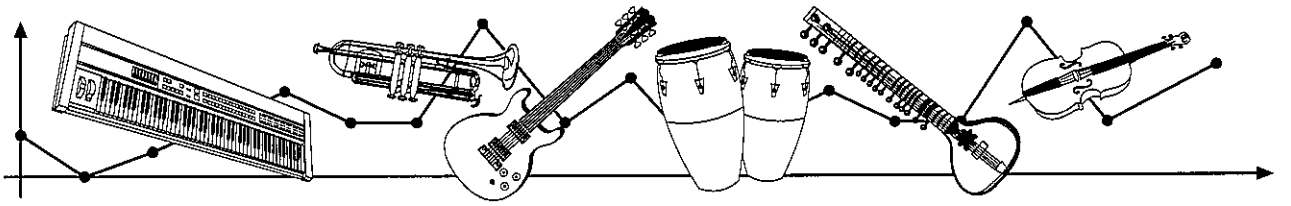

The Hidden Life of Geometry

Did you ever wonder why you have to learn all those vocabulary terms in geometry class? After all, what do they have to do with anything that matters in real life? How do they relate to anything outside geometry class?

If you ask your teachers, they will tell you that knowing mathematics and geometry is important in countless professions. At the very least you need to take math classes in order to graduate from high school, and if you want to get into the college of your choice, you will need good math grades. But if you aren't going into a job that uses the mathematics you are learning and you don't plan to go to college, it can seem as if you are learning math just to jump through hoops to get to another place in your life.

As you study mathematics in school year after year, trying to master each topic and stay on top of things, you can sometimes miss why, where, and how it is helpful. No matter who you are or what you do, whether you're a convenience store clerk, a student, an artist, or an astronaut, you are always making decisions about all kinds of things: what to eat for dinner, what clothing to buy, who to hang out with on the weekend, what streets to take to get downtown, and so on. Sometimes you might have difficulty making decisions and must then stop to "think it through" to figure out what decision will get you what you want. You analyze the situation and apply logical thought. Believe it or not, one big reason for studying mathematics is to do this very thing: to strengthen your ability to think logically and analyze things—even things that don't seem to be particularly mathematical. The ability to think logically can even be helpful when you are confused in your romantic life!

There's another side to how mathematics can enhance daily life. No matter what we do, most of us would say we want to be taken seriously by the people around us and be convincing when we communicate. In ways that might surprise you, studying the concepts of mathematics can help you with just that—expressing yourself better when you talk about things that have nothing to do with math! Many of the mathematics ideas you learn have counterparts in the real world that you might not have thought of. Geometric terms can be especially powerful in communicating ideas. People speak of having *parallel lives.* What does that mean? A conversation or argument may be called *circular.* What does that mean? These are examples of using a mathematics term as a *metaphor* for something else. A metaphor compares and connects two ideas that are essentially different but share some aspects on a meaningful level.

In Sound Shapes you are going to look at an example of how this idea applies to geometry and music. Musicians use mathematics ideas frequently, sometimes as metaphors and sometimes more directly. In order to keep track of notes and their relationships, musicians often create geometric mental pictures of the notes. In fact, many geometric terms and ideas are musical terms as well. As it turns out, musicians often think the same way as mathematicians and use geometric ideas to describe and organize what music does.

Music is just one example of using mathematics ideas to express nonmathematical things. In Sound Shapes you will explore these connections.

Help, Hints, and Geometric Terms

Understand the geometric terms.

Survey the list of terms and take notes from the class discussion on the exact meaning of the terms. Be careful not to assume that you know everything about what the term means. You need to know the meaning on a deep level to make a connection to music.

Listen to the music.

Your teacher will play an assortment of music examples. You will hear melodies, rhythms, and other musical patterns. Here are some questions to consider with your group to help you match the music to the geometric terms:

- Melodies
  How do the melodies relate to each other? Are they both changing? Do they change the same way together? Do they cross each other? How does their distance from each other change? Do the melodies suggest some kind of shape? Imagine that the pitch of the melody could be graphed, with high pitches high on the graph and low pitches low on the graph. Try to visualize what the melody would look like.
- Rhythms
  Try counting with the music. How are the beats grouped together?

Match the terms to the music.

Look at the list of geometric terms and find the term that best describes what is happening in each music example. If you get stuck, review the exact definition of each term and see if any aspect of the music example illustrates that idea.

Make alternate choices.

Several terms may fit a particular music example. Write these terms on the Geometry/Music Connection worksheet and explain what aspect of their meaning is demonstrated by the music.

Geometric terms

translated	angular	stretched	supplement
oblique	congruent	shrunk	adjacent
square	periodic	similar	even
round	reflection	intersection	obtuse
straight	symmetric	odd	
circular	parallel	space	

Name

The Geometry/Music Connection

Music example	Geometric term	Sketch (Draw a sketch to show the meaning of the geometric term.)	Written description (Explain how the geometric term applies to the music example. Use the exact definition of the geometric term.)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

ANSWERS

The Geometry/Music Connection

CD track	Primary geometric term	Other reasonable terms	Written description and notes
1	Intersection	Oblique Symmetric Angular Reflection	Students may choose *oblique* and *angular* before *intersection.* The piano plays musical lines that cross each other and share one note in common. The common note is a little difficult to hear. If the notes of each melody comprise a set, then the notes (elements of the set) in common form the intersection of the sets. The intersection in this case is one note.
2	Oblique	Angular	One instrument repeats the same note while the other moves. This example also suggests the image of an angle. Musicians call this *oblique motion.*
3	Parallel		*Hint:* Listen to the relationship between the notes of the two instruments. The notes that the two instruments play stay the same "distance" apart from each other for the extent of the musical line. Composers use the musical term *parallel motion* in melodic lines and pay close attention to this important element. It has the musical effect of diminishing the listener's ability to perceive two melodies as distinctly different.
4	Even	Symmetric Periodic	The primary rhythm cycle is an even number, 2 or 4 depending on how you count. Suggest to students that they count with the music and look for patterns of groupings of accents. Jazz and rock musicians commonly characterize a rhythm as *even* or *odd.*
5	Odd	Symmetric Periodic	The primary rhythm cycle is an odd number, 7, or can be counted as 3 and 4. This example is difficult.
6	Angular	Oblique Square Obtuse	If graphed, the contour of the melody would look like a jagged mountain range—sawtooth, very angular.
7	Square	Symmetric Periodic	This example illustrates a metaphorical and abstract way to describe melodic shape. Unlike terms such as *parallel* and *oblique,* which have specific technical definitions in music, a descriptor such as *square* is more subjective, describing character or feeling.
8	Congruent	Reflection	The two melodies are exactly the same in size and shape, hence congruent. (If performed at the same time, the musical term would be *unison.*) *Reflection* is not mathematically or musically correct, but it is intuitively logical.
9	Reflection	Symmetric Similar Congruent	The second melody is a vertical reflection around the beginning note. When one melody goes up, the other goes down by the exact same amount, like a mountain range reflecting on a lake. This is the same relationship as that of the graph of $y = f(x)$ to $y = -f(x)$. Composers have used techniques like this to compose melodies for hundreds of years. They are the topic of the activity Functional Composer. (Musicians use the term *inversion.*)
10	Round	Circular Stretched Shrunk	This is another subjective, metaphorical reference.