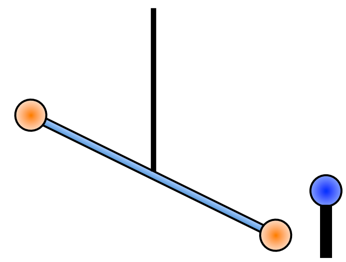
13-Series Problem

13.3) A 200 kg and 500 kg object are 4.00 meters apart.

a.) What is the net gravitational force on a 50.0 kg mass located half way between the two?

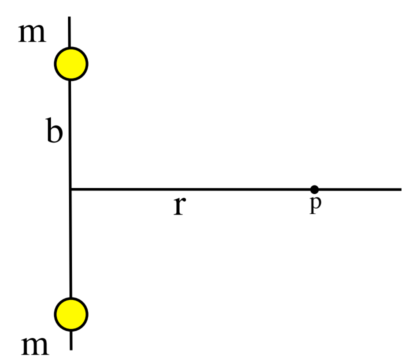
b.) Other than at infinity, where could the 50.0 kg mass be placed so as to experience *no* net gravitational force due to the presence of the two objects?



13.5) A Cavendish balance consists of a light (massless) beam hung by a thread attached at the beam's center with two equal masses in the form of balls at each end. A second, considerably larger, stationary mass is positioned close to one of the beam-end masses so that if the beam were to rotate about its central axis, the beam-end mass would collide with the larger ball. In the Cavendish experiment, the set-up was placed in a bell jar that was evacuated, the gravitational attraction between the large and small ball rotated the beam until torsion in the line brought it to rest, and a measure of that angular displacement allowed for the measurement of the torsion which, in turn, allowed for the calculation of the Universal Gravitational Constant *G* in Newton's general gravitational expression. Using the device in a little different manner, assume the small masses are 15.0 grams and the large mass is 1.50 kg, and assuming the separation between the large and small mass is 4.50 cm, determine the gravitational force between the two masses.

13.10) A meteoroid is three times the earth's radius above the earth's surface. What is its acceleration due to gravity?

13.12) On the moon, the acceleration of gravity is approximately one-sixth of that on Earth. The Earth's radius is approximately $6.37\text{x}10^6\,\text{m}$. The moon's radius is approximately one-quarter that of the Earth's. Determine the ratio of the average density of the moon to that of the Earth (i.e., ρ_{moon}/ρ_{earth}). Note that the volume of a sphere of radius *r* is $\frac{4}{3}\pi r^3$.



13.26) Two equal masses each a distance *b* units from the origin produce a gravitational acceleration field a distance *r* units down the *x-axis* (in fact, they produce an acceleration field everywhere, be we are only interested in the field at *Point p*).

a.) Determine the acceleration field *as a vector* at *Point P*.

b.) Without using math, explain what you would expect the acceleration field would do as $r \rightarrow 0$?

c.) Use the expression derived in *Part a* to justify your response in *Part b*.

d.) Without using math, why will the field go to $G\frac{(2m)}{r^2}$ as *r* becomes very big?

c.) Use the expression derived in *Part a* to justify your response in *Part d.*

13.28) A 100 kg satellite orbits the earth at $2x10^6$ m.

a.) How much potential energy is wrapped up in the earth/satellite system?
b.) Determine the gravitational force exerted by the earth on the satellite.
c.) Determine the gravitational force exerted by the satellite on the earth.

13.31) When stars like the Sun run out of nuclear fuel, their core begins to contract. The contraction produces non-nuclear heating which transfers to the area around the core. This motivates the star's outer shell to expand outward. With time, that expansion ultimately jettisons the star's outer shell leaving it only a white hot core. At this point, the star is about the size of the earth and is called a White Dwarf. This is how our star, the Sun, will die. Assuming the Sun's mass ($1.99x10^{30}$ kg) doesn't change during this process but that its new radius is, in fact, the size of the earth.

a.) What is the White Dwarf's average density?
b.) What is the magnitude of the gravitational acceleration field at its surface?
c.) If a 1.00 kg mass sat on the surface (assuming it *could* sit on the surface), what would be its gravitational potential energy?

13.34) Ignoring atmospheric friction and the earth's rotation, what would the speed of a rocket fired from the earth's surface be once it was "very far" from the earth if its initial velocity was $2.00x10^4$ m/s?

13.36) The escape velocity for a satellite being fired from the earth's surface is the velocity required of a satellite to completely free itself from the earth's influence.

a.) Derive an expression for the escape velocity v_{escape} of a satellite, ignoring atmospheric friction or the earth's rotation.
b.) Show that the velocity required of a satellite to move in a circular path at "tree top" (that is, with a radius essentially that of the earth's) would be $(2)^{1/2} v_{escape}$.

13.39) A 200 kg satellite orbits the earth in what is essentially a circular orbit above the equator at 200 km.

a.) What is the period of the satellite's orbit?
b.) What is the speed of the satellite?
c.) Taking into consideration the earth's rotation (but ignoring air friction), how much energy was required to put the satellite into orbit if it started from rest at the earth's equator?