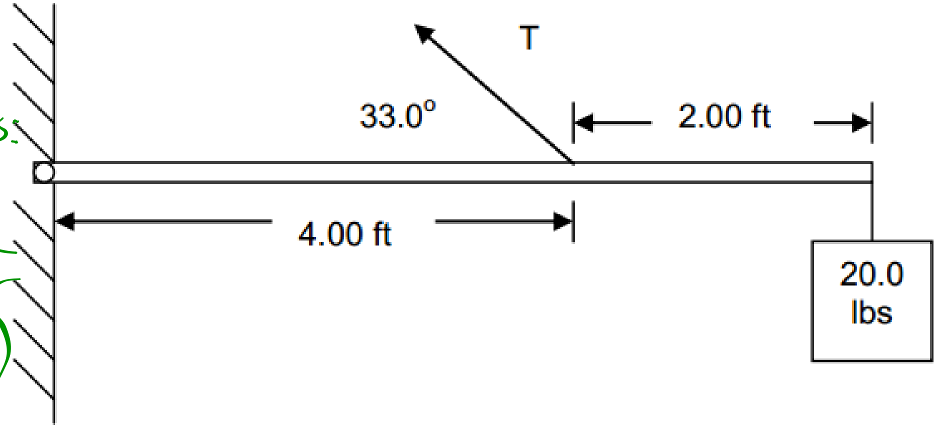
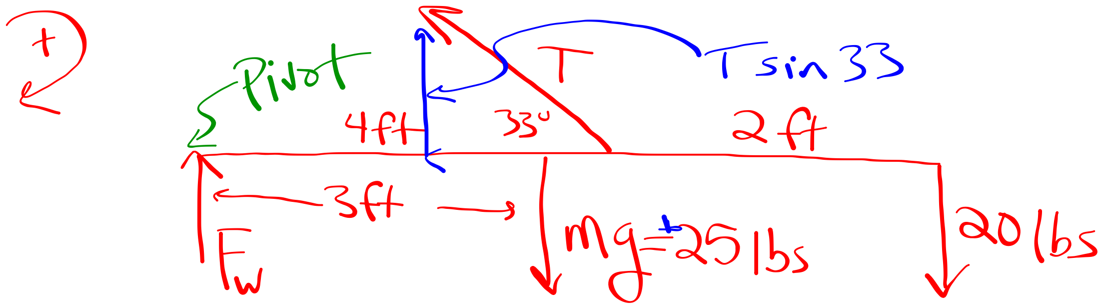
A 25.0-pound beam is supported by a string as shown. What is the tension? (Recall that the weight is taken at the center of the beam) [89.5 lb]

an object that has mass: assume the mass is in the physical center (Center of Mass)

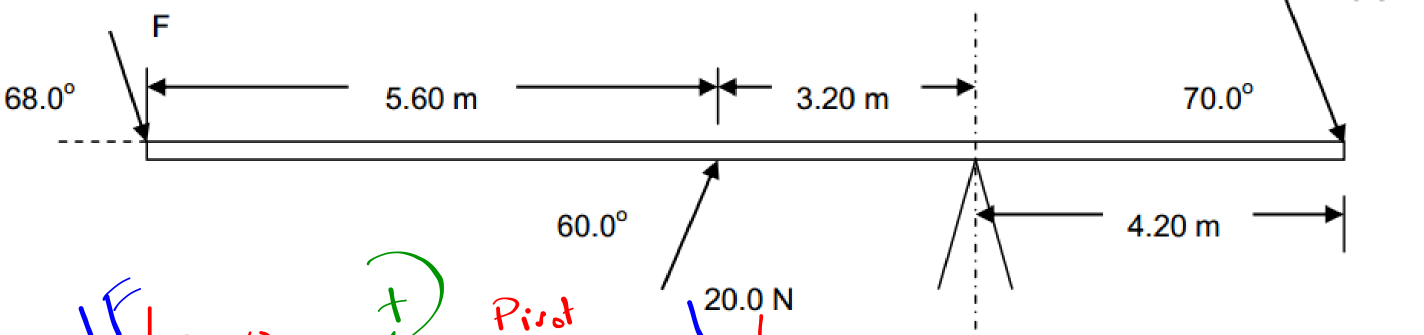


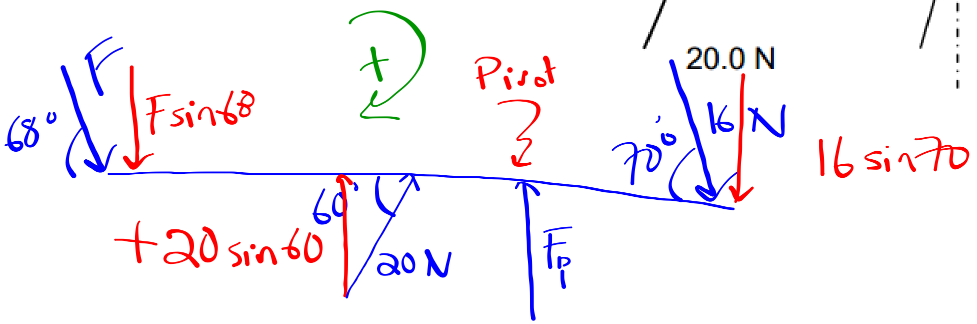


$$\sum \tau = \cancel{F_w(0)} + 25(3) + (T \sin 33)(4) + (20)(6)$$

$$T = \frac{-75 - 120}{4 \sin 33} = -89.5 \text{ lbs}$$

3. Find F for the following beam. [14.5 N]

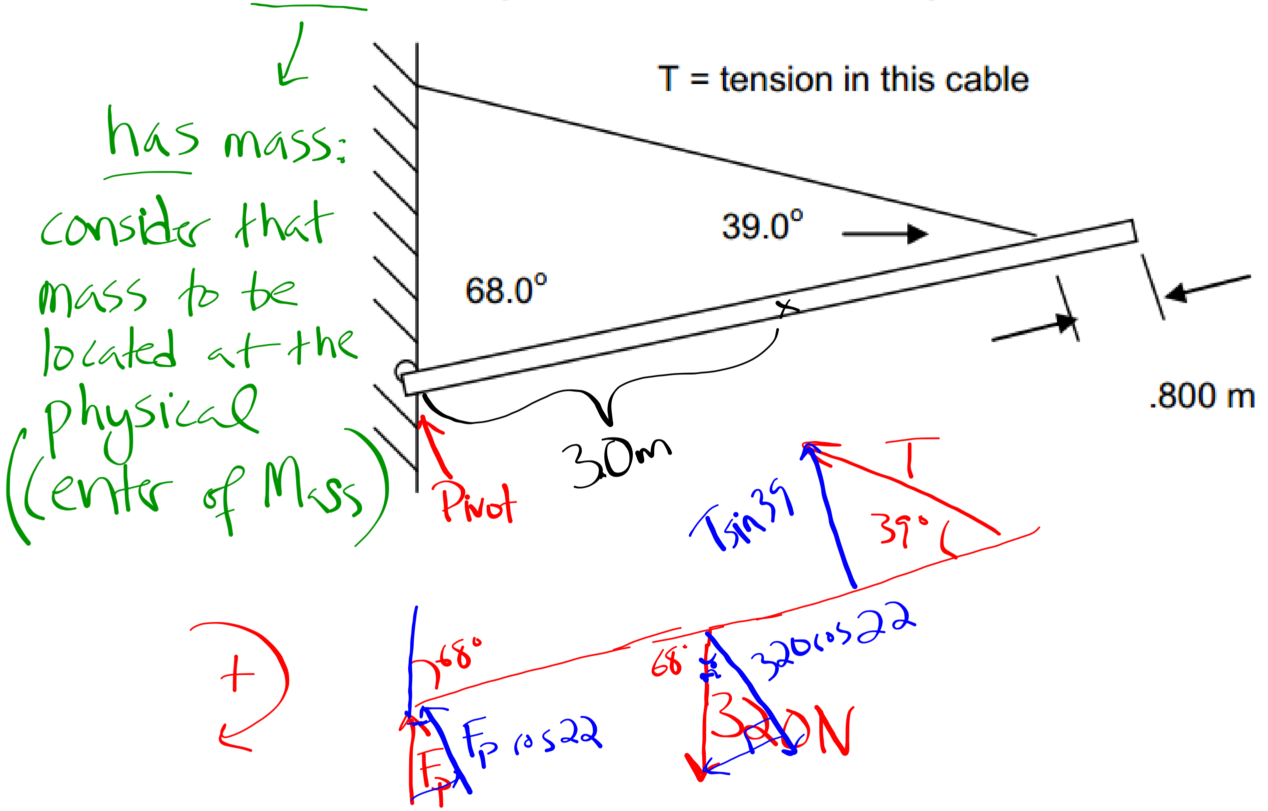


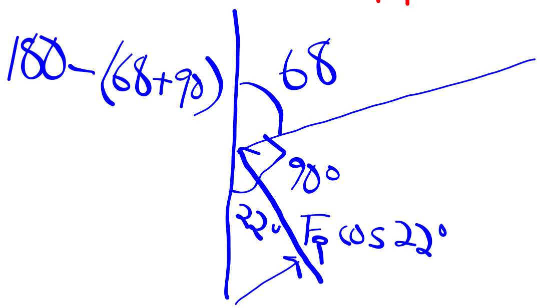


$$\Sigma \tau = (F \sin 68)(8.8) + (20)(\sin 60)(3.2) + (F_p)(0) + (16)(\sin 70)(4.2) = 0$$

$$F = \frac{-20(\sin 60)(3.2) + -16(\sin 70)(4.2)}{(\sin 68)(8.8)}$$

Find T if this beam has a length of 6.0 meters and a weight of 320 N. [T=272 N]

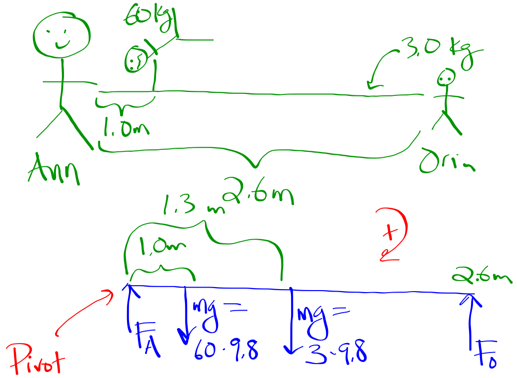




$$\Sigma \tau = F_p(\cos 22)(0) + 320(\cos 22)(3) + T(\sin 39)(5.2) = 0$$

$$T = \frac{(-320)(\cos 22)(3)}{(\sin 39)(5.2)}$$

Orin and Ann, two paramedics, rush a 60.0 kg man from the scene of an accident to a waiting ambulance, carrying him on a uniform 3.00 kg stretcher held by the ends. The stretcher is 2.60 m long and the man's center of mass is 1.00 m from Ann. How much force must Orin and Ann exert to keep the man horizontal? [Orin = 241 N; Ann = 376 N]



$$\sum \tau = \cancel{(F_A)(0)} + (60)(9.8)(1) + (3)(9.8)(1.3) + (F_O)(2.6)$$

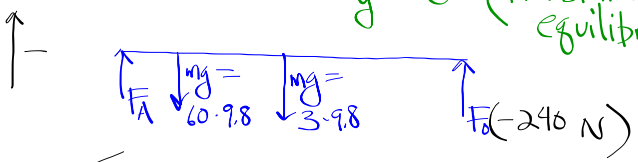
$$F_O = \frac{-60(9.8) + -3(9.8)(1.3)}{2.6}$$

$$F_O = -240\text{ N}$$

We can find Ann's force by:

(1) Switch the location of the pivot

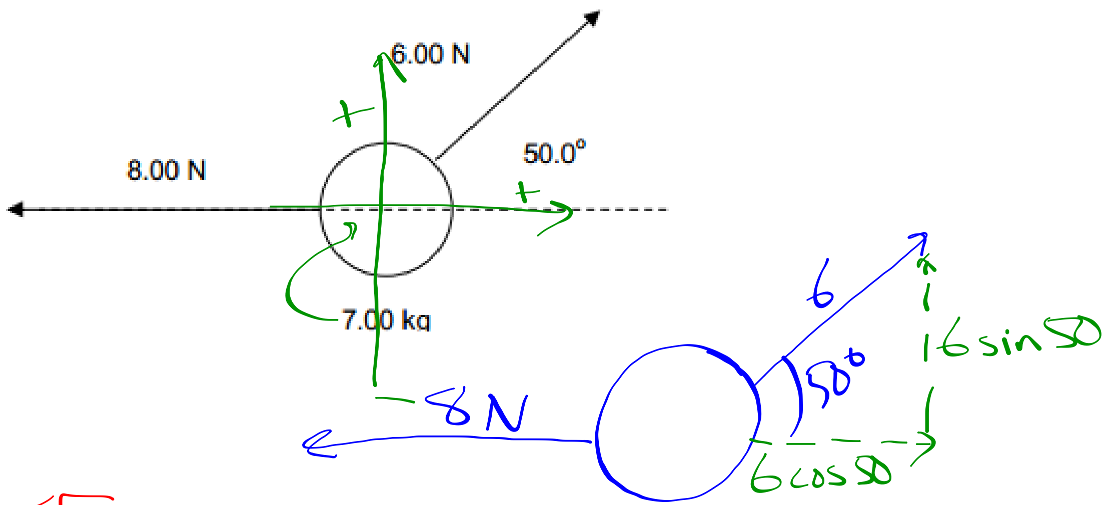
or (2) Use $\sum_y = 0$ (translational static equilibrium)



$$\sum F_y = 0 = F_A + (\underset{600}{60\cdot 9.8}) + (\underset{30}{3\cdot 9.8}) - 240$$

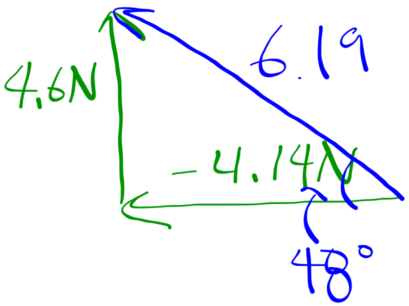
$$F_A \approx 390\text{ N}$$

For this particle in space (there is no gravity), find the accelerations and directions (an angle) of the mass shown.



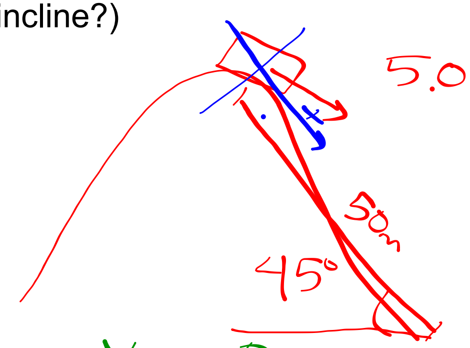
$$\Sigma F_x = -8 + 6\cos 50 = -4.14\ N$$

$$\Sigma F_y = 6\sin 50 = 4.6\ N$$



6.19N
48° above -X axis

(p. 67 #28) A roller coaster reaches the top of the steepest hill with a speed of 5.0 km/h. It then descends the hill which is at an average angle of 45° and is 50-m long. What will its speed be when it reaches the bottom? Neglect friction. (Hint: what did you just learn about the component of gravity's acceleration down an incline?)



$$5.0\,\frac{km}{hr}\cdot\frac{1000\,m}{km}\cdot\frac{1\,hr}{3600\,s}=1.39\,\frac{m}{s}$$

$x_0 = 0$

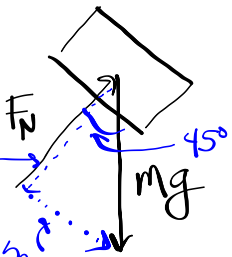
$x = 50\,m$

$v_0 = 1.39\,\frac{m}{s}$

$v = 26.4\,m/s$

$a = 6.93\,m/s^2$

$t =$



$$\Sigma F_x = \cancel{m}g\sin 45 = \cancel{m}a$$

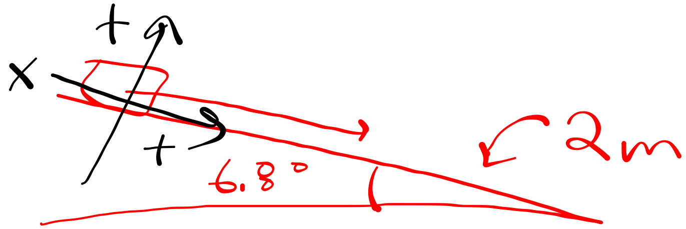
$$a = (9.8)(\sin 45) = 6.93\,m/s^2$$

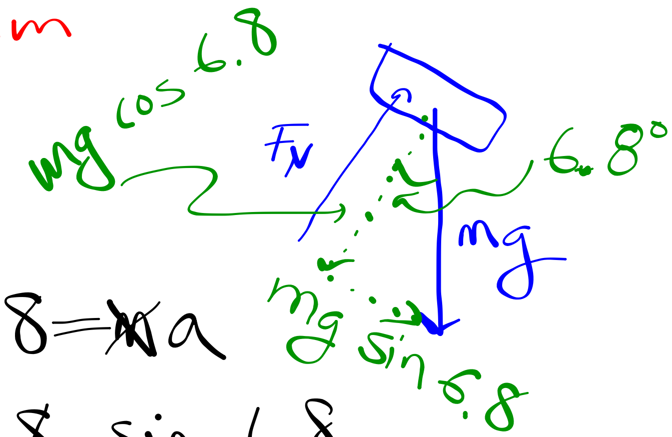
$$v^2 = v_0^2 + 2a(x - x_0)$$

$$= 1.39^2 + 2(6.93)(50)$$

$$\boxed{v = 26.4\,m/s}$$

(p. 67 #30) A wet bar of soap slides freely down a ramp 2.0 m long inclined at 6.8°. How long does it take to reach the bottom? Neglect friction. (Hint: look at the hint for the previous problem.)

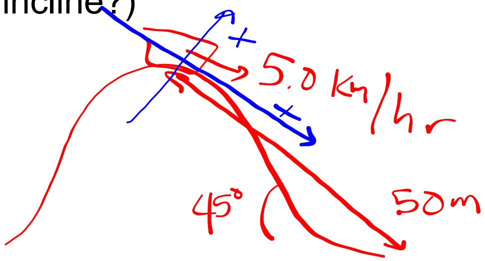




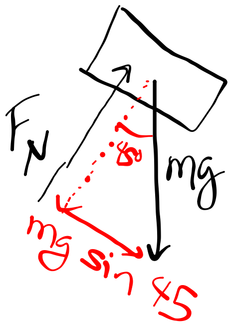
$x_0 = 0$
$x = 2$
$v_0 = 0$
$v =$
$a = 1.16\ m/s^2$
$t =$

$$\Sigma F_x = \cancel{m}g \sin 6.8 = \cancel{m}a$$
$$a = 9.8 \sin 6.8$$
$$= 1.16\ m/s^2$$
$$x = \cancel{x_0} + \cancel{v_0 t} + \frac{1}{2}at^2$$
$$2 = \frac{1}{2}(1.16)t^2$$
$$\boxed{t = 1.86\,s}$$

A roller coaster reaches the top of the steepest hill with a speed of 5.0 km/h. It then descends the hill which is at an average angle of 45° and is 50-m long. What will its speed be when it reaches the bottom? Neglect friction. (Hint: what did you just learn about the component of gravity's acceleration down an incline?)



$$5.0\,\frac{km}{hr}\cdot\frac{1000\,m}{km}\cdot\frac{1\,hr}{3600\,s}=1.39\,m/s$$



$x_0 = 0$

$x = 50m$

$v_0 = 1.39\,m/s$

$v =$

$a = \cancel{9.8\,m/s^2 (?)}$

$t =$

$$\Sigma F_x = \cancel{m}g\sin 45 = \cancel{m}a$$

$$a = 9.8\sin 45$$

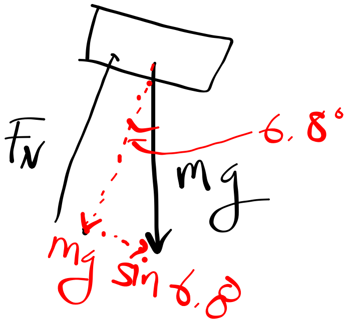
$$a = 6.9\,m/s^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$v^2 = 1.39^2 + 2(6.9)(50)$$

$$v = 26.3\,m/s$$

A wet bar of soap slides freely down a ramp 2.0 m long inclined at 6.8°. How long does it take to reach the bottom? Neglect friction. (Hint: look at the hint for the previous problem.)



$x_0 = 0$
$x = 2$
$v_0 = 0$
$v =$
$a = 1.16$
$t =$

$$\Sigma F_x = \cancel{m}g \sin 6.8 = \cancel{m}a$$

$$a = 9.8 \sin 6.8$$
$$= 1.16\ m/s^2$$

$$x = \cancel{x_0} + \cancel{v_0 t} + \frac{1}{2}at^2$$

$$2 = \frac{1}{2}(1.16)t^2$$

$$t = 1.86\ s$$

Dynamics (Newton's 2nd Law)

Forces from Springs

and

Inclined Planes

Dynamics: The case where forces do not all cancel.

If forces in any direction are not balanced, the object will accelerate in that direction.

$$\Sigma F \neq 0 \Rightarrow \Sigma F_x \neq 0$$

AND/OR

$$\Sigma F_y \neq 0$$

Newton's 2nd Law governs this situation:

$$\boxed{\Sigma \vec{F} = m\vec{a}} \Rightarrow \begin{array}{l} \Sigma \vec{F}_x = m\vec{a}_x \\ \Sigma \vec{F}_y = m\vec{a}_y \end{array}$$

Steps For Solving Dynamics Problems:

1. Draw a picture.
2. Establish a reference frame.
3. Identify variables / check units.
4. Draw a FBD.
5. Resolve all forces into X and Y components.
6. $\Sigma F_x = m a_x$
7. $\Sigma F_y = m a_y$
8. Solve for unknowns.

Note: A static situation is just a special case of the more general dynamic situation -- when the object(s) is not accelerating.

$$\sum F = ma$$

IF $a = 0$, THEN

$$\sum F = m(0) = 0$$

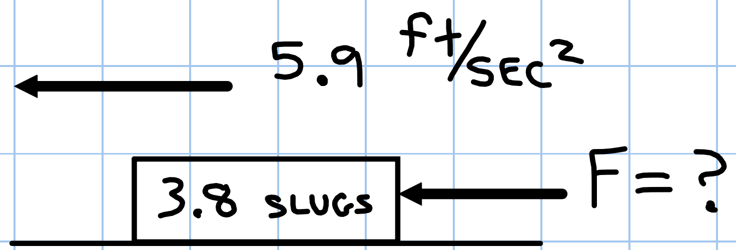
$$\sum F = 0 \quad \text{(STATICS)}$$

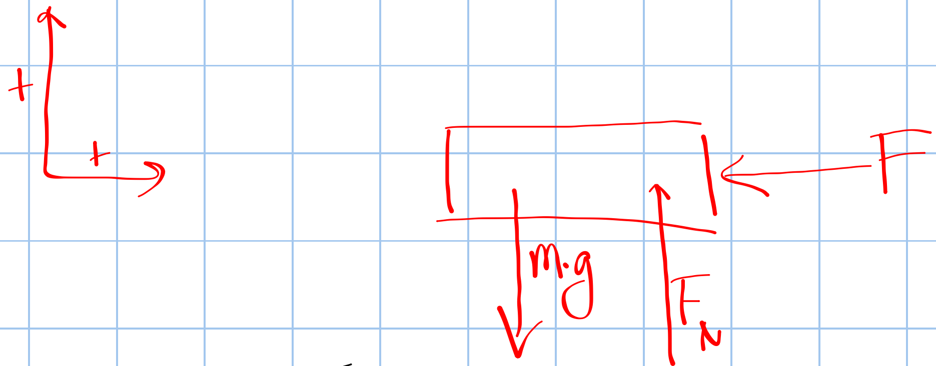
So, if you only end up remembering one thing, let it be this:

$$\boxed{\sum F = ma}$$

EXAMPLE 1:

Assume there is no friction in this and all of the following problems





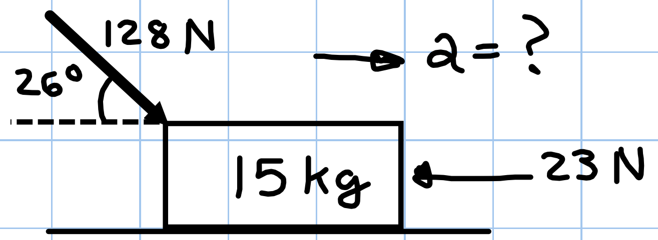
$$\Sigma_y = m\cdot g + F_N = 0$$

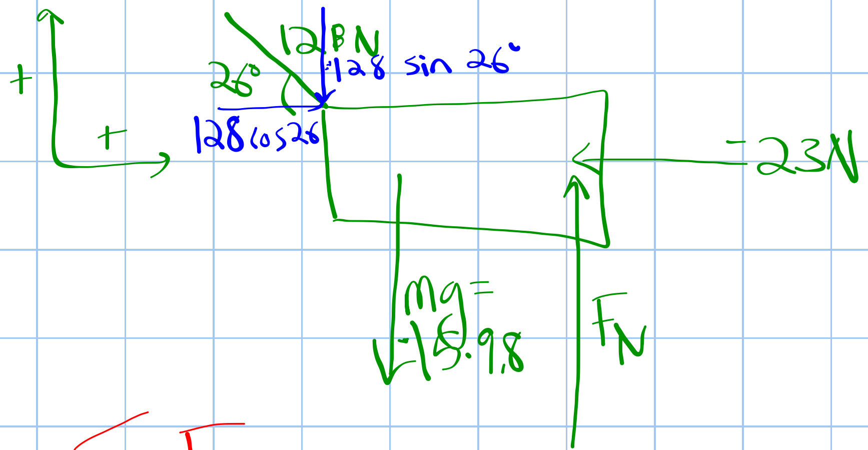
$$\Sigma_x = F = m a_x$$

$$F = (3.8)(5.9)$$

$$\boxed{F = 22.42 \text{ lbs}}$$

Example 2:





$$\Sigma F_y = -128 \sin 26 + -15 \cdot 9.8 + F_N = 0$$

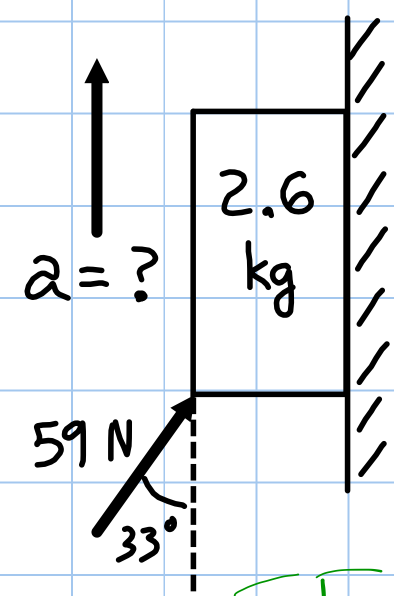
$$\Sigma F_x = 128 \cos 26 - 23 = 15 \cdot a$$

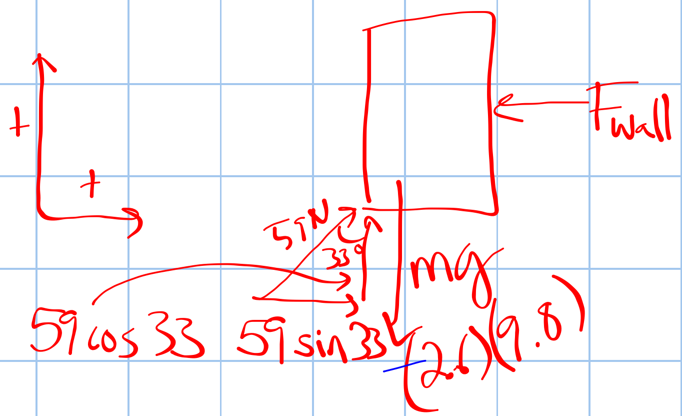
$$a = \frac{128 \cos 26 - 23}{15} = 6.14 \, m/s^2$$

EXAMPLE 3 :

$9.23 \, m/s^2$

~~1.94 m/s²~~



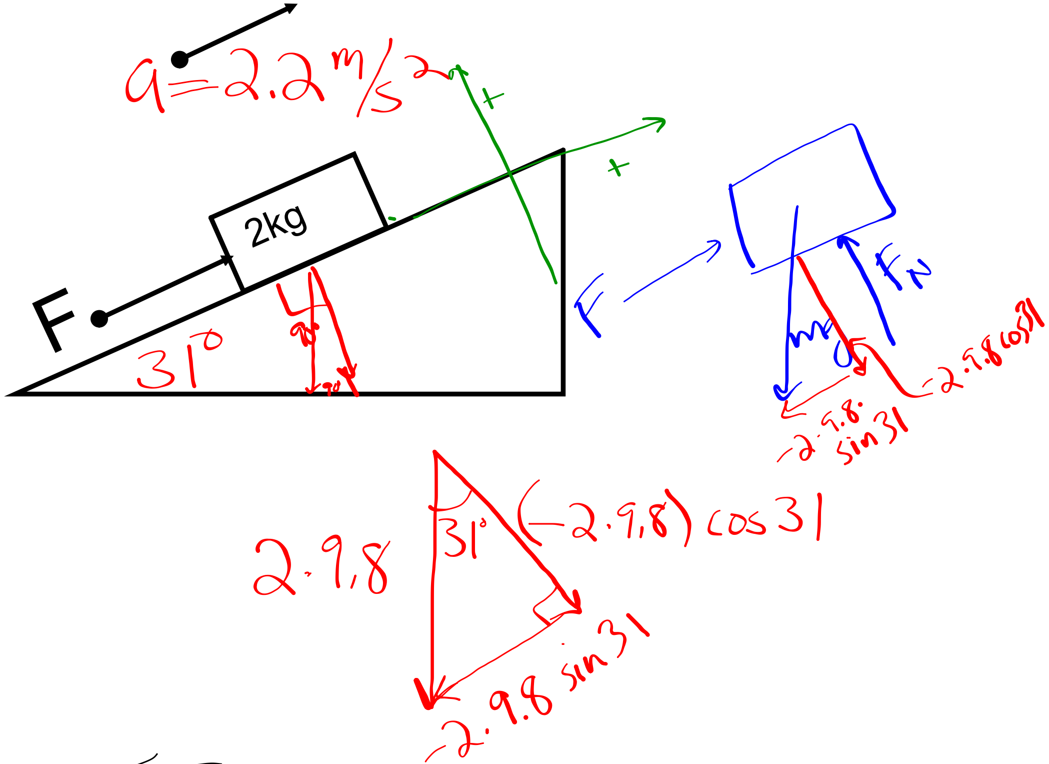


$$\sum F_x = 59 \sin 33 + F_{wall} = 0$$

$$\sum F_y = 59 \cos 33 - (2.6)(9.8) = m \cdot a_y$$

$$= 24 = 2.6 \, a_y$$

$$a_y = 9.2 \, m/s^2$$



$$\Sigma F_y = (-2\cdot 9.8)\cos 31 + F_N = 0$$

$$\Sigma F_x = -2\cdot 9.8\sin 31 + F = (2)(2.2)$$

$$F = (2)(2.2) + 2\cdot 9.8\sin 31$$

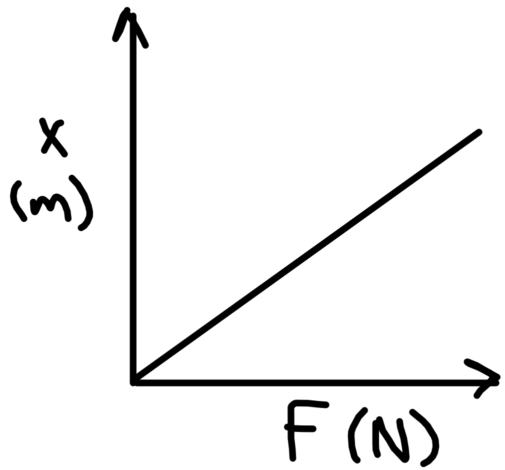
$$=$$

Let's Look at SPRINGS

All objects deflect (stretch or compress) when forces are applied to them.

When the deflection is directly proportional to the size of the applied force, the object is said to behave like an ideal spring.

Almost everything behaves like a spring to some extent. Therefore, springs are worth talking about.



An ideal spring behaves in a linear fashion. The greater the applied force, the greater the deflection.

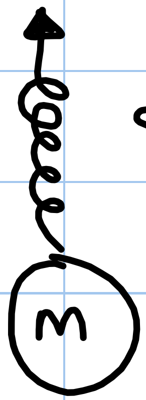
$$\boxed{F_{spring} = kx}$$

x = the deflection (in m, or ft) of spring from its non-deflected length

k = spring constant (N/m, N/cm, lb/in, etc...) This is unique for each spring

EXAMPLE 4:

5 cm

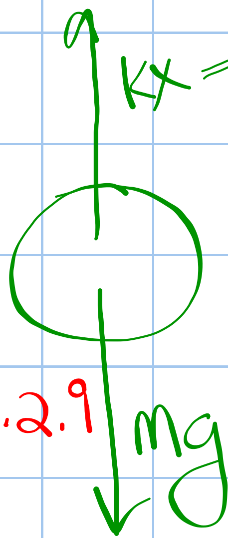


$8400\ \text{N/m}$ $\quad 5 \cdot \frac{1\ \text{m}}{100\ \text{cm}} = 84\ \frac{\text{N}}{\text{cm}}$

$+$

$a = 2.9\ \text{m/s}^2$

WHAT IS m?



$kx = 84 \cdot 5 = 420\text{N}$

$mg = m \cdot (-9.8)$

$$\Sigma F = 420\text{N} + (-9.8)m = m \cdot 2.9$$

$$420 + \cancel{-9.8m} = 2.9m$$

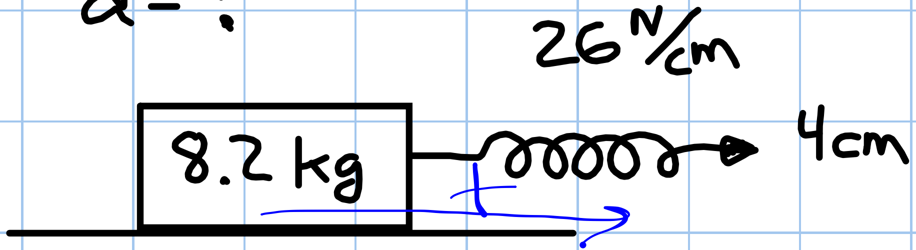
$$\cancel{+9.8m} + 9.8m$$

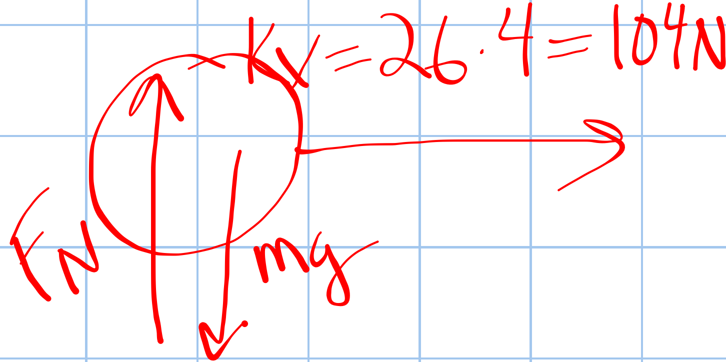
$$420 = 12.7m$$

$$m = 33.1\ \text{kg}$$

EXAMPLE 5

$a = ?$

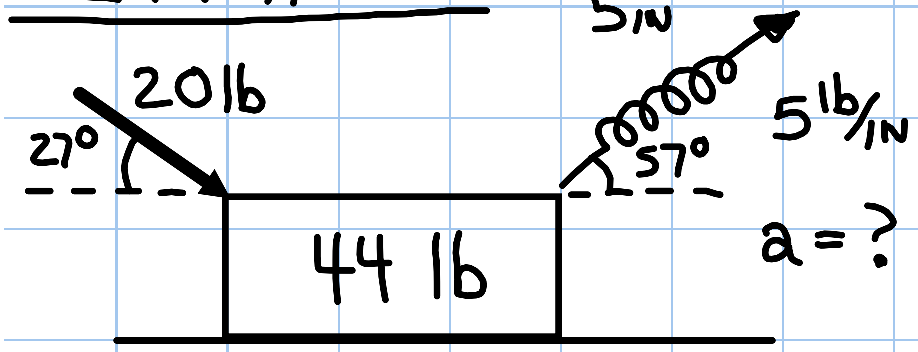




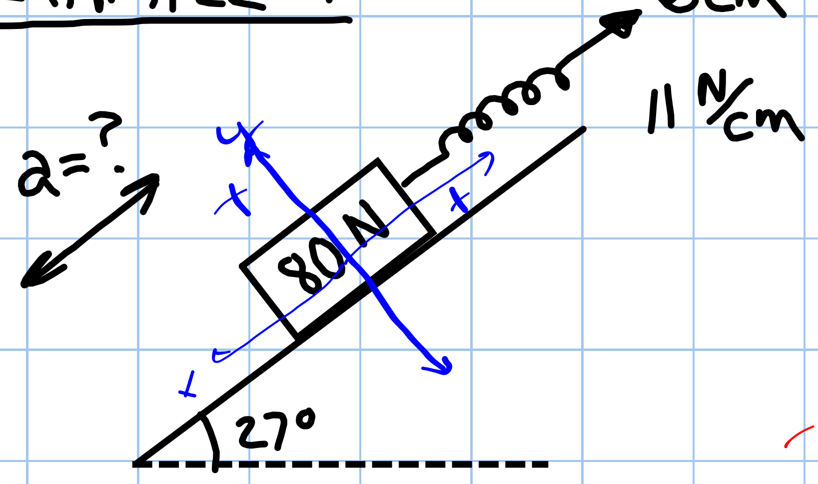
$$\Sigma F_x = \frac{104\text{ N}}{8.2\text{ kg}} = m \cdot a$$

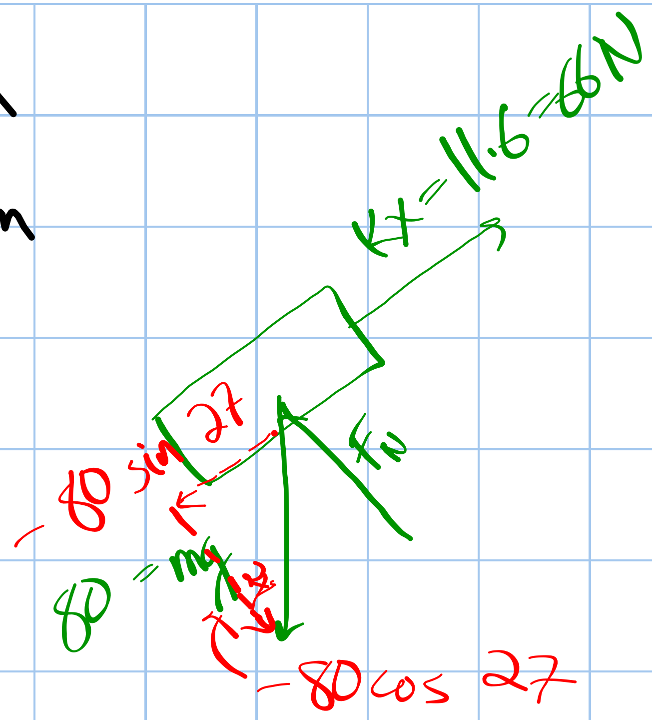
$$a = 12.7 \text{ m/s}^2$$

EXAMPLE 6:



EXAMPLE 7:





$$\Sigma F_x = -80\sin 27 + 66 = ma$$

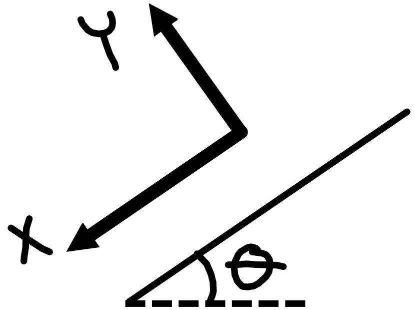
$$ma = 29.7N$$

$$\frac{\text{Weight}}{9.8} = \text{mass}$$

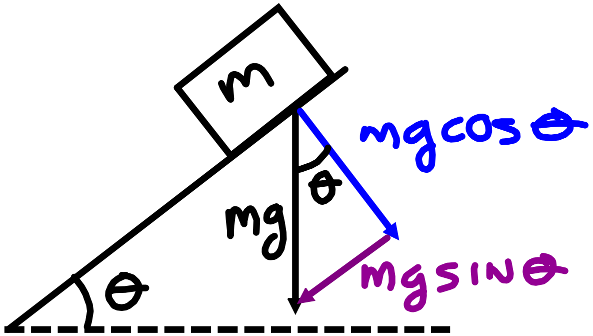
$$a = \frac{29.7N}{8.16kg} = 3.64 m/s^2 \qquad m = 8.16kg$$

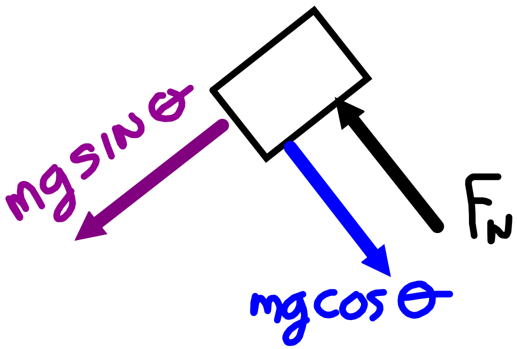
How should we handle inclines?

Use this reference frame . . . because motion will be along the incline

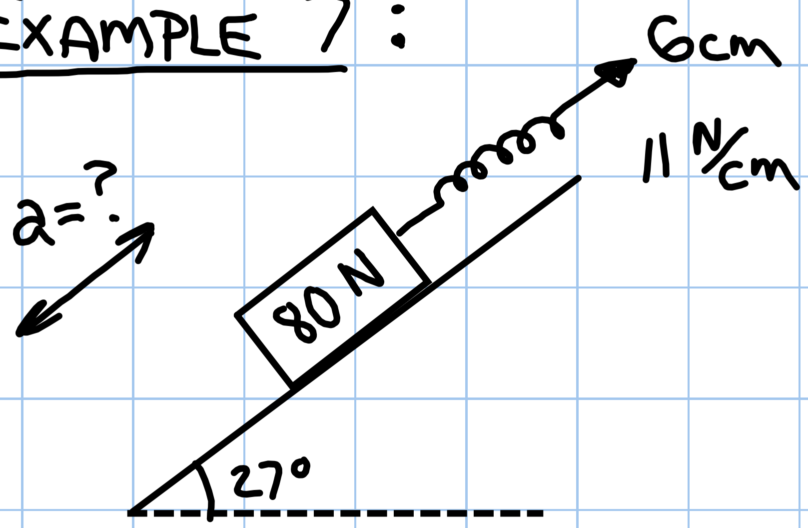


We need the force of gravity, which is vertically down, resolved into X and Y components for this new reference frame





EXAMPLE 7 :



EXAMPLE 8: