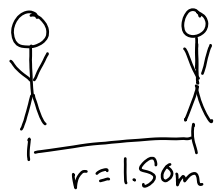


Worksheet 5.1 - Newton's Law of Universal Gravitation

1) Two students are sitting 1.50 m apart. One student has a mass of 70.0 kg and the other has a mass of 52.0 kg. What is the gravitational force between them?



$$F_g = \frac{GMm}{r^2}$$

$$= \frac{(6.67 \times 10^{-11})(70.0)(52.0)}{(1.50)^2}$$

$$= \underline{\underline{1.08 \times 10^{-7} \text{ N}}}$$

2) What gravitational force does the moon produce on the Earth if their centers are 3.88×10^8 m apart and the moon has a mass of 7.34×10^{22} kg?

$$F_g = \frac{GMm}{r^2}$$

$$= \frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})(7.34 \times 10^{22})}{(3.88 \times 10^8)^2}$$

$$= \underline{\underline{1.94 \times 10^{20} \text{ N}}}$$

3) If the gravitational force between objects of equal mass is 2.30×10^{-8} N when the objects are 10.0 m apart, what is the mass of each object?

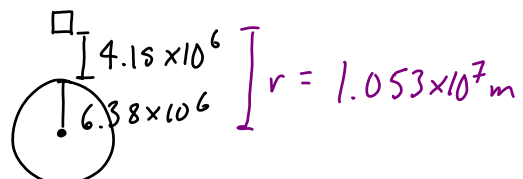
$$F_g = \frac{GMm}{r^2} \quad M = m$$

$$\therefore F_g = \frac{Gm^2}{r^2}$$

$$m = \sqrt{\frac{F_g r^2}{G}} = \sqrt{\frac{(2.30 \times 10^{-8})(10.0)^2}{6.67 \times 10^{-11}}}$$

$$= \underline{\underline{186 \text{ kg}}}$$

4) Calculate the gravitational force on a 6.50×10^4 kg that is 4.15×10^6 m above the surface of the Earth?



$$F_g = \frac{GMm}{r^2} = \frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})(6.50 \times 10^4)}{(1.053 \times 10^7)^2}$$

$$= \underline{\underline{2340 \text{ N}}}$$

5) The gravitational force between two objects that are 2.1×10^{-1} m apart is 3.2×10^{-6} N. If the mass of one object is 55 kg what is the mass of the other object?

$$F_g = \frac{GMm}{r^2}$$

$$M = \frac{F_g r^2}{Gm} = \frac{(3.2 \times 10^{-6})(2.1 \times 10^{-1})^2}{(6.67 \times 10^{-11})(55)}$$

$$= \underline{\underline{38 \text{ kg}}}$$

6) If two objects, each with a mass of 2.0×10^2 kg, produce a gravitational force between them of 3.7×10^{-6} N. What is the distance between them?

$$F_g = \frac{GMm}{r^2}$$

$$r = \sqrt{\frac{GMm}{F_g}}$$

$$= \sqrt{\frac{(6.67 \times 10^{-11})(2.0 \times 10^2)(2.0 \times 10^2)}{3.7 \times 10^{-6}}}$$

$$= \underline{\underline{0.85 \text{ m}}}$$

7) What is the gravitational force acting on a 70.0 kg object standing on the Earth's surface?

$$F_g = mg$$

$$= (70.0)(9.80)$$

$$= \underline{\underline{686 \text{ N}}}$$

8) What is the gravitational force on a 35.0 kg object standing on the Earth's surface?

(You can use your answer from #7 to reduce your calculations)

Since $F_g \propto m$
and $m_2 = \frac{1}{2} m_1$

$$F_g = 343 \text{ N}$$

9) What is the gravitational force on a 70.0 kg that is $6.38 \times 10^6 \text{ m}$ above the Earth's surface?

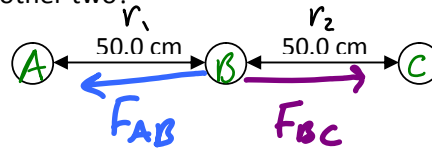
(You can use your answer from #7 to reduce your calculations)

$$F_{g1} = \frac{GMm}{r^2} = 686 \text{ N}$$

$$F_{g2} = \frac{GMm}{(2r)^2} = 4 \frac{GMm}{r^2}$$

$$= \frac{686}{4} = \underline{\underline{172 \text{ N}}}$$

10) Three objects each with a mass of 10.0 kg are placed in a straight line 50.0 cm apart. What is the net gravitational force on the center object due to the other two?



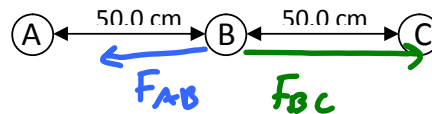
Since $m_A = m_C$

and $r_1 = r_2$

then $F_{AB} = F_{BC}$

$$\boxed{\therefore F_{\text{net}} = 0}$$

11) Three objects A, B, C are placed 50.0 cm apart along a straight line. A and B have a mass of 10.0 kg, while C has a mass of 15.0 kg. What is the net force on B due to A and C?



$$F_{BC} = \frac{Gm_B m_C}{r_2^2} = 4.00 \times 10^{-8} \text{ N}$$

$$F_{AB} = \frac{Gm_A m_B}{r_1^2} = 2.67 \times 10^{-8} \text{ N}$$

$$F_{\text{net}} = F_{BC} - F_{AB}$$

$$= \underline{\underline{1.33 \times 10^{-8} \text{ N}}}$$