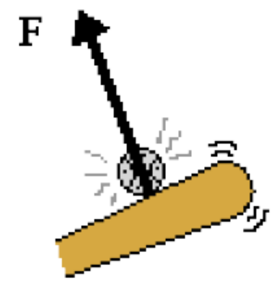
PRACTICE WITH FORCES IN 2 DIMENSIONS ANSWER KEY

Instructions*: Please show all of your work completely when answering the following questions in your journal.*

1. For the following situations, draw and label the force and its components in the given situation. Then use trigonometric functions to determine the magnitude of each component. Label the magnitudes of the component on the diagram.
   a. A baseball is hit by a bat with a force of 325 N at a direction of 105°.

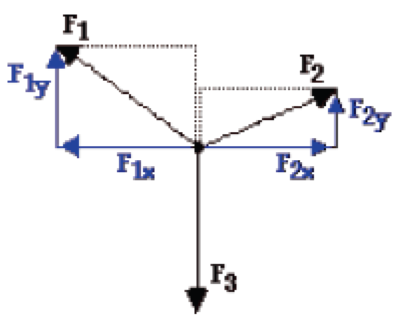
   $$F_x = F \cdot \cos\theta = (325\text{ N})\cos(180° - 105°) = \boxed{\textbf{84 N}}$$
   $$F_y = F \cdot \sin\theta = (325\text{ N})\sin(180° - 105°) = \boxed{\textbf{314 N}}$$



   b. Lon Mauer pulls up with a force of 75 N at an angle of 45° to the horizontal on the handle of his manual lawn mower.

   $$F_x = F \cdot \cos\theta = (75\text{ N})\cos(45°) = \boxed{\textbf{53 N}}$$
   $$F_y = F \cdot \sin\theta = (75\text{ N})\sin(45°) = \boxed{\textbf{53 N}}$$

2. Three forces - F_1, F_2, and F_3 - are acting upon an object. Their relative magnitude, direction, and components are shown in the diagram below. Complete the following mathematical statements by placing >, <, and = symbols in the blanks.



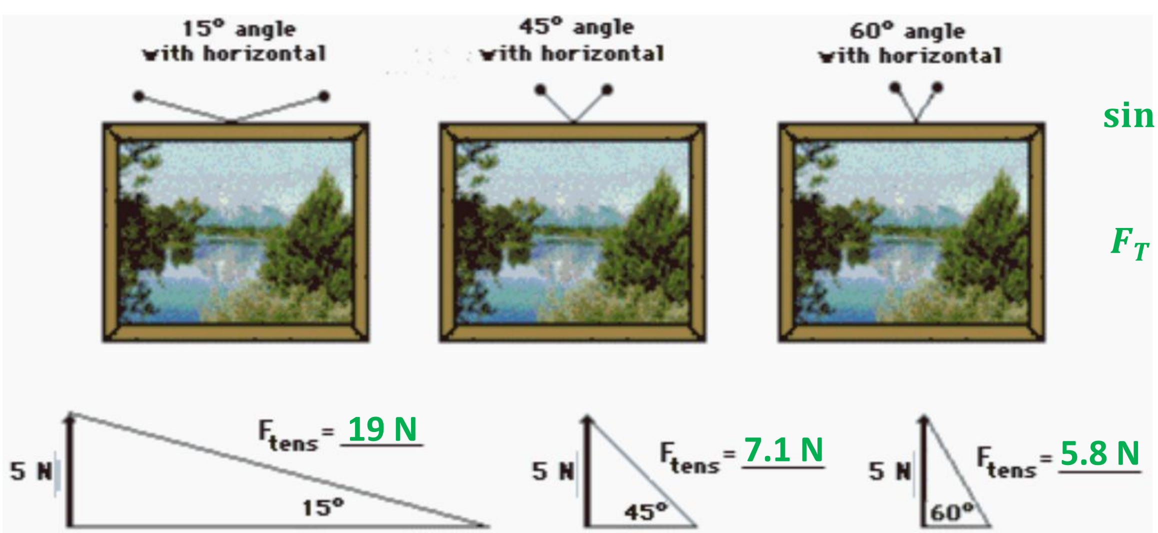
$F_{1(x)}$ __=__ $F_{2(x)}$

$F_{1(y)}$ __<__ F_3

$F_{2(y)}$ __<__ F_3

$F_{1(y)} + F_{2(y)}$ __=__ F_3

3. The three identical signs below are supported by wires at three different angle orientations. Since each sign has a weight of 10.0 N, each wire must exert a vertical component of force of 5.0 N. Determine the tension in each wire. Which is the safest? **The safest is the picture hung at 60° because it will have the lowest force of tension!**

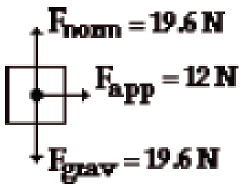


$$\sin\boldsymbol{\theta} = \frac{\textbf{5 N}}{\boldsymbol{F_T}}$$

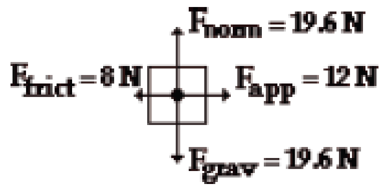
$$\boldsymbol{F_T} = \frac{\textbf{5 N}}{\sin\boldsymbol{\theta}}$$

4. Determine the acceleration value for the following two objects.

a.



b.



a. $F_{grav} = mg \rightsquigarrow m = \frac{F_{grav}}{g} = \frac{19.6\text{ N}}{9.80\text{ m}/\text{s}^2} = \underline{2.00\text{ kg}}$

$F_{NET(y)} = F_{norm} - F_{grav} = 19.6\text{ N} - 19.6\text{ N} = 0\text{ N}$

$F_{NET(x)} = F_{app} = \underline{12\text{ N}}$

$F_{NET(x)} = ma \rightsquigarrow a = \frac{F_{NET(x)}}{m} = \frac{12\text{ N}}{2.00\text{ kg}} = \boxed{6.0\text{ m}/\text{s}^2}$

b. $F_{grav} = mg \rightsquigarrow m = \frac{F_{grav}}{g} = \frac{19.6\text{ N}}{9.80\text{ m}/\text{s}^2} = \underline{2.00\text{ kg}}$

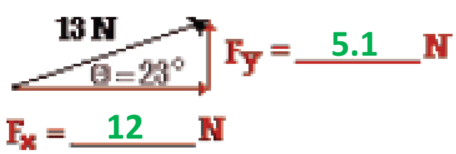
$F_{NET(y)} = F_{norm} - F_{grav} = 19.6\text{ N} - 19.6\text{ N} = 0\text{ N}$

$F_{NET(x)} = F_{app} - F_{frict} = 12\text{ N} - 8\text{ N} = \underline{4\text{ N}}$

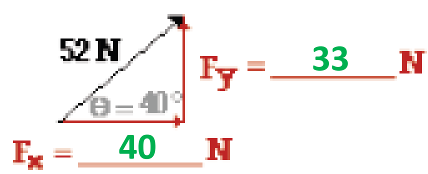
$F_{NET(x)} = ma \rightsquigarrow a = \frac{F_{NET(x)}}{m} = \frac{4\text{ N}}{2.00\text{ kg}} = \boxed{2\text{ m}/\text{s}^2}$

5. Resolve the following two forces into horizontal and vertical components.

a.



b.



a. $F_x = F \cdot \cos\theta = (13\text{ N})\cos(23°) = \boxed{12\text{ N}}$

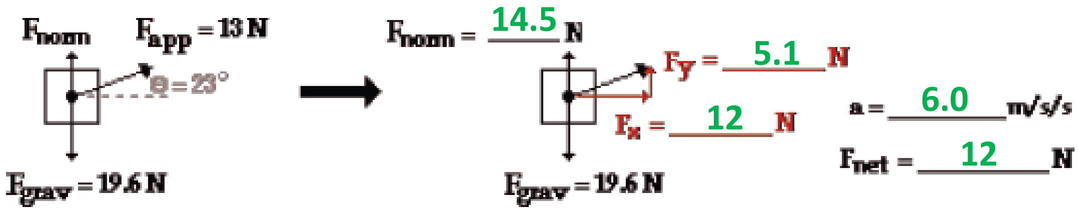
$F_y = F \cdot \sin\theta = (13\text{ N})\sin(23°) = \boxed{5.1\text{ N}}$

b. $F_x = F \cdot \cos\theta = (52\text{ N})\cos(40°) = \boxed{40\text{ N}}$

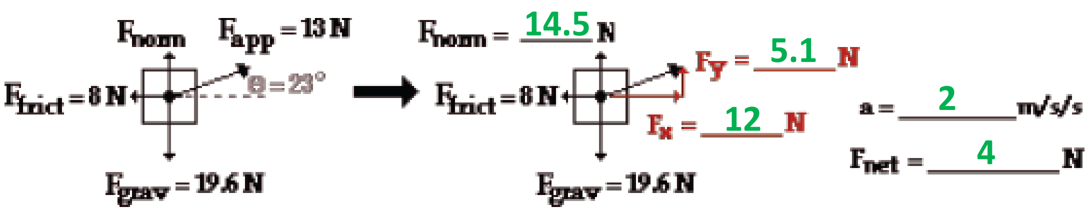
$F_y = F \cdot \sin\theta = (52\text{ N})\sin(40°) = \boxed{33\text{ N}}$

6. Fill in the blanks and determine the acceleration value for the following two situations.

a.



b.



a. $F_{grav} = mg \rightsquigarrow m = \frac{F_{grav}}{g} = \frac{19.6\text{ N}}{9.80\ ^{\text{m}}/_{\text{s}^2}} = \underline{2.00\text{ kg}}$

$F_{app(x)} = F \cdot \cos\theta = (13\text{ N})\cos(23°) = \boxed{\mathbf{12\ N}}$

$F_{app(y)} = F \cdot \sin\theta = (13\text{ N})\sin(23°) = \boxed{\mathbf{5.1\ N}}$

$F_{NET(y)} = 0\text{ N} = F_{norm} + F_{app(y)} - F_{grav}$

$\rightsquigarrow F_{norm} = -F_{app(y)} + F_{grav} = -5.1\text{ N} + 19.6\text{ N} = \boxed{\mathbf{14.5\ N}}$

$F_{NET(x)} = F_{app(x)} = \underline{12\text{ N}}$

$F_{NET(x)} = ma \rightsquigarrow a = \frac{F_{NET(x)}}{m} = \frac{12\text{ N}}{2.00\text{ kg}} = \boxed{\mathbf{6.0\ ^{m}/_{s^2}}}$

b. $F_{grav} = mg \rightsquigarrow m = \frac{F_{grav}}{g} = \frac{19.6\text{ N}}{9.80\ ^{\text{m}}/_{\text{s}^2}} = \underline{2.00\text{ kg}}$

$F_{app(x)} = F \cdot \cos\theta = (13\text{ N})\cos(23°) = \boxed{\mathbf{12\ N}}$

$F_{app(y)} = F \cdot \sin\theta = (13\text{ N})\sin(23°) = \boxed{\mathbf{5.1\ N}}$

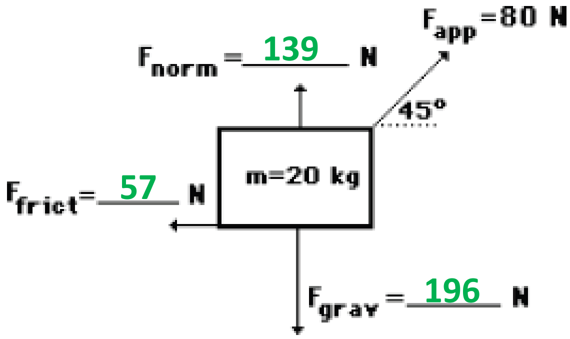
$F_{NET(y)} = 0\text{ N} = F_{norm} + F_{app(y)} - F_{grav}$

$\rightsquigarrow F_{norm} = -F_{app(y)} + F_{grav} = -5.1\text{ N} + 19.6\text{ N} = \boxed{\mathbf{14.5\ N}}$

$F_{NET(x)} = F_{app(x)} - F_{frict} = 12\text{ N} - 8\text{ N} = \underline{4\text{ N}}$

$F_{NET(x)} = ma \rightsquigarrow a = \frac{F_{NET(x)}}{m} = \frac{4\text{ N}}{2.00\text{ kg}} = \boxed{\mathbf{2\ ^{m}/_{s^2}}}$

7. A box is pulled at a constant speed of 0.4 m/s across a frictional surface. Perform an extensive force analysis of the diagram and fill in the blanks.



$$F_{NET} = ma = (20\text{ kg})\left(0\,{}^{\text{m}}/_{\text{s}^2}\right) = \underline{0\text{ N}}$$

$$F_{grav} = mg = (20\text{ kg})\left(9.80\,{}^{\text{m}}/_{\text{s}^2}\right) = \boxed{\mathbf{196\ N}}$$

$$F_{app(x)} = F \cdot \cos\theta = (80\text{ N})\cos(45°) = \underline{57\text{ N}}$$

$$F_{app(y)} = F \cdot \sin\theta = (80\text{ N})\sin(45°) = \underline{57\text{ N}}$$

$$F_{NET(x)} = 0\text{ N} = F_{app(x)} - F_{frict} \leadsto F_{app(x)} = F_{frict} = \boxed{\mathbf{57\ N}}$$

$$F_{NET(y)} = 0\text{ N} = F_{norm} + F_{app(y)} - F_{grav}$$

$$\leadsto F_{norm} = -F_{app(y)} + F_{grav} = -57\text{ N} + 196\text{ N} = \boxed{\mathbf{139\ N}}$$