**Chapter-13**

**1. During a solar eclipse, the Moon, the Earth, and the Sun all lie on the same line, with the Moon between the Earth and the Sun. (a) What force is exerted by the Sun on the Moon? (b) What force is exerted by the Earth on the Moon? (c) What force is exerted by the Sun on the Earth? (d) Compare the answers to parts (a) and (b). Why doesn’t the Sun capture the Moon away from the Earth?**

**Solution:**

(a) The Sun-Earth distance is 1.496 × 1011 m and the Earth-Moon distance is 3.84 × 108 m, so the distance from the Sun to the Moon during a solar eclipse is

1.496 × 1011 m − 3.84 × 108 m = 1.492 × 1011 m

The mass of the Sun, Earth, and Moon are





and 

We have



(b) 

(c) 

(d) 

**![Graphical user interface

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**Miranda, a satellite of Uranus, is shown in Figure P13.5a. It can be modeled as a sphere of radius 242 km and mass 6.68 x 1019 kg. (a) Find the free-fall acceleration on its surface. (b) A cliff on Miranda is 5.00 km high. It appears on the limb at the 11 o’clock position in Figure P13.5a and is magnified in Figure P13.5b. If a devotee of extreme sports runs horizontally off the top of the cliff at 8.50 m/s, for what time interval is he in flight? (c) How far from the base of the vertical cliff does he strike the icy surface of Miranda? (d) What will be his vector impact velocity?**

**Solution:**

(a) For the gravitational force on an object in the neighborhood of Miranda, we have



(b) We ignore the difference (of about 4%) in *g* between the lip and the base of the cliff. For the vertical motion of the athlete, we have



(c) 

We ignore the curvature of the surface (of about 0.7°) over the athlete’s trajectory.

(d) 



Thus  at  below the *x* axis.



**3. A spacecraft in the shape of a long cylinder has a length of 100 m, and its mass with occupants is 1 000 kg. It has strayed too close to a black hole having a mass 100 times that of the Sun (Fig. P13.7). The nose of the spacecraft points toward the black hole, and the distance between the nose and the center of the black hole is 10.0 km. (a) Determine the total force on the spacecraft. (b) What is the difference in the gravitational fields acting on the occupants in the nose of the ship and on those in the rear of the ship, farthest from the black hole? (This difference in accelerations grows rapidly as the ship approaches the black hole. It puts the body of the ship under extreme tension and eventually tears it apart.)**

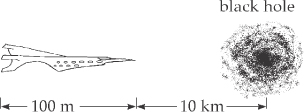
**![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDgRXhpZgAATU0AKgAAAAgABAE7AAIAAAAHAAAISodpAAQAAAABAAAIUpydAAEAAAAOAAAQyuocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFZlcmdpbAAAAAWQAwACAAAAFAAAEKCQBAACAAAAFAAAELSSkQACAAAAAzE2AACSkgACAAAAAzE2AADqHAAHAAAIDAAACJQAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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JWf/f9f8ah/wCEb0P/AKAun/8AgKn+FL/wjeh/9AbT/wDwFT/CgDH+JUt1a/D3V72wvbizubW2aSOS3faciovFGuXNhpPh6ztZXS41i9t7RpgfmRCNzsD67VIz2zmtDxxo9/4g8G6jpGli3E97CYg9zKyKme/yqxNRar4eudV0XSPMEEWo6Vcw3UQEhaMsnBXdtBwykjOOM9Dihb691/wRvZej/SxzXiLxndeEbrxTZRO9x9j06C8sfOcyGN5GMRUk5JG7a3J7mtc39xoHjTw7pb3U9zDq9rMsvnyFz50Sq4cZ6ZBYEDA6ccUl/wCBRr7eIrjVmSGfWLaO1iEZ3/Z0j5U5wMnedxHTgD3q9DoN5feKdN1nWFgjbS7WSGCOGQvukkwHfJAwMLgDryc0R6X/AK3t+gpeX9bf8Evaz4ks9CvdPtbyK4Z9RlMNuYo9wMm0sFJzwTis6Tx7p0Vtqcr2d+DpDbdQj8pd1sMA7j82GGDn5Sxx2qTxRomo6trHh+5sBa+Vpl99qm8+VkZhsZcKApyfmzyR0rIufCWtzQeNo1Gng+IBi1JuH/d/uRF8/wC746Z4z6e9LWzfr+n/AASrK6+X6/8AAO1F5b/Y1uzMi27KHErNhcHocn61B/bWl/8AQSs/+/6/41FpumlfDdpp2qwW8xjt0ilj/wBZGxUAfxAZHGeRSf8ACN6H/wBAXT//AAFT/CqlZNpERvbUm/trS/8AoJWf/f8AX/Gj+2tL/wCglZ/9/wBf8ah/4RvQ/wDoC6f/AOAqf4Uf8I3of/QF0/8A8BU/wpDJv7a0v/oJWf8A3/X/ABo/trS/+glZ/wDf9f8AGof+Eb0P/oC6f/4Cp/hR/wAI3of/AEBdP/8AAVP8KAJv7a0v/oJWf/f9f8awNa+JvhXw9rEGn6tqSwm4j8yOdR5kR5I2llzg8dwByOa2f+Eb0P8A6Aun/wDgKn+FYWsfCvwjr2sQahqWlo/kR+WlvGfKi6k7iqYJPOOTjAHFAC3Ou6Te+LdD1C01Szms1s7wtcRzqY15h6tnAoi+KfhC58RQaLY6vFeXcxYboOYkAUklpPu447E9qjuvDWh2virQ9Nt9GsI7F7O832y2yeW/MPVcYP402L4R+DbXxFBrNjpS2s8JYmKM5hkBUgho2yuOe2OQKAOo/trS/wDoJWf/AH/X/Gj+2tL/AOglZ/8Af9f8ah/4RvQ/+gLp/wD4Cp/hR/wjeh/9AXT/APwFT/CgCLVPFGl6ZpVzeC8t7hoYyyQxTKXlb+FFGeSTgD3NYOoGfTfD+j+H7/UdmoapKWvbkzbdqZ8y4KkngEny1x03r6VNeaHpd34006xs9Ls4Y9OUajcyRW6qS2SsCZA/vB3/AO2a+tTaXp9p4k1jUda1K0huoBIbKxWeIOFjiYh3AI4LSbue6olAG7/bWl/9BKz/AO/6/wCNH9taX/0ErP8A7/r/AI1D/wAI3of/AEBdP/8AAVP8KP8AhG9D/wCgLp//AICp/hQBN/bWl/8AQSs/+/6/41PFPBewM1rcJKhyu+Jw2D9R3ql/wjeh/wDQF0//AMBU/wAKuW1nbWEBisLaG3TJby4kCKT64AoA4/wnqdxbXPjM6he3N3BpuoN5XnybikYhV9o9uTWXB4k1C18H+GfFNzcytNqt/Cl1C0hMflTsQFVOg25Ugjk7TnOTXQeG/DupWOpeJH1iOyNtrF0Z0WCdnZVMaptYFF7LnINVLfwVdHStB0O8aFtO0S6W4WUOS84jz5SlccYyCTk/d468Eel/7v8A9sEutv73/ANDx3rdxo+kWUVi5judT1CCwSUDmMSN8zD3Chse+KjsNTlsfiRdeHDLLNbSaal9D50hkaNg5RxuYkkH5TyeDmpNa0PU/EFpLHfCzhkstRiu9MeN2ORGQw8zI4J+ZTjOAan07Qpv+EvvfEeoLGlxNax2cEMb7vLiVixJOByWP4ACiPn/AErafiD20/rXX8DM8S3s2n/Ebwy63lxHazQ3huYBORFIEiDKSpO3IyeT/StO98X2enWmmXF/Z30A1OYQQI0ILB2BKhgCcZx/jisvxp4Nu/FevaPKHjisbJZxLIly8U6s6gKyYUglSoPJwahvvD/izU7DQ4dSk0u4uNK1SO6e5Ezx/aI0yAdnlkK5B5GcZ70R6Lz/AAvqN/192hpv45sY/wC1Fax1Dz9JG6+gESloUK7g+d21gRzhSTweK3oL+1udNiv4plNrLEJUlY7QUIyDz04NcnL4Y1ltT8Y3CrY7Ncto4bUG4fKFYymX/d8D5s8Z6Vu+H9KksvCGn6Tq0VvK9vaJbzKh8yN9qhf4gMg47ihba+X63/QT308/0/4Ja/trS/8AoJWf/f8AX/Gj+2tL/wCglZ/9/wBf8ah/4RvQ/wDoC6f/AOAqf4Uf8I3of/QF0/8A8BU/woAm/trS/wDoJWf/AH/X/GsnxJrsT6ULDRb+F9S1GQWlt5Mqs0ZbO6TAP8CBn/4DWh/wjeh/9AXT/wDwFT/CsGwsdLTxdqWsx2dtZ2WiwNbJJFCqBpCA8z8DkKuxQex8wUATX15bx+KNL0UXwtrXTIBd3Bkn2mQ4McMZJOWz87n/AHFz1re/trS/+glZ/wDf9f8AGsPw7oNpf6c+r65plvNf6pIbuQXEKu0SMAI4+RxtjCAj13HvWt/wjeh/9AXT/wDwFT/CgCb+2tL/AOglZ/8Af9f8a57U/ih4T0bxAukarqiW0zxrJHMw3QuCSPvrkDkHritv/hG9D/6Aun/+Aqf4Vgaj8KPB+r6+NW1HSkmkWNY0gB8uFACTnYmMk5Oc5oAtWmoWep+P4LnTbuC7gbSX2ywSB1P75O44rqK5ay0yx0nx9BbaXZ29nAukviK3iEaj98nYCupoAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKAOf8Bf8k78P/wDYOg/9AFdBUdvbw2ltHb2sSQwxKEjjjUKqKOAABwBUlABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQBz+pf8j9oP/XpefzhroKja3he4jneJGmiDLHIVBZA2MgHtnAz9BUlABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAHPv/wAlJi/7BL/+jkroKj+zw/ahc+UnnhPLEu0bguc7c9cZGcVJQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFcj8T76607wFd3NhczW06yRhZYXKMMuAeRXXVxXxb/wCScXv/AF0i/wDQxW2H1rQT7r8zOt/Cl6P8il4I0i5kTS9WufGGoXjywCV7GW53qSycgjd2znp2rQ8I6rplvpGrXn/CR3ep21vMWmmvQ48jA+6M9vpUPgPwZoNno+k65bWRTUXtFdpvOc5LJ8x2k47ntXBaLHJJ8KfGIiBJF2pIHoGUn9K9CcY1ZTV9mlsl9o8+m5U4021vd7v+U9Ms/iR4Yv7i1gt75zNdyeXEjQOCxzgdunPWro8Y6IbjVIBdN5mlIXux5TfuwOvbn8K8mOo6fe6r8PYrCaOSW2WKOcJ1Rt68H3yD+dTzXltaeIviHHdTxwvNbyLEsjAFznoM9TzTlgqfS/X8HbsEcXN2vb7P4q/c9Nn8c6Bb6LaatNelbK8kMcMhif5iM5yMZHQ9aH8d+HU0M6u2oAWXnGFX8tsu47KuMmvJ9ZUP8HfCqtyDeuCP+BPXSfFiyjsE8NfY1jsbSG6ILpENkR+TDFeh4BP4VP1SlzqGusmvkhrFVHBz00in99zvNA8WaP4lMy6Vcl5Yf9ZFIjI6++COlcl8YNT1DTdN0o6ZfXNk0tyyu1vKyFhjvg81B4LhtZvibqd3Hrsmr3gtttxLFZpHC33cEMrkE8Y6djTPjeofStHU9DdMD/3zU06UIYqEVs7b/wDDL8ip1Zyw0291f+t3+ZWS61rwh8S9J0g+ILrV7a/C+bHdOWKbiR3Jx0znineKPE3iu08faZbyN/Z+mz3ohhjQgmdBIoLN35zx0/rXW6B8O/D3h+/S/sbaR7pR8kk0hfZkc4HTPvXM/FD/AJHjwf8A9fP/ALUjrSlUp1K8YpX0d21bu9jOpTqU8POV7bWSfotzW8W2nim41iWa21tNG0W3tyyyIy7ncLnkHB68degq58M9d1DxD4OS71Z/NnSZ4vN2geYoxg8fXH4Vn+Mtc8M6pqVx4W8TLNaiBPtKXLuEQtt42nOSfmPBHUVT+G3iSDSvhwlzr90YbaO9a3t5GjJyuAQPlB77uay5JSw3w66W07369WzVyUcQnzaa319OnRIt+OrLXdMtNS1628XT2lrGoaOyW2BAPACht3c98d63PANzqF74I0+61eZprqZWcu/UqWO39MVy/wAXbyS9XR/Ddocy6jcqzAf3c7V/U5/4DXotpbR2VlBawDbHDGsaD0AGBWdR2w0ebdvTRbLT8zSKviXy7Ja69X/wCaiiiuE7AooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACobuytdQtmt7+2huoGILRTRh1OOnB4qaijYBkMEVtAkFvEkUUahUjRQqqB0AA6Cs260SOHRr218PR2ulXFwpIkitk27/Vlxg+nIrVoqlJpi5UeaWPgTX7vX9Gutb/ALKtoNJcuTYpta4bIOSoUAZwK7u48P6Pd3jXd3pVlPcOuxpZbdWZhjGCSOeOK0KK1qV5za6W7GMKEIX637+RQfQdIezitH0qya2hbdFCbdCkZ9QuMA89qsXlla6hatb39tFcwN1jmQMp/A1PRWXNLubcqXQqafpWn6TCYtMsre0jY5ZYIggJ9TjrS32mWGpqi6lY212sZ3ILiFZAp9RkcVaoo5pXvfUXKrWtoFVbrTLC+nhmvbG2uJYDmKSaFXaM5zlSRx0HT0q1RSTad0NpNWZQ1DQ9K1Z0fVNNtLxk4Vp4VcgemSKkl0nTriyjs59PtZbWMgpA8KlEI6YUjAq3RT5pWtcXLG97FWXStPnvor2extpLqEYjneFTIg9mIyOpq1RRSu2OyQUUUUhhRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQB//Z)**

**Solution:**

(a) 

(b) 

ANS. FIG. P13.7



**4. Use Kepler’s third law to determine how many days it takes a spacecraft to travel in an elliptical orbit from a point 6 670 km from the Earth’s center to the Moon, 385 000 km from the Earth’s center.**

**Solution:**

For an object in orbit about Earth, Kepler’s third law gives the relation between the orbital period *T* and the average radius of the orbit (“semimajor axis”) as



We assume that the two given distances in the problem statements are the perigee and apogee, respectively.

Thus, if the average radius is



The period (time for a round trip from Earth to the Moon) would be

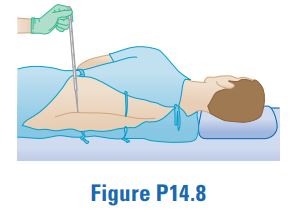


The time for a one-way trip from Earth to the Moon is then



**Chapter – 14**

**1. The human brain and spinal cord are immersed in the cerebrospinal fluid. The fluid is normally continuous between the cranial and spinal cavities and exerts a pressure of 100 to 200 mm of H2O above the prevailing atmospheric pressure. In medical work, pressures are often measured in units of millimeters of H2O because body fluids, including the cerebrospinal fluid, typically have the same density as water. The pressure of the cerebrospinal fluid can be measured by means of a spinal tap as illustrated in Figure P14.8. A hollow tube is inserted into the spinal column, and the height to which the fluid rises is observed. If the fluid rises to a height of 160 mm, we write its gauge pressure as 160 mm H2O. (a) Express this pressure in pascals, in atmospheres, and in millimeters of mercury. (b) Some conditions that block or inhibit the flow of cerebrospinal fluid can be investigated by means of Queckenstedt’s test. In this procedure, the veins in the patient’s neck are compressed to make the blood pressure rise in the brain, which in turn should be transmitted to the cerebrospinal fluid. Explain how the level of fluid in the spinal tap can be used as a diagnostic tool for the condition of the patient’s spine.**

**Solution:**

(a)  and the gauge pressure is



It would lift a mercury column to height



(b) 

**2 What must be the contact area between a suction cup (completely evacuated) and a ceiling if the cup is to support the weight of an 80.0-kg student.**

**Solution:**



When the cup barely supports the student, the normal force of the ceiling is zero and the cup is in equilibrium.



**3. A plastic sphere floats in water with 50.0% of its volume submerged. This same sphere floats in glycerin with 40.0% of its volume submerged. Determine the densities of (a) the glycerin and (b) the sphere.**

**Solution:**

(a) The buoyant force of glycerin supports the weight of the sphere which is supported by the buoyant force of water.





(b) The buoyant force from the water supports the weight of the sphere:







**4. Water is pumped up from the Colorado River to supply Grand Canyon Village, located on the rim of the canyon. The river is at an elevation of 564 m, and the village is at an elevation of 2 096 m. Imagine that the water is pumped through a single long pipe 15.0 cm in diameter, driven by a single pump at the bottom end. (a) What is the minimum pressure at which the water must be pumped if it is to arrive at the village? (b) If 4 500 m3 of water is pumped per day, what is the speed of the water in the pipe? Note: Assume the free-fall acceleration and the density of air are constant over this range of elevations. The pressures you calculate are too high for an ordinary pipe. The water is actually lifted in stages by several pumps through shorter pipes.**

**Solution:**

(a) The cross-sectinal area is the same everywhere, so the speed is the same everywhere:





(b) The volume flow rate is 



**Chapter - 15**

1. **The amplitude of a system moving in simple harmonic motion is doubled. Determine the change in (a) the total energy, (b) the maximum speed, (c) the maximum acceleration, and (d) the period.**

**Solution:**

(a) so if  

Therefore 

(b) , so if *A* is doubled, 

(c) , so if *A* is doubled, 

(d) is independent of *A*, so 

1. **A 2.00-kg object attached to a spring moves without friction (*b=* 0) and is driven by an external force given by the expression *F* = 3.00 sin (2*pt*), where *F* is in newtons and *t* is in seconds. The force constant of the spring is 20.0 N/m. Find (a) the resonance angular frequency of the system, (b) the angular frequency of the driven system, and (c) the amplitude of the motion.**

**Solution:**

We are given *F* = 3.00 sin (2*π t*), *k* = 20.0 N/m, and *m* = 2.00 kg.

(a) 

(b) From *F* = 3.00 sin (2*π t*), the angular frequency of the force is



(c) From equation 15.36, the amplitude *A* of a driven oscillator, with *b* = 0, gives



**3. A simple pendulum makes 120 complete oscillations in 3.00 min at a location where g 5 9.80 m/s2. Find (a) the period of the pendulum and (b) its length**

**Solution:**

The period of a pendulum is the time for one complete oscillation and is given by  where  is the length of the pendulum.

(a) 

(b) The length of the pendulum is

