9/5/2019 & 9/6/2019 → Mole Review and Hanging Weight

To calculate the # of grams per mole you use the atomic masses found on the periodic Table.

Oxygen has an atomic mass of approxiamately 16 amu/atom (atomic mass units per atom)

Hydrogen has an atomic mass of approxiamately 1 amu/atom

The chemical formula for water is H_2O (2 hydrogens and 1 Oxygen) so.....

$$(16)(1) + (2)(1) = 18 \text{ amu/atom}$$

O atomic mass → (16); # of oxygens → (1); # of Hydrogens → (2); H atomic mass → (1)

The ratio of amu/atom is equivalent to the ratio of g/mol so....

18 g/mol is the grams per mole ratio for Water

therefore to calculate the # of ~~[illegible]~~ grams in 1 mole of water we do the following

$$\frac{18\text{ g}}{\cancel{\text{mol}}}\;\Big|\;1\,\cancel{\text{mol}} = 18\text{ g}$$

A mole of something is 6.022×10^{23} of that something (see slides for more details)

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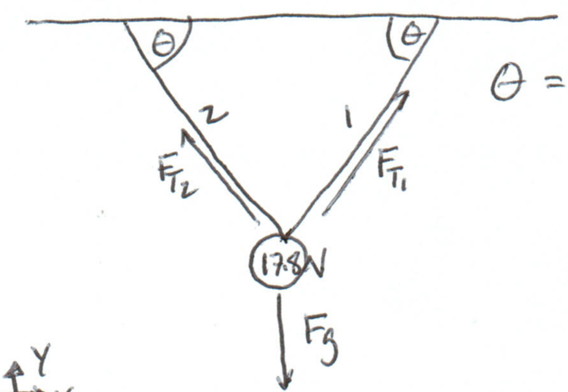
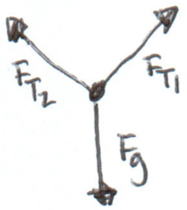
Hanging Weight Problem

What are the tension Forces?

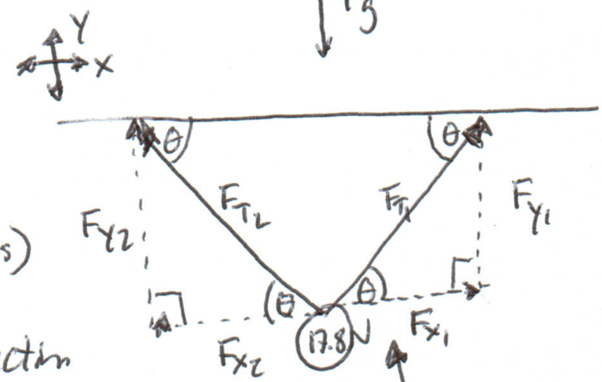


$\theta = 60^\circ$

Free Body Diagrams



The Free Body Diagram we get when we Break out the parts (or components) of the F_T forces in the x and y direction



θ is the same due to alternate interior angles

Because the weight is not accelerating (in fact it isn't moving at all) the net Force acting of the weight is zero

$$a = 0 \Rightarrow F_{net} = m \cdot a = m \cdot 0 = 0$$

In order for the net Force to be zero the sum of Forces in the x and y directions also must be zero...

the sum of $\rightarrow \sum F_x = F_{x_1} + F_{x_2} = 0$ $\qquad \sum F_y = F_{y_1} + F_{y_2} + F_g = 0$

from our drawing and FBD

We need to get F_{x_1}, F_{x_2}, F_{y_1} and F_{y_2} in terms of F_{T_1} and F_{T_2}. First because we have too many variables and too few equations. Second because we are looking for the tension forces.

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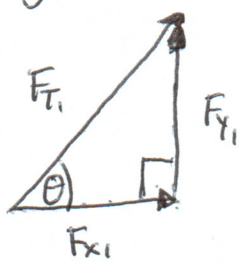
Let's start with the Forces in the x-direction.

Looking Back at our picture we can see that the F_T vectors for a right triangle with the Fx and Fy vectors. see picture for string 1.



we need F_{x_1} in terms of F_{T_1}.
The relationship between F_{x_1} and F_{T_1} is

$$\cos\theta = F_{x_1}/F_{T_1}$$

solve for F_{x_1} by multiplying both sides by F_{T_1}

$$F_{T_1} \cdot \cos\theta = \frac{F_{x_1}}{\cancel{F_{T_1}}} \cdot \cancel{F_{T_1}}$$

$$F_{T_1} \cos\theta = F_{x_1}$$

You can see Looking at the 2nd string that it will have the same relationship.

$$-F_{T_2} \cos\theta = F_{x2}$$

negative b/c F_{x2} is in negative x direction

So the $\sum F_x$ (sum of forces in the x direction) becomes

$$\sum F_x = F_{T_1} \cos\theta + -F_{T_2} \cos\theta = 0$$

Now for the Forces in the y direction... String 1 again

we need F_{Y_1} in terms of F_{T_1}. We can use the same right triangle pictured above and see the relationship between F_{Y_1} and F_{T_1} is

$$\sin\theta = F_{Y_1}/F_{T_1}$$

solve for F_{Y_1} by multiplying both sides by F_{T_1}

$$F_{T_1} \cdot \sin\theta = \frac{F_{Y_1}}{F_{T_1}} \cdot F_{T_1}$$

$$F_{T_1} \sin\theta = F_{Y_1}$$

the same is true for the 2nd String : $F_{Y2} = \sin\theta \, F_{T_2}$

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This gives us the following for the sum of forces in the y direction

$$\sum F_y = F_{T_1} \sin\theta + F_{T_2} \sin\theta + F_g = 0$$

but we know $F_g = -17.8\,N$ ← pointing in negative y direction

$$\sum F_y = F_{T_1} \sin\theta + F_{T_2} \sin\theta - 17.8N = 0$$

Now with our $\sum F_x = F_{T_1} \cos\theta + -F_{T_2} \cos\theta = 0$ we have two equations and two unknowns. We will use the substitution Method to solve this system.

Starting with our x equation...

$$F_{T_1} \cos\theta - F_{T_2} \cos\theta = 0$$
$$+F_{T_2} \cos\theta \quad + F_{T_2} \cos\theta$$

$$F_{T_1} \cancel{\cos\theta} = F_{T_2} \cancel{\cos\theta}$$

θ is the same the the cosθ's cancel out

$$F_{T_1} = F_{T_2}$$

Now I can plug F_{T_1} in for F_{T_2} in the y direction Equation

$$\sum F_y = F_{T_1} \sin\theta + F_{T_1} \sin\theta - 17.8N = 0$$

combine like terms and put in $\theta = 60°$

$$2 F_{T_1} \sin(60) - 17.8 = 0$$

$$\sin(60) = \frac{\sqrt{3}}{2}$$

$$\cancel{2} \cdot \frac{\sqrt{3}}{\cancel{2}} F_{T_1} - 17.8N = 0$$

(Add 17.8 to both sides and divide by $\sqrt{3}$)

$$\sqrt{3}\, F_{T_1} - 17.8N = 0$$

$$F_{T_1} = \frac{17.8}{\sqrt{3}} N = 10.27\,N = F_{T_2}$$ ← tension forces are equal

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