

## Basic Lesson Plan for Practical Proportionality Lesson

Equipment needed:

Balls of different sizes, including at least two of the same size but different densities.

Peanut butter, yoghurt (Greek is best), jelly, water all in containers big enough to push the balls in.

(Use different products if you want!)

Lots of tissues for cleaning up.

- 1) Explain that you will be investigating how easy/hard it is to push a sphere through a medium. Ask students what variables about the sphere or medium might affect how easy/hard it is to push it.
- 2) Narrow down the list to viscosity, radius of the sphere, density.
- 3) Experiment with the viscosity first: push the same ball through all the different mediums and ask how the viscosity affects how easy/hard it is to push. Ask students to write a proportionality statement about what they've found.
- 4) Next experiment with the density: push the two balls of same radius but different densities through the same medium, and discuss results. They might make predictions beforehand. Ask students to write a proportionality statement about what they've found.
- 5) Now experiment with the radius of the sphere by pushing all the balls through the same medium. Again, ask students to write a proportionality statement about what they've found.
- 6) Clear up all the mess! Put together all the proportionality statements into one equation for Johanson's number. Remember to tell them that in reality there might be a constant of proportionality and the variables might be squared or otherwise changed, but the basics are there.
- 7) Ask questions about changing the variables in a situation, e.g.: what happens if we double the viscosity? What happens if we half the radius of the sphere? If we double the radius of the sphere but want to keep Johanson's number the same, what else would we need to do?
- 8) Ask students to draw some graphs with Johanson's number on the y-axis, and one of the other variables on the x-axis.
- 9) At the end, ask students for other equations they know from physics or chemistry that demonstrate proportionality, e.g.:  $V=IR$ ,  $PV=nRT$ , etc. Discuss these and which variables are directly proportional and which inversely proportional.