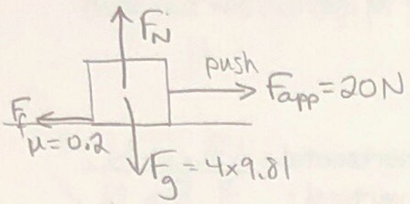
Vector Dynamics#1 Key

(name)

1. A box, mass 4.0 kg, is pushed along the rough horizontal floor by an applied force of 20.0 N. The coefficient of friction between the floor and the bottom of the box is 0.20.

a) Find the normal reaction force exerted by the floor on the box.



$F_N = F_g = 4kg \times 9.81 \frac{N}{kg}$

$= 39.24N$

$F_N =$ 39 N ✓

b) Calculate the frictional force acting on the box.

$F_f = \mu F_N$

$= (0.20)(39.24)$

$= 7.848$

$F_f =$ 7.8N ✓

c) Calculate the net horizontal force acting on the box.

$F_{net} = F_{app} - F_{ag}$

$= 20N - F_f$

$= 20N - 7.848 = 12.152$

$F_{net} =$ 12 N ✓

d) Calculate the horizontal acceleration of the box.

$F_{net} = ma$

$= (4kg)a$

$a = \frac{12.152}{4kg} = 3.038$

$a_x =$ 3.0 m/s^2 ✓

e) Calculate the time for the box to move 6.0 m from rest.

$d = 6m$

$V_i = 0 m/s$

$a =$

$t = ?$

$d = \cancel{v_i t}^{0} + \frac{1}{2}at^2$

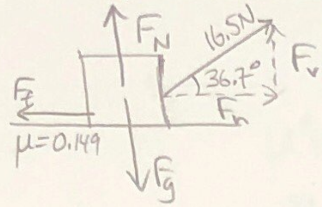
$6 = \frac{1}{2}(3.038)t^2$

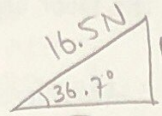
$t = 1.987$

$t =$ 2.0s ✓

2. A box, mass 8.44 kg is pulled along a rough horizontal floor by an applied force of 16.5 N acting upwards at 36.7 degrees above the horizontal. The coefficient of friction between the floor and the bottom of the box is 0.149.

a) Calculate the horizontal and vertical components of the applied force.





$F_v = 16.5 \sin 36.7 = 9.86081 \text{ N}$

$F_h = 16.5 \cos 36.7$
$= 13.22930 \text{ N}$

horizontal = 13.2 N ✓
vertical = 9.86 N ✓

b) Find the normal force exerted by the floor on the box.

$\Sigma F_{up} = \Sigma F_{down}$

$F_N + F_v = F_g$

$F_N = F_g - F_v = (8.44\text{kg})(9.81\frac{\text{N}}{\text{kg}}) - 9.8608\text{N} = 72.936 \text{ N}$ F_N = 72.9 N ✓

c) Calculate the frictional force acting on the box.

$F_f = \mu F_N$
$= (0.149)(72.936)$
$= 10.867 \text{ N}$

F_f = 10.9 N ✓

d) Calculate the net horizontal force acting on the box.

$F_{net} = F_{app} - F_{ag}$
$= F_h - F_f$
$= 13.2293 - 10.867 = 2.3618 \text{N}$ F_{Net} = 2.36 N

e) Calculate the horizontal acceleration of the box.

$ma = F_{net}$

$(8.44)a = 2.3618$ $a = 0.2798 \text{ m/s}^2$ a_x = 0.28 m/s²

Answers: 1 a) 39 N b) 7.8 N c) 12 N d) 3.0 $^m/_s{}^2$ e) 2.0 s 2. a) 13.2 N, 9.86 N b) 73 N c) 10.9 N d) 2.37 N e) 0.28 $^m/_s{}^2$

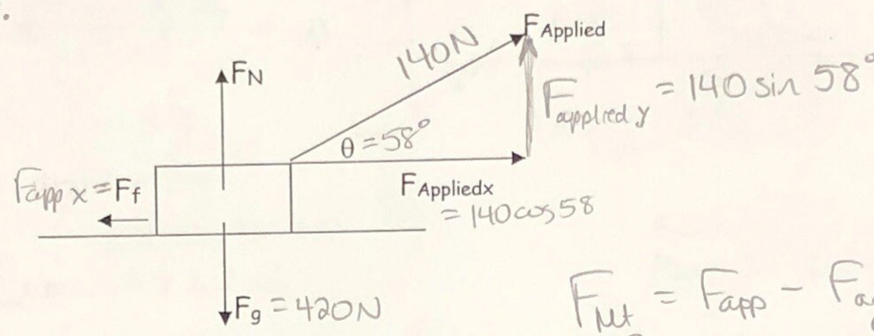
change to 72.9N ✓

2.36N ✓

Vector Dynamics#3 Key (name)

1. A box, weight 420 N, rests on a rough horizontal floor. A force of 140 N is applied to the box ~~horizontally~~. The box just begins to move horizontally when the angle θ is 58° above the horizontal. Determine the coefficient of friction between the floor and the bottom of the box. assume $a = 0$

$\mu = ?$



$F_{net} = F_{app} - F_{ag}$

$\cancel{ma}^{0} = F_{app\,x} - F_f$

$F_f = F_{app\,x}$

$\mu F_N = 140 \cos 58°$

$\mu = \dfrac{140 \cos 58°}{F_N}$

part of applied force is supporting the box so floor doesn't have to do it all.

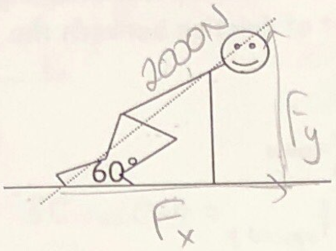
$= \dfrac{140 \cos 58°}{F_g - F_{app\,y}}$

$= \dfrac{140 \cos 58°}{420N - 140 \sin 58°}$

$= 0.24625$

$\mu =$ 0.25 ✓

2. A 75 kg track star, at the start of a sprint, pushes on the ground with a measured force of 2000 N at an angle of 60° as shown. What forward acceleration was produced? 2.0×10^3 N



$F_{net} = F_{app} - \cancel{F_{ag}}$ 0

nothing holding person back.

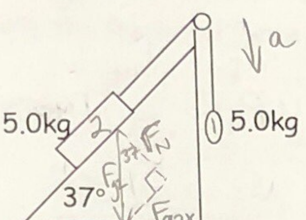
$ma = 2000\cos 60°$

$a = \dfrac{2000\cos 60°}{75\,kg}$

$= 13.\overline{3}\ m/s^2$

a = 13 m/s² ✓

3. What is the acceleration of the system if the coefficient of friction is 0.15?



← assume (if wrong must redo problem since friction is involved)

$F_{net} = F_{app} - F_{ag}$

$m_T a = F_{g1} - F_{g2x} - F_{f2}$

$m_T a = mg - m_2 g_2 \sin 37° - \mu mg\cos 37°$

$(10\,kg)a = (5)(9.81) - 5(9.81)\sin 37° - 0.15(5)(9.81)\cos 37°$

$a = 1.3655\ m/s^2$

a = 1.4 m/s² ✓

Answers: 1. 0.25 2. 13 $^m/_s{}^2$ 3. 1.4 $^m/_s{}^2$

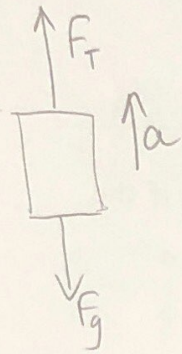
Vector Dynamics Worksheet #5

Key

(name)

1. An elevator, mass 4250 kg, is to be designed so that the maximum acceleration is 0.0500xg. What are the maximum and minimum forces the motor should exert on the supporting cable? $g = 9.81\ m/s^2$

up:



$F_{net} = F_T - F_g$

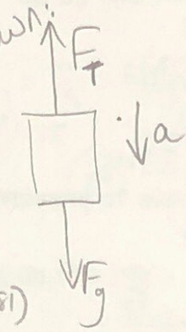
$F_T = F_{net} + F_g$

$= ma + mg$

$= 4250(0.05 \cdot 9.81 + 9.81)$

$F_{max} = 43777\ N$

down:



$F_{net} = F_g - F_T$

$F_T = F_g - F_{net}$

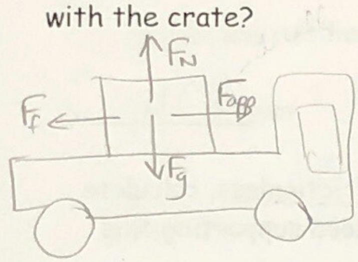
$= 4250(9.81 - 0.05 \times 9.81)$

$F_{min} = 39608$

F_{max} = 4.38×10^4 N [up] ✓

F_{min} = 3.96×10^4 N [down] ✓

2. A flatbed truck is carrying a 2800 kg crate of machinery. If the coefficient of friction between the crate and the truck bed is 0.55, what is the maximum rate the driver can decelerate when coming to a stop in order to avoid crushing the cab with the crate?



$F_{net} = \cancel{F_{app}}^{\,0} - F_{ag}$

$ma = -F_f$

$\cancel{m}a = -\mu \cancel{m}g$

$a = -(0.55)(9.81)$

$= -5.3955$

means slowing down

$F_{app} = 0$ when hit brakes since no more gas applied

a = $5.4\ m/s^2$ ✓ (decelerate)

3. If the coefficient of friction between a 25 kg crate and the floor is 0.45, how much force is required to move the crate at a steady speed across the floor?

$F_{net} = F_{app} - F_{ag}$

$\cancel{ma}^{\,0} = F_{app} - F_f$

$F_{app} = F_f$

$= \mu mg$

$= (0.45)(25\cancel{kg})(9.81 \tfrac{N}{\cancel{kg}})$

$= 110.36$

F = 110 N ✓

or 1.1×10^2 N

4. A force of 270 N is required to start a 40 kg box moving across a concrete floor. What is the coefficient of friction between the box and the floor?

$a = 0$

$\cancel{F_{net}}^{0} = F_{app} - F_{ag}$

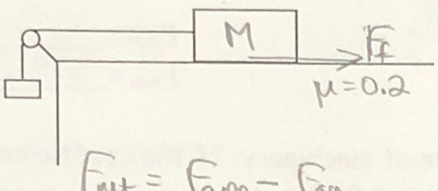
$F_f = F_{app}$

$\mu mg = 270N$

$\mu = \frac{270N}{(40kg)(9.81 N/kg)} = 0.68807$

μ = 0.69 ✓

5. What mass must the crate have to prevent any motion from occurring if the coefficient of friction is 0.20?



$F_{net} = F_{app} - F_{ag}$

$\cancel{m_T}^{0} a = F_g - F_f$

$0 = mg - \mu Mg$

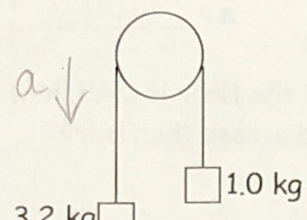
$\mu Mg = mg$

$M = \frac{mg}{\mu g}$

$= \frac{2 kg}{0.2}$

m = 10 kg ✓

6. Assuming that the pulley in the diagram is massless and frictionless, calculate the acceleration of the 3.2 kg mass and the tension in the cord supporting this mass.



accel:

$F_{net} = F_{app} - F_{ag}$

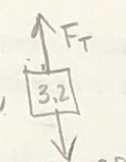
$m_T a = m_{3.2} g - m_1 g$

$a = \frac{(3.2)(9.81) - (1)(9.81)}{(3.2+1)}$

$= 5.139 m/s^2$

tension:

FBD



$F_{net} = F_{app} - F_{ag}$

$ma = mg - F_T$

$F_T = mg - ma$

$= 3.2(9.81 - 5.139)$

$= 14.9486$

a = 5.1 m/s² ✓

T = 15 N ✓

Answers: 1. Up, max: 43 800 N [up]; down, min: 39 600 N [up]
2. 5.4 m/s^2 3. 110 N 4. 0.69 5. 10. kg 6. 5.1 m/s^2, 15N