

Gravitation

SET Self Evaluation Test - 8

- Two identical spheres are placed in contact with each other. The force of gravitation between the spheres will be proportional to (R = radius of each sphere)
 - R
 - R^2
 - R^4
 - None of these
- Suppose that the force of earth's gravity suddenly disappears, choose the correct answer out of the following statements
 - The weight of the body will become zero but mass remains the same
 - The mass of the body will become zero but the weight remains the same
 - Both the mass and weight will be the same
 - Mass and weight will remain the same
- An earth satellite is moved from one stable circular orbit to a further stable circular orbit, which one of the following quantities increase
 - Gravitational force
 - Gravitational P.E.
 - Linear orbital speed
 - Centripetal acceleration
- Two planets revolve round the sun with frequencies N_1 and N_2 revolutions per year. If their average orbital radii be R_1 and R_2 respectively, then R_1 / R_2 is equal to
 - $(N_1 / N_2)^{3/2}$
 - $(N_2 / N_1)^{3/2}$
 - $(N_1 / N_2)^{2/3}$
 - $(N_2 / N_1)^{2/3}$
- There is no atmosphere on the moon because
 - It is closer to the earth
 - It revolves round the earth
 - It gets light from the sun
 - The escape velocity of gas molecules is lesser than their root mean square velocity here
- Two heavenly bodies S_1 and S_2 , not far off from each other are seen to revolve in orbits
 - Around their common centre of mass
 - Which are arbitrary
 - With S_1 fixed and S_2 moving round S_1
 - With S_2 fixed and S_1 moving round S_2
- The mass of the moon is about 1.2% of the mass of the earth. Compared to the gravitational force the earth exerts on the moon, the gravitational force the moon exerts on earth
 - Is the same
 - Is smaller
 - Is greater
 - Varies with its phase
- A clock S is based on oscillation of a spring and a clock P is based on pendulum motion. Both clocks run at the same rate on earth. On a planet having the same density as earth but twice the radius
 - S will run faster than P
 - P will run faster than S
 - They will both run at the same rate as on the earth
 - None of these
- Consider earth to be a homogeneous sphere. Scientist A goes deep down in a mine and scientist B goes high up in a balloon. The value of g measured by
 - A goes on decreasing and that by B goes on increasing
 - B goes on decreasing and that by A goes on increasing
 - Each decreases at the same rate
 - Each decreases at different rates
- The mass of the moon is $\frac{1}{81}$ of the earth but the gravitational pull is $\frac{1}{6}$ of the earth. It is due to the fact that
 - The radius of the moon is $\frac{81}{6}$ of the earth
 - The radius of the earth is $\frac{9}{\sqrt{6}}$ of the moon
 - Moon is the satellite of the earth
 - None of the above
- A weight is suspended from the ceiling of a lift by a spring balance. When the lift is stationary the spring balance reads W . If the lift suddenly falls freely under gravity, the reading on the spring balance will be
 - W
 - $2W$
 - $W/2$
 - 0
- If a planet consists of a satellite whose mass and radius were both half that of the earth, the acceleration due to gravity at its surface would be (g on earth = 9.8 m/sec^2)
 - 4.9 m/sec^2
 - 8.9 m/sec^2
 - 19.6 m/sec^2
 - 29.4 m/sec^2
- At a given place where acceleration due to gravity is ' g ' m/sec^2 , a sphere of lead of density ' d ' kg/m^3 is gently released in a column of liquid of density ' ρ ' kg/m^3 . If $d > \rho$, the sphere will
 - Fall vertically with an acceleration ' g ' m/sec^2
 - Fall vertically with no acceleration
 - Fall vertically with an acceleration $g \left(\frac{d-\rho}{d} \right)$
 - Fall vertically with an acceleration $g \left(\frac{\rho}{d} \right)$

- 14.** g_e and g_p denote the acceleration due to gravity on the surface of the earth and another planet whose mass and radius are twice as that of earth. Then
- (a) $g_p = g_e$ (b) $g_p = g_e / 2$
(c) $g_p = 2g_e$ (d) $g_p = g_e / 4$
- 15.** If the value of g at the surface of the earth is 9.8 m/sec^2 , then the value of g at a place 480 km above the surface of the earth will be (Radius of the earth is 6400 km)
- (a) 8.4 m/sec^2 (b) 9.8 m/sec^2
(c) 7.2 m/sec^2 (d) 4.2 m/sec^2
- 16.** The acceleration due to gravity about the earth's surface would be half of its value on the surface of the earth at an altitude of ($R = 4000 \text{ mile}$)
- (a) 1200 mile (b) 2000 mile
(c) 1600 mile (d) 4000 mile
- 17.** A pendulum clock is set to give correct time at the sea level. This clock is moved to hill station at an altitude of 2500 m above the sea level. In order to keep correct time of the hill station, the length of the pendulum
- (a) Has to be reduced
(b) Has to be increased
(c) Needs no adjustment
(d) Needs no adjustment but its mass has to be increased
- 18.** At some point the gravitational potential and also the gravitational field due to earth is zero. The point is
- (a) On earth's surface
(b) Below earth's surface
(c) At a height R_e from earth's surface ($R_e =$ radius of the earth)
(d) At infinity
- 19.** A body falls freely under gravity. Its speed is v when it has lost an amount U of the gravitational energy. Then its mass is
- (a) $\frac{Ug}{v^2}$ (b) $\frac{U^2}{g}$
(c) $\frac{2U}{v^2}$ (d) $2Ugv^2$
- 20.** The ratio of the radius of the earth to that of the moon is 10. The ratio of acceleration due to gravity on the earth and on the moon is 6. The ratio of the escape velocity from the earth's surface to that from the moon is
- (a) 10 (b) 6
(c) Nearly 8 (d) 1.66
- 21.** Escape velocity from the moon surface is less than that on the earth surface, because
- (a) Moon has no atmosphere while the earth has
(b) Radius of moon is less than that of the earth
(c) Moon is nearer to the sun
(d) Moon is attracted by other planets
- 22.** The ratio of the radius of a planet 'A' to that of planet 'B' is 'r'. The ratio of acceleration due to gravity on the planets is 'x'. The ratio of the escape velocities from the two planets is
- (a) xr (b) $\sqrt{\frac{r}{x}}$
(c) \sqrt{rx} (d) $\sqrt{\frac{x}{r}}$
- 23.** Time period of revolution of a nearest satellite around a planet of radius R is T . Period of revolution around another planet, whose radius is $3R$ but having same density is
- (a) T (b) $3T$
(c) $9T$ (d) $3\sqrt{3}T$
- 24.** The maximum possible velocity of a satellite orbiting round the earth in a stable orbit is
- (a) $\sqrt{2R_e g}$ (b) $\sqrt{R_e g}$
(c) $\sqrt{\frac{R_e g}{2}}$ (d) Infinite
- 25.** A man inside an artificial satellite feels weightlessness because the force of attraction due to earth is
- (a) Zero at that place
(b) Is balanced by the force of attraction due to moon
(c) Equal to the centripetal force
(d) Non-effective due to particular design of the satellite
- 26.** Two identical satellites A and B are circulating round the earth at the height of R and $2R$ respectively, (where R is radius of the earth). The ratio of kinetic energy of A to that of B is
- (a) $\frac{1}{2}$ (b) $\frac{2}{3}$
(c) 2 (d) $\frac{3}{2}$
- 27.** The mean radius of the earth's orbit round the sun is $1.5 \times 10^{11} \text{ m}$. The mean radius of the orbit of mercury round the sun is $6 \times 10^{10} \text{ m}$. The mercury will rotate around the sun in
- (a) A year (b) Nearly 4 years
(c) Nearly $\frac{1}{4}$ year (d) 2.5 years

AS Answers and Solutions

(SET - 8)

$$1. \quad (c) \quad F = G \frac{M \times M}{R^2} = \frac{G \times \left(\frac{4}{3} \pi R^3 \rho\right)^2}{(2R)^2} \Rightarrow F \propto \frac{R^6}{R^2} \propto R^4$$

2. (a) In the absence of gravity weight of the bodies will become zero but mass will not change.

3. (b) $U = \frac{-GMm}{r}$. If r increases then U also increases.

4. (d) According to Kepler's law $T^2 \propto R^3$

If N is the frequencies then $N^2 \propto (R)^{-3}$

$$\text{or } \frac{N_2}{N_1} = \left(\frac{R_2}{R_1}\right)^{-3/2} \Rightarrow \frac{R_1}{R_2} = \left(\frac{N_2}{N_1}\right)^{2/3}$$

5. (d)

6. (a)

7. (a) Force between earth and moon $F = \frac{Gm_m m_e}{r^2}$

This amount of force, both earth and moon will exert on each other *i.e.* they exert same force on each other.

8. (b) $g = \frac{4}{3} \pi \rho GR$. If density is same then $g \propto R$

According to problem $R_p = 2R_e \therefore g_p = 2g_e$

For clock P (based on pendulum motion) $T = 2\pi \sqrt{\frac{l}{g}}$

Time period decreases on planet so it will run faster because $g_p > g_e$

For clock S (based on oscillation of spring) $T = 2\pi \sqrt{\frac{m}{k}}$

So it does not change.

9. (d) For scientist A which goes down in a mine

$$g' = g \left(1 - \frac{d}{R}\right)$$

For scientist B , which goes up in a air $g' = g \left(1 - \frac{2h}{R}\right)$

So it is clear that value of g measured by each will decrease at different rates.

10. (b) Gravitational pull depends upon the acceleration due to gravity on that planet.

$$M_m = \frac{1}{81} M_e, g_m = \frac{1}{6} g_e$$

$$g = \frac{GM}{R^2} \Rightarrow \frac{R_e}{R_m} = \left(\frac{M_e}{M_m} \times \frac{g_m}{g_e}\right)^{1/2} = \left(81 \times \frac{1}{6}\right)^{1/2}$$

$$\therefore R_e = \frac{9}{\sqrt{6}} R_m$$

11. (d) Reading of spring balance $R = m(g - a)$

If the lift falls freely then $a = g \therefore R = 0$

12. (c) $g = \frac{GM}{R^2} \therefore g \propto \frac{M}{R^2}$

According to problem $M_p = \frac{M_e}{2}$ and $R_p = \frac{R_e}{2}$

$$\therefore \frac{g_p}{g_e} = \left(\frac{M_p}{M_e}\right) \left(\frac{R_e}{R_p}\right)^2 = \left(\frac{1}{2}\right) \times (2)^2 = 2$$

$$\Rightarrow g_p = 2g_e = 2 \times 9.8 = 19.6 \text{ m/s}^2$$

13. (c) Apparent weight = actual weight – upthrust force

$$Vdg' = Vdg - V\rho g$$

$$\Rightarrow g' = \left(\frac{d - \rho}{d}\right) g$$

14. (b) $g \propto \frac{M}{R^2}$. If mass and radius of the planet are twice

then g_p will be half that of g_e *i.e.* $g_p = \frac{g_e}{2}$

15. (a) The value of g on the surface of the earth $g \propto \frac{1}{R^2}$

At height h from the surface of the earth $g' \propto \frac{1}{(R+h)^2}$

$$\therefore g' = g \frac{R^2}{(R+h)^2} = \frac{9.8 \times (6400)^2}{(6400 + 480)^2} = 8.4 \text{ m/s}^2$$

16. (c) $\frac{g'}{g} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{2} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{2} = \left(\frac{4000}{4000+h}\right)^2$

By solving we get $h = 1656.85 \text{ mile} \approx 1600 \text{ mile}$

17. (a) $T = 2\pi\sqrt{\frac{l}{g}}$. At the hill g will decrease so to keep the time period same the length of pendulum has to be reduced.

18. (d) $V = \frac{-GM}{r}$ and $I = \frac{GM}{r^2}$

$V = 0$ and $I = 0$ at $r = \infty$

19. (c) $U =$ Loss in gravitational energy = gain in K.E.

$$\text{So, } U = \frac{1}{2}mv^2 \Rightarrow m = \frac{2U}{v^2}$$

20. (c) $\frac{v_e}{v_m} = \sqrt{\frac{g_e}{g_m} \frac{R_e}{R_m}} = \sqrt{6 \times 10} = \sqrt{60} \cong 8$ (nearly)

21. (b)

22. (c) $v_e = \sqrt{2gR} \Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{g_A}{g_B} \times \frac{R_A}{R_B}} = \sqrt{x \times r} \therefore \frac{v_A}{v_B} = \sqrt{rx}$

$$T = 2\pi\sqrt{\frac{R^3}{GM}} = 2\pi\sqrt{\frac{R^3}{G\frac{4}{3}\pi R^3\rho}} \therefore T \propto \sqrt{\frac{1}{\rho}}$$

i.e. time period of nearest satellite does not depend upon the radius of planet, it only depends upon the density of the planet.

In the problem, density is same so time period will be same.

24. (b) Otherwise centrifugal force exceeds the force of attraction or we can say that gravitational force won't be able to keep the satellite in circular motion.

25. (c)

26. (d) $\frac{K_A}{K_B} = \frac{r_B}{r_A} = \left(\frac{R+h_B}{R+h_A}\right) = \left(\frac{R+2R}{R+R}\right) = \frac{3}{2}$

27. (c) $\frac{T_{\text{mercury}}}{T_{\text{earth}}} = \left(\frac{r_{\text{mercury}}}{r_{\text{earth}}}\right)^{3/2} = \left(\frac{6 \times 10^{10}}{1.5 \times 10^{11}}\right)^{3/2} = \frac{1}{4}$

(approx.)

$$\therefore T_{\text{mercury}} = \frac{1}{4} \text{ year}$$

23. (a) Time period of satellite which is very near to planet