JEE Main Practice Test-12
Gravitation

Topic : GRAVITATION **Time: 75Min** **Marking +4 –1**

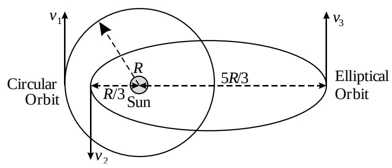
Section - A : MCQs with Single Option Correct

1. The time period of an earth satellite in circular orbit is independent of :
(A) The mass of the satellite
(B) Radius of its orbit
(C) Both the mass and radius of the orbit
(D) Neither the mass of the satellite nor the radius of its orbit

2. An astronaut of mass m is working on a satellite orbiting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is :

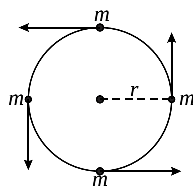
(A) Zero since astronaut feels weightless
(B) $\frac{GMm}{(R+h)^2} < F_G < \frac{GMm}{R^2}$
(C) $F_G = \frac{GMm}{(R+h)^2}$
(D) $0 < F_G < \frac{GMm}{R^2}$

3. Two satellites revolve around the Sun as shown in the figure. First satellite revolves in a circular orbit of radius R with speed v_1. Second satellite revolves in elliptical orbit, for which minimum and maximum distance from the sun are $\frac{R}{3}$ and $\frac{5R}{3}$ respectively. Velocities at these positions are v_2 and v_3 respectively. The correct order of speeds is :



(A) $v_2 > v_3 > v_1$ (B) $v_3 < v_2 > v_1$ (C) $v_2 > v_1 > v_3$ (D) $v_2 > v_3 = v_1$

4. Four similar particles of mass m are orbiting in a circle of radius r in the same direction and same speed because of their mutual gravitational attractive force as shown in the figure. Speed of a particle is given by :



(A) $\left[\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{\frac{1}{2}}$
(B) $\sqrt[3]{\frac{Gm}{r}}$
(C) $\sqrt{\frac{Gm}{r}(1+2\sqrt{2})}$
(D) zero

5. A space vehicle approaching a planet has a speed v, when it is very far from the planet. At that moment tangent of its trajectory would miss the centre of the planet by distance R. If the planet has mass M and radius r, what is the smallest value of R in order that the resulting orbit of the space vehicle will just miss the surface of the planet ?

(A) $R = \frac{r}{v}\left[v^2 + \frac{2GM}{r}\right]^{1/2}$ (B) $R = \frac{r}{v}\left[1 + \frac{GM}{2r}\right]$ (C) $R = \frac{r}{v}\left[v^2 + \frac{GM}{r}\right]$ (D) $R = \frac{r}{v}(2\,GM)$

6. The value of acceleration due to gravity at Earth's surface is 9.8 ms^{-2}. The altitude above its surface at which the acceleration due to gravity decreases to 4.9 ms^{-2}, is close to : (Radius of earth = 6.4×10^6 m)

(A) 1.6×10^6 m (B) 6.4×10^6 m (C) 9.0×10^6 m (D) 2.6×10^6 m

7. If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth, is :

(A) $2\, mgR$ (B) $\frac{1}{2} mgR$ (C) $\frac{1}{4} mgR$ (D) mgR

8. A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them, to take the particle far away from the sphere :
[you may take $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$]

(A) 13.34×10^{-10} J (B) 3.33×10^{-10} J (C) 6.67×10^{-9} J (D) 6.67×10^{-10} J

9. The change in the value of g at a height h above the surface of the earth is the same as at a depth d below the surface of earth. When both d and h are much smaller than the radius of earth, then which one of the following is correct ?

(A) $d = \frac{h}{2}$ (B) $d = \frac{3h}{2}$ (C) $d = 2h$ (D) $d = h$

10. Average density of the earth :

(A) Does not depend on g
(B) Is a complex function of g
(C) Is directly proportional to g
(D) Is inversely proportional to g

11. A solid sphere of mass 'M' and radius 'a' is surrounded by a uniform concentric spherical shell of thickness $2a$ and mass $2M$. The gravitational field at distance '$3a$' from the centre will be :

(A) $\frac{2GM}{9a^2}$ (B) $\frac{GM}{3a^2}$ (C) $\frac{GM}{9a^2}$ (D) $\frac{2GM}{3a^2}$

12. If g_E and g_M are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be :

(A) 1 (B) Zero (C) g_E / g_M (D) g_M / g_E

13. The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is :

(A) $\frac{R}{2}$ (B) $\sqrt{2}\, R$ (C) $2R$ (D) $\frac{R}{\sqrt{2}}$

14. Two bodies of masses m and $4m$ are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is :

(A) $-\frac{6Gm}{r}$ (B) $-\frac{9Gm}{r}$ (C) Zero (D) $-\frac{4Gm}{r}$

15. The potential energy of 4 particles each of mass 1 kg placed at the four vertices of a square of side length 1 m is :

(A) +4.0 G (B) −7.5 G (C) −5.4 G (D) +6.3 G

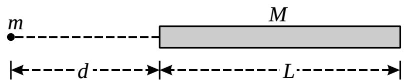
16. Taking the radius of the earth to be 6400 km, by what percentage will the acceleration due to gravity at a height of 100 km from the surface of the earth differ from that on the surface of the earth :

(A) About 1.5% (B) About 5% (C) About 8% (D) About 3%

17. Two identical solid uniform spheres each of radius R are kept touching each other. The gravitational force of attraction between them depends on R in following way :

(A) $F \propto R^2$ (B) $F \propto R^3$ (C) $F \propto R^4$ (D) $F \propto F^{-4}$

18. A particle of mass m is placed at a distance d from on end of a uniform rod with length L and mass M as shown in the figure. Find the magnitude of the gravitational force on the particle due to rod :



(A) $\frac{GmM}{d(L+2d)}$ (B) $\frac{GmM}{d(L+d)}$ (C) $\frac{GmM}{2(L+d)d}$ (D) $\frac{2GmM}{d(L+d)}$

19. Consider a thin uniform spherical layer of mass M and radius R. The potential energy of gravitational interaction of matter forming this shell is :

(A) $-\frac{GM^2}{R}$ (B) $-\frac{1}{2}\frac{GM^2}{R}$ (C) $-\frac{3}{2}\frac{GM^2}{R}$ (D) $-\frac{2}{3}\frac{GM^2}{R}$

20. Two particles of equal mass 'm' go around a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle with respect to their centre of mass is :

(A) $\sqrt{\frac{Gm}{R}}$ (B) $\sqrt{\frac{Gm}{4R}}$ (C) $\sqrt{\frac{Gm}{3R}}$ (D) $\sqrt{\frac{Gm}{2R}}$

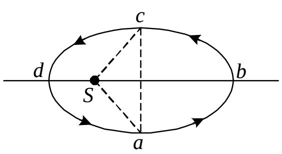
Section- B: INTEGER Answer Type Questions

21. A satellite is launched in the equatorial plane in such a way that it can transmit signals upto 60° latitude on the earth. The angular velocity of the satellite is $\sqrt{\frac{GM}{nR^3}}$. Find n.

22. The gravitational potential energy of a satellite revolving around the earth in circular orbit is – 4 MJ. Find the additional energy (in MJ) that should be given to the satellite so that it escapes from the gravitational force of the earth (consider only gravitational force on the satellite and no atmospheric resistance).

23. A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius R ($R << L$). A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period of star is T and its distance from the galaxy's axis is r, then $T \propto r^n$. Find n.

24. Figure shows elliptical path $abcd$ of a planet around the sun S such that the area of triangle csa is $\frac{1}{4}$ the area of the ellipse. (See figure) With db as the major axis, and ca as the minor axis if t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then $t_1 = nt_2$. Find n.



25. A body of mass m is moving in a circular orbit of radius R about a planet of mass M. At some instant, it splits into two equal masses. The first mass moves in a circular orbit of radius $\frac{R}{2}$, and the other mass, in a circular orbit of radius $\frac{3R}{2}$. The difference between the final and initial total energies is $-\frac{GMm}{nR}$. Find n.

26. The kinetic energy needed to project a body of mass m from the earth's surface (radius R) to infinity is $nmgR$. Find n.

27. Astronomers observe two separate solar systems, each consisting of a planet orbiting a sun. The two orbits are circular and have the same radius R. It is determined that the planets have angular momenta of the same magnitude L about their suns, and that the orbital periods are in the ratio of three to one; i.e., $T_1 = 3T_2$. Calculate the ratio m_1/m_2 of the masses of the two planets.

28. An object weighs 10 N at the north-pole on the earth. In a satellite distant $10R$ from the centre of the earth where R is the radius of earth. What will be the weight measured (in N) inside the satellite ?

29. A particle is projected in upward direction from the surface of the earth. It is found that potential energy is negative of four times the kinetic energy. If the projection speed is $\frac{v_e}{n}$ where v_e is the escape velocity. Find n.

30. A rocket has to be launched from earth in such a way that it never returns. If E is the minimum energy delivered by the rocket launcher, the minimum energy that the launcher should have if the same rocket is to be launched from the surface of the moon is $\frac{E}{n}$. Find n. Assume that the density of the earth and the moon are equal and that the earth's volume is 64 times the volume of the moon.

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ANSWER KEY

Section - A : MCQs with Single Option Correct

1. (A)	**2.** (C)	**3.** (C)	**4.** (A)
5. (A)	**6.** (D)	**7.** (B)	**8.** (D)
9. (C)	**10.** (C)	**11.** (B)	**12.** (A)
13. (C)	**14.** (B)	**15.** (C)	**16.** (D)
17. (C)	**18.** (B)	**19.** (B)	**20.** (B)

Section- B: INTEGER Answer Type Questions

21. [8]	**22.** [2]	**23.** [1]	**24.** [3]
25. [6]	**26.** [1]	**27.** [3]	**28.** [0]
29. [2]	**30.** [16]		

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