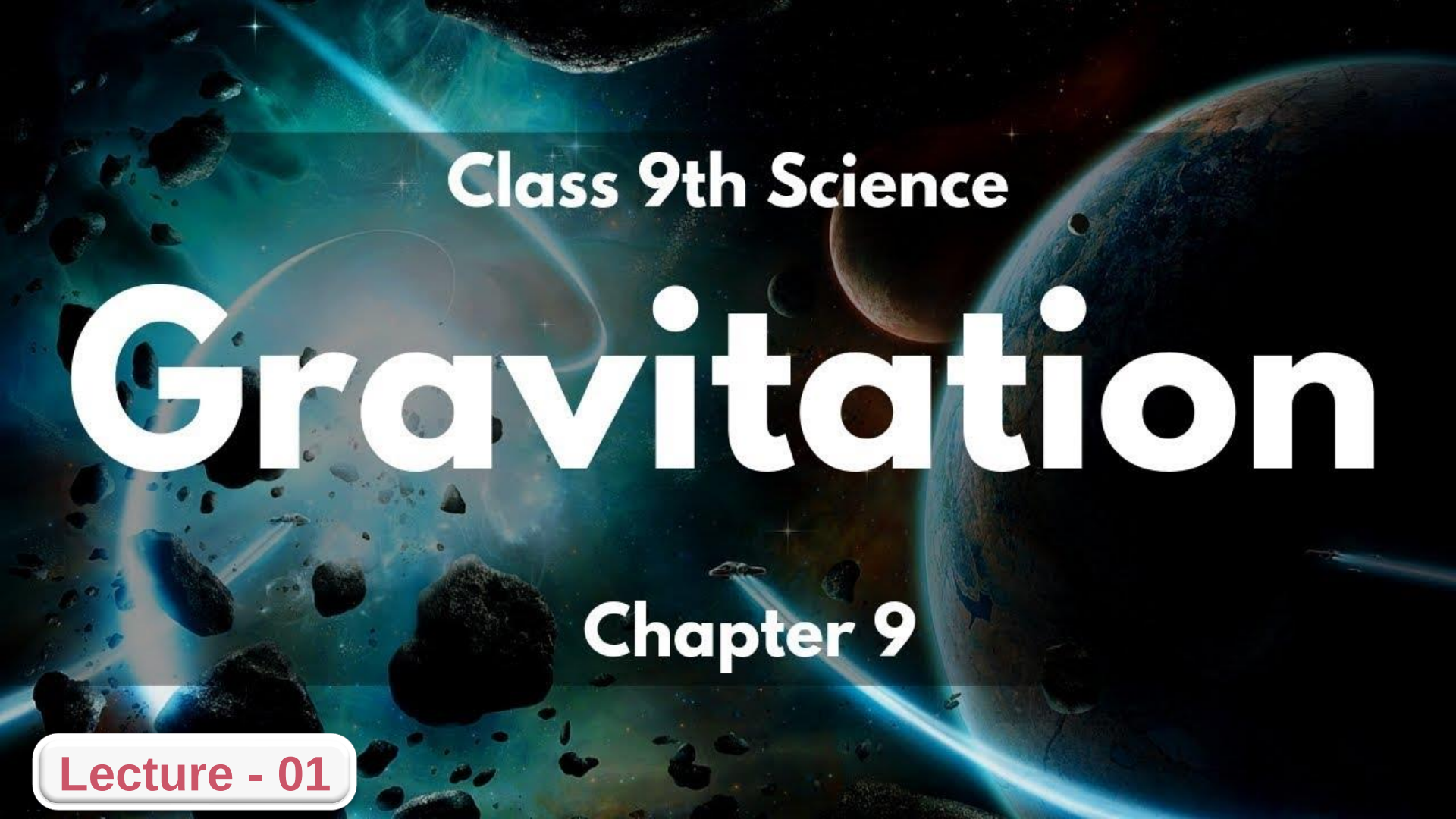

Class 9th Science
Gravitation
Chapter 9
Lecture - 01

TABLE OF CONTENTS

INTRODUCTION

Moksha in Gravitation

GRAVITATION

MASS:

- Cause of Gravitational force
- Property of body due to which it apply and experience gravitational force

Gravitational force :

- Every matter in this universe attracts every other matter by a force called Gravitational force (G.F)

$$F_g <<< F_{electro}$$

NEWTON'S LAW OF GRAVITATION

- Only valid for Point mass and Spherical Mass Bodies.
- Can’t be proved but can be verified only.
- Always attractive
- Weakest force in nature
- Follow inverse square law
- Long-range (within infinite distance)
- Central force
- Conservative in nature
- Does not depend on medium
- Reason of stability of universe
- Forms action-reaction pair

HISTORY OF GRAVITATION

“Gravitation is not responsible for people falling in love.”

—ALBERT EINSTEIN

HISTORICAL INTRODUCTION!

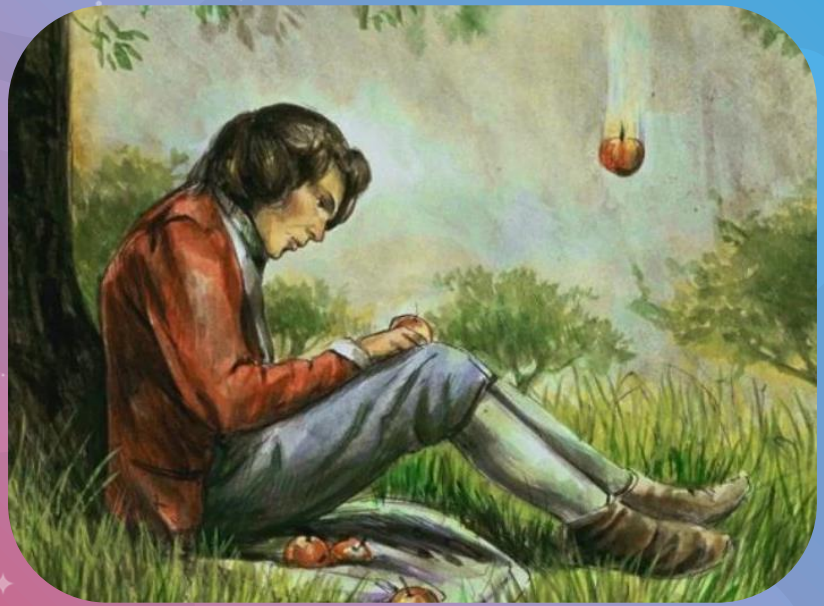
Aryabhat, in 5th century A.D studied Planetary motions in great detail and wrote his conclusions in his book ‘Aryabhatiya’

After Aryabhat, Tycho Brahe and Johannes Kepler studied planetary motion in great detail and Kepler Postulated three laws of planetary motion :

- All planets move in elliptical orbits with the sun at a focus.
- The radius vector from the sun to the planet sweeps equal area in equal time
- The square of the time period of a planet is proportional to the cube of the semimajor axis of the ellipse.

ISSAC NEWTON

The year 1665 was very fruitful for Isaac Newton aged 23. He was forced to take rest at his home in Lincolnshire after his college at Cambridge was closed for an indefinite period due to plague. In this year, he performed brilliant theoretical and experimental tasks mainly in the field of mechanics and optics. In this same year he focused his attention on the motion of the moon about the earth



$T = 27.3$ days

Duration of moon’s revolution around earth

$R = 3.85 \times 10^5$ km

Disatance between earth and the moon

$0.0027\ ms^{-2}$

Acceleration of moon

QUESTIONS OF ISSAC NEWTON !!

What is the force that produces this acceleration ?

What is the law governing this force ?

How He made the formula

- The acceleration of a body falling near the earth's surface is about 9. 8 ms^{-2} . Thus,

$$\frac{a_{apple}}{a_{moon}} = \frac{9{\cdot}8\ \text{m s}^{-2}}{0{\cdot}0027\ \text{m s}^{-2}} = 3600.$$

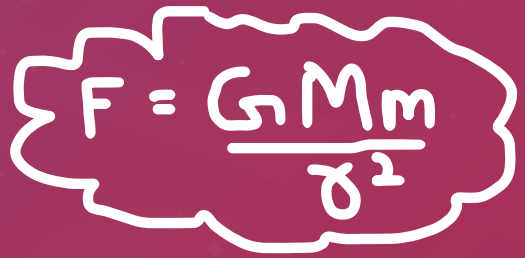
- Also,

$$\frac{\text{distance of the moon from the earth}}{\text{distance of the apple from the earth}} = \frac{d_{moon}}{d_{apple}} = \frac{3{\cdot}85 \times 10^{5}\ \text{km}}{6400\ \text{km}} = 60$$

Thus, $$\frac{a_{apple}}{a_{moon}} = \left(\frac{d_{moon}}{d_{apple}}\right)^{2}.$$

How He made the formula

- Newton further generalised the law by saying that "***not only the earth but all material bodies in the universe attract each other according to equation with same value of G***". The constant G is called ***universal constant of gravitation*** and its value is found to be $6.67 \times 10^{-11}\ Nm^2/kg^2$. Equation is known as the **Universal law of gravitation**



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UNIVERSAL LAW OF GRAVITATION

ULG

- It states that, " ***Every body in the universe attract every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.***"

- Mathematically,

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

Where,
F = Gravitational force
G = Universal Gravitational constant = $6.67 \times 10^{-11}\ Nm^2kg^{-2}$

Q.no

What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface ? (Mass of earth 6×10^{24} kg and radius of earth is 6.4×10^{6} m)

Q.no

How does the force of gravitation between two objects change when the distance between them is reduced to half ?

Q.no

What happens to the force between two objects, if

(i) The distance b/w the object Is tripled

(ii) The masses of both objects are doubled

(iii) The mass of one of the body is doubled and separation is halved ?

Olympiad level

Q.no

Two bodies A and B having mass m and 2m resp. are kept at a distance d apart. Where should a small particle be placed so that the net gravitational force on it due to the bodies A and B is zero ?

Olympiad level