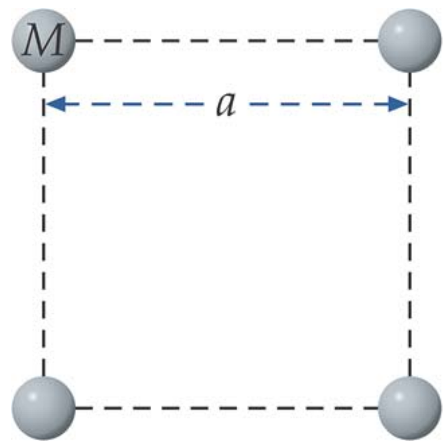
Phyx 135-1, Spring 2016, Quiz 5 **Name** ________________________________

1) (10 points) Four balls with equal masses M = 2 kg are arranged in a square with a = 30 cm as shown. Using (*i*, *j*) vector notation, what is the vector force operating on the upper left-hand ball labelled "M"? (It is OK to just write "G" for the gravitational constant. You don't need to multiply it out.)



Solution

From the symmetry of the problem, we can see that the *magnitudes* of the x and y force components will be the same. So, let us start by calculating just the x-component of the force on M. We have:

$F = \{G(2)(2) / 0.3^2\}\, \boldsymbol{i}$ (from the upper right-hand ball)

$+\, 0$ (from the lower left-hand ball)

$+\, \{G(2)(2) / [\sqrt{2}(0.3)]^2\}\, (\boldsymbol{i} / \sqrt{2})$ (from the lower right-hand ball)

Note that one could put in a sin(45°) instead of the ($\boldsymbol{i} / \sqrt{2}$), it is just a matter of taste. In any case we have G(44.44 + 15.71) = (60.15)G newtons for the x-force. The y-force will be the same except that it is going downwards, so it needs a negative sign. The final answer is:

$F = (60.15\ G)(\boldsymbol{i} - \boldsymbol{j})$

2) (10 points) The planet Mars has two small moons, Phobos and Deimos (aka Fear and Dread). Phobos orbits Mars at a radius of 9378 km with a period of 0.3189 days. Deimos orbits Mars at a radius of 23,459 km. What is the orbital period of Deimos in days?

Solution

Kepler's Third Law says that $T^2 = k\, a^3$. In this case we do not know the constant *k*, but if we just take the ratio of Phobos to Deimos, then *k* will cancel out. We have:

$T^2_{Deimos} / T^2_{Phobos} = a^3_{Deimos} / a^3_{Phobos}$, or

$T^2_{Deimos} = (23{,}459 / 9378)^3 (0.3189)^2$, or $T_{Deimos} = 1.26$ days

Notice that taking the ratio has the second advantage that you don't need to convert your units. If both radii are given in km, and both periods are given in days, then the units conversions just cancel out.