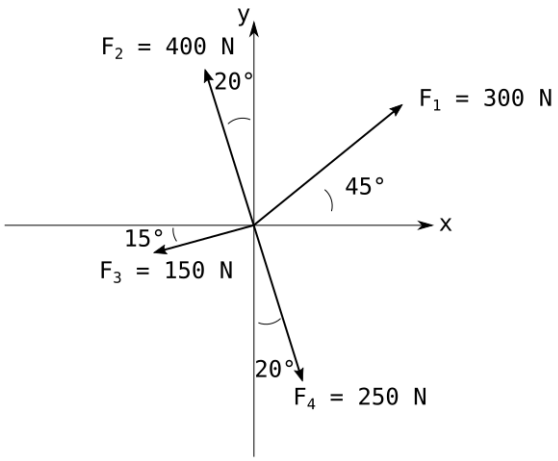
AEM 2011 Homework #1 Tuesday, January 17, 2023

Unless otherwise mentioned, these problems should be solvable using a basic calculator. Practice clear communication by showing all work (free body diagrams, algebra, etc). This will be required to receive full credit on any graded problems.

1. Vector $\mathbf{A} = 200N\angle 45^\circ$ counterclockwise from the x axis, and vector $\mathbf{B} = 300N\angle 70^\circ$ counterclockwise from the y axis.

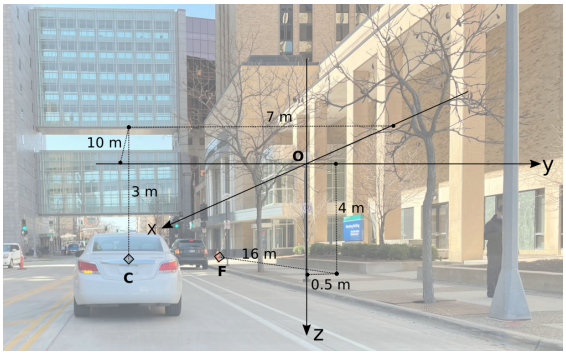
   Draw the vectors and find the resultant $\mathbf{R} = \mathbf{A} + \mathbf{B}$ by addition of scalar components.

2. Resolve each of the four vectors into x-components and y-components.

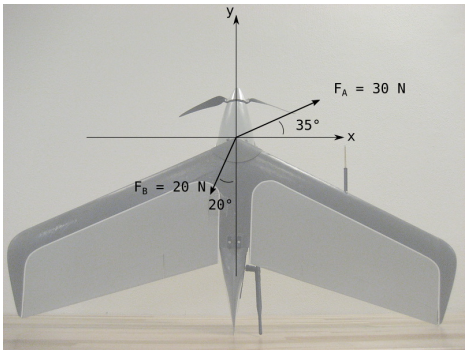


3. The City of Rochester installs a sensor atop a lamppost to monitor walking, biking, and car traffic patterns. To validate the installation, you want to compare the sensor output with measurements made using an alternate reference sensor, as shown in the image. Write out the position vector from the sensor origin to the:

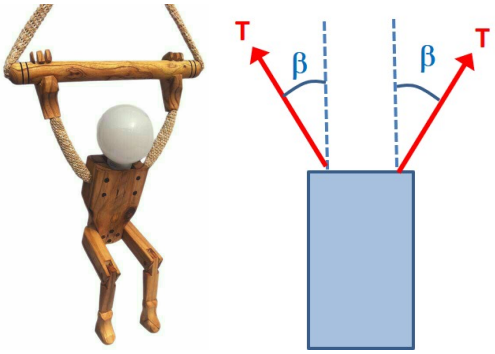
   - Fire Hydrant ($\mathbf{r}_{OF}$)
   - Car Emblem ($\mathbf{r}_{OC}$)



4. The wing-to-body connection of a survey UAV is tested by simultaneously applying the two forces shown. Using the graphical method of adding vectors, find the resultant of the two forces $\bar{\mathbf{F}}_A$ and $\bar{\mathbf{F}}_B$.



5. The figure below shows a hanging robot lamp and a simplified diagram of the hanging robot. The weight of the robot is $W = 4N$. The tension T in each robot arm acts at an angle $\beta = 25°$ from vertical. What is the tension T so that the total vertical force from the two arms balances the downward weight W of the robot?



6. A skid-steer loader breaks down at a job site. Two tow ropes are attached pulling along AB and AC. The tension in rope AB is $3kN$. The goal is to pull along AC such that a $4.8 - kN$ force is applied horizontally at point A, thereby pulling the skid-steer loader safely away from the job site.

   Determine the tension and direction (α) required to pull along AC to achieve this.

7. The Boeing 737-700 shown below has three main forces: a thrust force T from the engines, weight W, and a lift force L due to the airflow over the wings. The airplane has a mass of 40,000kg and the two engines produce a combined thrust force of $T = 200kN$ at an angle of $\alpha = 3°$ from horizontal. Assume that the aircraft is in a steady flight (no acceleration) so that the sum of the three forces is zero. Use trigonometry to determine the magnitude and direction of the force L required to achieve this steady flight condition.

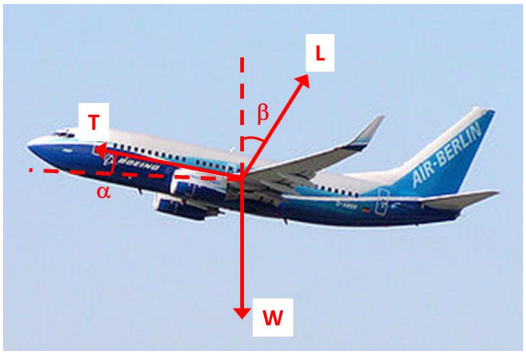


Figure 1: Free-body Diagram of Boeing 737-700 (Photo due to Arcturus)

8. A lift has the loading shown at point B. Find the required force in member AB to support this loading, knowing that the resultant of the three forces at point B must be directed along AB.