AP Physics ◆ Center-of-Mass Problems

1. Make sure that you are able to derive all of the following formulas for areas and volumes of the following geometric shapes using calculus.

    Area of a circle $= \pi r^2$
    Surface area of a sphere $= 4\pi r^2$
    Volume of a sphere $= \frac{4}{3}\pi r^3$
    Area of a triangle $= \frac{1}{2}bh$
    Lateral surface area of a cone $= \pi r l$, where $l =$ slant height
    Volume of a cone $= \frac{1}{3}\pi r^2 h$, where $h =$ altitude

In problems 2–9, find the coordinates of the center of mass of each geometric shape as many different ways that you can think of using calculus:

2. a uniform right triangular lamina.

3. a uniform arbitrary triangular lamina. (Hint: Use the results from problem 2)

4. a uniform semi-circular thin wire. (Answer: $2R/\pi$)

5. a uniform semi-circular disc. (Hint: Use the results from problem 3 or problem 4 or use rectangles.) (Answer: $4R/3\pi$)

6. a uniform hemispherical shell. (Hint: Use the results from problem 5.) (Answer: $R/2$)

7. a uniform hemispherical solid. (Hint: one way is to use the results from problem 5.) (Answer: $3R/8$)

8. a uniform conical surface (no base).

9. a uniform conical solid.