Variation of "g"

1. A hydrogen balloon released on the moon

1) Climbs up with an acceleration of 6x9.8ms^{-2}

2) Falls down with an acceleration of 9.8x6ms^{-2}

3) Falls with acceleration of 9.8 ms^{-2}

4) Falls with an acceleration of $\frac{9.8}{6}$ms^{-2}

2. The weight of an object in the coal mine, sea level and at the top of the mountain are respectively W_1, W_2 and W_3, then

1) $W_1 < W_2 > W_3$ 2) $W_1 = W_2 = W_3$ 3) $W_1 < W_2 < W_3$ 4) $W_1 > W_2 > W_3$

3. When a body is taken from the equator to the poles, its weight

1) Remains same 2) Increases

3) Decreases 4) Increases at N-pole and decreases at S-pole

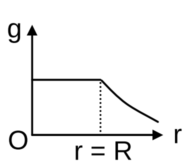
4. If the earth shrinks to half of its radius and mass remains constant, then the weight of an object on earth will become

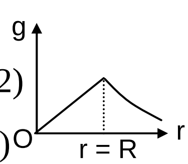
1) Doubled 2) Halved 3) Four times 4) Same

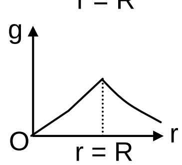
5. If R is radius of the earth, the height above the surface of the earth where the weight of a body is 36% less than its weight on the surface of the earth is

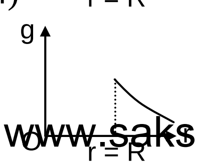
1) 4R/5 2) R/5 3) R/6 4) R/4

6. **Assume earth to be a uniform sphere of mass M and radius R. Which of the following graphs represents the variation of acceleration due to gravity (g) with distance (r) from the centre of the earth?**

1) 

2) 

3) 

4) 

7. If the earth were to rotate faster than its present speed, the weight of an object will

1) Increase at the equator but remain unchanged at the poles

2) Decrease at the equator but remain unchanged at the poles

3) Remain unchanged at the equator but decrease at the poles

4) Remain unchanged at the equator but increase at the poles

8. If earth suddenly shrinks to half of its present value, mass remaining unchanged, and then acceleration due to gravity at its surface with compare to the original will be

1) The same 2) Half

3) Double 4) Quadruple

9. If R is radius of the earth, g is mean acceleration due to gravity on its surface, mean density of the earth would be

1) $\frac{3g}{4\pi RG}$ 2) $\frac{4g}{3\pi RG}$ 3) $\frac{4G}{3\pi Rg}$ 4) $\frac{3G}{4\pi Rg}$

10. 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 the earth. When both d & h are very much smaller than the radius of the earth, then which one of the following is correct?

1) d=h 2) d=2h 3) $d=\frac{3h}{2}$ 4) $d=\frac{h}{2}$

11. The mass and diameter of a planet are two times those of earth. If a second's pendulum is taken to it, the time period of the pendulum in seconds is

1) $\frac{1}{\sqrt{2}}$ 2) $\frac{1}{2}$ 3) $2\sqrt{2}$ 4) $\sqrt{2}$

12. A person can jump safely from a height of 2m on the earth. On a planet where acceleration due to gravity is $2.45ms^{-2}$, the maximum height from which he can jump safely

1) 8m 2) 4m 3) 16m 4) 64m

13. The acceleration due to gravity at the latitude 45^0 on the earth becomes zero if the angular velocity of rotation of earth is equal to

1) $\sqrt{\frac{2}{gR}}$ 2) $\sqrt{2gR}$ 3) $\sqrt{\frac{2g}{R}}$ 4) $\sqrt{\frac{5R}{2}}$

14. At what height, the value of 'g' is half that on the surface of the earth of radius R?

1) R 2) 2R 3) 0.414R 4) 0.75R

15. The masses of two planets are in the ratio 1: 2. Their radii are in the ratio 1: 2. The acceleration due to gravity on the planets is in the ratio

1)1: 2 2) 2: 1 3)3: 5 4)5: 3

16. If earth is supposed to be a sphere of radius R, if g_{30} is value of acceleration due to gravity at latitude of 30^o and g at the equator, the value of $g - g_{30^o}$ is

1) $\frac{1}{4}\omega^2 R$ 2) $\frac{3}{4}\omega^2 R$ 3) $\omega^2 R$ 4) $\frac{1}{2}\omega^2 R$

17. If the density of a small planet is the same as that of earth, while the radius of the planet is 0.2 times that of the earth, the gravitational acceleration on the surface of that planet is

1) 0.2 g 2) 0.4 g 3)2 g 4)4 g

18. Acceleration due to gravity on moon is 1/6 of the acceleration due to gravity on earth. If the ratio of densities of earth (ρ_e) and moon (ρ_m) is $\left(\frac{\rho_e}{\rho_m}\right) = \frac{5}{3}$ then radius of moon R_m in terms of R_e will be

1) $\frac{5}{18}R_e$ 2) $\frac{1}{6}R_e$ 3) $\frac{3}{18}R_e$ 4) $\frac{1}{2\sqrt{3}}R_e$

19. If the value of 'g' acceleration due to gravity, at earth surface is $10\, m/s^2$, its value in m/s^2 at the centre of the earth, which is assumed to be a sphere of radius 'R' meter and uniform mass density is

1) 5 2) 10/R 3)10/2R 4) Zero

20. A research satellite of mass 200 kg circles the earth in an orbit of average radius 3R/2 where R is the radius of the earth. Assuming the gravitational pull on a mass of 1 kg on the earth's surface to be 10 N, the pull on the satellite will be

1) 880 N 2) 889 N

3) 890 N 4) 892 N

Key

1) 4	2) 1	3) 2	4) 3	5) 4	6) 2	7) 2	8) 1	9) 1	10)2
11) 4	12) 1	13) 3	14) 3	15) 2	16) 2	17) 1	18) 1	19) 4	20) 1

Hints

5. $g^1 = g\left(\frac{R}{R+h}\right)^2 \Rightarrow w^1 = W\left(\frac{R}{R+h}\right)^2$

$\frac{64}{100} = \left(\frac{R}{R+h}\right)^2 \Rightarrow h = \frac{R}{4}$

10. h < < R, d< < R

If $g_h = g_d$, *then* $g\left(1-\frac{2h}{R}\right) = g\left(1-\frac{d}{R}\right)$

d = 2h

11. $g \propto \frac{M}{R^2}$, $g_p = g\left(\frac{M_p}{M_e}\right) \times \left(\frac{R_e}{R_p}\right)^2 = g \times 2 \times \frac{1}{4} = \frac{g}{2}$

$T = 2\pi\sqrt{\frac{l}{g}}$

12. $h \propto \frac{1}{g}$

$$\frac{h_p}{h_e} = \frac{g_e}{g_p} \Rightarrow h_p = 2\frac{(9.8)}{2.45} = 8m$$

13. g_p **= g = r**$\omega^2 \cos^2\theta$

$$g_{45^0} = g - R\omega^2 \cos^2 45^0 = 0$$

$$g - \frac{R\omega^2}{2} = \mathbf{0} \Rightarrow \omega = \sqrt{\frac{2g}{R}}$$

14. $\frac{g_h}{g} = \frac{R^2}{(R+h)^2}$

15. $\frac{g'}{g} = \frac{M'}{M} \times \frac{R^2}{R'^2} = \frac{1}{2} \times \frac{4}{1} = \frac{2}{1}$

16. Acceleration due to gravity at latitude λ is given by

$$g' = g - R\omega^2 \cos^2\lambda$$

At 30^o, $g_{30^o} = g - R\omega^2 \cos^2 30^o = g - \frac{3}{4}R\omega^2$

$$\therefore\ g - g_{30} = \frac{3}{4}\omega^2 R.$$

17. $g = \frac{4}{3}\pi G R\rho$ and $g' = \frac{4}{3}\pi G R'\rho$

$$\therefore\ \frac{g'}{g} = \frac{R'}{R} = 0.2 \Rightarrow g' = 0.2\,g$$

18. $g = \frac{4}{3}\pi G\rho R \Rightarrow g \propto \rho R \Rightarrow \frac{g_e}{g_m} = \frac{\rho_e}{\rho_m} \times \frac{R_e}{R_m}$

$$\Rightarrow \frac{6}{1} = \frac{5}{3} \times \frac{R_e}{R_m} \Rightarrow R_m = \frac{5}{18}R_e$$

20. $g' = g\left(\frac{R}{R+h}\right)^2 = g\left(\frac{R}{3R/2}\right)^2 = \frac{4}{9}g$

$$\therefore\ W' = \frac{4}{9} \times mg = \frac{4 \times 200 \times 9.8}{9} = 880\ N$$