Calculate dosages using proportions	=	Use reasoning to solve equations and justify the solution method

Program Task: Calculate the desired amount of medication to be administered using the "Desired/Available Method"

Program Associated Vocabulary
PROPORTIONS, EQUATIONS, FRACTIONAL RELATIONSHIPS, DOSAGE

Program Formulas and Procedures
Many medications are used in health care. In order to assure patient safety, these medications must be calculated correctly. What you desire to administer to your patient may not be how the medication is available. Therefore, the "Desired/Available Method" must be used to ensure the correct dosage.

Lasix (furosemide) is a medication commonly given to reduce edema. Lasix is available 20mg po. Sometimes a patient requires a dosage higher than 20mg.

The student must realize that a direct proportion must be used. As the dosage the patient is to receive (desired) increases, so will the number of pills that must be administered. This information can be used to set up the following proportion commonly referred to as the "Desired/Available Method":

"Desired" is the amount the patient needs.
"Available" is the amount in each pill/caplet/capsule.

A patient needs 40 mg of Lasix. Lasix is available in pill form at 20mg po. What is the dosage required for this patient?

Desired = 40mg $\quad \frac{40\text{mg}}{20\text{mg}} = \frac{x}{1\text{ pill}}$
Available = 20mg/pill

$\frac{40\text{mg}}{20\text{mg}} = \frac{x}{1\text{ pill}}$

Then, cross multiply and solve.

$20(x) = 40 \times 1$
$20x = 40$
$x = 2$ pills

PA Core Standard: CC.2.2.HS.D.9

Description: Use reasoning to solve equations and justify the solution method.

Math Associated Vocabulary
INVERSE, RECIPROCAL, PROPORTION, CROSS MULTIPLICATION, RATIO, CONSTANT

Formulas and Procedures
Direct Proportions
Two quantities, A and B, are directly proportional if by whatever factor A changes, B changes by the same factor.

Example 1: Take the formula distance = rate x time. If the rate remains constant, 30 miles per hour, then the time and distance are directly proportional.
$d = 30t$
when $t = 2$, $d = 60$
when $t = 4$, $d = 120$

*Note that when the time doubles, so does the distance.

Example 2: If speed is directly proportional to distance and a car can travel 100 miles at 50 miles per hour. How far can that car travel during the same time if it travels 70 mph?

Step 1: Set up proportion.

$$\frac{50\text{ mph}}{70\text{ mph}} = \frac{100\text{ mi.}}{x}$$

Step 2: Cross multiply and divide to solve.
$50x = 70(100) \rightarrow 50x = 7000 \rightarrow x = 140$ miles

Indirect Proportions
Two quantities, A and B, are inversely proportional if by whatever factor A changes, B changes by the multiplicative inverse, or reciprocal of that factor.

Example 1: Take the formula distance = rate x time. If the distance is constant, 100 miles, then as the rate increases the time decreases.
$100 = rt$
When $r = 100$, $t = 1$
When $r = 50$, $t = 2$

*Note that when the rate doubles, the time

Example 2: If the time needed to complete a job is inversely proportional to the number of people working, how long would it take 4 people to paint a room if 1 person needs 8 hours?

Step 1: Set up the proportion.

$$\frac{1\text{ person}}{4\text{ people}} = \frac{8\text{ hours}}{x\text{ hours}}$$

Step 2: Invert (flipA) one ratio

$$\frac{1\text{ person}}{4\text{ people}} = \frac{x\text{ hours}}{8\text{ hours}}$$

Step 3: Cross-multiply and divide to solve
$4x = 8$, $x = 2$ 4 people can paint the room in 2 hours.

Teacher's Script - Comparing and Contrasting

Students must be able to use proportions for a variety of measurements and conversions. One of the most common uses in health care is the calculation of medication dosages. The student needs to be able to recognize the proportional relationship when using the "Desired/Available Method" to determine the correct dosage.

By setting up this proportion and cross multiplying, as in any other algebraic problem, the proper dosage can be precisely and efficiently calculated.

Common Mistakes Made By Students

Students need to be reminded about the different types of liquid measurements. Students also need to review the terms millimeters, ounces, and cc's so they do not use these measurements interchangeably. Students must remember to place the correct units in the numerator and denominator of each ratio. Students must also make sure that they are using like units for both desired and available units.

When students compare Direct and Inverse Proportional relationships, they may become confused and have difficulty differentiating one from the other. One way to keep them straight is to:

1. Set up one pair of values on the same line, e.g., $\frac{12"}{24"} = \frac{100 \text{ lbs.}}{x \text{ lbs.}}$ *(from problem #1)*
2. Beneath that line, place the other pair of values,
3. Cross multiply (24 times 100) and (12 times x), but first determine if you have to invert one ratio.
4. If you have to invert one ratio, then it is an inverse proportion.
5. If need be, set up the problem and do it both ways to see which answer makes sense! We know in *problem #9*, for example, that it won't take 5 rabbits more time than it took 1 rabbit to eat 20 carrots, so it must be an inverse proportion.

Lab Teacher's Extended Discussion

Medication administration is a task performed by many licensed health care professionals. It is imperative that dosages are calculated correctly to ensure patient safety. Students are always permitted to have the formula with them when calculating dosages as it is more important to correctly work through the formula than to memorize it.

Problems	Occupational (Contextual) Math Concepts	Solutions
1. Lanoxin is supplied to your unit labeled 0.5mg per 2cc. Mr. Green is to receive 0.25mg daily. How many cc's will you give him?		
2. Amitriptyline comes 50mg per tablet. Your patient is to receive 100mg. How many tablets will you need?		
3. The patient is ordered to receive 0.2mg atropine. The vial is labeled 0.5mg per 1 ml. How much should the patient receive?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. If it takes 12 eggs to make 1 dozen, how many eggs will be needed to make 9 dozen?		
5. The pressure of a gas and its corresponding volume are inversely proportional. If the pressure of 0.24 m^3 is 0.5 atm (atmospheres), what would the pressure be of 0.060 m^3 of the same gas at the same temperature?		
6. If it takes 26 lbs. of metal to make 10 castings, how many pounds of metal will be needed to make 14 castings?		
Problems	**PA Core Math Look**	**Solutions**
7. Given that y and x are **directly** proportional and y = 2 when x = 5, find the value of y when x = 15.		
8. Given that y and x are **inversely** proportional and y = 2 when x = 5, find the value of y when x = 15.		
9. If one rabbit can chew 20 carrots in 15 hours, how long will it take 5 rabbits to chew the same 20 carrots?		

Problems	Occupational (Contextual) Math Concepts	Solutions
1. Lanoxin is supplied to your unit labeled 0.5mg per 2cc. Mr. Green is to receive 0.25mg daily. How many cc's will you give him?	$\frac{0.25mg}{0.5mg} = \frac{x}{2cc}$	$0.5mg(x) = 0.25(2)$ mg/cc x = 0.5mg/0.5 mg cc **x = 1cc**
2. Amitriptyline comes 50mg per tablet. Your patient is to receive 100mg. How many tablets will you need?	$\frac{50\ mg}{100\ mg} = \frac{1\ tablet}{x}$	50mg(x) = 100(1) mg/tab x = 100 mg tab/50 mg **x = 2 tablets**
3. The patient is ordered to receive 0.2mg atropine. The vial is labeled 0.5mg per 1 ml. How much should the patient receive?	$\frac{0.2mg}{0.5mg\ \ 1ml} = \frac{x}{}$	0.5mg(x) = (1)0.2mgml x = 0.2 mg/0.5 mg ml **x = 0.4 ml**
Problems	**Related, Generic Math Concepts**	**Solutions**
4. If it takes 12 eggs to make 1 dozen, how many eggs will be needed to make 9 dozen?		**(Direct)** $\frac{12\ \text{eggs}}{x\ \text{eggs}} = \frac{1\ \text{dozen.}}{9\ \text{dozen}} \rightarrow 1x = 12(9) \rightarrow x = 108\ \text{eggs}$
5. The pressure of a gas and its corresponding volume are inversely proportional. If the pressure of 0.24 m^3 is 0.5 atm (atmospheres), what would the pressure be of 0.060 m^3 of the same gas at the same temperature?		**(Inverse)** $\frac{0.24m^3}{0.060m^3} = \frac{0.5atm}{xatm}$ (Invert one ratio since it is an inverse proportion) $\frac{0.24m^3}{0.060m^3} = \frac{xatm}{0.5atm} \rightarrow 0.24(0.5) = 0.060x \rightarrow x = 2atm.$
6. If it takes 26 lbs. of metal to make 10 castings, how many pounds of metal will be needed to make 14 castings?		**(Direct)** $\frac{10\ \text{castings}}{14\ \text{castings}} = \frac{26lbs.}{xlbs.} \rightarrow 10x = 26(14) \rightarrow x = 36.4lbs.$
Problems	**PA Core Math Look**	**Solutions**
7. Given that y and x are **directly** proportional and y = 2 when x = 5, find the value of y when x = 15.		**(Direct)** $\frac{5}{15} = \frac{2}{y} \rightarrow 5y = 2(15) \rightarrow y = 6$
8. Given that y and x are **inversely** proportional and y = 2 when x = 5, find the value of y when x = 15.		**(Inverse)** $\frac{5}{15} = \frac{y}{2} \rightarrow 15y = 2(5) \rightarrow y = 0.667$
9. If one rabbit can chew 20 carrots in 15 hours, how long will it take 5 rabbits to chew the same 20 carrots?		**(Inverse)** $\frac{1}{5} = \frac{x}{15} \rightarrow 5x = 1(15) \rightarrow x = 3\ \text{hours}$