**Background**

Snow Water Equivalent (SWE) is a common snowpack measurement. It is the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously.

For example, say there is a swimming pool that is filled with 36 inches of new powdery snow at 10% snow water density. If you could turn all the snow into water magically, you would be left with a pool of water 3.6 inches deep. In this case, the SWE of your snowpack would equal 36" x 0.10 = 3.6 inches.

To determine snow depth from SWE you need to know the density of the snow. The density of **new** snow ranges from about 5% when the air temperature is 14° F, to about 20% when the temperature is 32° F. After the snow falls its density increases due to gravitational settling, wind packing, melting and recrystallization.

Most snow that falls in the Cascade Mountains of Washington and Oregon tends to be higher density snow. In the Cascades, snowpack densities are around 20-30% in the winter to 30-50% in the spring. However, east of the Cascades, the snowpack density is much less. Typical values are 10-20% in the winter and 20-40% in the spring.

To determine the depth of snow using snow water equivalent and density, use the following formula:

[SWE] ÷ [Density] = Snow Depth

**Materials**

Mini Marshmallows (I think we used 4 bags for 5 periods. Maybe call it 1 bag/class period)

Graduated Cylinders pre-filled (5 Marshmallows displaces about 15 mL. We found 70 mL filled made it easier to keep the mallows submerged but left a good margin for measurement)

**Procedure:**

1. Ask students:
   1. What did you do at the SWE station?
      1. *Took samples to measure the water content.*
   2. How big were the samples?
      1. *10 cm*
   3. What did we use to measure the amount of water in the snow?
      1. *A scale*
   4. What amounts did you collect?
      1. *between 0.8 cm to 4.0 cm*
   5. What was the rest of our 10 cm of snow if only 1 cm is water?
      1. *air*

2. Explain that we are going to make a model of SWE with marshmallows. Marshmallows have air in them just like our snowpack. We can imagine that marshmallows represent a sample of snow. When we remove the air from the mallow, then it is similar to melting down our snow.

3. In groups, determine the volume of 5 mini marshmallows. Record your ratio. ~12 mL/5 mallows.

*As groups complete this portion then can clean up their cylinder and get a new one along with 5 new marshmallows.*

4. Then, determine the volume of 5 squished marshmallows. Record your ratio. ~6 mL/5 mallows.

*These numbers will vary but their accuracy isn't particularly important.*

5. Snowpack analogy.

We can imagine that one bag of marshmallows is our entire mountain snowpack.

*You can create a simple visual by making a peak in a sealed bag.*

If we know that our mallow "snowpack" contains 200 mallows, can we determine the total volume of "snow" (unsquished mallows) and "water" (squished mallows)?

6. Do this math in your small groups. *You can float the room and help students with their math.* Setting up to cancel units i.e. 12 mL/5 mallows\*200 mallows=480 mL

7. Now that you've done the math with round units and mallows you can set students up to calculate an estimated SWE for the snowpack on their visit. Use a SWE measurement from the old snow and the total height of snow. i.e. 3.0 cm SWE/10.0 cm Snow\*260 cm Snow = 78.0 cm SWE.

