

## Unit Dimensional Analysis Activity – Version 2

*Why?* In this activity we will see that it is possible to look at a situation from several points of view, or to take measurements of that same situation using different units of measure. Every measurement has 2 components: magnitude and dimension. Magnitude is the value of the number in the measurement and dimension is the unit of measure (e. g. grams, centimeters, inches or liters.)

- *If a measurement is given, can we convert that measurement to different units to meet our needs?*

## Model: Car Trip

Given:

90 miles

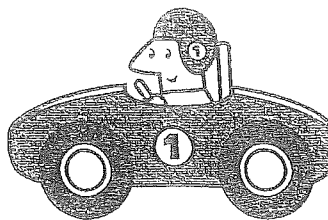
75 minutes

3 gallons of gasoline

\$12.00

1 bathroom break

27 songs on your iPod®



**Group Instructions:** When addressing each question, one group member should be assigned the task of reading the question aloud for the rest of the group. The manager should rotate that role among group members throughout the assignment.

**Critical Questions:**

1. How long does it take to drive 90 miles?
2. How long does it take to drive 180 miles?
3. How many miles can you drive on 3 gallons of gas?
4. How many miles can you drive on 1 gallon of gas?
5. Show how you solved question # 4. Be sure to include the units in your calculations.
6. Show the miles per gallon as a **fraction** (ratio) with numerator and denominator. Which is the numerator? Which is the denominator?
7. Using a grammatically correct sentence describe how you made the choice for # 6.
8. Is there another way to write the **fractional relationship** of gallons and miles? Show this way.
9. Why might you want to write the ratio this 2<sup>nd</sup> way?

10. Here are 3 other ratio relationships that we can obtain from the model:

$\frac{1 \text{ bathroom break}}{90 \text{ miles}}$

$\frac{3 \text{ gallons}}{75 \text{ minutes}}$

$\frac{27 \text{ songs}}{\$12.00}$

Write 4 other such relationships that you can obtain from the model:

These relationships are called **Conversion Factors**.

What are the components of a conversion factor?

Using complete sentences consult with your group and come up with a description of a conversion factor. What are its essential components and what is its purpose?

11. Which one of the conversion factors from #10 would you use to determine how long it would take to burn 8 gallons of gas?
12. Construct the conversion factor needed to determine how many songs you would hear in 500 miles.
13. Solve # 12 mathematically. Show your work below and be sure to *include units*.

**Reflections:**

14. As a group, write grammatically correct English sentences to describe the objective of the activity at this point. Be prepared to share your answer with the class.
15. After having shared with the class, does your group still agree with your initial assessment of what the objective is?
16. As a group, can you think of a situation when a scientist or chemist might need to use conversion factors to solve a problem? Give an example.

Exercises:

Using conversion factors to solve a problem is called Dimensional Analysis. You should now be able to solve the following problems.

17. Solve this problem *without using a calculator*: 
$$\frac{6 \times 17 \times 3 \times 13}{13 \times 9 \times 17} =$$

18. Write a mathematical rule that makes this problem easier to solve.

19. Solve this problem:

$$\frac{\text{miles} \times \text{songs} \times \text{gallons}}{\text{miles} \times \text{gallons}} =$$

It is often convenient to represent calculations of this type as a "cancellation line." The cancellation line for Problem 17 would look like this:

6	17	3	13	=	2
13	9	17			

Cancellation lines can also be used with units:  
Ex. Calculate the number of minutes in 5 days

5 days	24 hours	60 minutes	=	7200 min.
1 day	1 hour			

Use a cancellation line to solve the remaining problems.

20. How many miles would you have to drive to hear 43 songs? Show how you solve the problem using units and conversion factors.
  
21. Using your answer from # 20, how many minutes would this take? Again show how you solve the problem using units and conversion factors.
  
22. Show how you can combine problems # 20 and # 21 into one. Draw a line through any units that cancel. Put your answer on the board.
  
23. Write a grammatically correct English sentence to describe which unit you will be left with in the answer.

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## On your own

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24. The average human heart beats 72 beats/minute. If you live to be 80 years old, how many times does your heart beat. What conversion factors do you need to know to solve this problem. List these conversion factors.
  
25. What units should the answer be in? What value would you use to begin the problem and why? Solve the problem and show your work. Include all units and show cancellations of the units.