Worksheet: Newton's Law of Universal Gravitation

ANSWERS

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?

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = (6.67 \times 10^{-11})\frac{(70)(52)}{(1.5)^2}$$

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

2.

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

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = (6.67 \times 10^{-11})\frac{(7.34 \times 10^{22})(5.79 \times 10^{24})}{(3.88 \times 10^8)^2}$$

$$F = 1.94 \times 10^{20} N$$

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?

$$F = G\frac{m_1 m_2}{d^2}$$

$$2.30 \times 10^{-8} = (6.67 \times 10^{-11})\frac{mm}{(10)^2}$$

$$m^2 = \frac{(2.30 \times 10^{-8})(10)^2}{(6.67 \times 10^{-11})}$$

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

$$m = 185.7kg$$

4.

Calculate the gravitational force on a 6.50×10^2 kg that is 4.15×10^6 m above the surface of the Earth?

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = (6.67 \times 10^{-11})\frac{(6.58 \times 10^2)(5.79 \times 10^{24})}{(6.371 \times 10^6 + 4.15 \times 10^6)^2}$$

$$F = 2340N$$

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?

$$F = G\frac{m_1 m_2}{d^2}$$

$$3.2 \times 10^{-6} = (6.67 \times 10^{-11})\frac{(55)m}{(0.21)^2}$$

$$m = \frac{(3.2 \times 10^{-6})(0.21)^2}{(6.67 \times 10^{-11})(55)}$$

$$m = 38.47kg$$

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?

$$F = G\frac{m_1 m_2}{d^2}$$

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

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

$$square\ root\ both\ sides$$

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

$$d = 0.85m$$

7.

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

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = (6.67 \times 10^{-11})\frac{(70)(5.97 \times 10^{24})}{(6.37 \times 10^{6})^2}$$

$$F = 687N$$

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)

Half of the mass means half of the force (directly proportional)

½ of 687 = 343.5 N

9.

What is the gravitational force on a 70.0 kg that is 6.38×10^6 m **above** the Earth's surface?

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

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = (6.67 \times 10^{-11})\frac{(70)(5.97 \times 10^{24})}{(6.371 \times 10^6 + 6.38 \times 10^6)^2}$$

$$F = 172N$$

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?

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = \left(6.67\times10^{-11}\right)\frac{(10)(10)}{(0.5)^2}$$

$$F = 2.67\times10^{-8}\,N$$

To the left

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = \left(6.67\times10^{-11}\right)\frac{(10)(10)}{(0.5)^2}$$

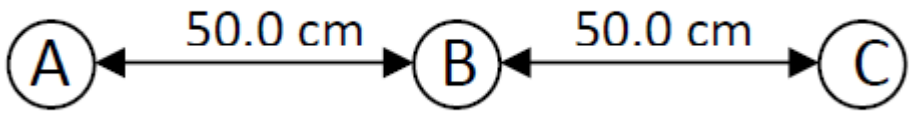
$$F = 2.67\times10^{-8}\,N$$

To the right

The net force at B is 0 N because the two forces cancel each other out.

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?



$$F = G\frac{m_1 m_2}{d^2}$$

$$F = \left(6.67\times10^{-11}\right)\frac{(10)(10)}{(0.5)^2}$$

$$F = 2.67\times10^{-8}\,N$$

To the left

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = \left(6.67\times10^{-11}\right)\frac{(15)(10)}{(0.5)^2}$$

$$F = 4.0\times10^{-8}\,N$$

To the right

The net force is (4.0 + (-2.67)) x 10^{-8} = 1.33 x 10^{-8} N