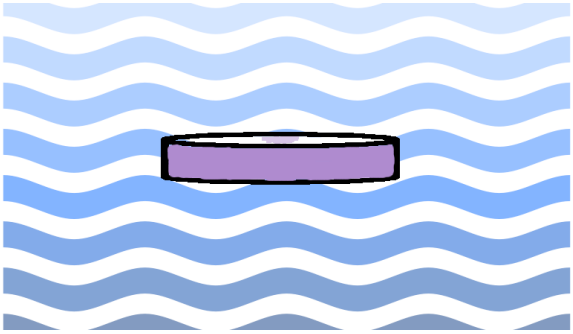
## Buoyancy: A Sand Dollar in the Ocean

A Sand Dollar (a kind of sea urchin, that's flat with very tiny spines) is rescued from the beach and tossed back into the ocean. You can approximate it as a thin cylinder with a diameter of 8cm and a thickness of 1 inch. Assume that it floats under the surface with no acceleration parallel to the bottom (see picture).



1. What forces act on the sea urchin? Draw these forces.

2. Write a general expression for the net force using $\Sigma\vec{F} = m\vec{a}$ on the sea urchin. When writing the net force, what will happen with the forces pushing in from the sides?

3. Now let's write this equation in terms that are useful in dealing with fluids.
   a. If P = F/A (A is area, here), then **F =**

   b. If $\rho$ = mass/volume, then **mass =**

   c. We may also need the volume of a cylinder: **V =**

4. Re-write your force equation in terms of pressure:

5. Substitute in your expressions for mass and volume:

6. Divide any terms that appear in all your expressions:

7. You derived this equation for a cylindrical shape. Will this apply to any shape object? Why/why not?

8. We derived this using a liquid. Will it still hold for gases? What might be different for gases vs. liquid?