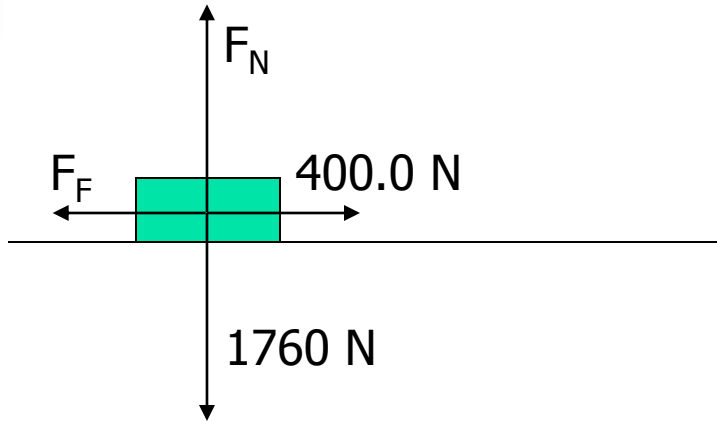




Worksheet Sliding Friction 1

1. A horizontal force of 400.0 N is required to pull a 1760 N trunk across the floor at constant speed. Find the coefficient of sliding friction.



$$\mu = \frac{F_f}{F_N} = \frac{400.0}{1760} = .227$$

$$\Sigma F = ma$$

$$400.00 - F_f = 0$$

$$F_f = 400.0$$

$$\Sigma F = ma$$

$$F_N - 1760 = 0$$

$$F_N = 1760$$

What do you know?

Draw a free body diagram.

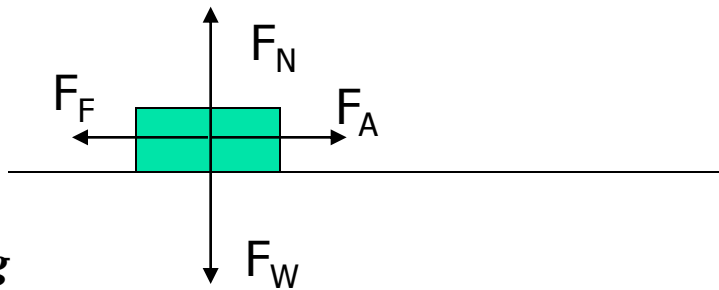
What are you to find?

What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

2. How much force must be applied to push a 1.35 kg book across the desk at constant speed if the coefficient of sliding friction is 0.30?



$m = 1.35\text{kg}$
 $\mu = .30$

$F_A =$

$\Sigma F = ma$
 $F_A - F_F = 0$
 $F_F = F_A$
 $F_f = \mu F_N$
 $F_f = (.30)(F_N)$
 $F_f = (.30)(13.2)$
 $F_f = 4.0\text{N}$

What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

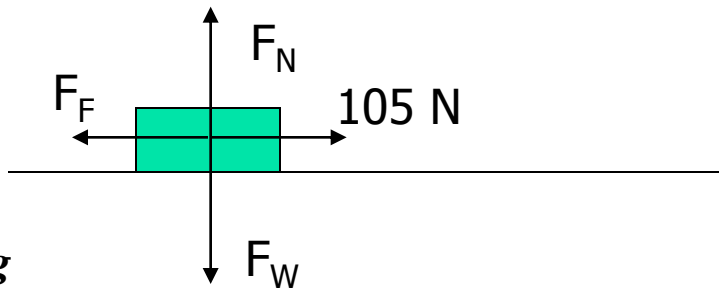
What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

What equation will enable you to find F_W ?

$\Sigma F = ma$
 $F_N - F_W = 0$
 $F_N = F_W$
 $F_W = mg$
 $F_W = (1.35)(9.81)$
 $F_W = 13.2\text{N}$

3. A force of 105 N is applied horizontally to a 20.0 kg box to move it across a horizontal floor. If the box has an acceleration of 3.0 m/s^2 , find the coefficient of sliding friction.



$$m = 20.0 \text{ kg}$$

$$a = 3.0 \text{ m/s}^2$$

$$\mu = \frac{F_f}{F_N} = \frac{45}{196} = .23$$

$$\Sigma F = ma$$

$$105 - F_f = ma$$

$$105 - F_f = (20.0)(3.0)$$

$$F_f = (105 - 60.0) = 45$$

$$\Sigma F = ma$$

$$F_N - F_W = 0$$

$$F_N = F_W$$

$$F_W = mg$$

$$F_W = (20.0)(9.81)$$

$$F_W = 196 \text{ N}$$

What do you know?

Draw a free body diagram.

What are you to find?

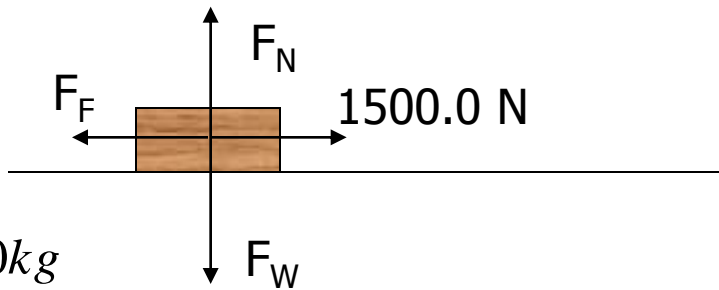
What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

What equation will enable you to find F_W ?

4. A 1500.0 N force is exerted on a 200.0 kg crate to move it across the floor. If the coefficient of sliding friction is 0.250, what is the crate's acceleration?



$$m = 200.0 \text{ kg}$$

$$\mu = 0.250$$

a

$$\Sigma \mathbf{F} = m\mathbf{a}$$

$$1500.0 - F_f = (200.0)a$$

$$1500.0 - 490. = (200.0)a$$

$$1010. = (200.0)a$$

$$5.050 \text{ m/s}^2 = a$$

$$F_f = \mu F_N$$

$$F_N = F_W$$

$$F_f = (0.250)F_W$$

$$F_f = (0.250)(1960)$$

$$F_f = 490. \text{ N}$$

$$F_W = mg$$

$$F_W = (200.0)(9.81)$$

$$F_W = 1960 \text{ N}$$

What do you know?

Draw a free body diagram.

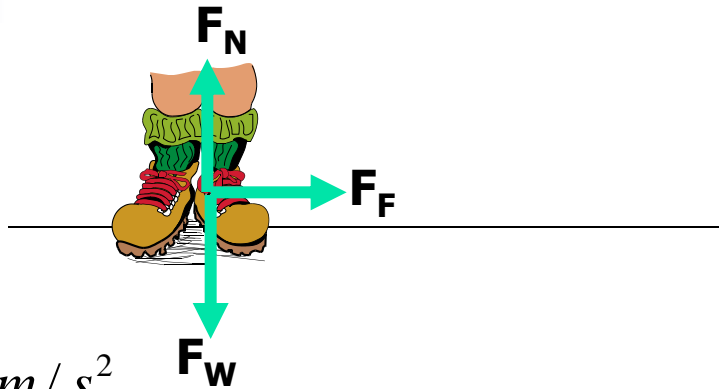
What are you to find?

What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_W ?

5. A 100.0 kg commuter is standing on a train accelerating at 3.70 m/s^2 . what coefficient of static friction must exist between the commuter's feet and the floor to avoid sliding?



$$a = 3.70 \text{ m/s}^2$$

$$m = 100.0 \text{ kg}$$

$$F_f = \mu F_N$$

$$370. = \mu(980.7)$$

$$0.377 = \mu$$

$$\Sigma F = ma$$

$$\Sigma F = F_f = ma$$

$$F_f = (100.0)(3.70)$$

$$F_f = 370. \text{ N}$$

$$F_N = F_W$$

$$F_W = mg$$

$$F_W = (100.0)(9.80665)$$

$$F_W = 980.7 \text{ N}$$

$$F_N = 980.7 \text{ N}$$

What do you know?

Draw a free body diagram.

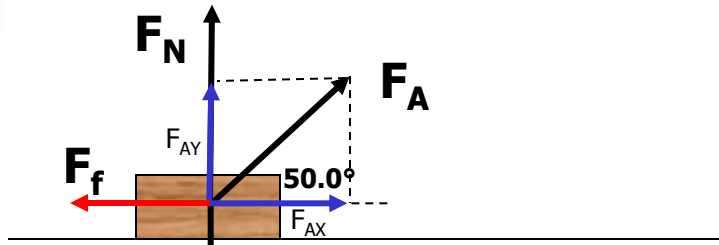
What are you to find?

What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

6. A 146 N force is used to pull a 350. N wood block at constant speed by a rope making an angle of 50.0° with the floor. Find the coefficient of sliding friction.



$$F_W = 350. N$$

$$F_A = 146 N$$

μ

$$F_f = \mu F_N$$

$$93.8 = \mu(238)$$

$$0.394 = \mu$$

$$\Sigma F = ma$$

$$F_f + F_{AX} = 0$$

$$F_{AX} = 146 \cos(50.0^\circ)$$

$$= 93.8 N$$

$$F_f + 93.8 = 0$$

$$F_f = -93.8 N$$

What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

$$\Sigma F = ma$$

$$F_W + F_{AY} + F_N = 0$$

$$F_{AY} = 146 \sin(50.0^\circ)$$

$$= 112 N$$

$$-350. + 112 + F_N = 0$$

$$F_N = 238 N$$

7. A 75.0 kg baby carriage is pushed along a level sidewalk by exerting a force of 50.0 N on the handle, which makes an angle of 60.0° with the horizontal. What is the coefficient of friction between the carriage and the sidewalk?

$$m = 75.0 \text{ kg}$$

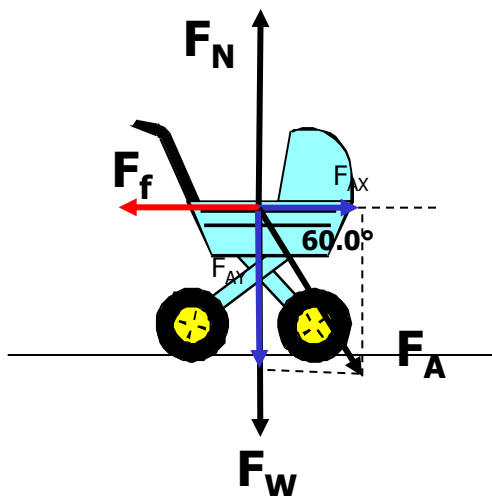
$$F_A = 50.0 \text{ N}$$

$$\mu$$

$$F_f = \mu F_N$$

$$25.0 = \mu(779)$$

$$0.321 = \mu$$



What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

What equation will enable you to find F_f ?

What equation will enable you to find F_N ?

$$\Sigma F = ma$$

$$F_f + F_{AX} = 0$$

$$F_{AX} = 50.0 \cos(60.0^\circ) \\ = 25.0 \text{ N}$$

$$F_f + 25.0 = 0$$

$$F_f = -25.0 \text{ N}$$

$$\Sigma F = ma$$

$$F_W + F_{AY} + F_N = 0 \quad -736 - 43.3 + F_N = 0$$

$$F_W = mg = (75.0)(9.81)$$

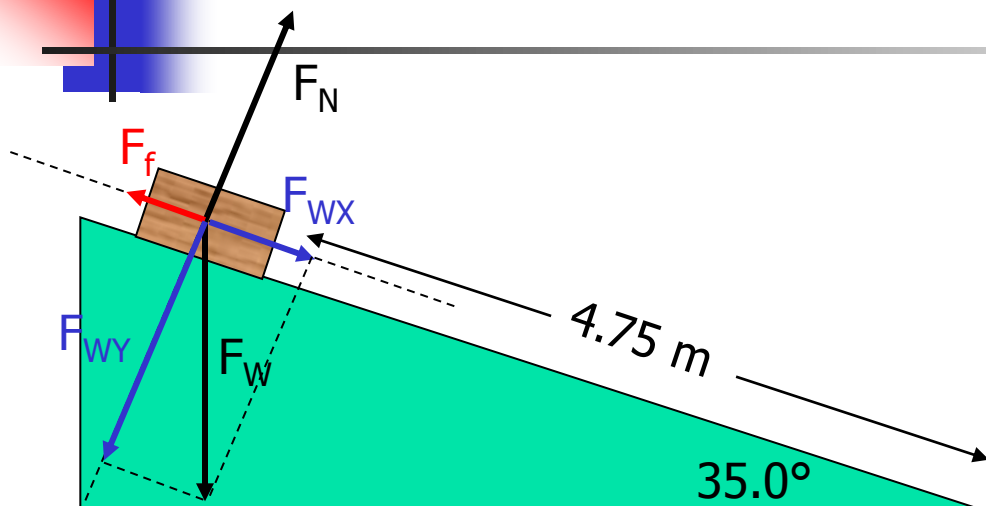
$$F_N = 779 \text{ N}$$

$$F_{AY} = 50.0 \sin(60.0^\circ)$$

$$= 43.3 \text{ N}$$

$$= 736 \text{ N}$$

8. A 3.00 kg wood box slides from rest down a 35.0° inclined plane. How long does it take the box to reach the bottom of the 4.75 m wood incline? (coefficient of friction = 0.30)



What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

What equation will enable you to find a ?

$$m = 3.00 \text{ kg}$$

$$v =$$

$$\mu = 0.30$$

$$v_o = 0$$

$$t$$

$$a =$$

$$\Sigma F = ma$$

$$F_f + F_{WX} = ma \Rightarrow -7.23 + 16.9 = 3.00a \Rightarrow a = 3.22 \text{ m/s}^2$$

$$F_f = \mu F_N = (0.30)(24.1) = 7.23 \text{ N}$$

$$F_N = F_{WY}$$

$$F_{WY} = F_W \cos 35.0 = 24.1 \text{ N}$$

$$F_{WX} = 29.4 \sin 35 = 16.9 \text{ N}$$

$$x = x_o + v_o t + \frac{1}{2} a t^2 \quad t = ?$$

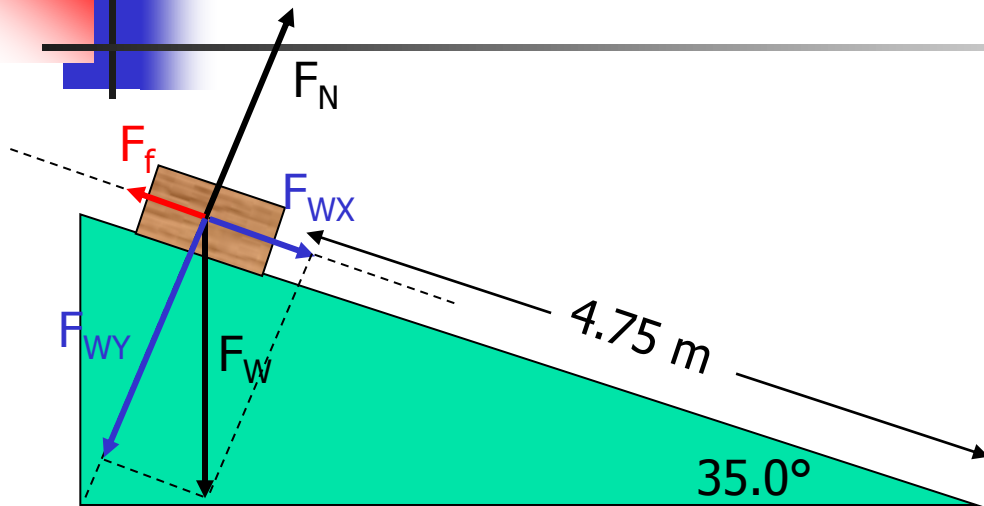
$$x = 4.75 \text{ m}$$

$$x_o = 0$$

$$F_W = mg = (3.00)(9.81)$$

$$F_W = 29.4 \text{ N}$$

8. A 3.00 kg wood box slides from rest down a 35.0° inclined plane. How long does it take the box to reach the bottom of the 4.75 m wood incline? (coefficient of friction = 0.30)



What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

What equation will enable you to find a ?

$$m = 3.00 \text{ kg}$$

$$v =$$

$$\mu = 0.30$$

$$v_o = 0$$

t

$$a = 3.22 \text{ m/s}^2$$

$$x = x_o + v_o t + \frac{1}{2} a t^2 \quad t = ?$$

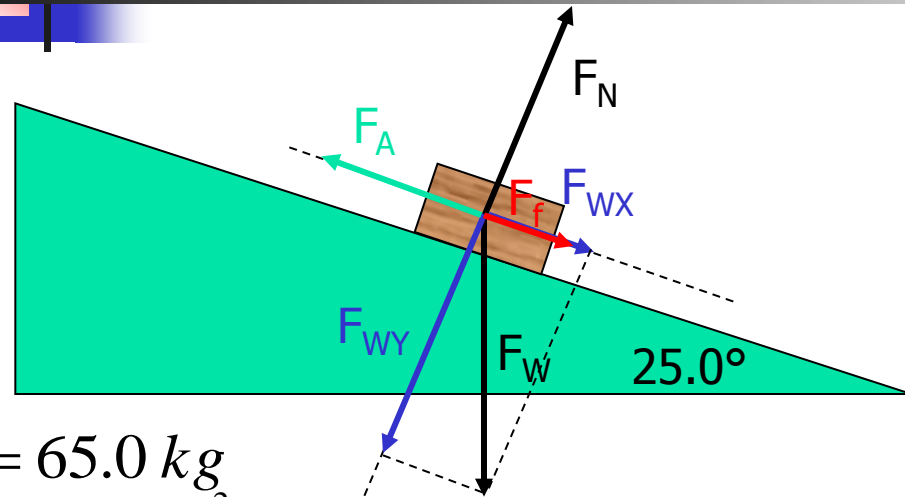
$$4.75 = 0 + 0t + \frac{1}{2} (3.22)t^2$$

$$x = 4.75 \text{ m}$$

$$t = \sqrt{\frac{2(4.75)}{3.22}} = 1.72 \text{ sec}$$

$$x_o = 0$$

9. A 65.0 kg crate is to be accelerated at 7.00 m/s² up an incline making an angle of 25.0° angle with the horizontal. If the coefficient of sliding friction between the crate and the incline is 0.200, how much force is required?



What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

$$m = 65.0 \text{ kg}$$

$$a = 7.00 \text{ m/s}^2$$

$$\mu = 0.200$$

$$F_A$$

$$\Sigma F = ma$$

$$F_A + F_f + F_{WX} = ma$$

$$F_A - 116 - 270 = (65.0)(7.00)$$

$$F_A = 841 \text{ N}$$

$$F_W = mg = (65.0)(9.81)$$

$$= 638 \text{ N}$$

$$F_{WX} = 638 \sin 25.0$$

$$F_{WX} = 270 \text{ N}$$

$$F_f = \mu F_N$$

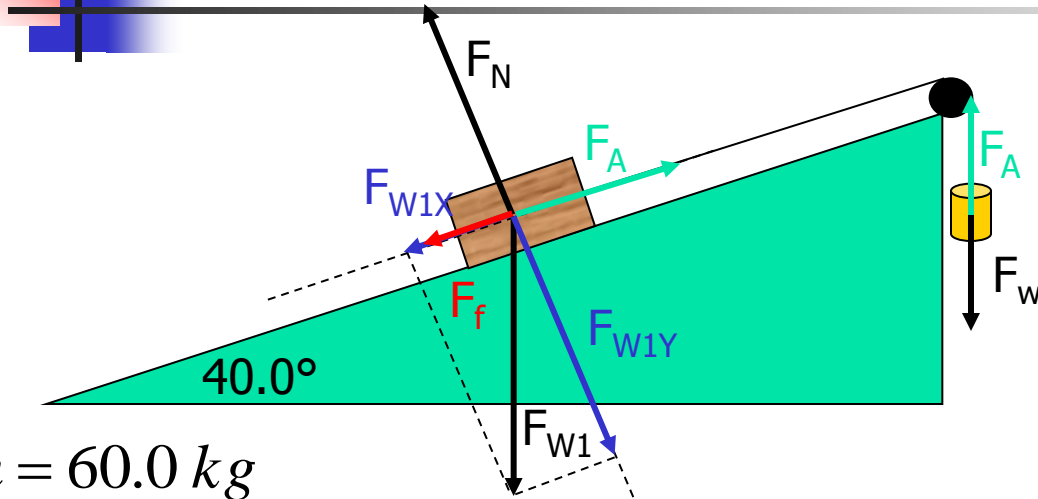
$$F_f = (.200)(578) = 116 \text{ N}$$

$$F_N = F_{WY}$$

$$F_{WY} = 638 \cos 25.0$$

$$F_{WY} = 578 \text{ N}$$

10. A 60.0 kg crate is attached to a weight by a cord that passes over a frictionless pulley, as shown in the diagram. (a) If the coefficient of friction is 0.500, what weight will keep the crate moving up the 40.0° incline at a constant speed? (b) If the cord is cut when the crate is at rest at the top of the incline, how far would the crate have slid by the time its speed reached 7.50 m/s?



What do you know?

Draw a free body diagram.

What are you to find?

What equation uses this variable?

$$m = 60.0 \text{ kg}$$

$$\mu = 0.500$$

$$a = 0 \text{ m/s}^2$$

$$F_w \quad \Sigma F = ma$$

$$F_A + F_f + F_{W1X} = ma \text{ and } F_A = F_w$$

$$F_{W1} = mg = (60.0)(9.81) = 589 \text{ N}$$

$$F_{W1X} = 589 \sin 40.0 \quad F_{W1Y} = 589 \cos 40.0$$

$$F_{W1X} = 379 \text{ N} \quad F_{W1Y} = 451 \text{ N}$$

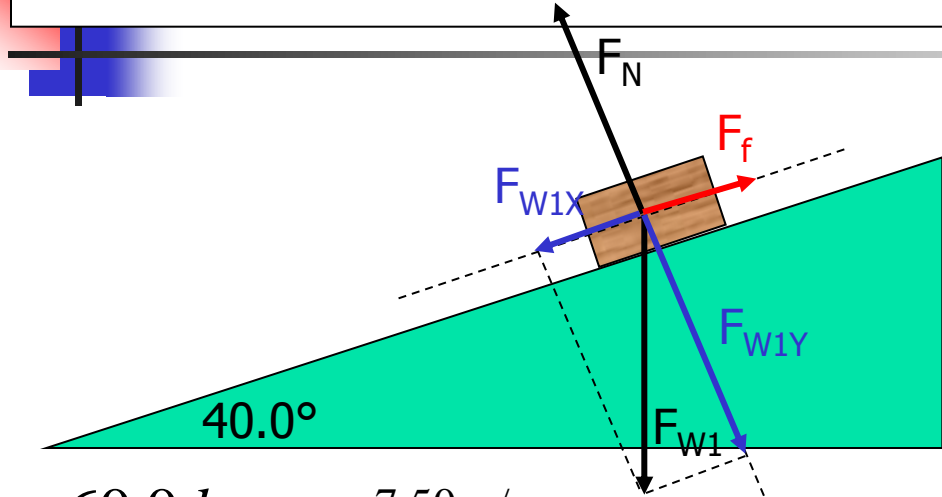
$$F_f = \mu F_N = (0.500)(451) = 226 \text{ N}$$

$$F_N = F_{W1Y}$$

$$F_A - 226 - 379 = 0$$

$$F_A = 605 \text{ N}$$

10. A 60.0 kg crate is attached to a weight by a cord that passes over a frictionless pulley, as shown in the diagram. (a) If the coefficient of friction is 0.500, what weight will keep the crate moving up the 40.0° incline at a constant speed? (b) If the cord is cut when the crate is at rest at the top of the incline, how far would the crate have slid by the time its speed reached 7.50 m/s?



$m = 60.0 \text{ kg}$ $v = -7.50 \text{ m/s}$
 $\mu = 0.500$ $v_o = 0$

x

$a =$
 $t =$
 $x =$
 $x_o = 0$

$$v^2 = v_o^2 + 2a(x - x_o)$$

$$\frac{v^2 - v_o^2}{2a} = x$$

$$\frac{(-7.50)^2 - 0^2}{2(-2.55)} = x$$

$-11.0 \text{ m} = x$

What do you know?
 Draw a free body diagram.
 F_A disappears and F_f is now up the incline
 What are you to find?
 What equation uses this variable?

You need to find a

$$\Sigma F = ma$$

$$F_{W1X} + F_f = ma$$

You know F_{W1X} and F_f from part A

$$a = -2.55 \text{ m/s}^2$$