Lesson Title: Math in Music (by Deborah L. Ives, Ed.D.)

GRADE LEVEL: 7-10

SUBJECT MATTER: Algebra; Music

TIME ALLOTMENT: Two 45-minute class periods

OVERVIEW
Using video segments and web interactives from ***Get the Math***, students engage in an exploration of mathematics, specifically proportional reasoning and sense making, to solve real world problems**.** In this lesson, students focus on understanding the Big Ideas of Algebra: patterns, relationships, equivalence, and linearity; learn to use a variety of representations, including modeling with variables; build connections between numeric and algebraic expressions; and use what they have learned previously about number and operations, measurement, proportionality, and discrete mathematics as applications of algebra. Methodology includes guided instruction, student-partner investigations, and communication of problem solving strategies and solutions.

In the Introductory Activity, students view a video segment in which they learn how two hip-hop musicians use math in their work and are presented with a mathematical music challenge. In the Learning Activities, students use an online simulation to complete the challenge, which involves using algebraic concepts and reasoning to calculate beats per minutes in an instrumental sample. Students discuss their strategies and view the approaches and solutions used by teams featured in ***Get the Math***. In an optional activity, students explore an additional online interactive to match the beats of new combinations of drum tracks and instrumental samples. In the Culminating Activity, students reflect upon and discuss their strategies and talk about the ways in which algebra can be applied in music and beyond.

LEARNING OBJECTIVES
Students will be able to:

- Describe scenarios that require musicians to use mathematics and algebraic reasoning in their work.
- Explain how to use algebraic concepts and reasoning to calculate beats per minute.
- Identify a strategy and create a model for problem solving.
- Understand and use rates, ratios, and proportions to solve problems (proportional reasoning).
- Recognize, describe, and represent linear relationships using words, tables, numerical patterns, graphs, and/or equations.
- Understand, explain, and use algebraic and numeric expressions and equations that are interconnected and build on one another to produce a coherent whole.

MEDIA RESOURCES FROM THE *GET THE MATH* WEBSITE
www.getthemath.org

- The Setup **(video)** ***Optional***
  An introduction to ***Get the Math*** and the professionals and student teams featured in the program.
- Math in Music: Introduction **(video)**
  Manny Dominguez and Luis Lopez of DobleFlo talk about how their duo got started, how they use math in producing hip-hop music, and set up a music-related algebra challenge.
- Math in Music: Take the challenge **(web interactive)**
  In this interactive activity, users try to solve the challenge presented in the video segment, "Math in Music: Introduction," by matching the tempo of the electronic drum track to the tempo of the instrumental sample.
- Math in Music: See how the teams solved the challenge **(video)**
  The teams use algebra to match the tempo of an electronic drum track to the tempo of an instrumental sample created by DobleFlo.
- Math in Music: Try other music challenges **(web interactive)**
  In this activity students select from several options of instrumental samples and drum tracks and then try to match the tempo of the selected drum track to that of the selected instrumental sample.

MATERIALS
For the class:

- Computer, projection screen, and speakers (for class viewing of online/downloaded video segments)
- One copy of "Math in Music: Take the challenge" answer key
- One copy of the "Math in Music: Try other music challenges" answer key

For each student:

- One copy of the "Math in Music: Take the challenge" handout
- One copy of the "Math in Music: Try other music challenges" handout
- One calculator for use in Learning Activities 1 and 2 (Optional)
- Grid paper, chart paper, whiteboards/markers or other materials for students to display their math strategies used to solve the challenges in the Learning Activities.
- Computers with internet access for Learning Activities 1 and 2 (Note: These activities can either be conducted with one computer and an LCD screen or by dividing students into small groups and using multiple computers.)

BEFORE THE LESSON
Prior to teaching this lesson, you will need to:

- Preview all of the video segments and web interactives used in this lesson.
- Download the video clips used in the lesson to your classroom computer(s) or prepare to watch them using your classroom's internet connection.
- Bookmark all web interactives you plan to use in the lesson on each computer in your classroom. Using an online bookmarking tool (such as delicious, diigo, or portaportal) will allow you to organize all the links in a central location.

- Make one copy of the "Math in Music: Take the challenge" and "Math in Music: Try other music challenges" handouts for each student.
- Print out one copy of the "Math in Music: Take the challenge" and the "Math in Music: Try other music challenges" answer keys.

THE LESSON

INTRODUCTORY ACTIVITY

1. Begin with a brief discussion about music. For example, ask students to tell you their favorite genres of music (jazz, hip-hop, pop, classical, etc.).

2. Explain that today's lesson will be focusing on the use of math in music. Ask students where they think mathematics might be used in music. (*Possible answers include: in counting the beat, in calculating the tempo, writing rhymes, in digital music programs, etc.)* Ask your students if they play a musical instrument and, if so, to describe how math can be helpful in mastering music.

3. Explain that today's lesson features video segments and interactives from ***Get the Math,*** a program that highlights how math is used in the real world. If this is your first time using the program with this class, you may choose to play the video segment The Setup, which introduces the professionals and student teams featured in ***Get the Math***.

4. Introduce the video segment Math in Music: Introduction by letting students know that you will now be showing them a segment which features musicians Manny Dominguez and Luis Lopez from Brooklyn, NY, who have formed a hip-hop duo named DobleFlo. Ask students to watch for the math that the artists are using and to write down their observations as they watch the video.

5. Play Math in Music: Introduction. After showing the segment, ask students to discuss the different ways that Manny and Luis use math in their music. *(Sample responses: counting, decimals, numerical operations, ratios, rates, subtraction, elapsed time, problem solving using proportions.)*

6. Ask students to describe the challenge that Manny and Luis posed to the teens in the video segment. (*In the featured sample of music, the tempo of the drum track doesn't match the tempo of the instrumental sample. The tempo, or speed, is measured in beats per minute (BPM). Since the drum beat is programmed electronically, it is possible to use the computer to speed up or slow down this beat to match the instrumental sample. In order to correctly match the drum beat to the sample, it is necessary to figure out the tempo of the sample. DobleFlo asked the students to calculate the BPM of the instrumental sample to determine the tempo.)*

LEARNING ACTIVITY 1

1. Explain that the students will now have an opportunity to solve the problem. Ask students what common rates they are familiar with in daily life. (*Sample responses: miles per gallon; miles per hour, etc.)*

2. Ask students if they have ever had their pulse taken at the doctor's office. Ask if the doctors/nurses hold their fingers on your pulse for a full minute or several minutes to find beats per minute. *(A part of a minute will be enough time.)* Discuss why you would need only part of a minute to calculate the pulse rate. *(You can compare a part to a whole using ratios/proportions.)*

3. Explain that word "per" means "for each" *(for example, miles per gallon/miles per hour)* and a rate can be represented by division. *(For example, to calculate miles per gallon, the equation would be miles divided by gallons.)*

4. Explain that just like the doctors/nurses only need to calculate the pulse for a few seconds to figure out the pulse rate, the same is true for calculating the beats per minute in music. Students only need to listen to the music for a few seconds to calculate the beats per minute.

5. Review the following terminology with your students:
   - **Tempo:** *the speed at which music is played, or the "beat" of the song.*
   - **BPM:** *beats per minute*

6. Distribute the "Math in Music: Take the challenge" handout.
   Note: The handout is designed to be used in conjunction with the "Math in Music: Take the challenge" activity on the ***Get the Math*** *website (From www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Take the challenge.")*

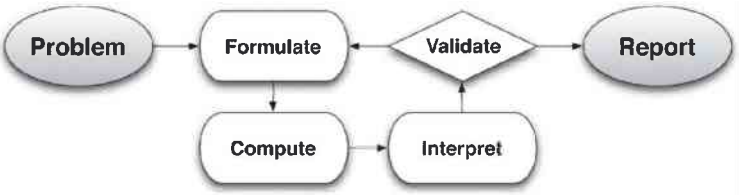
7. Let your students know that it is now their turn to solve the challenge DobleFlo presented to the teams in the video. Ask students to work together to explore the Math in Music Take the challenge interactive and complete the handout. Use the "Math in Music: Take the challenge" answer key as a guide to help students explore the interactive.
   - ***If you have multiple computers****, ask students to work in small groups to explore the interactive and complete the handout.*
   - ***If you only have one computer****, conduct the activity with your students as a group, so that they can all hear the instrumental sample and count the total number of beats together.*

8. As students complete the challenge, encourage them to use the following 6-step mathematical modeling cycle to solve the problem:

   - *Step 1: Understand the problem:* Identify variables in the situation that represent essential features *(For example, let "b" represent the number of*

beats and "t" represent the time, or specify in either seconds "s" or minutes "m").

- *Step 2: Formulate a model by* creating and selecting multiple representations *(For example, students may use symbolic representations such as a proportion, or may use a chart or table to record information).*
- *Step 3: Compute* by analyzing and performing operations on relationships to draw conclusions *(For example, operations include multiplication and algebraic transformations used to determine cross products as they solve a proportion).*
- *Step 4: Interpret* the results in terms of the original situation *(The results of the first three steps should be examined in the context of the challenge to mix the music tracks).*
- *Step 5:* Ask students to *validate* their conclusions by comparing them with the situation, and then either improving the model or, if acceptable,
- *Step 6: Report* on the conclusions and the reasoning behind them. *(This step allows a student to explain their strategy and justify their choices in a specific context.)*



Assess the reasoning process and product by asking students to articulate how they are solving the challenge:

- What strategy are you using to find the solution? How will your strategy help you to calculate the beats per minute?

9. After students have completed the handout, ask each group to share their solutions and problem solving strategies with the class using whiteboards, overhead transparencies, chart paper, or other tools to illustrate how they solved the challenge.

10. As students present their solutions, ask them to discuss the mathematics they used in solving the challenge. *(Sample responses: counting beats, numerical operations, ratios, rates, problem solving using proportions.)*

11. Introduce the Math in Music: See how the teams solved the challenge video segment by letting students know that they will now be seeing how the teams in the video calculated the BPM. Ask students to observe what strategies the teams used and whether they were similar to or different from the strategies presented by the class.

12. Play Math in Music: See how the teams solved the challenge. After showing the video, ask students to discuss the strategies the teams used and to compare them to the strategies presented by the class. During the discussion, point out that the two teams in the video solved the music challenge in two distinct ways. Ask students to

discuss why one team ended up with an incorrect answer. Discuss the strategies listed in the "Math in Music: Take the challenge" answer key, which the class has not yet discussed (if any).

LEARNING ACTIVITY 2:

1. Go to Math in Music: Try other music challenges (from www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Try other music challenges.") Let your students know that they will now calculate the Beats Per Minute using other music samples on the ***Get the Math*** website. Explain that this interactive provides students with additional opportunities to match the tempo of an electronic drum track to the tempo of the instrumental sample.
   Note: As in the previous challenge, you can conduct this activity with one computer and an LCD projector in front of the entire class or your students can work in small groups on computers. This can also be assigned to students to complete as an independent project or as homework using the accompanying handout as a guide.

2. Distribute the "Math in Music: Try other music challenges" handout. Clarify and discuss the directions. Ask students to explore the "Math in Music: Try other music challenges" interactive on the ***Get the Math*** website, using the handout as a guide. Ask students to complete all of the steps listed on the handout.

3. As in Learning Activity 1, encourage your students to use the 6-step mathematical modeling cycle as they develop a strategy to solve the challenge.

4. After students have completed the activity, lead a group discussion where students can share the strategies they used to find the correct tempo for each combination. Refer to and discuss the strategies and solutions presented in the "Math in Music: Try other music challenges" answer key, as desired.

CULMINATING ACTIVITY

1. Assess deeper understanding: Ask your students to reflect upon and write down their thoughts about the following:
   - How did you determine an effective strategy for the problem situation? What are your conclusions and the reasoning behind them? *(Sample answers: by looking for relationships between the number of beats and the time; by setting up a proportion and/or an equation to solve the problem you can compare part of a minute to a whole minute, or the number of samples in a whole minute, to find the solution.)*

   - Compare and contrast the various numerical and algebraic representations possible for the problem. How does the approach used to solve the challenge affect the choice of representations? *(Sample answers: some approaches use numerical operations in a sequence or order; another approach is to use symbols or variables to represent what is unknown and then write a proportion to solve the problem.)* Are all equivalent? *(Yes.)* Why do you think this is the

case? *(There are many different ways to represent and solve a problem; a proportion is an equation that can be written using ratios that are equivalent but in a different order as long as some common element ties the numerators together and a common element ties the denominators together, such as beats and minutes.)*

- What is proportionality? How does using this concept help you to understand and solve problems? *(Sample answer: When two quantities are proportional, a change in one quantity corresponds to a predictable change in the other. This helps to set up a comparison of the two quantities, or a ratio, that can be used to solve a problem by increasing or decreasing the ratio by the same factor.)*

- Why is it useful to represent real-life situations algebraically? (*Sample responses: Symbols or variables can be used to represent missing values to set up and solve equations to find a solution. Using algebra can be a simpler and efficient way to set up and solve problems by using ratios, rates, or proportions.)*

- What are some ways to represent, describe, and analyze patterns that occur in our world? *(Sample responses: Patterns can be represented with numbers, symbols, expressions/equations, words, and pictures or graphs.)*

2. After students have written their reflections, lead a group discussion where students can discuss their journal entries. During the discussion, ask students to share their thoughts about how algebra can be applied to music. Ask students to brainstorm other real-world situations which involve the type of math and problem solving that they used in this lesson to calculate the Beats Per Minute (for example, miles per gallon, pulse rate, etc).

LEARNING STANDARDS & SAMPLE END-OF-COURSE (EOC) QUESTIONS

Sample Related End-of-Course (EOC) Questions (available for download in the TEACHERS section at www.getthemath.org)
These sample questions, selected from state end-of-course exams, cover the same algebraic concepts explored in this lesson.

Common Core State Standards 2010
[Note: You may also wish to view Pathways 1 and 2 for Algebra I connections in the CCSS]

Algebra Overview

- Seeing Structure in Expressions
  - Interpret the structure of expressions
  - Write expressions in equivalent forms to solve problems
- Arithmetic with Polynomials and Rational Functions
  - Perform arithmetic operations on polynomials
  - Use polynomial identities to solve problems

  - Rewrite rational functions
- Creating Equations
  - Create equations that describe numbers or relationships
- Reasoning with Equations and Inequalities
  - Understand solving equations as a process of reasoning and explain the reasoning
  - Solve equations and inequalities in one variable

Functions Overview
- Interpreting Functions
  - Interpret functions that arise in applications in terms of the context
  - Analyze functions using different representations
- Building Functions
  - Build a function that models a relationship between two quantities
  - Build new functions from existing functions
- Linear, Quadratic, and Exponential Models
  - Interpret expressions for functions in terms of the situation they model

Modeling Standards
Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice.

Mathematical Practices
- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.
- Look for and express regularity in repeated reasoning.

American Diploma Project: Algebra I
Students will be able to represent and solve problems in the following areas:

O: Operations on Numbers and Expressions
O1. Number Sense and Operations
O1.a Reasoning with real numbers
O1.b Using ratios, rates, and proportions
O2. Algebraic Expressions
O2.b Operating with polynomial expressions
O2.c Factoring polynomial expressions

L: Linear Relationships
L1. Linear Functions

L1.a Representing linear functions in multiple ways
L1.b Analyzing linear function
L1.d Using linear models
L2. Linear Equations and Inequalities
L2.a Solving linear equations (and inequalities)
L2.e Modeling with single variable linear equations

Name:_____ Date:_____

Math in Music: Take the Challenge

Student Handout

The Hip Hop duo DobleFlo is trying to mix an electronic drum track with an instrumental sample, but the tempos don't match. To help them fix the track, calculate the tempo (speed) of the instrumental sample in BPM (Beats Per Minute).

- Go online to www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Take the Challenge."
- Select "Next" to begin. You should now see the mixed track, drum track and instrumental sample. Play each one and then follow the steps below.

1. **Identify what you already know:**
   - View the NEXT screen, "Find the Tempo of the Instrumental Sample. "
   - How long is the sample?

     Length of sample (in seconds): _____

   - Listen to the instrumental sample and count the total number of beats.

     Number of beats: _____

2. **Plan it out.** What is the problem you want to solve? How will you do it?

3. **Solve your problem** in the space below. *Show all your steps and be sure to label (for example: seconds, beats).*

4. **Enter your answer** on the screen and complete the interactive.

    - Number of beats per minute: _____
    (Round your answer to the nearest whole beat.)

    - **Listen to the sound of your mixed track**. Do the tempos of the sample and the drum track match up? Explain why your plan did or didn't work.

5. **How did you figure out your final solution?** If you were going to email DobleFlo to **explain your strategy**, what would you tell them?

6. **If you had to find the tempo of a new instrumental sample, with a different number of beats (let's say, *b* beats) and a different length (*t* seconds)**, explain what steps you would take.

Name:_____ Date:_____

Math in Music: Try other music challenges

Student Handout

The Hip Hop group DobleFlo is trying to mix an electronic drum track with an instrumental sample, but the tempos don't match.

Your challenge is to help DobleFlo mix the tracks by calculating the tempo (speed) of the instrumental sample in BPM (beats per minute).

Go online to www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Try other music challenges." Select "Next" to begin.

1. **Choose your music. Play the samples and drum tracks and select one of each:**

   Instrumental sample # ____ Electronic drum track # ____

2. **Identify what you already know.** Select "Next" to continue. Count the number of beats in the sample and write down the length of the sample (in seconds) as indicated above the sample on the screen:

   - The number of beats in the instrumental sample is _____.
   - The length of the instrumental sample is _____ seconds.

3. **Plan it out.** What is the problem you want to solve? How will you do it?

4. **Solve your problem** in the space below. Show all your steps and be sure to label, for example: seconds, beats.

Solution: The tempo of the instrumental sample in BPM is:_____
(Round your answer to the nearest whole beat.)

5. **Listen to the sound of your mixed track.**

   - Do the tempos of the sample and the drum track match up? Explain why your plan did or didn't work.

6. **How did you figure out your final solution?** If you were going to email DobleFlo to explain your strategy, what would you tell them?

7. **If you had the find the tempo of a new instrumental sample, with a different number of beats (let's say, *b* beats) and a different length (*t* seconds),** explain what steps you would take.

Math in Music: Take the Challenge

Answer Key

The Hip Hop duo DobleFlo is trying to mix an electronic drum track with an instrumental sample, but the tempos don't match. To help them fix the track, calculate the tempo (speed) of the instrumental sample in BPM (Beats Per Minute).

- Go online to www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Take the Challenge."
- Select "Next" to begin. You should now see the mixed track, drum track and instrumental sample. Play each one and then follow the steps below.

1. **Identify what you already know:**
   - View the NEXT screen, "Find the Tempo of the Instrumental Sample. "
   - How long is the sample?
     Length of sample (in seconds): ___8.889 seconds_____
   - Listen to the instrumental sample and count the total number of beats.
     Number of beats: _____16_____

2. **Plan it out.** What is the problem you want to solve? How will you do it?
   [Students may restate mission. See below for possible strategies or "how."]

3. **Solve your problem** in the space below. *Show all your steps and be sure to label (for example: seconds, beats).*

   Possible Strategies:
   - **Set up a proportion:**
     Beats in the sample/length of sample = x beats per minute/60 seconds
     16 beats/8.889 seconds = x beats/60 seconds
     Solving the proportion for x should yield an answer of approximately 108 BPM.

   - **Figure out the length of one beat, then divide 60 seconds by that length to determine how many beats in a minute:**
     8.889 seconds/16 beats = 0.556 seconds per beat
     60 seconds per minute/0.556 seconds per beat = 108 BPM

   - **Determine how many samples there are in one minute, then multiply by the number of beats in the sample:**
     Divide 60 seconds by 8.889 = about 6.75 samples per minute.
     6.75 samples per minute x 16 beats per sample = 108 BPM.

4. **Enter your answer** on the screen and complete the interactive.

   - Number of beats per minute: ___108_____
     (Round your answer to the nearest whole beat.)

   - **Listen to the sound of your mixed track**. Do the tempos of the sample and the drum track match up? Explain why your plan did or didn't work. [Student responses will vary depending on their strategy/solutions.]

5. **How did you figure out your final solution?** If you were going to email DobleFlo to **explain your strategy**, what would you tell them? [Student responses will vary depending on their strategy/solutions.]

6. **If you had to find the tempo of a new instrumental sample, with a different number of beats (let's say, *b* beats) and a different length (*t* seconds)**, explain what steps you would take.

   Possible Strategies:
   - **Set up a proportion:**
     Beats in the sample / length of sample = x beats per minute / 60 seconds
     OR $b / t = x / 60$
   - **Figure out the length of one beat, then divide 60 seconds by that length to determine how many beats in a minute.**
   - **Determine how many samples there are in one minute, then multiply by the number of beats in the sample.**

Math in Music: Try other music challenges

Answer Key

The Hip Hop group DobleFlo is trying to mix an electronic drum track with an instrumental sample, but the tempos don't match.

Your challenge is to help DobleFlo mix the tracks by calculating the tempo (speed) of the instrumental sample in BPM (beats per minute).

Go online to www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Music: Try other music challenges." Select "Next" to begin.

1. **Choose your music. Play the samples and drum tracks and select one of each:**

   Instrumental sample # ____ Electronic drum track # ____
   [See possible combinations on the next page.]

2. **Identify what you already know.** Select "Next" to continue. Count the number of beats in the sample and write down the length of the sample (in seconds) as indicated above the sample on the screen:

   - The number of beats in the instrumental sample is _____.
   - The length of the instrumental sample is _____ seconds.
     [See possible combinations on the next page.]

3. **Plan it out.** What is the problem you want to solve? How will you do it?

4. **Solve your problem** in the space below. Show all your steps and be sure to label, for example: seconds, beats.

   Solution: The tempo of the instrumental sample in BPM is:_____
   (Round your answer to the nearest whole beat.)
   [See possible solutions on the next page.]

5. **Listen to the sound of your mixed track.**

   - Do the tempos of the sample and the drum track match up? Explain why your plan did or didn't work. [Student responses will vary depending on their strategy/solutions.]

6. **How did you figure out your final solution?** If you were going to email DobleFlo to explain your strategy, what would you tell them? [Student responses will vary depending on their strategy/solutions.]

POSSIBLE COMBINATIONS AND SOLUTIONS

Here are the possible instrumental sample and drum track combinations and three possible ways to solve the problem for each combination:

COMBINATION A:
Sample # 1 Drum Track # 1, 2 or 3 # of beats 8 Sample Length 5 seconds

Possible Strategies for Combination A:

- **Strategy A1:**
  - **Figure out the length of one beat:** 5 seconds/8 beats = 0.625 seconds per beat
  - **Divide 60 seconds by that length to determine # of beats per minute**: 60 seconds per minute/0.625seconds per beat = 96 BPM

- **Strategy A2:**
  - **Determine how many samples there are in one minute:** Divide 60 seconds by 5 seconds = about 12 samples per minute.
  - **Multiply by the number of beats in the sample:** 8 beats per sample x 12 samples per minute = 96 BPM.

- **Strategy A3:**
  - **Set up a proportion:** Beats in the sample/length of sample = x beats per minute/60 seconds
    8 beats/5 seconds = x beats/60 seconds
    Solving the proportion for x should yield an answer of approximately 96 BPM.

Tempo (in BPM): 96 BPM *(Note: Round answers to the nearest whole beat.)*

COMBINATION B:
Sample # 2 Drum Track# 1, 2 or 3 # of beats 16 Sample Length 8.571 seconds

Possible Strategies for Combination B:

- **Strategy B1:**
  - **Figure out the length of one beat:** 8.571 seconds/16 beats ≈ 0.5357 seconds per beat
  - **Divide 60 seconds by that length to determine how many beats in a minute:** 60 seconds per minute/0.5357 seconds per beat ≈ 112 BPM

- **Strategy B2**
  - **Determine how many samples there are in one minute:** Divide 60 seconds by 8.571 seconds ≈ about 7 samples per minute.
  - **Multiply by the number of beats per sample:** 16 beats per sample x 7 samples per minute = 112 BPM.

- **Strategy B3:**
  - **Set up a proportion:**
    Beats in the sample/length of sample = x beats per minute/60 seconds
    16 beats/8.571 seconds = x beats/60 seconds
    Solving the proportion for x should yield an answer of approximately 112 BPM.

Tempo (in BPM): **112 BPM** *(Note: Round answers to the nearest whole beat.)*

COMBINATION C:
Sample # **3** **Drum Track #** **1, 2 or 3** **# of beats** **8** **Sample Length** **6 seconds**

Possible Strategies for Combination C:

- **Strategy C1:**
  - **Figure out the length of one beat:** 6 seconds/8 beats = 0.75 seconds per beat
  - **Divide 60 seconds by that length to determine how many beats in a minute:** 60 seconds per minute/0.75seconds per beat = 80 BPM

- **Strategy C2:**
  - **Determine how many samples there are in one minute:** Divide 60 seconds by 6 seconds = 10 samples per minute.
  - **Multiply by the number of beats per sample:**
    8 beats per sample x 10 samples per minute = 80 BPM.

- **Strategy C3:**
  - **Set up a proportion:**
    Beats in the sample/length of sample = x beats per minute/60 seconds
    8 beats/6 seconds = x beats/60 seconds
    Solving the proportion for x should yield an answer of approximately 80 BPM.

Tempo (in BPM): **80 BPM** *(Note: Round answers to the nearest whole beat.)*

7. **If you had the find the tempo of a new instrumental sample, with a different number of beats (let's say, *b* beats) and a different length (*t* seconds),** explain what steps you would take.

Possible Strategies:

- **Set up a proportion:**
  Beats in the sample / length of sample = x beats per minute / 60 seconds
  OR ***b / t = x / 60***
- **Figure out the length of one beat, then divide 60 seconds by that length to determine how many beats in a minute.**
- **Determine how many samples there are in one minute, then multiply by the number of beats in the sample.**