

b. GravitationBook Back questions1. Kepler's three laws:-

(i) Law of orbits (ii) Law of area (iii) Law of period

(i) Laws of orbits:- Each planet moves around the sun in an elliptical orbit with the sun at one of the foci.

(ii) Laws of Area:- The radial vector (line joining the sun to a planet) sweeps equal areas in equal intervals of time.

(iii) Law of period:- The square of the time period of revolution of a planet around the sun in its elliptical orbit is directly proportional to the cube of the semi-major axis of the ellipse.

2. Newton's Universal law of gravitation:-

The strength of this force of attraction is found to be directly proportional to the product of their masses and is inversely proportional to the square of the distance between them.

$$\vec{F} = -\frac{G M_1 M_2}{r^2} \hat{r} \quad G = 6.626 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

3. Will Angular momentum of a planet can be conserved?

Justify your answer.

$$\vec{\tau} = \vec{r} \times \vec{F} = \vec{r} \times \left(-\frac{GM_s M_E}{r^2} \hat{r} \right) = 0 \quad \text{since } \vec{r} = r \hat{r}, (\vec{r} \times \hat{r}) = 0$$

So $\vec{\tau} = \frac{d\vec{L}}{dt} = 0$. It implies that angular momentum $\vec{L}$ is a constant vector. The Angular momentum of the Earth about sun is constant throughout the motion. It is true for all the planets.

4. Gravitational field: (i) The gravitational field is defined as the gravitational force experienced by unit mass placed at that point. It is given by ratio $\frac{\vec{F}_a}{m_a}$

$$\vec{E} = -\frac{Gm}{r^2} \hat{r}$$

(ii) The gravitational field at a point is equivalent to the acceleration experienced by a particle at the point

$$\vec{a} = \vec{E}$$

(iii) Its unit is N/kg (or) ms^{-2} .

5. Superposition of gravitational field: The Total gravitational field at a point P due to all the masses is given by vector sum of gravitational field due to individual masses

$$\begin{aligned} \vec{E}_{total} &= \vec{E}_1 + \vec{E}_2 + \dots + \vec{E}_n \\ &= -\frac{Gm_1}{r_1^2} \hat{r}_1 - \frac{Gm_2}{r_2^2} \hat{r}_2 - \dots - \frac{Gm_n}{r_n^2} \hat{r}_n \\ &= -\sum_{i=1}^n \frac{Gm_i}{r_i^2} \hat{r}_i \end{aligned}$$

6. Gravitational potential energy: Gravitational potential energy of a system of two masses m_1 and m_2 separated by a distance r as the amount of work done to bring the mass m_2 from infinity to a distance r assuming m_1 to be fixed in its position. $U(r) = -\frac{Gm_1 m_2}{r}$. Its unit

8. Gravitational potential - The gravitational potential at distance r is equivalent to gravitational potential energy per unit mass at the same distance r . It is a scalar quantity. Its unit is Jkg^{-1} . $V(r) = -\frac{Gm_1m_2}{r}$

Gravitational potential	Gravitational potential energy
(i) $V(r) = -\frac{Gm}{r}$ (ii) Scalar quantity (iii) Its unit is J/kg (iv) The mass will move from a region of higher gravitational potential to a region of lower gravitational potential (v) In h height, gravitational potential of an object $V(h) = V(h)/m = gh$	(i) $U(r) = -\frac{Gm_1m_2}{r}$ (ii) It is a scalar quantity (iii) Its unit is Joule (J) (iv) It depends upon two masses and distance between them. (v) In h height, gravitational potential energy of an object is mgh.

10. Escape speed: The speed of an object thrown vertically up such that it escapes the Earth's gravity and would never come back is called escape speed.

Escape speed of Earth = 11.2 km/s (or) 11.2 kms^{-1}

11. Why is energy of satellite negative? $E = -\frac{GM_s M_E}{2(R_E + h)}$

The negative sign in the total energy implies that the satellite is bound to the Earth and it cannot escape from the earth.

12) Geostationary: The stationary satellite which is 36,000 km far away from the surface of earth is called geo-stationary satellites.
polar satellites: This type of satellite that orbits earth from North pole to South pole is called a polar satellite. which is placed at a distance of 500 to 800 km from surface of earth.

13) weight:

- (i) weight is the gravitational force acting on a body.
- (ii) It is a measure of how strongly gravity pulls on that body.
- (iii) The Direction of weight is in the direction of gravitational force.
- (iv) Its unit is newton.

14) Why is there no lunar eclipse and solar eclipse every month?

- (i) If the orbits of the moon and Earth lie on same plane, during full moon of every month, we can observe lunar eclipse.
- (ii) If this is so during new Moon we can observe solar eclipse.
- (iii) But the Moon's orbit is tilted 5° with respect to Earth's orbit.
- (iv) Due to this 5° tilt, only during certain periods of year, the sun, Earth and moon align in straight line leading to either lunar eclipse or solar eclipse depending on the alignment.

15. Earth spinning itself:

(i) The Earth's spinning motion can be proved by observing star's position over a night.

(ii) Due to Earth's spinning motion, the stars in sky appear to move in circular motion about the pole star.

7. Is potential energy the property of a single object? Justify.

No, potential energy is a property of a system rather than of a single object due to its physical position. Because gravitation potential energy depends on relative position. So, a reference level at which to set the potential energy equal to zero.

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