Answers

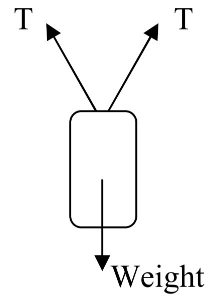
1.
   a. Weight = Mass x Gravity. 20 kg x 9.8 = 196 Newtons
   b. Normal force equals the weight on horizontal surfaces. Normal force = 196 Newtons
   c. Friction = normal force x coefficient of friction.
      Since the box is not moving, use the static coefficient. Friction = 196 N x 0.38 = 74.5 N
   d. Calculate the friction force again, but use the kinetic coefficient since the box is moving.
      Friction force = 196 N x 0.15 = 29.4 N.
      Use the Forces = Mass x Acceleration formula.
      Pushing force – Friction force = Mass x Acceleration.
      Pushing force – 29.4 N= 20 kg x 0.5 m/s^2.
      Pushing force – 29.4 N = 10 N
      Pushing force = 39.4 Newtons.

2.
   a. The normal force is equal to the weight. You were given the weight in the problem, so the normal force is 50 pounds.
   b. Friction = normal force x coefficient of friction.
      Since the box is not moving, use the static coefficient. Friction = 50 lb x 0.5 = 25 lb

3. Use the Force = Mass x Acceleration formula. The motor is not moving, so acceleration equals zero.
   Tension – Weight of engine = mass x acceleration
   Tension – 350 lb = 0
   Tension = 350 lb

4. First, calculate the weight of the sculpture.
   Weight = Mass x Gravity
   Weight = 90 kg x 9.8
   Weight = 882 Newtons
   Next, use the Forces = Mass x Acceleration formula. The sculpture is not moving, so acceleration equals zero.
   Tension – Weight = Mass x Acceleration
   Tension – 882 N = 0
   Tension = 882 N

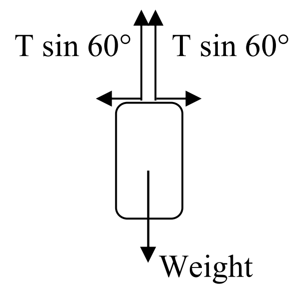
5. First, draw a free body diagram of the bag. The ropes are at the same angle, so the tension in both ropes is the same. Just write “T” for the tension.



Next, calculate the weight of the bag.

Weight = Mass x Gravity
Weight = 100 kg x 9.8
Weight = 980 Newtons

Now, change the angled tension vectors into x and y components (You don’t really need the x-components because the bag isn’t moving in x direction.)



Y of Tension = T x sin 60° = 0.866T

Finally, use the Forces = Mass x Acceleration formula. The bag is not moving, so acceleration equals zero. You are just going to add the forces going up and down.

$\text{Tension}_y + \text{Tension}_y – \text{Weight} = \text{Mass x Acceleration}$
$0.866T + 0.866T – 980 \text{ N} = 0$
$1.732T – 980 \text{ N} = 0$
$1.732T = 980 \text{ N}$
$T = 566 \text{ N}$

6. Torque = Force x Radius. Torque = 30 pounds x 4 feet = 120 foot-pounds

7. Since the seesaw is balanced, the torque on the left must equal the torque on the right.

40 pounds x 6 feet = 52 pounds x Distance
240 = 52 x Distance
4.61 feet = Distance

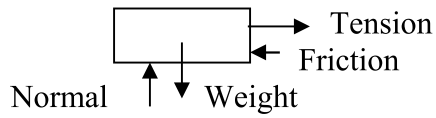
8.
   a. Weight = Mass x Gravity. Weight = 30 kg x 9.8 = 294 Newtons
   b. Normal force on a slant = Weight x cos (Angle) = 294 x cos 42° = 218.5 Newtons
   c. The weight force down the slide = Weight x sin (Angle) = 196.7 Newtons
   d. Use the Force = Mass x Acceleration formula. Only use the forces parallel to the slide because that’s the only way the box is moving.

      196.7 N = 30 kg x Acceleration
      6.56 m/s^2 = Acceleration

9.
   a. Weight = Mass x Gravity. Weight = 46 kg x 9.8 = 450.8 Newtons
   b. Normal force on a slant = Weight x cos (Angle) = 450.8 x cos 55° = 258.6 Newtons
   c. The weight force down the slide = Weight x cos (Angle) = 450.8 x sin 55° = 369.3 N
   d. Friction = Normal force x Coefficient of friction = 258.6 x 0.48 = 124.1 N
   e. The box’s weight force pointing down the slide is greater than the friction force pointing up the slide, so the box would be moving down the slide.

10.

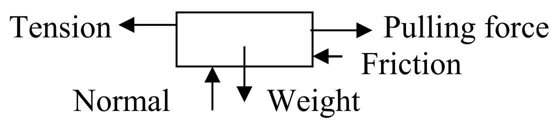
a.



b. Weight = Mass x Acceleration. Weight = 20 kg x 9.8 = 196 Newtons
c. Normal force = weight on a horizontal surface. Normal force = 196 Newtons
d. Friction force = Normal force x coefficient of friction. Friction = 196 x 0.27 = 52.9 N
e. Use the Force = Mass x Acceleration formula to solve for the tension.

Tension – Friction = Mass x Acceleration
Tension – 52.9 N = 20 kg x 0.3 m/s^2
Tension – 52.9 N = 6 N
Tension = 58.9 N

f.



g. Weight = Mass x Acceleration. Weight = 30 kg x 9.8 = 294 Newtons
h. Normal force = weight on a horizontal surface. Normal force = 294 Newtons
i. Friction force = Normal force x coefficient of friction. Friction = 294 x 0.27 = 79.4 N
j. Use the Force = Mass x Acceleration formula to solve for the tension.

Pulling force -Tension – Friction = Mass x Acceleration
Pulling force – 58.9 N – 79.4 N = 30 kg x 0.3 m/s^2
Pulling force – 138.3 N = 9 N
Pulling force = 147.3 N

11. Honors: Calculate the weight of the mass. Weight = 2940 N.
Convert the tension vectors into x and y components. The ropes are at different angles, so they will have different tension.
You will use the F=ma formula two times. Acceleration equals zero.

First, add the force in the x-direction. $T_1 \cos 50° - T_2 \cos 45° = 0$
Rearrange this equation to solve for T_1. $T_1 \cos 50° = T_2 \cos 45°$

$$T_1 = \frac{T_2 \cos 45°}{\cos 50°}$$

$$T_1 = T_2\,(1.10)$$

Now, add the forces in the y-direction. $T_1 \sin 50° + T_2 \sin 45° - \text{Weight} = 0$
Substitute $T_2\,(1.10)$ for T_1. $T_2\,(1.10) \sin 50° + T_2 \sin 45° - 2940\text{ N} = 0$
Simplify and solve for T2. $T_2\,(0.843) + T_2\,(0.707) = 2940\text{ N}$

$$T_2\,(1.55) = 2940\text{ N}$$

$$T_2 = 1897\text{ N}$$

Take the answer you got for T2 and put it in your first equation to solve for T1.

$$T_1 = T_2\,(1.10) = 1897\,(1.10) = 2086\text{ N}$$

12. Calculate the weight, normal force and friction force for both boxes.
Use the horizontal forces on the left box and write the F = ma formula.

Tension – friction = mass x acceleration $T - 58.8\ N = 30a$

Rearrange to solve for T. $T = 30a + 58.8\ N$

Use the horizontal force on the right box and write the F=ma formula.

Pulling force – Tension – Friction = Mass x Acceleration $600\ N - T - 49 = 25a$

Substitute 30a – 58.86 for T. $600\ N - (30a + 58.86) - 49 = 25a$

Solve for a. $600 - 30a - 58.86 - 49 = 25a$

$$492 - 30a = 25\ a$$
$$492 = 55a$$
$$8.95\ m/s^2 = a$$

Use your value for a to solve for T. $T = 30a + 58.8\ N = 30(8.95) + 58.8 = 327.3\ N$