Investigation 1 - Separating Mixtures

Students make mixtures of water and solid materials and separate the mixtures with screens and filters. They find that water and salt make a special kind of mixture, a solution, which cannot be separated with a filter but only through evaporation. Students are challenged with a problem: how to separate a mixture of three dry solid materials. The investigation concludes with students going outdoors to see what natural materials make solutions with water.

Standard - 5-PS1-1, 5-PS1-2, 3-5 ETS1-1, 3-5 ETS1-2, 3-5 ETS1-3

Investigation 1	**Summary of Lesson**	**Priority**
Part 1: Making and Separating Mixtures ***	Students make three mixtures of solid materials (salt, gravel, and diatomaceous earth) and water. After they observe the mixtures, they attempt to separate them with screens and filters. They discover that water and salt make a special kind of mixture - a solution - that cannot be separated with a filter. *Activity, "Tutorial: Mixtures"* *FQ - How can a mixture be separated?*	High Introduction to new concepts and content vocabulary.
Part 2: Separating a Salt Solution **	Students add a measured amount of salt to a measured amount of water to make a solution. They compare the total mass of a mixture to the mass of its parts to infer that the invisible salt is still present. Students evaporate the salt solution to reclaim the salt as crystals. *Read, "Mixtures".* *Activity, "Tutorial: Solutions".* *FQ -Where does the solid material go when a solution is made?*	High Introduction to new concepts and content vocabulary.
Part 3: Separating a Dry Mixture **	Students are given a dry mixture (gravel, powder, and salt) to separate. The mixture includes a new mystery materials, magnetite. Students separate the mixture by using magnets, screens, filters, and evaporation. Students review the elements of engineering design as they design an efficient system to separate a dry mixture. They discuss their efforts in terms of science and engineering practices. *Read, "Taking Mixtures Apart", "Science Practices", "Engineering Practices"* *Activity, "Separating Mixtures", "Virtual Investigation: Separating Mixtures".* *Video, "Elements, Compounds, and Mixtures".* *FQ - How can you separate a mixture of dry materials?*	High/Medium Strongly meets the standard **5-PS1-1,** reinforcing that matter can be separated.

Part 4: Outdoor Solutions	Students are challenged to discover if natural materials in the schoolyard will make solutions when mixed with water. When students observe that organic material changes the color of the water, they are introduced to the concept of an extract. *Read,"Extracts" and "The Story of Salt(optional)"* *FQ - Are there materials outdoors that will dissolve in water?*	Low This lesson is very long and could be skipped. The idea of an extract could be included in the preceeding lesson. The important piece is the reading.
Assessment	i-Check	

Investigation 1 cont. - Separating Mixtures

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

3-5 ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5 ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5 ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Investigation 2 - Developing Models

Students make multisensory observations of sealed black boxes in an effort to determine what is inside. They develop models and try to reach consensus with other students who investigated the same boxes. Students construct physical models of black boxes in an effort to replicate the behaviors of the original black boxes. Students investigate melting and freezing in terms of models and conservation of mass and clarify the difference between the processes of melting and dissolving.

Standards - 5-PS1-1, 5-PS1-2

Part 1 and 2 could be done at the end of the Unit as it doesn't connect with other investigations.

Investigation 2	Summary of Lesson	Priority
Part 1: Black Boxes *	Students make multisensory observations of sealed black boxes in an effort to determine what is inside. They develop models and try to reach consensus with other students who investigated the same boxes. Students construct physical models of black boxes in an effort to replicate the behaviors of the original black boxes. *Activity, "Black Box".* *FQ-What is the process to develop a model of the black box?*	Low This lesson doesn't strongly connect with any standards at 5th grade. This does however relate to DCI's by developing models being explanations of objects, events, or systems that cannot be observed directly. *** This activity is high interest for students.*
Part 2: Drought Stopper **	Students observe a device that delivers 600-700 mL of water when only 100 mL of water is put in. They develop conceptual models to explain how they think the device works. *Read, "Beachcombing Science".* *FQ - How does a drought-stopper system work?*	Low This lesson doesn't strongly connect with any standards at 5th grade. This does however relate to DCI's by developing models as representations for communicating and testing. *** This activity is high interest for students.*
Part 3:Models for Change in Properties ***	Students use hot water to heat four common solid materials and observe that one melts, two solten, and one is unchanged. With this review of phase change and melting, students are asked to develop models of dissolving and melting and tell how they are different. *Read, "Solid to LIquid", "Liquid and Gas Changes" and Celsius and Fahrenheit" (optional)* *Video, "Changes in Properties of Matter".* *FQ - What is the difference between dissolving and melting?*	High This lesson connects with previous lesson of solids and liquids and could be the done at the end of Investigation 1.
Assessment	i-Check	

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

Investigation 3 - Concentration

Students observe and compare soft-drink solutions that differ in the amount of powder (water held constant) and in the amount of water (powder held constant) in order to develop the concept of concentration. They make salt solutions of different concentrations and compare them, using a balance. Students determine the relative concentrations of three mystery solutions made from the sale solid material by comparing the mass of equal volumes of the solutions. Finally, students layer salt solutions to determine their relative concentrations.

Standards - 5-PS1-1, 5-PS1-2

Investigation 3	Summary of Lesson	Priority
Part 1: Soft-Drink Recipes **	Students observe and compare soft-drink solutions that differ in the amount of powder (water held constant) and in the amount of water (powder held constant) to develop the concept of concentration. *Read, "Solutions Up Close".* *Activity, "Tutorial:Conservation of Mass"* *FQ - Area all solutions made with soft-drink powder and water the same?*	High Introduction to new concepts and content vocabulary.
Part 2: Salt Concentration **	Students make salt solutions and compare their concentrations. Taste is no longer a viable indicator, so students use a balance to determine the relative concentration of the salt solution. *Read, "Concentrated Solutions"* *FQ - How can you determine which salt solution is more concentrated?*	High Introduction to connection of mass and concentration.
Part 3:Mystery Solutions ***	Students determine the relative concentrations of three mystery salt solutions (the most concentrated and the most dilute) by comparing equal volumes on a balance. More concentrated solutions have a greater mass. *Read, "The Air" and "Famous Scientists".* *Activity, "Virtual Investigation: Saltwater Concentration".* *FQ - How can you determine the relative concentrations of three mystery solutions?*	Medium This is a repeat of Part 2 and could be skipped if lack of time, however reinforces the concept of density. The important piece of this lesson is the reading.

Part 4: Liquid Layers	Students observe that a mass piece sinks in one liquid and floats in another, because the liquids are different densities. Armed with the knowledge that less dense objects float on more dense liquids, students investigate four salt solutions to discover which more concentrated based on how they layer. *Read, "Carbon Dioxide Concentration in the Air" and "The Frog Story".* Video, "Why are Oceans Salty" Activity, "Tutorial: Density" *FQ - What is the relationship between salt-solution concentration and density?*	High This lesson brings all concepts of density and concentration together in this Part. ***Very high interest with students.*
Assessment	i-Check	

Investigation 3 cont. - Concentration

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

Investigation 4 - Reaching Saturation

Students make a saturated solution by adding salt to water until no more alt with dissolve. They also make a saturated Epsom salts solution. Using a balance, they compare the solubility of the two solid materials by comparing the mass of the salt and Epsom salts dissolved in the saturated solutions. Students use the property of solubility to identify an unknown material. They analyze local water samples, using separation techniques and design a way to remove salt from ocean water.

Standards - 5-PS1-1, 5-PS1-3, 3-5 ETS1-1, 3-5 ETS1-2

Investigation 4	Summary of Lesson	Priority
Part 1: Salt Saturation	Students make a saturated solution by adding salt to water until no more salt will dissolve. After separating the undissolved solid salt, students use a balance to determine the mass of salt needed to saturate 50 milliliters (mL) of water. The two components of a solution are identified as the solvent and solute. *Read, "The Bends".* *FQ - Is there a limit to the amount of salt that will dissolve in 50 mL of water?*	High This lessons reinforce the concepts of solution being a solvent and solute.
Part 2: Epson Salts Saturation	Students add Epsom salts to 50 mL of water to make a saturated solution. They use a balance to determine the mass of Epsom salts in the saturated solution in order to compare the solubility of salt and Epsom salts. *FQ - Does it always take the same amount of solid materials to saturate 50 mL of water?*	High This lessons reinforce the concepts of mass and saturation.
Part 3: The Saturation Puzzle	Students are given an unknown substance (citric acid) to identify based on its properties. They determine the unknown's solubility and compare their results to a table of known solubilities for five substances. Students evaporate the unknown solution and compare the crystals to photographic images to confirm their identification. *Read, "A Sweet Solution" and "Sour Power".* *Activity, "Tutorial: Saturation" and "Virtual Investigation: Solubility"* *FQ - What is the identify of the mystery substance?*	High This lessons strongly meets standard **5-PS1-3,** looking at materials based on their properties.
Part 4: What's in your water?	Students collect water samples from the school and use observation and evaporation to determine what's in each sample. Students find out about the source of their local water, where it is stored, and hot it is treated. They apply their knowledge of solution chemistry to design a process to make ocean suitable for drinking.	Low This lesson could be skipped.

	Read, "East Bay Academy for Young Scientists", "Drinking Ocean Water" and "Creative Solutions". *Video, "The Water Cycle".* *FQ - What is in our water samples? What is a design to remove salt from ocean water?*	
Assessment		

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3 Make observations and measurements to identify materials based on their properties

3-5 ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5 ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Investigation 5 - Flzz Quiz

Students make three solutions with water, calcium chloride, baking soda, and citric acid. They systematically mix pairs of those solutions and observe changes that occur. The changes (formation of a gas and a white precipitate) are identified as evidence of a chemical reaction. Students repeat the reactions in sealed zip bags to observe the volume of gas produced.

Standards - 5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4

Investigation 5	**Summary of Lesson**	**Priority**
Part 1: Chemical Reactions	Students use three substances (calcium chloride, baking soda, and citric acid) to make three different combinations of two substances. They add water and observe the changes that occur. The new products that form (a gas and a white precipitate) are identified as evidence of a chemical reaction *Read, "Ask a Chemist".* *Activity, "Fizz Quiz"* *FQ - What is the effect of mixing two substances with water?*	High Meets standard **5-PS1-3.**
Part 2:Reaction Products	Students use technique from earlier investigations (filtering and evaporation) to separate the products of the reactions. They identify the products by testing the precipitate with vinegar to see it is is chalk, and by evaporating the liquid to discover the typical square crystals of salt. *Read, "When Substances Change".* *Video, "Chemical Reactions"* *FQ - How can we identify the products from the baking soda and calcium chloride reaction?*	High Meets standard **5-PS1-3.**
Part 3: Reaction in a Zip Bag	Using combinations of the substances used in Parts 1 and 2, students produce chemical reactions in zip bags. The closed systems allow students to effectively observe the volume of gas and discover a new precipitate when all three substances are mixed in a bag. *Read, "Air Bags".* *Video, "Changes in Properties of Matter".* *Activity, "Tutorial: Reaction or Not?""* *FQ- What happens when you mix substances with water in a bag?*	High Meets standard **5-PS1-4.**
Assessment		

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-3 Make observations and measurements to identify materials based on their properties

5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.