PHYSICS

BOOKS - MODERN PUBLICATION

Acceleration due to gravity

Example

1. Calculate the period of revolution of neptune around the sun, given that diameter of its orbit is 30 times the diameter of earth's

orbit around the sun, both orbits being assumed to be circular.

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2. A sphere of mass 40 kg is placed at a distance of 0.9 from a sphere of mass 60 kg. If the two spheres attract eacch other with a force of 0.02 mgf, find the value of gravitational constant.

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3. Assuming the earth to be a uniform sphere of radius 6,380 km and density $5.5gcm^{-3}$, find the value of acceleration due to gravity on its surface. Given that gravitational constant, $G = 6.66x10^{-11}Nm^2kg^2$

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4. Find the value of g at a height of 400 km above the surface of earth. Given that radius of earth, R= 6,400 km and value of g at the surface of earth = $9.8ms^{-2}$

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5. Assuming the earth to be a sphere of uniform mass density, how much would a body weigh 800 km below the surface of the earth, if it weighed 360 N on the surface ? Given that radius of the earth, R = 6,400 km.

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6. The time period of a satellite of earth is 7 hours. If the separation between the earth and the satellite is increased to 2 times the previous value, what will be its new time period?

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7. According to Kepler's law of periods, $T^2 = kr^3$ where k is a constant. Compute the constant k for the earth. Given that orbital

radii of the earth and Venus are 1.496×10^{11} m and 1.082×10^{11}m and their respective periods are 1 year and 0.615 year.

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8. According to Kepler's law of periods, $T^2 = kr^3$ where k is a constant. Compute the constant k for the earth. Given that orbital radii of the earth and Venus are 1.496×10^{11} m and 1.082×10^{11}m and their respective periods are 1 year and 0.615 year.

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9. Suppose that the gravitational force varies inversely as the nth power of distance. In that situation what will be the time period of a planet in a circular orbit of radius R around the sun?

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10. How fast (in $m^2 s^{-1}$) is area swept out by (a) the radius from sun to earth ? (b) the

radius from the earth to moon . Given distance of sun to earth= $1.496 \times 10^{11} m$, Distance of earth to moon = $3.845 \times 10^{8} m$ and period of revolution of moon = $27\frac{1}{3}$ days.

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11. The largest and the shortest distance of the earth from the sun is r_1 and r_2. What will be its distance from the sun when it is at perpendicular to the major axis of the orbit drawn from the sun?

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12. Find the gravitational attraction between the two atoms in a hydrogen molecule. Given that G=$6.67 \times 10^{-}11 N m^{2} k g^{-2}$, mass of a hydrogen atom = 1.67×10^{-27} and distance between the two atoms = 1×10^{-10}

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13. Approximate the gravitational force exerted on the moon by the earth and the sun

during a solar eclipse. Given that mass of the sun=2×10^{30}kg, mass of earth =6×10^{24} kg, mass of the moon =2.74×10^{22}kg radius of earth's orbit around the sun = 1.5×10^{11}m and radius of the moon's orbit around the earth =3.8×10^{8}m and G= $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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14. Approximate the gravitational force exerted on the moon by the earth and the sun

during a lunar eclipse. Given that mass of the sun=2×10^{30}kg, mass of earth =6×10^{24} kg, mass of the moon =7.4×10^{22}kg radius of earth's orbit around the sun = 1.5×10^{11}m and radius of the moon's orbit around the earth =3.8×10^{8}m and G= $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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15. At some point between the earth and the moon the gravitational force on a space ship

due to the earth and the moon together is zero. Where is this point? given that the earth-moon distance is $3.845 \times 10^8 m$ and the moon has 1.2% of the mass of earth.

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16. If the mass of the sun is 2×10^{30}kg the distance of the earth from the sun is 1.5×10^{11}m and period of revolution of the earth around the sun is 365.3 days, calculate the value of gravitational constant

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17. the mass of planet Jupiter is 1.9×10^{27}kg and that of the sun is 1.99×10^{30}kg. The mean distance of the Jupiter from the sun is 7.8×10^{11}m. Calculate the gravitational force which the sun exerts on Jupiter.

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18. the mass of planet Jupiter is 1.9×10^{27}kg and that of the sun is 1.99×10^{30}kg. The mean

distance of the Jupiter from the sun is 7.8×10^{11}m. Assuming that Jupiter moves in a circular orbit around the sun calculate the speed of the Jupiter.

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19. the value of g on the surface of earth is $9.8\frac{m}{s^2}$. find its value on the surface of the moon. given mass of the earth is equal to 6×10^{24} kg, mass of the moon =7.4×10^{22}kg,

radius of earth =

$6.4 \times 10^6 m, radius of moon = 1.74xx10^6`m$

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20. The acceleration due to gravity on the planet A is 8 times the acceleration due to gravity on the planet B. A man jumps to a height of 1.5 m on the surface of A. What is the height of jump by the same person on the planet B ?

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21. The radius of earth is about 6400Km and that of mars is about 3200 km The mass of the earth is about 10 times the mass of mars. An object weight 200N on earth 's surface, then its weight on the surface of mars will be:

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22. Compare the gravitational acceleration of the earth due to attraction of the sun with that due to attraction of the moon. Given that

mass of sun, $M_s = 1.99 \times 10^{30}$kg, mass of moon, $M_m = 7.35 \times 10^{22}$ kg , distance of sun from earth , $r_{es} = 1.49 \times 10^{11}$m and the distance moon from earth $r_{em} = 3.84 \times 10^{8}$ m.

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23. The value of acceleration due to gravity at the surface of the earth is $9.8ms^{-2}$ and the mean radius is about 6.4×10^{6}m . Assuming that we could get more soil some where,

estimate how thick would an added uniform outer layer on the earth have to have the value of acceleration due to gravity $10ms^{-2}$ exactly ?

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24. At what height from the surface of the earth will the value of g be reduced by 36% of present the value at the surface. radius of earth = 6400 km

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25. A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth ?

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26. Find the percentage decrease in weight of a body when taken 16 km below the surface of the earth. Take radius of the earth 6400 km.

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27. If the earth where a perfect sphere of radius 6.37×10^6m, rotating about its axis with a period of one day (=8.64×10^4s), how much would the acceleration due to gravity differ from the poles to the equator?

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28. Calculate the mass and mean density of the earth from the following data:

Gravitational constant (G),= $6.6 \times 10^{-11} Nm^2 kg^{-2}$, Radius of the earth (R)=6.37×10^6m, Acceleration due to gravity (g)= $9.8 ms^{-2}$

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29. The acceleration due to gravity at the moon's surface is $1.67 ms^{-2}$. If the radius of the moon is 1.74×10^6 m , calculate the mass of the moon.

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30. Three particles, each of mass 'm' are situated at the vertices of an equilateral triangle of side 'a'. the only force acting on the particles are their mutual gravitatinoal foces. It is desired that each particle move on a circle, while maintaining the original mutual separation 'a'. Find the initial velocity that should be given to each particle and also the time period of the circular motion.

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31. Determine the speed with which they earth have to rotate on its axis so that a person on the equator would weigh (3/5)th of as much at present. Take the equitorial radius as 6400 km

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32. What is gravitational force?

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33. Which one is greater-the gravitational force of the earth on 1 kg iron or the force of gravitation applied by 1 kg on earth ?

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34. gravitational force between two bodies is one newton. if the distance between them is made twice what will be the force?

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35. Explain Newton's laws of gravitation and hence deduce the definitin of universal gravitational constant.

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36. Why is G called universal gravitational constant ?

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37. what is the nature of motion of an object falling freely under the action of gravity?

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38. Is the value of 'g' at a given place same for different bodies or it is variable ?

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39. explain why a body weighs more at the poles and less at the equator

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40. What will be the weight of a body at the centre of the earth?

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41. The mass and weight both of a body becomes zero at the centre of the earth. (T or F)

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42. Why does a body becomes weightless at the centre of earth ?

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43. Where does body weight more at the surface of the earth or in a mine?

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44. what is the effect of rotation of earth on value of g?

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45. At what place on earth the value of g does not change due to its rotational motion?

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46. At what place on earth, the centirpetal force is maximum?

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47. State Keplers' laws of planetary motion.

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48. The moon revolves around the earth and the earth-moon system revolves around the sun. If the earth could be removed suddenly without disturbing the motion of the moon, what would be the subsequent path of the moon?

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49. Show that Kepler's second law follows from the law of conservation of angular momentum.

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50. According to Newton's second law of motion everybody in this universe attracts every other body. But we do not see bodies on the surface of the earth moving towards on

another on account of this force of attraction. Why?

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51. According to Newton's law of gravitation, the apple and the earth experience equal and opposite forces due to gravitation. But it is the apple that falls towards the earth and not vice-versa. Why?

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52. Two spherical balls each of mass 1kg are place 10 cm apart. Find the gravitational force of attraction between them. Given that universal gravitational constant G= $6.7 \times 10^{-11} Nm^2 kg^{-2}$

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53. A 50kg boy stands 1m away from a 45kg girl. Calculate the force of attraction between them? Given that universal gravitational constant G=$6.7 \times 10^{-11} Nm^2 kg^{-2}$

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54. Imagine a spacecraft going from earth to the moon. HOw does its weight vary as it goes from the earth to the moon? Will there be any change in the mass?

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55. Among the known types of forces in nature,gravitational force is the weakest.Why

then does it play a diminant role for motin of bodies on the terrestrial,astronomical and cosmological scale?

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56. Do the forces of friction and other contact forces arise due to gravitational attraction? If not, what is the origin of these forces?

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57. Cavendish he is said to have been the first person to have weighed the earth. Comment.

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58. On the surface of earth the weight of a body is about $9.8Nkg^{-1}$ justify the statement

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59. If a planet of a given density were made larger, it's force of attraction for an object on its surface food increase because of planets greater mass, but would decrease because of greater distance from the object to the centre of planet. Which effect does predominate?

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60. Establish the relation: $g=\left(\frac{4}{3}\right)\pi GR\rho$ where ρ is mean density of the earth, R is the

radius of the earth, g is acceleration due to gravity at the surface of the earth and G is gravitational constant.

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61. Prove that acceleration due to gravity is independent of mass.

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62. A bullet is dropped from the same height and the at exactly the same moment, another bullet is fired horizontally. Discuss the motion of each of the two bullets

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63. If the diameter of earth becomes two times its present value and its mass remains unchanged, then how the weight of an object on the surface of the earth be affected?

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64. A tennis ball jumps higher at hills than at planes. Explain.

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65. Why one can jump higher on the surface of moon than on the earth?

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66. If earth suddenly stops rotating about its axis, what would the effect on g? Would this effect be same at all places?

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67. Choose the correct alternative :- Acceleration due to gravity $\in creases/decreases$ with increasing altitude.

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68. the distance of the planet Jupiter from the sun is 5.2 times that of the earth. Find the period of the jupiter's revolution around the sun.

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69. The average distance between the sun and Mars is 1.524 times the average distance between the earth and sun. If the time period of revolution of the earth is $1 year$ find the period of Mars.

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70. The radius of the orbit of the earth is 1.5×10^8km and that of the mars is 2.5×10^{11}m. In how many years, the mars completes its one revolution?

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71. Calculate the gravitational force of attraction between two spherical bodies, each

of mass 2kg placed at 10m apart $\left(G = 6.67 \times 10^{-11} Nm^2 / kg^2\right)$.

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72. A sphere of mass 40 kg is placed at a distance of 0.9 from a sphere of mass 60 kg. If the two spheres attract eacch other with a force of 0.02 mgf, find the value of gravitational constant.

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73. Approximate the gravitational force exerted on the moon by the earth and the sun during a solar eclipse. Given that mass of the sun=2×10^{30}kg, mass of earth =6×10^{24} kg, mass of the moon =2.74×10^{22}kg radius of earth's orbit around the sun = 1.5×10^{11}m and radius of the moon's orbit around the earth =3.8×10^{8}m and G= $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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74. The radius of earth is 6,400 km, mean density of earth is 5,600 kg m and the distance from the earth to the sun is $1.5x10^8$ km. Use the data to calculate the mean force of attraction exerted on the earth by the sun. Assume that the period of revolution of the earth around the sun is 365 days.

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75. The radius of moon is $1.7 \times 10^6 m$ and its mass is $7.35 \times 10^{22} kg$. What is the acceleration due to gravity on the surface of moon ? Given $G = 6.67 \times 10^{-11} Nm^2 / kg^2$.

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76. Plans are being made for a colony on the planet mars. Compute the value of acceleration due to gravity, the colonists would experience on the martian surface?

Given, radius of the mars is 3.4×10^6 m and its mass is $6.44x10^{23}$ kg. Take G= $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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77. Assume that if the earth were made of lead of relative density 11.3gm/cc , then what would be the value of acceleration due to gravity on the earth surface ? Take radius of the earth to be 6.37×10^6 m and G= $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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78. On a planet whose size is the same and mass three times as that of our earth, find the amount of work done to lift 5 kg mass vertically upwards through 10 m distance on the planet. The value of g on the surface of earth is $9.8ms^{-2}$

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79. A 75-kg man weighs 735 N on the Earth's surface. How far above the surface of the Earth would he have to go to lose 10% of his body weight?

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80. A body weighs 90 kg on the surface of earth how much will it weigh on surface of mars whose mass is 1/9 and radius of 1/2 of that of the earth?

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81. An astronaut on the moon measures the acceleration due to gravity to be $1.7ms^{-2}$. He known that the radius of the moon is about 0.27 times that of the earth . Find the ratio of the mass of the earth to that of the moon , if the value of g on the earth's surface is $9.8ms^{-2}$

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82. The radii of the planets are respectively R_1 and R_2, densities are respectively ρ_1, and ρ_2. What is the ratio of acceleration due to gravity at their surface?

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83. The Mount Everst is 8848 m above sea level. Estimate the accelleration due to gravity at this height, given that mean g on the surface of the earth is $9.8ms^{-2}$ and mean radius of

the earth is 6.37×10^6m. Ignore variation in g due to rotation and small departure from spherical shape.

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84. At what height above the surface of the earth acceleration due to gravity will be 25% of its value on the surface of the earth. given radius of earth = 6400 km

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85. how far away from the surface of the earth acceleration due to gravity reduces by 64 % of its value on the surface. radius of earth = 6400 km

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86. how far away from the surface of the earth does the acceleration due to gravity become 4:00 percentage of its value on the surface of earth.radius of earth = 6400 km

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87. At what height above the earth's surface the acceleration due to gravity will be $\frac{1}{9}$ th of its value at the earth's surface? Given radius of earth, $R = 6400km$

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88. Find the percentage decrease in weight of a body when taken 16 km below the surface of the earth. Take radius of the earth 6400 km.

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89. at what depth below the surface of earth, value of g is same as that at a height 64 km above the surface of the earth?

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90. what would be the angular speed of the earth, so that the bodies lying on the equator may appear weightless? Take g=$10ms^{-2}$ radius of earth = 6400 km

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91. At what angular velocity would the earth have to rotate so that bodies at the equator became weightless? The density of the earth is $5600 kg metre^{-3}$ and the universal gravitational constant is $6.67 \times 10^{-11} Nm^2 kg^{-2}$

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92. how many times faster than the present speed of the earth have to rotate about its own axis in order that the apparent weight of the bodies at the equator be zero. given radius of the earth $=6.37 \times 10^6$ m. What would be the duration of the day in that case?

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93. Determine the speed with which they earth have to rotate on its axis so that a person on

the equator would weigh (3/5)th of as much at present. Take the equitorial radius as 6400 km

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94. A body of mass 10 kg is taken from the equator to the pole of the earth. Calculate the change in its weight if the radius of the earth is 6.38×10^6m, time period of the earth's rotation about its axis is 24h.

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95. on the surface of earth a body of mass 20 kg is attracted by a body of mass 165 kg with the equal force of 0.25 mgf. The centres of the two masses are 0.3 m apart. Calculate mass of the earth. Radius of earth = 6400 km and acceleration due to gravity on the surface of the earth g= $9.8ms^{-2}$

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96. The mean angular velocity of the earth around the sun is 1° in 24hours. The distance

from the earth to the sun is 1.5×10^{11}km. Taking G=$6.67 \times 10^{-11} Nm^2 kg^{-2}$, determine the mass of the sun

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97. If the radius of the earth were increased by a factor of 2 keeping the mass constant, by what factors would its density have to be changed to keep g same?

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98. The mean distance of the earth from the sun is 1.496×10^8km and it's siderel Revolution period 365.3 days. The siderel Revolution period of the earth's two neighbouring planets Venus and Mars are respectively 224.7 days and 687.0 days, where a day means a terrestrial day. Find the distance of these planets from the sun. neglect the effect of other planets when considering the motion of the planets around sun.

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99. determine the gravitational force of attraction between uniform sphere of mass M and uniform rod of mass m and length L, if the distance of the near end of the rod from the centre of the sphere is r.

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100. A mass is divided into two parts so that the force of gravitation between them is maximum. Find the ratio of the masses of the two parts.

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101. A man can jump 1.5 m high on the earth. calculate the approximate height he might be able to jump on moon where mean density is $\left(\frac{1}{4}\right)$th and radius is $\left(\frac{1}{3}\right)$rd than that of Earth

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102. is the radius of earth shrinks by 1.5 %, mass remains same then how would the value of acceleration due to gravity change?

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103. If the earth, supposed to be a unifrom sphere contracts slightly so that its radius becomes less by $(1/n)$ than before, show that the length of the day shortens by $(48/n)$ hours

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Exercise

1. State Keplers' laws of planetary motion.

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2. Derive Newton's law of gravitation from Kepler's law.

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3. Show that the angular momentum is equal to twice the product of mass and real velocity.

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4. explain how the mass of the sun can be found by studying the motion of the earth around it

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5. State and explain Newton's third Law of motion.

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6. Explain Newton's laws of gravitation and hence deduce the definitin of universal gravitational constant.

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7. State the universal law of gravitation.

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8. What is meant by acceleration due to gravity ?

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9. The acceleration due to gravity depends on

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10. Derive an expression for the variation of acceleration due to gravity with depth.

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11. How g and G are related?

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12. show that the acceleration of free fall g at the surface of earth and gravitational constant are related by the expression $g = \left(\frac{4}{3}\right)\pi\rho GR$ where ρ is mean density of earth and R is the radius of earth

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13. Starting from the expression of gravitational force between two bodies obtain the expression for the mass of the earth

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14. How does value of acceleration due to gravity vary with altitude

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15. How does value of acceleration due to gravity vary with altitude

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16. What do you mean by acceleration due to gravity?

Watch Video Solution

17. What do you mean by acceleration due to gravity?

Watch Video Solution

18. Define acceleration due to gravity. What is the value?

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19. Derive an expression for the variation of acceleration due to gravity with depth.

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20. The acceleration due to gravity depends on

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21. The value of g at the centre of the earth is

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22. prove that the distance we have to cover into earth below its surface is two times the distance we have to cover above the surface to get the same change in the value of g.

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23. How can you say that the value of acceleration due to gravity at the surface of the earth is more than that at points above and below it.

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24. Calculate the mass and mean density of the earth from the following data: Gravitational constant (G),= $6.6 \times 10^{-11} Nm^2 kg^{-2}$, Radius of the earth (R

)=6.37×10^{6}m, Acceleration due to gravity (g)= $9.8ms^{-2}$

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25. State the universal law of gravitation.

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26. Define acceleration due to gravity. What is the value?

Watch Video Solution

27. Define acceleration due to gravity. What is the value?

Watch Video Solution

28. Define acceleration due to gravity. What is the value?

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29. The acceleration due to gravity depends on

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