Question #45368, Physics, Mechanics | Kinematics | Dynamics

What are the magnitude and the direction of the net gravitational force on the 20.0 kg mass in the figure? Give the direction as an angle.

Solution:



$$\begin{split} M &= 20 kg - \text{first mass;} \\ m &= m_1 = m_2 = 10 kg - \text{second mass;} \\ \text{The center of the 10 kg mass from 20 kg mass is at a distance given by (Pythagorean theorem for the right triangle)} \end{split}$$

$$d^{2} = (20 \text{ cm})^{2} + (5 \text{ cm})^{2}$$

$$d = \sqrt{(20 \text{ cm})^{2} + (5 \text{ cm})^{2}} = 20.62 \text{ cm} = 0.2062 \text{ m}$$

From the right triangle:

$$\cos \theta = \frac{20 \text{ cm}}{d} = \frac{20 \text{ cm}}{20.6 \text{ cm}} = 0.97$$

The gravitational force on 20 kg due to one 10 kg is

$$F_1 = G \frac{M \cdot m}{d^2}$$

The horizontal component of this force is nullified by the horizontal component of the force due to the other 10 kg mass. The vertical components add up, thus direction of the net gravitational force is the same direction of the vector y (upwards), angle with vertical is zero.

Hence the resultant gravitational force on the 20 kg is

$$F_{\text{net}} = 2 \cdot F_{1x} = 2 \cdot \left(G \frac{M \cdot m}{d^2} \cdot \cos \theta\right) = 2 \cdot \left(6.67 \cdot 10^{-11} \frac{N \cdot m^2}{\text{kg}^2}\right) \frac{20 \text{ kg} \cdot 10 \text{ kg}}{(0.2062 \text{ m})^2} \cdot 0.97 = 6.087 \cdot 10^{-7} \text{ N}$$

Answer: magnitude of the net gravitational force: $6.087 \cdot 10^{-7}$ N Direction: same direction of the vector y (upwards), angle with vertical is 0°.

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