COMMON CORE MATHEMATICS

Integration Activity

Pathway: Animal, Plant, and Soil Science

Lesson: APSR C5–5: Veterinary Math

Common Core State Standards for Mathematics: 9-12.F-BF.1

Domain: Building Functions F-BF

Cluster: Build a function that models a relationship between two quantities.

Standard: 1. Write a function that describes a relationship between two quantities.

Standard: 1a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Student Objective: Students will use knowledge of unit conversions needed to determine the correct dosage of medication to write functions relating two quantities of interest.

BACKGROUND KNOWLEDGE for Teachers and Students

Math Concepts:

A function is a relationship in which one quantity depends on another. It is usually written as an equation, but the relationship can also be represented by a table or graph.

Example: The equation below is a function that describes the relationship between kilograms (x) and pounds (y).

$$y = 2.2x$$

The two quantities that the function relates are referred to as *input* (usually x) and *output* (usually y). For example, in the function above, we can put in a value of 60 kilograms for x and determine the corresponding value for y.

$$y = 2.2(60)$$
$$y = 132 \text{ lb}$$

Thus, when we put **in** a value of 60 kilograms, we get **out** a value of 132 pounds. Every function can be thought of in terms of input and output. The value we get as output *depends on* what value is used as input, which is the description of a function.

Agriculture Concepts:

When any medicine or drug is administered to an animal, whether by a veterinarian, veterinary technician, or animal owner, it is critical to determine the correct amount to give. This requires an understanding of dosage—the amount of the drug to be given per unit of body weight, usually given as milligrams per kilogram (mg/kg) and concentration—the strength of a solution of medication, usually given as milligrams per milliliter (mg/mL). Unit conversions can be used to determine how many milliliters of medication to administer to an animal given its body weight.

Guided Practice Exercises: ANSWER KEY

1. $450 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{20 \text{ mg}}{1 \text{ kg}} \times \frac{1 \text{ mL}}{300 \text{ mg}} = \frac{450 \times 20}{2.2 \times 300} = \frac{9{,}000}{660} = 13.6 \text{ mL}$

2. In the calculations above, we ended up taking the weight times 20, divided by the product of 2.2 and 300. To write a function, we need to replace 450 lb with a variable, x. We will use y to represent the dose.

$$y = \frac{x(20)}{(2.2)(300)} = \frac{20x}{660} = \frac{x}{33}$$

So, the function is $y = \frac{x}{33}$, where x is in pounds and y is in milliliters.

3.

Weight (lb)	Dose (mL)
300	**300/33 = 9.1 mL**
350	**350/33 = 10.6 mL**
400	**400/33 = 12.1 mL**
450	**450/33 = 13.6 mL**
500	**500/33 = 15.2 mL**
550	**550/33 = 16.7 mL**
600	**600/33 = 18.2 mL**

4. $450 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{2.5 \text{ mg}}{1 \text{ kg}} \times \frac{1 \text{ mL}}{100 \text{ mg}} = \frac{450 \times 2.5}{2.2 \times 100} = \frac{1{,}125}{220} = 5.1 \text{ mL}$

5. To write the function, follow the calculations done in question 4, replacing the weight of 450 with the variable, x.

$$y = \frac{x(2.5)}{(2.2)(100)} = \frac{2.5x}{220} = \frac{x}{88}$$

So, the function is $y = \frac{x}{88}$, where x is in pounds and y is in milliliters.

6.

Weight (lb)	Dose (mL)
300	**300/88 = 3.4 mL**
350	**350/88 = 4.0 mL**
400	**400/88 = 4.5 mL**
450	**450/88 = 5.1 mL**
500	**500/88 = 5.7 mL**
550	**550/88 = 6.3 mL**
600	**600/88 = 6.8 mL**

7. a. The dose we calculated earlier was 13.6 mL. Use unit conversions to determine the cost.

$$13.6 \text{ mL} \times \frac{\$69.95}{100 \text{ mL}} = \frac{13.6 \times 69.95}{100} = \frac{951.32}{100} = \$9.51$$

A 13.6 mL dose would cost $9.51.

b. The dose we calculated earlier was 5.1 mL. Use unit conversions to determine the cost.

$$5.1 \text{ mL} \times \frac{\$221.95}{50 \text{ mL}} = \frac{5.1 \times 221.95}{50} = \frac{1{,}131.945}{50} = \$22.64$$

A 5.1 mL dose would cost $22.64.

8. Brand B

9. Brand A

Independent Practice Exercises: ANSWER KEY

1. $60 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{0.03 \text{ mg}}{1 \text{ kg}} \times \frac{1 \text{ mL}}{1 \text{ mg}} = \frac{60 \times 0.03}{2.2} = \frac{1.8}{2.2} = 0.8 \text{ mL}$

2. To write the function, follow the calculations you did in question 1, replacing the 60 lb with the variable x.

$$y = \frac{x(0.03)}{2.2} = \frac{3x}{220}$$

The function is $y = \frac{3x}{220}$, where x represents the weight of the dog, in pounds, and y represents the dose.

3.

Weight (lb)	Dose (mL)
40	**3(40)/220 = 0.5 mL**
45	**3(45)/220 = 0.6 mL**
50	**3(50)/220 = 0.7 mL**
55	**3(55)/220 = 0.75 mL**
60	**3(60)/220 = 0.8 mL**
65	**3(65)/220 = 0.9 mL**
70	**3(70)/220 = 1.0 mL**

4. $60 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{1.1 \text{ mg}}{1 \text{ kg}} \times \frac{1 \text{ mL}}{10 \text{ mg}} = \frac{60 \times 1.1}{2.2 \times 10} = \frac{66}{22} = 3 \text{ mL}$

5. Follow the calculations you did in question 4, replacing 60 lb with the variable x.

$$y = \frac{x(1.1)}{2.2(10)} = \frac{1.1x}{22} = \frac{x}{20}$$

The function is $y = \frac{x}{20}$, where x represents the weight of the dog, in pounds, and y represents the dose.

6.

Weight (lb)	Dose (mL)
40	**40/20 = 2.0 mL**
45	**45/20 = 2.3 mL**
50	**50/20 = 2.5 mL**
55	**55/20 = 2.8 mL**
60	**60/20 = 3.0 mL**
65	**65/20 = 3.3 mL**
70	**70/20 = 3.5 mL**

7. Medetomidine (0.8 mL for a 60-lb dog, compared to 3 mL of acepromazine for a 60-lb dog)

8. a. Cost of 1 mL: $\$55 \div 10 \text{ mL} = \$5.50$ per mL

   Cost of dose: We found the dose to be 0.8 mL for a 60-lb dog, so the cost would be $\$5.50 \times 0.8 \text{ mL} = \$4.40$

   b. Cost of 1 mL: $\$25.94 \div 50 \text{ mL} = \$0.52$ per mL

   Cost of dose: We found the dose to be 3 mL for a 60-lb dog, so the cost would be $\$0.52 \times 3 = \$1.56$

9. Acepromazine

10. Many factors besides cost and dose should be considered. Possible answers may include:
    - Side effects of each drug
    - How specific breeds react to each drug (e.g., boxers are sensitive to acepromazine)
    - Availability
    - Methods of administering (injection vs. pill or tablet)
    - Length of time for sedative to take effect
    - Amount of time the animal will be sedated on one dose

Name: _____

Guided Practice Exercises:

Randy has a 450-lb heifer with pinkeye. He needs to administer an antibiotic to clear up the infection before it spreads to other animals. He has two brands of antibiotics to choose from.

Brand A	Brand B
Dosage: 20 mg/kg Concentration: 300 mg/mL Cost: $69.95/100 mL	Dosage: 2.5 mg/kg Concentration: 100 mg/mL Cost: $221.95/50 mL

1. How many mL of Brand A would Randy need to administer to his heifer? Show all the calculations that lead to your answer.

2. It would be helpful, given the weight of the animal in pounds, to have an equation that could be used to quickly calculate the dose. Using the calculations you did in question 1, write a function (equation) relating the weight of an animal, in pounds, to the number of milligrams of Brand A that should be administered.

3. Use your function to complete the table below. For each weight given, determine the dose of Brand A antibiotic that should be administered.

Weight (lb)	Dose (mL)
300	
350	
400	
450	
500	
550	
600	

4. If Randy uses Brand B antibiotic, determine the correct dose for a 450-lb heifer. Show all the calculations that lead to your answer.

5. Based on the calculations you did in question 4, write a function that relates the weight of the animal, in pounds, to the dose of Brand B that should be administered.

6. Use your function to complete the table below.

Weight (lb)	Dose (mL)
300	
350	
400	
450	
500	
550	
600	

7. In choosing between the two brands of medication, Randy wants to consider the cost of using each.

   a. Determine the cost of a dose of Brand A medication for Randy's 450-lb heifer.

b. Determine the cost of a dose of Brand B medication for Randy's 450-lb heifer.

8. Which brand requires the smallest dose of medication?

9. Which brand is the cheapest per dose?

Name: _____

Independent Practice Exercises:

The animal clinic you work for is ordering drugs that will anesthetize dogs for routine procedures and sedate anxious dogs to make routine checkups easier. The clinic is considering two types of anesthesia: medetomidine and acepromazine. Either can be used as a sedative, muscle relaxer, pain reliever, and mild anesthetic. Information for each drug is listed below.

Medetomidine
Dosage: 0.03 mg/kg
Concentration: 1 mg/mL
Cost for 10-mL vial: $55

Acepromazine
Dosage: 1.1 mg/kg
Concentration: 10 mg/mL
Cost for 50-mL vial: $25.94

1. Determine the dose of medetomidine that should be given to sedate a 60-lb dog. Show all the calculations that lead to your answer.

2. Based on the calculations you did in question 1, write a function that relates the weight of the dog, in pounds, to the dose of medetomidine that would be administered.

3. Use your function to complete the table below for various weights of dogs.

Weight (lb)	Dose (mL)
40	
45	
50	
55	
60	
65	
70	

4. Determine the dose of acepromazine that should be given to sedate a 60-lb dog. Show all the calculations that lead to your answer.

5. Based on the calculations you did, write a function that relates the weight of the dog, in pounds, to the dose of acepromazine that would be administered.

6. Use your function to complete the table below for various weights of dogs.

Weight (lb)	Dose (mL)
40	
45	
50	
55	
60	
65	
70	

7. Which drug requires a smaller dose to sedate a dog?

8. Before deciding which drug to purchase, the clinic should consider the cost of each drug.

   a. Find the cost of 1 mL of medetomidine. What is the cost of a dose for a 60-lb dog?

   b. Find the cost of 1 mL of acepromazine. What is the cost of a dose for a 60-lb dog?

9. Which drug is cheaper per dose?

10. What else might you want to know about these drugs before deciding which to purchase for use at the clinic?