Class 11 Physics Chapter 7: Gravitation

Multiple Choice Questions I

1. The earth is an approximate sphere. If the interior contained matter which is not of the same density everywhere, then on the surface of the earth, the acceleration due to gravity:

Options:

a) will be directed towards the centre but not the same everywhere

b) will have the same value everywhere but not directed towards the centre

c) will be same everywhere in magnitude directed towards the centre

d) cannot be zero at any point

Answer: d) cannot be zero at any point

Explanation: Even with non-uniform density, gravitational acceleration cannot be zero anywhere on Earth's surface due to the presence of mass beneath.

2. As observed from earth, the sun appears to move in an approximate circular orbit. For the motion of another planet like mercury as observed from earth, this would:

Options:

a) be similarly true

b) not be true because the force between earth and mercury is not inverse square law

c) not be true because the major gravitational force on mercury is due to sun

d) not be true because mercury is influenced by forces other than gravitational forces

Answer: c) not be true because the major gravitational force on mercury is due to sun

Explanation: Mercury's primary gravitational interaction is with the Sun, not Earth, so its apparent motion from Earth won't be circular.

3. Different points in earth are at slightly different distances from the sun and hence experience different forces due to gravitation. For a rigid body, we know that if various forces act at various points in it, the resultant motion is as if a net force acts on the cm causing translation and a net torque at the cm causing rotation around an axis through the cm. For the earth-sun system:

Options:

a) the torque is zero

b) the torque causes the earth to spin

c) the rigid body result is not applicable since the earth is not even approximately a rigid body

d) the torque causes the earth to move around the sun

Answer: a) the torque is zero

Explanation: The gravitational field of the Sun creates equal and opposite torques on different parts of Earth, resulting in zero net torque.

4. Satellites orbiting the earth have finite life and sometimes debris of satellites fall to the earth. This is because:
Options:
a) the solar cells and batteries in satellites run out
b) the laws of gravitation predict a trajectory spiralling inwards
c) of viscous forces causing the speed of satellite and hence height to gradually decrease
d) of collisions with other satellites
Answer: c) of viscous forces causing the speed of satellite and hence height to gradually decrease
Explanation: Atmospheric drag (viscous forces) at orbital altitudes gradually reduces satellite velocity and orbital height.

5. Both earth and moon are subject to the gravitational force of the sun. As observed from the sun, the orbit of the moon:
Options:
a) will be elliptical
b) will not be strictly elliptical because the total gravitational force on it is not central
c) is not elliptical but will necessarily be a closed curve
d) deviates considerably from being elliptical due to influence of planets other than earth
Answer: b) will not be strictly elliptical because the total gravitational force on it is not central
Explanation: The Moon experiences gravitational forces from both Earth and Sun, making the net force non-central.

6. In our solar system, the inter-planetary region has chunks of matter called asteroids. They:
Options:
a) will not move around the sun since they have very small masses compared to sun
b) will move in an irregular way because of their small masses and will drift away outer space
c) will move around the sun in closed orbits but not obey Kepler's laws
d) will move in orbits like planets and obey Kepler's laws
Answer: d) will move in orbits like planets and obey Kepler's laws
Explanation: Kepler's laws apply to any object in gravitational orbit, regardless of mass.

7. Choose the wrong option:
Options:
a) inertial mass is a measure of difficulty of accelerating a body by an external force whereas the gravitational mass is relevant in determining the gravitational force on it by an external mass

b) that the gravitational mass and inertial mass are equal is an experimental result
c) that the acceleration due to gravity on earth is the same for all bodies is due to the equality of gravitational mass and inertial mass
d) gravitational mass of a particle like proton can depend on the presence of neighbouring heavy objects but the inertial mass cannot
Answer: d) gravitational mass of a particle like proton can depend on the presence of neighbouring heavy objects but the inertial mass cannot
Explanation: Both gravitational and inertial mass are intrinsic properties and don't change due to nearby objects.

8. Particles of masses 2M, m and M are respectively at points A, B, and C with AB = ½(BC). m is much smaller than M and at time t = 0, they are all at rest. At subsequent times before any collision takes place:

Options:
a) m will remain at rest
b) m will move towards M
c) m will move towards 2M
d) m will have oscillatory motion
Answer: c) m will move towards 2M
Explanation: The gravitational force from 2M on m is stronger than from M due to both larger mass and closer distance.

Multiple Choice Questions II

9. Which of the following options are correct?
Options:
a) acceleration due to gravity decreases with increasing altitude
b) acceleration due to gravity increases with increasing depth
c) acceleration due to gravity increases with increasing latitude
d) acceleration due to gravity is independent of the mass of the earth
Answer:

- a) acceleration due to gravity decreases with increasing altitude
- c) acceleration due to gravity increases with increasing latitude

Explanation:

- At altitude h: $g = GM/(R+h)^2 < GM/R^2$
- At latitude ϕ: $g\_eff = g - \omega^2 R \cos^2\phi$ (minimum at equator, maximum at poles)

10. If the law of gravitation, instead of being inverse-square law, becomes an inverse-cube law:

Options:

a) planets will not have elliptic orbits

b) circular orbits of planets is not possible

c) projectile motion of a stone thrown by hand on the surface of the earth will be approximately parabolic

d) there will be no gravitational force inside a spherical shell of uniform density

Answer:

- a) planets will not have elliptic orbits
- b) circular orbits of planets is not possible
- c) projectile motion of a stone thrown by hand on the surface of the earth will be approximately parabolic

Explanation: Inverse-cube law doesn't allow stable planetary orbits, but local projectile motion remains parabolic.

11. If the mass of sun were ten times smaller and gravitational constant G were ten times larger in magnitudes:

Options:

a) walking on ground would become more difficult

b) the acceleration due to gravity on earth will not change

c) raindrops will fall much faster

d) airplanes will have to travel much faster

Answer:

- a) walking on ground would become more difficult
- c) raindrops will fall much faster
- d) airplanes will have to travel much faster

Explanation: Earth's surface gravity increases: $g_{new} = G_{new} M_{earth}/R^2 = 10G M_{earth}/R^2 = 10g$

12. If the sun and the planets carried huge amounts of opposite charges:

Options:

a) all three of Kepler's laws would still be valid

b) only the third law will be valid

c) the second law will not change

d) the first law will still be valid

Answer:

- a) all three of Kepler's laws would still be valid
- c) the second law will not change
- d) the first law will still be valid

Explanation: Electrostatic force follows $1/r^2$ law like gravity, so Kepler's laws remain valid.

13. There have been suggestions that the value of the gravitational constant G becomes smaller when considered over very large time period in the future. If that happens for our earth:

Options:

a) nothing will change

b) we will become hotter after billions of years

c) we will be going around but not strictly in closed orbits

d) after sufficiently long time we will leave the solar system

Answer:

- c) we will be going around but not strictly in closed orbits
- d) after sufficiently long time we will leave the solar system

Explanation: Decreasing G weakens gravitational binding, leading to spiral outward motion and eventual escape.

14. Supposing Newton's law of gravitation for gravitation forces F_1 and F_2 between two masses m_1 and m_2 at positions r_1 and r_2 read:

$F_1 = -F_2 = (r_{12}/r_{12}^3)\, GM_0^2(m_1m_2/M_1^2)^n$

where M_0 is a constant of dimension of mass, $r_{12} = r_1 - r_2$ and n is a number. In such a case:

Options:

a) the acceleration due to gravity on earth will be different for different object

b) none of the three laws of Kepler will be valid

c) only the third law will become invalid

d) for n negative, an object lighter than water will sink in water

Answer:

- a) the acceleration due to gravity on earth will be different for different object
- c) only the third law will become invalid
- d) for n negative, an object lighter than water will sink in water

15. Which of the following are true?

Options:

a) a polar satellite goes around the earth's pole in north-south direction

b) a geostationary satellite goes around the earth in east-west direction

c) a geostationary satellite goes around the earth in west-east direction

d) a polar satellite goes around the earth in east-west direction

Answer:

- a) a polar satellite goes around the earth's pole in north-south direction
- c) a geostationary satellite goes around the earth in west-east direction

16. The centre of mass of an extended body on the surface of the earth and its centre of gravity:

Options:

a) are always at the same point for any size of the body

b) are always at the same point only for spherical bodies

c) can never be at the same point

d) is close to each other for objects, say of sizes less than 100 m e) both can change if the object is taken deep inside the earth

Answer: d) is close to each other for objects, say of sizes less than 100 m