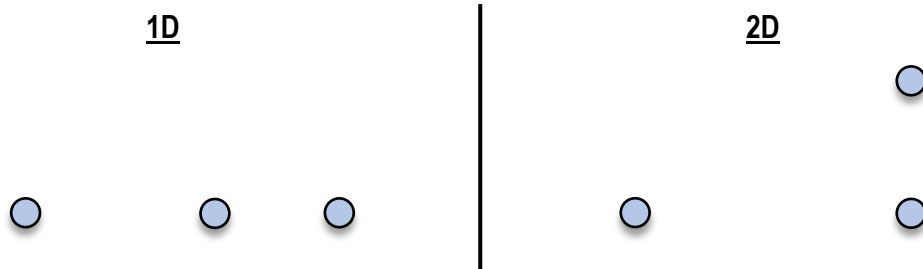
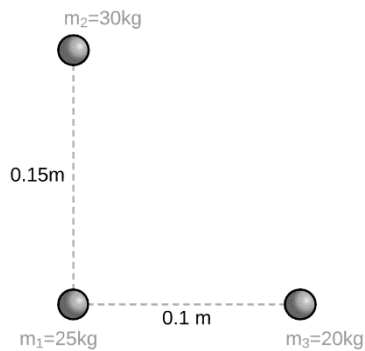


CONCEPT: Gravitational Forces in 2D

- To solve for net forces in non-linear arrangements, we must use _____.
- Remember that gravity is a force/vector, so we can break it up into its _____.



EXAMPLE: Calculate the magnitude and direction of the net gravitational force on m_1 in the figure. Assume point masses.

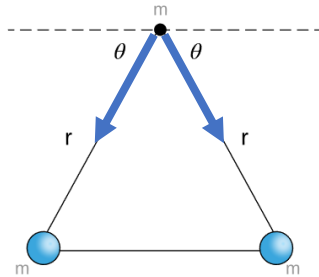


Point Masses

$$F_G = \frac{Gm_1m_2}{r^2}$$

CONCEPT: Using Symmetry in 2D Gravitation

- When given equal masses & distances, use symmetry to cancel out vector components.

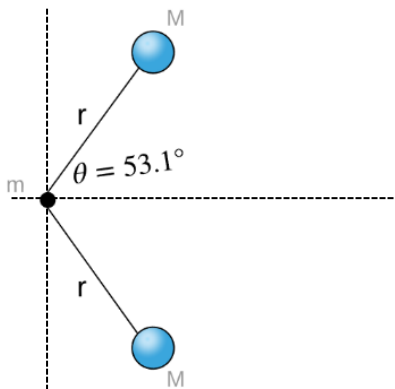


VECTOR EQUATIONS

$F_x = F \cos(\theta)$
$F_y = F \sin(\theta)$
$F = \sqrt{F_x^2 + F_y^2}$
$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

- Same **m's**, **r's** → same _____
- Same **F_G**, **θ** → same _____ → cancel if opposite!

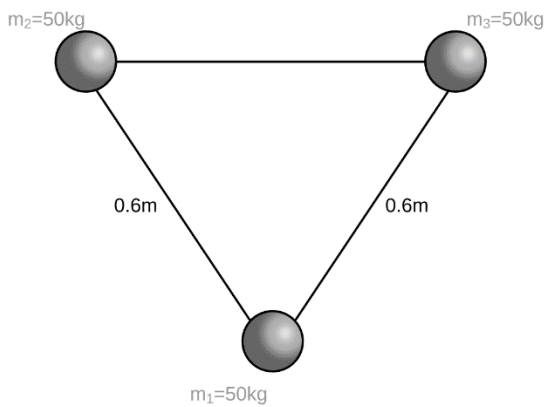
EXAMPLE: In the figure below, what is the net gravitational force on mass **m** if it feels a 5N force from each **M** on the right?



CONCEPT: Finding Net Forces in 2D Gravitation

- To solve 2D Gravitation problems, combine Newton's Law of Gravity (F_G), vector addition, and symmetry.

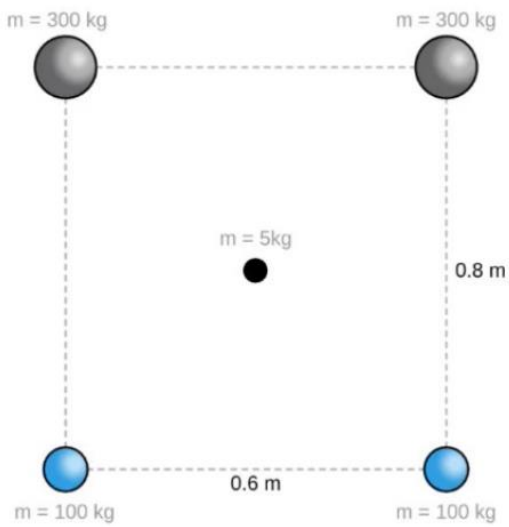
EXAMPLE: Three 50-kg masses are arranged in an equilateral triangle with side length 0.6m. Find the magnitude and direction of the net gravitational force on the bottom mass. (Equilateral triangles have 60° angles between their sides.)



STEPS FOR 2D GRAV.

- 1) Label Forces
- 2) Calculate Forces
- 3) Decompose & Symmetry
- 4) Add Components $\rightarrow F_{\text{net}}$

PRACTICE: Find the magnitude & direction of the net gravitational force on the center 5-kg mass in the rectangle below.



STEPS FOR 2D GRAV.
1) Label Forces
2) Calculate Forces
3) Decompose & Symmetry
4) Add Components $\rightarrow F_{\text{net}}$