GRAVITATION ENGLISH MEDIUM

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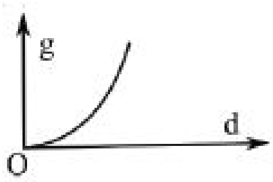
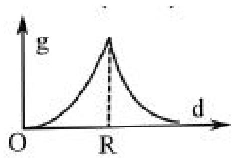
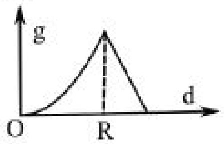
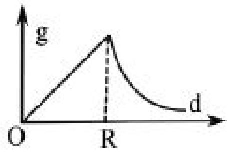
PHYSICS

1. An iron ball and a wooden ball of the same radius are released from a height $'h'$ in vacuum. The time taken by both of them to reach the ground is
   (A) Unequal (B) Exactly equal
   (C) Roughly equal (D) Zero
2. The variation of acceleration due to gravity g with distance d from centre of the earth is best represented by($R =$ Earth's radius):

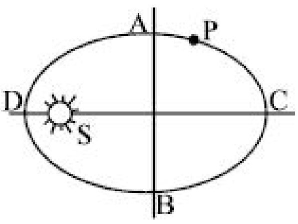
(A) 

(B) 

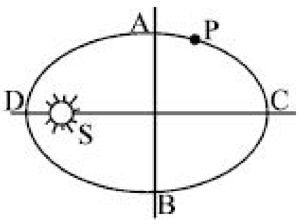
(C) 

(D) 

3. If Gravitational constant is decreasing in time, what will remain unchanged in case of a satellite orbiting around earth
   (A) Time period (B) Orbiting radius
   (C) Tangential velocity (D) Angular velocity
4. Two masses m_1 and $m_2\,(m_1 < m_2)$ are released from rest from a finite distance. They start under their mutual gravitational attraction
   (A) acceleration of m_1 is more than that of m_2
   (B) acceleration of m_2 is more than that of m_1
   (C) centre of mass of system will remain at rest in all the reference frame
   (D) total energy of system does not remain constant
5. Figure shows the orbit of a planet P round the sun $S.\ AB$ and CD are the minor and major axes of the ellipse.
   If t_1 is the time taken by the planet to travel along ACB and t_2 the time along BDA, then



   (A) $t_1 = t_2$ (B) $t_1 > t_2$
   (C) $t_1 < t_2$ (D) nothing can be concluded
6. Potential energy of a satellite having mass $'m'$ and rotating at a height of $6.4 \times 10^6\,m$ from the earth surface is
   (A) $-0.5\,mgR_e$ (B) $-mgR_e$
   (C) $-2\,mgR_e$ (D) $4\,mgR_e$
7. Suppose that the force of earth's gravity suddenly disappears, choose the correct answer out of the following statements
   (A) The weight of the body will become zero but mass remains the same
   (B) The mass of the body will become zero but the weight remains the same
   (C) Both the mass and weight will be the same
   (D) Mass and weight will remain the same
8. Figure shows the orbit of a planet P round the sun $S.\ AB$ and CD are the minor and major axes of the ellipse.
   If U is the potential energy and K kinetic energy then $|U| > |K|$ at



   (A) Only D (B) Only C
   (C) both D & C (D) neither D nor C
9. At the surface of a certain planet, acceleration due to gravity is one-quarter of that on earth. If a brass ball is transported to this planet, then which one of the following statements is not correct
   (A) The mass of the brass ball on this planet is a quarter of its mass as measured on earth
   (B) The weight of the brass ball on this planet is a quarter of the weight as measured on earth
   (C) The brass ball has the same mass on the other planet as on earth
   (D) The brass ball has the same volume on the other planet as on earth
10. Where can a geostationary satellite be installed
    (A) Over any city on the equator (B) Over the north or south pole
    (C) At height R above earth (D) At the surface of earth
11. Asatellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius $1.02\,R.$ The period of second satellite is larger than the first one by approximately .... $\%$
    (A) 1.5 (B) 3
    (C) 1 (D) 2
12. A body starts from rest from a point distance R_0 from the centre of the earth. The velocity acquired by the body when it reaches the surface of the earth will be (R represents radius of the earth).
    (A) $2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (B) $\sqrt{2GM\left(\frac{1}{R_0}-\frac{1}{R}\right)}$
    (C) $GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (D) $2GM\sqrt{\left(\frac{1}{R}-\frac{1}{R_0}\right)}$
13. Suppose the law of gravitational attraction suddenly changes and becomes an inverse cube law i.e. $F \propto \frac{1}{r^3}$, but still remaining a central force. Then
    (A) Keplers law of areas still holds
    (B) Keplers law of period still holds
    (C) Keplers law of areas and period still hold

(D) Neither the law of areas, nor the law of period still holds

14. A satellite of mass m is placed at a distance r from the centre of earth (mass M). The mechanical energy of the satellite is

(A) $-\frac{GMm}{r}$ (B) $\frac{GMm}{r}$

(C) $\frac{GMm}{2r}$ (D) $-\frac{GMm}{2r}$

15. Two satellites of masses m_1 and $m_2(m_1 > m_2)$ are revolving round the earth in circular orbits of radius r_1 and $r_2(r_1 > r_2)$ respectively. Which of the following statements is true regarding their speeds v_1 and v_2 ?

(A) $v_1 = v_2$ (B) $v_1 < v_2$

(C) $v_1 > v_2$ (D) $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

16. Which of the following astronomer first proposed that sun is static and earth rounds sun

(A) Copernicus (B) Kepler

(C) Galileo (D) None

17. 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) $3\sqrt{3}T$

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

(A) Remains constant (B) Increases

(C) Decreases (D) Increases at N-pole and decreases at S-pole

19. Height of geostationary satellite is .... km

(A) 16000 (B) 22000

(C) 28000 (D) 36000

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. 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

(A) $\frac{5}{18}R_e$ (B) $\frac{1}{6}R_e$

(C) $\frac{3}{18}R_e$ (D) $\frac{1}{2\sqrt{3}}R_e$

22. 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 Needs no adjustment

(B) Has to be increased-

(C) Needs no adjustment but its mass has to be increased (D) Needs no adjustment but its mass has to be increased

23. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s. If the body is projected at an angle of 45^o with the vertical, the escape velocity will be .... km/s

(A) $\frac{11}{\sqrt{2}}$ (B) $11\sqrt{2}$

(C) 22 (D) 11

24. If the change in the value of $'g'$ at a height h above the surface of the earth is the same as at a depth x below it, then (both x and h being much smaller than the radius of the earth)

(A) $x = h$ (B) $x = 2h$

(C) $x = \frac{h}{2}$ (D) $x = h^2$

25. The mass of a planet that has a moon whose time period and orbital radius are T and R respectively can be written as

(A) $4\pi^2R^3G^{-1}T^{-2}$ (B) $8\pi^2R^3G^{-1}T^{-2}$

(C) $12\pi^2R^3G^{-1}T^{-2}$ (D) $16\pi^2R^3G^{-1}T^{-2}$

26. If the radius of a planet is R and its density is ρ, the escape velocity from its surface will be

(A) $v_e \propto \rho R$ (B) $v_e \propto \sqrt{\rho}R$

(C) $v_e \propto \frac{\sqrt{\rho}}{R}$ (D) $v_e \propto \frac{1}{\sqrt{\rho}R}$

27. A man of $50\,kg$ mass is standing in a gravity free space at a height of $10\,m$ above the floor. He throws a stone of $0.5\,kg$ mass downwards with a speed $2\,m/s$. When the stone reaches the floor, the distance of the man above the floor will be ...... m

(A) 9.9 (B) 10.1

(C) 10 (D) 20

28. Distance of geostationary satellite from the surface of earth $radius\ (R_e = 6400\ km)$ in terms of R_e is ....

(A) 13.76 (B) 10.76

(C) 6.56 (D) 2.56

29. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of earth

(A) The acceleration of S is always directed towards the centre of the earth

(B) The angular momentum of S about the centre of the earth changes in direction but its magnitude remains constant

(C) The total mechanical energy of S varies periodically with time

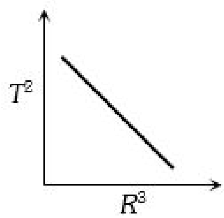
(D) The linear momentum of S remains constant in magnitude

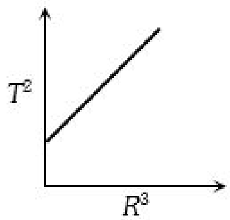
30. A satellite is revolving in a circular orbit at a height h from the earth surface, such that $h << R$ where R is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected the minimum increase in the speed required so that the satellite could escape from the gravitational field of earth is

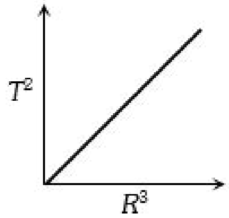
(A) $\sqrt{2gR}$ (B) $\sqrt{gR}$

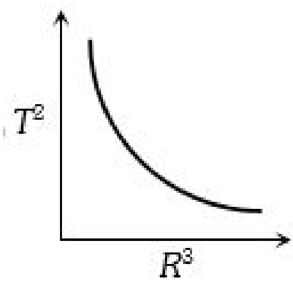
(C) $\sqrt{\frac{gR}{2}}$ (D) $\sqrt{gR}(\sqrt{2}\ - 1)$

31. Which of the following graphs represents the motion of a planet moving about the sun

(A) 

(B) 

(C) 

(D) 

32. $Assertion$: The length of the day is slowly increasing.
$Reason$: The dominant effect causing a slowdown in the rotation of the earth is the gravitational pull of other planets in the solar system.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

33. A satellite is to revolve round the earth in a circle of radius $8000\,km$. The speed at which this satellite be projected into an orbit, will be......... km/s

(A) 3 (B) 16

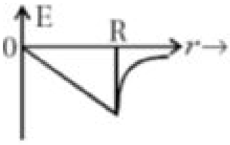
(C) 7.15 (D) 8

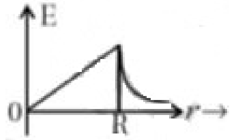
34. What will be the acceleration due to gravity at height h if $h >> R$. Where R is radius of earth and g is acceleration due to gravity on the surface of earth

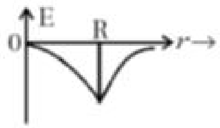
(A) $\dfrac{g}{\left(1+\dfrac{h}{R}\right)^2}$ (B) $g\left(1-\dfrac{2h}{R}\right)$

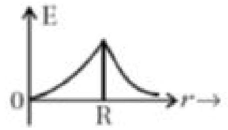
(C) $\dfrac{g}{\left(1-\dfrac{h}{R}\right)^2}$ (D) $g\left(1-\dfrac{h}{R}\right)$

35. Dependence of intensity of gravitational field (E) of earth with distance (r) from centre of earth is correctly represented by

(A) 

(B) 

(C) 

(D) 

36. An object weights $72\,N$ on earth. Its weight at a height of $R/2$ from earth is .... N

(A) 32 (B) 56

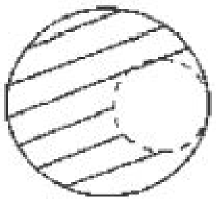
(C) 72 (D) 0

37. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on

(A) Mass of the earth (B) Mass of the projectile

(C) Radius of the projectile's orbit (D) Gravitational constant

38. From a solid sphere of mass M and radius R, a spherical portion of radius $R/2$ is removed, as shown in the figure. Taking gravitational potential $V=0$ at $r=\infty$, the potential at the centre of the cavity thus formed is
($G=$ gravitational constant)



(A) $\dfrac{-GM}{R}$ (B) $\dfrac{-2GM}{3R}$

(C) $\dfrac{-2GM}{R}$ (D) $\dfrac{-GM}{2R}$

39. 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) $\dfrac{2mg_0R^2}{R+h}$ (B) $-\dfrac{2mg_0R^2}{R+h}$

(C) $\dfrac{mg_0R^2}{2(R+h)}$ (D) $-\dfrac{mg_0R^2}{2(R+h)}$

40. If mass of earth is M, radius is R and gravitational constant is G, then work done to take $1\,kg$ mass from earth surface to infinity will be

(A) $\sqrt{\dfrac{GM}{2R}}$ (B) $\dfrac{GM}{R}$

(C) $\sqrt{\dfrac{2GM}{R}}$ (D) $\dfrac{GM}{2R}$

41. The diameters of two planets are in the ratio $4:1$ and their mean densities in the ratio $1:2$. The acceleration due to gravity on the planets will be in ratio

(A) $1:2$ (B) $2:3$

(C) $2:1$ (D) $4:1$

42. Escape velocity on the earth

(A) Is less than that on the moon (B) Depends upon the mass of the body

(C) Depends upon the direction of projection (D) Depends upon the height from which it is projected

43. The periodic time of a communication satellite is .... $hours$

(A) 6 (B) 12

(C) 18 (D) 24

44. If the density of the earth is doubled keeping its radius constant then acceleration due to gravity will be........ m/s^2 . $(g=9.8\,m/s^2)$

(A) 19.6 (B) 9.8

(C) 4.9 (D) 2.45

45. The kinetic energy needed to project a body of mass m from the earth surface (radius R) to infinity is

(A) $mgR/2$ (B) $2\,mgR$

(C) mgR (D) $mgR/4$

46. Two satellites, A and B, have masses m and $2\,m$ respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius $2R$ around the earth. The ratio of their kinetic energies, $K.E._A/K.E._B$, is

(A) $\dfrac{1}{2}$ (B) 1

(C) 2 (D) $\sqrt{\dfrac{1}{2}}$

47. The acceleration due to gravity is g at a point distant r from the centre of earth of radius R. If $r<R$, then

(A) $g\propto r$ (B) $g\propto r^2$

(C) $g\propto r^{-1}$ (D) $g\propto r^{-2}$

48. The gravitational field due to a mass distribution is $E=K/x^3$ in the $X-$direction. (K is a constant). Taking the gravitational potential to be zero at infinity, its value at a distance X is

(A) K/x (B) $K/2x$

(C) K/x^2 (D) $K/2x^2$

49. An astronaut orbiting the earth in a circular orbit $120\,km$ above the surface of earth, gently drops a spoon out of space-ship. The spoon will

(A) Fall vertically down to the earth (B) Move towards the moon

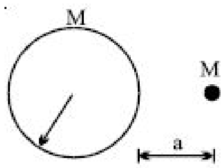
(C) Will move along with space-ship (D) Will move in an irregular way then fall down to earth

50. The escape velocity from the earth is about 11 km/second. The escape velocity from a planet having twice the radius and the same mean density as the earth, is .... km/sec

(A) 22 (B) 11

(C) 5.5 (D) 15.5

51. A particle of mass M is at a distance a from surface of a thin spherical shell of equal mass and having radius a.



(A) Gravitational field and potential both are zero at centre of the shell.

(B) Gravitational field is zero not only inside the shell but at a point outside the shell also.

(C) Inside the shell, gravitational field alone is zero.

(D) Neither gravitational field nor gravitational potential is zero inside the shell.

52. Assuming the earth to be a sphere of uniform density, the acceleration due to gravity inside the earth at a distance of r from the centre is proportional to

(A) r (B) r^{-1}

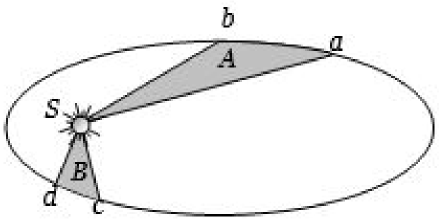
(C) r^2 (D) r^{-2}

53. A point particle is held on the axis of a ring of mass m and radius r at a distance r from its centre C. When released, it reaches C under the gravitational attraction of the ring. Its speed at C will be

(A) $\sqrt{\frac{2Gm}{r}(\sqrt{2}\ -1)}$ (B) $\sqrt{\frac{Gm}{r}}$

(C) $\sqrt{\frac{2Gm}{r}\left(1-\frac{1}{\sqrt{2}}\right)}$ (D) $\sqrt{\frac{2Gm}{r}}$

54. The figure shows the motion of a planet around the sun in an elliptical orbit with sun at the focus. The shaded areas A and B are also shown in the figure which can be assumed to be equal. If t_1 and t_2 represent the time for the planet to move from a to b and d to c respectively, then



(A) $t_1 < t_2$ (B) $t_1 > t_2$

(C) $t_1 = t_2$ (D) $t_1 \leq t_2$

55. A simple pendulum has a time period T_1 when on the earth's surface and T_2 when taken to a height R above the earth's surface, where R is the radius of the earth. The value of T_2/T_1 is

(A) 1 (B) $\sqrt{2}$

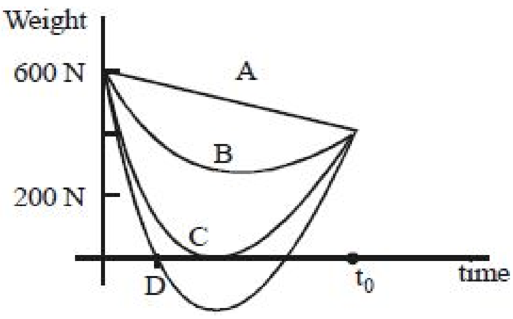
(C) 4 (D) 2

56. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocities from the Planets A and B are v_{A} and v_{B}, respectively, then $\frac{v_{\mathrm{A}}}{v_{\mathrm{B}}}=\frac{\mathrm{n}}{4}$ The value of n is

(A) 4 (B) 1

(C) 2 (D) 3

57. Suppose, the acceleration due to gravity at the Earth's surface is $10\,m\,s^{-2}$ and at the surface of Mars it is $4.0\,m\,s^{-2}$. A $60\,kg$ pasenger goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of figure best represents the weight (net gravitational force) of the passenger as a function of time?



(A) A (B) B

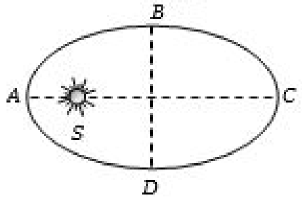
(C) C (D) D

58. The escape velocity from the surface of earth is V_e. The escape velocity from the surface of a planet whose mass and radius are 3 times those of the earth will be

(A) V_e (B) $3V_e$

(C) $9V_e$ (D) $27V_e$

59. A planet is revolving around the sun as shown in elliptical path the orbital velocity of the planet will be minimum at



(A) A (B) B

(C) C (D) D

60. Assuming earth to be a sphere of a uniform density, what is the value of gravitational acceleration in a mine $100\,km$ below the earth's surface .... m/s^2. (Given $R = 6400\,km$)

(A) 9.66 (B) 7.64

(C) 5.06 (D) 3.10

61. An astronaut of mass m is working on a satellite or biting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is

(A) Zero since astronaut feels weightless (B) $\frac{GMm}{(R+h)^2} < F_G < \frac{GMm}{R^2}$

(C) $F_G = \frac{GMm}{(R+h)^2}$ (D) $0 < F_G < \frac{GMm}{R^2}$

62. Weightlessness experienced while orbiting the earth in space-ship, is the result of

(A) Inertia (B) Acceleration

(C) Zero gravity (D) Free fall towards earth

63. The escape velocity of a projectile from the earth is approximately .... km/sec

(A) 0.112 (B) 112

(C) 11.2 (D) 11200

64. v_e and v_p denotes the escape velocity from the earth and another planet having twice the radius and the same mean density as the earth. Then

(A) $v_e = v_p$ (B) $v_e = v_p/2$

(C) $v_e = 2v_p$ (D) $v_e = v_p/4$

65. If a new planet is discovered rotating around Sun with the orbital radius double that of earth, then what will be its time period (in earth's days)

(A) 1032 (B) 1023

(C) 1024 (D) 1043

66. Assuming that the gravitational potential energy of an object at infinity is zero, the change in potential energy (final-initial) of an object of mass m, when to a height h from the surface of earth (of radius R), is given

(A) $-\frac{\mathrm{GMm}}{\mathrm{R+h}}$ (B) $\frac{\mathrm{GMmh}}{\mathrm{R(R+h)}}$

(C) mgh (D) $\frac{\mathrm{GMm}}{\mathrm{R+h}}$

67. 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) A goes on decreasing and that by B goes on increasing (B) B goes on decreasing and that by A goes on increasing

(C) Each decreases at the same rate (D) Each decreases at different rates

68. The force of gravitation is

(A) repulsive (B) conservative

(C) electrostatic (D) non-conservative

69. A spaceship orbits around a planet at a height of $20\,km$ from its surface. Assuming that only gravitational field of the plant acts on the spaceship. What will be the number of complete revolutions made by the spaceship in $24\,hours$ around the plane? [Given: Mass of plane $=\ 8\times10^{22}\,kg,$ Radius of planet $=\ 2\times10^{6}\,m,$ Gravitational constant $G = 6.67\times10^{-11}\,Mn^2/kg^2$]

(A) 9 (B) 11

(C) 13 (D) 17

70. Who among the following gave first the experimental value of G

(A) Cavendish (B) Copernicus

(C) Brook Teylor (D) None of these

71. If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is

(A) $4\pi G/3gR$ (B) $3\pi R/4gG$

(C) $3g/4\pi RG$ (D) $\pi RG/12G$

72. Aplanet of mass m is in an elliptical orbit about the sun $(m << M_{sun})$ with an orbital period T. If A be the area of orbit, then its angular momentum would be :
(A) $\frac{2mA}{T}$ (B) mAT
(C) $\frac{mA}{2T}$ (D) $2mAT$

73. The angular velocity of the earth with which it has to rotate so that acceleration due to gravity on 60^o latitude becomes zero is (Radius of earth $= 6400\,km$. At the poles $g = 10\,ms^{-2}$)
(A) $2.5\times10^{-3}\,rad/s$ (B) $5.0\times10^{-1}\,rad/s$
(C) $10\times10^{1}\,rad/s$ (D) $7.8\times10^{-2}\,rad/s$

74. At what height over the earth's pole, the free fall acceleration decreases by one percent .... km. (assume the radius of earth to be $6400\,km$)
(A) 32 (B) 80
(C) 1.253 (D) 64

75. 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
(A) Is the same (B) Is smaller
(C) Is greater (D) Varies with its phase

76. A geostationary satellite is orbiting the earth at a height $5R$ 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) $5\ hr$ (B) $10\ hr$
(C) $6\sqrt{2}\ hr$ (D) $10\sqrt{2}\ hr$

77. A spring balance is graduated on sea level. If a body is weighed with this balance at consecutively increasing heights from earth's surface, the weight indicated by the balance
(A) Will go on increasing continuously (B) Will go on decreasing continuously
(C) Will remain same (D) Will first increase and then decrease

78. Radius of earth is around $6000\,km$. The weight of body at height of $6000\,km$ from earth surface becomes
(A) Half (B) One-fourth
(C) One third (D) No change

79. Out of the following, the only incorrect statement about satellites is
(A) A satellite cannot move in a stable orbit in a plane passing through the earth's centre
(B) Geostationary satellites are launched in the equatorial plane
(C) We can use just one geostationary satellite for global communication around the globe
(D) The speed of a satellite increases with an increase in the radius of its orbit

80. If a body describes a circular motion under inverse square field, the time taken to complete one revolution T is related to the radius of the circular orbit as
(A) $T\propto r$ (B) $T\propto r^2$
(C) $T^2\propto r^3$ (D) $T\propto r^4$

81. If radius of the earth contracts 2% and its mass remains the same, then weight of the body at the earth surface
(A) Will decrease (B) Will increase
(C) Will remain the same (D) None of these

82. Hubble's law states that the velocity with which milky way is moving away from the earth is proportional to
(A) Square of the distance of the milky way from the earth
(B) Distance of milky way from the earth
(C) Mass of the milky way
(D) Product of the mass of the milky way and its distance from the earth

83. When a satellite moves around the earth in a certain orbit, the quantity which remains constant is :
(A) angular velocity (B) kinetic energy
(C) aerial velocity (D) potential energy

84. The least velocity required to throw a body away from the surface of a planet so that it may not return is (radius of the planet is $6.4\times10^6 m,\ g = 9.8\,m/sec^2$)
(A) $9.8\times10^{-3}\,m/sec$ (B) $12.8\times10^{3}\,m/sec$
(C) $9.8\times10^{3}\,m/sec$ (D) $11.2\times10^{3}\,m/sec$

85. The escape velocity of a rocket launched from the surface of the earth
(A) Does not depend on the mass of the rocket
(B) Does not depend on the mass of the earth
(C) Depends on the mass of the planet towards which it is moving
(D) Depends on the mass of the rocket

86. 3 particles each of mass m are kept at vertices of an equilateral triangle of side L. The gravitational field at centre due to these particles is
(A) Zero (B) $\frac{3GM}{L^2}$
(C) $\frac{9GM}{L^2}$ (D) $\frac{12}{\sqrt{3}}\frac{GM}{L^2}$

87. Orbital velocity of an artificial satellite does not depend upon
(A) Mass of the earth (B) Mass of the satellite
(C) Radius of the earth (D) Acceleration due to gravity

88. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to half the escape velocity for that planet. The maximum height attained by the body is
(A) $R/3$ (B) $R/2$
(C) $R/4$ (D) $R/5$

89. A body of mass m kg. starts falling from a point $2R$ above the Earth's surface. Its kinetic energy when it has fallen to a point $'R'$ above the Earth's surface [$R-$Radius of Earth, $M-$Mass of Earth, $G-$Gravitational Constant]
(A) $\frac{1}{2}\frac{GMm}{R}$ (B) $\frac{1}{6}\frac{GMm}{R}$
(C) $\frac{2}{3}\frac{GMm}{R}$ (D) $\frac{1}{3}\frac{GMm}{R}$

90. A planet has orbital radius twise as the earth's orbital radius then the time period of planet is .... $years$
(A) 4.2 (B) 2.8
(C) 5.6 (D) 8.4

91. The additional kinetic energy to be provided to a satellite of mass m revolving around a planet of mass M, to transfer it from a circular orbit of radius R_1 to another of radius $R_2\,(R_2 > R_1)$ is
(A) $GMm\left(\frac{1}{{R_1}^2}-\frac{1}{{R_2}^2}\right)$ (B) $\mathrm{GMm}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
(C) $2\mathrm{GMm}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ (D) $\frac{1}{2}\mathrm{GMm}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

92. Choose the correct statement from the following :Weightlessness of an astronaut moving in a satellite is a situation of
(A) Zero g (B) No gravity
(C) Zero mass (D) Free fall

93. At what distance from the centre of the earth, the value of acceleration due to gravity g will be half that on the surface ($R =$ radius of earth)
(A) $2\,R$ (B) R
(C) $1.414\,R$ (D) $0.414\,R$

94. Let g be the acceleration due to gravity at earth's surface and K be the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2% keeping all other quantities same, then
(A) g decreases by 2% and K decreases by 4% (B) g decreases by 4% and K increases by 2%
(C) g increases by 4% and K increases by 4% (D) g decreases by 4% and K increases by 4%

95. Weight of a body is maximum at

(A) Moon (B) Poles of earth

(C) Equator of earth (D) Centre of earth

96. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then,

(A) the acceleration of S is always directed towards the centre of the earth.

(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

(C) the total mechanical energy of S varies periodically with time.

(D) the linear momentum of S remains constant in magnitude.

97. The mass and diameter of a planet are twice those of earth. What will be the period of oscillation of a pendulum on this planet if it is a seconds pendulum on earth ?

(A) $\sqrt{2}$ second (B) $2\sqrt{2}$ seconds

(C) $\frac{1}{\sqrt{2}}$ second (D) $\frac{1}{2\sqrt{2}}$ second

98. At what distance from the centre of the moon is the point at which the strength of the resultant field of earth's and moon's gravitational field is equal to zero. The earth's mass is 81 times that of moon and the distance between centres of these planets is $60\,R$ where R is the radius of the earth

(A) $6\ R$ (B) $4\ R$

(C) $3\ R$ (D) $5\ R$

99. A spherical planet far out in space has a mass M_0 and diameter D_0. A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity which is equal to

(A) GM_0/D_0^2 (B) $4mGM_0/D_0^2$

(C) $4GM_0/D_0^2$ (D) GmM_0/D_0^2

100. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then

(A) the acceleration of S is always directed towards the centre of the earth

(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant

(C) the total mechanical energy of S varies periodically with time

(D) the linear momentum of S remains constant in magnitude

101. A man of mass m starts falling towards a planet of mass M and radius R. As he reaches near to the surface, he realizes that he will pass through a small hole in the planet. As he enters the hole, he sees that the planet is really made of two pieces a spherical shell of negligible thickness of mass $\frac{2M}{3}$ and a point mass $\frac{M}{3}$ at the centre. Change in the force of gravity experienced by the man is

(A) $\frac{2}{3}\frac{GMm}{R^2}$ (B) 0

(C) $\frac{1}{3}\frac{GMm}{R^2}$ (D) $\frac{4}{3}\frac{GMm}{R^2}$

102. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

(A) $2R$ (B) $4R$

(C) $\frac{1}{4}R$ (D) $\frac{1}{2}R$

103. The escape velocity of a sphere of mass m from earth having mass M and radius R is given by

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

(C) $\sqrt{\frac{2GMm}{R}}$ (D) $\sqrt{\frac{GM}{R}}$

104. A research satellite of mass $200\,kg$ circles the earth in an orbit of average radius $3\,R/2$ 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 .... N.

(A) 880 (B) 889

(C) 890 (D) 892

105. At ..... km height from the surface of earth the gravitation potential and the value of g are $-5.4\times10^7\ Jkg^{-1}$ and $6.0\ ms^{-2}$ respectively . Take the radius of earth as $6400\,km$.

(A) 1600 (B) 1400

(C) 2000 (D) 2600

106. The mass of the earth is 81 times that of the moon and the radius of the earth is 3.5 times that of the moon. The ratio of the escape velocity on the surface of earth to that on the surface of moon will be

(A) 0.2 (B) 2.57

(C) 4.81 (D) 0.39

107. The condition for a uniform spherical mass m of radius r to be a black hole is [$G=$ gravitational constant and $g=$ acceleration due to gravity]

(A) $(2Gm/r)^{1/2}\le c$ (B) $(2Gm/r)^{1/2}=c$

(C) $(2Gm/r)^{1/2}\ge c$ (D) $(gm/r)^{1/2}\ge c$

108. The escape velocity of an object on a planet whose g value is 9 times on earth and whose radius is 4 times that of earth in km/s is

(A) 67.2 (B) 33.6

(C) 16.8 (D) 25.2

109. 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

(A) W (B) $2W$

(C) $W/2$ (D) 0

110. A satellite of the earth is revolving in circular orbit with a uniform velocity $V.$ If the gravitational force suddenly disappears, the satellite will

(A) continue to move with the same velocity in the same orbit.

(B) move tangentially to the original orbit with velocity $V.$

(C) fall down with increasing velocity.

(D) come to a stop somewhere in its original orbit.

111. Which of the following is the evidence to show that there must be a force acting on earth and directed towards the sun

(A) Deviation of the falling bodies towards east

(B) Revolution of the earth round the sun

(C) Phenomenon of day and night

(D) Apparent motion of sun round the earth

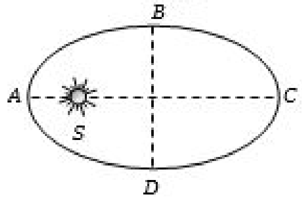
112. The maximum possible velocity of a satellite orbiting round the earth in a stable orbit is

(A) $\sqrt{2R_eg}$ (B) $\sqrt{R_eg}$

(C) $\sqrt{\frac{R_eg}{2}}$ (D) Infinite

113. A planet is revolving around the sun as shown in elliptical path

The correct option is



(A) The time taken in travelling DAB is less than that for BCD

(B) The time taken in travelling DAB is greater than that for BCD

(C) The time taken in travelling CDA is less than that for ABC

(D) The time taken in travelling CDA is greater than that for ABC

114. The acceleration due to gravity on a planet is same as that on earth and its radius is four times that of earth. What will be the value of escape velocity on that planet if it is v_e on earth

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

115. The gravitational field in a region is given by
$\vec{E} = (5\,N/kg)\,\hat{i} + (12\,N/kg)\,\hat{j}$
If the potential at the origin is taken to be zero, then the ratio of the potential at the points $(12\,m, 0)$ and $(0, 5\,m)$ is

(A) Zero (B) 1
(C) $\frac{144}{25}$ (D) $\frac{25}{144}$

116. What is the intensity of gravitational field of the centre of a spherical shell

(A) Gm/r^2 (B) g
(C) Zero (D) None of these

117. If the gravitational force between two objects were proportional to $\frac{1}{R}$ (and not as $1/R^2$) where R is separation between them, then a particle in 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) $\frac{1}{R}$

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

119. If the distance between two masses is doubled, the gravitational attraction between them

(A) Is doubled (B) Becomes four times
(C) Is reduced to half (D) Is reduced to a quarter

120. Assume that the acceleration due to gravity on the surface of the moon is 0.2 times the acceleration due to gravity on the surface of the earth. If R_e is the maximum range of a projectile on the earth's surface, what is the maximum range on the surface of the moon for the same velocity of projection

(A) $0.2\,R_e$ (B) $2\,R_e$
(C) $0.5\,R_e$ (D) $5\,R_e$

121. If the radius and acceleration due to gravity both are doubled, escape velocity of earth will become .... km/s

(A) 11.2 (B) 22.4
(C) 5.6 (D) 44.8

122. The magnitudes of the gravitational force at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2 respectively. Then

(A) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$
(B) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 > R$ and $r_2 > R$
(C) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ and $r_2 > R$
(D) Both (a) and (b)

123. 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 $'\rho'$ kg/m^3. If $d > \rho$, the sphere will

(A) Fall vertically with an acceleration $'g'$ $m/\sec^2$
(B) Fall vertically with no acceleration
(C) Fall vertically with an acceleration $g\left(\frac{d-\rho}{d}\right)$
(D) Fall vertically with an acceleration $g\left(\frac{\rho}{d}\right)$

124. Two satellite A and B, ratio of masses $3 : 1$ are in circular orbits of radii r and $4r$. Then ratio of total mechanical energy of A to B is

(A) $1:3$ (B) $3:1$
(C) $3:4$ (D) $12:1$

125. A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius $R (R << L)$. A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period of star is T and its distance from the galaxy's axis is r, then

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

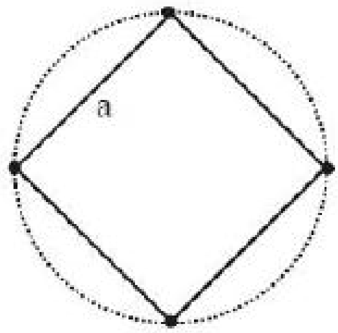
126. A satellite whose mass is M, is revolving in circular orbit of radius r around the earth. Time of revolution of satellite is

(A) $T \propto \frac{r^5}{GM}$ (B) $T \propto \sqrt{\frac{r^3}{GM}}$
(C) $T \propto \sqrt{\frac{r}{GM^2/3}}$ (D) $T \propto \sqrt{\frac{r^3}{GM^1/4}}$

127. For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

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

128. Four identical particles of mass M are located at the corners of a square of side $'a'$. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



(A) $1.35\sqrt{\frac{GM}{a}}$ (B) $1.16\sqrt{\frac{GM}{a}}$
(C) $1.41\sqrt{\frac{GM}{a}}$ (D) $1.21\sqrt{\frac{GM}{a}}$

129. The acceleration of a body due to the attraction of the earth (radius R) at a distance $2\,R$ from the surface of the earth is (g = acceleration due to gravity at the surface of the earth)

(A) $\frac{g}{9}$ (B) $\frac{g}{3}$
(C) $\frac{g}{4}$ (D) g

130. If a satellite orbits as close to the earth's surface as possible,

(A) its speed is maximum
(B) time period of its rotation is minimum
(C) the total energy of the 'earth plus satellite' system is minimum
(D) all of the above

131. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2. The ratio of the accelerations due to gravity at their surfaces is

(A) $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$ (B) $g_1 : g_2 = R_1R_2 : \rho_1\rho_2$
(C) $g_1 : g_2 = R_1\rho_2 : R_2\rho_1$ (D) $g_1 : g_2 = R_1\rho_1 : R_2\rho_2$

132. In a gravitational field, at a point where the gravitational potential is zero

(A) The gravitational field is necessarily zero
(B) The gravitational field is not necessarily zero
(C) Nothing can be said definitely about the gravitational field
(D) None of these

133. The radius and mass of earth are increased by 0.5%. Which of the following statements are true at the surface of the earth

(A) Potential energy will remain unchanged
(B) g will decrease
(C) Escape velocity will remain unchanged
(D) All of the above

134. A body of mass m is taken to the bottom of a deep mine. Then

(A) Its mass increases
(B) Its mass decreases
(C) Its weight increases
(D) Its weight decreases

135. When a satellite in a circular orbit around the earth enters the atmospheric region, it encounters small air resistance to its motion. Then

(A) its kinetic energy increases
(B) its kinetic energy decreases
(C) its angular momentum about the earth decreases
(D) (A) and (C) both

136. In order to find time, the astronaut orbiting in an earth satellite should use

(A) A pendulum clock
(B) A watch having main spring to keep it going
(C) Either a pendulum clock or a watch
(D) Neither a pendulum clock nor a watch

137. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth

(A) the acceleration of S is always directed towards the centre of the earth
(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant
(C) the total mechanical energy of S varies periodically with time
(D) the linear momentum of S remains constant in magnitude

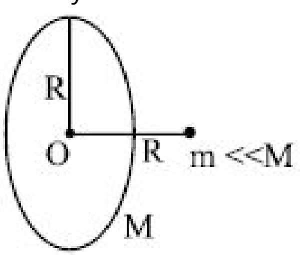
138. Gravitational potential at the centre of curvature of a hemispherical bowl of radius R and mass M is V.

(A) gravitational potential at the centre of curvature of a thin uniform wire of mass M, bent into a semicircle of radius R, is also equal to V.
(B) In part (A) if the same wire is bent into a quarter of a circle then also the gravitational potential at the centre of curvature will be V.
(C) In part (A) if the same wire mass is nonuniformly distributed along its length and it is bent into a semicircle of radius R, gravitational potential at the centre is V.
(D) (A) and (C) both

139. Radius of orbit of satellite of earth is R. Its kinetic energy is proportional to

(A) $\frac{1}{R}$
(B) $\frac{1}{\sqrt{R}}$
(C) R
(D) $\frac{1}{R^{3/2}}$

140. A particle starts from rest at a distance R from the centre and along the axis of a fixed ring of radius R& mass M. Its velocity at the centre of the ring is :



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

141. In order to make the effective acceleration due to gravity equal to zero at the equator, the angular velocity of rotation of the earth about its axis should be $(g = 10\,ms^{-2}$ and radius of earth is $6400\,kms)$

(A) $0\ rad\sec^{-1}$
(B) $\frac{1}{800}rad\,sec^{-1}$
(C) $\frac{1}{80}rad\,sec^{-1}$
(D) $\frac{1}{8}rad\,sec^{-1}$

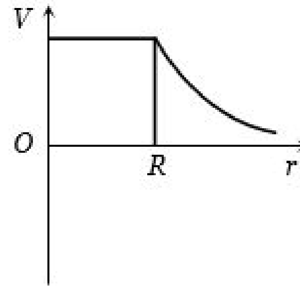
142. The escape velocity for a body projected vertically upwards from the surface of earth is $11\,km/s$. If the body is projected at an angle of 45^o with the vertical, the escape velocity will be .... km/s

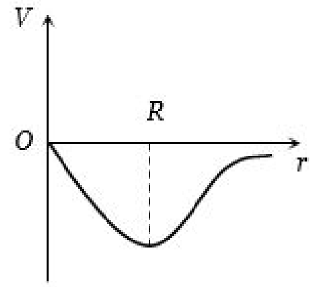
(A) 22
(B) 11
(C) $\frac{11}{\sqrt{2}}$
(D) $11\sqrt{2}$

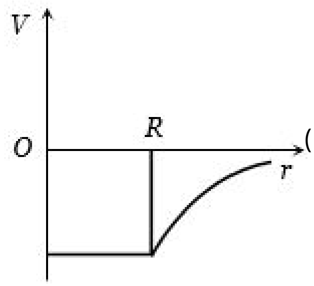
143. In the solar system, which is conserved

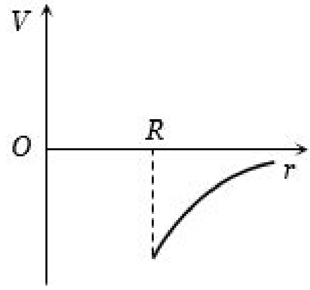
(A) Total Energy
(B) K.E.
(C) Angular Velocity
(D) Linear Momentum

144. By which curve will the variation of gravitational potential of a hollow sphere of radius R with distance be depicted

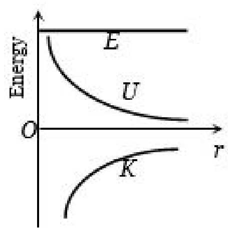
(A)


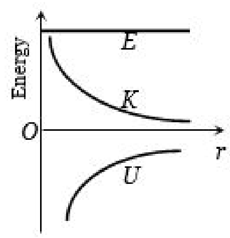
(B)


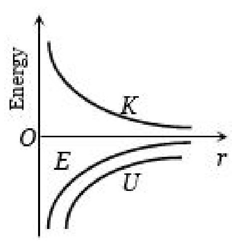
(C)


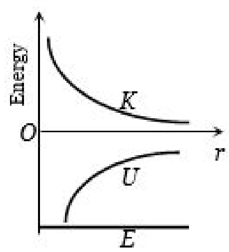
(D)


145. The correct graph representing the variation of total energy (E_t) kinetic energy (E_k) and potential energy (U) of a satellite with its distance from the centre of earth is

(A)


(B)


(C)


(D)


146. The value of escape velocity on a certain planet is $2\,km/s$. Then the value of orbital speed for a satellite orbiting close to its surface is

(A) $12\,km/s$
(B) $1\,km/s$
(C) $\sqrt{2}\,km/s$
(D) $2\sqrt{2}\ km/s$

147. The acceleration due to gravity at pole and equator can be related as

(A) $g_p < g_e$
(B) $g_p = g_e = g$
(C) $g_p = g_e < g$
(D) $g_p > g_e$

148. The escape velocity for the earth is $11.2\,km/sec$. The mass of another planet is 100 times that of the earth and its radius is 4 times that of the earth. The escape velocity for this planet will be .... km/sec

(A) 112.0
(B) 5.6
(C) 280.0
(D) 56.0

149. Taking the gravitational potential at a point infinte distance away as zero, the gravitational potential at a point A is $-5\,unit$. If the gravitational potential at point infinite distance away is taken as $+10\,units$, the potential at point A is .... $unit$

(A) -5
(B) $+5$
(C) $+10$
(D) $+15$

150. A communications Earth satellite

(A) goes round the earth from west to east
(B) can be in the equatorial plane only
(C) can be vertically above any place on the earth
(D) (A) and (B) both

151. Orbital velocity of earth's satellite near the surface is $7\,km/s$. When the radius of the orbit is 4 times than that of earth's radius, then orbital velocity in that orbit is .... km/sec

(A) 3.5
(B) 7
(C) 72
(D) 14

152. Kepler's second law (law of areas) is nothing but a statement of

(A) Work energy theorem
(B) Conservation of linear momentum
(C) Conservation of angular momentum
(D) Conservation of energy

153. The distance of neptune and saturn from the sun is nearly 10^{13} and 10^{12} meter respectively. Assuming that they move in circular orbits, their periodic times will be in the ratio

(A) 10
(B) 100
(C) $10\sqrt{10}$
(D) 1000

154. The distance between centre of the earth and moon is $384000\,km$. If the mass of the earth is $6 \times 10^{24} kg$ and $G = 6.66 \times 10^{-11}\,Nm^2/kg^2$. The speed of the moon is nearly......... km/sec

(A) 1
(B) 4
(C) 8
(D) 11.2

155. The height at which the weight of a body becomes $\frac{1}{16}^{th}$, its weight on the surface of earth (radius R), is

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

156. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.
Statement-1: For a mass M kept at the centre ofa cube of side 'a', the flux of gravitational field passing through its sides $4\pi GM$.
Statement-2: If the direction of a field due to a point source is radial and its dependence on the distance 'r' from the source is given as $\frac{1}{r^2}$, its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.

(A) Statement -1 is false, Statement-2 is true
(B) Statement -1 is true, Statement-2 is true; Statement -2 is a correct explanation for Statement-1
(C) Statement -1 is true, Statement-2 is true; Statement -2 is not a correct explanation for Statement-1
(D) Statement -1 is true, Statement-2 is false

157. The orbital speed of Jupiter is

(A) Greater than the orbital speed of earth
(B) Less than the orbital speed of earth
(C) Equal to the orbital speed of earth
(D) Zero

158. A body weight $500\,N$ on the surface of the earth. How much would it weigh half way below the surface of the earth .... N

(A) 125
(B) 250
(C) 500
(D) 1000

159. Mass M is divided into two parts xM and $(1-x)\,M$. For a given separation, the value of x for which the gravitational attraction between the two pieces becomes maximum is

(A) 0.5
(B) $\frac{3}{5}$
(C) 1
(D) 2

160. A body has a weight $90\,kg$ on the earth's surface, the mass of the moon is $1/9$ that of the earth's mass and its radius is $1/2$ that of the earth's radius. On the moon the weight of the body is .... kg

(A) 45
(B) 202.5
(C) 90
(D) 40

161. A body weighs $700\,gm$ wt on the surface of the earth. How much will it weigh on the surface of a planet whose mass is $\frac{1}{7}$ and radius is half that of the earth .... $gm\,wt$

(A) 200
(B) 400
(C) 50
(D) 300

162. The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is v. For a satellite orbiting at an altitude of half of the earth's radius, the orbital velocity is

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

163. An earth satellite of mass m revolves in a circular orbit at a height h from the surface of the earth. R is the radius of the earth and g is acceleration due to gravity at the surface of the earth. The velocity of the satellite in the orbit is given by

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

164. The escape velocity of a body on the surface of the earth is $11.2\,km/s$. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become .... km/s

(A) 5.6
(B) 11.2
(C) 22.4
(D) 44.8

165. A satellite moves around the earth in a circular orbit of radius r with speed v. If the mass of the satellite is M, its total energy is

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

166. A particle is moving with a uniform speed in a circular orbit of radius R in a central force inversely proportional to the n^{th} power of R. If the period ofrotation of the particle is T, then

(A) $T \propto R^{\frac{n}{2}+1}$
(B) $T \propto R^{\frac{(n+1)}{2}}$
(C) $T \propto R^{\frac{n}{2}}$
(D) $T \propto R^{\frac{3}{2}}$ For any n

167. If radius of earth is R then the height $'h'$ at which value of $'g'$ becomes one-fourth is

(A) $\frac{R}{4}$
(B) $\frac{3R}{4}$
(C) R
(D) $\frac{R}{8}$

168. The ratio of the weights of a body on the Earth's surface to that on the surface of a planet is $9:4$. The mass of the planet is $\frac{1}{9}^{th}$ of that of the Earth. If $'R'$ is the radius of the Earth, what is the radius of the planet ? (Take the planets to have the same mass density)

(A) $\frac{R}{3}$
(B) $\frac{R}{4}$
(C) $\frac{R}{9}$
(D) $\frac{R}{2}$

169. Consider a satellite going round the earth in an orbit. Which of the following statements is wrong

(A) It is a freely falling body
(B) It suffers no acceleration
(C) It is moving with a constant speed
(D) Its angular momentum remains constant

170. Two sphere of mass m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be

(A) F (B) $\frac{F}{3}$

(C) $\frac{F}{9}$ (D) $3\,F$

171. When a satellite going round the earth in a circular orbit of radius r and speed v loses some of its energy, then r and v change as

(A) r and v both with increase (B) r and v both will decrease

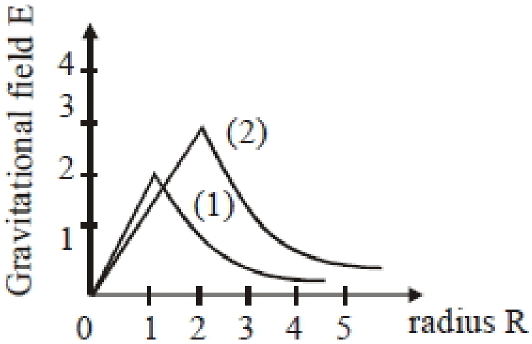
(C) r will decrease and v will increase (D) r will increase and v will decrease

172. 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 $\frac{a}{2}$ distance from the centre, will be

(A) $-\frac{3GM}{a}$ (B) $-\frac{2GM}{a}$

(C) $-\frac{GM}{a}$ (D) $-\frac{4GM}{a}$

173. Consider two solid spheres of radii $\mathrm{R_1 = 1\ m}$ $\mathrm{R_2 = 2\ m}$ and masses $\mathrm{M_1}$ and $\mathrm{M_2}$, respectively. The gravitational field due to sphere (1) and (2) are shown. The value of $\frac{\mathrm{M_1}}{\mathrm{M_2}}$ is



(A) $\frac{1}{2}$ (B) $\frac{2}{3}$

(C) $\frac{1}{3}$ (D) $\frac{1}{6}$

174. An artificial satellite is placed into a circular orbit around earth at such a height that it always remains above a definite place on the surface of earth. Its height from the surface of earth is .... km

(A) 6400 (B) 4800

(C) 32000 (D) 36000

175. A geostationary satellite is revolving around the earth. To make it escape from gravitational field of earth, is velocity must be increased .... $\%$

(A) 100 (B) 41.4

(C) 50 (D) 59.6

176. The weight of a body at the centre of the earth is

(A) Zero (B) Infinite

(C) Same as on the surface of earth (D) None of the above

177. If satellite is shifted towards the earth. Then time period of satellite will be

(A) Increase (B) Decrease

(C) Unchanged (D) Nothing can be said

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

(A) $-2\,mgR_e$ (B) $2\,mgR_e$

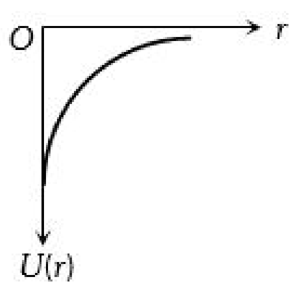
(C) $\frac{1}{2}mgR_e$ (D) $-\frac{1}{2}mgR_e$

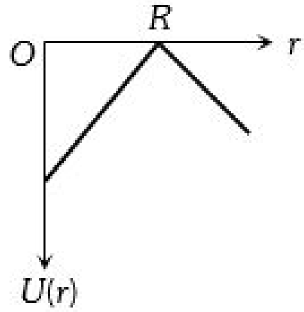
179. Planetary system in the solar system describes

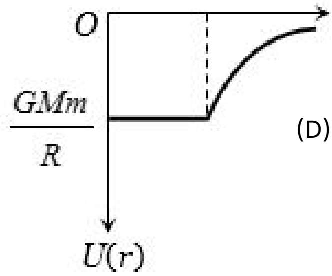
(A) Conservation of energy (B) Conservation of linear momentum

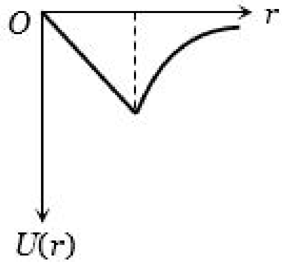
(C) Conservation of angular momentum (D) None of these

180. A shell of mass M and radius R has a point mass m placed at a distance r from its centre. The gravitational potential energy $U\,(r)$ vs r will be

(A)


(B)


(C)


(D)


181. Reason of weightlessness in a satellite is

(A) Zero gravity (B) Centre of mass

(C) Zero reaction force by satellite surface (D) None

182. The orbital angular momentum of a satellite revolving at a distance r from the centre is L. If the distance is increased to $16r$, then the new angular momentum will be

(A) $16L$ (B) $64L$

(C) $\frac{L}{4}$ (D) $4L$

183. Assuming the earth to be a sphere of uniform density the acceleration due to gravity

(A) at a point outside the earth is inversely proportional to the square of its distance from the centre

(B) at a point outside the earth is inversely proportional to its distance from the centre

(C) at a point inside is proportional to its distance from the centre.

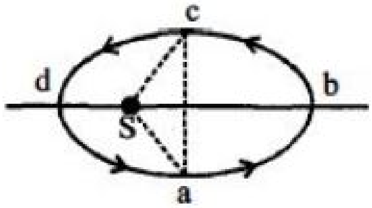
(D) (A) and (C) both

184. If it is assumed that the spinning motion of earth increases, then the weight of a body on equator

(A) Decreases (B) Remains constant

(C) Increases (D) Becomes more at poles

185. Figure shows elliptical path $abcd$ of a planet around the sun S such that the area of triangle csa is $\frac{1}{4}$ the area of the ellipse. (See figure) With db as the semimajor axis, and ca as the semiminor axis. If t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then



(A) $t_1 = 4t_2$ (B) $t_1 = 2t_2$

(C) $t_1 = 3t_2$ (D) $t_1 = t_2$

186. The escape velocity for a rocket from earth is $11.2\,km/sec.$ Its value on a planet where acceleration due to gravity is double that on the earth and diameter of the planet is twice that of earth will be in .... km/sec

(A) 11.2 (B) 5.6

(C) 22.4 (D) 53.6

187. If M the mass of the earth and R its radius, the ratio of the gravitational acceleration and the gravitational constant is

(A) $\frac{R^2}{M}$ (B) $\frac{M}{R^2}$

(C) MR^2 (D) $\frac{M}{R}$

188. 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

(A) S will run faster than P (B) P will run faster than S

(C) They will both run at the same rate as on the earth (D) None of these

189. The time period of a simple pendulum on a freely moving artificial satellite is

(A) $Zero$ (B) $2\,sec$

(C) $3\,sec$ (D) Infinite

190. The distance of a geo-stationary satellite from the centre of the earth (Radius $R = 6400\,km$) is nearest to

(A) $5R$ (B) $7R$

(C) $10R$ (D) $18R$

191. 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

(A) $(N_1/N_2)^{3/2}$ (B) $(N_2/N_1)^{3/2}$

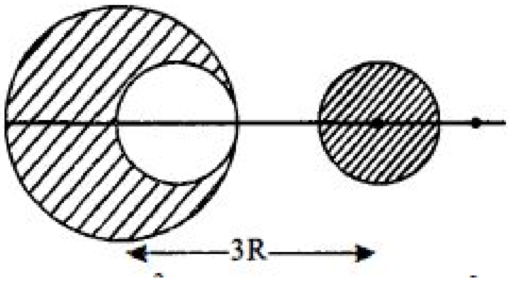
(C) $(N_1/N_2)^{2/3}$ (D) $(N_2/N_1)^{2/3}$

192. The mass and diameter of a planet have twice the value of the corresponding parameters of earth. Acceleration due to gravity on the surface of the planet is .... m/sec^2.

(A) 9.8 (B) 4.9

(C) 980 (D) 19.6

193. From a sphere of mass M and radius R, a smaller sphere of radius $\frac{R}{2}$ is carved out such that the cavity made in the original sphere is between its centre and the periphery (See figure) . For the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is $3R$, the gravitational force between the two sphere is



(A) $\frac{41GM^2}{3600R^2}$ (B) $\frac{41GM^2}{450R^2}$

(C) $\frac{59GM^2}{450R^2}$ (D) $\frac{GM^2}{225R^2}$

194. The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to four times the previous value, the new time period will become .... $hours$

(A) 20 (B) 10

(C) 80 (D) 40

195. Two point masses of mass $4m$ and m respectively separated by d distance are revolving under mutual force of attraction. Ratio of their kinetic energies will be :

(A) $1:4$ (B) $1:5$

(C) $1:1$ (D) $1:2$

196. A satellite of the earth is revolving in a circular orbit with a uniform speed v. If the gravitational force suddenly disappears, the satellite will

(A) Continue to move with velocity v along the original orbit (B) Move with a velocity v, tangentially to the original orbit

(C) Fall down with increasing velocity (D) Ultimately come to rest somewhere on the original orbit

197. 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) $\sqrt{\frac{x}{r}}$

198. At what altitude will the acceleration due to gravity be 25% of that at the earth's surface (given radius of earth is R) ?

(A) $R/4$ (B) R

(C) $3R/8$ (D) $R/2$

199. A geostationary satellite orbits around the earth in a circular orbit of radius $36000\,km$. Then, the time period of a satellite orbiting a few hundred kilometres above the earth's surface $(R_{\mathrm{Earth}} = 6400\,km)$ will approximately be .... $hours$

(A) $\frac{1}{2}$ (B) 1

(C) 2 (D) 4

200. An iron ball and a wooden ball of the same radius are released from a height $'h'$ in vacuum. The time taken by both of them to reach the ground is equal is based on

(A) Acceleration due to gravity in vacuum is same irrespective of size and mass of the body

(B) Acceleration due to gravity in vacuum depends on the mass of the body

(C) There is no acceleration due to gravity in vacuum

(D) In vacuum there is resistance offered to the motion of the body and this resistance depends on the mass of the body

ANSWER KEY

PHYSICS

1 - B	2 - D	3 - C	4 - A	5 - B	6 - A	7 - A	8 - C	9 - A	10 - A
11 - B	12 - B	13 - D	14 - D	15 - B	16 - A	17 - A	18 - B	19 - D	20 - C
21 - A	22 - A	23 - D	24 - B	25 - A	26 - B	27 - B	28 - C	29 - A	30 - D
31 - C	32 - C	33 - C	34 - A	35 - A	36 - A	37 - B	38 - A	39 - D	40 - B
41 - C	42 - D	43 - D	44 - A	45 - C	46 - B	47 - A	48 - D	49 - C	50 - A
51 - D	52 - A	53 - C	54 - C	55 - D	56 - A	57 - C	58 - A	59 - C	60 - A
61 - C	62 - D	63 - C	64 - B	65 - A	66 - B	67 - D	68 - B	69 - B	70 - A
71 - C	72 - A	73 - A	74 - A	75 - A	76 - C	77 - B	78 - B	79 - D	80 - C
81 - B	82 - B	83 - C	84 - D	85 - A	86 - A	87 - B	88 - A	89 - B	90 - B
91 - D	92 - D	93 - D	94 - C	95 - B	96 - A	97 - B	98 - A	99 - C	100 - A
101 - A	102 - D	103 - A	104 - A	105 - D	106 - C	107 - C	108 - A	109 - D	110 - B
111 - B	112 - B	113 - A	114 - B	115 - B	116 - C	117 - B	118 - C	119 - D	120 - D
121 - B	122 - D	123 - C	124 - D	125 - A	126 - B	127 - B	128 - B	129 - A	130 - D
131 - D	132 - A	133 - D	134 - D	135 - D	136 - B	137 - A	138 - D	139 - A	140 - D
141 - B	142 - B	143 - A	144 - C	145 - C	146 - C	147 - D	148 - D	149 - B	150 - D
151 - A	152 - C	153 - C	154 - A	155 - C	156 - B	157 - B	158 - B	159 - A	160 - D
161 - B	162 - C	163 - D	164 - C	165 - A	166 - B	167 - C	168 - D	169 - B	170 - A
171 - C	172 - A	173 - D	174 - D	175 - B	176 - A	177 - B	178 - D	179 - C	180 - C
181 - C	182 - D	183 - D	184 - A	185 - C	186 - C	187 - B	188 - B	189 - D	190 - B
191 - D	192 - B	193 - A	194 - D	195 - A	196 - B	197 - C	198 - B	199 - C	200 - A

SOLUTION

PHYSICS

1. An iron ball and a wooden ball of the same radius are released from a height $'h'$ in vacuum. The time taken by both of them to reach the ground is

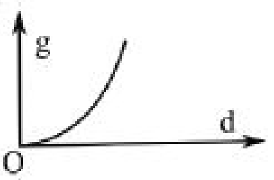
(A) Unequal (B) ✓Exactly equal

(C) Roughly equal (D) Zero

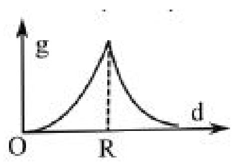
Sol : (b) Time of decent $t = \sqrt{\frac{2h}{g}}$. In vacuum no other force works except gravity so time period will be exactly equal.

2. The variation of acceleration due to gravity g with distance d from centre of the earth is best represented by($R =$ Earth's radius):

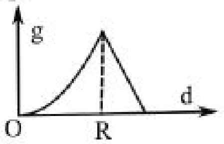
(A)

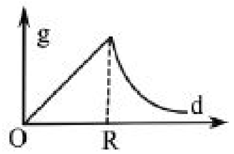


(B)



(C)





(D) ✓

Sol : Variation of acceleration due to garvity, g with distance $'d'$ from center of the earth

$If \quad d < R, g = \frac{Gm}{R^2}.d \;\; i.e., g \propto d\,(straight\,line)$

$If \quad d = R, g_s = \frac{Gm}{R^2}$

$If \quad d > R, g = \frac{Gm}{d^2} \quad i.e., g \propto \frac{1}{d^2}$

3. If Gravitational constant is decreasing in time, what will remain unchanged in case of a satellite orbiting around earth

(A) Time period (B) Orbiting radius

(C) ✓Tangential velocity (D) Angular velocity

Sol : (c)$T^2 = \frac{4\pi^2}{GM}r^3$. If G is variable then time period, angular velocity and orbital radius also changes accordingly.

4. Two masses m_1 and $m_2\,(m_1 < m_2)$ are released from rest from a finite distance. They start under their mutual gravitational attraction

(A) ✓acceleration of m_1 is more than that of m_2

(B) acceleration of m_2 is more than that of m_1

(C) centre of mass of system will remain at rest in all the reference frame

(D) total energy of system does not remain constant

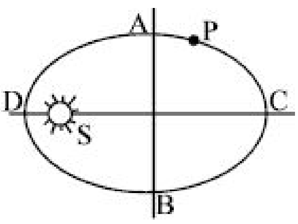
Sol : Same force acts on both masses

Hence $a \propto \frac{1}{m} \qquad (F = ma)$

In absence of external force $(remember\, mutual\, gravitational\, force\, is\, an\, internal\, force\, for\, the\, system)$ total energy remains constant.

5. Figure shows the orbit of a planet P round the sun S. AB and CD are the minor and major axes of the ellipse.

If t_1 is the time taken by the planet to travel along ACB and t_2 the time along BDA, then



(A) $t_1 = t_2$ (B) ✓$t_1 > t_2$

(C) $t_1 < t_2$ (D) nothing can be concluded

Sol : Since serial velocity is constant so $t_1 > t_2$

6. Potential energy of a satellite having mass $'m'$ and rotating at a height of $6.4 \times 10^6\,m$ from the earth surface is

(A) ✓$-0.5\,mgR_e$ (B) $-mgR_e$

(C) $-2\,mgR_e$ (D) $4\,mgR_e$

Sol : (a) Potential energy = $\frac{-GMm}{r}$

$= \frac{GMm}{R_e + h}$

$= \frac{-GMm}{2R_e}$

$= -\frac{gR_e^2 m}{2R_e}$

$= -\frac{1}{2}mgR_e$

$= -0.5mgR_e$

7. Suppose that the force of earth's gravity suddenly disappears, choose the correct answer out of the following statements

(A) ✓The weight of the body will become zero but mass remains the same

(B) The mass of the body will become zero but the weight remains the same

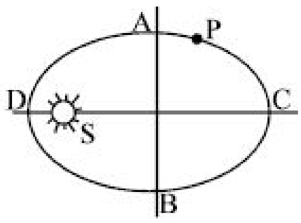
(C) Both the mass and weight will be the same

(D) Mass and weight will remain the same

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

8. Figure shows the orbit of a planet P round the sun S. AB and CD are the minor and major axes of the ellipse.

If U is the potential energy and K kinetic energy then $|U| > |K|$ at



(A) Only D (B) Only C

(C) ✓both D & C (D) neither D nor C

Sol : At any point, $P.E. = \frac{-GMm}{a}$ and

$K.E. = \frac{GMm}{2a}$

Now $|P.E.| = \frac{GMm}{a}$ and $|K.E.| = \frac{GMm}{2a}$

We can clearly observe that $|P.E.| = 2|K.E.| \Rightarrow |U| > |K|$ at D and C.

9. At the surface of a certain planet, acceleration due to gravity is one-quarter of that on earth. If a brass ball is transported to this planet, then which one of the following statements is not correct

(A) ✓The mass of the brass ball on this planet is a quarter of its mass as measured on earth

(B) The weight of the brass ball on this planet is a quarter of the weight as measured on earth

(C) The brass ball has the same mass on the other planet as on earth

(D) The brass ball has the same volume on the other planet as on earth

Sol : (a)Mass of the ball always remain constant. It does not depend upon the acceleration due to gravity

10. Where can a geostationary satellite be installed

(A) ✓Over any city on the equator (B) Over the north or south pole

(C) At height R above earth (D) At the surface of earth

Sol : (a)

11. Asatellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius $1.02\,R$. The period of second satellite is larger than the first one by approximately .... %

(A) 1.5 (B) ✓3

(C) 1 (D) 2

Sol : When $r = R$

$V = \sqrt{g/R}$

$T_1 = \frac{2\pi R}{\sqrt{g/R}}$

$= \frac{2\pi}{\sqrt{g}}(\sqrt{R})^3$

When $r = 1.02R$

$V = \sqrt{1.02g/R}$

$T_2 = \frac{2\pi\sqrt{1.02R}}{g/R}$

%Change in time period

$= \frac{2\pi}{g}(\sqrt{R})^3 \times (\sqrt{1.02})^3 - (1)^3 \times 100$

$= \frac{2\pi}{g}$

$= 3\%$

12. A body starts from rest from a point distance R_0 from the centre of the earth. The velocity acquired by the body when it reaches the surface of the earth will be (R represents radius of the earth).

(A) $2GM\left(\frac{1}{R} - \frac{1}{R_0}\right)$ (B) ✓$\sqrt{2GM\left(\frac{1}{R_0} - \frac{1}{R}\right)}$

(C) $GM\left(\frac{1}{R} - \frac{1}{R_0}\right)$ (D) $2GM\sqrt{\left(\frac{1}{R} - \frac{1}{R_0}\right)}$

Sol : $P.E = \int_{R_0}^{R} \frac{GMm}{r^2}dr = -GMm\left[\frac{1}{R} - \frac{1}{R_0}\right]$

The $K.E.$ acuired by the body at the

$surface = \frac{1}{2}m\,v^2$

$\therefore \frac{1}{2}mv^2 = -GMm\left[\frac{1}{R} - \frac{1}{R_0}\right]$

$v = \sqrt{2GM\left(\frac{1}{R_0} - \frac{1}{R}\right)}$

13. Suppose the law of gravitational attraction suddenly changes and becomes an inverse cube law i.e. $F \propto \frac{1}{r^3}$, but still remaining a central force. Then

(A) Keplers law of areas still holds

(B) Keplers law of period still holds

(C) Keplers law of areas and period still hold

(D) ✓Neither the law of areas, nor the law of period still holds

Sol : (d)

14. A satellite of mass m is placed at a distance r from the centre of earth (mass M). The mechanical energy of the satellite is

(A) $-\frac{GMm}{r}$ (B) $\frac{GMm}{r}$

(C) $\frac{GMm}{2r}$ (D) ✓$-\frac{GMm}{2r}$

Sol : (d) Mechanical energy $= K.E + U$ (kinetic energy + potential energy)

$U = -\frac{GmM}{r}$

$K \cdot E = \frac{1}{2}mv^2$

$K.E = \frac{1}{2}\frac{GmM}{r}$

$M.E = K.E + U$

$= -\frac{GmM}{r} + \frac{1}{2}\frac{GmM}{r}$

$M.E = -\frac{GmM}{2r}$

15. Two satellites of masses m_1 and $m_2 (m_1 > m_2)$ are revolving round the earth in circular orbits of radius r_1 and $r_2 (r_1 > r_2)$ respectively. Which of the following statements is true regarding their speeds v_1 and v_2 ?

(A) $v_1 = v_2$ (B) ✓$v_1 < v_2$

(C) $v_1 > v_2$ (D) $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

Sol : (b)$v = \sqrt{\frac{GM}{r}}$if $r_1 > r_2$ then $v_1 < v_2$

Orbital speed of satellite does not depends upon the mass of the satellite

16. Which of the following astronomer first proposed that sun is static and earth rounds sun

(A) ✓Copernicus (B) Kepler

(C) Galileo (D) None

Sol : (a)

17. 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) $3\sqrt{3}T$

Sol : (a) Time period of satellite which is very near to planet

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

i.e. time period of nearest satellite does not depends 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.

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

(A) Remains constant (B) ✓Increases

(C) Decreases (D) Increases at N-pole and decreases at S-pole

Sol : (b)Because acceleration due to gravity increases

19. Height of geostationary satellite is .... km

(A) 16000 (B) 22000

(C) 28000 (D) ✓36000

Sol : The height of geostationary satellites is

given by $h = \left(\frac{T^2R^2g}{4\pi^2}\right)^{1/3} - R$

$T = 24\,hr, R = 6.4 \times 10^6 m, g = 9.8 m/s^2$

$and\ comes\ out\ to\ be\ 35930\ km.$

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

Sol : (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. 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

(A) ✓$\frac{5}{18}R_e$ (B) $\frac{1}{6}R_e$

(C) $\frac{3}{18}R_e$ (D) $\frac{1}{2\sqrt{3}}R_e$

Sol : (a) $g = \frac{4}{3}\pi G\rho R \Rightarrow\ g \propto \rho R\ \Rightarrow\ \frac{g_e}{g_m} = \frac{\rho_e}{\rho_m} \times \frac{R_e}{R_m}$

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

22. 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 Needs no adjustment

(B) Has to be increased-

(C) Needs no adjustment but its mass has to be increased

(D) Needs no adjustment but its mass has to be increased

Sol : (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.

23. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s. If the body is projected at an angle of 45^o with the vertical, the escape velocity will be .... km/s

(A) $\frac{11}{\sqrt{2}}$

(B) $11\sqrt{2}$

(C) 22

(D) ✓11

Sol : (d)Escape velocity does not depends upon the angle of projection.

24. If the change in the value of $'g'$ at a height h above the surface of the earth is the same as at a depth x below it, then (both x and h being much smaller than the radius of the earth)

(A) $x = h$

(B) ✓$x = 2h$

(C) $x = \frac{h}{2}$

(D) $x = h^2$

Sol : (b) The value of g at the height h from the surface of earth $g' = g\ \left(1 - \frac{2h}{R}\right)$

The value of g at depth x below the surface of earth $g' = g\ \left(1 - \frac{x}{R}\right)$

These two are given equal, hence $\left(1 - \frac{2h}{R}\right) = \left(1 - \frac{x}{R}\right)$

On solving, we get $x = 2h$

25. The mass of a planet that has a moon whose time period and orbital radius are T and R respectively can be written as

(A) ✓$4\pi^2R^3G^{-1}T^{-2}$

(B) $8\pi^2R^3G^{-1}T^{-2}$

(C) $12\pi^2R^3G^{-1}T^{-2}$

(D) $16\pi^2R^3G^{-1}T^{-2}$

Sol : (a)$m\omega^2R = \frac{GMm}{R^2}\ \Rightarrow\ \left(\frac{2\pi}{T}\right)^2R = \frac{GM}{R^2} \Rightarrow\ M\ = \frac{4\pi^2R^3}{GT^2}$

26. If the radius of a planet is R and its density is ρ, the escape velocity from its surface will be

(A) $v_e\ \propto \rho R$

(B) ✓$v_e\ \propto\ \sqrt{\rho}R$

(C) $v_e\ \propto\ \frac{\sqrt{\rho}}{R}$

(D) $v_e\ \propto\ \frac{1}{\sqrt{\rho}R}$

Sol : (b) $v_e\ = R\sqrt{\frac{8}{3}G\pi\rho}$

$v_e\ \propto R\sqrt{\rho}$

27. A man of $50\,kg$ mass is standing in a gravity free space at a height of $10\,m$ above the floor. He throws a stone of $0.5\,kg$ mass downwards with a speed $2\,m/s$. When the stone reaches the floor, the distance of the man above the floor will be ...... m

(A) 9.9

(B) ✓10.1

(C) 10

(D) 20

Sol : Since the man is in gravity free space, $force\ on\ man + stone\ system$ is zero.

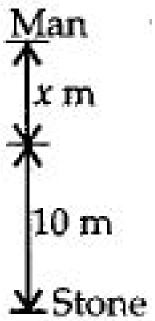
Therefore center of mass of the system remains at rest. Let tha man goes x m above when the stone reches the floor, then

$M_{man} \times x = M_{stone} \times 10$

$x = \frac{0.5}{50} \times 10$

$x\ = 0.1\ m$

Therefore final height of man above floor $=\ \ 10\ +\ x\ \ =\ 10\ +\ 0.1\ \ =\ \ 10.1\ m$



28. Distance of geostationary satellite from the surface of earth $radius\ (R_e = 6400\ km)$ in terms of R_e is ....

(A) 13.76

(B) 10.76

(C) ✓6.56

(D) 2.56

Sol : (c)

29. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of earth

(A) ✓The acceleration of S is always directed towards the centre of the earth

(B) The angular momentum of S about the centre of the earth changes in direction but its magnitude remains constant

(C) The total mechanical energy of S varies periodically with time

(D) The linear momentum of S remains constant in magnitude

Sol : (a) As gravitational force on satellite due to earth acts always towards the centre of earth, thus acceleration of S is always directed towards the centre of the earth. Also, as there is no external force so according to conservation of energy, total mechanical energy of S is constant always.

Also, as in the absence of external torque L is constant in magnitude and direction.

Thus, $mrv =$ constant $\Longrightarrow v$ varies as r changes

Hence, $p = mv$ is not constant

30. A satellite is revolving in a circular orbit at a height h from the earth surface, such that $h\ <<\ R$ where R is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected the minimum increase in the speed required so that the satellite could escape from the gravitational field of earth is

(A) $\sqrt{2gR}$

(B) $\sqrt{gR}$

(C) $\sqrt{\frac{gR}{2}}$

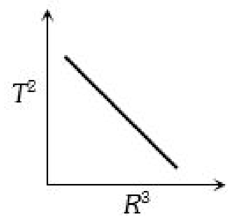
(D) ✓$\sqrt{gR}(\sqrt{2}\ - 1)$

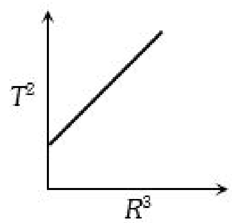
Sol : $\Delta V = V_f - V_i$

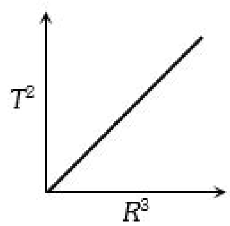
$= \sqrt{\frac{2gMe}{R_e}} - \sqrt{\frac{gMe}{R_e}}$

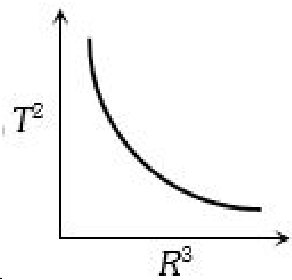
$= (\sqrt{2}\ - 1)\ \sqrt{gR_e}$

31. Which of the following graphs represents the motion of a planet moving about the sun

(A)


(B)


(C) ✓


(D)


Sol : (c)Kepler's law $T^2 \propto R^3$

32. $Assertion$: The length of the day is slowly increasing.
$Reason$: The dominant effect causing a slowdown in the rotation of the earth is the gravitational pull of other planets in the solar system.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) ✓If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

Sol : The length of the day is slowly increasing not due to gravitational pull of other planets in the solar system but due to viscous force between the earth and the atmosphere around it. So Assertion is correct but Reason is incorrect

33. A satellite is to revolve round the earth in a circle of radius $8000\,km$. The speed at which this satellite be projected into an orbit, will be......... km/s

(A) 3 (B) 16

(C) ✓7.15 (D) 8

Sol : (c) $v_0 = \sqrt{\dfrac{GM}{r}}$

$= \sqrt{\dfrac{gR^2}{r}}$

$= \sqrt{\dfrac{10 \times (64 \times 10^5)^2}{8000 \times 10^3}}$

$= 71.5 \times 10^2\,m/s$

$= 7.15\,km/s$

34. What will be the acceleration due to gravity at height h if $h >> R$. Where R is radius of earth and g is acceleration due to gravity on the surface of earth

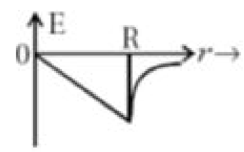
(A) ✓$\dfrac{g}{\left(1+\dfrac{h}{R}\right)^2}$ (B) $g\left(1-\dfrac{2h}{R}\right)$

(C) $\dfrac{g}{\left(1-\dfrac{h}{R}\right)^2}$ (D) $g\left(1-\dfrac{h}{R}\right)$

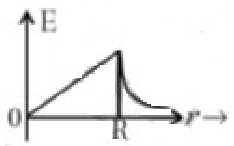
Sol : (a)$g' = g\left(\dfrac{R}{R+h}\right)^2 = \dfrac{g}{\left(1+\dfrac{h}{R}\right)^2}$

35. Dependence of intensity of gravitational field (E) of earth with distance (r) from centre of earth is correctly represented by

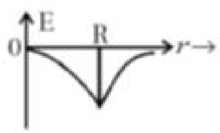
(A) ✓



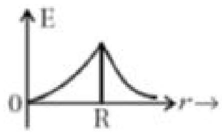
(B)



(C)



(D)



Sol : For a point inside the earth $i.e. r < R$

$E = -\dfrac{GM}{R^3}r$

Where M and R be mass and radius of the earth respectively.

At the center, $r = 0$

$\therefore E = 0$

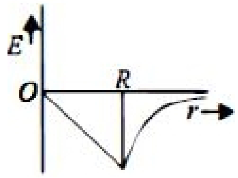
For a point outside the earth $i.e. r > R$,

$E = -\dfrac{GM}{r^2}$

On the surface of the earth $i.e. r > R$,

$E = -\dfrac{GM}{R^2}$

The variation of E with distance r from the center is as shown in the figure.



36. An object weights $72\,N$ on earth. Its weight at a height of $R/2$ from earth is .... N

(A) ✓32 (B) 56

(C) 72 (D) 0

Sol : (a) $g' = g\left(\dfrac{R}{R+h}\right)^2 = g\left(\dfrac{R}{R+\dfrac{R}{2}}\right)^2 = \dfrac{4}{9}g$

$\therefore\ W' = \dfrac{4}{9} \times W = \dfrac{4}{9} \times 72 = 32\,N$

37. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on

(A) Mass of the earth (B) ✓Mass of the projectile

(C) Radius of the projectile's orbit (D) Gravitational constant

Sol : (b) At a certaing velocity projection, the body will go out of the gravitational field of the earth and will never return to the earth. Thic initial velocity is called escape velocity. The kinetic energy given to the body should be equal to potential energy for body to escape. i.e., potentiial energy =kinetic energy

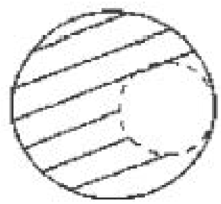
$+\dfrac{GM_e m}{R} = \dfrac{1}{2}mv_e^2$

Where m is mass of projectile, M_e is mass of earth, G is gravitational constant, R is radius.

$\therefore v_e = \sqrt{\dfrac{2GM_e}{R_e}}$

The above formula shows that escape velocity is independent of the mass of the projectile.

38. From a solid sphere of mass M and radius R, a spherical portion of radius $R/2$ is removed, as shown in the figure. Taking gravitational potential $V = 0$ at $r = \infty$, the potential at the centre of the cavity thus formed is
($G =$ gravitational constant)



(A) ✓$\dfrac{-GM}{R}$ (B) $\dfrac{-2GM}{3R}$

(C) $\dfrac{-2GM}{R}$ (D) $\dfrac{-GM}{2R}$

Sol : Due to complete solid sphere, potential at point p

$V_{sphere} = \dfrac{-GM}{2R^3}\left[3R^2 - \left(\dfrac{R}{2}\right)^2\right]$

$= \dfrac{-GM}{2R^3}\left(\dfrac{11R^2}{4}\right) = -11\dfrac{GM}{8R}$

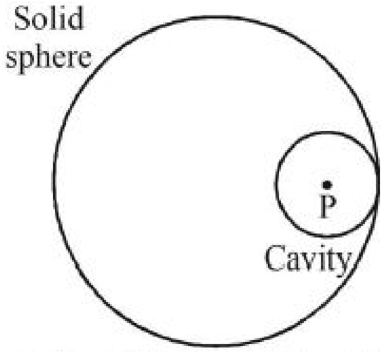
Due to cavity part potential at point P

$V_{cavity} = -\dfrac{3}{2}\dfrac{\dfrac{GM}{8}}{\dfrac{R}{2}} = -\dfrac{3GM}{8R}$

So potential at the center of carvity

$= V_{sphere} - V_{cavity} = -\dfrac{11GM}{8R} - \left(-\dfrac{3}{8}\dfrac{GM}{R}\right)$

$= \dfrac{-GM}{R}$



39. 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) $\frac{2mg_0R^2}{R+h}$ (B) $-\frac{2mg_0R^2}{R+h}$

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

Sol : Total energy of satellite at height h from the earth surface,

$E = PE + KE$

$= -\frac{GMm}{(R+h)} + \frac{1}{2}mv^2 \qquad ...(i)$

Also, $\frac{mv^2}{(R+h)} = \frac{GMm}{(R+h^2)}$

or, $v^2 = \frac{GM}{R+h} \qquad ...(ii)$

From eqns, (i) and (ii),

$E = -\frac{GMm}{(R+h)} + \frac{1}{2}\frac{GMm}{(R+h)} = -\frac{1}{2}\frac{GMm}{(R+h)}$

$= -\frac{1}{2}\frac{GM}{R^2} \times \frac{mR^2}{(R+h)}$

$= -\frac{mg_0R^2}{2(R+h)} \qquad \left(g_0 = \frac{GM}{R^2}\right)$

40. If mass of earth is M, radius is R and gravitational constant is G, then work done to take $1\,kg$ mass from earth surface to infinity will be

(A) $\sqrt{\frac{GM}{2R}}$ (B) ✓$\frac{GM}{R}$

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

Sol : (b) Potential energy of the $1\,kg$ mass which is placed at the earth surface $= -\frac{GM}{R}$

its potential energy at infinite $= 0$

Work done = change in potential energy = $\frac{GM}{R}$

41. The diameters of two planets are in the ratio $4:1$ and their mean densities in the ratio $1:2$. The acceleration due to gravity on the planets will be in ratio

(A) $1:2$ (B) $2:3$

(C) ✓$2:1$ (D) $4:1$

Sol : (c) $g = \frac{4}{3}G\pi R\rho \Rightarrow \frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{1}{2} \times \frac{4}{1} = \frac{2}{1}$

42. Escape velocity on the earth

(A) Is less than that on the moon (B) Depends upon the mass of the body

(C) Depends upon the direction of projection (D) ✓Depends upon the height from which it is projected

Sol : (d) $v_e = \sqrt{\frac{2GM}{(R+h)}}$

43. The periodic time of a communication satellite is .... $hours$

(A) 6 (B) 12

(C) 18 (D) ✓24

Sol : (d) A geostationary satellite (having time period of $24\,hr$) is used for communication

44. If the density of the earth is doubled keeping its radius constant then acceleration due to gravity will be........ m/s^2 . $(g = 9.8\,m/s^2)$

(A) ✓19.6 (B) 9.8

(C) 4.9 (D) 2.45

Sol : (a)$g \propto \rho$

45. The kinetic energy needed to project a body of mass m from the earth surface (radius R) to infinity is

(A) $mgR/2$ (B) $2\,mgR$

(C) ✓mgR (D) $mgR/4$

Sol : (c) $\frac{1}{2}mv_e^2 = \frac{1}{2}m\;2gR = mgR$

46. Two satellites, A and B, have masses m and $2\,m$ respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius $2R$ around the earth. The ratio of their kinetic energies, $K.E._A/K.E._B$, is

(A) $\frac{1}{2}$ (B) ✓1

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

Sol : $KE_A = \frac{1}{2}m\left(\frac{GM}{R}\right)$

$KE_B = \frac{1}{2}(2m)\left(\frac{GM}{2R}\right)$

$\Rightarrow \frac{KE_A}{KE_B} = 1$

47. The acceleration due to gravity is g at a point distant r from the centre of earth of radius R. If $r < R$, then

(A) ✓$g \propto r$ (B) $g \propto r^2$

(C) $g \propto r^{-1}$ (D) $g \propto r^{-2}$

Sol : (a) Inside the earth $g' = \frac{4}{3}\pi\rho G r$

$g' \propto r$

48. The gravitational field due to a mass distribution is $E = K/x^3$ in the $X-$direction. (K is a constant). Taking the gravitational potential to be zero at infinity, its value at a distance X is

(A) K/x (B) $K/2x$

(C) K/x^2 (D) ✓$K/2x^2$

Sol : (d) Gravitational potential $= \int I\,dx = \int_x^\infty \frac{K}{x^3}dx$

$= K\left(\frac{x^{-3+1}}{-3+1}\right)_x^\infty = \left|\frac{-K}{2x^2}\right|_x^\infty = \frac{K}{2x^2}$

49. An astronaut orbiting the earth in a circular orbit $120\,km$ above the surface of earth, gently drops a spoon out of space-ship. The spoon will

(A) Fall vertically down to the earth (B) Move towards the moon

(C) ✓Will move along with space-ship (D) Will move in an irregular way then fall down to earth

Sol : (c)The velocity of the spoon will be equal to the orbital velocity when dropped out of the space-ship.

50. The escape velocity from the earth is about 11 km/second. The escape velocity from a planet having twice the radius and the same mean density as the earth, is .... km/sec

(A) ✓22 (B) 11

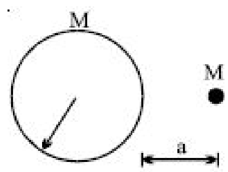
(C) 5.5 (D) 15.5

Sol : (a) $v_e = \sqrt{\frac{2GM}{R}} = R\sqrt{\frac{8}{3}\pi G\rho}$

$v_e \propto R$ if ρ= constant

Since the planet having double radius in comparison to earth therefore the escape velocity becomes twice i.e. $22\,km/s$.

51. A particle of mass M is at a distance a from surface of a thin spherical shell of equal mass and having radius a.



(A) Gravitational field and potential both are zero at centre of the shell.

(B) Gravitational field is zero not only inside the shell but at a point outside the shell also.

(C) Inside the shell, gravitational field alone is zero.

(D) ✓Neither gravitational field nor gravitational potential is zero inside the shell.

Sol : The gravitational field inside the shell is zero due to the shell. But due to mass M, on the circumference of the shell, Neither gravitational field nor gravitational potential is zero inside the shell.

52. Assuming the earth to be a sphere of uniform density, the acceleration due to gravity inside the earth at a distance of r from the centre is proportional to

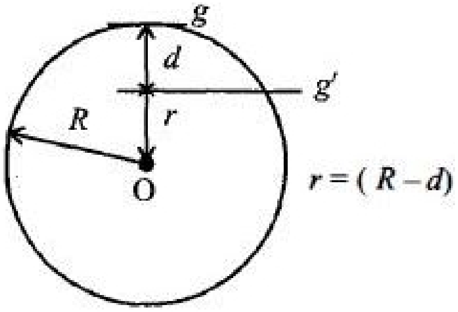
(A) ✓r (B) r^{-1}

(C) r^2 (D) r^{-2}

Sol : Acceleration due to gravity at depth d from the surface of the earth or at a distance r

from the center $'O'$ of the earth' $= \frac{4}{3}\pi\rho G r$

Hence $g' \propto r$



53. A point particle is held on the axis of a ring of mass m and radius r at a distance r from its centre C. When released, it reaches C under the gravitational attraction of the ring. Its speed at C will be

(A) $\sqrt{\frac{2Gm}{r}(\sqrt{2}-1)}$ (B) $\sqrt{\frac{Gm}{r}}$

(C) ✓$\sqrt{\frac{2Gm}{r}\left(1-\frac{1}{\sqrt{2}}\right)}$ (D) $\sqrt{\frac{2Gm}{r}}$

Sol : Let $'M'$ be the mass of the particle

Now, $E_{initial} = E_{final}$

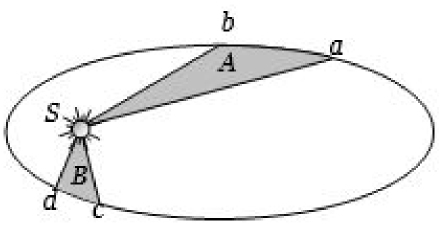
$$i.e., \frac{GMm}{\sqrt{2}r} + 0 = \frac{GMm}{r} + \frac{1}{2}MV^2$$

$$or, \frac{1}{2}MV^2 = \frac{GMm}{r}\left[1-\frac{1}{\sqrt{2}}\right]$$

$$\Rightarrow \frac{1}{2}V^2 = \frac{Gm}{r}\left[1-\frac{1}{\sqrt{2}}\right]$$

$$or,\ V = \sqrt{\frac{2Gm}{r}\left(1-\frac{1}{\sqrt{2}}\right)}$$

54. The figure shows the motion of a planet around the sun in an elliptical orbit with sun at the focus. The shaded areas A and B are also shown in the figure which can be assumed to be equal. If t_1 and t_2 represent the time for the planet to move from a to b and d to c respectively, then



(A) $t_1 < t_2$ (B) $t_1 > t_2$

(C) ✓$t_1 = t_2$ (D) $t_1 \leq t_2$

Sol : (c) Areal velocity of the planet remains constant. If the areas A and B are equal then $t_1 = t_2$.

55. A simple pendulum has a time period T_1 when on the earth's surface and T_2 when taken to a height R above the earth's surface, where R is the radius of the earth. The value of T_2/T_1 is

(A) 1 (B) $\sqrt{2}$

(C) 4 (D) ✓2

Sol : (d) If acceleration due to gravity is g at the surface of earth then at height R it value becomes

$$g' = g\left(\frac{R}{R+h}\right)^2 = \frac{g}{4}$$

$$T_1 = 2\pi\sqrt{\frac{l}{g}} \text{and } T_2 = 2\pi\sqrt{\frac{l}{g/4}}$$

$$\frac{T_2}{T_1} = 2$$

56. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocities from the Planets A and B are v_{A} and v_{B}, respectively, then $\frac{v_{\mathrm{A}}}{v_{\mathrm{B}}} = \frac{\mathrm{n}}{4}$ The value of n is

(A) ✓4 (B) 1

(C) 2 (D) 3

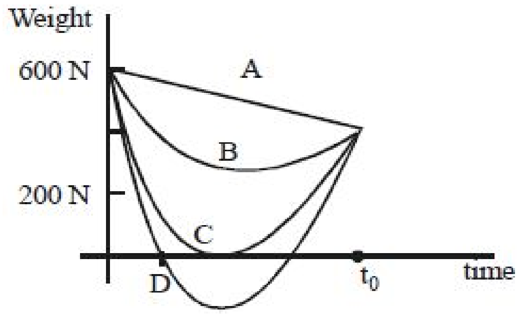
Sol : $\mathrm{V_e} = \sqrt{\frac{2\mathrm{GM}}{\mathrm{R}}}$ (Escape velocity)

$$V_A = \sqrt{\frac{2GM}{R}}$$

$$V_B = \sqrt{\frac{2G[M/2]}{R/2}} = \sqrt{\frac{2GM}{R}}$$

$$\frac{\mathrm{V_A}}{\mathrm{V_B}} = 1 = \frac{\mathrm{n}}{4} \Rightarrow \mathrm{n} = 4$$

57. Suppose, the acceleration due to gravity at the Earth's surface is $10\,m\,s^{-2}$ and at the surface of Mars it is $4.0\,m\,s^{-2}$. A $60\,kg$ pasenger goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of figure best represents the weight (net gravitational force) of the passenger as a function of time?



(A) A (B) B

(C) ✓C (D) D

Sol : $g \propto \frac{1}{R^2}$ so we will not get a straight line.

Also $F = 0$ at a point where Force due to Earth $=$ Force due to Mars

58. The escape velocity from the surface of earth is V_e. The escape velocity from the surface of a planet whose mass and radius are 3 times those of the earth will be

(A) ✓V_e (B) $3V_e$

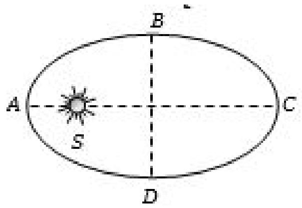
(C) $9V_e$ (D) $27V_e$

Sol : (a) $v_e = \sqrt{\frac{2GM}{R}}$

$$v_e \propto \sqrt{\frac{M}{R}}$$

If mass and radius of the planet are three times than that of earth then escape velocity will be same.

59. A planet is revolving around the sun as shown in elliptical path the orbital velocity of the planet will be minimum at



(A) A (B) B

(C) ✓C (D) D

Sol : (c) Because distance of point C is maximum from the sun.

60. Assuming earth to be a sphere of a uniform density, what is the value of gravitational acceleration in a mine $100\,km$ below the earth's surface .... m/s^2. (Given $R = 6400\,km$)

(A) ✓9.66 (B) 7.64

(C) 5.06 (D) 3.10

Sol : (a)$g' = g\left(1 - \dfrac{d}{R}\right) = 9.8\left(1 - \dfrac{100}{6400}\right) = 9.66\,m/s^2$

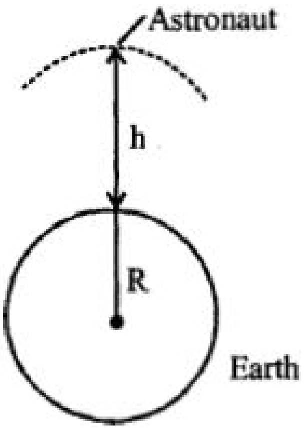
61. An astronaut of mass m is working on a satellite or biting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is

(A) Zero since astronaut feels weightless (B) $\dfrac{GMm}{(R+h)^2} < F_G < \dfrac{GMm}{R^2}$

(C) ✓$F_G = \dfrac{GMm}{(R+h)^2}$ (D) $0 < F_G < \dfrac{GMm}{R^2}$

Sol : According to universal law of Gravitation,

Gravitational force $F = \dfrac{GMm}{(R+h)^2}$



62. Weightlessness experienced while orbiting the earth in space-ship, is the result of

(A) Inertia (B) Acceleration

(C) Zero gravity (D) ✓Free fall towards earth

Sol : (d)

63. The escape velocity of a projectile from the earth is approximately .... km/sec

(A) 0.112 (B) 112

(C) ✓11.2 (D) 11200

Sol : (c) Escape velocity $= \sqrt{2gR}$

$\Rightarrow \quad V_e = \sqrt{2 \times 10 \times 6400 \times 1000}$

$\Rightarrow \quad V_e = 11.2\mathrm{Km/sec}$

64. v_e and v_p denotes the escape velocity from the earth and another planet having twice the radius and the same mean density as the earth. Then

(A) $v_e = v_p$ (B) ✓$v_e = v_p/2$

(C) $v_e = 2v_p$ (D) $v_e = v_p/4$

Sol : (b) $v_e = \sqrt{\dfrac{2GM}{R}} = R\sqrt{\dfrac{8}{3}\pi G\rho}$

If mean density is constant then $v_e \propto R$

$\dfrac{v_e}{v_p} = \dfrac{R_e}{R_p} = \dfrac{1}{2} \Rightarrow v_e = \dfrac{v_p}{2}$

65. If a new planet is discovered rotating around Sun with the orbital radius double that of earth, then what will be its time period (in earth's days)

(A) ✓1032 (B) 1023

(C) 1024 (D) 1043

Sol : (a) $T^2 \propto R^3$

$$\left(\frac{T_P}{T_E}\right)^2 = \left(\frac{R_P}{R_E}\right)^3 = \left(\frac{2R_E}{R_E}\right)^3$$

$$\frac{T_P}{T_E} = (2)^{3/2} = 2\sqrt{2}$$

$T_P = 2\sqrt{2} \times 365 = 1032.37 = 1032$ days

66. Assuming that the gravitational potential energy of an object at infinity is zero, the change in potential energy (final-initial) of an object of mass m, when to a height h from the surface of earth (of radius R), is given

(A) $-\dfrac{\mathrm{GMm}}{\mathrm{R+h}}$ (B) ✓$\dfrac{\mathrm{GMmh}}{\mathrm{R(R+h)}}$

(C) mgh (D) $\dfrac{\mathrm{GMm}}{\mathrm{R+h}}$

Sol : $\Delta \mathrm{U} = -\mathrm{GMm}\left[\dfrac{1}{\mathrm{r_f}} - \dfrac{1}{\mathrm{r_i}}\right] = -\mathrm{GMm}\left[\dfrac{1}{\mathrm{R+h}} - \dfrac{1}{\mathrm{R}}\right] = \dfrac{\mathrm{GMmh}}{\mathrm{R(R+h)}}$

67. 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) A goes on decreasing and that by B goes on increasing (B) B goes on decreasing and that by A goes on increasing

(C) Each decreases at the same rate (D) ✓Each decreases at different rates

Sol : (d) For scientist A which goes down in a mine $g' = g\left(1 - \dfrac{d}{R}\right)$

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

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

68. The force of gravitation is

(A) repulsive (B) ✓conservative

(C) electrostatic (D) non-conservative

Sol : The work done by force of gravitation does not depend on path taken hence force of gravitation is conservative

69. A spaceship orbits around a planet at a height of $20\,km$ from its surface. Assuming that only gravitational field of the plant acts on the spaceship. What will be the number of complete revolutions made by the spaceship in $24\,hours$ around the plane? [Given: Mass of plane $=\ 8 \times 10^{22}\,kg$, Radius of planet $=\ 2 \times 10^6\,m$, Gravitational constant $G = 6.67 \times 10^{-11}\,Mn^2/kg^2$]

(A) 9 (B) ✓11

(C) 13 (D) 17

Sol : $\dfrac{mV^2}{r} = \dfrac{GMm}{r^2}$

$$V = \sqrt{\frac{GM}{r}}$$

$$n = \frac{VT}{2\pi r} = \sqrt{\frac{GM}{r}}\frac{T}{2\pi r}$$

$$= \left(\sqrt{\frac{GM}{r^3}}\right) \times \frac{T}{2\pi} = \sqrt{\frac{6.67 \times 10^{-11} \times 8 \times 10^{22}}{(202 \times 10^4)^3}} \times \frac{T}{2\pi}$$

$$= \frac{24 \times 3600}{2 \times 3.14}\sqrt{\frac{6.67 \times 8 \times 10^{11}}{(202)^3 \times 10^{12}}}$$

$$= \frac{24 \times 3600}{2 \times 3.14 \times 1242.8} = \frac{24 \times 3600}{78.51} \simeq 11$$

70. Who among the following gave first the experimental value of G

(A) ✓Cavendish (B) Copernicus

(C) Brook Teylor (D) None of these

Sol : (a)

71. If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is

(A) $4\pi G/3gR$ (B) $3\pi R/4gG$

(C) ✓$3g/4\pi RG$ (D) $\pi RG/12G$

Sol : (c) $g = \frac{GM}{R^2}$ and $M = \frac{4}{3}\pi R^3 \times D$

$\therefore\ g = \frac{4\pi R^3 \times GD}{3 \quad R^2} \Rightarrow D = \frac{3g.}{4\pi RG}$

72. Aplanet of mass m is in an elliptical orbit about the sun $(m << M_{sun})$ with an orbital period T. If A be the area of orbit, then its angular momentum would be :

(A) ✓$\frac{2mA}{T}$ (B) mAT

(C) $\frac{mA}{2T}$ (D) $2mAT$

Sol : $\frac{dA}{dt} = \frac{L}{2m}$

$L = \frac{A2m}{T}$

73. The angular velocity of the earth with which it has to rotate so that acceleration due to gravity on 60^o latitude becomes zero is (Radius of earth $= 6400\,km$. At the poles $g = 10\,ms^{-2}$)

(A) ✓$2.5 \times 10^{-3}\,rad/s$ (B) $5.0 \times 10^{-1}\,rad/s$

(C) $10 \times 10^{1}\,rad/s$ (D) $7.8 \times 10^{-2}\,rad/s$

Sol : (a) $g' = g - \omega^2 R\cos^2\lambda \Rightarrow 0 = g - \omega^2 R\cos^2 60^o$

$0 = g - \frac{\omega^2 R}{4} \Rightarrow \omega = 2\sqrt{\frac{g}{R}} = \frac{1}{400}\frac{rad}{\sec}$

74. At what height over the earth's pole, the free fall acceleration decreases by one percent .... km. (assume the radius of earth to be $6400\,km$)

(A) ✓32 (B) 80

(C) 1.253 (D) 64

Sol : (a) $g \propto \frac{GM}{r^2} \Rightarrow g \propto \frac{1}{r^2}$or $r \propto \frac{1}{\sqrt{g}}$

If g decrease by one percent then r should be increase by $\frac{1}{2}\%$

i.e. $R = \frac{1}{2 \times 100} \times 6400 = 32\ km$

75. 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

(A) ✓Is the same (B) Is smaller

(C) Is greater (D) Varies with its phase

Sol : (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.

76. A geostationary satellite is orbiting the earth at a height $5R$ 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) $5\ hr$ (B) $10\ hr$

(C) ✓$6\sqrt{2}\ hr$ (D) $10\sqrt{2}\ hr$

Sol : According to Kepler's third law $T \propto r^{3/2}$

$\therefore \frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2} = \left(\frac{R+2R}{R+5R}\right)^{3/2} = \frac{1}{2^{3/2}}$

Since $T_1 = 24\,hours$

$So,\ \frac{T_2}{24} = \frac{1}{2^{3/2}}\ or\ T_2 = \frac{24}{2^{3/2}} = \frac{24}{2\sqrt{2}} = 6\sqrt{2}\,hours$

77. A spring balance is graduated on sea level. If a body is weighed with this balance at consecutively increasing heights from earth's surface, the weight indicated by the balance

(A) Will go on increasing continuously (B) ✓Will go on decreasing continuously

(C) Will remain same (D) Will first increase and then decrease

Sol : (b) Because value of g decreases with increasing height.

78. Radius of earth is around $6000\,km$. The weight of body at height of $6000\,km$ from earth surface becomes

(A) Half (B) ✓One-fourth

(C) One third (D) No change

Sol : (b) $g' = g\left(\frac{R}{R+h}\right)^2$

$\Rightarrow$ when $h = R$ then $g' = \frac{g}{4}$ So the weight of the body at this height will become one-fourth.

79. Out of the following, the only incorrect statement about satellites is

(A) A satellite cannot move in a stable orbit in a plane passing through the earth's centre

(B) Geostationary satellites are launched in the equatorial plane

(C) We can use just one geostationary satellite for global communication around the globe

(D) ✓The speed of a satellite increases with an increase in the radius of its orbit

Sol : (d) $v \propto \frac{1}{\sqrt{r}}$. The speed of satellite decreases with an increase in the radius of its orbit.

80. If a body describes a circular motion under inverse square field, the time taken to complete one revolution T is related to the radius of the circular orbit as

(A) $T \propto r$ (B) $T \propto r^2$

(C) ✓$T^2 \propto r^3$ (D) $T \propto r^4$

Sol : (c) $E \propto \frac{1}{r^2}$

$F \propto \frac{1}{r^2}$

$F = \frac{k}{r^2}$

$\frac{K}{r^2} = \frac{mv^2}{r} \quad T = \frac{2\pi r}{v}$

$v^2 = \frac{k}{mr}$

$v = \sqrt{\frac{k}{mr}}$

$T = \frac{2\pi r}{\sqrt{\frac{R}{mr}}}$

$\Rightarrow T = \frac{2\pi\ r^{3/2} m^{1/2}}{\sqrt{k}}$

$T^2 = \frac{4\pi^2 r^3 m}{ki}$

$T^2 \propto r^3$

81. If radius of the earth contracts 2% and its mass remains the same, then weight of the body at the earth surface

(A) Will decrease (B) ✓Will increase

(C) Will remain the same (D) None of these

Sol : (b)$g \propto \frac{1}{R^2}$. If radius of earth decreases by 2% then g will increase by 4%

i.e. weight of the body at earth surface will increase by 4%

82. Hubble's law states that the velocity with which milky way is moving away from the earth is proportional to

(A) Square of the distance of the milky way from the earth

(B) ✓Distance of milky way from the earth

(C) Mass of the milky way

(D) Product of the mass of the milky way and its distance from the earth

Sol : (b)

83. When a satellite moves around the earth in a certain orbit, the quantity which remains constant is :

(A) angular velocity (B) kinetic energy

(C) ✓aerial velocity (D) potential energy

Sol : From Kepler's law aerial velocity remains instant

84. The least velocity required to throw a body away from the surface of a planet so that it may not return is (radius of the planet is $6.4 \times 10^6 m,\ g = 9.8\, m/sec^2$)

(A) $9.8 \times 10^{-3}\, m/sec$ (B) $12.8 \times 10^3\, m/sec$

(C) $9.8 \times 10^3\, m/sec$ (D) ✓$11.2 \times 10^3\, m/sec$

Sol : (d) Escape velocity from surface of earth $v_e = \sqrt{2gR}$

$= \sqrt{2 \times 9.8 \times 6.4 \times 10^6} = 11.2 \times 10^3\ m/s$

85. The escape velocity of a rocket launched from the surface of the earth

(A) ✓Does not depend on the mass of the rocket

(B) Does not depend on the mass of the earth

(C) Depends on the mass of the planet towards which it is moving

(D) Depends on the mass of the rocket

Sol : (a) $V = \sqrt{\frac{2GM}{R}}$

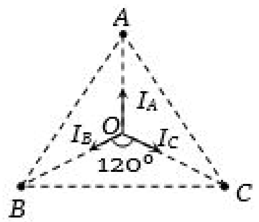
86. 3 particles each of mass m are kept at vertices of an equilateral triangle of side L. The gravitational field at centre due to these particles is

(A) ✓Zero (B) $\frac{3GM}{L^2}$

(C) $\frac{9GM}{L^2}$ (D) $\frac{12}{\sqrt{3}}\frac{GM}{L^2}$

Sol : (a)Due to three particles net intensity at the centre $I = \vec{I}_A + \vec{I}_B + \vec{I}_C = 0$

because out of these three intensities one equal in magnitude and the angle between each other is $120°$.



87. Orbital velocity of an artificial satellite does not depend upon

(A) Mass of the earth (B) ✓Mass of the satellite

(C) Radius of the earth (D) Acceleration due to gravity

Sol : (b)$v = \sqrt{\frac{GM}{r}}$

88. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to half the escape velocity for that planet. The maximum height attained by the body is

(A) ✓$R/3$ (B) $R/2$

(C) $R/4$ (D) $R/5$

Sol : (a) If body is projected with velocity v $(v < v_e)$ then height up to which it will rise,

$$h = \frac{R}{\frac{v_e^2}{v^2} - 1}$$

$v = \frac{v_e}{2}$ (given)

$$h = \frac{R}{\left(\frac{v_e}{v_e/2}\right)^2 - 1} = \frac{R}{4-1} = \frac{R}{3}$$

89. A body of mass m kg. starts falling from a point $2R$ above the Earth's surface. Its kinetic energy when it has fallen to a point $'R'$ above the Earth's surface [$R-$Radius of Earth, $M-$Mass of Earth, $G-$Gravitational Constant]

(A) $\frac{1}{2}\frac{GMm}{R}$ (B) ✓$\frac{1}{6}\frac{GMm}{R}$

(C) $\frac{2}{3}\frac{GMm}{R}$ (D) $\frac{1}{3}\frac{GMm}{R}$

Sol : (b) Potential energy $U = \frac{-GMm}{r} = -\frac{GMm}{R+h}$

$U_{initial} = -\frac{GMm}{3R}$ and $U_{final} = -\frac{-GMm}{2R}$

Loss in PE = gain in $KE = \frac{GMm}{2R} - \frac{GMm}{3R} = \frac{GMm}{6R}$

90. A planet has orbital radius twise as the earth's orbital radius then the time period of planet is .... $years$

(A) 4.2 (B) ✓2.8

(C) 5.6 (D) 8.4

Sol : (b) $T_2 = T_1\left(\frac{R_2}{R_1}\right)^{3/2}$

$= 1 \times (2)^{3/2} = 2.8\ year$

91. The additional kinetic energy to be provided to a satellite of mass m revolving around a planet of mass M, to transfer it from a circular orbit of radius R_1 to another of radius $R_2\,(R_2 > R_1)$ is

(A) $GMm\left(\frac{1}{{R_1}^2} - \frac{1}{{R_2}^2}\right)$ (B) $\mathrm{GMm}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(C) $2\mathrm{GMm}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (D) ✓$\frac{1}{2}\mathrm{GMm}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Sol : $-\frac{GMm}{2R_1} + KE = -\frac{GMm}{2R_2}$

$KE = \frac{GMm}{2}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

92. Choose the correct statement from the following :Weightlessness of an astronaut moving in a satellite is a situation of

(A) Zero g (B) No gravity

(C) Zero mass (D) ✓Free fall

Sol : (d)

93. At what distance from the centre of the earth, the value of acceleration due to gravity g will be half that on the surface ($R =$ radius of earth)

(A) $2\,R$ (B) R

(C) $1.414\,R$ (D) ✓$0.414\,R$

Sol : (d) $g' = g\left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{\sqrt{2}} = \frac{R}{R+h}$

$\Rightarrow R + h = \sqrt{2}\,R \Rightarrow h = (\sqrt{2}-1)R = 0.414\,R$

94. Let g be the acceleration due to gravity at earth's surface and K be the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2% keeping all other quantities same, then

(A) g decreases by 2% and K decreases by 4% (B) g decreases by 4% and K increases by 2%

(C) ✓g increases by 4% and K increases by 4% (D) g decreases by 4% and K increases by 4%

Sol : (c) $g = \frac{GM}{R^2}$ and $K = \frac{L^2}{2I}$

If mass of the earth and its angular momentum remains constant then $g \propto \frac{1}{R^2}$ and $K \propto \frac{1}{R^2}$

i.e. if radius of earth decreases by 2% then g and K both increases by 4%.

95. Weight of a body is maximum at

(A) Moon (B) ✓Poles of earth

(C) Equator of earth (D) Centre of earth

Sol : (b) We know that the weight of the body is the product of mass and acceleration due to gravity and the acceleration due to gravity increases with the latitude

Now the latitude is minimum at the equator and maximum at the poles So, acceleration due to gravity and hence weight is maximum at the poles and minimum at the equator

Hence correct answer is option A

96. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then,

(A) ✓the acceleration of S is always directed towards the centre of the earth.

(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

(C) the total mechanical energy of S varies periodically with time.

(D) the linear momentum of S remains constant in magnitude.

Sol : The gravitational force on the satellite S acts towards the centre of the earth, so the acceleration of the satellite S is always directed towards the centre of the earth.

97. The mass and diameter of a planet are twice those of earth. What will be the period of oscillation of a pendulum on this planet if it is a seconds pendulum on earth ?

(A) $\sqrt{2}$ second (B) ✓$2\sqrt{2}$ seconds

(C) $\frac{1}{\sqrt{2}}$ second (D) $\frac{1}{2\sqrt{2}}$ second

Sol : $g=\frac{GM}{R^2}$ and $g'=\frac{G\cdot 2M}{4R^2}$

$=\frac{1}{2}g$

$T\propto\frac{1}{\sqrt{g}}\Rightarrow\frac{T_2}{T_1}=\sqrt{\frac{g_1}{g_2}}$

$T=\sqrt{\frac{g}{g/2}}=\sqrt{2}$

$\therefore T_2=\sqrt{2}T_1=2\sqrt{2}\mathrm{s}$

98. At what distance from the centre of the moon is the point at which the strength of the resultant field of earth's and moon's gravitational field is equal to zero. The earth's mass is 81 times that of moon and the distance between centres of these planets is $60\,R$ where R is the radius of the earth

(A) ✓$6\ R$ (B) $4\ R$

(C) $3\ R$ (D) $5\ R$

Sol : Let m be the mass at a distance $\times$ from the centre of the moon where gravitation force is zero.

$\therefore\frac{GM_em}{(60R-x)^2}=\frac{GM_{moon}m}{x^2}$

or $\frac{81}{(60R-x)^2}=\frac{1}{x^2}$ or $\frac{9}{60R-x}=\frac{1}{x}$

or $x=6R$

99. A spherical planet far out in space has a mass M_0 and diameter D_0. A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity which is equal to

(A) GM_0/D_0^2 (B) $4mGM_0/D_0^2$

(C) ✓$4GM_0/D_0^2$ (D) GmM_0/D_0^2

Sol : (c)$g=\frac{GM}{R^2}=\frac{GM_0}{(D_0/2)^2}=\frac{4GM_0}{D_0^2}$

100. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then

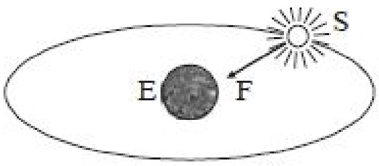
(A) ✓the acceleration of S is always directed towards the centre of the earth

(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant

(C) the total mechanical energy of S varies periodically with time

(D) the linear momentum of S remains constant in magnitude

Sol : Force on satellite is always directed towards earth, So, acceleration of satellite S is always directed towards centre of earth. Net torque of this gravitational force F about centre of earth is zero. Therefore , angular momentum (both in magnitude and direction) of S about centre of earth is constant throughout. Since, the force F is conservative in nature, therefore, mechanical energy of satellite remains constant. Speed of S is maximum when it is nearest to earth and minimum when it is farthest.



101. A man of mass m starts falling towards a planet of mass M and radius R. As he reaches near to the surface, he realizes that he will pass through a small hole in the planet. As he enters the hole, he sees that the planet is really made of two pieces a spherical shell of negligible thickness of mass $\frac{2M}{3}$ and a point mass $\frac{M}{3}$ at the centre. Change in the force of gravity experienced by the man is

(A) ✓$\frac{2}{3}\frac{GMm}{R^2}$ (B) 0

(C) $\frac{1}{3}\frac{GMm}{R^2}$ (D) $\frac{4}{3}\frac{GMm}{R^2}$

Sol : Gravitational field inside the shell is zero, but the force on the man due to the point mass at the centre is

$F_{\text{new}}=\frac{GMm}{3R^2}, F_{\text{old}}=\frac{GMm}{R^2}$

Change in force $=\frac{2GMm}{3R^2}$ Itbr.

102. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

(A) $2R$ (B) $4R$

(C) $\frac{1}{4}R$ (D) ✓$\frac{1}{2}R$

Sol : (d)$g=\frac{4}{3}\pi\rho GR\Rightarrow\frac{R_p}{R_e}=\left(\frac{g_p}{g_e}\right)\left(\frac{\rho_e}{\rho_p}\right)=(1)\times\left(\frac{1}{2}\right)$

$\Rightarrow R_p=\frac{R_e}{2}=\frac{R}{2}$

103. The escape velocity of a sphere of mass m from earth having mass M and radius R is given by

(A) ✓$\sqrt{\frac{2GM}{R}}$ (B) $2\sqrt{\frac{GM}{R}}$

(C) $\sqrt{\frac{2GMm}{R}}$ (D) $\sqrt{\frac{GM}{R}}$

Sol : (a)Escape velocity does not depend on the mass of the projectile

104. A research satellite of mass $200\,kg$ circles the earth in an orbit of average radius $3\,R/2$ 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 .... N.

(A) ✓880 (B) 889

(C) 890 (D) 892

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

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

105. At ..... km height from the surface of earth the gravitation potential and the value of g are $-5.4\times 10^7\ Jkg^{-1}$ and $6.0\ ms^{-2}$ respectively . Take the radius of earth as $6400\,km$.

(A) 1600 (B) 1400

(C) 2000 (D) ✓2600

Sol : Gravitation potential at a height h from the surface of earth, $V_h=\ -5.4\times 10^7\,J\,kg^{-1}$

At the same point acceleration due to gravity,

$g_h=6\,ms^{-2}$

$R=6400\,km=6.4\times 10^6\,m$

We know, $V_h=\ -\frac{GM}{(R+h)}$

$g_h=\frac{GM}{(R+h)^2}=\ -\frac{V_h}{R+h}\Rightarrow R+h=\ -\frac{V_h}{g_h}$

$\therefore\ h=-\frac{V_h}{g_h}-R=\frac{(-5.4\times 10^7)}{6}-6.4\times 10^6$

$=9\times 10^6-6.4\times 10^6=2600\,Km$

106. The mass of the earth is 81 times that of the moon and the radius of the earth is 3.5 times that of the moon. The ratio of the escape velocity on the surface of earth to that on the surface of moon will be

(A) 0.2 (B) 2.57

(C) ✓4.81 (D) 0.39

Sol : (c) Escape velocity $v_e = \sqrt{\frac{2GM}{R}}$

$\frac{v_e}{v_m} = \sqrt{\frac{M_e R_m}{M_m R_e}} = \sqrt{\frac{81}{3.5}} = 4.81$

107. The condition for a uniform spherical mass m of radius r to be a black hole is [G = gravitational constant and g = acceleration due to gravity]

(A) $(2Gm/r)^{1/2} \leq c$ (B) $(2Gm/r)^{1/2} = c$

(C) ✓$(2Gm/r)^{1/2} \geq c$ (D) $(gm/r)^{1/2} \geq c$

Sol : (c)Escape velocity for that body $v_e = \sqrt{\frac{2Gm}{r}}$

v_e should be more than or equal to speed of light

i.e.$\sqrt{\frac{2Gm}{r}} \geq c$

108. The escape velocity of an object on a planet whose g value is 9 times on earth and whose radius is 4 times that of earth in km/s is

(A) ✓67.2 (B) 33.6

(C) 16.8 (D) 25.2

Sol : (a) $\frac{v_p}{v_e} = \sqrt{\frac{g_p}{g_e} \times \frac{R_p}{R_e}} = \sqrt{9 \times 4} = 6$

$v_p = 6 \times v_e = 67.2\,km/s$

109. 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

(A) W (B) $2W$

(C) $W/2$ (D) ✓0

Sol : (d) Reading of spring balance $R = m(g - a)$

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

110. A satellite of the earth is revolving in circular orbit with a uniform velocity V. If the gravitational force suddenly disappears, the satellite will

(A) continue to move with the same velocity in the same orbit.

(B) ✓move tangentially to the original orbit with velocity V.

(C) fall down with increasing velocity.

(D) come to a stop somewhere in its original orbit.

Sol : The satellite is revolving around earth because the centripetal force is balanced by earth's gravitational pull.f. the gravitational pull disappears, the satellite free of centripetal force. So, it will travel with its instantaneous velocity i.e. in the direction tangential to the circular path.

111. Which of the following is the evidence to show that there must be a force acting on earth and directed towards the sun

(A) Deviation of the falling bodies towards east

(B) ✓Revolution of the earth round the sun

(C) Phenomenon of day and night

(D) Apparent motion of sun round the earth

Sol : (b) The earth revolves around the sun due to gravitation pull of the sun. Due to this gravitational attraction between this celestial body, centripetal force is generated which binds the solar system together. Hence revolution of earth round the sun is the evidence to show that there ust be force acting on earth nd directed towards the sun.

112. The maximum possible velocity of a satellite orbiting round the earth in a stable orbit is

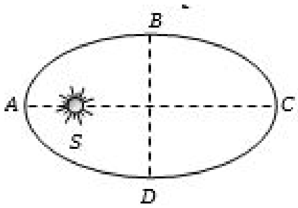
(A) $\sqrt{2R_e g}$ (B) ✓$\sqrt{R_e g}$

(C) $\sqrt{\frac{R_e g}{2}}$ (D) Infinite

Sol : (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.

113. A planet is revolving around the sun as shown in elliptical path

The correct option is



(A) ✓The time taken in travelling DAB is less than that for BCD

(B) The time taken in travelling DAB is greater than that for BCD

(C) The time taken in travelling CDA is less than that for ABC

(D) The time taken in travelling CDA is greater than that for ABC

Sol : (a) During path DAB planet is nearer to sun as comparison with path BCD. So time taken in travelling DAB is less than that for BCD because velocity of planet will be more in region DAB.

114. The acceleration due to gravity on a planet is same as that on earth and its radius is four times that of earth. What will be the value of escape velocity on that planet if it is v_e on earth

(A) v_e (B) ✓$2v_e$

(C) $4v_e$ (D) $\frac{v_e}{2}$

Sol : (b)$v = \sqrt{2gR}$

$\Rightarrow \frac{v_p}{v_e} = \sqrt{\frac{g_p}{g_e} \times \frac{R_p}{R_e}} = \sqrt{1 \times 4} = 2$

$v_p = 2v_e$

115. The gravitational field in a region is given by

$\vec{E} = (5\,N/kg)\,\hat{i} + (12\,N/kg)\,\hat{j}$

If the potential at the origin is taken to be zero, then the ratio of the potential at the points $(12\,m, 0)$ and $(0, 5\,m)$ is

(A) Zero (B) ✓1

(C) $\frac{144}{25}$ (D) $\frac{25}{144}$

Sol : From question,

$E_x = 5\,N/kg\, and\, E_y = 12\,N/kg$

Gravitational potential

$= Gravitational\ field \times\ distance$

$\therefore V_{(12m,0)} = E_x \times 12\,J/kg$

$and\,V_{(0.5m)} = E_y \times 5\ J/kg$

$(Give\ :\ potential\,at\,the\,origin\,is\,zero)$

$\therefore \frac{V_{(12\,m,0)}}{V_{(0,5m)}} = \frac{E_x \times 12}{E_y \times 5} = \frac{5 \times 12}{12 \times 5} = 1$

116. What is the intensity of gravitational field of the centre of a spherical shell

(A) Gm/r^2 (B) g

(C) ✓Zero (D) None of these

Sol : (c) It is zero.

It's because the pull from every direction is exactly the same. This is obvious from the center, but as you move to one side, you're closer to that side, which increases its pull, but this is exactly offset by the fact that there's now MORE mass on the other side.

117. If the gravitational force between two objects were proportional to $\frac{1}{R}$ (and not as $1/R^2$) where R is separation between them, then a particle in 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) $\frac{1}{R}$

Sol : (b)Gravitational force provides the required centripetal force for orbiting the satellite

$\frac{mv^2}{R} = \frac{K}{R}$ because $\left(F \propto \frac{1}{R}\right)$

$v \propto R^{\circ}$

118. 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) Raindrops will fall faster.

(B) Walking on the ground would become more difficult.

(C) ✓ $'g'$ on the Earth will not change.

(D) Time period of a simple pendulum on the Earth would decrease.

Sol : If universal Gravitational constant becomes ten times, then $G' = 10\,G$.
So, acceleration due to gravity increases.

119. If the distance between two masses is doubled, the gravitational attraction between them

(A) Is doubled (B) Becomes four times

(C) Is reduced to half (D) ✓Is reduced to a quarter

Sol : (d) $F \propto \frac{1}{r^2}$. If r becomes double then F reduces to $\frac{F}{4}$

120. Assume that the acceleration due to gravity on the surface of the moon is 0.2 times the acceleration due to gravity on the surface of the earth. If R_e is the maximum range of a projectile on the earth's surface, what is the maximum range on the surface of the moon for the same velocity of projection

(A) $0.2\,R_e$ (B) $2\,R_e$

(C) $0.5\,R_e$ (D) ✓$5\,R_e$

Sol : (d) Range of projectile $R = \frac{u^2 \sin 2\theta}{g}$

if u and θ are constant then $R \propto \frac{1}{g}$

$\frac{R_m}{R_e} = \frac{g_e}{g_m} \Rightarrow \frac{R_m}{R_e} = \frac{1}{0.2} \Rightarrow R_m = \frac{R_e}{0.2} \Rightarrow R_m = 5R_e$

121. If the radius and acceleration due to gravity both are doubled, escape velocity of earth will become .... km/s

(A) 11.2 (B) ✓22.4

(C) 5.6 (D) 44.8

Sol : (b) $v = \sqrt{2gR}$. If g and R both are doubled then v will becomes two times i.e. $2\ \times 11.2\ = 22.4\,km/s$

122. The magnitudes of the gravitational force at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2 respectively. Then

(A) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1\ < R$ and $r_2 < R$

(B) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1\ > R$ and $r_2 > R$

(C) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1\ > R$ and $r_2 > R$

(D) ✓Both (a) and (b)

Sol : (d) $g = \frac{4}{3}\pi\rho G r$

$g \propto r$ if $r < R$

$g = \frac{GM}{r^2}$

$g \propto \frac{1}{r^2}$ if $r > R$

If $r_1 < R$ and $r_2 < R$ then $\frac{F_1}{F_2} = \frac{g_1}{g_2} = \frac{r_1}{r_2}$

If $r_1 > R$ and $r_2 > R$ then $\frac{F_1}{F_2} = \frac{g_1}{g_2} = \left(\frac{r_2}{r_1}\right)^2$

123. 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 $'\rho'\ kg/m^3$. If $d > \rho$, the sphere will

(A) Fall vertically with an acceleration $'g'\ m/\mathrm{sec}^2$

(B) Fall vertically with no acceleration

(C) ✓Fall vertically with an acceleration $g\left(\frac{d-\rho}{d}\right)$

(D) Fall vertically with an acceleration $g\left(\frac{\rho}{d}\right)$

Sol : (c) Apparent weight = actual weight - upthrust force

$Vdg' = Vdg - V\rho g$

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

124. Two satellite A and B, ratio of masses $3\ :\ 1$ are in circular orbits of radii r and $4r$. Then ratio of total mechanical energy of A to B is

(A) $1:3$ (B) $3:1$

(C) $3:4$ (D) ✓$12:1$

Sol : (d) Total mechanical energy of satellite $E = \frac{-GMm}{2r}$

$\frac{E_A}{E_B} = \frac{m_A}{m_B} \times \frac{r_B}{r_A}$

$= \frac{3}{1} \times \frac{4r}{r}$

$= \frac{12}{1}$

125. A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius $R(R << L)$. A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period of star is T and its distance from the galaxy's axis is r, then

(A) ✓$T\ \propto\ r$ (B) $T\ \propto\ \sqrt{r}$

(C) $T\ \propto\ r^2$ (D) $T^2\ \propto\ r^3$

Sol : $F = \frac{2GM}{Lr}m\ or,\ \frac{mv^2}{r} = \frac{2GM}{Lr}m$

$mr\left(\frac{2\pi}{T}\right)^2 = \frac{2GMm}{Lr}\left[v = r\omega\,and\,\omega\ = \frac{2\pi}{T}\right]$

$\Rightarrow\ T \propto r$

126. A satellite whose mass is M, is revolving in circular orbit of radius r around the earth. Time of revolution of satellite is

(A) $T \propto \frac{r^5}{GM}$ (B) ✓$T \propto \sqrt{\frac{r^3}{GM}}$

(C) $T \propto \sqrt{\frac{r}{GM^2/3}}$ (D) $T \propto \sqrt{\frac{r^3}{GM^1/4}}$

127. For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

(A) 2 (B) ✓$\frac{1}{2}$

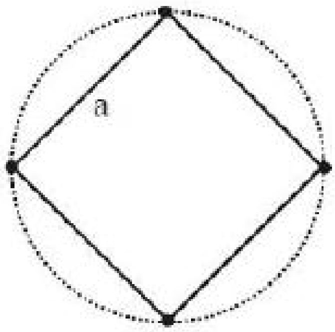
(C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{2}$

Sol : (b) For a moving satellite kinetic energy $= \frac{GMm}{2r}$

Potential energy $= \frac{-GMm}{r}$

$\frac{\text{Kinetic energy}}{\text{Potential energy}} = \frac{1}{2}$

128. Four identical particles of mass M are located at the corners of a square of side $'a'$. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



(A) $1.35\sqrt{\frac{GM}{a}}$ (B) ✓$1.16\sqrt{\frac{GM}{a}}$

(C) $1.41\sqrt{\frac{GM}{a}}$ (D) $1.21\sqrt{\frac{GM}{a}}$

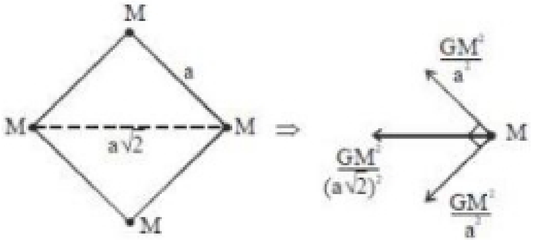
Sol : Net force on particle towards center of circle is

$$F_c = \frac{GM^2}{2a^2} + \frac{GM^2}{a^2}\sqrt{2}$$
$$= \frac{GM^2}{a^2}\left(\frac{1}{2} + \sqrt{2}\right)$$

This force will act as centripetal force.

Diatance of particle from center of circle is $\frac{a}{\sqrt{2}}$.

$$r = \frac{a}{\sqrt{2}}, F_c = \frac{mv^2}{r}$$
$$\frac{mv^2}{\frac{a}{\sqrt{2}}} = \frac{GM^2}{a^2}\left(\frac{1}{2} + \sqrt{2}\right)$$
$$v^2 = \frac{GM}{a}\left(\frac{1}{2\sqrt{2}} + 1\right)$$
$$v^2 = \frac{GM}{a}(1.35) \ ; \ v = 1.16\sqrt{\frac{GM}{a}}$$



129. The acceleration of a body due to the attraction of the earth (radius R) at a distance $2R$ from the surface of the earth is (g = acceleration due to gravity at the surface of the earth)

(A) ✓$\frac{g}{9}$ (B) $\frac{g}{3}$

(C) $\frac{g}{4}$ (D) g

Sol : (a) $g' = g\left(\frac{R}{R+h}\right)^2 = g\left(\frac{R}{R+2R}\right)^2 = \frac{g}{9}$

130. If a satellite orbits as close to the earth's surface as possible,

(A) its speed is maximum

(B) time period of its rotation is minimum

(C) the total energy of the 'earth plus satellite' system is minimum

(D) ✓all of the above

Sol : Speed of satellite $\alpha \frac{1}{\sqrt{r}}$ Speed will be maximum Time period

$\alpha r^{\frac{3}{2}}$ it will be minimum

Total Energy $= -\frac{GMm}{2r}$

Total energy is minimum.

131. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2. The ratio of the accelerations due to gravity at their surfaces is

(A) $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$ (B) $g_1 : g_2 = R_1R_2 : \rho_1\rho_2$

(C) $g_1 : g_2 = R_1\rho_2 : R_2\rho_1$ (D) ✓$g_1 : g_2 = R_1\rho_1 : R_2\rho_2$

Sol : (d) $g = \frac{4}{3}\pi\rho GR$

$$\therefore \frac{g_1}{g_2} = \frac{R_1\rho_1}{R_2\rho_2}$$

132. In a gravitational field, at a point where the gravitational potential is zero

(A) ✓The gravitational field is necessarily zero (B) The gravitational field is not necessarily zero

(C) Nothing can be said definitely about the gravitational field (D) None of these

Sol : (a) $I = \frac{-dV}{dx}$

If $V = 0$ then gravitational field is necessarily zero.

133. The radius and mass of earth are increased by 0.5%. Which of the following statements are true at the surface of the earth

(A) Potential energy will remain unchanged (B) g will decrease

(C) Escape velocity will remain unchanged (D) ✓All of the above

Sol : (d) $g = \frac{GM}{R^2}, v_e = \sqrt{\frac{2GM}{R}}$ and $U = \frac{-GMm}{R}$

$g \propto \frac{M}{R^2}, v_e \propto \sqrt{\frac{M}{R}}$ and $U \propto \frac{M}{R}$

If both mass and radius are increased by 0.5% then v_e and U remains unchanged where as g decrease by 0.5%.

134. A body of mass m is taken to the bottom of a deep mine. Then

(A) Its mass increases (B) Its mass decreases

(C) Its weight increases (D) ✓Its weight decreases

Sol : (d)Because acceleration due to gravity decreases

135. When a satellite in a circular orbit around the earth enters the atmospheric region, it encounters small air resistance to its motion. Then

(A) its kinetic energy increases (B) its kinetic energy decreases

(C) its angular momentum about the earth decreases (D) ✓(A) and (C) both

Sol : $KE = \frac{GMm}{2r} \uparrow$

Due to air resistance angular mometum will decreases

$T = 2\pi\sqrt{\frac{r^3}{GM}}$, so option (A) and (C) are correct.

136. In order to find time, the astronaut orbiting in an earth satellite should use

(A) A pendulum clock (B) ✓A watch having main spring to keep it going

(C) Either a pendulum clock or a watch (D) Neither a pendulum clock nor a watch

Sol : (b) In pendulum clock the time period depends on the value of g, while in spring watch, the time period is independent of the value of g.

137. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth

(A) ✓the acceleration of S is always directed towards the centre of the earth

(B) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant

(C) the total mechanical energy of S varies periodically with time

(D) the linear momentum of S remains constant in magnitude

Sol : As we know that, the force on satellite is an only gravitational force which will always be towards the centre of the earth. Thus, the acceleration is S is always directed towards the centre of the earth

138. Gravitational potential at the centre of curvature of a hemispherical bowl of radius R and mass M is V.

(A) gravitational potential at the centre of curvature of a thin uniform wire of mass M, bent into a semicircle of radius R, is also equal to V.

(B) In part (A) if the same wire is bent into a quarter of a circle then also the gravitational potential at the centre of curvature will be V.

(C) In part (A) if the same wire mass is nonuniformly distributed along its length and it is bent into a semicircle of radius R, gravitational potential at the centre is V.

(D) ✓(A) and (C) both

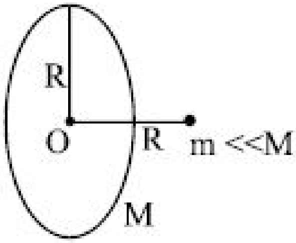
139. Radius of orbit of satellite of earth is R. Its kinetic energy is proportional to

(A) ✓$\frac{1}{R}$ (B) $\frac{1}{\sqrt{R}}$

(C) R (D) $\frac{1}{R^{3/2}}$

Sol : (a) $K.E. = \frac{GMm}{2R}$

140. A particle starts from rest at a distance R from the centre and along the axis of a fixed ring of radius $R\&$ mass M. Its velocity at the centre of the ring is :



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

Sol : Applying conservation of energy

$v = \frac{-G\times M}{\sqrt{x^2+R^2}}$

Potential energy $= v \times m = \frac{-GmM}{\sqrt{x^2+R^2}}$

Initial kinetic energyr $_i = 0$

Potential energy at center $= \frac{-GMm}{R}\{x=0\}$

$\frac{-GMm}{\sqrt{x^2+R^2}} + 0 = \frac{GMm}{R} + \frac{1}{2}mv^2$

$\frac{1}{2}mv^2 = \frac{GMm}{R} - \frac{GMm}{\sqrt{x^2+R^2}} = GMm\left\{\frac{1}{R} - \frac{1}{\sqrt{x^2+R^2}}\right\}$

$v^2 = \frac{2GMm}{m}\left\{\frac{1}{R} - \frac{1}{\sqrt{x^2+R^2}}\right\}$

$v^2 = \sqrt{\left(2-\frac{2}{\sqrt{2}}\right)\left(\frac{GM}{R}\right)} = \sqrt{(2\sqrt{2})\frac{GM}{R}}$

141. In order to make the effective acceleration due to gravity equal to zero at the equator, the angular velocity of rotation of the earth about its axis should be ($g = 10\,ms^{-2}$ and radius of earth is $6400\,kms$)

(A) $0\ rad\sec^{-1}$ (B) ✓ $\frac{1}{800} rad\,sec^{-1}$
(C) $\frac{1}{80} rad\,sec^{-1}$ (D) $\frac{1}{8} rad\,sec^{-1}$

Sol : (b)$g' = g - \omega^2 R\cos^2\lambda$

For weightlessness at equator $\lambda = 0$ and $g' = 0$

$0 = g - \omega^2 R$

$\omega = \sqrt{\frac{g}{R}} = \frac{1}{800}\frac{rad}{s}$

142. The escape velocity for a body projected vertically upwards from the surface of earth is $11\,km/s$. If the body is projected at an angle of 45^o with the vertical, the escape velocity will be .... km/s

(A) 22 (B) ✓11
(C) $\frac{11}{\sqrt{2}}$ (D) $11\sqrt{2}$

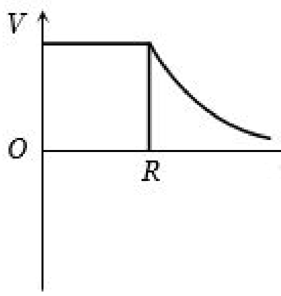
Sol : Since escape velocity $(v_e = \sqrt{2gR_e})$ independent of angle of projection, so it will not change

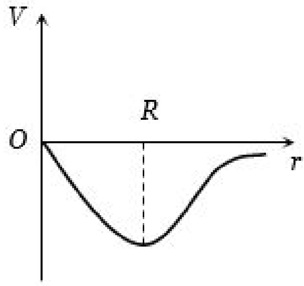
143. In the solar system, which is conserved

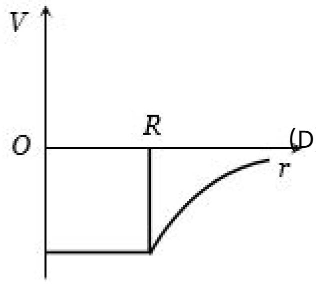
(A) ✓Total Energy (B) K.E.
(C) Angular Velocity (D) Linear Momentum

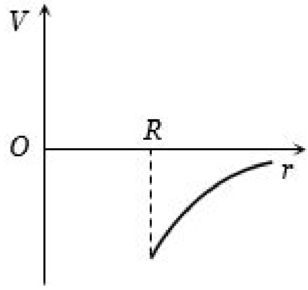
Sol : (a)

144. By which curve will the variation of gravitational potential of a hollow sphere of radius R with distance be depicted

(A) 

(B) 

(C) ✓ 

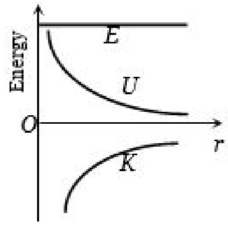
(D) 

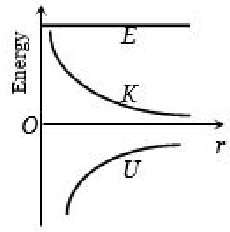
Sol : (c) For hollow sphere

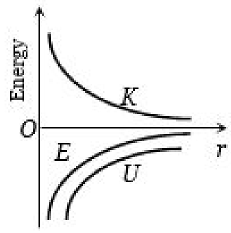
$V_{in} = \frac{-GM}{R}, V_{\text{surface}} = \frac{-GM}{R},\ V_{out} = \frac{-GM}{r}$

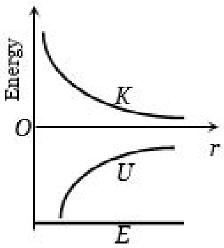
i.e. potential remain constant inside the sphere and it is equal to potential at the surface and increase when the point moves away from the surface of sphere.

145. The correct graph representing the variation of total energy (E_t) kinetic energy (E_k) and potential energy (U) of a satellite with its distance from the centre of earth is

(A) 

(B) 

(C) ✓ 

(D) 

Sol : (c) $U = \frac{-GMm}{r}, K = \frac{GMm}{2r}$ and $E = \frac{-GMm}{2r}$

For a satellite U, K and E varies with r and also U and E remains negative whereas K remain always positive.

146. The value of escape velocity on a certain planet is $2\,km/s$. Then the value of orbital speed for a satellite orbiting close to its surface is

(A) $12\,km/s$ (B) $1\,km/s$
(C) ✓$\sqrt{2}\,km/s$ (D) $2\sqrt{2}\ km/s$

Sol : (c) $v_0 = \frac{v_e}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}\ km/s$

147. The acceleration due to gravity at pole and equator can be related as

(A) $g_p < g_e$ (B) $g_p = g_e = g$
(C) $g_p = g_e < g$ (D) ✓$g_p > g_e$

Sol : (d)

148. The escape velocity for the earth is $11.2\,km/sec$. The mass of another planet is 100 times that of the earth and its radius is 4 times that of the earth. The escape velocity for this planet will be .... km/sec

(A) 112.0 (B) 5.6
(C) 280.0 (D) ✓56.0

Sol : $v = \sqrt{\frac{2GM}{R}} \Rightarrow \frac{v_p}{v_e} = \sqrt{\frac{M_p}{M_e}\times\frac{R_e}{R_p}}$

$\Rightarrow\ v_p = 5v_e = 5\times 11.2 = 56\ km/s$

149. Taking the gravitational potential at a point infinte distance away as zero, the gravitational potential at a point A is $-5\,unit$. If the gravitational potential at point infinite distance away is taken as $+10\,units$, the potential at point A is .... $unit$

(A) -5 (B) ✓$+5$
(C) $+10$ (D) $+15$

Sol : The gravitational potential V at a point distance $'r'$ from a body of mass m is equal to the amount of work done in moving a unit mass from infinity to that point.

$$V_r - v_\propto = -\int_\propto^r \overrightarrow{E}.d\overrightarrow{r} = -GM\,(1/r - 1/\propto)$$

$$= \frac{-GM}{r}\left(As\,\overrightarrow{E} = \frac{-dv}{dr}\right)$$

(i) In the first case

$$when\,v_\propto = 0,\ V_r = \frac{-GM}{r} = -5\,unit$$

(ii) In the second case $v^\propto = +10\,unit$

$$V_r - 10 = -5$$

or $$V_r = +5\,unit$$

150. A communications Earth satellite

(A) goes round the earth from west to east
(B) can be in the equatorial plane only
(C) can be vertically above any place on the earth
(D) ✓(A) and (B) both

151. Orbital velocity of earth's satellite near the surface is $7\,km/s$. When the radius of the orbit is 4 times than that of earth's radius, then orbital velocity in that orbit is .... km/sec

(A) ✓3.5
(B) 7
(C) 72
(D) 14

Sol : (a) $v \propto \frac{1}{\sqrt{r}}$.

If orbital radius becomes 4 times then orbital velocity will become half.

i.e. $\frac{7}{2} = 3.5\,km/s$

152. Kepler's second law (law of areas) is nothing but a statement of

(A) Work energy theorem
(B) Conservation of linear momentum
(C) ✓Conservation of angular momentum
(D) Conservation of energy

Sol : (c)

153. The distance of neptune and saturn from the sun is nearly 10^{13} and 10^{12} meter respectively. Assuming that they move in circular orbits, their periodic times will be in the ratio

(A) 10
(B) 100
(C) ✓$10\sqrt{10}$
(D) 1000

Sol : $T^2 \propto R^3$ $(According\,to\,kepler's\,law)$

$$T_1^2 \propto (10^{13})^3\ and\,T_2^2 \propto (10^{12})^3$$

$$\therefore \frac{T_1^2}{T_2^2} = (10)^3\ or\ \frac{T_1}{T_2} = 10\sqrt{10}$$

154. The distance between centre of the earth and moon is $384000\,km$. If the mass of the earth is $6\times10^{24}kg$ and $G = 6.66\times10^{-11}\,Nm^2/kg^2$. The speed of the moon is nearly......... km/sec

(A) ✓1
(B) 4
(C) 8
(D) 11.2

Sol : (a) $v = \sqrt{\frac{GM}{r}}$

$$= \sqrt{\frac{6.67\times10^{-11}\times6\times10^{24}}{384000\times10^3}}$$

$$= 1\,km/s$$

155. The height at which the weight of a body becomes $\frac{1}{16}^{th}$, its weight on the surface of earth (radius R), is

(A) $5\,R$
(B) $15\,R$
(C) ✓$3\,R$
(D) $4\,R$

Sol : Accleration due to gravity at a height h from the suface of earth is

$$g' = \frac{g}{\left(1+\frac{h}{R}\right)^2} \qquad ...(i)$$

Where g is the acceleration due to gravity at the surface of earth and R is the radius of earth.
Multiplying by $m\ (mass\ of\ the\ body)$ on both sides in (i), we get

$$mg' = \frac{mg}{\left(1+\frac{h}{R}\right)^2}$$

$\therefore$ Weight of body at height h, $w' = mg'$

Weight of body at surface of earth, $W = mg$

According to question, $W' = \frac{1}{16}W$

$$\therefore \frac{1}{16} = \frac{1}{\left(1+\frac{h}{R}\right)^2}$$

$$\left(1+\frac{h}{R}\right)^2 = 16\ or\ 1+\frac{h}{R} = 4$$

$$or\ \frac{h}{R} = 3\ or\ h = 3R.$$

156. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.
Statement-1: For a mass M kept at the centre ofa cube of side 'a', the flux of gravitational field passing through its sides $4\pi GM$.
Statement-2: If the direction of a field due to a point source is radial and its dependence on the distance 'r' from the source is given as $\frac{1}{r^2}$, its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.

(A) Statement -1 is false, Statement-2 is true
(B) ✓Statement -1 is true, Statement-2 is true; Statement -2 is a correct explanation for Statement-1
(C) Statement -1 is true, Statement-2 is true; Statement -2 is not a correct explanation for Statement-1
(D) Statement -1 is true, Statement-2 is false

Sol : Gravitational flux through a closed surface is given by

$$\int \overrightarrow{E_g}\,\overrightarrow{d}S = -4\pi GM$$

$$where,\ M = mass\,enclosed\,in\,the\,closed\,surface$$

This relationship is valid When $|E_g| \propto \frac{1}{r^2}$.

157. The orbital speed of Jupiter is

(A) Greater than the orbital speed of earth
(B) ✓Less than the orbital speed of earth
(C) Equal to the orbital speed of earth
(D) Zero

Sol : (b) Orbital radius of Jupiter >Orbital radius of Earth

$\frac{v_J}{v_e} = \frac{r_e}{r_J}$ As $r_J > r_e$ therefore $v_J < v_e$

158. A body weight $500\,N$ on the surface of the earth. How much would it weigh half way below the surface of the earth .... N

(A) 125
(B) ✓250
(C) 500
(D) 1000

Sol : (b) Weight on surface of earth, $mg = 500\,N$ and weight below the surface of earth at $d = \frac{R}{2}$

$$mg' = mg\left(1-\frac{d}{R}\right) = mg\left(1-\frac{1}{2}\right) = \frac{mg}{2} = 250\,N$$

159. Mass M is divided into two parts xM and $(1-x)\,M$. For a given separation, the value of x for which the gravitational attraction between the two pieces becomes maximum is

(A) ✓0.5
(B) $\frac{3}{5}$
(C) 1
(D) 2

Sol : (a) $F \propto xm \times (1-x)m = xm^2(1-x)$

For maximum force $\frac{dF}{dx} = 0$

$\Rightarrow \frac{dF}{dx} = m^2 - 2xm^2 = 0 \Rightarrow x = 1/2$

160. A body has a weight $90\,kg$ on the earth's surface, the mass of the moon is $1/9$ that of the earth's mass and its radius is $1/2$ that of the earth's radius. On the moon the weight of the body is .... kg

(A) 45 (B) 202.5

(C) 90 (D) ✓40

Sol : (d) $\frac{g_m}{g_e} = \frac{M_m}{M_e} \times \left(\frac{R_e}{R_m}\right)^2 = \left(\frac{1}{9}\right)\left(\frac{2}{1}\right)^2 = \frac{4}{9} \Rightarrow g_m = \frac{4}{9} g_e$

$W_m = \frac{4}{9} \times W_e = \frac{4}{9} \times 90 = 40\,kg$

161. A body weighs $700\,gm$ wt on the surface of the earth. How much will it weigh on the surface of a planet whose mass is $\frac{1}{7}$ and radius is half that of the earth .... $gm\,wt$

(A) 200 (B) ✓400

(C) 50 (D) 300

Sol : (b) We know that $g = \frac{GM}{R^2}$

On the planet $g_p = \frac{GM/7}{R^2/4} = \frac{4g}{7} = \frac{4}{7} g$

Hence weight on the planet $= 700 \times \frac{4}{7} = 400\,gm\,wt$

162. The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is v. For a satellite orbiting at an altitude of half of the earth's radius, the orbital velocity is

(A) $\frac{3}{2}v$ (B) $\sqrt{\frac{3}{2}}v$

(C) ✓$\sqrt{\frac{2}{3}}v$ (D) $\frac{2}{3}v$

Sol : (c) $v = \sqrt{\frac{GM}{R+h}}$

For first satellite $h = 0$, $v_1 = \sqrt{\frac{GM}{R}}$

For second satellite $h = \frac{R}{2}$, $v_2 = \sqrt{\frac{2GM}{3R}}$

$v_2 = \sqrt{\frac{2}{3}} v_1 = \sqrt{\frac{2}{3}} v$

163. An earth satellite of mass m revolves in a circular orbit at a height h from the surface of the earth. R is the radius of the earth and g is acceleration due to gravity at the surface of the earth. The velocity of the satellite in the orbit is given by

(A) $\frac{gR^2}{R+h}$ (B) gR

(C) $\frac{gR}{R+h}$ (D) ✓$\sqrt{\frac{gR^2}{R+h}}$

Sol : (d)$v_0 = \sqrt{\frac{GM}{r}} = \sqrt{\frac{gR^2}{R+h}}$

164. The escape velocity of a body on the surface of the earth is $11.2\,km/s$. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become .... km/s

(A) 5.6 (B) 11.2

(C) ✓22.4 (D) 44.8

Sol : (c) $v_e = \sqrt{\frac{2GM}{R}}$

$v_e \propto \sqrt{\frac{M}{R}}$

If M becomes double and R becomes half then escape velocity becomes two times.

165. A satellite moves around the earth in a circular orbit of radius r with speed v. If the mass of the satellite is M, its total energy is

(A) ✓$-\frac{1}{2}Mv^2$ (B) $\frac{1}{2}Mv^2$

(C) $\frac{3}{2}Mv^2$ (D) Mv^2

Sol : (a) Total energy = – (kinetic energy) = $-\frac{1}{2}Mv^2$

166. A particle is moving with a uniform speed in a circular orbit of radius R in a central force inversely proportional to the n^{th} power of R. If the period ofrotation of the particle is T, then

(A) $T \propto R^{\frac{n}{2}+1}$ (B) ✓ $T \propto R^{\frac{(n+1)}{2}}$

(C) $T \propto R^{\frac{n}{2}}$ (D) $T \propto R^{\frac{3}{2}}$ For any n

Sol : $m\omega^2 R = Force \propto \frac{1}{R^n}$ $\left(Force = \frac{mv^2}{R}\right)$

$\Rightarrow \omega^2 \propto \frac{1}{R^{n+1}} \Rightarrow \omega \propto \frac{1}{R^{\frac{n+1}{2}}}$

$Time\,period\,T = \frac{2\pi}{\omega}$

$Time\,period,\ T \propto R^{\frac{n+1}{2}}$

167. If radius of earth is R then the height $'h'$ at which value of $'g'$ becomes one-fourth is

(A) $\frac{R}{4}$ (B) $\frac{3R}{4}$

(C) ✓R (D) $\frac{R}{8}$

Sol : (c) $g' = g\left(\frac{R}{R+h}\right)^2 = \frac{g}{4}$.

By solving $h = R$

168. The ratio of the weights of a body on the Earth's surface to that on the surface of a planet is $9:4$. The mass of the planet is $\frac{1}{9}^{th}$ of that of the Earth. If $'R'$ is the radius of the Earth, what is the radius of the planet ? (Take the planets to have the same mass density)

(A) $\frac{R}{3}$ (B) $\frac{R}{4}$

(C) $\frac{R}{9}$ (D) ✓$\frac{R}{2}$

Sol : Since mass of the object remains same

$\therefore$ Weight of object will be proporational to $'g'$ $(acceleration\,due\,to\,gravity)$ Given ;

$\frac{W_{earth}}{W_{planet}} = \frac{9}{4} = \frac{g_{earth}}{g_{planet}}$

Also,$g_{surface} = \frac{GM}{R^2}$ $(M\,is\,mass\,planet,\ G\,is\,unversal\,gravitational\,c$

$\therefore \frac{9}{4} = \frac{GM_{earth}R^2_{planet}}{GM_{planet}R^2_{earth}} = \frac{M_{earth}}{M_{planet}} \times \frac{R^2_{planet}}{R^2_{earth}}$

$= 9\frac{R^2_{planet}}{R^2_{earth}}$

$\therefore R_{planet} = \frac{R_{earth}}{2} = \frac{R}{2}$

169. Consider a satellite going round the earth in an orbit. Which of the following statements is wrong

(A) It is a freely falling body (B) ✓It suffers no acceleration

(C) It is moving with a constant speed (D) Its angular momentum remains constant

Sol : (b)Centripetal acceleration works on it.

170. Two sphere of mass m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be

(A) ✓F (B) $\frac{F}{3}$

(C) $\frac{F}{9}$ (D) $3\,F$

Sol : (a)Gravitational force does not depend on the medium.

171. When a satellite going round the earth in a circular orbit of radius r and speed v loses some of its energy, then r and v change as

(A) r and v both with increase

(B) r and v both will decrease

(C) ✓r will decrease and v will increase

(D) r will increase and v will decrease

Sol : (c) $B.E. = -\frac{GMm}{r}$.

If $B.E.$ decreases then r also decreases and v increases as $v \propto \frac{1}{\sqrt{r}}$

172. 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 $\frac{a}{2}$ distance from the centre, will be

(A) ✓$-\frac{3GM}{a}$

(B) $-\frac{2GM}{a}$

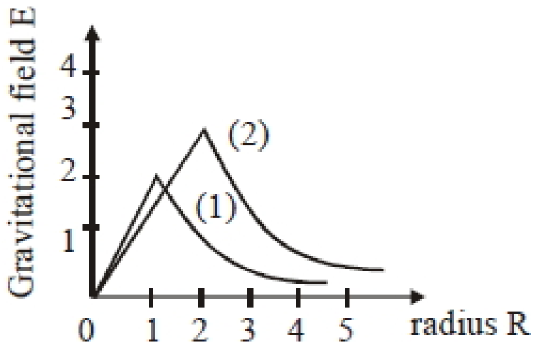
(C) $-\frac{GM}{a}$

(D) $-\frac{4GM}{a}$

Sol : Potential at the given point = Potential at the point due to the shell + Potential due to the particle

$= -\frac{GM}{a} - \frac{2GM}{a} = -\frac{3GM}{a}$

173. Consider two solid spheres of radii $R_1 = 1$ m $R_2 = 2$ m and masses M_1 and M_2, respectively. The gravitational field due to sphere (1) and (2) are shown. The value of $\frac{M_1}{M_2}$ is



(A) $\frac{1}{2}$

(B) $\frac{2}{3}$

(C) $\frac{1}{3}$

(D) ✓$\frac{1}{6}$

Sol : Gravitational field on the surface of a solid sphere

$I_g = \frac{GM}{R^2}$

By the graph

$\frac{GM_1}{(1)^2} = 2$

and $\frac{GM_2}{(2)^2} = 3$

On solving

$\frac{M_1}{M_2} = \frac{1}{6}$

174. An artificial satellite is placed into a circular orbit around earth at such a height that it always remains above a definite place on the surface of earth. Its height from the surface of earth is .... km

(A) 6400

(B) 4800

(C) 32000

(D) ✓36000

Sol : As the satellite always remains stationary $w.r.t$ earth surface, thus its time period revolution is equal to time period of rotation of earth i.e $24\,hrs$

Time period of satellite $T = 2\pi\sqrt{\frac{r^3}{gR^2}}$ where $R = 6400\text{km} = 6.4 \times 10^6\text{m}$

$\therefore 24 \times 3600 = 2\pi\sqrt{\frac{r^3}{9.8\,(6.4 \times 10^6)^2}}$

OR $\frac{r^3}{401.408 \times 10^{12}} = 1.89 \times 10^8 \implies r^3 = 76 \times 10^{21}$

$\Rightarrow r = 42400\text{km}$

Thus height of satellite above earth surface $h = 42400 - 6400 = 36000\text{km}$

175. A geostationary satellite is revolving around the earth. To make it escape from gravitational field of earth, is velocity must be increased .... %

(A) 100

(B) ✓41.4

(C) 50

(D) 59.6

Sol : (b) $v_e = \sqrt{2}v_0 = 1.414\ v_0$

Fractional increase in orbital velocity $\left(\frac{\Delta v}{v}\right)$

$= \frac{v_e - v_0}{v_0} = 0.414$

Percentage increase $= 41.4\%$

176. The weight of a body at the centre of the earth is

(A) ✓Zero

(B) Infinite

(C) Same as on the surface of earth

(D) None of the above

Sol : (a) Inside the earth, gravitational force will vary as

$F = \frac{GM\frac{r^3}{R^3}}{r^2} = \frac{GMr}{R^3}$

Hence, at $r = 0, F = 0$

177. If satellite is shifted towards the earth. Then time period of satellite will be

(A) Increase

(B) ✓Decrease

(C) Unchanged

(D) Nothing can be said

Sol : (b)$T^2 \propto r^3$

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

(A) $-2\,mgR_e$

(B) $2\,mgR_e$

(C) $\frac{1}{2}mgR_e$

(D) ✓$-\frac{1}{2}mgR_e$

Sol : (d) $\Delta U = U_2 - U_1 = \frac{mgh}{1 + \frac{h}{R_e}} = \frac{mgR_e}{1 + \frac{R_e}{R_e}} = \frac{mgR_e}{2}$

$\Rightarrow U_2 - (-mgR_e) = \frac{mgR_e}{2} \Rightarrow U_2 = -\frac{1}{2}mgR_e$

179. Planetary system in the solar system describes

(A) Conservation of energy

(B) Conservation of linear momentum

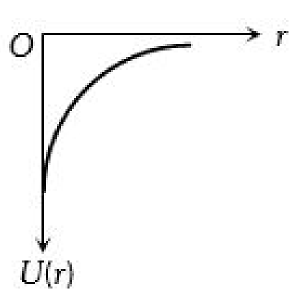
(C) ✓Conservation of angular momentum

(D) None of these

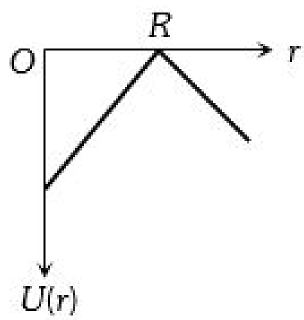
Sol : (c)

180. A shell of mass M and radius R has a point mass m placed at a distance r from its centre. The gravitational potential energy $U(r)$ vs r will be

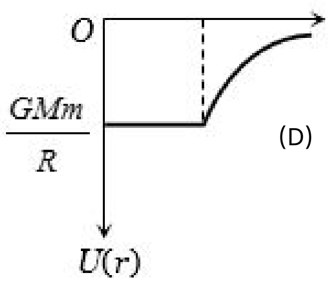
(A)



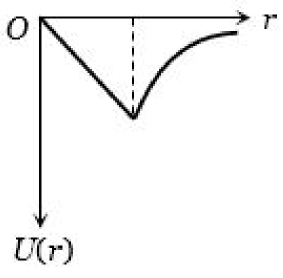
(B)



(C) ✓



(D)



Sol : (c) Gravitational $P.E. = m\times$ gravitational potential $U = mV$ So the graph of U will be same as that of V for a spherical shell.

181. Reason of weightlessness in a satellite is

(A) Zero gravity (B) Centre of mass

(C) ✓Zero reaction force by satellite surface (D) None

Sol : (c)

182. The orbital angular momentum of a satellite revolving at a distance r from the centre is L. If the distance is increased to $16r$, then the new angular momentum will be

(A) $16L$ (B) $64L$

(C) $\frac{L}{4}$ (D) ✓$4L$

Sol : (d) $L = mvr = m\sqrt{\frac{GM}{r}}r = m\sqrt{GMr}$

$\therefore\ L \propto \sqrt{r}$

183. Assuming the earth to be a sphere of uniform density the acceleration due to gravity

(A) at a point outside the earth is inversely proportional to the square of its distance from the centre

(B) at a point outside the earth is inversely proportional to its distance from the centre

(C) at a point inside is proportional to its distance from the centre.

(D) ✓(A) and (C) both

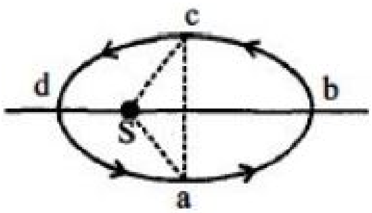
184. If it is assumed that the spinning motion of earth increases, then the weight of a body on equator

(A) ✓Decreases (B) Remains constant

(C) Increases (D) Becomes more at poles

Sol : (a)$g' = g - \omega^2 R,$ when ω increases g' decreases.

185. Figure shows elliptical path $abcd$ of a planet around the sun S such that the area of triangle csa is $\frac{1}{4}$ the area of the ellipse. (See figure) With db as the semimajor axis, and ca as the semiminor axis. If t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then



(A) $t_1 = 4t_2$ (B) $t_1 = 2t_2$

(C) ✓$t_1 = 3t_2$ (D) $t_1 = t_2$

Sol : Let area of ellipse abcd $= x$

Area of $SabcS$

$= \frac{x}{2} + \frac{x}{4}\ (i.e.,\ ar\,of\,abcd + SacS)$

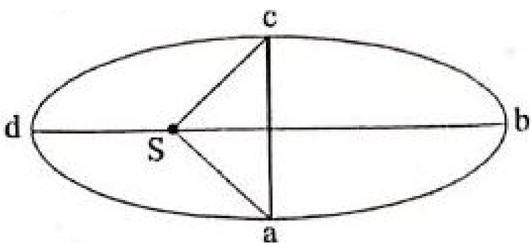
$(Area\,of\,half\,ellipse + Area\,of\,triangle)$

$= \frac{3x}{4}$

$Area\,of\,SadcS = x - \frac{3x}{4} = \frac{x}{4}$

$\frac{Area\,of\,SabcS}{Area\,of\,SabcS} = \frac{3x/4}{x/4} = \frac{t_1}{t_2}$

$\frac{t_1}{t_2} = 3\ or,\ t_1 = 3t_2$



186. The escape velocity for a rocket from earth is $11.2\,km/sec.$ Its value on a planet where acceleration due to gravity is double that on the earth and diameter of the planet is twice that of earth will be in .... km/sec

(A) 11.2 (B) 5.6

(C) ✓22.4 (D) 53.6

Sol : (c) $\frac{v_p}{v_e} = \sqrt{\frac{g_p}{g_e} \times \frac{R_p}{R_e}} = \sqrt{2\times 2} = 2$

$\Rightarrow v_p = 2 \times v_e = 2 \times 11.2 = 22.4\ km/s$

187. If M the mass of the earth and R its radius, the ratio of the gravitational acceleration and the gravitational constant is

(A) $\frac{R^2}{M}$ (B) ✓$\frac{M}{R^2}$

(C) MR^2 (D) $\frac{M}{R}$

Sol : (b) Acceleration due to gravity $g = \frac{GM}{R^2}$

$\frac{g}{G} = \frac{M}{R^2}$

188. 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

(A) S will run faster than P (B) ✓P will run faster than S

(C) They will both run at the same rate as on the earth (D) None of these

Sol : (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.

189. The time period of a simple pendulum on a freely moving artificial satellite is

(A) $Zero$ (B) $2\,sec$

(C) $3\,sec$ (D) ✓Infinite

Sol : (d) Time period of simple pendulum $T = 2\pi\sqrt{\frac{l}{g'}}$

In artificial satellite $g' = 0\ T =$ infinite.

190. The distance of a geo-stationary satellite from the centre of the earth (Radius $R = 6400\,km$) is nearest to

(A) $5R$ (B) ✓$7R$

(C) $10R$ (D) $18R$

Sol : (b) $6R$ from the surface of earth and $7R$ from the centre.

191. 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

(A) $(N_1/N_2)^{3/2}$ (B) $(N_2/N_1)^{3/2}$

(C) $(N_1/N_2)^{2/3}$ (D) ✓$(N_2/N_1)^{2/3}$

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

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

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

192. The mass and diameter of a planet have twice the value of the corresponding parameters of earth. Acceleration due to gravity on the surface of the planet is .... $m/\sec^2$.

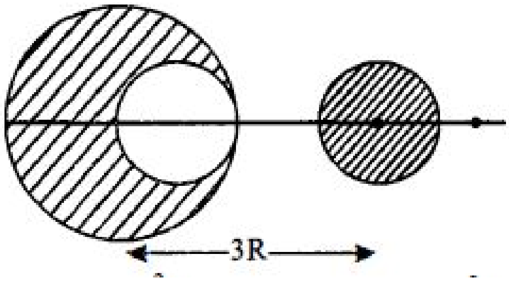
(A) 9.8 (B) ✓4.9

(C) 980 (D) 19.6

Sol : (b) $\frac{g'}{g} = \frac{M'}{M}\left(\frac{R}{R'}\right)^2 = \left(\frac{2M}{M}\right)\left(\frac{R}{2R}\right)^2 = \frac{1}{2}$

$\Rightarrow g' = \frac{g}{2} = \frac{9.8}{2} = 4.9\ m/s^2$

193. From a sphere of mass M and radius R, a smaller sphere of radius $\frac{R}{2}$ is carved out such that the cavity made in the original sphere is between its centre and the periphery (See figure) . For the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is $3R$, the gravitational force between the two sphere is



(A) ✓ $\frac{41GM^2}{3600R^2}$
(B) $\frac{41GM^2}{450R^2}$
(C) $\frac{59GM^2}{450R^2}$
(D) $\frac{GM^2}{225R^2}$

Sol : Volume of removed sphere

$$V_{remo} = \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{4}{3}\pi R^3\left(\frac{1}{8}\right)$$

Volume of the sphere (remaining)

$$V_{remain} = \frac{4}{3}\pi R^3 - \frac{4}{3}\pi R^3\left(\frac{1}{8}\right)$$

$$= \frac{4}{3}\pi R^3\left(\frac{7}{8}\right)$$

Therefore mass of sphere carved and remaining sphere are at respectively $\frac{1}{8}M\ and\ \frac{7}{8}M.$

Therefore, gravitational force between these two sphere

$$F = \frac{GMm}{r^2}$$

$$= \frac{G\frac{7M}{8}\times\frac{1}{8}M}{(3R)^2} = \frac{7}{64\times 9}\frac{GM^2}{R^2}$$

$$= \frac{41}{3600}\frac{GM^2}{R^2}$$

194. The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to four times the previous value, the new time period will become .... $hours$

(A) 20
(B) 10
(C) 80
(D) ✓40

Sol : (d) $T_2 = T_1\left(\frac{R_2}{R_1}\right)^{3/2} = T_1(4)^{3/2} = 8T_1 = 40\,hr$

195. Two point masses of mass $4m$ and m respectively separated by d distance are revolving under mutual force of attraction. Ratio of their kinetic energies will be :

(A) ✓$1:4$
(B) $1:5$
(C) $1:1$
(D) $1:2$

Sol : They will revolue about this centre of mass

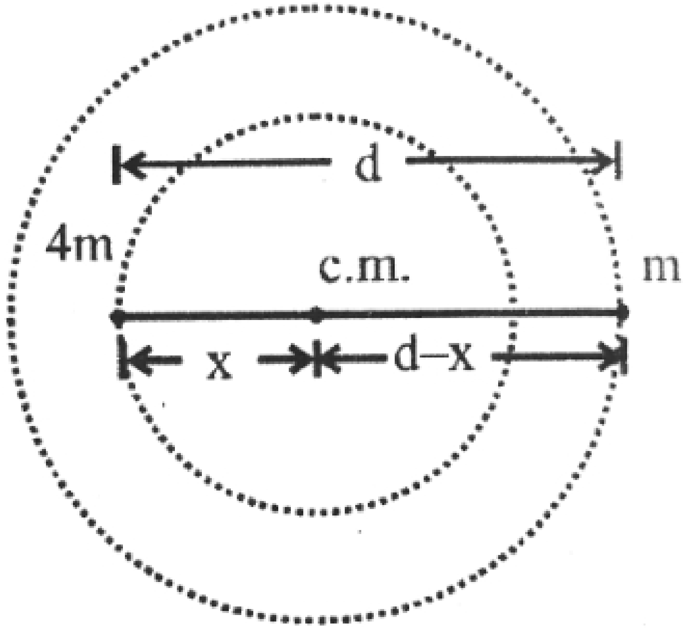
$$0 = 4m(-x) + m(d-x)$$

$$x = \frac{d}{5}$$

They will same ω

$$\frac{K_{4m}}{K_m} = \frac{\frac{1}{2}I_{4m}\omega^2}{\frac{1}{2}I_m\omega^2} \Rightarrow \frac{K_{4m}}{K_m} = \frac{I_{4m}}{I_m}$$

$$\frac{K_{4m}}{K_m} = \frac{\frac{1}{2}(4m)(d/5)^2}{\frac{1}{2}(m)(4d/5)^2} \Rightarrow \frac{K_{4m}}{K_m} = \frac{1}{4}$$



196. A satellite of the earth is revolving in a circular orbit with a uniform speed v. If the gravitational force suddenly disappears, the satellite will

(A) Continue to move with velocity v along the original orbit
(B) ✓Move with a velocity v, tangentially to the original orbit
(C) Fall down with increasing velocity
(D) Ultimately come to rest somewhere on the original orbit

Sol : (b)Due to inertia of direction.

197. 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) $\sqrt{\frac{x}{r}}$

Sol : (c) $v_e = \sqrt{2gR}$==>$\frac{v_A}{v_B} = \sqrt{\frac{g_A}{g_B}\times\frac{R_A}{R_B}} = \sqrt{x\times r}$?

$$\frac{v_A}{v_B} = \sqrt{rx}$$

198. At what altitude will the acceleration due to gravity be 25% of that at the earth's surface (given radius of earth is R) ?

(A) $R/4$
(B) ✓R
(C) $3R/8$
(D) $R/2$

Sol : $g = \frac{GM}{r^2} \Rightarrow g_0 = \frac{GM}{R^2}\ldots(1)$

$$g_h = \frac{GM}{(R+h)^2}\ldots(2)$$

$$\frac{g_h}{g_0} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{4} = \left(\frac{R}{R+h}\right)^2$$

$$\frac{R}{R+h} = \frac{1}{2}$$

$$R+h = 2R \Rightarrow h = R$$

199. A geostationary satellite orbits around the earth in a circular orbit of radius $36000\,km$. Then, the time period of a satellite orbiting a few hundred kilometres above the earth's surface ($R_{\text{Earth}} = 6400\,km$) will approximately be .... $hours$

(A) $\frac{1}{2}$
(B) 1
(C) ✓2
(D) 4

Sol : (c) $\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2}$

$$\Rightarrow T_2 = 24\left(\frac{6400}{36000}\right)^{3/2} \cong 2\,hour$$

200. An iron ball and a wooden ball of the same radius are released from a height $'h'$ in vacuum. The time taken by both of them to reach the ground is equal is based on

(A) ✓Acceleration due to gravity in vacuum is same irrespective of size and mass of the body
(B) Acceleration due to gravity in vacuum depends on the mass of the body
(C) There is no acceleration due to gravity in vacuum