## Multiple Choice Questions

**1. Two objects of different masses falling freely near the surface of the moon would**

(a) have the same velocities at any instant

(b) have different accelerations

(c) experience forces of the same magnitude

(d) undergo a change in their inertia

**Answer:** (a) have the same velocities at any instant

**Explanation:** The acceleration of an object in free fall is exclusively dictated by gravity's acceleration, and mass has no bearing. As a result, an object in free fall will have the same velocity at any given moment, regardless of its mass.

**2. The value of acceleration due to gravity**

(a) is the same on the equator and poles

(b) is least on poles

(c) is least on the equator

(d) increases from the pole to the equator

**Answer:** (c) is least on the equator

**Explanation:** The value of acceleration due to gravity is the least on the equator because the distance between the surface of the earth and its center is more on the equator than in the poles.

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

As the radius of the earth is smaller at the poles as compared to the equator, the value of g is greater at the poles and is least on the equator.

**3. The gravitational force between two objects is F. If the masses of both objects are halved without changing the distance between them, then the gravitational force would become**

**(a)** $\frac{F}{4}$

**(b)** $\frac{F}{2}$

**(c)** F

**(d)** 2F

**Answer:** (a) $\frac{F}{4}$

**Explanation:** The gravitational force between two things is equal to their masses and inversely proportional to the square of their distance. As a result, half the masses of both objects while keeping the same distance decreases the gravitational force between them to one-fourth of their original intensity.

(a): Let the masses of two objects be $m_1$ and $m_2$ placed at d distance apart.

So, $F = \frac{Gm1m2}{d^2}$

When the masses of two objects are halved,

$F' = G\frac{\frac{m1}{2}.\frac{m2}{2}}{d^2} = \frac{Gm1m2}{4d^2} = \frac{F}{4}$

**4. A boy is whirling a stone tied with a string in a horizontal circular path. If the string breaks, the stone**

(a) will continue to move in the circular path

(b) will move along a straight line toward the centre of the circular path

(c) will move along a straight line tangential to the circular path

(d) will move along a straight line perpendicular to the circular path away from the boy

**Answer:** (c) will move along a straight line tangential to the circular path

**Explanation:** If the string breaks, the force that was causing it to move along a circular path, i.e., centripetal force is no longer there, so the stone will move along a straight line tangential to the circular path.

5. An object is put one by one in three liquids having different densities. The object floats with 1/9, 2/11 and 3/7 parts of their volumes of outside the liquid surface in liquids of densities d1, d2 and d3 respectively. Which of the following statements is correct?

**(a) d1> d2> d3**

**(b) d1> d2< d3**

**(c) d1< d2> d3**

**(d) d1< d2< d3**

**Ans:** (d) d1< d2< d3

**Explanation:** Let us find the LCM of fractions of volumes outside the liquid surface in each other.

$\Rightarrow \frac{1}{9} = \frac{2}{22} = \frac{3}{7}$

LCM of the denominator is 693 and using this, the fractions can be written as follows:

$\Rightarrow \frac{77}{693} = \frac{126}{693} = \frac{297}{693}$

This shows that the fractions are in ascending order. The density of the liquid determines the upward force it exerts on the item. The force exerted on an object is related to its density. As a result, the densities of liquids are presented in increasing order.

**6. In the relation F = G M m/d2, the quantity G**

(a) depends on the value of g at the place of observation

(b) is used only when the earth is one of the two masses

(c) is greatest at the surface of the earth

(d) is a universal constant of nature

**Answer:** (d) is a universal constant of nature

**Explanation:** G is called as Newton's constant. It is the force of gravity on a body. Value of G is $6.66 \times 10^{-11}\ Nm^2kg^{-2}$

**7. Law of gravitation gives the gravitational force between**

(a) The Earth and a point mass only

(b) The Earth and Sun only

(c) any two bodies having some mass

(d) two charged bodies only

**Answer:** (c) any two bodies having some mass

**8. The value of quantity G in the law of gravitation**

(a) depends on the mass of the earth only

(b) depends on the radius of the earth only

(c) depends on both the mass and radius of the earth

(d) is independent of the mass and radius of the earth

**Answer:** (d) is independent of the mass and radius of the earth

**Explanation:** Because G is a universal constant, its value is independent of the earth's mass or radius.

**9. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be**

(a)$\frac{1}{4}$ times

(b) 4 times

(c) $\frac{1}{2}$ times

(d) unchanged

**Answer:** (b) **4 times**

**Explanation:** we know:

F= G × 2$m_1$ x $\frac{2m_2}{r^2}$

F= G × $m_1$ x $\frac{2m_2}{r^2}$

F= 4 x G × $m_1$ x $\frac{2m_2}{r^2}$

The gravitational force between two objects is proportional to their masses and inversely proportional to their distance squared. As a result, doubling the masses of both objects without changing their distance will result in a fourfold increase in gravitational force between them.

**10. The atmosphere is held to the earth by**

(a) gravity

(b) wind

(c) clouds

(d) earth's magnetic field

**Answer:** (a) gravity

**11. The force of attraction between two unit point masses separated by a unit distance is called**

(a) gravitational potential

(b) acceleration due to gravity

(c) gravitational field

(d) universal gravitational constant

**Ans:** (d) universal gravitational constant

**Explanation:** we know,

F= G × 2$m_1$ x $\frac{2m_2}{r^2}$

Given: m1 = 1 unit, m2= 1unit, r= 1 unit

Here point masses are separated by unit distance

Hence m1, m2 and r = 1

So, F= G(universal gravitational constant)

**12. The weight of an object at the centre of the earth of radius R is**

(a) zero

(b) infinite

(c) R times the weight at the surface of the earth

(d) 1/R2 times the weight at the surface of the earth

**Answer:** (a) zero

**Explanation:** At the centre of the earth acceleration due to gravity is zero. Since weight is the product of mass and gravity. Weight of the object at the centre of the earth will be zero.

**13. An object weighs 10 N in air. When immersed fully in water, it weighs only 8 N. The weight of the liquid displaced by the object will be**

(a) 2 N

(b) 8 N

(c) 10 N

(d) 12 N

**Answer:** (a) 2 N

**Explanation:** An object of weight displace d by liquid = weight in the air- weight in liquid

= 10N - 8N = 2N

**14. A girl stands on a box having 60 cm length, 40 cm breadth and 20 cm width in three ways. In which of the following cases, the pressure exerted by the brick will be**

(a) maximum when length and breadth form the base

(b) maximum when breadth and width form the base

(c) maximum when width and length form the base

(d) the same in all the above three cases

Answer: (b) maximum when breadth and width form the base

**Explanation:** The force exerted by the box on base = Weight of object = W

The pressure that it exerts on the base = $\frac{W}{A}$

where A is the area of the base.

Hence the pressure is maximum for smallest area of the base, which is when formed by breadth and width.

**15. An apple falls from a tree because of gravitational attraction between the earth and the apple. If F1 is the magnitude of the force exerted by the earth on the apple and F2 is the magnitude of the force exerted by the apple on the earth, then**

(a) F1 is very much greater than F2

(b) F2 is very much greater than F1

(c) F1 is only a little greater than F2

(d) F1 and F2 are equal

**Answer:** (d) F1 and F2 are equal

**Explanation:** This is in accordance with Newton's Third Law of Motion which states that for every action there is an equal and opposite reaction.

According to Newton's III law, "Every action has an equal and an opposite reaction". An apple falling down has the force of gravity acting downward (F1) which is the action. The opposite reaction is the force the apple exerts on the earth (F2).

## Short Answer Questions

**16. What is the source of the centripetal force that a planet requires revolving around the Sun? On what factors does that force depend?**

Answer: The gravitational force of the sun is the source of the centripetal force that a planet needs to revolve around the sun. This force depends on the distance between the planet and the sun, as well as the masses of both the planet and the sun.

Centripetal force is a force that causes an object to move towards the center of a circular path. Other sources of centripetal force include tension force, friction, and spring force.

**17. On the earth, a stone is thrown from a height in a direction parallel to the earth's surface while another stone is simultaneously dropped from the same height. Which stone would reach the ground first and why?**

**Ans:** Both stones will take the same amount of time to reach the bottom since they fall from the same height.

For vertical motion of the stone, u = 0, a = g and s = h

Using $s = ut + \frac{1}{2}at^2$,

we get $t = \sqrt{\frac{2h}{g}}$

Similarly, for the second stone, vertical motion is same as that of first.

**18. Suppose gravity of earth suddenly becomes zero, then in which direction will the moon begin to move if no other celestial body affects it?**

**Answer:** Because the moon's circular motion is due to the centripetal force provided by the earth's gravitational force, and if gravitational force becomes zero, the moon will begin to move in a straight line in the direction it was moving at the time. As a result, it will follow a straight line.

**19. Identical packets are dropped from two airplanes, one above the equator and the other above the north pole, both at height h. Assuming all conditions are identical, will those packets take the same time to reach the surface of the earth. Justify your answer.**

**Answer:** The value of 'g' is smaller towards the equator than it is at the poles. As a result, near the equator, the package falls more slowly than at the poles. As a result, the package will linger in the air for longer when dropped at the equator.

**20. The weight of any person on the moon is about 1/6 times that on the earth. He can lift a mass of 15 kg on the earth. What will be the maximum mass, which can be lifted by the same force applied by the person on the moon?**

**Answer:**

The weight of person on the moon = $1/6^{th}$ of the weight on earth

Therefore, 'g' on moon = 1/6th 'g' on earth

The force that is applied by the man to lift mass 'm' is

F = mg = 15g (on earth)

If he can lift a certain mass 'm' by applying the same force on the moon, then

F = 15*6=90kg

This proves acceleration due to gravity on the moon is 1/6$^{th}$ of acceleration due to gravity on Earth. Hence the person can lift a mass 6 times heavier on the moon than on Earth.

**21. Calculate the average density of the earth in terms of g, G, and R.**

**Answer:** We know,

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

Mass(M) = $\frac{gR^2}{G}$

Density = $\frac{Mass}{Volume}$ = $\frac{gR^2}{G\ x\ V}$

(where is the volume of the earth, M is the mass of the earth, R is the radius of the earth,

G is the universal gravitational constant)

Hence,

Density (D) = $\frac{gR^2}{G\ x\ \frac{4\pi R^3}{3}}$ = $\frac{3g}{4\pi GR}$

**22. The earth is acted upon by gravitation of the Sun, even though it does not fall into the Sun. Why?**

**Answer:** The centripetal force necessary to keep the earth in orbit is supplied by the sun's gravitational force. The centrifugal force caused by the earth's rotation counteracts this. As a consequence, these pressures balance each other on a second-by-second basis, letting the earth remain in its orbit without colliding with the sun or drifting obliquely away from its circle.

## Long Answer Questions

**23. How does the weight of an object vary with respect to the mass and radius of the earth? In a hypothetical case, if the diameter of the earth becomes half of its present value and its mass becomes four times of its present value, then how would the weight of any object on the surface of the earth be affected?**

**Ans:** The weight of an object is directly proportional to the mass of the earth and inversely proportional to the square of the radius of the earth. i.e.,

Weight of a body = $\infty \frac{M}{R^2}$

Original weight

W = mg = $mG\frac{M}{R^2}$

When hypothetically M becomes 4 M and R become $\frac{R}{2}$

Then weight becomes

$W_n = mG_2\frac{4M}{\frac{R}{2}}$ = (16mG) $\frac{M}{R^2}$ = 16 x W

The weight will become 16 times the present weight.

**24. How does the force of attraction between the two bodies depend upon their masses and the distance between them? A student thought that two bricks tied together would fall faster than a single one under the action of gravity. Do you agree with his hypothesis or not? Comment.**

**Ans:** (i) According to Newton's law of attraction

The force of attraction between the two bodies is directly proportional to the product of masses of two bodies i.e

$F \propto m_1m_2$

And inversely proportional to the square of the distance between the two bodies i.e

$$F \propto \frac{1}{a^2}$$

(ii) we know that g= G $\frac{M}{r^2}$

We may deduce from the preceding relationship that the value of g (gravitational acceleration) is independent of the mass of the falling body, hence in free-fall, the two bricks fall at the same speed and hit the ground at the same moment.

As a result, the hypothesis stated in the question is incorrect.

**25. Two objects of masses $m_1$ and $m_2$ having the same size are dropped simultaneously from heights $h_1$and $h_2$ respectively. Find out the ratio of time they would take in reaching the ground. Will this ratio remain the same if (i) one of the objects is hollow and the other one is solid and (ii) both of them are hollow, size remaining the same in each case? Give a reason.**

**Ans:** We know that

v = u + at

Here v = 0 and a = g

so 0 = u + gt

u = -gt

we also know

$v^2 - u^2 = 2aS$ ……**(ii)**

Here v=0, u = -gt from eq$^n$(i) and S = $h_1$ and taking t = $t_1$

putting all above values in **eq (ii)**

$h_1 = \frac{1}{2} gt^2$

or

$h_1 = \frac{1}{2} gt^2$ ……(iii)

Similarly for S = $h_2$ and t = $t_2$

$h_2 = \frac{1}{2} gt^2$ ……(iv)

**Dividing eq$^n$** (iii) & (iv) we get,

$$\Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}$$

The ratio will not change in either case because acceleration remains the same. In the case of free fall, acceleration does not depend upon the mass and size of the body.

**26. (a) A cube of side 5 cm is immersed in water and then in a saturated salt solution. In which case, will it experience a greater buoyant force? If each side of the cube is reduced to 4 cm and then immersed in water, what will be the effect on the buoyant force experienced by the cube as compared to the first case for water? Give the reason for each case.**

**Ans:** (i) Because the density of the saturated salt solution is larger than that of water, the cube will feel a stronger buoyant force.

(ii)Because the smaller cube has a smaller volume than the original cube, it will have a lower buoyant force.

**(b) A ball weight 4 kg of density 4000 kg $m^{-3}$ is completely immersed in water of density 103kg $m^{-3}$. Find the force of buoyancy on it. (Given g = 10 $ms^{-2}$.)**

**Ans:** Buoyant force = weight of the liquid displaced

= density of water × volume of water displaced × g

$1000 \times \frac{4}{4000} \times 10 = 10$ N