

## NEWTON'S LAW OF UNIVERSAL GRAVITATION

04 MARCH 2014



### Lesson Description

In this lesson we:

- Describe and explain Newton's Law of Universal Gravitation
- Demonstrate the acceleration due to gravity is independent of the mass of the object
- Solve problems involving Newton's Law of Universal Gravitation



### Summary

#### Newton's Law of Universal Gravitation

The force of attraction between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

As an equation:

$$F = \frac{Gm_1m_2}{r^2}$$

Where: F = force of attraction (N)

G = Universal Gravitational constant =  $6,67 \times 10^{-11} \text{ N.m}^2.\text{kg}^{-2}$

$m_1$  &  $m_2$  = mass of objects (kg)

r = distance between their centres (m)



### Test Yourself

#### Question 1

A feather and a coin are placed in a tube that contains very little air. These objects are allowed to fall from the top of the tube to the bottom of the tube. What can you say about the time taken for these objects to fall?

- A The feather takes longer to fall than the coin
- B The coin takes longer than the coin
- C The coin and feather hit the bottom of the tube at the same time
- D You cannot tell which object will fall faster

#### Question 2

An object experiences a force of 490N on earth. What force will the same object experience if it is placed on the surface of the moon? The acceleration due to gravity on the moon is one sixth of the acceleration due to gravity on the Earth.

- A 81,67N
- B 490N
- C 2940N
- D None of the above

**Question 3**

Two objects of mass  $M_1$  and  $M_2$  experience a force of attraction,  $F$  when placed a distance  $r$  away from each other. What will the force be in the mass of  $M_1$  is doubled and the distance  $r$  is doubled?

- A  $\frac{1}{4}F$
- B  $\frac{1}{2}F$
- C  $F$
- D  $2F$

**Question 4**

A learner plots a graph showing the relationship between the force of gravitational attraction and the distance between the centres of two masses. The graph is a straight line passing through the origin.

What is the label on the horizontal axis?

- A  $r^2$
- B  $r$
- C  $F$
- D  $\frac{1}{r^2}$



**Improve your Skills**

**Question 1**

The radius of the Earth is  $6,4 \times 10^8\text{m}$  and its mass,  $M$  is  $6,00 \times 10^{24}\text{kg}$ . Use Newton's Law of Universal Gravitation to calculate the acceleration of an object falling from the second floor of a building. Ignore the effect of air resistance.

**Question 2**

Calculate the magnitude of the force between a person with a mass of 100 kg and a person of mass 75 kg if they are 0,5 m apart.

**Question 3**

The force between a man with a mass of 100 kg, and the earth is 9800 N. If the mass of the earth is taken as  $6,00 \times 10^{24}$  kg, determine the radius of the earth in km

**Question 4**

An object has a mass of 48 kg. What gravitational force will this object experience if it is released from a height equal to twice the radius above the Earth? (The radius of the Earth is  $6,4 \times 10^8\text{m}$  and its mass,  $M$  is  $6,00 \times 10^{24}\text{kg}$ ).