



# LifeX Merchant Navy

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CLASS 11 PHYSICS · NCERT CHAPTER 7 · IMU CET PRACTICE

## Gravitation

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Questions: 45 MCQs

Each question has exactly one correct option. Attempt all questions first, then check the Answer Key and Solutions at the end.

- 1 The value of the universal gravitational constant  $G$  is  
(A)  $6.67 \times 10^{11} \text{ N m}^2 \text{ kg}^{-2}$  (B)  $6.67 \times 10^{-8} \text{ N m}^2 \text{ kg}^{-2}$   
(C)  $9.8 \text{ N m}^2 \text{ kg}^{-2}$  (D)  $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
- 2 If the distance between two masses is doubled, the gravitational force between them becomes  
(A) four times (B) double  
(C) one-fourth (D) half
- 3 The relation between  $g$  and  $G$  is  
(A)  $g = GMR^2$  (B)  $g = GM/R^2$   
(C)  $g = GM/R$  (D)  $g = GR^2/M$
- 4 If the radius of the Earth shrinks by 1% with mass unchanged, the value of  $g$  on the surface  
(A) decreases by 2% (B) increases by 1%  
(C) decreases by 1% (D) increases by 2%
- 5 The acceleration due to gravity at a height  $h$  ( $h \ll R$ ) above the Earth's surface is  
(A)  $g(1 - 2h/R)$  (B)  $g(1 - h/R)$   
(C)  $g(1 + h/R)$  (D)  $g(1 + 2h/R)$
- 6 The acceleration due to gravity at a depth  $d$  below the Earth's surface is  
(A)  $g(1 - d/R)$  (B)  $g(1 + d/R)$   
(C)  $g(1 - 2d/R)$  (D)  $g$
- 7 The value of  $g$  at the centre of the Earth is  
(A) infinite (B) zero  
(C) maximum (D)  $9.8 \text{ m/s}^2$
- 8 At what height above the Earth's surface does  $g$  become one-fourth of its surface value? ( $R$  = Earth's radius)  
(A)  $R/2$  (B)  $R$   
(C)  $2R$  (D)  $4R$



- 9 Due to the Earth's rotation, the value of  $g$  is  
(A) minimum at the equator and maximum at the poles  
(B) maximum at the equator  
(C) same everywhere  
(D) minimum at the poles
- 
- 10 The escape velocity from the Earth's surface is about  
(A) 3 km/s (B) 42 km/s  
(C) 11.2 km/s (D) 7.9 km/s
- 
- 11 The escape velocity from a planet does NOT depend on  
(A) the radius of the planet (B) the mass of the projected body  
(C) the value of  $G$  (D) the mass of the planet
- 
- 12 The ratio of escape velocity to orbital velocity (close to the surface) is  
(A)  $1/\sqrt{2}$  (B) 1  
(C)  $\sqrt{2}$  (D) 2
- 
- 13 If a planet has twice the mass and twice the radius of the Earth, its escape velocity is  
(A)  $\sqrt{2}$  times that of the Earth (B) twice that of the Earth  
(C) half that of the Earth (D) equal to that of the Earth
- 
- 14 The orbital velocity of a satellite close to the Earth's surface is about  
(A) 7.9 km/s (B) 3.1 km/s  
(C) 11.2 km/s (D) 1 km/s
- 
- 15 The time period of a geostationary satellite is  
(A) 12 h (B) 365 days  
(C) 1 h (D) 24 h
- 
- 16 The height of a geostationary satellite above the Earth's surface is approximately  
(A) 6,400 km (B) 3,600 km  
(C) 42,000 km (D) 36,000 km
- 
- 17 Kepler's law of areas is a consequence of conservation of  
(A) linear momentum (B) angular momentum  
(C) mass (D) energy
- 
- 18 According to Kepler's third law,  $T^2$  is proportional to  
(A)  $r$  (B)  $r^{3/2}$   
(C)  $r^3$  (D)  $r^2$
- 
- 19 If the radius of a satellite's orbit is made 4 times, its time period becomes  
(A) 2 times (B) 8 times  
(C) 4 times (D) 16 times
- 
- 20 The orbital speed of a satellite is independent of  
(A) mass of the Earth (B)  $G$   
(C) mass of the satellite (D) radius of the orbit
-



- 21 The total energy of a satellite in a circular orbit is  
(A) positive  
(B) negative and equal to  $-(\text{kinetic energy})$   
(C) equal to its potential energy  
(D) zero
- 
- 22 The gravitational potential energy of a body of mass  $m$  at the Earth's surface is  
(A)  $-GMm/R^2$   
(B)  $-GMm/R$   
(C)  $mgR$   
(D)  $GMm/R$
- 
- 23 The energy required to move a satellite of mass  $m$  from the Earth's surface to infinity is  
(A)  $GMm/R$   
(B)  $GMm/2R$   
(C) zero  
(D)  $2GMm/R$
- 
- 24 Astronauts in an orbiting satellite feel weightless because  
(A) they and the satellite are both in free fall  
(B) their mass becomes zero  
(C) there is no gravity in space  
(D) gravity is cancelled by air pressure
- 
- 25 The gravitational field inside a uniform spherical shell is  
(A) varies inversely with distance  
(B) maximum  
(C)  $GM/R^2$   
(D) zero
- 
- 26 The gravitational potential inside a uniform spherical shell of mass  $M$  and radius  $R$  is  
(A)  $-GM/R$  (constant)  
(B) zero  
(C) varies as  $r^2$   
(D) varies as  $1/r$
- 
- 27 A body weighs 72 N on the Earth's surface. Its weight at a height equal to half the Earth's radius is  
(A) 48 N  
(B) 24 N  
(C) 36 N  
(D) 32 N
- 
- 28 The mass of a body on the Moon compared to its mass on the Earth is  
(A) one-sixth  
(B) zero  
(C) the same  
(D) six times
- 
- 29 A planet has mass and radius both half those of the Earth. The value of  $g$  on it is  
(A)  $g$   
(B)  $2g$   
(C)  $4g$   
(D)  $g/2$
- 
- 30 Two satellites revolve in orbits of radii  $r$  and  $4r$ . The ratio of their orbital speeds is  
(A) 1 : 2  
(B) 1 : 4  
(C) 4 : 1  
(D) 2 : 1
- 
- 31 The gravitational force between two bodies is  $F$ . If the mass of each is doubled and distance is also doubled, the force becomes  
(A)  $4F$   
(B)  $2F$   
(C)  $F/4$   
(D)  $F$
-



- 32** If the Earth stops rotating, the value of  $g$  at the equator will  
(A) remain same (B) become zero  
(C) increase (D) decrease
- 33** The angular speed of the Earth for which bodies on the equator would feel weightless is ( $g = 10 \text{ m/s}^2$ ,  $R = 6400 \text{ km}$ )  
(A)  $1/800 \text{ rad/s}$  (B)  $1/8000 \text{ rad/s}$   
(C)  $1/80 \text{ rad/s}$  (D)  $1/400 \text{ rad/s}$
- 34** The kinetic energy needed to project a body of mass  $m$  from the Earth's surface to escape is  
(A)  $mg/R$  (B)  $mgR/2$   
(C)  $mgR$  (D)  $2mgR$
- 35** The period of a satellite orbiting very close to the Earth's surface is about  
(A) 12 h (B) 24 h  
(C) 84 min (D) 1 min
- 36** Kepler's first law states that planets move in  
(A) elliptical orbits with the Sun at one focus  
(B) circular orbits with the Sun at the centre  
(C) parabolic orbits  
(D) elliptical orbits with the Sun at the centre
- 37** A planet moves fastest when it is  
(A) at the end of the minor axis (B) nearest to the Sun (perihelion)  
(C) same speed everywhere (D) farthest from the Sun (aphelion)
- 38** The binding energy of a satellite of mass  $m$  orbiting at radius  $r$  around a planet of mass  $M$  is  
(A)  $GMm/r$  (B)  $GMm/2r$   
(C)  $2GMm/r$  (D)  $-GMm/2r$
- 39** The dimensional formula of gravitational potential is  
(A)  $[ML^2T^{-2}]$  (B)  $[M^{-1}L^3T^{-2}]$   
(C)  $[L^2T^{-2}]$  (D)  $[LT^{-2}]$
- 40** The gravitational field intensity at a point is the  
(A) energy per unit mass (B) mass per unit volume  
(C) force per unit charge (D) force per unit mass
- 41** The ratio of the kinetic energy to the potential energy of a satellite in circular orbit is  
(A)  $-1/2$  (B) 2  
(C)  $-2$  (D)  $1/2$
- 42** Weight of a body is maximum at  
(A) the top of Mount Everest (B) the equator  
(C) the poles (D) the centre of the Earth



**43** If the mass of the Earth becomes 4 times and its radius 2 times, the escape velocity becomes

- (A)  $\sqrt{2}$  times
- (B) 2 times
- (C) 4 times
- (D) unchanged

**44** If a satellite's orbital speed is increased by about 41.4%, it will

- (A) fall to the Earth
- (B) move in a smaller orbit
- (C) remain in the same orbit
- (D) escape from the Earth's gravitational field

**45** Gravitational force is

- (A) always attractive
- (B) attractive or repulsive depending on masses
- (C) zero between small masses
- (D) always repulsive

## Answer Key

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

## Hints & Solutions

- (D)  $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$  in SI.
- (C)  $F \propto 1/r^2 \rightarrow F/4$ .
- (B)  $mg = GMm/R^2 \rightarrow g = GM/R^2$ .
- (D)  $g \propto 1/R^2 \rightarrow \Delta g/g = -2\Delta R/R = +2\%$ .
- (A)  $g_h = g(1 + h/R)^{-2} \approx g(1 - 2h/R)$ .
- (A) Only the inner sphere attracts:  $g_d = g(1 - d/R)$ .
- (B)  $g_d = g(1 - d/R)$ ; at  $d = R$ ,  $g = 0$ .
- (B)  $g/4 = g R^2/(R + h)^2 \rightarrow R + h = 2R \rightarrow h = R$ .
- (A)  $g' = g - \omega^2 R \cos^2 \lambda$ ; reduction is maximum at the equator ( $\lambda = 0$ ) and zero at the poles.
- (C)  $v_e = \sqrt{2gR} \approx 11.2 \text{ km/s}$ .
- (B)  $v_e = \sqrt{2GM/R}$  is independent of the mass of the body being projected.
- (C)  $v_e = \sqrt{2gR}$ ,  $v_o = \sqrt{gR} \rightarrow$  ratio  $\sqrt{2}$ .
- (D)  $v_e \propto \sqrt{M/R} = \sqrt{2/2} = 1 \rightarrow$  same as Earth.
- (A)  $v_o = \sqrt{gR} = \sqrt{9.8 \times 6.4 \times 10^6} \approx 7.9 \text{ km/s}$ .
- (D) A geostationary satellite rotates with the Earth, so  $T = 24 \text{ h}$ .
- (D) Orbit radius  $\approx 42,000 \text{ km}$  from centre, i.e.,  $\approx 36,000 \text{ km}$  above the surface.
- (B)  $dA/dt = L/2m$  is constant because angular momentum is conserved under a central force.
- (C)  $T^2 \propto a^3$  (law of periods).
- (B)  $T \propto r^{3/2} \rightarrow 4^{3/2} = 8$ .
- (C)  $v = \sqrt{GM/r}$ , independent of the satellite's mass.
- (B)  $K = GMm/2r$ ,  $U = -GMm/r \rightarrow E = -GMm/2r = -K$ .
- (B)  $U = -GMm/r$  with  $r = R$ .
- (A)  $\Delta U = 0 - (-GMm/R) = GMm/R$ .



24. (A) Both are accelerating towards the Earth with the same acceleration, so the normal reaction is zero.
25. (D) By the shell theorem, the net gravitational field inside a uniform shell is zero.
26. (A) Since the field is zero inside, the potential is constant and equal to its surface value  $-GM/R$ .
27. (D)  $W' = W R^2/(1.5R)^2 = 72/2.25 = 32 \text{ N}$ .
28. (C) Mass is an intrinsic property and does not change; only weight changes.
29. (B)  $g \propto M/R^2 = (1/2)/(1/4) = 2 \rightarrow 2g$ .
30. (D)  $v \propto 1/\sqrt{r} \rightarrow \sqrt{4} : 1 = 2 : 1$ .
31. (D)  $F' = G(2m)(2m)/(2r)^2 = F$ .
32. (C) Without rotation, the term  $\omega^2 R$  is removed, so  $g$  at the equator increases.
33. (A)  $\omega^2 R = g \rightarrow \omega = \sqrt{(10/6.4 \times 10^6)} = \sqrt{(1.5625 \times 10^{-6})} = 1.25 \times 10^{-3} = 1/800 \text{ rad/s}$ .
34. (C)  $\frac{1}{2}mv_e^2 = \frac{1}{2}m(2gR) = mgR$ .
35. (C)  $T = 2\pi\sqrt{(R/g)} = 2\pi\sqrt{(6.4 \times 10^6/9.8)} \approx 5075 \text{ s} \approx 84.6 \text{ min}$ .
36. (A) The law of orbits — elliptical paths with the Sun at a focus.
37. (B) From conservation of angular momentum,  $mvr = \text{constant}$ , so  $v$  is maximum at minimum  $r$ .
38. (B) Binding energy  $= -E = GMm/2r$ .
39. (C) Potential = energy per unit mass  $= [ML^2T^{-2}]/[M] = [L^2T^{-2}]$ .
40. (D)  $E_g = F/m$ , with unit  $N/kg = m/s^2$ .
41. (A)  $K = GMm/2r$ ,  $U = -GMm/r \rightarrow K/U = -1/2$ .
42. (C)  $g$  is maximum at the poles (no rotational reduction, smaller radius).
43. (A)  $v_e \propto \sqrt{(M/R)} = \sqrt{(4/2)} = \sqrt{2}$ .
44. (D)  $1.414 v_o = \sqrt{2} v_o = \text{escape velocity at that orbit}$ , so it escapes.
45. (A) Gravity between masses is always attractive.

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