

SOLUTIONS

Universal Gravitation examples

CONVERT TO
↓ METRES

1. What is the force of gravity between a 60 kg student and a 50 kg student if they are 30.0 cm apart?

$$F_g = ? \quad F_g = \frac{G M_1 M_2}{d^2}$$

$$m_1 = 50 \text{ kg} \quad = \frac{(6.67 \times 10^{-11} \frac{\text{N} \cdot \text{m}^2}{\text{kg}^2})(50)(60)}{(0.30 \text{ m})^2} = 2.2 \times 10^{-6} \text{ N}$$

$$m_2 = 60 \text{ kg}$$

$$d = 0.30 \text{ m}$$

2. What is the force of gravity between the moon and the earth? (mass of the moon is 7.35×10^{22} kg, mass of the earth is 5.98×10^{24} kg, distance between moon and earth is 3.84×10^8 m)

$$F_g = \frac{G M_1 M_2}{d^2} = \frac{(6.67 \times 10^{-11}) (7.35 \times 10^{22}) (5.98 \times 10^{24})}{(3.84 \times 10^8)^2}$$

$$= 1.99 \times 10^{20} \text{ N} = 2.0 \times 10^{20} \text{ N}$$

3. What is the distance between two 5000.0 kg masses if the force of attraction is 6.67×10^{-7} N?

$$d = ? \quad F_g = \frac{G M_1 M_2}{d^2}$$

$$F_g = 6.67 \times 10^{-7} \text{ N}$$

$$\therefore d = \sqrt{\frac{G M_1 M_2}{F_g}} = \sqrt{\frac{(6.67 \times 10^{-11}) (5000)(5000)}{6.67 \times 10^{-7}}}$$

$$= 50 \text{ m}$$

4. What is the force of gravity:

a. On a 5000 kg mass at the earth's surface? (radius of the earth is 6400 km) = $6400000 \text{ m} = 6.4 \times 10^6 \text{ m}$

SINCE THE MASS IS ON THE EARTH'S SURFACE YOU CAN USE: $F_g = mg$

$$m = 5000 \text{ kg}$$

$$g = 9.8 \text{ m/s}^2$$

$$F_g = mg = (5000 \text{ kg})(9.8 \text{ m/s}^2) = 4.9 \times 10^4 \text{ N}$$

b. On this mass if it is 5 times the radius of the earth away (from the center of the earth)?

$$d_2 = 5d_1$$

$$F_1 = 4.9 \times 10^4 \text{ N (at EARTH'S SURFACE)}$$

$$F_2 = ?$$

$$F_2 = \left(\frac{d_1^2}{d_2^2}\right) F_1$$

$$= \frac{d_1^2}{(5d_1)^2} F_1 = \frac{1}{5^2} (4.9 \times 10^4 \text{ N})$$

$$= 2.0 \times 10^3 \text{ N}$$

c. On this mass if it is 64000 km from the center of the earth?

$$F_2 = ?$$

$$F_1 = 4.9 \times 10^4 \text{ N}$$

$$d_2 = 64000 \text{ km} = 10d_1$$

$$F_2 = \left(\frac{d_1^2}{d_2^2}\right) F_1$$

$$= \frac{d_1^2}{(10d_1)^2} F_1 = \frac{1}{10^2} (4.9 \times 10^4 \text{ N})$$

$$= 4.9 \times 10^2 \text{ N}$$

NOTE
 $d_1 = 6400 \text{ km}$