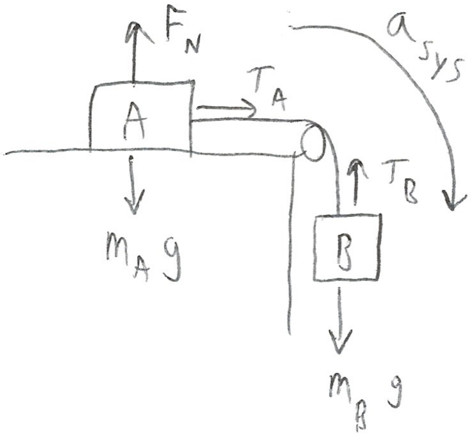
$V_f^2 = V_i^2 + 2a\Delta x$

$V_f^2 = 0^2 + 2(4.06)(7.72)$

$\sqrt{V_f^2} = \sqrt{62.7}$

$V_f = 7.92\ m/s$

4.



Look at system (clockwise is positive, counterclockwise is negative)

$$F_{net,\,sys} = m_B g - T_B + T_A = m_{tot} a_{sys}$$

$$2(9.8) - \cancel{T_B} + \cancel{T_A} = (4+2)a$$

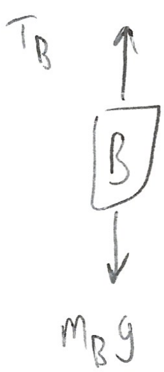
Equal because of Newton's 3rd Law

$$19.6 = 6a$$

$$a = 3.27\ \text{m/s}^2$$

acceleration of both boxes is $3.27\ \text{m/s}^2$

To find acceleration, we had to look at both boxes together. To find T_A and T_B, we need to look at A or B individually (doesn't matter which one).



$a = -3.27$
(negative because box B is moving down)

$$F_{net,B,y} = T_B - m_B g = m_B a_y$$

$$T_B - 2(9.8) = 2(-3.27)$$

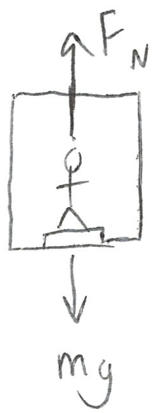
$$T_B - 19.6 = -6.54$$

$$T_B = 13.1\ N$$

$$T_A = 13.1\ N$$

$T_A = T_B$
(Newton's 3rd Law)

5.



weight = 76.4 N ⟹ $mg = 76.4$

$\uparrow a = 2.3\ m/s^2$

$m = \frac{76.4}{9.8}$

$m = 7.80\ kg$

Reading on scale = F_N

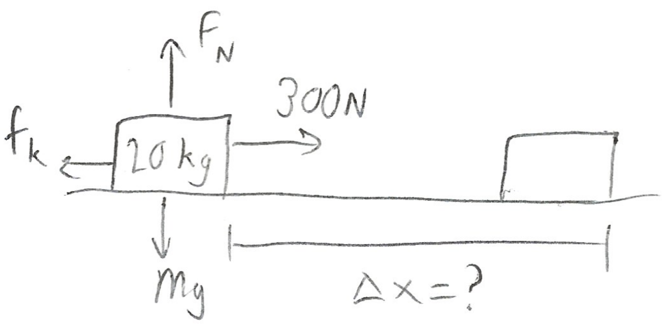
$F_{net,y} = F_N - mg = ma_y$

$F_N - 7.80(9.8) = 7.80(2.3)$

$F_N - 76.4 = 17.9$

$F_N = 94.3\ N$

6.



$f_k = \mu_k F_N$ $\quad f_k = .3(196) = 58.8\ N$

$F_{net,y} = F_N - mg = m\cancel{a_y}^{\,0}$ (not moving in y direction)

$F_N = mg$

$F_N = 20(9.8)$

$F_N = 196$

$F_{net,x} = 300 - f_k = ma_x$

$300 - 58.8 = 20a$

$241.2 = 20a$

$a = 12.1\ m/s^2$

$v_i = 0$
v_f
$a = 12.1$
$t = 5$
$\Delta x = ?$

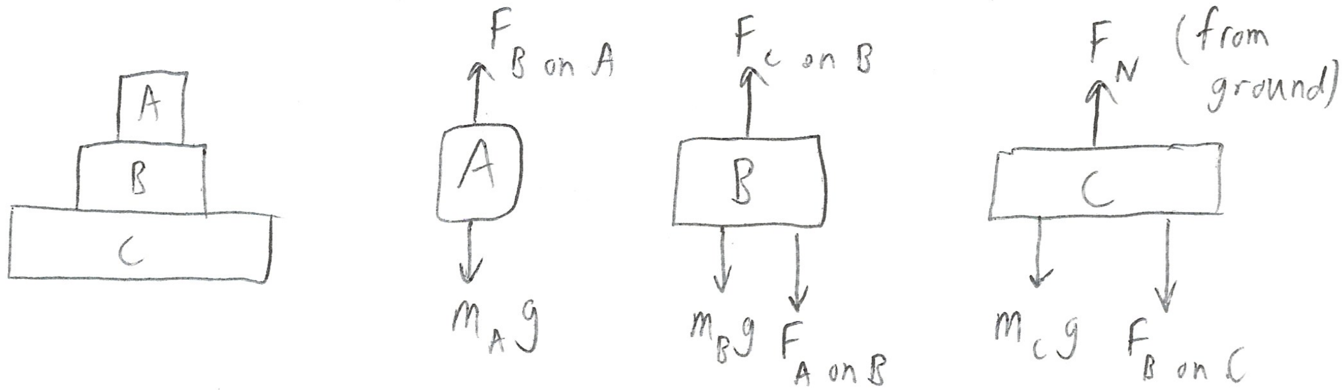
$\Delta x = v_i t + \frac{1}{2} a t^2$

$\Delta x = 0(5) + \frac{1}{2}(12.1)(5)^2$

$= 0 + 151.3$

$\Delta x = 151.3\ m$

7.



$$F_{net,y,A} = F_{B\ on\ A} - m_A g = m_A a^{\nearrow 0} \text{ (not moving)}$$

$$F_{B\ on\ A} = m_A g$$

$$= 3(9.8)$$

$$F_{B\ on\ A} = 29.4\ N$$

Force of Block B on Block A is 29.4 N

$$F_{net,y,B} = F_{C\ on\ B} - m_B g - F_{A\ on\ B} = m_B a^{\nearrow 0} \text{ (not moving)}$$

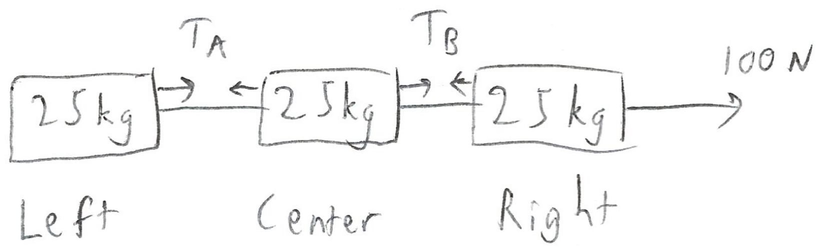
$$F_{C\ on\ B} - 6(9.8) - 29.4 = 0$$

$$F_{C\ on\ B} = 6(9.8) + 29.4$$

$$= 88.2\ N$$

Force of Block B on Block C is 88.2 N

8.



Ignore forces in y direction (we don't need them)

$$F_{net,\ system} = \cancel{T_A} - \cancel{T_A} + \cancel{T_B} - \cancel{T_B} + 100 = m_{tot}\, a$$

↑ look at all boxes (system) first

$$100 = 25 \cdot 3\, a$$

$$\frac{100}{75} = a$$

$$a = 1.33\ m/s^2$$

$$F_{net,\ left} = T_A = m\, a$$

$$T_A = 25(1.33)$$

$$\boxed{T_A = 33.3\ N}$$

$$F_{net,\ right} = 100 - T_B = m\, a$$

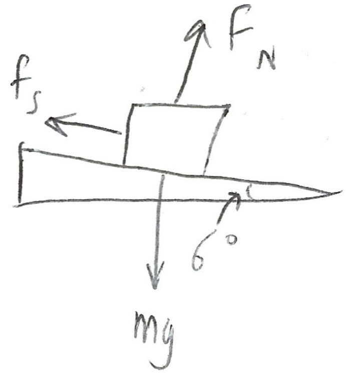
$$100 - T_B = 25(1.33)$$

$$T_B = 100 - 25(1.33)$$

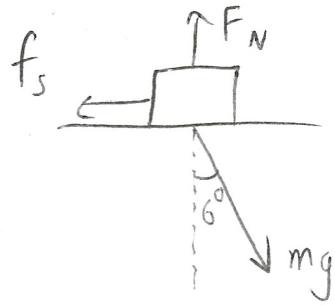
$$\boxed{T_B = 66.7\ N}$$

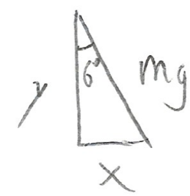
Note: you can also use $F_{net,center}$ to find T_A and T_B

9.



Tilt diagram



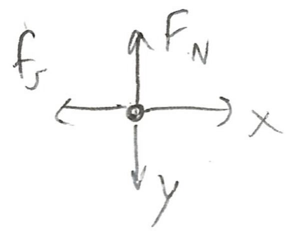


$x = mg\sin 6°$

$y = mg\cos 6°$

Note: Do NOT use

$f_{s,max} = \mu_s \cdot F_N$



$F_{net,x} = x - f_s = m\cancel{a_x}^{0}$ (not moving)

$x = f_s \qquad mg\sin 6° = f_s \qquad f_s = \boxed{9.10\ N}$

$mg = 87\ N$ (weight)

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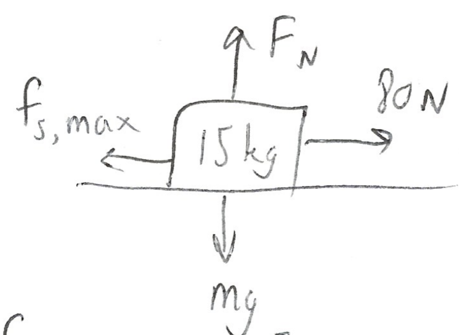
10. "just enough" $\Rightarrow$ use $f_{s,max} = \mu_s \cdot F_N$



$F_{net,y} = F_N - mg = m\cancel{a_y}^{0}$ (not moving)

$F_N = mg$

$F_N = 15(9.8) = 147\ N$

$F_{net,x} = 80 - f_{s,max} = m\cancel{a_x}^{0}$ (not moving)

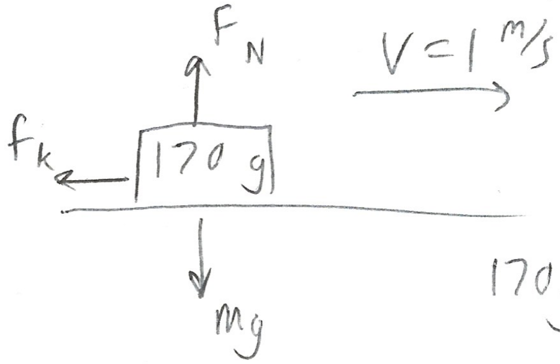
$80 = f_{s,max}$

$f_{s,max} = \mu_s \cdot F_N$

$80 = \mu_s (147)$

$\boxed{\mu_s = .544}$

11.



$170g = .17kg$

$F_{Net,y} = F_N - mg = m a_y^{\,0}$

(not moving in y direction)

$F_N = mg$

$F_N = .17(9.8) = 1.67\ N$

$f_k = \mu_k \cdot F_N$

$f_k = .02(1.67) = .0333\ N$

$F_{net,x} = -f_k = ma$

$-.0333 = .17a$

$a = -.196\ m/s^2$

$V_i = 1$

$V_f = 0$ (comes to rest)

$a = -.196$

t

$\Delta x = ?$

$V_f^2 = V_i^2 + 2a\Delta x$

$0^2 = 1^2 + 2(-.196)\Delta x$

$0 = 1 - .392\Delta x$

$.392\Delta x = 1$

$\Delta x = \boxed{2.55\ m}$