JEE NEET CBSE GRAVITATION

Assertion Reason

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer -

[a] If both assertion and reason are true and reason is the correct explanation of assertion.

[b] If both assertion and reason are true but reason is not the correct explanation of assertion.

[c] If assertion is true but reason is false.

[d] If both assertion and reason are false.

[e] If assertion is false but reason is true.

Q 1. **Assertion** : Smaller the orbit of the planet around the sun, shorter is the time it takes to complete one revolution.

Reason : According to Kepler's third law of planetary motion, square of time period is proportional to cube of mean distance from sun.

Q 2. **Assertion** : Gravitational force between two particles is negligibly small compared to the electrical force.

Reason : The electrical force is experienced by charged particles only.

Q 3. **Assertion** : The universal gravitational constant is same as acceleration due to gravity.

Reason : Gravitational constant and acceleration due to gravity have same dimensional formula.

Q 4. **Assertion** : The value of acceleration due to gravity does not depend upon mass of the body.

Reason : Acceleration due to gravity is a constant quantity.

Q 5. **Assertion** : If a pendulum is suspended in a lift and lift is falling freely, then its time period becomes infinite.

Reason : Free falling body has acceleration equal to acceleration due to gravity.

Q 6. **Assertion** : If earth suddenly stops rotating about its axis, then the value of acceleration due to gravity will become same at all the places.

Reason : The value of acceleration due to gravity is independent of rotation of earth.

Q 7. **Assertion** : The difference in the value of acceleration due to gravity at pole and equator is proportional to square of angular velocity of earth.

Reason : The value of acceleration due to gravity is minimum at the equator and maximum at the pole.

Q 8. **Assertion** : There is no effect of rotation of earth on acceleration due to gravity at poles.

Reason : Rotation of earth is about polar axis.

Q 9. **Assertion** : A force act upon the earth revolving in a circular orbit about the sun. Hence work should be done on the earth.

Reason : The necessary centripetal force for circular motion of earth, comes from the gravitational force between earth and sun.

Q 10. **Assertion** : The ratio of inertial mass to gravitational mass is equal to one.

Reason : The inertial mass and gravitational mass of a body are equivalent.

Q 11. **Assertion** : Gravitational potential of earth at every place on it is negative.

Reason : Every body on earth is bound by the attraction of earth.

Q 12. **Assertion** : Even when orbit of a satellite is elliptical, its plane of rotation passes through the centre of earth.

Reason : According to law of conservation of angular momentum plane of rotation of satellite always remain same.

Q 13. **Assertion** : A planet moves faster, when it is closer to the sun in its orbit and vice versa.

Reason : Orbital velocity in orbital of planet is constant.

Q 14. **Assertion** : Orbital velocity of a satellite is greater than its escape velocity.

Reason : Orbit of a satellite is within the gravitational field of earth whereas escaping is beyond the gravitational field of earth.

Q 15. **Assertion** : If an earth satellite moves to a lower orbit, there is some dissipation of energy but the satellite speed increases.

Reason : The speed of satellite is a constant quantity.

Q 16. **Assertion** : Earth has an atmosphere but the moon does not.

Reason : Moon is very small in comparison to earth.

Q 17. **Assertion** : The time period of geostationary satellite is 24 hours.

Reason : Geostationary satellite must have the same time period as the time taken by the earth to complete one revolution about its axis.

Q 18. **Assertion** : The principle of superposition is not valid for gravitational force.

Reason : Gravitational force is a conservative force.

Q 19. **Assertion** : Two different planets have same escape velocity.

Reason : Value of escape velocity is a universal constant.

Q 20. **Assertion** : The time period of revolution of a satellite close to surface of earth is smaller than that revolving away from surface of earth.

Reason : The square of time period of revolution of a satellite is directly proportional to cube of its orbital radius.

Q 21. **Assertion** : When distance between two bodies is doubled and also mass of each body is also doubled, gravitational force between them remains the same.

Reason : According to Newton's law of gravitation, force is directly proportional to mass of bodies and inversely proportional to distance between them.

Q 22. **Assertion** : Generally the path of a projectile from the earth is parabolic but it is elliptical for projectiles going to a very large height.

Reason : The path of a projectile is independent of the gravitational force of earth.

Q 23. **Assertion** : A body becomes weightless at the centre of earth.

Reason : As the distance from centre of earth decreases, acceleration due to gravity increases.

Q 24. **Assertion** : Space rockets are usually launched in the equatorial line from west to east.

Reason : The acceleration due to gravity is minimum at the equator.

Q 25. **Assertion** : The binding energy of a satellite does not depend upon the mass of the satellite.

Reason : Binding energy is the negative value of total energy of satellite.

Q 26. **Assertion** : We can not move even a finger without disturbing all the stars.

Reason : Every body in this universe attracts every other body with a force which is inversely proportional to the square of distance between them.

Q 27. **Assertion** : If earth were a hollow sphere, gravitational field intensity at any point inside the earth would be zero.

Reason : Net force on a body inside the sphere is zero.

Q 28. **Assertion** : For a satellite revolving very near to earth's surface the time period of revolution is given by 1 hour 24 minutes.

Reason : The period of revolution of a satellite depends only upon its height above the earth's surface.

Q 29. **Assertion** : A person sitting in an artificial satellite revolving around the earth feels weightless.

Reason : There is no gravitational force on the satellite.

Q 30. **Assertion** : The speed of satellite always remains constant in an orbit.

Reason : The speed of a satellite depends on its path.

Q 31. **Assertion** : The speed of revolution of an artificial satellite revolving very near the earth is 8 kms^{-1}.

Reason : Orbital velocity of a satellite, become independent of height of near satellite.

Q 32. **Assertion** : Viscous force increase the velocity of satellite.

Reason : Orbital velocity of a satellite is proportional to square root of radius of earth.

Q 33. **Assertion** : Gravitational field is zero both at centre and infinity.

Reason : The dimensions of gravitational field are $[LT^{-2}]$.

Q 34. **Assertion** : The escape velocity from the surface of jupiter is less than that from earth's surface.

Reason : The radius of jupiter is smaller than earth.

Q 35. **Assertion** : The periodic time of communication satellite is 18 hours.

Reason : The time of revolution of a satellite depends upon its distance from earth surface.

Q 36. **Assertion** : For the planets orbiting around the sun, angular speed, linear speed, *K.E.* changes with time, but angular momentum remains constant.

Reason : No torque is acting on the rotating planet. So its angular momentum is constant.

Q 37. **Assertion** : The square of the period of revolution of a planet is proportional to the cube of its distance from the sun.

Reason : Sun's gravitational field is inversely proportional to the square of its distance from the planet.

Q 38. **Assertion** : If polar ice melts, days will be shorter.

Reason : Moment of inertia decreases and thus angular velocity increases.

Q 39. **Assertion** : Planet is a heavenly body revolving round the sun.

Reason : Star is luminous body made of gaseous material.

Q 40. **Assertion** : Newton solved the apple-Earth problem using Shell theorem.

Reason : Newton's law of gravitation applies strictly to a particles.

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Assertion Reason

Answer Sheet

Ans.1. (a) ***Both assertion and reason are true and reason is the correct explanation of assertion.*** According to Kepler's third law of motion, the square of the time period of a planet about the sun is proportional to the cube of the semi major axis of the ellipse or mean distance of the planet from the sun. *i.e.* $T^2 \propto a^3$, when *a* is smaller, shorter is the time period.

Ans.2. (b) ***Both assertion and reason are true but reason is not the correct explanation of assertion.*** If *r* is the distance between two electrons then according to Newtons's law, the gravitational force between them is $F_a = G\frac{m^2}{r^2}$

$$= 6.67 \times 10^{11} \times \frac{(9.1\times10^{-31})^2}{r^2} = \frac{5\times10^{-71}}{r^2}$$

and according to Coulomb's law, the electrical force between electrons is

$$F_e = \frac{q\times q}{r^2} = 9\times10^{-9}\times\frac{(1.6\times10^{-19})^2}{r^2} \cong \frac{2\times10^{-28}}{r^2}$$

$$\therefore \quad \frac{F_G}{F_e} \cong \frac{10^{-71}}{10^{-28}} \cong 10^{-43} \quad \text{i.e., } F_G = 10^{-43}F_e$$

i.e., gravitational force between two particles is negligible compared to the electrical force.

Ans.3. (d) ***Both assertion and reason are false.***

The universal gravitational constant *G* is totally different from *g*. The constant *G* is scalar and posses the dimensions $[M^{-1}L^{3}T^{-2}]$ $\left(G = \frac{FR^2}{Mm}\right)$. While g is a vector and has got the dimensions $[M^{\circ}LT^{-2}]$ $\left(g = \frac{GM}{R^2}\right)$. It is not a universal constant.

Ans.4. (c) ***Assertion is true but reason is false.*** Acceleration due to gravity is given by $g = GM/R^2$. Thus it does not depend on mass of body on which it is acting. Also it is not a constant quantity it changes with change in value of both *M* and *R* (distance between two bodies).

Ans.5. (b) ***Both assertion and reason are true but reason is not the correct explanation of assertion.*** If a pendulum is suspended in a lift and lift is moving downward with some acceleration *a,* then time period of pendulum is given by, $T = 2\pi\sqrt{\frac{l}{g-a}}$ In the case of free fall, $a = g$ then $T = \infty$. *i.e.,* the time period of pendulum becomes infinite.

Ans.6. (c) ***Assertion is true but reason is false.*** The value of *g* at any place is given by the relation, $g' = g - \omega^2 R_e \cos^2\lambda$ When λ is angle of latitude and ω is the angular velocity of earth. If earth suddenly stops rotating, then $\omega = 0$

$\therefore \quad g' = g$

i.e., the value of *g* will be same at all places.

Ans.7. (b) *Both assertion and reason are true but reason is not the correct explanation of assertion.*

Acceleration due to gravity,

$g' = g - R\omega^2 \cos^2\lambda$

At equator, $\lambda = 0°$ $\therefore$ $\cos 0° = 1$

$\therefore$ $g_e = g - R\omega^2$

At poles, $\lambda = 90°$ $\therefore$ $\cos 90° = 0$

$\therefore$ $g_p = g$

Thus, $g_p - g_e = g - g + R\omega^2 = R\omega^2$

Also, the value of *g* is maximum at poles and minimum at equators.

Ans.8. (a) *Both assertion and reason are true and reason is the correct explanation of assertion.* At poles, radius of horizontal circle is zero.

$\therefore$ Centripetal force $F = mr\omega^2 = 0$. Hence *g* at poles is not affected by rotation of earth.

Ans.9. (e) ***Assertion is false but reason is true.*** **Because the earth is revolving in the circular orbit about the sun, hence the force acting on it is the centripetal force which is always perpendicular to the direction of motion of the earth. Hence work done by the force will be zero.**

Ans.10. (a) ***Both assertion and reason are true and reason is the correct explanation of assertion.*** **Inertial mass and gravitational mass are equivalent. Both are scalar quantities and measured in the same unit. They are quite different in the method of their measurement. Also gravitational mass of a body is affected by the presence of other bodies near it where as internal mass remain unaffected.**

Ans.11. (a) ***Both assertion and reason are true and reason is the correct explanation of assertion.***

The gravitational potential at a point in the gravitational field of a body is defined as the work done in bringing a unit mass from infinity to earth, it is attracted by the earth gravitational field, so work is done on the body, so the gravitational potential is negative.

Ans.12. ***(a)Both assertion and reason are true and reason is the correct explanation of assertion.***

As no torque is acting on the planet, its angular momentum must stay constant in magnitude as well as direction. Therefore, plane of rotation must pass through the centre of earth.

Ans.13. (c) ***Assertion is true but reason is false.***

According to Kepler's law of planetary motion, a planet revolves around the sun in such a way that its areal velocity is constant, *i.e.,* it move faster, when it is closer the sun and vice-versa.

Ans.14. (e) ***Assertion is false but reason is true.***

The orbital velocity, if a satellite close to earth is $V_o = \sqrt{gR_e}$, while the escape velocity for a body

Thrown from the earth's surface is $V_e = \sqrt{2gR_e}$. Thus $\frac{V_0}{V_e} = \frac{\sqrt{gR_e}}{\sqrt{2gR_e}} = \frac{1}{\sqrt{2}}$

or $V_e = \sqrt{2}\,V_0$

i.e., if the orbital velocity of a satellite revolving close to the earth happens to increase to $\sqrt{2}$ times, the satellite would escape.

Ans.15. (c) Assertion is true but reason is false.

Due to resistance force of atmosphere, the satellite revolving around the earth losses kinetic energy. Therefore in a particular orbit the gravitational attraction of earth on satellite becomes greater than that required for circular orbit there. Therefore satellite moves down to a lower orbit. In the lower orbit as the potential energy becomes more negative (U = - GMm/r), hence

kinetic energy $\left(E_K = \frac{GMm}{2r}\right)$ increases, and hence speed of satellite increases.

Ans.16. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

The value of escape velocity on the surface of moon is small (only 2.5 kms^{-1}). The molecules of the atmosphere gases, on the moon have thermal velocity greater than escape velocity. Due to which all the molecules of gases have escaped and there is no atmosphere.

Ans.17. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

As the geostationay satellite is established in an orbit in the plane of the equator at a particular place, so it move in the same sense as the earth and hence its time period of revolution is equal to 24 hours, which is equal to time period of revolution of earth about its axis.

Ans.18. (e) Assertion is false but reason is true.

The total gravitational force on one particle due to number of particles is the resultant of force of attraction (or gravitational

force) exerted on the given particle due to individual particles, i.e., $\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \ldots$. It means the principle of superposition is valid.

Ans.19. (d) Both assertion and reason are false.

As, escape velocity = $\sqrt{\frac{2Gm}{R}}$, so its value depends on mass of planet and distance of a body from planet. The two different planets have same escape velocity, when these quantities (mass and radius) of planets are equal.

Ans.20. (a) Both assertion and reason are true and reason is the correct explanation of assertion. The time period of satellite, $T \propto r^{3/2}$

or, $T \propto (R_e + h)^{3/2}$

For a satellite revolving close to surface of earth,

$h \approx 0$

$\therefore T \propto R_e^{3/2}$. It is evident that the period of revolution of a satellite depends upon its height above the earth's surface. Greater is the height of a satellite above the earth's surface, greater is its period of revolution.

Ans.21. (a) Both assertion and reason are true and reason is the correct explanation of assertion. According to Newton's law of gravitation,

Ans.22. (c) Assertion is true but reason is false.

Upto ordinary heights, the change in the distance of a projectile from the centre of earth is negligible compared to the radius of earth. Hence the projectile moves under a nearly uniform gravitational force and the path is parabolic .But for the projectiles moving to a large height the gravitational force decreases quite rapidly (as $F \propto 1/r^2$). Under such a rapidly decreasing variable force, the path of the projectile becomes elliptical.

Ans.23. (c) Assertion is true but reason is false. Variation of g with depth from surface of earth is given by $g' = g\left(1-\frac{d}{R}\right)$. At the centre of earth, d = R, $\therefore\ g' = g\left(1-\frac{R}{R}\right) = 0$

$\therefore$ Apparent weight of body = mg' = 0

Ans.24. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. We know that earth revolves from west to east about its polar axis. Therefore, all the particles

on the earth have velocity from west to east. This velocity is maximum in the equatorial line, as $v = R\omega$, where R is the radius of earth and ω is the angular velocity of revolution of earth about its polar axis. When a rocket is launched from west to east in equatorial plane, the maximum linear velocity is added to the launching velocity of the rocket, due to which launching becomes easier.

Ans.25. (e) Assertion is false but reason is true.

Binding energy is the minimum energy required to free a satellite from the gravitational attraction. It is the negative value of total energy of satellite. Let a satellite of mass m be revolving around earth of mass M and radius R. Total energy of satellite = PE. + K.E.

$$= -\frac{GMm}{R} + \frac{1}{2}mv^2$$

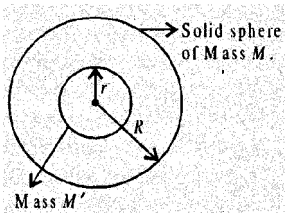
$$= -\frac{GMm}{R} + \frac{m}{2}\frac{GM}{R} = -\frac{GMm}{2R}$$

∴ Binding energy of satellite = - [total energy of satellite] which depend on mass of the satellite.

Ans.26. (a) Both assertion and reason are true and reason is the correct explanation of assertion. According to Newton's law of gravitation, every body in this universe attracts every other body

with a force which is inversely proportional to the square of the distance between them. When we move our finger, the distance of the objects with respect to finger changes, hence the force of attraction changes, disturbing the entire universe, including stars.

Ans.27. (a) Both assertion and reason are true and reason is the correct explanation of assertion. A uniform shell of matter exerts no gravitational force on a particle located inside it. This also means if a particle is located inside a uniform solid sphere of matter at distance r from its centre, the gravitational force exerted on the particle is due only to the mass M' that lies within a sphere of radius r. This mass M' is given by $M' = \rho \frac{4\pi r^3}{3}$, where ρ is density of the sphere.



Ans.28. (a) Both assertion and reason are true and reason is the correct explanation of assertion. The time period of a satellite at a height h above the earth surface,

$$T = 2\pi \sqrt{\frac{(R_e + h)^3}{gR_e^2}}$$

For a satellite revolving very near to earth's surface, h ~ 0

$\therefore \quad T = 2\pi\sqrt{\frac{R_e}{g}} = 2 \times 3.14 \sqrt{\frac{6.37 \times 10^6}{9.8}} = 5063 \text{ sec}$

$\cong$ 84 minutes $\cong$ 1 hour 24 minutes.

Ans.29. (c) Assertion is true but reason is false.

A person feels his weight only when the surface on which he is standing exerts a reactionary force on him. Because the acceleration of the person and that of the satellite revolving round the earth are equal (= g), hence acceleration of the person with respect to the satellite is zero. Therefore person feels weightless on satellite, although the gravitational force is acting on a satellite.

Ans.30. (e) Assertion is false but reason is true.

If the orbital path of a satellite is circular, then its speed is constant and if the orbital path of a satellite is elliptical, then its speed in its orbit is not constant. In that case its areal velocity is constant.

Ans.31. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

$V_0 = R_e \sqrt{\frac{g}{R_e + h}}$ for a satellite revolving very near the earth surface, Re + h = Re

$\therefore \quad V_0 = \sqrt{R_e g} = \sqrt{64 \times 10^5 \times 10}$

$= 8 \times 10^3$ m/s = 8 kms^{-1}. Which is independent of height of satellite.

Ans.32. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. When a satellite of mass m revolves in a circular orbit of radius r around the earth of mass M the gravitational attraction of earth provides the required centripetal force i.e., $\frac{mv^2}{r} = \frac{GMm}{r^2}$

or, $mv^2r = GMm$ or $(mvr)v$ = a constant

or, Lv = a constant …. (i)

Where mvr =L, angular momentum of a satellite. According to law of conversation of momentum it no external torque acts on the satellite, then its angular momentum L is conserved. Since the air friction will provide a retarding torque to satellite, therefore, there will be decrease in angular momentum of the satellite in air. As a result of it, the velocity of satellite increases according to relation.

Ans.33. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Gravitational field intensity at a point distance r from centre of earth is $E = GM/r^2$.

When $r = \infty$, $E = 0$.

When point is inside the earth, then $E = \frac{G}{r^2} \times \frac{4}{3}\pi r^3 \rho = \frac{4\pi G \rho r}{3}$ when $r = 0$, $E = 0$.

Ans.34. (d) Both assertion and reason are false.

The radius and mass of Jupiter's larger than that of earth. Therefore, the escape velocity $\left(= \frac{\sqrt{2GM}}{R}\right)$ is more at the surface of Jupiter than at earth's surface.

Ans.35. (e) Assertion is false but reason is true.

A communication satellite completes one revolution in the same time as that of earth about its axis. So the time period of revolution of communication satellite is 24 hours.

Ans.36. (a) Both assertion and reason are true and reason is the correct explanation of assertion. The torque on a body is given by

$$\Rightarrow \vec{\tau} = \frac{d\vec{L}}{dt}$$

In case of planet orbiting around sun no torque is acting on it.

$\therefore$ 0 = $\frac{d\vec{L}}{dt} \Rightarrow \vec{L}$ (angular momentum) = constant.

Ans.37. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

To make our calculations easy, let's take the semi-major axis of the ellipse be equal to the average distance of the Sun from the planet. By applying Newton's law,

$$\frac{GMm}{a^2} = m\omega^2 a$$

ω = angular velocity of the planet

= $\frac{2\pi}{T}$ (T = time period of the planet)

$\therefore$ $\frac{GMm}{a^2} = m\frac{(2\pi)^2}{T^2}a$ **or $T^2 = \left(\frac{4\pi^2}{GM}\right)a^2$**

or, $T^2 \propto a^3$. Which is also known as Kepler's third law or the law of period, according to which the square of period of any planet is proportional to the cube of the semi major axis of its orbit.

Ans.38. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

As the polar ice melts, it will flow towards the equator thereby increasing the moment of inertia of earth. Hence the angular velocity decreases. So, the day length will become longer.

Ans.39. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

A heavenly body revolving round the sun is called a planet and there are nine planets in our solar system. A heavenly body made of gaseous material and luminous due to its own energy, is called a star.

Ans.40. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. According to Newton's Shell theorem "A uniform spherical shell of matter attracts a particle that is outside the shell as if all the shell's mass were concentrated at its centre." Thus, from apple's point of view, Earth does behave like particle, located at the centre of earth and having a mass equal to that of the planet.

Newton's law of gravitation applies strictly to particles, we can also apply it to real object as long as the size of the objects are small compared to the distance between them. The moon and earth are far enough apart so that, to a good approximation, we can treat them both as particles.