Gravitation Conceptual questions for class 11

Question 1 How does the force of gravity between two bodies changes when the distance between them is halved?

Question 2 When is your weight equals *mg*? Give an example when your weight is more than **mg.** Give an example when it is zero.

Question 3 Gravitational forces acts on all bodies in proportion to their masses. Why, then, doesn't a heavy body fall faster than lighter body?

Question 4 What would be the path of moon if somehow gravitational forces on it vanished to zero?

Question 5 A person says that , since Earth's gravity is so much stronger than the Moon's gravity, rocks on the moon could be dropped to the Earth. What is wrong with this assumption?

Question 6 What is the magnitude of the gravitational force at the Earth's center?

Question 7 If the Earth were of uniform density, what would be the value of g inside Earth at half its radius?

Question 8 If the Earth were hollow, but still had same mass and same radius, would your weight in your present location be more, less or the same it is now? Explain.

Question 9 Find the change in the force of gravity between two planets when the distance between them is decreased by a factor of five.

Question 10 Show that your gravitational acceleration towards an object of mass M at a distance d is always

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

And therefore does not depend on your mass.

Question 11 Why does a person in free fall experience weightlessness, while a person falling at terminal velocity (the constant speed that a freely falling object eventually reaches when the resistance of the medium through which it is falling prevents further acceleration) does not.

Question 12 What is the minimum speed for orbiting the Earth in close orbit? The maximum speed ? What happens above this speed?

Question 13 Define these terms

a. Kepler's law (state all three laws)	**b.** Escape speed	**c.** law of universal gravitation	**d.** Inverse square law
e. Weight	**f.** Weightlessness	**g.** gravitational field	

Answers to selected problems

Question 1

According to the law of gravitation, the force of attraction acting between two bodies is given by,

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

Where m_1 and m_2 are the masses of two objects under consideration, r is the mass bodies and G is the gravitational constant. If the distance between the bodies is reduced to half then

$r' = \frac{r}{2}$. Now force of interaction between them becomes

$$F' = G\frac{m_1 m_2}{r'^2} = G\frac{m_1 m_2}{\left(\frac{r}{2}\right)^2} = 4F$$

Thus, when the distance between the objects is reduced to half the gravitational force increases by four times the original force.

Question 2 F_n =mg+ma when a=0

When a person stands on a scale in an elevator and the elevator is speeding up with acceleration 'a', on reading the scale, he will find his apparent weight more than his real weight i.e.

F_n =mg+ma, which is GREATER than the true weight.

If the elevator cable were to break, he will find the needle of the scale at zero i.e., weightless or zero weight. It can also be 0 when under neglible gravity (i.e. in deep space)

Question 3 The larger mass needs a larger force to give it just the same acceleration this is because *g* is the same for all objects near the Earth's surface. To prove this let *F* be the gravitational force acting on a body of mass *m*, then it can be given by,

$$F = G\frac{mM}{r^2} = mg$$

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

From the above equations we can see that $F \propto m$, although g (acceleration due to gravity) does not depend on m . Hence, all bodies fall with the same acceleration provided there is no air or other resistance.

Question 4 It would continue in a straight line along the path it was following when the gravity stopped. The reason behind any object orbiting another is gravity; the moment you remove it , it'll just continue in a straight line.

Question 5 The force of gravity on moon rocks at the Moon's surface is considerably stronger than the force of gravity of the distant Earth. Rocks dropped on the Moon fall onto the Moon surface. (The force of the Moon's gravity is about 1/6 of the weight the rock would have on Earth; the force of the Earth's gravity at that distance is only about 1/3600 of the rock's Earth-weight.)

Question 6 It is **Zero**. A body is weightless at the center of earth. All of the outer materials of the Earth are pulling outward in all directions, all canceling each other out, and thus the center of Earth gravitational field is zero.

According to Newton's law of gravity it would be infinity, but Newton's law of gravity is meant for use with point masses. Spherical bodies can only be treated as point masses, when considering them from EXTERNAL to the body.

Question 7 The gravitational field halfway to the center will be half of the gravitational field at the surface.

Question 8 From the gravitational force equation , we see that gravitational force and hence one's weight does not change if the mass and radius of the Earth do not change. But one's weight would be zero inside a hollow uniform shell, on the outside one's weight would be no different than if the same-mass Earth were solid.

Question 9 We know that the force of gravity is an inverse square relationship . So F is proportional to $\frac{1}{r^2}$. So, if r is decreased by a factor of five, the force is INCREASED by a factor of 25.

Question 11 A person is weightless when the only force acting is gravity, and there is no support force. Hence the person in free fall is weightless. But more than gravity acts on the person falling at terminal velocity. In addition to gravity, the falling person is "supported" by air drag.

Question 12 8 km/s is the minimum speed for orbiting the Earth in a close orbit. 11.2km/s is the maximum speed an object can orbit the Earth. Above 11.2 km/s and the object will escape the Earth.