



Chapter 7 : Gravitation (50 Important MCQs)

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Notes

50 important MCQs from GSEB, CBSE, NEET and JEE exams · Answer key at the end

Section A — Multiple Choice Questions

Each question carries 1 mark. Choose the correct option.

Q.1 For different satellites revolving around a planet in different circular orbits, which of the following shows the relation between the angular momentum L and the orbital radius r ?

- (A) $L \propto r^2$ (B) $L \propto \sqrt{r}$ (C) $L \propto \frac{1}{r^2}$ (D) $L \propto \frac{1}{\sqrt{r}}$

Q.2 What kind of relation exists between the kinetic energy E_k and the orbital radius r of a satellite revolving around the earth?

- (A) $E_k \propto r$ (B) $E_k \propto r^2$ (C) $E_k \propto \frac{1}{r}$ (D) $E_k \propto \frac{1}{r^2}$

Q.3 Using the orbital radius r and the corresponding time period T of different satellites revolving around a planet, what would be the slope of the graph of $\log T$ against $\log r$?

- (A) $\frac{3}{2}$ (B) $\frac{2}{3}$ (C) 3 (D) 2

Q.4 The value of g at a particular point is 9.8 m/s^2 . Suppose the earth suddenly shrinks uniformly to half its present size without losing any mass. The value of g at the same point (the distance of the point from the centre of the earth is unchanged) will now be

- (A) 4.9 m/s^2 (B) 3.1 m/s^2 (C) 9.8 m/s^2 (D) 19.6 m/s^2

Q.5 The radius of the earth is 4 times that of the moon and its mass is 80 times that of the moon. If the acceleration due to gravity on the surface of the earth is 10 m/s^2 , that on the surface of the moon will be

- (A) 1 m/s^2 (B) 2 m/s^2 (C) 3 m/s^2 (D) 4 m/s^2

Q.6 If the gravitational force between two objects were proportional to $1/R$ (and not $1/R^2$), where R is the distance between them, then a particle in a circular orbit under such a force would have its orbital speed v proportional to

- (A) $\frac{1}{R^2}$ (B) R^0 (C) R^1 (D) $\frac{1}{R}$

Q.7 The distances of two planets from the sun are 10^{13} m and 10^{12} m respectively. The ratio of their time periods is

- (A) $\sqrt{10}$ (B) 100 (C) $10\sqrt{10}$ (D) $\frac{1}{\sqrt{10}}$

Q.8 The earth (mass 6×10^{24} kg) revolves around the sun with an angular velocity of 2×10^{-7} rad/s in a circular orbit of radius 1.5×10^8 km. The force exerted by the sun on the earth, in newton, is

- (A) 18×10^{25} (B) zero (C) 27×10^{39} (D) 36×10^{21}

Q.9 A particle of mass m is thrown upwards from the surface of the earth with a velocity U . M and R are the mass and radius of the earth, G is the gravitational constant and g the acceleration due to gravity on the surface. The minimum value of U so that the particle does not return to the earth is

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

Q.10 The earth is assumed to be a sphere of radius R . A platform is arranged at a height R from the surface of the earth. The escape velocity of a body from this platform is fv , where v is its escape velocity from the surface of the earth. The value of f is

- (A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\sqrt{2}$

Q.11 In the elliptical orbit of a planet about the sun S , the area swept by the radius vector from C to D is twice the area swept from A to B . If t_1 is the time for the planet to move from C to D and t_2 from A to B , then

- (A) $t_1 = 4t_2$ (B) $t_1 = 2t_2$ (C) $t_1 = t_2$ (D) $t_1 > t_2$

Q.12 The average densities of two planets are the same but their radii are R_1 and R_2 . If the accelerations due to gravity on the planets are g_1 and g_2 , then

- (A) $\frac{g_1}{g_2} = \frac{R_1}{R_2}$ (B) $\frac{g_1}{g_2} = \frac{R_2}{R_1}$ (C) $\frac{g_1}{g_2} = \frac{R_1^2}{R_2^2}$ (D) $\frac{g_1}{g_2} = \frac{R_1^3}{R_2^3}$

Q.13 The escape velocity from the earth's surface is 11 km/s. If the radius of a planet is two times the radius of the earth but its average density is the same as that of the earth, the escape velocity from the planet will be

- (A) 22 km/s (B) 11 km/s (C) 5.5 km/s (D) 15.5 km/s

Q.14 If the mass of the earth is M , its radius R and G the universal gravitational constant, the work done against gravity to move a body of mass 1 kg from the surface of the earth to infinity is

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

Q.15 The escape velocity from the surface of the earth is v_e . The escape velocity from the surface of a planet whose mass and radius are both 3 times those of the earth will be

- (A) v_e (B) $3v_e$ (C) $9v_e$ (D) $27v_e$

Q.16 The gravitational potential energy of a body of mass m at the earth's surface is $-mgR_e$. Its gravitational potential energy at a height R_e from the earth's surface will be (R_e = radius of the earth)

- (A) $-2mgR_e$ (B) $2mgR_e$ (C) $\frac{1}{2}mgR_e$ (D) $-\frac{1}{2}mgR_e$

Q.17 Kepler's third law states $T^2 = Kr^3$, where K is a constant. If the masses of the sun and planet are M and m and the force of attraction between them is $F = \frac{GMm}{r^2}$, the relation between G and K is

- (A) $GK = 4\pi^2$ (B) $GK = 4\pi^2$ (C) $K = G$ (D) $K = \frac{1}{G}$

Q.18 A remote-sensing satellite of the earth revolves in a circular orbit at a height of 0.25×10^6 m above the surface. If the earth's radius is 6.38×10^6 m and $g = 9.8 \text{ m s}^{-2}$, the orbital speed of the satellite is

- (A) 6.67 km s^{-1} (B) 7.76 km s^{-1} (C) 8.56 km s^{-1} (D) 9.13 km s^{-1}

Q.19 At what height from the surface of the earth are the gravitational potential and the value of g equal to $-5.4 \times 10^7 \text{ J kg}^{-1}$ and 6.0 m s^{-2} respectively? Take the radius of the earth as 6400 km.

- (A) 1600 km (B) 1400 km (C) 2000 km (D) 2600 km

Q.20 A satellite of mass m orbits the earth (radius R) at a height h from its surface. The total energy of the satellite in terms of g_0 , the acceleration due to gravity at the earth's surface, is

- (A) $\frac{2mg_0R^2}{R+h}$ (B) $-\frac{2mg_0R^2}{R+h}$ (C) $\frac{mg_0R^2}{2(R+h)}$ (D) $-\frac{mg_0R^2}{2(R+h)}$

Q.21 Treat the earth as a uniform solid sphere. If the acceleration due to gravity at a depth d below the earth's surface equals its value at a height h above the surface, and both equal $g/4$, the ratio h/d is

- (A) 1 (B) $\frac{4}{3}$ (C) $\frac{3}{2}$ (D) $\frac{2}{3}$

Q.22 A satellite of mass m revolves in a circular orbit of radius $3R_E$ around the earth (mass M_E , radius R_E). How much extra energy must be spent to shift it to an orbit of radius $9R_E$?

- (A) $\frac{GM_Em}{3R_E}$ (B) $\frac{GM_Em}{18R_E}$ (C) $\frac{3GM_Em}{2R_E}$ (D) $\frac{GM_Em}{9R_E}$

Q.23 A planet moves in an elliptical orbit about the sun S . A is the point of the orbit nearest the sun (perihelion), C the farthest (aphelion), and B is a point where SB is perpendicular to the major axis AC . If K_A , K_B , K_C are the kinetic energies at A , B and C , then

- (A) $K_B > K_A > K_C$ (B) $K_A < K_B < K_C$ (C) $K_B < K_A < K_C$ (D) $K_A > K_B > K_C$

Q.24 If the mass of the sun were ten times smaller and the universal gravitational constant ten times larger, which of the following is **not** correct?

- (A) 'g' on the earth will not change.
(B) Raindrops will fall faster.
(C) The time period of a simple pendulum on the earth would decrease.
(D) Walking on the ground would become more difficult.

Q.25 At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the earth's atmosphere? (Mass of oxygen molecule $m = 2.76 \times 10^{-26} \text{ kg}$, $k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$, escape speed 11.2 km/s)

- (A) $1.254 \times 10^4 \text{ K}$ (B) $2.508 \times 10^4 \text{ K}$ (C) $5.016 \times 10^4 \text{ K}$ (D) $8.360 \times 10^4 \text{ K}$

Q.26 The work done to raise a mass m from the surface of the earth to a height h equal to the radius R of the earth is

- (A) $\frac{3}{2}mgR$ (B) mgR (C) $2mgR$ (D) $\frac{1}{2}mgR$

Q.27 A body weighs 200 N on the surface of the earth. How much will it weigh halfway down to the centre of the earth?

- (A) 100 N (B) 150 N (C) 200 N (D) 250 N

Q.28 A body weighs 72 N on the surface of the earth. What is the gravitational force on it at a height equal to half the radius of the earth?

- (A) 32 N (B) 30 N (C) 24 N (D) 48 N

Q.29 A particle of mass m is projected with a velocity $v = kV_e$ ($k < 1$) from the surface of the earth (V_e = escape velocity). The maximum height above the surface reached by the particle is

- (A) $\frac{Rk^2}{1-k^2}$ (B) $R\left(\frac{k}{1-k}\right)^2$ (C) $R\left(\frac{k}{1+k}\right)^2$ (D) $\frac{R^2k}{1+k^2}$

Q.30 Two bodies of masses m and $9m$ are placed at a distance R apart. The gravitational potential at the point on the line joining them where the gravitational field is zero is

- (A) $-\frac{20Gm}{R}$ (B) $-\frac{8Gm}{R}$ (C) $-\frac{12Gm}{R}$ (D) $-\frac{16Gm}{R}$

Q.31 A satellite orbits just above the surface of the earth with period T . If d is the density of the earth and G the universal constant of gravitation, the quantity $\frac{3\pi}{Gd}$ represents

- (A) $\sqrt{T}$ (B) T (C) T^2 (D) T^3

Q.32 The mass of a planet is $1/10$ that of the earth and its diameter is half that of the earth. The acceleration due to gravity on that planet is

- (A) 4.9 m s^{-2} (B) 3.92 m s^{-2} (C) 19.6 m s^{-2} (D) 9.8 m s^{-2}

Q.33 A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is

- (A) gx (B) $\frac{gR}{R-x}$ (C) $\frac{gR^2}{R+x}$ (D) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

Q.34 Suppose the gravitational force varies inversely as the n^{th} power of distance. Then the time period of a planet in a circular orbit of radius R around the sun will be proportional to

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

Q.35 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 to take the particle far away from the sphere. ($G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$)

- (A) $6.67 \times 10^{-9} \text{ J}$ (B) $6.67 \times 10^{-10} \text{ J}$ (C) $13.34 \times 10^{-10} \text{ J}$ (D) $3.33 \times 10^{-10} \text{ J}$

Q.36 A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11 km s^{-1} , the escape velocity from the surface of the planet would be

- (A) 1.1 km s^{-1} (B) 11 km s^{-1} (C) 110 km s^{-1} (D) 0.11 km s^{-1}

Q.37 The height at which the acceleration due to gravity becomes $g/9$ (g = acceleration due to gravity on the earth's surface), in terms of the earth's radius R , is

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

Q.38 Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

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

Q.39 From a solid sphere of mass M and radius R , a spherical portion of radius $R/2$ is removed; the cavity touches the surface and its centre is at $R/2$ from the centre of the sphere. Taking $V = 0$ at infinity, the gravitational potential at the centre of the cavity is

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

Q.40 Two stars of mass 3×10^{31} kg each, at a distance 2×10^{11} m, rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the stars' rotation plane. The minimum speed it should have at O to escape from the gravitational field of this double star is ($G = 6.67 \times 10^{-11}$ N m² kg⁻²)

- (A) 2.8×10^5 m/s (B) 1.4×10^5 m/s (C) 3.8×10^4 m/s (D) 2.4×10^4 m/s

Q.41 A box weighs 196 N on a spring balance at the North Pole. Its weight recorded on the same balance at the equator is close to ($g = 10$ m/s² at the North Pole, radius of the earth = 6400 km)

- (A) 194.32 N (B) 194.66 N (C) 195.32 N (D) 195.66 N

Q.42 On the x-axis at a distance x from the origin, the gravitational field due to a mass distribution is

$E = \frac{Ax}{(x^2 + a^2)^{3/2}}$ in the x-direction. The magnitude of the gravitational potential on the x-axis at distance x, taking its value to be zero at infinity, is

- (A) $\frac{A}{(x^2 + a^2)^{3/2}}$ (B) $A(x^2 + a^2)^{3/2}$ (C) $A(x^2 + a^2)^{1/2}$ (D) $\frac{A}{(x^2 + a^2)^{1/2}}$

Q.43 A body moves in a low circular orbit about a planet of mass M and radius R (orbit radius $\approx R$). The ratio of the speed of this body in the orbit to the escape velocity from the planet is

- (A) 1 (B) $\frac{1}{\sqrt{2}}$ (C) $\sqrt{2}$ (D) 2

Q.44 A tunnel is dug along a chord of the earth at a distance R/2 from the centre. A particle released in the tunnel executes SHM. Its time period is

- (A) $2\pi\sqrt{\frac{R}{2g}}$ (B) $2\pi\sqrt{\frac{R}{g}}$ (C) $\pi\sqrt{\frac{R}{2g}}$ (D) $4\pi\sqrt{\frac{R}{g}}$

Q.45 A particle moves in a circle with uniform speed under the action of a central force $F \propto \frac{1}{r^3}$. Its period of revolution is proportional to

- (A) $\frac{1}{r^2}$ (B) r^2 (C) r (D) $\frac{1}{r}$

Q.46 A comet revolves around the sun in an elliptical orbit. Its closest and farthest distances from the sun are 8.0×10^{10} m and 1.6×10^{12} m respectively. Its speed at the closest distance is 6×10^4 m s⁻¹. Its speed at the farthest distance is

- (A) 1.5×10^3 m/s (B) 3.0×10^3 m/s (C) 4.5×10^3 m/s (D) 6.0×10^3 m/s

Q.47 The radius of a planet is R and its period of rotation is 24 h. A geostationary satellite is at an altitude of 11R. Find the time period of a satellite at an altitude of 2R.

- (A) 12 h (B) 8 h (C) 4 h (D) 3 h

Q.48 A small point mass m is placed at a distance 2R from the centre O of a big uniform solid sphere of mass M and radius R; the gravitational force on m is F_1 . A spherical part of radius R/3, touching the surface of the sphere on the side of m (its centre at 2R/3 from O), is removed, and the force on m due to the remaining part is F_2 . The ratio $F_1 : F_2$ is

- (A) 12 : 9 (B) 11 : 10 (C) 12 : 11 (D) 16 : 9

Q.49 A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius 1.03R. The time period of the second satellite is larger than that of the first by approximately

- (A) 9% (B) 2.5% (C) 3% (D) 4.5%

Q.50 Four identical particles of mass m each are placed at the four corners of a square. The gravitational force exerted on one of the masses by the others is $\left[\frac{2\sqrt{2} + 1}{32} \right] \frac{Gm^2}{l^2}$. The side of the square is

(A) $2l$ (B) $4l$ (C) $\frac{l}{2}$ (D) l 

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	11	B	21	B	31	C	41	C
2	C	12	A	22	D	32	B	42	D
3	A	13	A	23	D	33	D	43	B
4	C	14	B	24	A	34	A	44	B
5	B	15	A	25	D	35	B	45	B
6	B	16	D	26	D	36	C	46	B
7	C	17	B	27	A	37	B	47	D
8	D	18	B	28	A	38	B	48	C
9	A	19	D	29	A	39	B	49	D
10	A	20	D	30	D	40	A	50	B

