# Equilibrium Problems

| Net Force in the x | Net Force in the y |
|---|---|
| 0 | 0 |

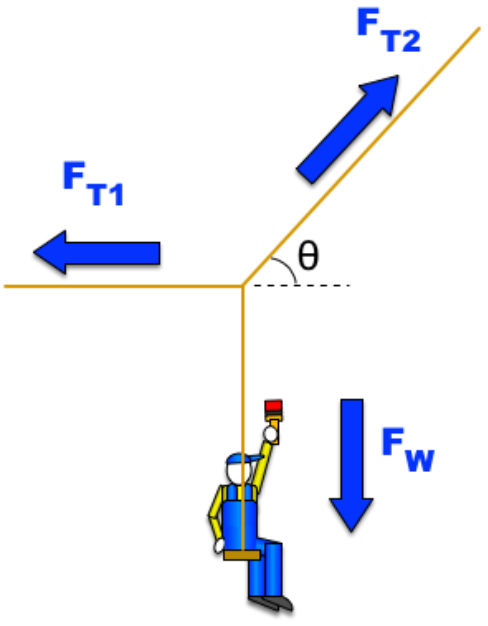
| | |
|---|---|
| ☐ gaining speed. | ☐ gaining speed. |
| ☒ constant speed. | ☒ constant speed. |
| ☐ losing speed. | ☐ losing speed. |

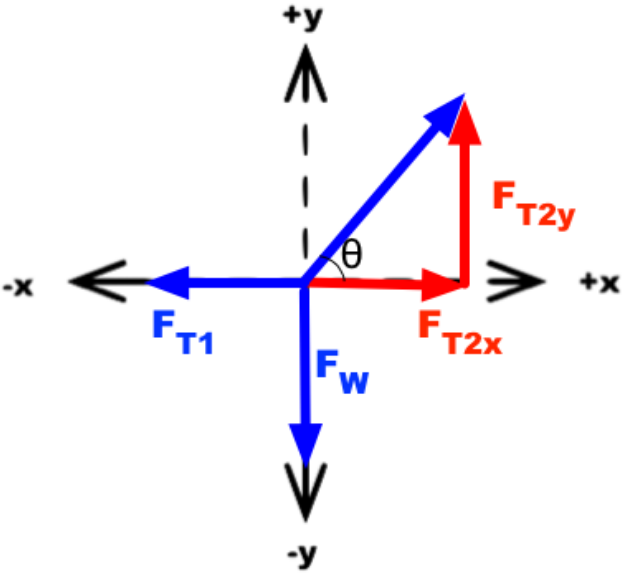
You can use the fact that…

all forces must cancel out in the x &
all forces must cancel out in the y

to deduce unknown forces and angles.

**Assuming that the painter is at rest and staying at rest...**

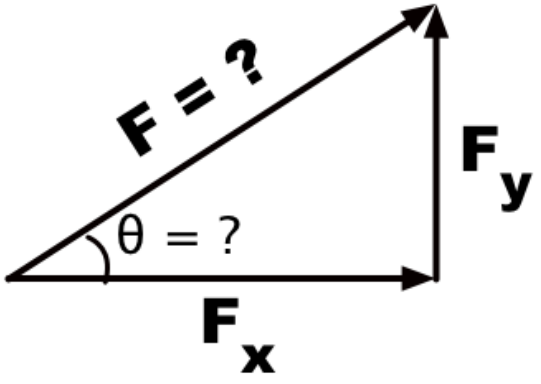



**What has to be true of $F_{T1}$ and $F_{T2x}$?**

**What has to be true of $F_{T2y}$ and $F_W$?**

**HOW TO GET THE ORIGINAL FORCE AND ANGLE FROM THE COMPONENTS.**

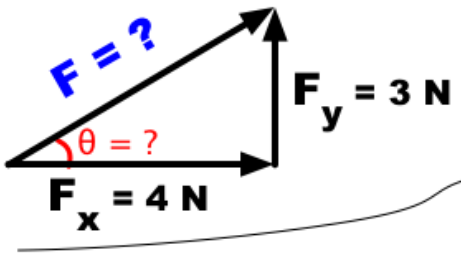



**Use Inverse-Tangent to get the angle.**

$$\theta = \tan^{-1}\left(\frac{F_X}{F_Y}\right)$$

**Use Pythagorean Theorem to get the original force.**

$$F = \sqrt{F_X^2 + F_Y^2}$$




**How to get the original force and angle from the components.**

**Use Pythagorean Theorem to get the original force.**

$$F = \sqrt{F_y^2 + F_x^2}$$

$$F = \sqrt{(3)^2 + (4)^2}$$

$$= \sqrt{(9) + (16)}$$

$$= \sqrt{(25)}$$

$$= 5 \text{ N}$$

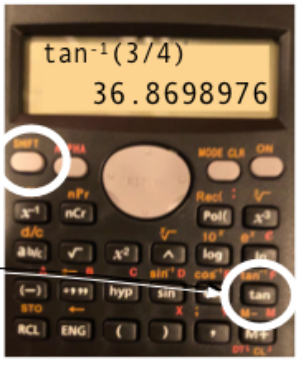
**Use Inverse-Tangent to get the angle.**

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$$

$$\theta = \tan^{-1}\left(\frac{3}{4}\right)$$

$$\theta = 36.9°$$

Inverse tangent on most calculators is Shift-Tan or 2nd-Tan



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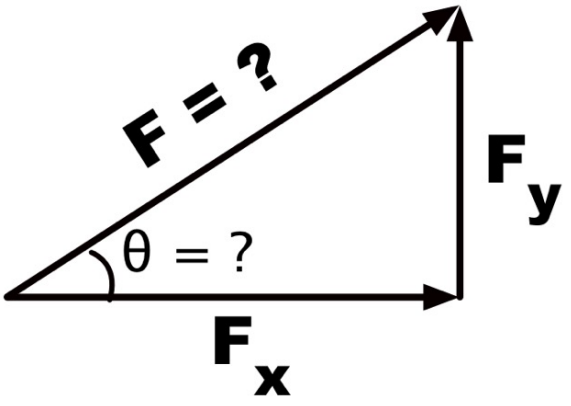


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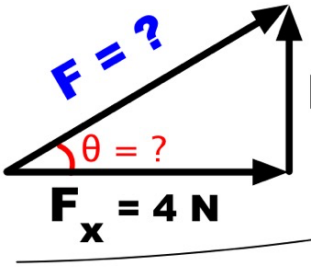


## How to get the original force and angle from the components.

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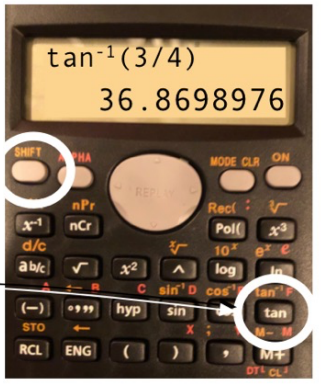
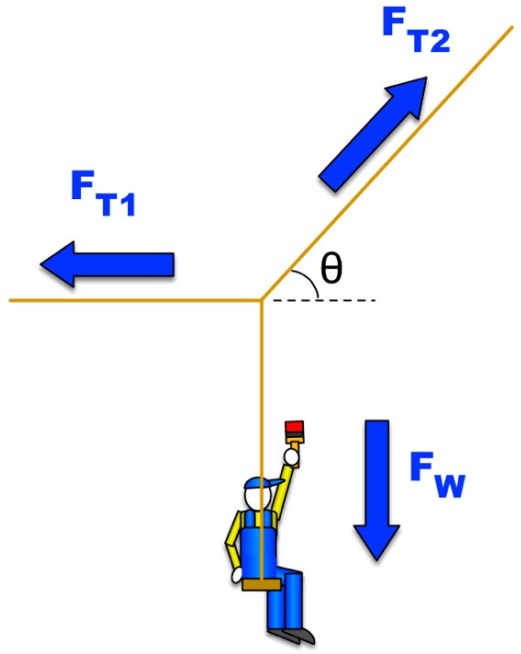
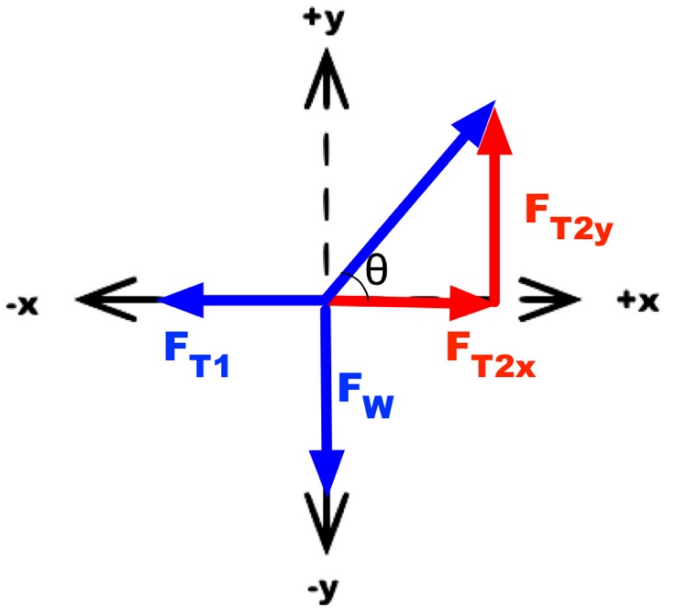


**Assuming that the painter is at rest and staying at rest...**

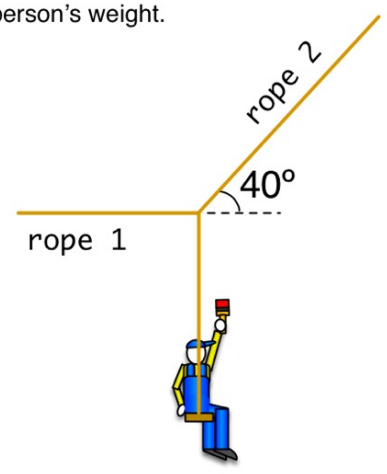


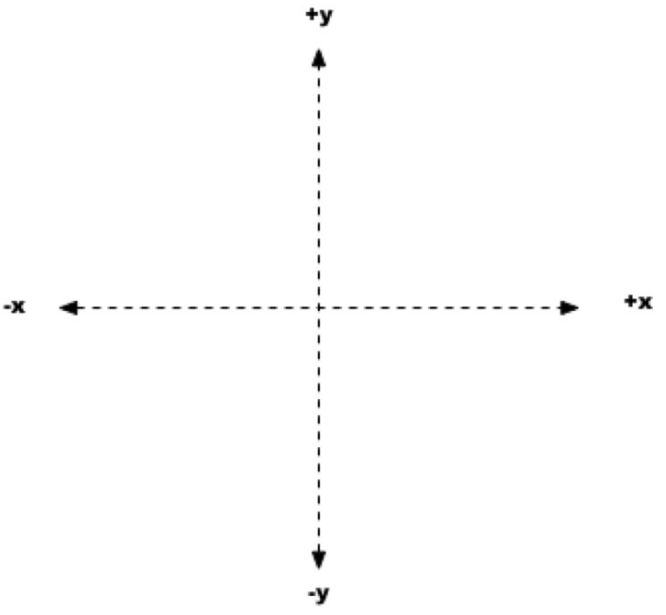




**What has to be true of $F_{T1}$ and $F_{T2x}$?**

**What has to be true of $F_{T2y}$ and $F_W$?**

The person is at rest and staying at rest, and not touching the ground. The tension in rope 2 is 800 N. Determine the tension in rope 1 and the person's weight.



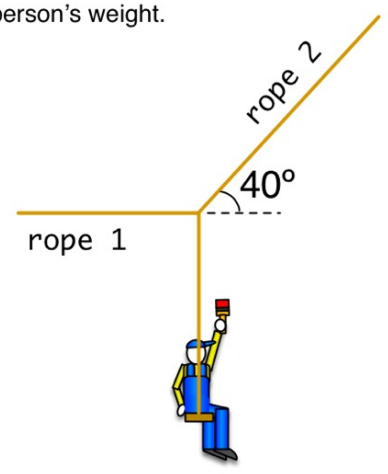




| X Net Force | Y Net Force |
|---|---|
| | |

☐ gaining speed.
☐ constant speed.
☐ losing speed.

☐ gaining speed.
☐ constant speed.
☐ losing speed.

The person is at rest and staying at rest, and not touching the ground. The tension in rope 2 is 800 N. Determine the tension in rope 1 and the person's weight.




$$\frac{Fx}{F} = \cos(\theta)$$

$$\frac{Fx}{800\ N} = \cos(40°)$$

$$\frac{Fx}{800\ N} = 0.766$$

$$Fx = (0.766)(800\ N)$$

$$Fx = 612.8\ N$$

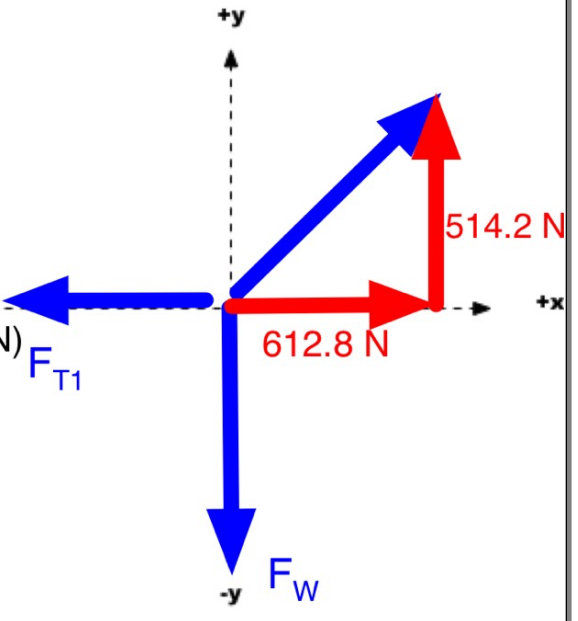
$$\frac{Fy}{F} = \sin(\theta)$$

$$\frac{Fy}{800\ N} = \sin(40°)$$

$$\frac{Fy}{800\ N} = 0.643$$

$$Fy = (0.643)(800\ N)$$

$$Fy = 514.2\ N$$




Since the forces in the x have to cancel out, $F_{T1}$ must equal 612.8 N

Since the forces in the y have to cancel out, $F_W$ must equal 514.2 N

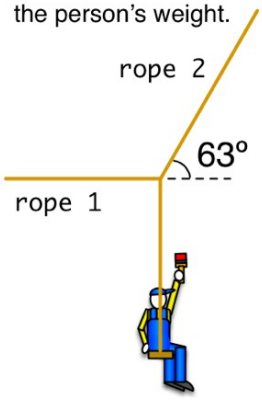
| X Net Force |
|---|
| 0 |

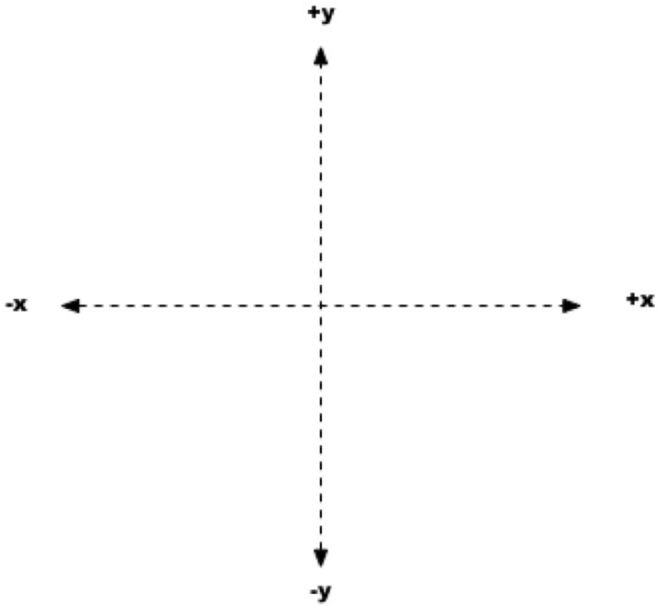
☐ gaining speed.
☒ constant speed.
☐ losing speed.

| Y Net Force |
|---|
| 0 |

☐ gaining speed.
☒ constant speed.
☐ losing speed.

The person is at rest and staying at rest, and not touching the ground. The tension in rope 2 is 1,000 N. Determine the tension in rope 1 and the person's weight.



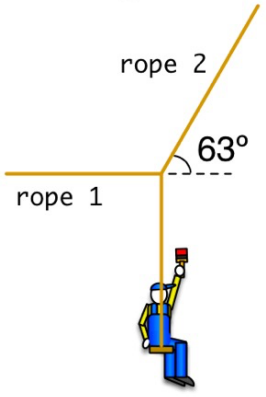




| X Net Force | Y Net Force |
|---|---|
| | |

☐ gaining speed.
☐ constant speed.
☐ losing speed.

☐ gaining speed.
☐ constant speed.
☐ losing speed.

The person is at rest and staying at rest, and not touching the ground. The tension in rope 2 is 1,000 N. Determine the tension in rope 1 and the person's weight.




$$\frac{Fx}{F} = \cos(\theta)$$

$$\frac{Fx}{1000\ N} = \cos(63°)$$

$$\frac{Fx}{1000\ N} = 0.454$$

$$Fx = (0.454)(1000\ N)$$

$$Fx = 454\ N$$

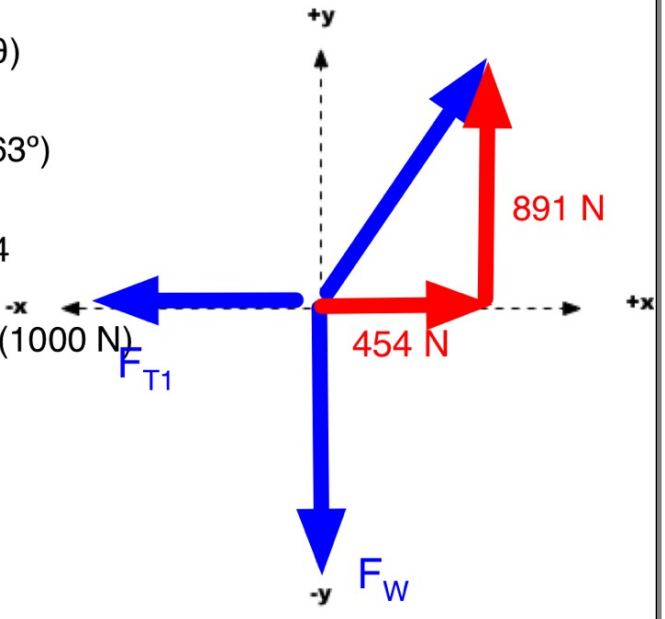
$$\frac{Fy}{F} = \sin(\theta)$$

$$\frac{Fy}{1000\ N} = \sin(63°)$$

$$\frac{Fy}{1000\ N} = 0.891$$

$$Fy = (0.891)(1000\ N)$$

$$Fy = 891\ N$$




Since the forces in the x have to cancel out, $F_{T1}$ must equal 454 N

Since the forces in the y have to cancel out, $F_W$ must equal 891 N

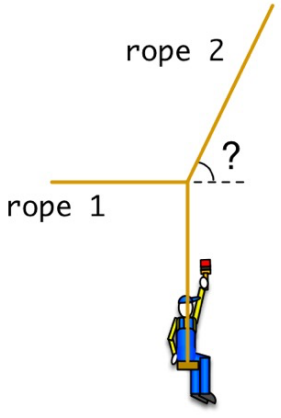
| X Net Force |
|---|
| 0 |

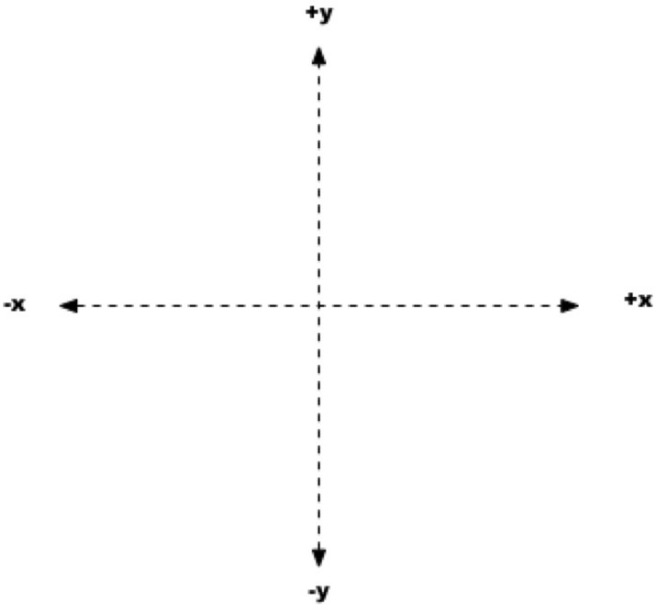
☐ gaining speed.
☒ constant speed.
☐ losing speed.

| Y Net Force |
|---|
| 0 |

☐ gaining speed.
☒ constant speed.
☐ losing speed.

The person is at rest and staying at rest, and not touching the ground. The tension in rope 1 is 600 N and the painter weighs 850 N. Determine the tension in rope 2 and the angle.



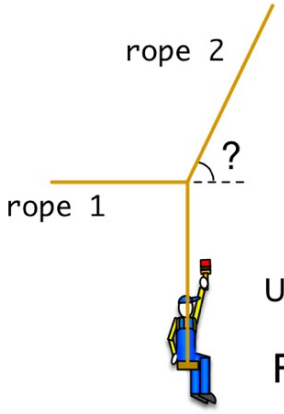



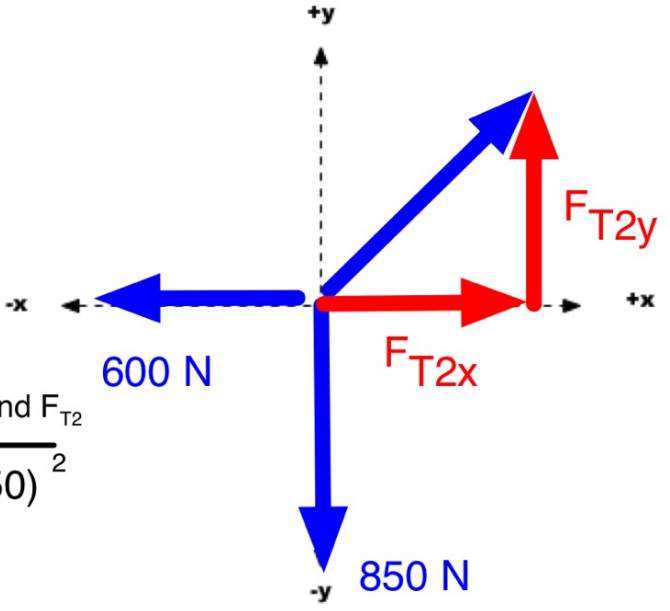

| X Net Force | Y Net Force |
|---|---|
| | |

☐ gaining speed.
☐ constant speed.
☐ losing speed.

☐ gaining speed.
☐ constant speed.
☐ losing speed.

The person is at rest and staying at rest, and not touching the ground. The tension in rope 1 is 600 N and the painter weighs 850 N. Determine the tension in rope 2 and the angle.




Use Pythag. Theo. to find $F_{T2}$

$$F_{T2} = \sqrt{(600)^2 + (850)^2}$$

$$F_{T2} = 1040.4 \text{ N}$$

| X Net Force | Y Net Force |
|---|---|
| 0 | 0 |

☐ gaining speed.
☒ constant speed.
☐ losing speed.

☐ gaining speed.
☒ constant speed.
☐ losing speed.

Use Inverse Tangent to find the angle

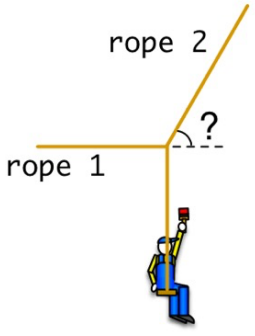
$$\theta = \tan^{-1}\left(\frac{600}{850}\right)$$

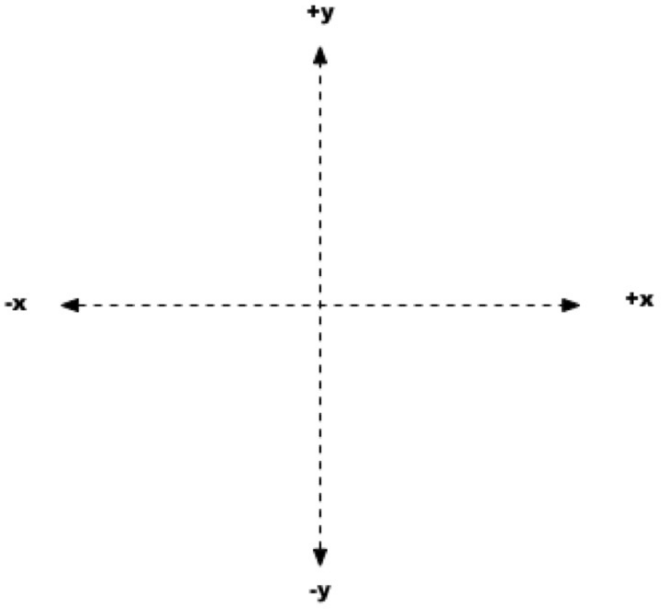
$$\theta = 35.2°$$

Since the forces in the x have to cancel out, $F_{T2x}$ must equal 600 N

Since the forces in the y have to cancel out, $F_{T2y}$ must equal 850 N

The person is at rest and staying at rest, and not touching the ground. The tension in rope 1 is 500 N and the painter weighs 900 N. Determine the tension in rope 2 and the angle.




| X Net Force | Y Net Force |
|---|---|
| | |

| | |
|---|---|
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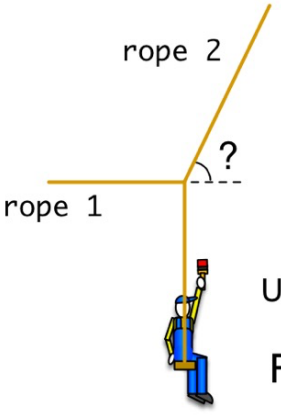


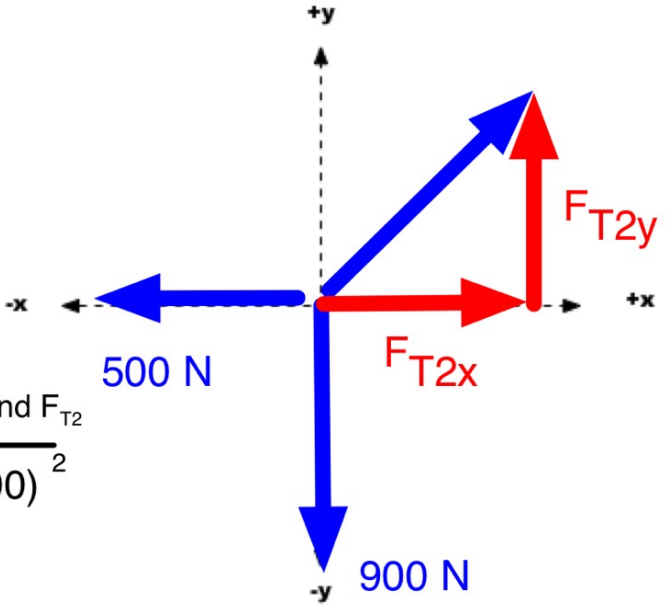


Use Pythag. Theo. to find $F_{T2}$

$$F_{T2} = \sqrt{(500)^2 + (900)^2}$$

$$F_{T2} = 1030 \text{ N}$$

Use Inverse Tangent to find the angle

$$\theta = \tan^{-1}\left(\frac{900}{500}\right)$$

$$\theta = 61°$$

| X Net Force | Y Net Force |
|---|---|
| 0 | 0 |

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☐ losing speed.

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Since the forces in the x have to cancel out, $F_{T2x}$ must equal 500 N

Since the forces in the y have to cancel out, $F_{T2y}$ must equal 900 N