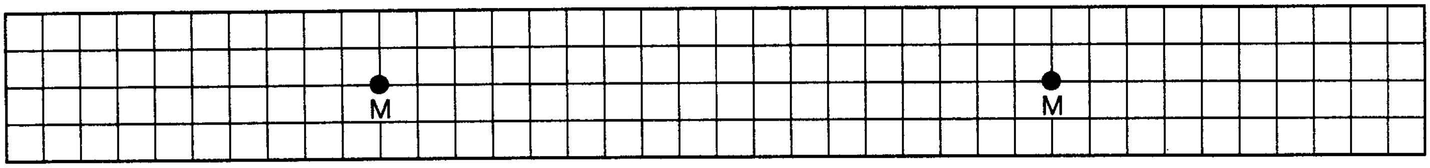
Prelude: Review of Gravitation

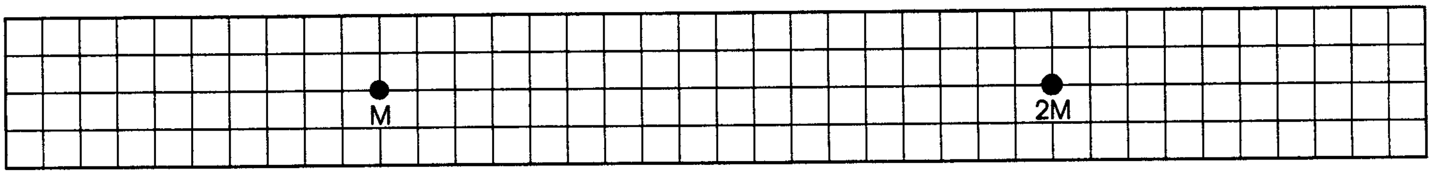
In-Class Exercises

In exercises #1 through #6, draw arrows representing force vectors, such that the length of the arrow is proportional to the magnitude of the force it represents. Use the same scale for all exercises on this page, so that if, e.g., a force in exercise #2 has twice the magnitude of a force in exercise #1, the arrows representing these forces will also have a length ratio of two to one.

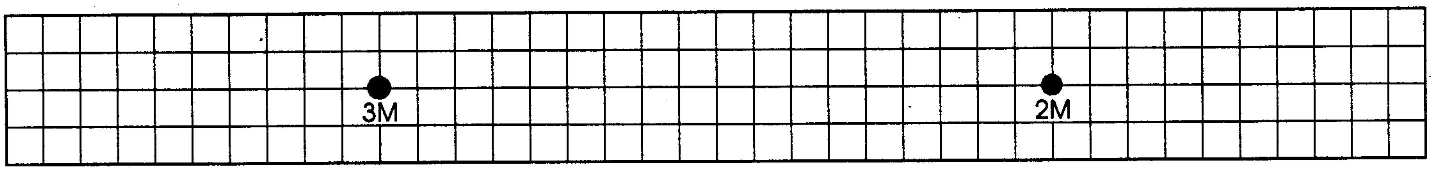
1. In this figure, two equal spherical masses (mass = "M") are shown. Draw the vectors representing the gravitational forces the masses exert on each other. Draw your *shortest* vector to have a length equal to *one* of the grid squares.



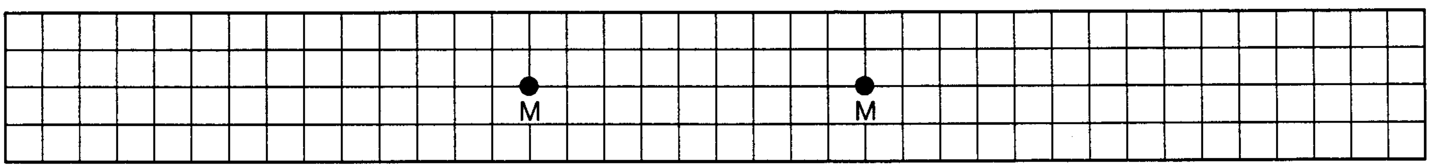
2. Now, one of the spheres is replaced with a sphere of mass 2M. Draw a new set of vectors representing the mutual gravitational forces in this case.



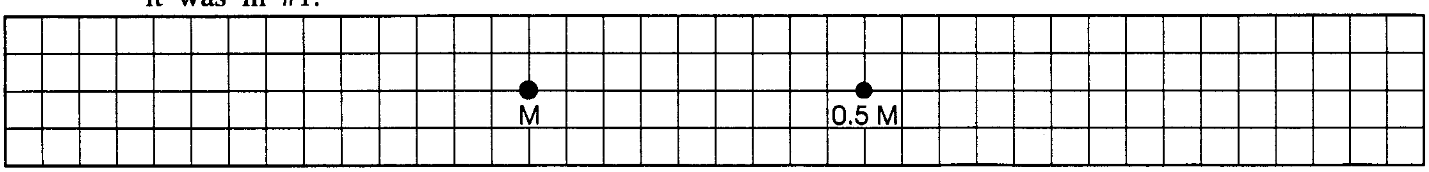
3. In this case, the spheres have masses 2M and 3M. Again, draw the vectors representing the mutual gravitational forces.



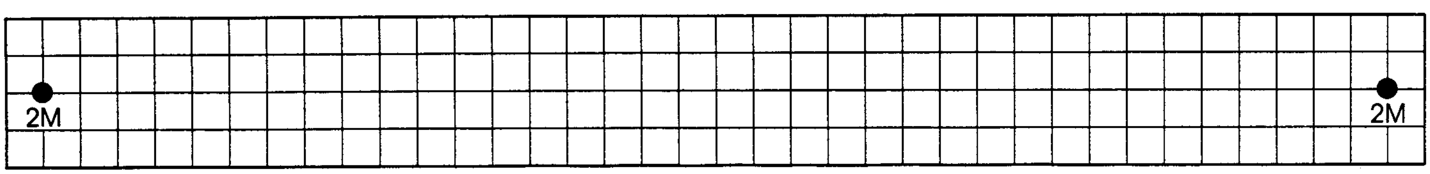
4. In this situation, the spheres again have equal mass M, but their separation distance is ***half*** of what it was in #1.



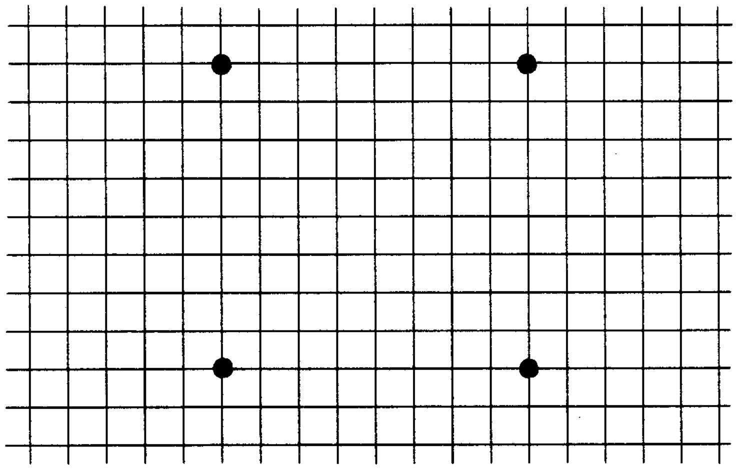
5. Here the spheres have mass M and 0.5 M, but again their separation distance is ***half*** what it was in #1.



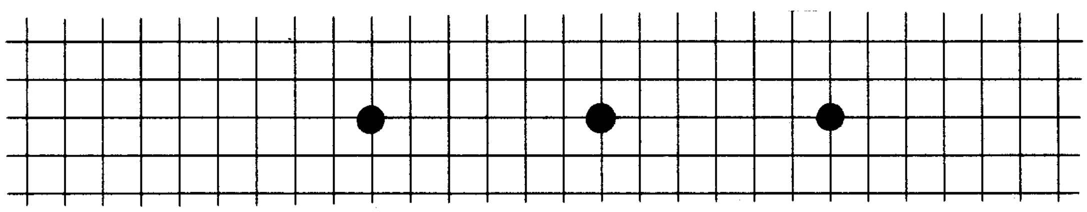
6. Here, the spheres have equal mass 2M, but their separation is ***twice*** what it was in #1.



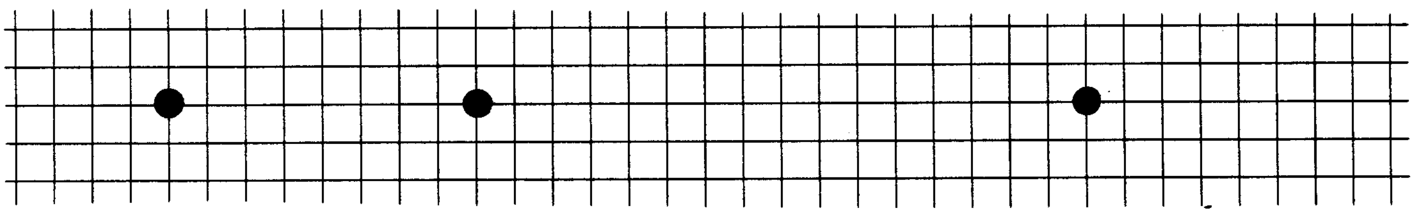
7. In this figure, four equal masses are arranged at the corners of a square. On each mass, draw arrows representing the gravitational forces exerted by the *other three masses* (so you will have three arrows attached to each mass). Make the lengths of the arrows proportional to the magnitudes of the forces.



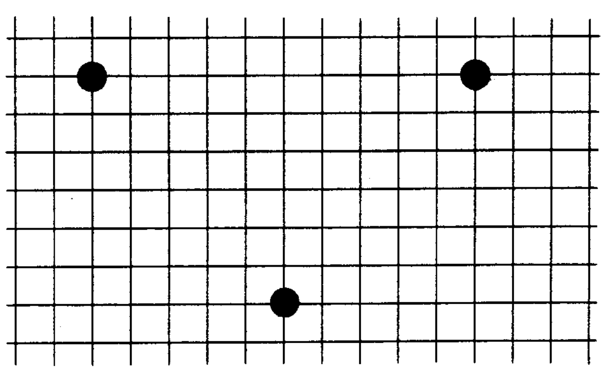
8. In this figure, three equal masses are shown. Draw arrows representing the ***net gravitational force*** acting on each mass. If there is no net force on a mass, do not draw an arrow attached to that mass, but below it write "$\mathbf{F_{net} = 0}$."



9. In this figure again, three equal masses are shown. On the ***center mass only***, draw in *black* arrows representing the forces exerted by the other two masses. In *red*, draw an arrow representing the ***net*** gravitational force acting on this center mass.



10. In this figure, three equal masses are shown. Draw an arrow representing the ***net*** gravitational force acting on the mass at the *bottom*.



Physics 112
Homework #1: Gravitation

Name: ______________________

Total value: 5 points. Homework due Thursday, August 31, 2000. Late Homework: half credit.

Draw an x-y coordinate system with the sun at the origin; ***Use graph paper!***

$M_{Sun} = 3 \times 10^5\ M_{Earth}$
$M_{Jupiter} = 300\ M_{Earth}$
$M_{Saturn} = 100\ M_{Earth}$

1. Put the Earth at position (A, 0) where A represents the distance from the Earth to the Sun. [Choose A to be a certain number of grid squares.] Draw a force vector at the position of the Earth that represents the magnitude and direction of the gravitational force acting on the Earth. ***Caution:*** The length of this vector arrow is arbitrary, but you will need to plan this out so that all of #1-3 will fit on the same page.

2. On the same diagram, put Jupiter at the (–5A, 0) position. Draw a force vector at the position of Jupiter that represents the magnitude and direction of the net gravitational force acting on Jupiter.

3. On the same diagram, put Saturn at the (0, 10A) position. Draw a force vector at the position of Saturn that represents the magnitude and direction of the net gravitational force acting on Saturn.

4. Now assume that the Sun and Jupiter disappear. On a second diagram, draw a new set of force vectors representing the gravitational forces now acting on the Earth and Saturn.

   Assume that the Sun, Earth, and planets are "points," i.e. represent them all by dots, not by circles of various sizes.

   Length of force vector arrows should be proportional to the magnitudes of the forces. (That is, larger magnitude forces are represented by longer arrows.) In #4, you will need to use a different scale to represent force magnitudes than you used in #1-3; Explain why.

5. Homework exercises, Workbook Chapter 1; #1–6, pp. 10-12.
   Note: mass of the proton is $1.7 \times 10^{-27} kg$.