

Gravitation — NEET Physics PYQ (2005-2021)

Class 11 Physics · 29 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. The escape velocity from the Earth's surface is v . The escape velocity from the surface of another planet having a radius, four times that of Earth and same mass density is :

- (A) v
- (B) $2v$
- (C) $3v$
- (D) $4v$

NEET 2021

2. 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) $R (k/(1 - k))^2$
- (B) $R (k/(1 + k))^2$
- (C) $R^2 k/(1 + k)$
- (D) $Rk^2/(1 - k^2)$

NEET 2020 · Q143

3. 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) 48 N
- (B) 32 N
- (C) 30 N
- (D) 24 N

NEET 2019 · Q16

4. A body weighs 200 N on the surface of the earth. How much will it weigh half way down to the centre of the earth?

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

NEET 2019 · Q29

5. The work done to raise a mass m from the surface of the earth to a height h , which is equal to the radius of the earth, is:

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

NEET 2018 · Q40

6. If the mass of the Sun were ten times smaller and the universal gravitational constant were ten times larger in magnitude, which of the following is not correct?

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

NEET 2017 · Q157

7. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then:

- (A) $d = 1/2$ km
- (B) $d = 1$ km
- (C) $d = 3/2$ km
- (D) $d = 2$ km

NEET 2017 (Gujarati paper) · Q141

8. A satellite of mass m is in circular orbit of radius $3R_E$ about earth (mass of earth M_E , radius of earth R_E). How much additional energy is required to transfer the satellite to an orbit of radius $9R_E$?

- (A) $GM_E m/(18R_E)$
- (B) $3GM_E m/(2R_E)$
- (C) $GM_E m/(9R_E)$
- (D) $GM_E m/(3R_E)$

NEET 2017 (Gujarati paper) · Q144

9. Imagine earth to be a solid sphere of mass M and radius R . If the value of acceleration due to gravity at a depth ' d ' below earth's surface is same as its value at a height ' h ' above its surface and equal to $g/4$ (where g is the value of acceleration due to gravity on the surface of earth), the ratio of h/d will be:

- (A) $4/3$
- (B) $3/2$
- (C) $2/3$
- (D) 1

NEET 2016 Phase 2 · Q12

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

- (A) $mg_0R^2/(2(R + h))$
- (B) $-mg_0R^2/(2(R + h))$
- (C) $2mg_0R^2/(R + h)$
- (D) $-2mg_0R^2/(R + h)$

NEET 2016 Phase 1 · Q36

11. The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is:

- (A) $1:2$
- (B) $1:2\sqrt{2}$
- (C) $1:4$
- (D) $1:\sqrt{2}$

AIPMT 2015

12. Kepler's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet, i.e. $T^2 = Kr^3$, here K is constant. If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is $F = GMm/r^2$, here G is gravitational constant. The relation between G and K is described as:

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

AIPMT 2015

13. Two spherical bodies of mass M and $5M$ and radii R and $2R$ are released in free space with initial separation between their centres equal to $12R$. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is:

- (A) $1.5R$
- (B) $2.5R$
- (C) $4.5R$
- (D) $7.5R$

AIPMT 2014

14. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98×10^{24} kg) have to be compressed to be a black hole?

- (A) 10^{-6} m
- (B) 10^{-2} m
- (C) 100 m
- (D) 10^{-9} m

NEET 2013

15. A body of mass m is taken from the earth's surface to the height equal to twice the radius (R) of the earth. The change in potential energy of body will be

- (A) $2mgR$
- (B) $(2/3)mgR$
- (C) $3mgR$
- (D) $(1/3)mgR$

NEET 2013

16. Infinite number of bodies, each of mass 2 kg, are situated on x-axis at distances 1 m, 2 m, 4 m, 8 m, ... respectively, from the origin. The resulting gravitational potential due to this system at the origin will be

- (A) $-G$
- (B) $-(8/3)G$
- (C) $-(4/3)G$
- (D) $-4G$

AIPMT 2012 Mains

17. If v_e is escape velocity and v_o is orbital velocity of a satellite for orbit close to the earth's surface, then these are related by

- (A) $v_o = \sqrt{2} v_e$
- (B) $v_o = v_e$
- (C) $v_e = \sqrt{2} v_o$
- (D) $v_e = \sqrt{2} v_o$

AIPMT 2012 Prelims

18. The height at which the weight of a body becomes 1/16th of its weight on the surface of earth (radius R) is

- (A) $4R$
- (B) $5R$
- (C) $15R$
- (D) $3R$

AIPMT 2012 Prelims

19. A geostationary satellite is orbiting the earth at a height of $5R$ above the surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of $2R$ from the surface of the earth is

- (A) $6/\sqrt{2}$
- (B) 5
- (C) 10
- (D) $6\sqrt{2}$

AIPMT 2012 Prelims

20. A spherical planet has a mass M_p and diameter D_p . A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity, equal to

- (A) $4GM_p m/D_p^2$
- (B) $4GM_p/D_p^2$
- (C) $GM_p m/D_p^2$
- (D) GM_p/D_p^2

AIPMT 2011 Mains

21. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a . The magnitude of the gravitational potential at a point situated at $a/2$ distance from the centre, will be

- (A) $4GM/a$
- (B) GM/a
- (C) $2GM/a$
- (D) $3GM/a$

AIPMT 2011 Mains

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

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

AIPMT 2011 Prelims

23. A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2 . If v_1 and v_2 are the linear velocities at these points respectively, then the ratio v_1/v_2 is

- (A) r_1/r_2
- (B) $(r_1/r_2)^2$
- (C) r_2/r_1
- (D) $(r_2/r_1)^2$

AIPMT 2010 Prelims · Q12

24. The radii of circular orbits of two satellites A and B of the earth, are $4R$ and R , respectively. If the speed of satellite A is $3V$, then the speed of satellite B will be

- (A) $3V/2$
- (B) $3V/4$
- (C) $6V$
- (D) $12V$

25. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a . The gravitational potential at a point situated at $a/2$ distance from the centre, will be

- (A) $-4GM/a$
- (B) $-3GM/a$
- (C) $-2GM/a$
- (D) $-GM/a$

26. The Figure shows elliptical orbit of a planet m about the sun S . The shaded area SCD is twice the shaded area SAB . If t_1 is the time for the planet to move from C to D and t_2 is the time to move from A to B then:

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

27. Two satellites of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2 . Which one of the following statements is true?

- (A) The potential energies of earth satellites in the two cases are equal.
- (B) S_1 and S_2 are moving with the same speed.
- (C) The kinetic energies of the two satellites are equal.
- (D) The time period of S_1 is four times that of S_2 .

28. 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_e , where v_e is its escape velocity from the surface of the earth. The value of f is :

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

29. Imagine a new planet having the same density as that of earth but it is 3 times bigger than the earth in size. If the acceleration due to gravity on the surface of earth is g and that on the surface of the new planet is g' , then :

- (A) $g' = 3g$
- (B) $g' = g/9$
- (C) $g' = 9g$
- (D) $g' = g/3$

Answer key and explanations

1. Answer: (D) $4v$

$v_e = \sqrt{(2GM/R)}$ with $M = (4/3)\pi R^3 \rho$ gives $v_e = R\sqrt{(8\pi G\rho/3)}$, so $v_e \propto R$ at fixed density. Four times the radius gives $4v$. Answering $2v$ uses $v_e \propto \sqrt{R}$, which holds only at fixed mass, not fixed density.

2. Answer: (D) $Rk^2/(1 - k^2)$

Energy conservation: $(1/2)mk^2(2GM/R) - GMm/R = -GMm/(R + h)$. This gives $1/(R + h) = (1 - k^2)/R$, so $R + h = R/(1 - k^2)$ and $h = Rk^2/(1 - k^2)$. Using the flat-earth formula $v^2/2g$ would wrongly give $h = k^2R$.

3. Answer: (B) 32 N

Gravitational force varies as $1/r^2$, so at $r = R + R/2 = 1.5R$ the force is $72 \times (1/1.5)^2 = 72 \times 4/9 = 32$ N. The approximation $g(1 - 2h/R)$ is only valid for $h \ll R$ and would wrongly give zero here.

4. Answer: (D) 100 N

Inside the earth $g(d) = g(1 - d/R)$; at $d = R/2$, g is halved, so the weight becomes 100 N. 150 N wrongly uses a quarter reduction.

5. Answer: (C) $\frac{1}{2} mgR$

$W = GMm(1/R - 1/2R) = GMm/2R = \frac{1}{2} mgR$. mgR assumes g stays constant up to height R , which is invalid.

6. Answer: (D) 'g' on the Earth will not change.

$g = GM_E/R^2$ depends on G and the Earth's mass, not the Sun's. With G ten times larger, g becomes ten times larger, so the claim that g stays the same is wrong; the larger g also shortens the pendulum period and makes raindrops fall faster.

7. Answer: (D) $d = 2$ km

For small heights $g_h = g(1 - 2h/R)$ and at depth $g_d = g(1 - d/R)$. Equating gives $d = 2h = 2$ km. Taking $d = h$ ignores the factor 2 in the height formula.

8. Answer: (C) $GM_E m/(9R_E)$

Total energy in a circular orbit is $-GMm/2r$. $\Delta E = GM_E m/2 \times (1/3R_E - 1/9R_E) = GM_E m/2 \times 2/(9R_E) = GM_E m/(9R_E)$. Using only potential energies would double this to $2GM_E m/(9R_E)$.

9. Answer: (A) $4/3$

Below the surface $g(1 - d/R) = g/4$ gives $d = 3R/4$. Above the surface $g/(1 + h/R)^2 = g/4$ gives $1 + h/R = 2$, so $h = R$. Hence $h/d = R/(3R/4) = 4/3$. Using the small-height formula $g(1 - 2h/R)$ would be wrong here because h is not small compared with R .

10. Answer: (B) $-mg_0 R^2/(2(R + h))$

Total energy of a circular orbit is $-GMm/(2r)$ with $r = R + h$. Using $GM = g_0 R^2$ gives $E = -mg_0 R^2/(2(R + h))$. The positive expression is the kinetic energy, not the total energy, which must be negative for a bound orbit.

11. Answer: (B) $1:2\sqrt{2}$

$v_e = \sqrt{2GM/R}$ and $M = (4/3)\pi R^3 \rho$, so $v \propto R\sqrt{\rho}$. For the planet $v \propto 2R \times \sqrt{2\rho} = 2\sqrt{2}$ times earth's value. Hence $v_e:v_p = 1:2\sqrt{2}$; ignoring the density change gives $1:2$.

12. Answer: (C) $GMK = 4\pi^2$

Gravity provides the centripetal force: $GMm/r^2 = m(2\pi/T)^2 r$, so $T^2 = (4\pi^2/GM)r^3$. Hence $K = 4\pi^2/GM$, i.e. $GMK = 4\pi^2$. $GK = 4\pi^2$ drops the Sun's mass.

13. Answer: (D) $7.5 R$

Only internal forces act, so the centre of mass stays fixed. It is $5M \times 12R/6M = 10R$ from the small body initially. At contact the centres are $R + 2R = 3R$ apart and the small body is $2.5R$ from the centre of mass, so it moves $10R - 2.5R = 7.5R$.

14. Answer: (B) 10^{-2} m

Setting escape speed $\sqrt{2GM/R}$ equal to c gives $R = 2GM/c^2 = 2 \times 6.67 \times 10^{-11} \times 5.98 \times 10^{24}/(9 \times 10^{16}) \approx 8.9 \times 10^{-3}$ m, which is of the order 10^{-2} m.

15. Answer: (B) $(2/3)mgR$

$\Delta U = GMm/R - GMm/3R = (2/3)GMm/R = (2/3)mgR$, using $GM = gR^2$. The answer $2mgR$ comes from wrongly using mgh with $h = 2R$, which is valid only for heights much smaller than R .

16. Answer: (D) $-4G$

$V = -Gm(1/1 + 1/2 + 1/4 + 1/8 + \dots) = -G \times 2 \times [1/(1 - 1/2)] = -G \times 2 \times 2 = -4G$. Forgetting the 2 kg mass gives $-2G$ -type answers; the sum of the geometric series is 2.

17. Answer: (D) $v_e = \sqrt{2} v_o$

Near the surface, orbital speed $v_o = \sqrt{GM/R}$ and escape speed $v_e = \sqrt{2GM/R}$, so $v_e = \sqrt{2} \cdot v_o$. The escape speed is the larger one, so $v_o = \sqrt{2} \cdot v_e$ is reversed.

18. Answer: (D) $3R$

$g_h = g/(1 + h/R)^2$. For $g_h = g/16$, $1 + h/R = 4$, so $h = 3R$. $4R$ is the distance from the centre of the earth, not the height above the surface.

19. Answer: (D) $6\sqrt{2}$

Orbit radii are $6R$ (geostationary, $T = 24$ h) and $3R$ (height $2R$). By Kepler's law $T \propto r^{3/2}$: $T = 24 \times (3R/6R)^{3/2} = 24/(2\sqrt{2}) = 6\sqrt{2}$ h. Using heights ($5R$ and $2R$) instead of orbital radii gives a wrong value.

20. Answer: (B) $4GM_p/D_p^2$

$g = GM/R^2$ and $R = D_p/2$, so $g = GM_p/(D_p/2)^2 = 4GM_p/D_p^2$. Acceleration does not depend on the particle's mass m , so expressions containing m are forces, not accelerations.

21. Answer: (D) $3GM/a$

Potential due to the central particle at $a/2$ is $-GM/(a/2) = -2GM/a$; inside a shell the potential is constant at $-GM/a$. Total = $-3GM/a$, magnitude $3GM/a$. Taking only the particle's contribution gives $2GM/a$, forgetting that the shell's potential inside is not zero.

22. Answer: (C) $\sqrt{2GM/R}$

To not return, the particle must reach infinity: $\frac{1}{2}mu^2 = GMm/R$, so $u = \sqrt{2GM/R}$ ($= \sqrt{2gR}$). $\sqrt{2GM/R^2}$ and $\sqrt{2gR^2}$ are dimensionally wrong as speeds.

23. Answer: (C) r_2/r_1

Gravity exerts no torque about the sun, so angular momentum is conserved; at perihelion and aphelion the velocity is perpendicular to the radius, so $mv_1r_1 = mv_2r_2$ and $v_1/v_2 = r_2/r_1$. The planet moves faster when closer, so the ratio must exceed 1, which rules out r_1/r_2 .

24. Answer: (C) $6V$

Orbital speed $v = \sqrt{GM/r}$, so $v \propto 1/\sqrt{r}$. $v_B/v_A = \sqrt{4R/R} = 2$, so $v_B = 2 \times 3V = 6V$. Using $v \propto 1/r$ would give $12V$.

25. Answer: (B) $-3GM/a$

Inside the shell its potential is constant at $-GM/a$. The point mass at the centre contributes $-GM/(a/2) = -2GM/a$. Total $V = -2GM/a - GM/a = -3GM/a$. Forgetting the shell gives $-2GM/a$.

26. Answer: (B) $t_1 = 2t_2$

Kepler's second law: the radius vector sweeps equal areas in equal times, so time is proportional to area swept. Area $SCD = 2 \times$ area SAB gives $t_1 = 2t_2$. The fact that the planet moves faster near the sun is already accounted for by the equal-area law.

27. Answer: (B) S_1 and S_2 are moving with the same speed.

Orbital speed $v = \sqrt{GM/r}$ depends only on the orbit radius, so both move with the same speed (and period). Potential and kinetic energies are proportional to the satellite mass, so they differ by a factor of 4.

28. Answer: (B) $1/\sqrt{2}$

Escape velocity from a point at distance r from the centre is $\sqrt{2GM/r}$. The platform is at $r = R + R = 2R$, so the escape velocity is $v_e/\sqrt{2}$ and $f = 1/\sqrt{2}$. Escape becomes easier, not harder, so f cannot exceed 1.

29. Answer: (A) $g' = 3g$

$g = GM/R^2 = (4/3)\pi G\rho R$, so at equal density $g \propto R$. A planet with 3 times the radius has $g' = 3g$. $g/9$ would follow only if the mass stayed the same.

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