PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

GRAVITATION

Example

1. A particle of mass $1kg$ is kept on the surface of a uniform sphere of mass $20kg$ and radius $1.0m$. Find the work to be done against the gravitational force between them to take the particle away from the sphere.

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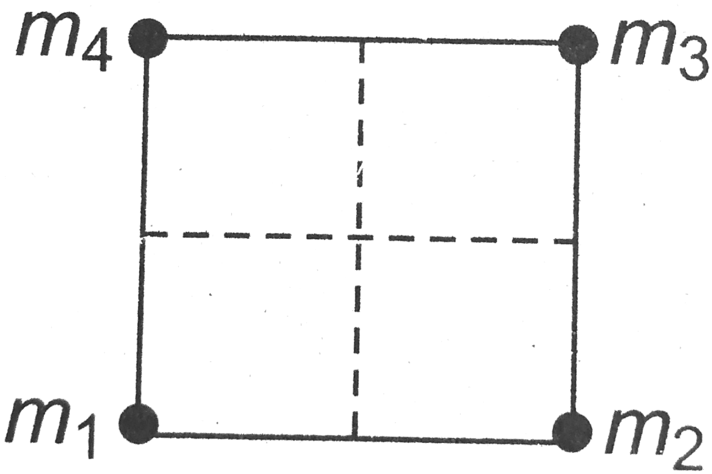
2. Four paticle of masses $m_1 = 2m, m_2 = 4m, m_3 = m$ and m_4 are placed at four corners of a square. What should be the value of m_4 so that the centres of mass of all the four particle are exactly at the centre of the square ?



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3. (a) An astronaut whose height h is 1.70 m floats "feet down" in an orbiting space shuttle at distance $r = 6.77 \times 10^6$m away from the centerof Earth. What is the difference between the gravitational ecceleration at her feet and at her head ?

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4. An asteroid, headed directly toward Earth, has a speed of 12 km/s relative to the planet when the asteroid is 10 Earth radii from Earth's center. Neglecting the effects of Earth's atmosphere on the asteroid, find the asteroid's speed v_f when it reaches Earth's surface.

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5. Comet Halley orbits the sun with a period of 76 years and, in 1986,had a distance of closestapproach to the Sun, its perihelion distance R_p,of $8.9 \times 10^{10} m$.Table 13-3 shows that this is between the orbits of Mercury and Venus.

(a) What is the comet's farthest distance from the Sun, which is called its aphelion distanceR_a?

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6. A playful astronaut raleases a bowling ball, of mass m= 7.20 kg, into circular orbit about Earth at an altitude h of 350 km.

(a) What is the mechanical energy E of the ball in its orbit ?

(b) What is the mechanical energy E_0 of the ball on the launchpad at the Kennedy Space Center (bofore launch) ?

From there to the orbit, what is the change ΔE in the ball's mechanical energy?

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7. A spaceship of mass $m = 4.50 \times 10^3 kg$ is in a circular Earth orbit of radius $r = 8.00 \times 10^6$ m and period $T_0 = 118.6$ min $= 7.119 \times 10^3$ s when a thruster is fired in the forward direction to decrease the speed to 96.0% of the original speed. What is the period T of the resulting elliptical orbit ?

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Checkpoint

1. A particle is to be placed, in turn, outside four objects each of mass m:(1) a large uniform solid sphere, (2) a large uniform spherical shell,(3) a small uniform solid sphere, and (4) a small uniform shell. In each situation,the distance between the particle and the center of the object is d. Rank the objects according tothe magnitude of the gravitational force they exert on the particle, greatest first.

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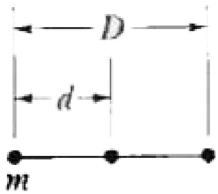
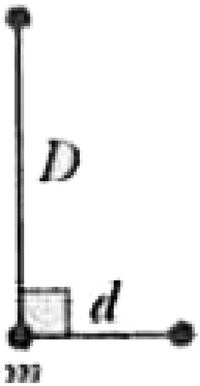
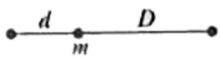
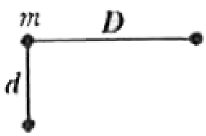
2. The figure shows four arrangements of three particles of equal masses. (a) Rank the arrangements accroding to the magnitude of the net gravitational force on the particlelabeled m, greatest first. (b) In arrangement 2, is the direaction of the net force closer of the line of length d or to theline of length D

?

A. 

B. 

C. 

D. 

Answer:

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3. You move a ball of mass m away form a sphere of mass M. (a) Does the gravitational patential energy of the systemof ball and sphere increase or decrease ? (b) Is positive work or negative work done by the gravitational force between the ball and the sphere ?

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4. Satellite 1 is in a certain circular orbit around a planet, while satellite 2 is in a larger circular orbit. Which satellite has (a) the longer period and (b) the greater speed ?

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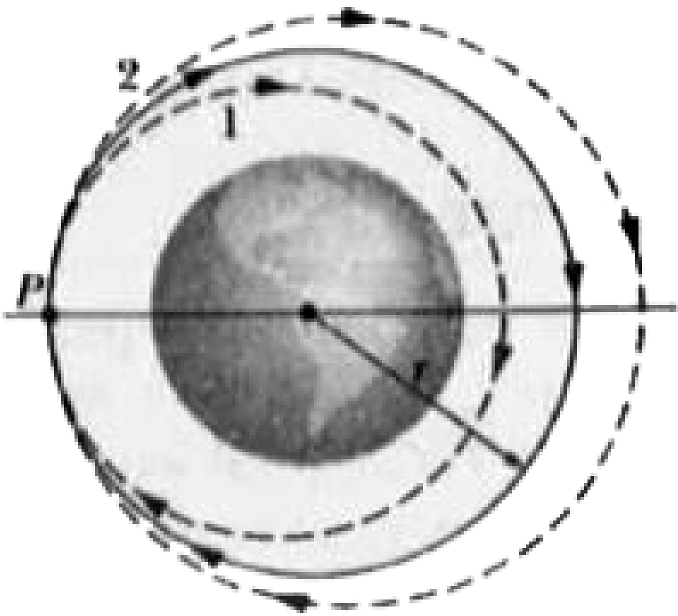
5. In the figure here, a space shuttle is initially in a circular orbit of radius r about Earth. At point P,the pilot briefly fires a forward-pointing thruster to decrease the shuttle's kinetic energy K and mechanical energy E. (a) Which of the dashed elliptical orbits shows in the firgure will the shuttle then take ? (b) is the orbital period T of the shuttle (the time to return to P) then greater then, less than, or the same as in the circular orbit ?



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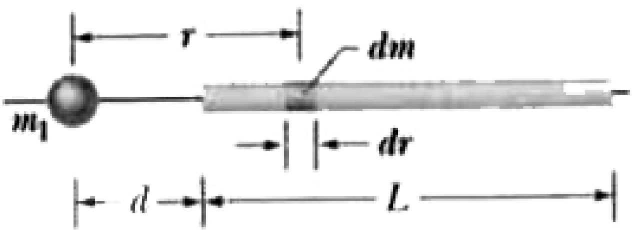
Problems

1. A particle of mass $m_1 = 0.67kg$ is a distance d = 23 cm from one end of a uniform rod with length L = 2.5 m and mass M = 4.0 kg. What is the magnitude of the gravitational for $\vec{F}$ the particle from the rod ?



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2. Two neutron stars are separated by a distance of 1.0×10^{11} m. They each have a mass of 1.0×10^{30} kg and a radius of 2.0×10^{5} m. They are initially at rest with respect to each other. As measured from that rest frame, how fast are they moving when (a) their separation has decreased to one-half its initial value and (b) they are about to collide ?

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3. In a certain binary-star system, each star has the same mass as our Sun, and they revolve about their center of mass. The distance between them is the same as the distance between Earth and the Sun. What is their period of revolution in years ?

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4. Miniature black holes. Left over from the big-bang beginning of the uniberse, tiny black holes might still wander through the universe. If one with a mass of $5.0 \times 10^{11} kg$ (and a radius of only $5.0 \times 10^{-16} m$) reached Earth, at what distance from your head would its gravitational pull on you match that of Earth's?

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5. A rocket is to be shot radially outward from Earth's surface. Neglecting Earth's rotation, find the radial distance from Earth's center that the rocket reaches if it is launched with (a) 0.400 times the escape speed from Earth and (b) 0.400 times the kinetic energy that is required to escape Earth. (c) At launch, what is the least mechanical energy required for it to escape Earth ?

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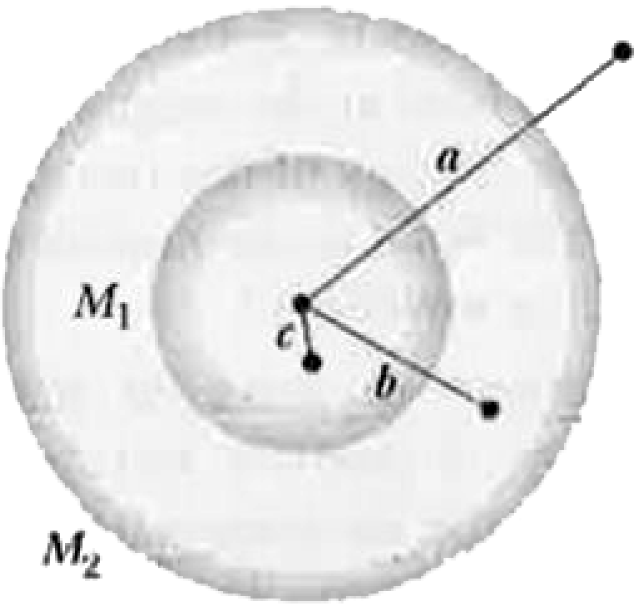
6. Two concentric sperical shells with uniformly distributed masses $M_1 = 5.00 \times 10^3 kg$ and $M_2 = 9.00 \times 10^3 kg$ are situated as shown. Find the magnitude of the net gravitational force on a particle of mass $m = 2.00$ kg due to the shells, when the particle is located at radial distance (a) a = 11.0 m, (b) b = 6.00 m and (c) c = 2.00 m.



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7. At what height above Earth's surface is the energy required to lift a satellite to that height equal to the kinetic energy required for the satellite to be in orbit at that height ?(b) For greater heights, which is greater, the energy for lifting or the kinetic energy for orbiting ?

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8. We want to position a space probe along a line that extends directly toward the Sun in order to monitor solar flares. How far from Earth's center is the point on the line where the Sun's gravitational pull on the probe balances Earth's pull ?

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9. Two satellites, A and B, both of mass $m = 150kg$, move in the same circular orbit of radius $r = 7.87 \times 10^{6}$m around Earth but in opposite senses of rotationand therefore on a collision course. (a) Find the total mechanical energy $E_A + E_B$ of the two satellites + Earth system before the collision. (b) If the collision is completely inelastic so that the wreckage remains as on piece of tangled meterial (mass = 2m), find the total mechanical energy immediately after the collision. (c) Just after the collision,is the wreckage falling directly toward

Earth's center or orbiting around Earth ?

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10. A satellite is in a circular Earth orbit of radius r. The area A enclosed by the orbit depends on r^2 because $A = \pi r^2$. Determine how the following properties of the satellite depend on r. (a)period, (b) kinetic energy, (c) angular momentum, and (d) speed.

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11. Three deminsions. Three point particles are fixed in place in a xyz coordinate system. Particle A, at the origin, has mass m_A. Particle B, at xyz coordinates (2.00d,1.00d. 200), has mass 2.00 m_A, and particle C, at coordinates (-1.00d,2.00d,-3.00d), has mass $3.00 m_A$. A fourth particle D,with mass $4.00 m_A$,is to be placed near the other particles. In terms of distance d, at what (a)x, (b)y, and (c)z coordinate should D be placed so that the net gravitational force on A from B, C, and D is zero ?

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12. A comet that was seen in April 574 by Chinese astronomers on a day known by them as the Woo Woo day was spotted again in May 1994. Assume the time between observations is the period of the Woo Woo day comet and its eccentricity is 0.9932. What are (a) the semimajor axis of the comet's orbit and (b) its greatest distance from the Sun in terms of the mean orbital radius R_p of Pluto?

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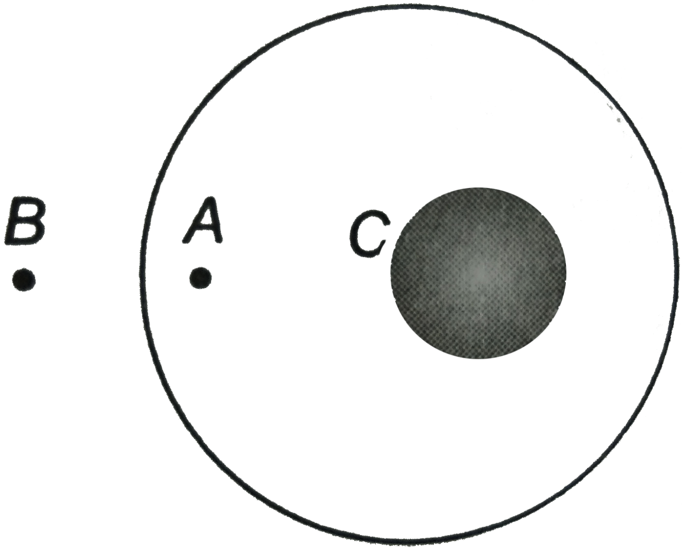
13. A uniform metal sphere of radius R and mass m is surrounded by a thin uniform spherical shell of same mass and radius $4R$. The centre of the shell C falls on the surface of the inner sphere. Find the gravitational fields at points A and B.



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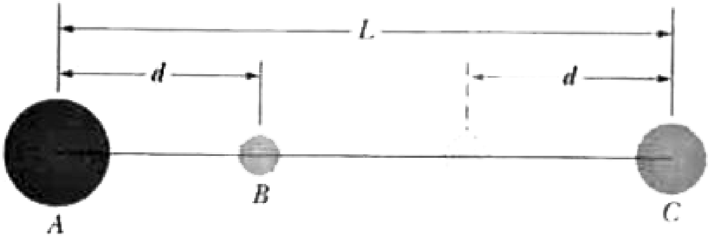
14. The three spheres in with masses $m_A = 80g, m_B, = 10g,$ and $m,_C = 20g$, have their centers on a common line, with L = 14 cm and d = 2.0 cm. You move sphere B along the line until its center-to-center separation from C is d = 2.0 cm. How much work is done on sphere B (a) by you and (b) by the net gravitational force on B due to spheres

A and C?



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15. The Sun and Earth each exert a gravitational force on the Moon. What is the ratio $F_{\text{sun}} / F_{\text{Earth}}$ of these two forces? (The average Sun-Moon distance is equal to the Sun Earth distance.)

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16. The first known collision between space debris and a functioning satellite occurred in 1996: At an altitude of 700 km,

a year-old French spy satellite was hit by a piece of an Ariane rocket. A stabilizing boom on the satellite was demolished, and the satellite was sent spinning out of control. Just before the collision and in kilometers per hour, what was the speed of the rocket piece relative to the satellite if both were in circular orbits and the collision was (a) head-on and (b) along perpendicular paths?

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17. The Sun's center is at one focus of Earth's orbit. How far from this focus is the other focus, (a) in meters and (b) in terms of the solar radius, 6.96×10^{8} m? The eccentricity is 0.0167, and the semimajor axis is 1.50×10^{11} m.

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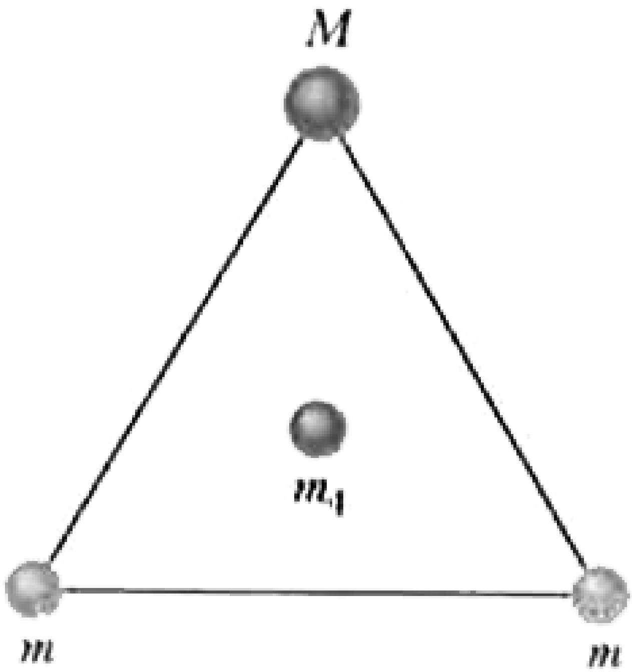
18. As seen in two spheres of mass m and a third sphere of mass M form an equilateral triangle, and a fourth sphere of mass m_4 is at the center of the triangle. The net gravitational force on that central sphere from the three other spheres is zero. (a) What is M in terms of m? (b) If we double the value of m_4 what then is the magnitude of the net gravitational force on the central sphere?



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19. A satellite is in circular orbit about Earth at an altitude of 300 km. What are its (a) orbital period, (b) orbital fre quency, and (c) linear speed?

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20. An orbiting satellite stays over a certain spot on the equator of (rotating) Earth. What is the altitude of the orbit (called a geosynchronous orbit?

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21. What multiple of the energy needed to escape from Earth gives the energy needed to escape from (a) a moon of mass

1.472×10^{23} kg and radius 3.480×10^{6} m and (b) Jupiter?

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22. Two particles are separated by 19 m when their gravitational attraction has a magnitude of 4.0×10^{-12} N. If the mass of particle 1 is 5.2 kg, what is the mass of particle 2?

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23. What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R?

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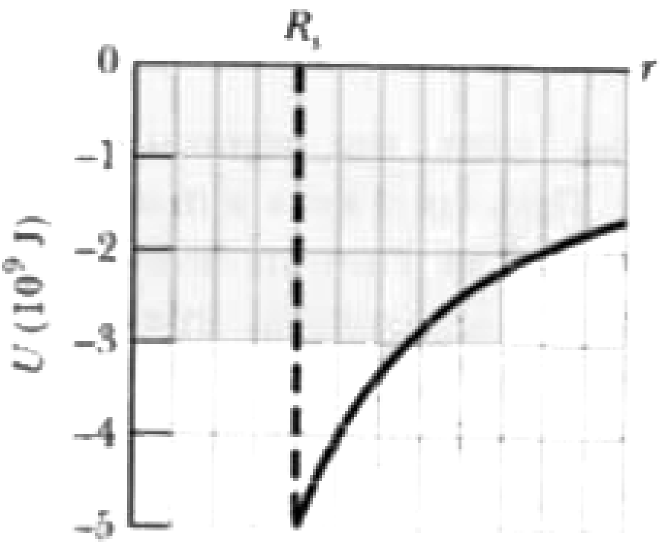
24. Gives the potential energy function U(r) of a projectile, plotted outward from the surface of a planet of radius R_s. If the projectile is launched radially outward from the surface with a mechanical energy of -2.0×10^9 J, what are (a) its kinetic energy at radius $r = 1.15R_s$, and (b) its turning point (see Section 8.4) in terms of R_s?



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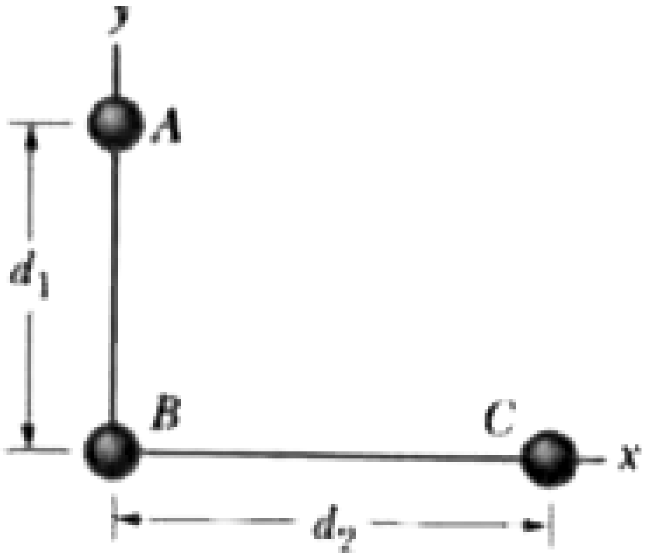
25. Three 8.00 kg spheres are located at distances d_1 = 0.300 m and d_2 = 0.400 m. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the net gravitational force on sphere B due to spheres A and C?



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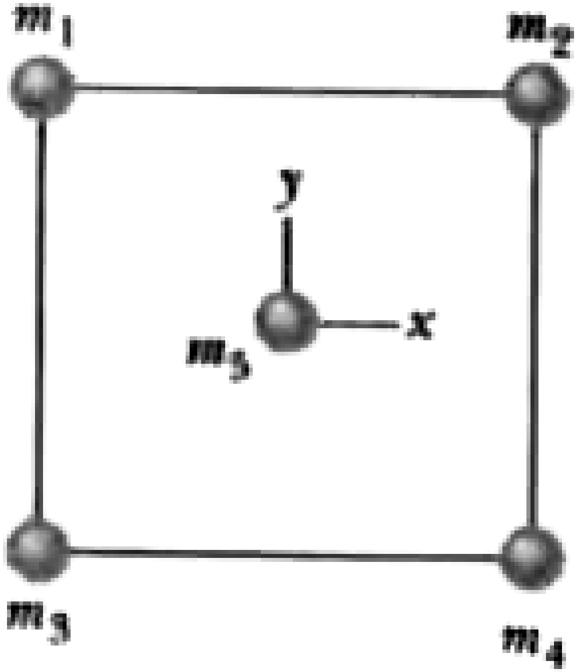
26. A square of edge length 20.0 cm is formed by four spheres of masses

$m_1 = 5.00g$, $m_2 = 3.00g$, $m_3 = 1.00g$, and $m_4 = 5.00g$. In unit-vector notation, what is the net gravitational force from them on a central sphere with mass $m_5 = 2.00g$?



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27. In deep space, sphere A of mass 20 kg is located at the origin of an x axis and sphere B of mass 10 kg is located on the axis at x = 0.95 m. Sphere B is released from rest while sphere A is held at the origin. (a) What is the gravitational potential energy of the two-sphere system just as B is released? (b) What is the kinetic energy of B when it has moved 0.15 m toward A?

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28. Consider an object of mass M that is small enough to be treated as a particle but large enough that a section of mass m can be removed and positioned 3.0 mm from the remaining part. To maximize the magnitude of the gravitational force between the removed section and the remaining part, what should the ratio of m/M be?

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29. A mars satellite moving in an orbit of radius 9.4×10^3 km take 27540 s to complete one revolution. Calculate the mass of mars.

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30. In 1610, Galileo used his telescope to discover four moons around Jupiter, with these mean orbital radii a and periods T.

Name	$a(10^8$ m)	T (days)
Io	4.22	1.77
Europa	6.71	3.55
Ganymede	10.7	7.16
Callisto	18.8	16.7

(a) Plot log a (y axis) against log T (x axis) and show that you get a straight line. (b) Measure the slope of the line and compare it with the value that you expect from Kepler's third law. (c) Find the mass of Jupiter from the intercept of this line with the y axis.

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31. Three identical stars of mass M form an equilateral triangle that rotates around the triangle's center as the stars move in a common circle about that center. The triangle has edge length L. What is the speed of the stars?

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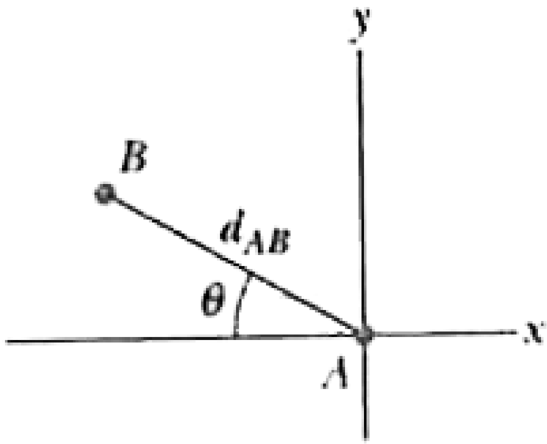
32. Three point particles are fixed in position in an xy plane. Two of them, particle A of mass 6.00 g and particle B of mass 12.0 g, are shown with a separation of $d_{AB} = 0.500 m$at angle $\theta = 30^{\circ}$. Particle C, with mass 10.0 g, is not shown. The net gravitational force acting on particle A due to particles B and C is 2.77×10^{-14} N at an angle of -163.8° from the positive direction of the x axis. What are (a) the x coordinate and (b) the y coordinate of particle C?



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33. A satellite, moving in an elliptical orbit, is 1440 km above Earth's surface at its farthest point and 180 km above at its closest point. Calculate (a) the semimajor axis and (b) the eccentricity of the orbit.

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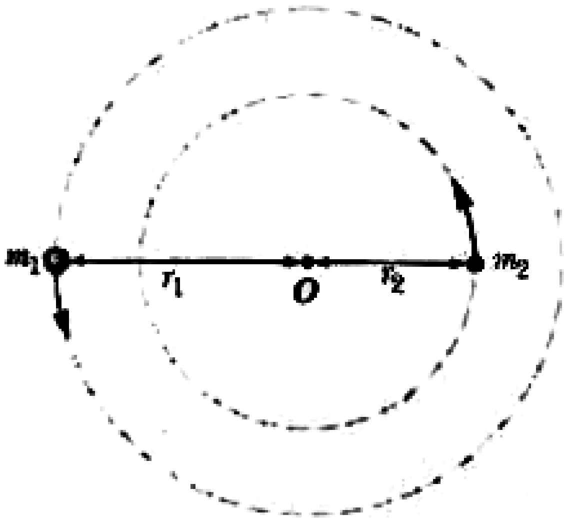
34. Hunting a black hole. Observations of the light from a certain star indicate that it is part of a binary (two-star) system. This visible star has orbital speed y = 270 km/s, orbital period T = 1.70 days, and approximate mass $m_1 = 6M_s$ where M_s is the Sun's mass, $1.99 \times 10^{30} kg$. Assume that the visible star and its companion star, which is dark and unseen, are both in circular orbits . What integer multiple of M gives the approximate mass m_2 of the dark star?



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35. (a) What is the escape speed on a spherical asteroid whose radius is 700 km and whose gravitational acceleration at the surface is $4.5m / s^2$? (b) How far from the surface will a particle go if it leaves the asteroid's surface with a radial speed of 1000 m/s? (c) With what speed will an object hit the asteroid if it is dropped from 1000 km above the surface?

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36. At what altitude above Earth's surface would the gravitational acceleration be $2.0m/s^2$?

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37. An asteroid, whose mass is 2.0×10^{-4} times the mass of Earth, revolves in a circular orbit around the Sun at a distance that is 3.0 times Earth's distance from the Sun. (a) Calculate the period of revolution of the asteroid in years. (b) What is the ratio of the kinetic energy of the asteroid to the kinetic energy of Earth?

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38. The radius R_h and massM_h of a block hole are related by $R_h = 2GM_h / c^2$, where c is the speed of light. Assume that the gravitational acceleration a_g of an object at a distance $r_o = 1.001R_h$ from the center of a block hole is given by (it is, for large block holes). (a) In terms of M_h increases ? (b) Does a_g at r_o increase or decease as $M_h$increases ? (b) Does a_g at r_o increase or decrease as M_h increase ? (c) What is a_g at r_o for a very large black hole whose mass is 1.55×10^{12} times the solar mass of 1.99×10^{30} kg ? (d) If an astronaut of height 1.66 m is at r_o with her feet down, what is the difference in gravitational acceleration between her head the difference in gravitaional acceleration between her head and feet ? (e) Is the tendency to stretch the astronaut severe ?

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39. One way to attack a satellite in Earth orbit is to launch a swarm of pellets in the same orbit as the satellite but in the opposite direction. Suppose a satellite in a circular orbit 500 km above Earth's surface collides with a pellet having mass 5.0 g. (a) What is the kinetic energy of the pellet in the reference frame of the satellite just before the collision? (b) What is the ratio of this kinetic energy to the kinetic energy of a 5.0 g bullet from a modern army rifle with a muzzle speed of 950 m/s?

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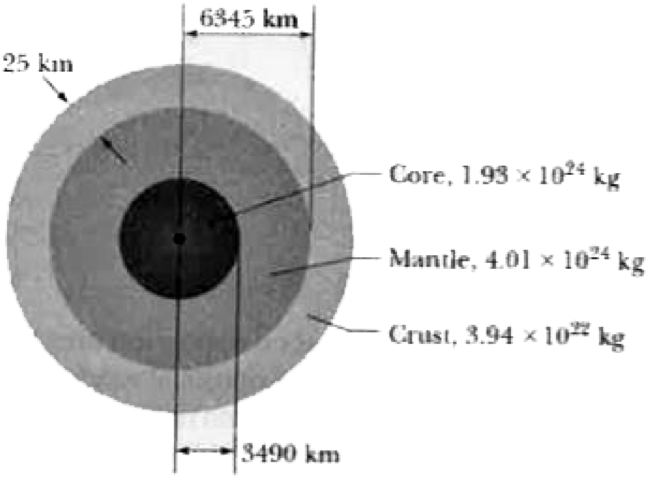
40. Not to scale, a cross section through the interior of Earth. Rather than being uniform throughout, Earth is divided into three zones: an outer crust, a mantle, and an inner core. The dimensions of these zones and the masses contained within them are shown on the figure. Earth has a total mass of 5.98×10^{21} kg and a radius of 6370 km. Ignore rotation and assume that Earth is spherical. (a) Calculate a at the surface. (b) Suppose that a bore hole (the Mohole) is driven to the crust-mantle interface at a depth of 25.0 km, what would be the value of a_g at the bottom of the hole? (C) Suppose that Earth were a uniform sphere with the same total mass and size. What would be the value of a_g at a depth of 25.0 km? (Precise measurements of a_g are sensitive probes of the interior structure of Earth, although results can be clouded by local variations in mass distribution.)



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41. Moon effect. Some people believe that the Moon controls their activities. If the Moon moves from being directly on the opposite side of Earth from you to being directly overhead, by what percent does (a) the Moon's gravitational pull on you increase and (b) your weight (as measured on a scale) decrease? Assume that the Earth-Moon (center-to-center) distance is 3.82×10^{8} m and Earth's radius is 6.37×10^{6} m.

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42. In Problem 29, what ratio m/M gives the least gravitational potential energy for the system?

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43. A solid sphere has a uniformly distributed mass of $1.0 \times 10^{4} g$ and a radius of 1.0 m. What is the magnitude of the gravitational force due to the sphere on a particle of mass m = 2.0 kg when the particle is located at a distance of (a) 1.5 m and (b) 0.50 m from the center of the sphere? (c) Write a general expression for the magnitude of the gravitational force on the particle at a distance $r \leq 1.0$, from the center of the sphere.

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44. Two Earth satellites, A and B, each of mass m, are to be launched into circular orbits about Earth's center. Satellite A is to orbit at an altitude of 6370 km. Satellite B is to orbit at an altitude of 19 850 km. The radius of Earth R, is 6370 km. (a) What is the ratio of the potential energy of satellite B tu trial of satellite A, in orbit? (b) What is the ratio of the kinetic energy of satellite R to that of satellite A, in orbit? (C) Which satellite has the greater total energy if each has a mass of 14.6 kg? (d) By how much?

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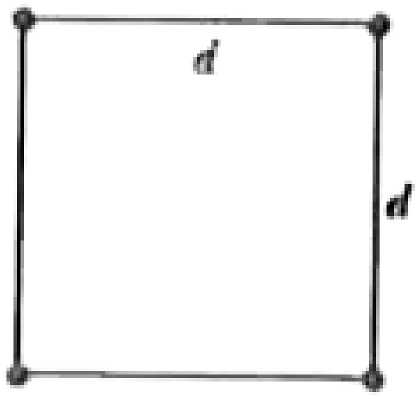
45. Four particles, each of mass 20.0 g, that form a square with an edge length of d = 0.600 m. If d is increased to 1.20 m, what is the change in the gravitational potential energy of the four-particle system?



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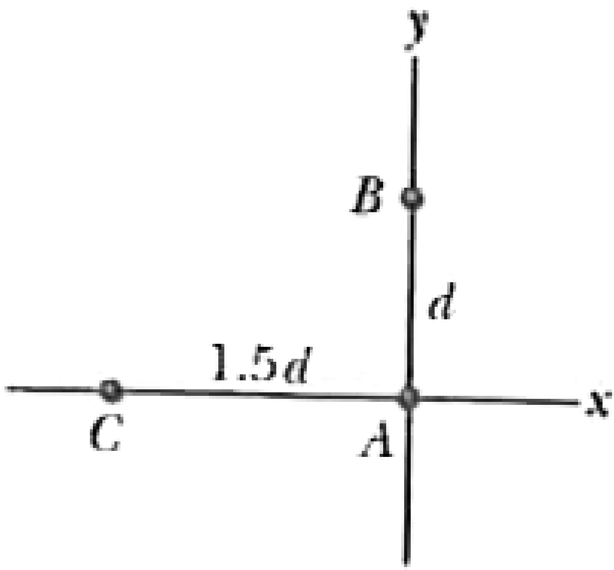
46. Two dimensions. Three point particles are fixed in place in an xy plane. Particle A has mass m_A, particle B has mass $2.00m_A$ and particle C has mass $3.00m_A$. A fourth particle D, with mass $12.0m_A$ is to be placed near the other three particles. In order for the net force on particle A due to the other three particles to be zero, where should particle D be located? Give (a) the distance from A in terms of d and (b) the angle relative to the positive direction of the x axis?



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47. What are (a) the speed and (b) the period of a 400 kg satellite in an approximately circular orbit 900 km above the surface of Earth? Suppose the satellite loses mechanical energy at the average rate of 1.4×10^5 J per orbital revolution. Adopting the reasonable approximation that the satellite's orbit becomes a "circle of slowly diminishing radius," determine the satellite's (c) altitude, (d) speed, and (e) period at the end of its 1500th revolution. (f) What is the magnitude of the average retarding force on the satellite? Is angular momentum around Earth's center conserved for (g) the satellite and (h) the satellite-Earth system (assuming that system is isolated)?

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48. Zero, a hypothetical planet, has a mass of 5.0×10^2 kg, a radius of 3.5×10^6 m, and no atmosphere. A 10 kg space probe is to be launched vertically from its surface. (a) If the probe is launched with an initial energy of 5.0×10^7 J, what will be its kinetic energy when it is 4.0×10^6m from the center of Zero? (b) If the probe is to achieve a maximum distance of 8.0×10^6 m from the center of Zero, with what initial kinetic energy must it be launched from the surface of Zero?

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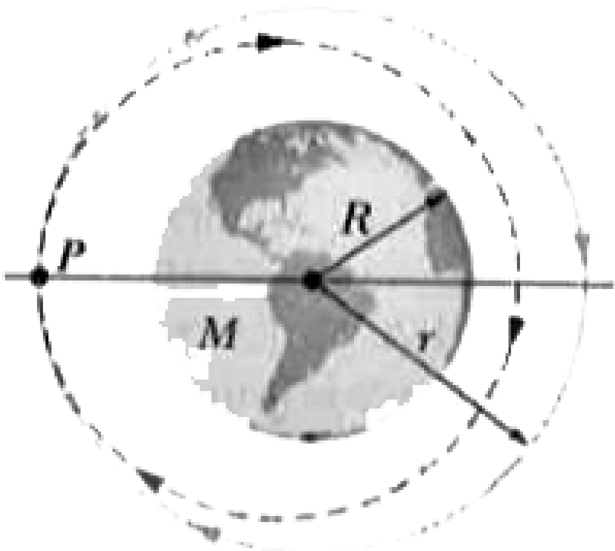
49. Two small spaceships, each with mass m = 1500 kg, are in the circular Earth orbit of at an altitude h of 400 km. Igor, the commander of one of the ships, arrives at any fixed point in the orbit 90 s ahead of Picard, the commander of the other ship. What are the (a) period T_0 and (b) speed v_0 of the ships? At point P in Fig. 13-35, Picard fires an instantaneous burst in the forward direction, reducing his ship's speed by 100%. After this burst, he follows the elliptical orbit shown dashed in the figure. What are the (c) kinetic energy and (d) potential energy of his ship immediately after the burst? In Picard's new elliptical orbit, what are (e) the total energy E. (f) the semimajor axis a, and (g) the orbital period T? (h) How much earlier than Igor will Picard return to P?



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50. The mean distance of Mars from the Sun is 1.52 times that of Earth from the Sun. From Kepler's law of periods, calculate the number of years required for Mars to make one revolution around the Sun, compare your answer with the value given in Appendix C.

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51. (a) What will an object weigh on the Earth's surface if it weighs 160 N on the Moon's surface? (b) How many Earth radii must this same object be from the center of Earth if it is to weigh the same as it does on the Moon?

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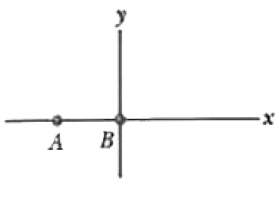
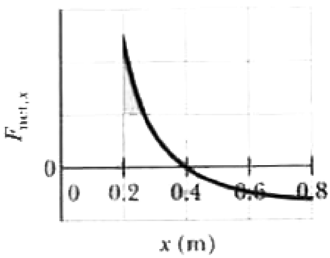
52. Particle A is fixed in place at x = -0.20 m on the x axis and particle B, with a mass of 1.5 kg, is fixed in place at the origin. Particle C (not shown) can be moved along the x axis, between particle B and $x = \infty$. shows the x component $F_{\text{net,x}}$ of the net gravitational force on particle B due to particles A and C, as a function of position x of particle C. The plot actually extends to the right, approaching an asymptote of -4.17×10^{-10} N as $x \to \infty$. What are the masses of (a) particle A and (b) particle C?



(a)



(b)

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53. A uniform solid sphere of radius R produces a gravitational acceleration of a_g on its surface. At what distance from the sphere's center are there points (a) inside and (b) outside the sphere where the gravitational acceleration is $a_g/2$?

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54. A satellite is put in a circular orbit about Earth with a radius equal to two-thirds the radius of the Moon's orbit. What is its period of revolution in lunar months? (A lunar month is the period of revolution of the Moon)

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55. The mean diameters of Mars and Earth are 6.9×10^3 km and 1.3×10^4 km, respectively. The mass of Mars is 0.11 times Earth's mass. (a) What is the ratio of the mean density (mass per unit volume) of Mars to that of Earth? (b) What is the value of the gravitational acceleration on Mars? (c) What is the escape speed on Mars?

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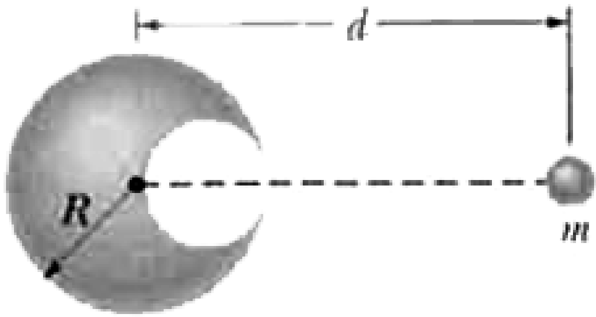
56. A spherical hollow inside a lead sphere of radius R = 2.00 cm, the surface of the hollow passes through the center of the sphere and "touches" the right side of the sphere. The mass of the sphere before hollowing was M = 2.95 kg. With what gravitational force does the hollowed-out lead sphere attract a small sphere of mass m = 0.950 kg that lies at a distance d 9.00

cm from the center of the lead sphere, on the straight line connecting the centers of the spheres and of the hollow?



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57. At what angular speed of rotation is the surface material on the equator of a neutron star on the verge of flying off the star if the star is spherical with a radius of 18.0 km and a mass of 7.72×10^{24} kg?

Watch Video Solution

58. Mountain pull. A large mountain can slightly affect the direction of "down" as determined by a plumb line. Assume that we can model a mountain as a sphere of radius R = 1.80 km and density (mass per unit volume) $2.6x10^3 kg/m^3$. Assume also that we hang a 0.50 m plumb line at a distance of 3R from the sphere's center and such that the sphere pulls horizontally on the lower end. How far would the lower end move toward the sphere?

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59. The Sun, which is 2.2×10^{20} m from the center of the Milky Way galaxy, revolves around that center once every 2.5×10^8 years. Assuming each star in the Galaxy has a mass equal to the Sun's mass of 2.0×10^{30} kg, the stars are distributed uniformly in a sphere about the galactic center, and the Sun is at the edge of that sphere, estimate the number of stars in the Galaxy.

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60. Assume a planet is a uniform sphere of radius R that (somehow) has a narrow radial tunnel through its center (Fig. 13-8). Also assume we can position an apple anywhere along the tunnel or outside the sphere. Let F_R be the magnitude of the gravitational force on the apple when it is located at the planet's surface. How far from the surface is there a point where the magnitude is $1/3F_R$ if we move the apple (a) away from the planet and (b) into the tunnel?

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61. (a) What is the gravitational potential energy of the two-particle system in Problem 22? If you triple the separation between the particles, how much work is done (b) by the gravitational force between the particles and (c) by you?

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62. A satellite circles a planet of unknown mass in circular orbit of radius $2 \times 10^7 m$. The magnitude of the gravitational forcce exerted on the satellite by the planet is 80 N . The kinetic energy of satellite in this orbit in joule is

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63. A 30 kg satellite has a circular orbit with a period of 2.0 h and a radius of 9.0×10^6 m around a planet of unknown mass. If the magnitude of the gravitational acceleration on the surface of the planet is $6.0m/s_2$. what is the radius of the planet?

Watch Video Solution

Practice Questions Single Correct Choice Type

1. Read the following statements :

S_1 : An object shall weigh more at pole than at equator when weighed by using a physical balance.

S_2 : It shall weigh the same at pole and equator when weighed by using a physical balance.

S_3 : It shall weigh the same at pole and equator when weighed by using a spring balance.

S_4 : It shall weigh more at the pole than at equator when weighed using a spring balance.

Which of the above statements is/are correct ?

A. At the North Pole.

B. At the Equator.

C. Near the center of Earth.

D. On the Moon.

Answer: C

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2. A spaceship is launched into a circular orbit close to the earth's surface . What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull. Radius of earth $= 6400 km, g = 9.8 m / s^2$.

A. 2.458 km/s

B. 5.343 km/s

C. 3.278 km/s

D. 4.811 km/s

Answer: C

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3. Three point masses 'm' each are placed at the three vertices of an equilateral traingle of side 'a'. Find net gravitational force on any point mass.

A. $\frac{2Gm^2}{d^2}$

B. $\frac{Gm^2}{d^2}$

C. $\frac{\sqrt{3}Gm^2}{d^2}$

D. $\frac{\sqrt{3}Gm^2}{2d^2}$

Answer: C

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4. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius (1.01) R. The period of the second satellite is larger than the first one by approximately

A. 0.007

B. 0.015

C. 0.01

D. 0.03

Answer: B

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5. 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. $T^2 \propto r^3$

B. $T \propto r^2$

C. $T \propto r$

D. $T \propto \sqrt{r}$

Answer: C

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6. The orbit of a certain a satellite has a semi-major axis of 1.5×10^7 m and an eccentricity of 0.20. Its perigee (minimum distance) and apogee (maximum distance), respectively, are

A. $6.0 \times 10^6 m, 9.0 \times 10^6 m$

B. $3.0 \times 10^6 m, 1.2 \times 10^7 m$

C. $1.2 \times 10^7 m, 1.8 \times 10^7 m$

D. $1.0 \times 10^7 m, 1.2 \times 10^7 m$

Answer: A

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7. Let the acceleration due to gravity be g_1 at a height h above the earth's surface g_2 at a depth d below the earth's surface. If $g_1 = g_2, h < \, < R$ and $d < \, < R$ then

A. h=d

B. h=2d

C. 2h =d

D. It is not possible for g_1 to be equal to g_2

Answer: C

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8. Consider a planet in some solar system which has a mass double the mass of the earth and density equal to the average density of the earth. An object weighing W on the earth will weigh

A. W

B. 2W

C. $\frac{W}{2}$

D. $2^{1/3}$ W at the planet

Answer: D

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9. The astronaut in a satellite, moving in a circular orbit around the earth, experiences a feeling of weightlessness because

A. falls directly down to the Earth.

B. continues in orbit at reduced speed.

C. continues in orbit with the satellite.

D. flies off tangentially into space.

Answer: C

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10. A particle of mass $1kg$ is placed at a distance of $4m$ from the centre and on the axis of a uniform ring mass $5kg$ and radius $3m$. The work done to increase the distance of the particle from $4m$ to $3\sqrt{3}$m is

A. $1.05 \times 10^{-11} J$

B. $1.11 \times 10^{-11} J$

C. $1.43 \times 10^{-11} J$

D. $1.80 \times 10^{-11} J$

Answer: B

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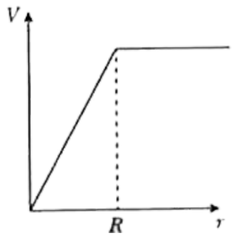
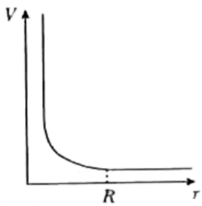
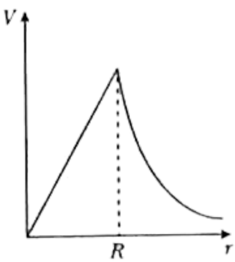
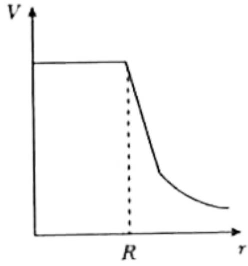
11. A spherically symmetric gravitational system of particles has a mass density $\rho = \begin{cases} \rho_0 & f \text{ or } \quad r \; < \; R \\ 0 & f \text{ or } \quad r \; > \; R \end{cases}$ where ρ_0 is a constant. A test mass can undergo circular motion under the influence of the gravitational field of particles. Its speed v as a function of distahce $r(0 < r < OO)$ form the centre of the system is represented by

A. 

B. 

C. 

D. 

Answer: C

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12. A planet of radius $R = \frac{1}{10} \times (radius of Earth)$ has the same mass density as Earth. Scientists dig a well of depth $\frac{R}{5}$ on it and lower a wire of the same length and a linear mass density $10^{-3} kgm(_ 1)$ into it. If the wire is not touching anywhere, the force applied at the top of the wire by a person holding it inplace is (take the radius of Earth $= 6 \times 10^6 m$ and the acceleration due to gravity on Earth is $10 ms^{-2}$

A. 96 N

B. 108 N

C. 120 N

D. 150 N

Answer: D

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13. A system of binary stars of mass m_A and m_B are moving in circular orbits of radii r_A and r_B respectively. If T_A and T_B are at the time periods of masses m_A and m_B respectively then

A. $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{3/2}$

B. $T_A > T_B \text{ if } r_A > r_B$

C. $T_A > T_B \text{ if } m_A > m_B$

D. $T_A = T_B$

Answer: D

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14. How far from earth must a body be along a line towards the sun so that the sun's gravitational pull on it balances that of the earth . Distance between sun and earth's centre is 1.5×10^{10} km . Mass of the sun is 3.24×10^5 times mass of the earth .

A. $1.30 \times 10^8 m$

B. 2.60×10^8m

C. 3.90×10^8m

D. $5.20 \times 10^8 m$

Answer: B

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15. An elevator is supported by a single cable.There is no counter weight.The.elevator receives passengers atthe ground floor and takes them to the top floor, where they disembark. New passengers enter and are taken down to the ground floor. During this round trip, when is the tension in the cable equal to the weight of the elevator plus passengers ? When greater ? When less ?

A. The net work done by the two forces is zero.

B. The magnitude of work done by the gravitational force is greater than that done by tension.

C. The magnitude of the work done by the tension is greater than that done by the gravitational force.

D. The net work done by the gravitational force is negative.

Answer: A

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16. A satellite orbiting close to the surface of earth does not fall down because the gravitational pull of earth

A. The Earth does not exert any force on the water.

B. The Earth's force of attraction on the water is exactly balanced by the force created by the satellite's motion.

C. The water and the glass have the same acceleration, equal to g, toward the center of the Earth, and hence there is no relative motion between them.

D. The gravitational attraction between the glass and the water balances the Earth's attraction on the water.

Answer: C

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Practice Questions More Than One Correct Choice Type

1. A satellite is to be geo-stationary, which of the following are essential conditions?

A. It must always be stationed above the Equator.

B. It must rotate from West to East.

C. It must be about 36,000 km above the Earth.

D.

Answer: A::B::C::D

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2. Two bodies of mass m_1 and m_2 are initially at rest placed infinite distance apart. They are then allowed to move towards each other under mutual gravitational attaction. Show that their relative velocity of approach at separation r betweeen them is

$$v = \frac{\sqrt{2G(m_1 + m_2)}}{r}$$

A. $\left[2G\frac{(m_1 - m_2)}{r}\right]^{1/2}$

B. $\left[\frac{2G}{r}(m_1 + m_2)\right]^{1/2}$

C. $\left[\frac{r}{2G(m_1 m_2)}\right]^{1/2}$

D. $\left[\frac{2G}{r}m_1 m_2\right]^{1/2}$

Answer: A::C::D

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3. satellite revolving in circular orbit suppose V_0 is the orbital speed, T its time period, u its potential energy and K the kinetic energy. Now value of G is decreasesd. Then

A. v_0 decreases

B. T decrease

C. U = v/2 decreases

D. K decreases

Answer: A::D

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4. Two spherical planets P and Q have the same uniform density ρ, masses M_p and M_Q and surface areas A and 4A respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the plantes P,Q and R are $V_P V_Q$ and V_R respectively. Then

A. $v_Q > v_R > v_P$

B. $v_R > v_Q > v_P$

C. $\frac{v_R}{v_P} = 3$

D. $\frac{v_p}{v_Q} = \frac{1}{2}$

Answer: B::D

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5. Two bodies, each of mass M, are kept fixed with a separation 2L. A particle of mass m is projected from the midpoint of the line joining their cehntres, perpendicualr to the line. The gravitational constant is G. The correct statement (s) is (are)

A. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $4\sqrt{\frac{GM}{L}}$.

B. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $2\sqrt{\frac{GM}{L}}$.

C. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $\sqrt{\frac{2GM}{L}}$.

D. The energy of the mass m remains constant.

Answer: B::D

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6. The magnitude of the gravitational field at distance r_1 and

r_2

$omthecentreofaun$ if $romsphereofradiusR$ and $massmare$

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. $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 > R$ and $r_2 < R$

Answer: A::B

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7. A small mass m is moved slowly from the surface of the earth to a height h above the surface. The work done (by an external agent) in doing this is

A. mgh, for alll values of h

B. mgh, for h ltlt R

C. $\frac{1}{2}mgh$, for h = R

D. $-\frac{1}{2}mgh$,for h = R

Answer: B::C

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Practice Questions Linked Comprehension

1. While weight of a body depends directly on acceleration due to gravity g, the value of g depends upon many factors. It depends on the shape of the Earth, rotation of the Earth, etc. Weight of a body at a pole is more than that at a place on equator because g is maximum at poles and minimum on equator. Acceleration due to gravity g varies with latitude λ according to the equation $g_x = g - R\omega^2 \cos^2 \lambda$, where R is radius of Earth and ω is angular velocity of Earth. A body of mass m weighs W_r in a train at rest. The train then begins to run with a velocity v around the equator from west to east. It conserved that weight W_m of the same body in the moving train is different from W_r. Let v_e be the velocity of a point on equator with respect to axis of rotation of Earth and R be the radius of the Earth. Clearly, the relative velocity between Earth and train will affect the weight of the body.

Difference between weight W_r and the gravitational attraction on the body can be given as

A. $\frac{mv^2}{R}$

B. $\frac{1}{2}\frac{mv^2}{R}$

C. $\frac{mv_e^2}{R}$

D. $\frac{mv_e^2}{R}$

Answer: D

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2. While weight of a body depends directly on acceleration due to gravity g, the value of g depends upon many factors. It depends on the shape of the Earth, rotation of the Earth, etc. Weight of a body at a pole is more than that at a place on equator because g is maximum at poles and minimum on equator. Acceleration due to gravity g varies with latitude λ according to the equation $g_x = g - R\omega^2 \cos^2 \lambda$, where R is radius of Earth and ω is angular velocity of Earth. A body of mass m weighs W_r in a train at rest. The train then begins to run with a velocity v around the equator from west to east. It conserved that weight W_m of the same body in the moving train is different from W_r Let v_e be the velocity of a point on equator with respect to axis of rotation of Earth and R be the radius of the Earth. Clearly, the relative velocity between

Earth and train will affect the weight of the body.

Weight W_m of the body can be given as

A. $mg - m\frac{(V_e + v)^2}{R}$

B. $mg - m\frac{(v_e - v)^2}{R}$

C. $\frac{m}{R}\left[v_e^2 - (v_e + v)^2\right]$

D. $mg + m\frac{(v_e + v)^2}{R}$

Answer: C

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3. While weight of a body depends directly on acceleration due to gravity g, the value of g depends upon many factors. It depends on the shape of the Earth, rotation of the Earth, etc. Weight of a body at a pole is more than that at a place on equator because g is maximum at poles and minimum on equator. Acceleration due to gravity g varies with latitude λ according to the equation $g_x = g - R\omega^2 \cos^2 \lambda$, where R is radius of Earth and ω is angular velocity of Earth. A body of mass m weighs W_r in a train at rest. The train then begins to run with a velocity v around the equator from west to east. It conserved that weight W_m of the same body in the moving train is different from W_r Let v_e be the velocity of a point on equator with respect to axis of rotation of Earth and R be the radius of the Earth. Clearly, the relative velocity between Earth and train will affect the weight of the body.

Difference in the weight in the two given states

A. $\frac{m}{R} v_e^2$

B. $\frac{m}{R} (V_e + v)^2$

C. $\frac{m}{R} \left[(v_e + v)^2 - v_e^2 \right]$

D. $\frac{m}{R}p\left[(v_e - v)^2 - v_r^2\right]$

Answer: C

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4. A small body is dropped into a narrow channel drilled along the Earth axis. Considering the Earth to be a homogeneous sphere and disregarding air resistance answer the following questions. (Acceleration due gravity on the surface of the Earth is g, Radius of Earth is R)

The magnitude of body's acceleration, a(r) as a function of the distance r from the Earth's center is

A. $g\frac{r}{R}$

B. $2g\frac{r}{R}$

C. $g\frac{r}{2R}$

D. None of these

Answer: D

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5. A small body is dropped into a narrow channel drilled along the Earth axis. Considering the Earth to be a homogeneous sphere and disregarding air resistance answer the following questions. (Acceleration due gravity on the surface of the Earth is g, Radius of Earth is R)

The magnitude of body's speed as a function of r is

A. $\sqrt{\frac{2g(R^2 - r^2)}{R}}$

B. $\sqrt{\frac{g(R^2 - r^2)}{R}}$

C. $\sqrt{\dfrac{g(R^2 - r^2)}{2R}}$

D. None of these

Answer: B

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6. A small body is dropped into a narrow channel drilled along the Earth axis. Considering the Earth to be a homogeneous sphere and disregarding air resistance answer the following questions. (Acceleration due gravity on the surface of the Earth is g, Radius of Earth is R)

The ratio of speed of the body at the instant when it reaches the center of Earth to the escape speed on the surface of the Earth is

A. $\frac{1}{2}$

B. 1

C. $\frac{1}{\sqrt{2}}$

D. None of these

Answer: C

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Practice Questions Integer Type

1. Graviational acceleration on the surface of plane fo $\frac{\sqrt{6}}{11}g$. where g is the gracitational acceleration on the surface of the earth. The average mass density of the planet is $\frac{2}{3}$ times that of the earth. If the escape speed on the surface of the earht is taken to be $11kms^{-1}$ the escape speed on teh surface of the planet in kms^{-1} will be

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2. A body weighs 64 N on the surface of the Earth. What is the gravitational force on it (in N) due to the Earth at a height equal to one-third of the radius of the Earth?

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3. What must the separation be between a 5.2 kg particle and a 2.4 kg particle for their gravitational attraction to have a magnitude of 2.3×10^{-12} N?

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4. If the value of gravitational constant becomes double, what is the ratio of inertial mass to gravitational mass of Moon?