Lesson Title: Teaching Powder Volume to Ten-Year-Olds

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Lesson Overview	**Overall Purpose:** The purpose of this lesson is for learners to understand and become proficient with powder volume calculations and how they relate to dosing accuracy. **Estimated Timeframe:** This lesson is designed to be completed in 2 parts using the REACT lesson planning process. Part 1 includes can be hybrid or in person and covers Relating, Experiencing, and Applying. Part 2 requires group work and if possible, should be completed in person. It includes Cooperating and Transferring. Our classes are 3 hours long so we have time to successfully leverage groupwork in one session. **Courses for Implementation**: Pharmacy Technology Chemistry **Format: Hybrid** **Key Terms:** Diluent – A liquid that decreases the concentration of a solution by diluting it, or turns powder into a liquid Solvent – A solvent is usually a liquid that has the ability to dissolve another substance. The most common and available solvent is water. Solute – A substance dissolved into a solvent to make a solution mixture Solution – A liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent) Suspension – A liquid solution contains undissolved drug particles suspended in it. Constitute – When drugs in powder form need to be mixed with a fluid before they are administered Constitute- To add a liquid diluent to a lyophilized (freeze-dried) drug in powder form to make a specific concentration of liquid. * Reconstitute – to add a liquid diluent to a drug in powder form to make a specific concentration of liquid. Powder volume – The volume or space that the powdered drug occupies after it is reconstituted. * While technically the term re-constitute refers only to lyophilized powders, it is commonly used as a universal term for changing any powder medication form into a liquid. For this class, we will use re-constitute for both powdered and lyophilized forms.

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	Sources: https://www.pharmacy-tech-test.com/medical-terms-definitions.html https://wtcs.pressbooks.pub/nursingskills/chapter/5-10-reconstituted-medication/ **Standards/Skills Addressed:** **Academic** Pharmacy calculations: weights & measures, powder volume and concentration **Technical** Calculate powder volume displacement Calculate diluent amounts to alter final concentration **21st Century/Employability** Critical thinking Oral presentation skills **Learner Outcomes/Student Learning Objectives:** (Learners will be able to) • Define diluent, solvent, solute, solution, and suspension • Determine the amount of solvent required to prepare oral and parenteral powder medication • Explain why some medications are available in powder form • Calculate the volume to be measured when given a specific dose. • Calculate the amount of medication in a given volume. • Calculate powder volume, diluent, total concentration and final volume of constituted/reconstituted medications.
Equipment/Materials	**List of Materials/Equipment/Texts:** **Text** Pharmacy Calculations for Technicians - Sixth Edition - Ballington, McKennon ISBN 10: 0763884189 ISBN 13: 9780763884185 Publisher: Kendall Hunt Publishing, 2018 **Equipment** • Graduated cylinders • Distilled water • Compounding syringes and needles • Various water-soluble powders or powder product examples

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	Presentation Supplies • include but are not limited to: blocks, sugar, sugar cubes, graduated cylinders, bowls, digital scales, prescription bottles, food coloring, oral syringes, colored paper, powdered drink mix. Any common household objects appropriate for demonstration purposes. **Safety Precautions:** Use gloves when weighing powders **Cleanup Instructions:** Students - Wash, and properly store graduated cylinders Students – Properly store all additional supplies
Discussion	**Industry/Real-world Scenario:** **The following is a scenario developed to add context and a bit of fun. The goal of the assignment is to understand powder volume concepts and calculations so well, they can teach it to a child.** Community service is a core value of our program. Each student or student group must participate in 1 project each semester. This year, you chose to join a group going over to the local primary school to teach 10-year-old students. The assigned topic is volume displacement. The school wants to make the lesson more relatable and asked if the group could incorporate pharmacy into the lesson. **Design a show and tell demonstration of the concepts related to powder volume to the class** • Using common household and or lab items, design something that explains the concepts in such a way that a 10-year-old can understand. • Available supplies include but are not limited to: blocks, sugar, sugar cubes, graduated cylinders, bowls, digital scales, prescription bottles, food coloring, oral syringes, colored paper, powdered drink mix.
Instructional Strategies	**Proposed Teaching Strategies:** Direct instruction, active learning, teamwork, analysis, calculations, teaching **Creative License (Choice/Discovery/Reflection):** Emphasis can be placed on the following focus points but may also be used to expand into accuracy, medication errors and patient safety. · powder volume, · diluent volume, · total volume,

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	· final concentration, and · how to obtain different concentrations **Bloom's:** Solve, illustrate, calculate, use, relate, apply, explain, demonstrate **REACT:** **Relating** Powder Volume Why do some medications come in powder or lyophilized (freeze-dried) powders? The reasons include: improved stability, longer expiration, and easier storage with concern to temperature requirements. The volume or space that the powdered drug occupies after it is reconstituted is called powder volume. For some drugs, the powder volume is so small that it is considered negligible. Other drugs have substantial powder volume which needs to be taken into consideration when reconstituting. A common comparison is that most people do not leave significant, if any, room for the sugar they add to their morning coffee. In this scenario we can say that powder volume is negligible. Although you do not dissolve, you do not fill a bathtub full of water before getting in. **Experiencing** Demonstration/experiment- Take two containers that can hold three liters of volume. In one container, add enough gelatin mix to make three liters of gelatin. In the other container, fill it with three liters of fluid. Then using a funnel, add all the water from the one container to the other one with the gelatin. If you pour out all the fluid, a significant amount of fluid will spill everywhere. In this case, we can say that the gelatin mix has a significant amount of powder volume that we should have accounted for. References:https://boudreaux.weebly.com/uploads/3/7/1/4/37140563/ch_18_-_powder_volume_calculations.pdf **Applying** **Direct Instruction** (Example slide set) **Introduction to worksheet:** We should consider several different ways that we can find powder volume. Sometimes the package insert or vial labels will tell you. Other times you will be told how much to reconstitute it with and be given either the concentration or the total volume. From there you can find the powder volume by taking the total volume and subtracting the amount of diluent added.

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	Example If 95 mL of sterile water for injection (SWFI) is added to a 10 g bulk powdered drug pharmacy container, the concentration obtained is 100 mg/mL. What is the powder volume of the drug? QUESTION What is the powder volume of the drug? DATA 95 mL SWFI added (this is the diluent added) 10 g powdered drug (this is the weight of drug) 100 mg/mL (this is our final concentration) FORMULA/METHOD Powder Volume + Diluent Added Total Volume MATH We know the diluent added is 95 mL, and since we have the weight of the drug in the vial and the final concentration after reconstitution, we can find the total volume as follows: $\frac{\text{mL}}{100\text{mg}} \times \frac{1000\text{mg}}{1\text{g}} \times \frac{10\text{g}}{1} = 100\text{mL}$ total volume, often referred to as final volume. Powder Volume = ??? + Diluent Added = 95 mL Total Volume = 100 mL $100\text{mL} - 95\text{mL} = 5\text{mL Powder Volume}$ DOES THE ANSWER MAKE SENSE? Yes It is noteworthy focusing on how we obtained the total volume. The final concentration and the quantity of drug in the vial are both reflective of what will be in the vial immediately after reconstitution is complete, and therefore are appropriate to use when determining the total volume in the vial after reconstitution.

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	Now, you should attempt some problems to ensure that the concepts are making sense thus far. **Practice Problems** 1) You want to prepare a 500 mg dose of ceftriaxone for IM injection. If you reconstitute it with 1.8 ml of 2% lidocaine, you attain a concentration of 250 mg/ml. What is the powder volume of the drug? 2) A 20 million unit (MU) vial of penicillin g potassium has 8 mL of powder volume. *(Notice that this problem has already given you the powder volume)* a) How many mL will you reconstitute it with to attain a concentration of 500,000 unit/mL? *(Hint: You can use the concentration to determine the total volume, which will be necessary to determine the volume of diluent needed.)* *b)* How many mL of the reconstituted solution will you draw up for a 12 MU dose? One more concept to cover is the idea of changing the quantity of diluent used to reconstitute a preparation in order to obtain a different concentration. Let's look at an example problem to explain this scenario. ***Example*** Ordinarily IVIG is reconstituted to a concentration of 50 mg/mL. To obtain this concentration, a 5 g vial is reconstituted with 93 mL of diluent. What is the powder volume for a 5 g vial of IVIG? How much would you reconstitute it with if the patient was fluid restricted and the physician requested a concentration of 100 mg/mL? You can find the powder volume by doing the same steps as we have already done on previous problems. The first step is to determine what the total volume would be, and conveniently, the problem already gave us a volume for diluent added if reconstituted to a concentration of 50 mg/mL. $$\frac{\text{mL}}{50\text{mg}} \times \frac{1000\text{mg}}{1\text{g}} \times \frac{5\text{g}}{1} = 100\text{mL}\,\text{totalvolume}$$ Powder Volume = ??? + Diluent Added = 93 mL Total Volume = 100 mL

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	100 mL – 93 mL = **7 mL powder volume** Now that we've answered the first question about powder volume, we can determine the amount of diluent to add to obtain the desired concentration of 100 mg/mL. We will once again need to determine the total volume, but this time for our new concentration. $\frac{\text{mL}}{100\text{mg}} \times \frac{1000\text{mg}}{1\text{g}} \times \frac{5\text{g}}{1} = 50\text{mL}\text{totalvolume}$ Powder Volume = 7 mL + Diluent Added = ??? Total Volume = 50 mL 50 mL – 7 mL = **43 mL of diluent** to obtain the requested concentration. Now, using the example problem as a template, solve the practice problem below. ***Practice Problem*** A 1 g vial of vancomycin ordinarily is reconstituted with 19.5 mL of sterile water for injection (SWFI) to obtain a concentration of 50 mg/mL. What is the powder volume and how much should you reconstitute it with if you needed a concentration of 100 mg/mL? **Worksheet 1** Name Date: Solve the following powder volume problems. 1) If 192 mL of sterile water for injection (SWFI) is used to reconstitute a 20 g vial of cefazolin Na, the concentration obtained is 100 mg/mL. What is the powder volume of this drug? 2) Using another 20 g vial of cefazolin Na, how many mL of SWFI should be added to obtain a concentration of 200 mg/mL instead? *(Hint: The powder volume from the previous question is required to solve this.)* 3) A vial contains a combination drug of ampicillin/sulbactam. There is 1 g of ampicillin and 0.5 g of sulbactam in the vial. When the vial is reconstituted with 3.2 mL of sterile water, you end up with a total volume of 4.0 mL.

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	a) How many mL of powder volume are there? b) What is the concentration of each drug? 4) The label on a bottle of oral amoxicillin suspension states you are to add 39 mL of purified or distilled water to the bottle to obtain a suspension with a concentration of 150 mg/tsp. The total amount of active ingredient in the bottle is 2 g. What is the powder volume? 5) The directions for a vial containing 1 g of lyophilized ceftriaxone states that the addition of 3.6 mL of SWFI will yield a solution with a concentration of 250 mg/mL. What is the powder volume of the drug? 6) If you dissolve 5 MU of penicillin with 8 mL of SWFI, and you know that this vial contains 2 mL of powder volume, what is the concentration of the drug in the solution? 7) A 4 g vial of a powdered drug is reconstituted with 4.9 mL of SWFI to obtain a concentration of 800 mg/mL. a) What is the powder volume of the drug? b) If 2.6 mL of the reconstituted solution is added to a 500 mL bag of D5W, how much medication is in the IV bag? 8) If a 20 MU vial of penicillin g potassium has a powder volume of 8 mL, what would be concentration obtained if each of the possible volumes of SWFI listed below were used to reconstitute the vial? a) 32 mL b) 42 mL c) 72 mL d) 92 mL 9) You add 4.3 mL of diluent to a 1 g vial and have a final volume of 5 mL. a) What is the powder volume? b) What is the final concentration in mg/mL? c) How many mL would you need to add to a 50 mL bag of NS if a dose of 250 mg were required? 10) A pharmacist asks you to prepare cefazolin eye drops. You will need to add 9.8 mL of NSS to a 500 mg vial of cefazolin which has 0.2 mL of powder volume according to the package insert. You will draw up 1 mL of the reconstituted solution and filter through a 0.5 micron filter into a sterile eye dropper. Then you will add 9 mL of NSS to the eye

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	dropper (this will also need filtered). What is the final concentration of cefazolin in the eye dropper? *(Hint: You will first need to figure out the concentration of the solution in the vial before you can calculate the concentration in the eye dropper.)* **Cooperating** **Groupwork-** Group size variable. Suggest 2-4 students. Groups will work through additional problems as a group to solidify understanding. Introduce scenario and activity: Community service is a core value of our program. Each student or student group must participate in 1 project each semester. This year, you chose to join a group going over to the local primary school to teach 10-year-old students. The assigned topic is volume displacement. The school wants to make the lesson more relatable and asked if the group could incorporate pharmacy into the lesson. **Design a show and tell demonstration of the concepts of powder volume to the class** - Using common household and or lab items, design something that explains the concepts in such a way that a 10-year-old can understand. - Available supplies include but are not limited to: blocks, sugar, sugar cubes, graduated cylinders, bowls, digital scales, prescription bottles, food coloring, oral syringes, colored paper, powdered drink mix. Any additional household or classroom items may be used. Encourage creativity. **Transferring** Student presentations Each group will give their presentation to the class as if they were the class of ten-ear-old students.
Activities/Lesson Procedure	**Activity Preparation:** **Instructor** Prepare appropriate direct instruction for solving powder volume equations (see attached example) Gather supplies and set up creativity station in the classroom or lab If you have access, gather example oral and injectable powdered medications and supplies for reconstitution: oral antibiotic, distilled water, graduated cylinder, reconstitube, o.9% NaCl 10 or sterile water for injection 10 mL vials, lyophilized injectables, 5 and 10 mL syringes, 18-22 gauge needles, alcohol swabs. Gather various supplies students my use to prepare group presentations

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	Learner Read chapter prior to class and submit at least one question you have about the material. Work with group members to verify common understanding of powder volume. Work with group to develop a visual demonstration of a diluent, solvent, solute, solution, reconstitution, powder volume, final concentration, and dose determination. **Activity Steps/Lesson Procedure:** See REACT lesson plan **Expected Results/Learner Products:** (Observations, data collection, calculations, products, wrap-up/conclusions, etc.) The goal is for students to have a deeper understanding of how powder volume can affect drug concentration and therefore affect patient safety in addition to successfully completing assigned calculation problems. If students are engaged in the process and create viable demonstrations they will be encouraged to break all difficult concepts down into relatable chunks.
Faculty Resources	**Background Material:** Knowledge of reconstitution techniques and powder volume calculations. **Suggested Website Links:** https://www.youtube.com/watch?v=UO9pe6s9E68&t=435s https://www.youtube.com/watch?v=2laAfOvWy9Y&t=2s
Assessment	**How will students demonstrate what they have learned?** Students will present their mock demonstrations to the class. Each group will be evaluated using an instructor / peer review rubric. The rubric will focus on the efficacy of each groups ability to break down and demonstrate an understanding of key concepts. **This is not an exercise to assess presentation skills.** Students will also gather as a group to work through additional calculations.