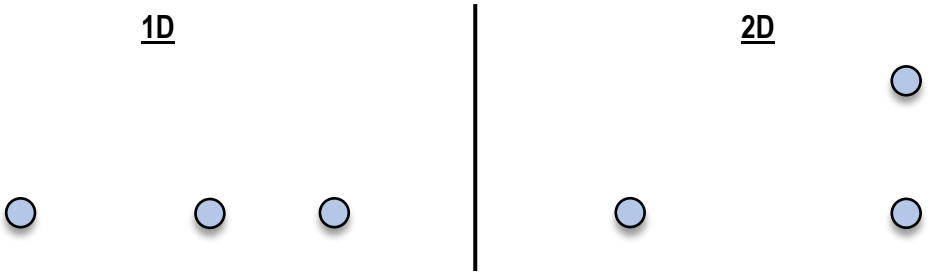
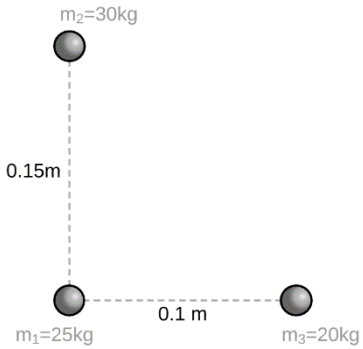
CONCEPT: Gravitational Forces in 2D

● 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 _____.



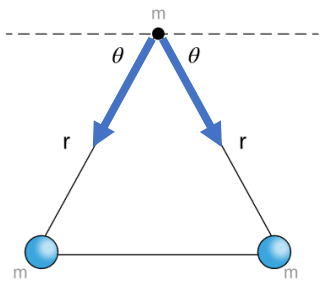
EXAMPLE: Calculate the magnitude and direction of the net gravitational force on m_1 in the figure. Assume point masses.



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

$F_x = F\cos(\theta)$

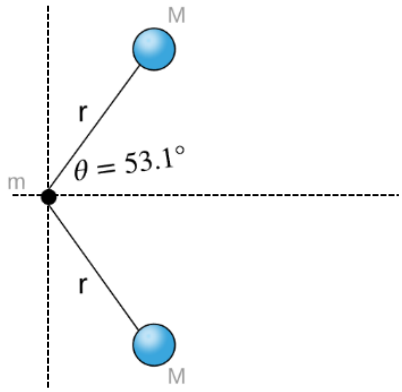
$F_y = F\sin(\theta)$

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

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

- Same **m's**, **r's** → same _____
- Same $\mathbf{F_G}$, **Θ** → same _____ → cancel if opposite!

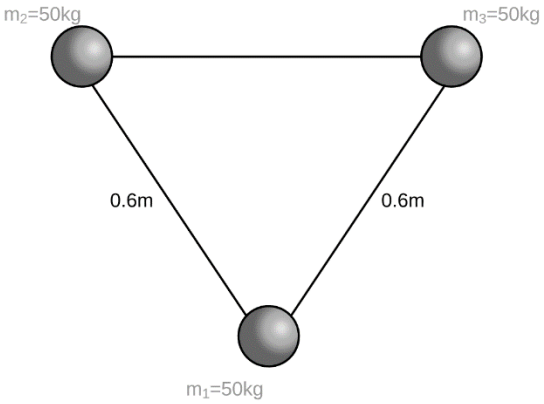
EXAMPLE: In the figure below, what is the net gravitational force on mass **m** if it feels a 5N force from each **M** on the right?



CONCEPT: Finding Net Forces in 2D Gravitation

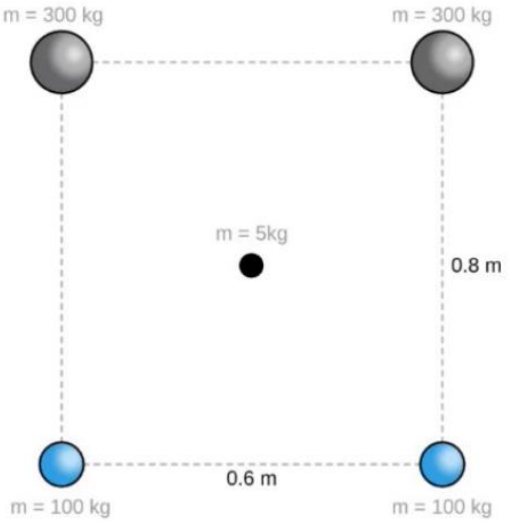
● To solve 2D Gravitation problems, combine Newton's Law of Gravity (F_G), vector addition, and symmetry.

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 → F_{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
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