Newton’s Universal Law of Gravitation

Every one of us knows that ”Whatever goes up must come down”. Just like an apple falling from the tree or a pencil falling from the desk. But have you ever thought why do satellites don’t fall? The answer this is the universal law of gravitation. So whatever goes up must come down and might not come down too. Let us study this in detail.

Newton’s Law of Gravitation

The questions like why did the apple fall on the ground and why didn’t the satellite fall on the ground fascinated the scientist Newton. He came up with the universal law of gravitation.

Statement

”Every body in the universe attracts 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 ”. That is if objects are very close to each other than the distance between them is less and so the force with which they attract each other will be more.

Suppose you have a ball and a box both lying on the floor. Do they actually start moving towards each other? According to the universal law, the ball and the box should be moving towards each other. But in actual this does not happen. This is because the force with which they are attracting each other is very much small.

So here if the mass of the ball is m_1 and mass of the box is m_2 then, F $\propto m_1 m_2$, and is inversely proportional to the distance between them.

F $\propto$

1

r^2

As you move the objects far away from each other the force will be less and if the objects are brought close then the force will be much greater.

The Mathematical Form of Law of Gravitation

We have two masses m_1 and m_2

We know that, F $\propto m_1 m_2$ and F $\propto$

1

r^2

From these two we can say that, $F \propto \frac{m_1 m_2}{r^2}$

Now we need to convert this proportionality into equality, So we introduce a gravitational constant,

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

- G = Gravitational constant.

- SI unit of G is $Nm^2 kg^{-2}$
- Value of G is 6.673×10^{-11} $Nm^2 kg^{-2}$

Suppose you have kept two pens on the table and you want to know the force of attraction between them, you can find out easily if you know the masses of the two pens, we can calculate the force by the above universal formula.

Importance of Newton's Universal Law of Gravitation

- It has explained us the force that binds us to the earth i.e how every object is pulled from the earth.
- It explains the motion of the moon around the earth.
- Also, the motion of the planets around the earth is explained.

Suppose you are standing on the top of the building and you throw a stone from a great height. Have you noticed that the stone falls to the ground? That is a free fall. The object is falling freely on the ground.The gravitational pull attracts the object and the object completely. During free fall the direction of the motion remains unchanged. The motion is in a downward direction towards the motion of the earth.

Solved Question For You

Q. The gravitational attraction between the two bodies increases when their masses are

A. reduced and distance reduces
B. increased and distance is reduced
C. reduced and distance is increased
D. increases and distance is increased

Ans: B. F = $\frac{G m_1 m_2}{r^2}$

where F is the gravitational force of attraction, which increases when the masses are increased and distance is reduced.

Thrust, Pressure and Buoyancy

In your schools, you must have seen bulletin boards. So when you try to fix a notice or a paper on the notice board, what you do is you try to fix the pin on the board. Here you need to apply the force to fix the pin on the board. What is the phenomenon behind this? The answer to this is thrust. Let us study about thrust in detail.

Thrust & Pressure

Most of you must have noticed that the small vehicle like car have small and thin tyres, while the vehicle like the bus and trucks have thick tyres. It's heavier the vehicle, the thicker are the tyres. Why is it so? This can be all explained by thrust and pressure. Thrust and pressure are both related to the gravity and gravitational pull of the earth.

Let us first try to understand what is thrust:

The force acting on the object perpendicular to the surface is called as thrust. Thrust is a vector quantity and its unit is same as that of the force i.e is Newton.

Have you ever noticed that when you stand on the sand at the beach, your feet go deep into the sand? But on the other hand, if you lie down on the sand your body does not go that deep into the sand. Here in both the cases, the force is exerted by the body but still, its effect is different in both the cases.

Why is that so? When you stand on the loose sand, the force that is the weight of your body is acting on the area, area equal to your feet. When you lie down, in that case, the same force acts on an area equal to the area of your whole body. Here we see that effect of the thrust of the same magnitude is different on the different areas. This means the effects of thrust depends on an area it acts.

Hence the physical quantity that explains the dependence of thrust on the area is the pressure. It is thrust per unit area. The SI unit of pressure is Pascal or N/m^2

$$P = \frac{Thrust}{Area}$$

$$P = \frac{F}{A}$$

What is Buoyancy?

There are objects that float on the surface of the water while some of them sink into the water. Why does this happen? Why do certain objects float and some objects sink? The floating or sinking of the objects is based on the concept of buoyancy.

Lets us see an example to understand this.Suppose you throw a stone in the water, the stone goes deep into the water, on the other hand, if you throw a plastic bottle in the water, you see that the bottle starts floating on the surface of the water. So whenever any object is put into the water, the object will float or sink depends on the upward force exerted by the water.

An upward force is applied by the water on any object floating on it which is called as Buoyancy. Thus, if any object is sinked inthe water it is experiencing buoyancy.

So here there are two forces acting on the stone and the plastic bottle. One is the gravitational pull which acts in downwards direction and other is the upthrust that acts in upwards direction. In this case, the density of the bottle is less, while the density of the stone is more. In case of the stone, the gravitational pull is more and so the stone sinks into the water.

Solved Question For You

Q1. Why can camels easily run in deserts but not other animals or we humans?

Ans: Every time we walk on the sand, our feet go inside the sand. In case of camels, they have broad and flat feet. Since their feet are broad the area is more. As we know when the area is more, the pressure is less and so they do not sink into the sand. So as the area is more they are able to run or walk more easily as compared to us or other animals.

Acceleration Due to Gravity

Let us carry out a small activity! Throw a ball up in the air. Now let the ball come down on its own. Did you notice one thing? When the ball is going in upwards direction the speed of the ball is less as compared to when it comes down. This is because the acceleration is produced due to the force of gravity. Let us now study about acceleration due to gravity in detail.

Acceleration Due to Gravity

When the object falls towards the earth due to the earth's gravitational force, it something we call as free fall of the object. So during the free fall, the only force acting on the object is the gravitational force of the earth. The acceleration due to gravity is the acceleration produced in the freely falling body due to the influence of the gravitational pull of the earth.

Acceleration due to gravity is denoted by ‘ g ‘ but its values vary. Like, for example, the acceleration due to gravity on the moon is different from that of the earth.

Read the Concept of Acceleration here for better understanding of this topic.

Browse more Topics under Gravitation

- Newton's Universal Law of Gravitation
- Thrust, Pressure and Buoyancy
- Earth Satellites
- Escape Velocity
- Gravitational Potential Energy
- Kepler's Law
- Weightlessness

Expression of the Acceleration Due to Gravity

Let us suppose you are standing on the top of the building with a small stone in your hand. So let the mass of the stone be ‘ m ‘. When you throw the stone on the ground, the gravitational force of the earth attracts the stones downwards. The gravitational force acting on the stone is F = mg.

Also, we know that force between two objects is given by the universal law of gravitation. So here one object is the stone and object is the earth.

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

- M = mass of the earth
- m = mass of the stone
- d = distance

$$\Rightarrow mg = \frac{GMm}{d^2}$$

, or

$g = \frac{GM}{d^2}$

Suppose the object is on the surface of the earth or nearby.

Now, in this case, d = R+ h

So, $g = \frac{GM}{(R+h)^2}$

Let us calculate the value of g on the earth, i.e h=0. As we know the value of g,

$g =$

GM

R

2

- $G = 6.7 \times 10^{-11}$ Nm²/kg²
- $M = 6 \times 10^{24}$ kg
- $R = 6.4 \times 10^{6}$ m

So putting these values we will get the value of acceleration due to gravity.

g =

6.7×

10

11

×6×

10

24

(6.4×

10

6

)

2

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

This is the value of acceleration due to gravity. The value of this acceleration due to gravity changes from place to place. It is not universal constant.

Learn more about Newtons Universal Law of Gravitation here

Solved Questions For You

Q1. The ratio of the value of gravitational constant G between Earth and Moon system and Earth and Sun system is-

A. > 1

B. > 1

C. 1

D. Cannot be calculated.

Ans: C. In Newton's law of gravitation, F =

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

. G is the gravitational constant which has the fixed value 6.7×10^{-11} $m^3/kg^{-1} s^{-2}$. Therefore the ratio of the value of gravitational constant G between Earth and Moon system and Earth and Sun system is 1.

Q2. Which of the following is/are true about the value of g

A. The value of g is minimum at the equator
B. The value of g is maximum at poles.
C. Average value of g is 9.8 m/s^2
D. All of the above.

Ans: D. At a given place the value of acceleration due to gravity is constant but it varies from one place to another place on the surface of the earth. This is the reason that the earth is not of the perfect shape. It is flattened at the poles and bulged out at the equator.

Earth Satellites

What comes to your mind when you think of the satellites? Yes, you may definitely think of the MOON. Do you know what are earth satellites and how do these satellites orbit the earth? Let us study about earth satellites in detail.

Earth Satellites

What is an Earth Satellite? An object revolving around the earth is earth satellite. Do you why the reason why do the satellite's orbit? The satellites orbit due to the 1st law of motion which states that an object is at rest or in a state of motion unless acted upon by an external force.

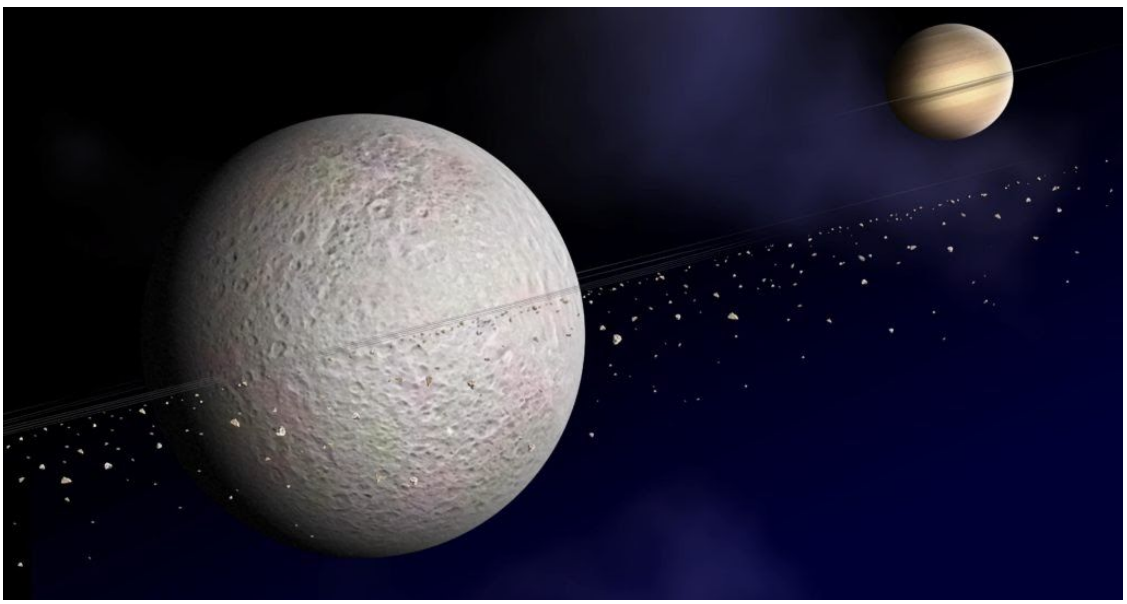
So when we talk about a planet and a satellite, when the satellite is orbiting around the planet is because of two reasons. The first reason is that there is a gravitational force between the satellite and the planet. The second reason is that it just wants to speed past the planet. It just wants to go out of the orbit. Satellites are classified into two types.

- Natural Satellites

- Artifical Satellites

Natural Satellites

The satellites there have existed in nature on their own are natural satellites. No efforts have been put to discover these satellites. For example the Moon is a natural satellite of the earth.



In fact, the Moon is the only natural satellite for earth that has existed on its own and keeps on revolving around the earth.

Artificial Satellites

Artificial satellites are the objects that are intentionally placed by humans which orbits the earth for practical uses. These artificial satellites are built for various purposes. They are used for:

- Communication satellites are used for wide communications. eg. Mobile phones.
- Television broadcast
- Navigation
- Military support
- Weather observations
- Scientific Research.

Time period of Earth Satellites

Let us derive an expression to determine the time taken by the satellite to complete one rotation around the earth. Suppose a satellite keeps on revolving around them in a circular orbit. So as it moves in circular motion, there is a centripetal force acting on it.

$F_c =$

mv^2

r²

$F_c =$

mv²

R

e

+h

, ‘ h ‘ is the distance above earth’s surface.

This centripetal force will act towards the centre. Now there is another gravitational force between the earth and the satellite that is,

- m = mass of the satellite
- M_e = mass of the Sun

$F_G =$

Gm

M

e

(

R

e

+h

)

2

Now $F_C = F_G$, implies

mv^2

R

e

+h

=

Gm

M

e

(

R

e

+h

)

2

$\Rightarrow \; v^2 =$

−G

M

e

R

e

+h

$\Rightarrow \; v =$

G

M

e

R

e

+h

—

—

—

—

√

= Velocity

We want to calculate the time period of the satellite. We know that, satellite covers a distance of 2π (R_e+ h) in one revolution

T =

distance

velocity

=

2π(

R

e

+h)

v

T =

2π(

R

e

+h

)

3/2

√G

M

e

Thus this is the time period taken by the satellite to revolve around the earth.

The Energy of Orbiting Satellites

We know that m is the mass of the satellite and the velocity with which it moves is v. So what is the kinetic energy of the satellite? It is given by

1

2

mv^2

As we know v =

G

M

e

m

R

e

+h

–

–

–

–

–

√

So, the kinetic energy is,

1

2

G

M

e

m

R

e

+h

Now the potential energy is,

−G

M

e

m

R

e

+h

Toatl energy = kinetic energy + potential energy

1

2

G

M

e

m

R

e

+h

+

−G

M

e

m

R

e

+h

Total energy =

$$\frac{-GM_e m}{2(R_e+h)}$$

Solved Question For You

Q1. Out of the following statements, the one which correctly describes a satellite orbiting about the earth is

A. There is no force acting on the satellite.
B. The acceleration and velocity of the satellite are roughly in the same direction.
C. Satellite is always accelerating around the earth.
D. The satellite must fall back to earth when its fuel is exhausted.

Ans: C. When the satellite is revolving around the earth, it is because of the gravitational force towards the earth that acts as a centripetal force. Since the initial speed is less than the escape speed, earth's gravity pulls the satellite towards the centre of the earth. So the satellite is always accelerating around the earth.

Escape Velocity

Suppose you are playing cricket and you hit the ball with some velocity, the ball will again come down on the surface of the ground. But in case you hit the ball with greater velocity, the ball will escape out of the gravitational field. This is what we call escape velocity. Let us learn more about this.

Escape Velocity

To understand the term Escape Velocity let us carry out a small activity.

(Source: The cheap route)

Suppose you are having a ball in your hand. You throw a ball in the air and you see that it comes down. We know that it comes back because of the force of gravitation. Now you throw the ball with greater velocity, in this case, the balls reach a greater height but eventually, it comes down and falls on the surface of the ground.

Because it still experiences the force of attraction by the surface of the earth. Now suppose you throw the ball with such a high velocity that it never comes back on the ground. This is where escape velocity comes into the picture. Escape velocity is the velocity that a body must attain to escape a gravitational field.

So if you throw the ball with the velocity which is at least equal to the escape velocity, in that case, the ball will go out of the gravitational field.

Mathematical Expression

Suppose the ball is initially in your hand. So that is the initial position of the ball. Now throw the ball at a greater velocity, that it never comes back. As we don't know where did the ball go, so its final velocity is ∞. So with this assumption let us derive the expression.

At initial position,

Total energy = Kinetic energy + Potential energy

Or, T.E = K.E + P.E

Kinetic Energy =

1

2

mv^2

Potential Energy =

−GMm

R

e

+h

Here M is the mass of the earth and m is the mass of the ball. At the earth's surface, P.E (0) = 0.

Hence, T. E (0) =

1

2

mv^2

At final position (∞),

K.E =

1

2

mv_f^2

$$P.E = \frac{-GM_e m}{R_e + h} = 0 \quad \{h = \infty\}$$

Now by the law of conservation of energy, the total energy at the initial position should be equal to the final position.

T.E (∞) = T.E (0)

Or,

1

2

$mv_f^2 =$

1

2

$m v_i^2 -$

G

M

e

m

R

e

+h

L.H.S has to be alawys +ve, which implies

1

2

$m v_i^2 -$

G

M

e

m

R

e

+h

≥ 0

$\Rightarrow$

1

2

$m\ v_i^2 =$

G

M

e

m

R

e

+h

⇒ v_i^2 =

2G

M

e

R

e

+h

Assume the ball is thrown from earth's surface.

h << R_e ⇒R_e+h ~ R_e

⇒ v_i^2 =

2G

M

e

R

e

$\Rightarrow$ vi =

2G

M

e

R

e

—

—

—

—

√

This is the velocity in which the objects never comes back. In terms of ' g '

g =

GM

R^2

⇒ gR_e =

G

M

e

R

e

$v_e = \sqrt{(2gR_e)}$

Solved Questions For You

Q1. The escape velocity of a particle depends on its mass m as:

A. mass m as m^2

B. as m^{-1}

C. mass m as m^0

D. as m^1

Ans: C. Escape velocity, $v_e = \sqrt{2gR}$. It is independent of the mass of the particle. Thus, it will depend on m^0

Q2. The earth retains its atmosphere. This is due to:

A. the special shape of the earth

B. the escape velocity which is greater than the mean speed of the atmospheric molecules.

C. the escape velocity which is less than the mean speed of the atmospheric molecules.

D. the suns gravitational effect.

Ans: B. The earth retains its atmosphere. This is due to the escape velocity is been greater than the mean speed of the atmospheric molecules.

Gravitational Potential Energy

Suppose you are driving a car and there is a hill, you slow down or stop because of the steep road. Where does the energy go? The answer to this that the energy turns into gravitational potential energy. Let us explore more about Gravitational Potential Energy.

Gravitational Potential Energy

Gravitational Potential is the work done per unit mass to bring that body from infinity to that point. It is represented by V. SI unit of gravitational potential is J/Kg. It is the potential body arising out of the force of gravity. If due to the force, if the position changes, then the change in the potential energy is the work done on the body by the force.

The most common use of gravitational potential energy is for an object near the surface of the Earth where the gravitational acceleration is a constant at about 9.8 m/s^2.

Expression of Gravitational Potential Energy

Case 1. ‘g’ is Constant

Consider this image of the earth. Assume an object at point A and later it moves to point B. So, in this case, the work done is force × displacement.

$$W_{BA} = \text{Force} \times \text{displacement}$$

Force is nothing but the gravitational force exerted by the earth. The height of point A from the surface of the earth is h_2 and that of point B is h_1

$$W_{BA} = mg\,(h_2 - h_1) = mg\,h_2 - mg\,h_1$$

the work done in moving the object is the difference in its potential energy between its final and initial position.

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- Acceleration Due to Gravity
- Earth Satellites
- Escape Velocity
- Kepler's Law
- Weightlessness

Case 2. 'g' is Not Constant

Let the position vector of the first object be r_1 and the position vector of the second object be r_2 . So here the work done in bringing the object from one position to another is:

W =

$\int$

r

2

r

1

Fdr

where, F =

G

M

e

m

r

2

W =

$\int$

r

2

r

1

G

M

e

mdr

= – GMem[

1

r

2

–

1

r

1

]

Solved Examples For You

Q1. The gravitational potential difference between the surface of a planet and a point 20m above the surface is 2 joule/Kg. If the gravitational field is uniform then the work carrying a 5 Kg body to a height of 4m above the surface is:

A. 2 Joule
B. 20 Joule
C. 40 Joule
D. 10 Joule

Ans: A. Since the gravitational field is uniform,

Gradient of potential =

Potentialdifference

distancebetweenthepoints

=

2

20

= 0.1 J/ Kgs

Total work is done = Mass ×distance × potential gradient = 5 × 4 × 0.1 = 2 Joule.

Q2. An object is taken from a point P to another point Q in a gravitational field

A. assuming the earth to be spherical if both P and Q lie on the earth's surface, the work done is zero.
B. if P is on the earth's surface and Q above it, the work done is minimum when it is taken along the straight line PQ.
C. the work done depends only on the position of PO and Q and is independent of the path along which the particle is taken.
D. there is no work if the object is taken from P to Q and then brought back to P along any path.

Ans: If P and Q both lie on the earth surface, this means both have same potential energy that implies same mechanical energy. Thus there is no work in moving an object from P to Q. As the gravitational field is the conservative field and thus work done by the gravitational force depends only on the position of P and Q and is independent of the path taken. Also, work done by a conservative force along a closed loop is zero.

Kepler's Law of Planetary Motions – Orbits, Areas, Periods

Kepler's Law states that the planets move around the sun in elliptical orbits with the sun at one focus. There are three different Kepler's Laws. Law of Orbits, Areas, and Periods. Let us know about them one by one.

Kepler's Three Law:

1. Kepler's Law of Orbits – The Planets move around the sun in elliptical orbits with the sun at one of the focii.
2. Kepler's Law of Areas – The line joining a planet to the Sun sweeps out equal areas in equal interval of time.
3. Kepler's Law of Periods – The square of the time period of the planet is directly proportional to the cube of the semimajor axis of its orbit.

Kepler's 1st Law of Orbits:

This law is popularly known as the law of orbits. The orbit of any planet is an ellipse around the Sun with Sun at one of the two foci of an ellipse. We know that planets revolve around the Sun in a circular orbit. But according to Kepler, he said that it is true that planets revolve around the Sun, but not in a circular orbit but it revolves around an ellipse. In an ellipse, we have two focus. Sun is located at one of the foci of the ellipse.

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Kepler's 2nd Law of Areas:

This law is known as the law of areas. The line joining a planet to the Sun sweeps out equal areas in equal interval of time. The rate of change of area with time will be constant. We can see in the above figure, the Sun is located at the focus and the planets revolve around the Sun.

Assume that the planet starts revolving from point P_1 and travels to P_2 in a clockwise direction. So it revolves from point P_1 to P_2, as it moves the area swept from P_1 to P_2 is Δt. Now the planet moves future from P3 to P4 and the area covered is Δt.

As the area traveled by the planet from P_1 to P_2 and P_3 to P_4 is equal, therefore this law is known as the Law of Area. That is the aerial velocity of the planets remains constant. When a planet is nearer to the Sun it moves fastest as compared to the planet far away from the Sun.

Kepler's 3rd Law of Periods:

This law is known as the law of Periods. The square of the time period of the planet is directly proportional to the cube of the semimajor axis of its orbit.

T^2

$\propto$

a^3

That means the time ‘ T ‘ is directly proportional to the cube of the semi major axis i.e. ‘a’. Let us derive the equation of Kepler’s 3rd law. Let us suppose,

- m = mass of the planet
- M = mass of the Sun
- v = velocity in the orbit

So, there has to be a force of gravitation between the Sun and the planet.

F =

GmM

r^2

Since it is moving in an elliptical orbit, there has to be a centripetal force.

F_c =

mv^2

r^2

Now, $F = F_c$

$\Rightarrow$

GM

r

$= v^2$

Also, v =

circumference

time

=

$2\pi r$

t

Combining the above equations, we get

⇒

GM

r

=

$4\pi^2 r^2$

T^2

$T^2 =$

4

π

2

r

3

)

GM

⇒ T^2

$\propto$

r^3

Solved Questions For You

Q1. A planet moves around the sun in an elliptical orbit with the sun at one of its foci. The physical quantity associated with the motion of the planet that remains constant with time is:

A. velocity
B. Centripetal force
C. Linear momentum
D. Angular momentum

Answer: D. Angular momentum is conserved (constant) because of the force of gravitational attraction between the planets and the sun exerts zero torque on the planet.

Q2. Kepler's second law states that the radius vector to a planet from the sun sweeps out equal areas in equal intervals of time. This law is a consequence of the conservation of:

A. Time

B. Mass

C. Angular momentum

D. Linear momentum

Answer: C. Area velocity =

$$\frac{\Delta A}{\Delta t} = \frac{L}{2m}$$

. Since the radius vector of planet sweeps out equal area in equal interval of time, thus,

$$\frac{\Delta A}{\Delta t} = \text{constant}$$

$\Rightarrow$ L = Constant

Thus Kepler's second law is a consequence of the conservation of angular momentum.

Weightlessness

Weightlessness is a condition when your body is in free fall and the acceleration is downward at gravity. This condition can be defined by the term zero gravity. So weightlessness occurs when there is zero support of force on our body. Let us learn more about weightlessness.

Weightlessness

Weightlessness is a situation in which the gravitational force is 0. We feel weight because the ground exerts an equal and opposite force on our body after our body exerts a force on the ground due to gravitational attraction.

Now, when falling freely under g, there is no solid thing which can exert a force on us, which thus makes us feel to be having weightlessness. In general, the ground exerts equal and opposite force on you and hence you feel the weight, and in the same way, if you fall freely we feel being weightless.

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- Gravitational Potential Energy

- Kepler's Law

Video on Gravitation

Weight of Object on the Moon

Let us suppose there is an object whose weight on the earth is 10 newtons. So how much do you think the weight of the same object varies on the moon. The force with which the moon attracts the object is the weight of the object. We know that mass of the moon is less than the mass of the earth. Let the mass of the object be"m",

- Weight of the object on the moon is denoted by W_m
- Mass of the moon is M_m
- Radius of the moon is R_m

$$m_{moon} < m_{earth}$$

$$W_m < W_e$$

Weight of the object on the moon is m × g_m (acceleration due to gravity on the moon) = m ×

G

M

m

R

2

m

Weight of the object on the earth is

G

M

m

R

2

e

or

−G

M

e

R

e

+h

- Mass of the earth = 6×10^{24} kg
- Mass of the moon = 7.63×10^{27} Kg
- Radius of the Earth = 6.63×10^{6} m
- Radius of the moon = 1.74×10^{6} m

Putting these values into the equation we get,

w

m

w

e

=

1

6

Or, $W_m =$

1

6

W_e

So if the weight of the object on the earth is 10 Newton, the weight on the moon will be 10/6.

Solved Questions for You

Q1. If a rock is brought from the surface of the moon,

A. mass will change
B. weight will change not mass
C. both mass and weight will change
D. its mass and weight both remains same

Ans: B. Mass will remain same but its weight W = mg, as the rock is brought from the moon, the gravity will change so the weight will also change.

Q2. A man weighs 75kg on the surface of the earth. His weight in a geostationary satellite is:

A. infinity
B. 150kg
C. zero
D. 75/2 kg

Ans: C. A satellite revolves around the earth with the same time period of earth's rotation that is 24 hours. Since it revolves with the same speed, the relative velocity is zero with respect to the earth hence anybody inside geostationary satellite doesn't feel the gravity. So here the weight would be equal to zero.

Q3. A person sitting in a chair in a satellite feels weightless because

A. the earth does not attract the object in the satellite.
B. normal force by the chair of the person balances the earth's attraction.
C. the normal force is zero
D. person in the satellite is not accelerated.

Answer: C. As the person sits on the chair, he experiences two forces. One is the gravitational force and other is the force of the chair. This is due to this normal force the person sitting in a chair in a satellite feels weightless.