

**Grade Level:**  
 11th Grade

**Subject:**  
 Chemistry

**Exhibit:**  
 #9 Desalination  
 (TDS Analysis)

**Approximate Time Frame:**  
 2 hours (more than one class period)

**Materials:**

- computer and internet
- 4 cylinders
- markers
- rulers
- salt water
- gallon distilled water
- test tubes
- paper and pencil

**Lesson Plan - "Pass the Salt, Please"**



**Science TEKS:**

1. A Demonstrate safe practices during field and laboratory investigations.
2. A Plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology.
2. B Collect data and make measurements with precision.
2. C Express and manipulate chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures.
2. D Organize, analyze, evaluate, make inferences, and predict trends from data.
2. E Communicate valid conclusions.
3. A Analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information.
3. B Make responsible choices in selecting everyday products and services using scientific information.
3. C Evaluate the impact of research on scientific thought, society, and the environment.
3. D Describe the connection between chemistry and future careers.
3. E Research and describe the history of chemistry and contributions of scientists.
4. A Differentiate between physical and chemical properties of matter.
4. C Investigate and identify properties of mixtures and pure substances.
- 12.C Evaluate the significance of water as a solvent in living organisms and in the environment.
13. A Compare unsaturated, saturated, and supersaturated solutions.
13. B Interpret relationships among ionic and covalent compounds, electrical conductivity, and colligative properties of solutions.

**Related TEKS:** Environmental Science

**Vocabulary of Instruction:**

brackish water	concentrate
nano-parts	osmosis
electro conductivity	total dissolved solids
buoyancy	solution

**Advanced Preparation:**

Organize students' into groups and perform a desalination project, model, or experiment. Discuss how the bi-product is managed.

**Instructional Procedure (5 E)**

**Engage:** The students will understand the reverse osmosis filtration system and compare it with other desalination processes. Discuss the pros and cons of each desalination process. Students may refer to the "Water from Water" PowerPoint at [tech2o.org](http://tech2o.org) and/or use other internet resources.

**Explore:** Use your knowledge in mixing solutions to create five different concentrations of salt water (4000 mg/l, 2000 mg/l, 1000 mg/l, and 500 mg/l, and distilled water). Make sure all of your glass ware you are using is washed well and rinsed with distilled water before filling. Do not taste the water at any time.

1. Start with one liter of distilled water
2. Add 4.0 grams of salt you have just made the first solution of 4000 mg/l.
3. Pour 80 ml of this into a 100 ml graduated cylinder and label the cylinder.
4. Now pour 40 ml of the 4000 mg/l solution into a 100 ml graduated cylinder and top with 40 ml of distilled water. You have just diluted the concentration in half to create 80 ml of 2000 mg/l solution so now you can label this cylinder.
5. Next pour 20 ml of your 4000 mg/l solution into another graduated cylinder and top with 60 ml of distilled water to create 80 ml of 1000 mg/l solution. Label this cylinder as well.
6. Next take 10 ml of your 4000 mg/l solution and pour into another graduated cylinder and top it off with 70 ml of distilled water to create 80 ml of 500 mg/l solution. Label this as well.
7. Finally fill the last graduated cylinder with 80 ml of distilled water and label.

Take a narrow piece of tape that will fit along the length of a narrow test tube and make graduation marks in pen using the millimeter marks of a ruler, making larger marks every centimeter. Label the centimeters from 0 to 10 cm. Get one test tubes or a pointed centrifuge test tube and stick the marked tape the long way on the test tube making sure the tape comes within one centimeter from the top of the test tube.



# What are total dissolved solids?

Put enough sand in the bottom of the test tube so that it floats just below the first markings on the tape near the top of the test tube when placed in the graduated cylinder with the distilled water. Take a reading and record the mark where it floats as distilled water. Now take out the test tube, being careful not to spill any sand or get any water into the test tube, dry the outside and take readings where it floats in the other four solutions you made earlier. Record your results.

Next the instructor will give you an unknown solution somewhere between 4000 mg/l and distilled water for you to test for TDS. The instructor should accurately measure the solution somewhere in between one of the constants to force the students to rely on their graduation marks on their tape. An example of an unknown solution would be 800 mg/l or 1500 mg/l. Record your results of your test for the unknown and answer the questions.

**Explain:** An important measurement that must be taken when determining how brackish water is, is to measure the total dissolved solids (TDS). TDS are present in all water except for distilled water in varying amounts and determine the saltiness of the water. Mineral constituents such as sodium, potassium, calcium, magnesium, chloride and sulfate contribute to the level of TDS. Water with a TDS value of 750 mg/l has no perceptible salty taste. 750 to 1500 mg/l is slightly salty, and greater than 2500 mg/l is salty. The state and federal standards for TDS is 1000.00 mg/l and the EPWU plants release water that is well below that ranging from 600 to 700 mg/l. One simple method to measure TDS is with a weighted floating bobber calibrated to measure TDS according to how far it sinks in the water being tested. The fewer TDS in the water the less buoyant force the water will have and the farther the bobber will sink. They say even a non swimmer can swim in Salt Lake in Salt Lake City because it is so full of TDS that the buoyant force will keep you afloat.

### **Elaborate/Extend:**

#### **Questions:**

- What are total dissolved solids?
- What are some other ways that scientists may be able to measure TDS?
- What do TDS have to do with osmosis?
- What is buoyancy?
- How do TDS affect buoyancy?
- Why would water deep within an aquifer have high levels of TDS?
- What would you expect the TDS to be in sea water?
- Would you like to drink sea water?
- Why or why not?

**Evaluate:** Closure of class will consist of student groups developing and presenting a statement about what they learned today and how it may change their ideas about water availability in El Paso. How much will you be willing to pay for fresh water?