# Gravitation

## Assertion Reason Questions

**Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes** (a), (b), (c) and (d) as given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

**1. Assertion (A):** The difference in the value of acceleration due to gravity at the pole and equator is the proportional to the square of angular velocity of the earth.
**Reason (R):** The value of acceleration due to gravity is minimum at the equator and maximum at the pole.

**Ans.** (b) Both A and R are true and R is not the correct explanation of A.
**Explanation:** Acceleration due to gravity,

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

At equator, $\lambda = 0°$,

$\therefore \quad \cos 0° = 1$

$\therefore \quad g_e = g - R_e^2$

At poles, $\lambda = 90°$,

$\therefore \quad \cos 90° = 0$

$g_p = g$

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

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

**2. Assertion (A):** The comets do not obey Kepler's Laws of planetary motion.
**Reason (R):** The comets do not have elliptical orbits.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.
**Explanation:** The orbit of a comet is not elliptical. As a result, it does not obey Kepler's rule of planetary activity. They travel on hyperbolic or nearly parabolic routes.

**3. Assertion (A):** If the rotation of the earth its axis suddenly stops then the acceleration due to gravity will increase at all places on the earth.

**Reason (R):** At height h from the surface of the earth. Acceleration due to gravity is:

$$g_h = g\left(1 - \frac{2h}{R_e}\right)$$

**Ans.** (b) Both A and R are true and R is not the correct explanation of A.
**Explanation:** The acceleration of gravity is caused by the gravitational force that the earth exerts on things, but because the world rotates, various centrifugal forces impinge on objects at different latitudes, hence the acceleration of gravity varies. If the earth stops
rotating, the centrifugal force disappears and just the gravitational force occurs, and the acceleration due to gravity becomes the same everywhere.

**4. Assertion (A):** A body falling freely under the force of gravity has constant acceleration (9.81 $m/sec^2$).
**Reason (R):** Earth attracts everybody towards its center by the same force.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.
Explanation: The gravity of the Earth is the total acceleration that is imparted to the objects due to the combined effect of gravitation and the centrifugal force. It is denoted by "g" and is approximately equal to 9.8 $m/s^2$ (meter per Second Square). Gravity is the force by which the planet or any other body draws the objects towards its center and therefore the force of gravity keeps all of the planets in orbit around the Sun. Any object which has mass has gravity. Objects with more mass have more gravity and those with less mass have less gravity. Also, the gravity gets weaker with distance and therefore, the closer objects to each other have the stronger gravitational pull. Earth's gravity comes from all its mass which makes the combined gravitational pull on all the mass in the body that gives us the weight. We exert the same gravitational force on the Earth that the Earth does on us. Since the Earth is more massive than us, our force does not work on it. The Earth is one massive object with very strong gravitational force. As a result, the gravity of Earth attracts all objects towards the center of Earth.

**5. Assertion (A):** Kepler's law of areas is equivalent to the law of conservation of angular momentum.
**Reason (R):** For planetary motion

$$\frac{dA}{dt} = \frac{L}{2m} = \text{Constant.}$$

**Ans.** (a) Both A and R are true and R is the correct explanation of A.
**Explanation:** According to Kepler's law,

$$\frac{dA}{dt} = \text{constant}$$

$$\frac{dA}{dt} = \frac{1}{2}r^2\frac{d\theta}{dt} = \frac{1}{2}r^2\omega$$

$$\frac{mr^2\omega}{2m} = \frac{L}{2m}$$

$$L = \text{constant}$$

**6. Assertion (A):** A person feels weightlessness in an artificial satellite of the earth. However, a person on the moon (natural satellite) feels his weight.
**Reason (R):** Artificial satellite is a freely falling, body and on the moon's surface, the weight is mainly due to the moon's gravitational attraction.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.
**Explanation:** In artificial satellites, there is no gravitation but on the surface of the moon gravity is present with its effect very little in amount. That is why people feel weightlessness due to the absence of gravity on the artificial satellite and have some weight on the surface of the moon. Weightlessness is a phenomenon when the gravitational force is completely used up for providing centripetal acceleration.

**7. Assertion (A):** An astronaut in an orbiting space station above the earth experiences weightlessness.
**Reason (R):** An object moving around the earth under the influence of the earth's gravitational force is in a state of free fall.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.
**Explanation:** The astronaut's typical force aboard the orbiting space station is zero. As a result, the apparent weight of an astronaut aboard an orbiting space station is zero. An astronaut is said to be in a condition of weightlessness. This is due to the fact that both the astronaut and the spacecraft are free-falling bodies. So, both assertion and the reason are correct and reason is the correct explanation for assertion.

**8. Assertion (A):** Angular momentum of a satellite remains conserved. Conservation of linear momentum leads to
**Reason (R):** conservation of angular momentum.

**Ans.** (c) A is true but R is false.

**Explanation:** The only force acting on the satellite is the force of gravitational attraction which points directly toward the center of mass of the primary, the torque caused by this force equals zero, and therefore angular momentum of a satellite in an elliptical orbit is conserved about the center of mass of the primary. Angular momentum, like energy and linear momentum, is conserved. This universally applicable law is another sign of underlying unity in physical laws. Angular momentum is conserved when net external torque is zero, just as linear momentum is conserved when the net external force is zero.

**9. Assertion (A):** A body kept inside a spherical shell does not experience any gravitational force.

**Reason (R):** The body inside a spherical shell is protected from the gravitational attraction outside the shell.

**Ans.** (d) A is false and R is also false

**Explanation:** Inside the shell, the gravitational force is zero. This is because is no mass inside, the gravitational field is zero, thereby is zero. However, unlike a metallic shell which shield electrical forces, the shell does not shield other bodies outside it from exerting gravitational forces on a particle inside.