3. Gravitation

Let us assess

1. Question

If the distance between two bodies that attract each other is trebled, how many times will their mutual force of attraction be?

(9 times, 3 times, 1/3, 1/9).

Answer

The correct option is $\left(\frac{1}{9}\right)$.Explanation:

The mutual force of attraction between two bodies is inversely

proportional to the square of the distance between them.$F \, \alpha \frac{1}{r^2}$

where r = distance between the two bodies.

Thus, if the distance is tripled (3×), the mutual force of attraction will

become $1/9^{th}$ of its original value.

Using the formula:

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

Now, r becomes 3r after tripling and F becomes F' , $F' = \frac{GMm}{(3r)^2} = \frac{GMm}{9r^2} = \frac{F}{9}$ as $F = \frac{GMm}{r^2}$

2. Question

A body, the mass and the weight of which were already determined as the Equator, is now placed at the Pole. In this context, choose the correct statement from the following:

a. Mass does not change, weight is maximum

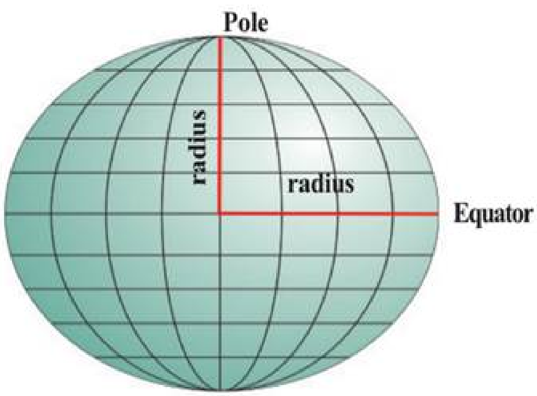
b. Mass does not change, weight is minimum

c. Both mass and weight are maximum

d. Both mass and weight are minimum.

Answer

(a. Mass does not change, weight is maximum)



Due to the shape of the earth, the radius at the poles is less than the radius of earth at equator.

The value of acceleration due to gravity is calculated as$g = \frac{GM}{R^2}$

whereg=acceleration due to gravityM= Mass of earthR=radius of earthG=Universal gravitational constant

More the radius of the earth, lesser is the acceleration due to gravity. Thus, g is minimum at equator

and maximum at the poles.

The weight(W) of a body is given byW=mass(m)×acceleration due to gravity(g)⇒W=mgAt the equator, due to minimum value of acceleration due to gravity, the weight is minimum.

At the poles due to maximum value of acceleration due to gravity, the weight is maximum.Tip: The mass of a body does not depend on acceleration due to gravity.Thus, the mass remains constant at both the equator and the poles.

3 A. Question

What is meant by the terms mass and weight?

Answer

The mass is the fundamental property of a body that is a measure of its resistance to change in the state of motion. It also describes the strength of its mutual gravitational force of attraction to other bodies. It does not depend on the value of g. It is measured by a beam balance.The weight of a body is the force with which earth pulls the body towards its centre.

Weight(W)=mass(m)×Acceleration due to gravity(g)W=mgIt changes with the change in the value of g. It is measured by a spring balance.

3 B. Question

Are they vector or scalar quantities? Why?

Answer

Weight is a force. It has both magnitude and a direction. The direction of weight is towards the centre of the earth. Thus, weight is vector quantity.Mass has no direction but only magnitude. Thus, mass is scalar quantity.

3 C. Question

The mass of a body is 30 kg. What is its weight on earth?(g = 9.8 ms^{-2})

Answer

Mass of body = 30 kg

Acceleration due to gravity = 9.8 ms^{-2}

Formula used:Weight(W) = mass(m)×Acceleration due to gravity(g)

⇒ W = 30 kg × 9.8 ms^{-2}

=294 $kgms^{-2}$

3 D. Question

What is its weight on the moon?(g = 1.62 ms^{-2})

Answer

Mass of the body=30 kgAcceleration due to gravity on moon=1.62 ms^{-2}Formula used:Weight(W) = mass(m)×Acceleration due to gravity(g)W_1=30×1.62=48.6 $kgms^{-2}$

5. Question

If a body of mass 40 kg is kept at a distance of 0.5 m from a body of mass 60 kg, what is the mutual force of attraction between them?

Answer

Given:Mass of one body(M)=60 kg

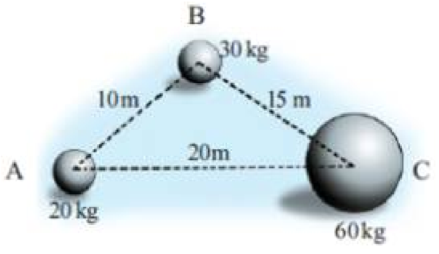
Mass of other body(m)=40 kgDistance between the bodies(R)=0.5 mFormula Used: $F = \frac{GMm}{R^2}$whereF=Mutual force of attraction between two bodiesG=Universal Gravitational Constant=6.67×10^{-11} Nm^2kg^{-2}M=Mass of one bodym=Mass of other bodyR=Distance between the bodiesPutting these values,

$$F = \frac{(6.67 \times 10^{-11} \times 60 \times 40)}{(0.5)^2} = 6.4032 \times 10^{-7} N$$

6. Question

Observe the figure and complete the table.

Attracting bodies	Force of gravitation
A, B	
B, C	
C, A	



Answer

Given:Mass of ball A=20 kgMass of ball B=30 kgMass of ball C=60 kgFormula Used:

$$F_{Mm} = \frac{GMm}{r^2}$$

whereF=Mutual force of attraction between two bodiesG=Universal Gravitational Constant=6.67×10^{-11} Nm^2/kg^2M=Mass of one bodym=Mass of other bodyr=Distance between the bodiesTip: We have to consider two attracting bodies at a time to calculate the mutual force between them.For A and B,

$$F_{AB} = \frac{G \times 20 \times 30}{10^2} = 6G = 6 \times 6.67 \times 10^{-11} = 4.002 \times 10^{-10} N$$For B and C,

$$F_{BC} = \frac{(G \times 30 \times 60)}{15^2} = 8G = 8 \times 6.67 \times 10^{-11} = 5.336 \times 10^{-10} N$$For C and A,

$$F_{CA} = \frac{(G \times 60 \times 20)}{20^2} = 3G = 3 \times 6.67 \times 10^{-11} = 2.001 \times 10^{-10} N$$

Attracting bodies	Force of gravitation
A, B	4.002×10^{-10} N
B, C	5.336×10^{-10}N
C, A	2.001×10^{-10}N

Extended activities

1. Question

Collect different types of lamina and determine their centres of gravity.

Answer

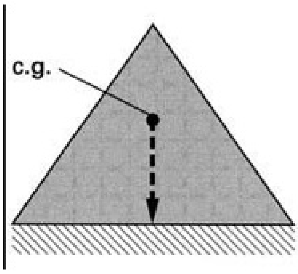
S. No.	Shape of the lamina	Centre of gravity
1	Square	Point of intersection of diagonals
2	Rectangle	Point of intersection of diagonals
3	Circular lamina	Geometric centre of the circle
4	Triangle	Point of intersection of medians
5	Right Angled Triangle	Point of intersection of medians
6	Bangle	Geometric center

2. Question

Prepare a table of things that can keep their stability by overcoming great disturbances.

Answer

For a body to remain stable during great disturbances, the vertical line through its centre of gravity must pass through its base. This condition is known as stable equilibrium.

A funnel kept upside down on its base	
A half-filled bottle of sand kept on its base	
A prism on its base	

3. Question

The values of g on different planets are given. Determine the weight of a body of mass 100 kg on these planets.

Planet	Value of g on each planet (approx. in m/s^2)
Earth	9.8
Mercury	3.7
Venus	8.9
Mars	3.7
Jupiter	23.1
Saturn	9.00
Uranus	8.7
Neptune	11.00

Answer

Given:Mass of body(m)=100 kgFormula Used:

Weight(W)=Mass(m)×Acceleration due to gravity(g)W=mg

Planet	Value of g on each planet (approx. in ms^{-2})	Weight of body (in $kgms^{-2}$) W=mg
Earth	9.8	100×9.8=980
Mercury	3.7	100×3.7=370
Venus	8.9	100×8.9=890
Mars	3.7	100×3.7=370
Jupiter	23.1	100×23.1=2310
Saturn	9.00	100×9.00=900
Uranus	8.7	100×8.7=870
Neptune	11.00	100×11.00=1100