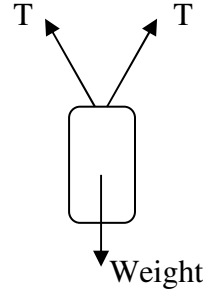


Answers

1.
 - a. $\text{Weight} = \text{Mass} \times \text{Gravity}$. $20 \text{ kg} \times 9.8 = 196 \text{ Newtons}$
 - b. Normal force equals the weight on horizontal surfaces. Normal force = 196 Newtons
 - c. $\text{Friction} = \text{normal force} \times \text{coefficient of friction}$.
Since the box is not moving, use the static coefficient. $\text{Friction} = 196 \text{ N} \times 0.38 = 74.5 \text{ N}$
 - d. Calculate the friction force again, but use the kinetic coefficient since the box is moving.
 $\text{Friction force} = 196 \text{ N} \times 0.15 = 29.4 \text{ N}$.
Use the Forces = Mass x Acceleration formula.
 $\text{Pushing force} - \text{Friction force} = \text{Mass} \times \text{Acceleration}$.
 $\text{Pushing force} - 29.4 \text{ N} = 20 \text{ kg} \times 0.5 \text{ m/s}^2$.
 $\text{Pushing force} - 29.4 \text{ N} = 10 \text{ N}$
 $\text{Pushing force} = 39.4 \text{ Newtons}$.
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. $\text{Friction} = \text{normal force} \times \text{coefficient of friction}$.
Since the box is not moving, use the static coefficient. $\text{Friction} = 50 \text{ lb} \times 0.5 = 25 \text{ lb}$
3. Use the Force = Mass x Acceleration formula. The motor is not moving, so acceleration equals zero.
 $\text{Tension} - \text{Weight of engine} = \text{mass} \times \text{acceleration}$
 $\text{Tension} - 350 \text{ lb} = 0$
 $\text{Tension} = 350 \text{ lb}$
4. First, calculate the weight of the sculpture.
 $\text{Weight} = \text{Mass} \times \text{Gravity}$
 $\text{Weight} = 90 \text{ kg} \times 9.8$
 $\text{Weight} = 882 \text{ Newtons}$
Next, use the Forces = Mass x Acceleration formula. The sculpture is not moving, so acceleration equals zero.
 $\text{Tension} - \text{Weight} = \text{Mass} \times \text{Acceleration}$
 $\text{Tension} - 882 \text{ N} = 0$
 $\text{Tension} = 882 \text{ N}$

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.

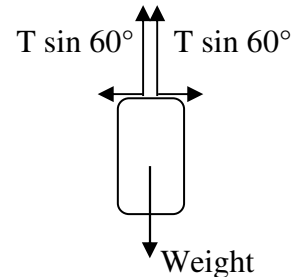
$$\text{Weight} = \text{Mass} \times \text{Gravity}$$

$$\text{Weight} = 100 \text{ kg} \times 9.8$$

$$\text{Weight} = 980 \text{ Newtons}$$

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.)

$$Y \text{ of Tension} = T \times \sin 60^\circ = 0.866T$$



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.

$$\text{Tension}_y + \text{Tension}_y - \text{Weight} = \text{Mass} \times \text{Acceleration}$$

$$0.866T + 0.866T - 980 \text{ N} = 0$$

$$1.732T - 980 \text{ N} = 0$$

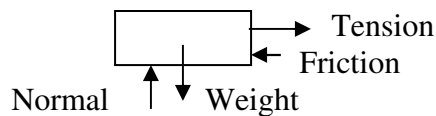
$$1.732T = 980 \text{ N}$$

$$T = 566 \text{ N}$$

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.
 $40 \text{ pounds} \times 6 \text{ feet} = 52 \text{ pounds} \times \text{Distance}$
 $240 = 52 \times \text{Distance}$
 $4.61 \text{ feet} = \text{Distance}$
- 8.
- Weight = Mass x Gravity. Weight = 30 kg x 9.8 = 294 Newtons
 - Normal force on a slant = Weight x cos (Angle) = 294 x cos 42° = 218.5 Newtons
 - The weight force down the slide = Weight x sin (Angle) = 196.7 Newtons
 - 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.
 $196.7 \text{ N} = 30 \text{ kg} \times \text{Acceleration}$
 $6.56 \text{ m/s}^2 = \text{Acceleration}$
- 9.
- Weight = Mass x Gravity. Weight = 46 kg x 9.8 = 450.8 Newtons
 - Normal force on a slant = Weight x cos (Angle) = 450.8 x cos 55° = 258.6 Newtons
 - The weight force down the slide = Weight x sin (Angle) = 450.8 x sin 55° = 369.3 N
 - Friction = Normal force x Coefficient of friction = 258.6 x 0.48 = 124.1 N
 - 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.

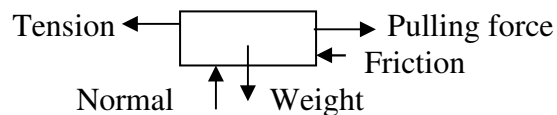
$$\text{Tension} - \text{Friction} = \text{Mass} \times \text{Acceleration}$$

$$\text{Tension} - 52.9 \text{ N} = 20 \text{ kg} \times 0.3 \text{ m/s}^2$$

$$\text{Tension} - 52.9 \text{ N} = 6 \text{ N}$$

$$\text{Tension} = 58.9 \text{ N}$$

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.

$$\text{Pulling force} - \text{Tension} - \text{Friction} = \text{Mass} \times \text{Acceleration}$$

$$\text{Pulling force} - 58.9 \text{ N} - 79.4 \text{ N} = 30 \text{ kg} \times 0.3 \text{ m/s}^2$$

$$\text{Pulling force} - 138.3 \text{ N} = 9 \text{ N}$$

$$\text{Pulling force} = 147.3 \text{ N}$$

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. $T_1 \cos 50^\circ - T_2 \cos 45^\circ = 0$

Rearrange this equation to solve for T_1 . $T_1 \cos 50^\circ = T_2 \cos 45^\circ$

$$T_1 = \frac{T_2 \cos 45^\circ}{\cos 50^\circ}$$

$$T_1 = T_2 (1.10)$$

Now, add the forces in the y-direction. $T_1 \sin 50^\circ + T_2 \sin 45^\circ - \text{Weight} = 0$

Substitute $T_2 (1.10)$ for T_1 . $T_2 (1.10) \sin 50^\circ + T_2 \sin 45^\circ - 2940 \text{ N} = 0$

Simplify and solve for T_2 . $T_2 (0.843) + T_2 (0.707) = 2940 \text{ N}$

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

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

Take the answer you got for T_2 and put it in your first equation to solve for T_1 .

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

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.

$$\text{Tension} - \text{friction} = \text{mass} \times \text{acceleration} \quad T - 58.8 \text{ N} = 30a$$

$$\text{Rearrange to solve for T.} \quad T = 30a + 58.8 \text{ N}$$

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

$$\text{Pulling force} - \text{Tension} - \text{Friction} = \text{Mass} \times \text{Acceleration} \quad 600 \text{ N} - T - 49 = 25a$$

$$\text{Substitute } 30a - 58.86 \text{ for T.} \quad 600 \text{ N} - (30a + 58.86) - 49 = 25a$$

$$\text{Solve for a.} \quad 600 - 30a - 58.86 - 49 = 25a$$

$$492 - 30a = 25a$$

$$492 = 55a$$

$$8.95 \text{ m/s}^2 = a$$

Use your value for a to solve for T.

$$T = 30a + 58.8 \text{ N} = 30(8.95) + 58.8 = 327.3 \text{ N}$$