



Lesson: A+ Math Connections

OVERVIEW

This math activity where students make calculations by using percentages and ratios allows students to experiment with the concept of percentage of error that Thomas C. Duffy used as the basis for composing the piece, A+.

LEARNING GOAL

Students will understand the math Thomas Duffy used to compose A+: A "Precise" Prelude and An "Excellent" March.

RESOURCES & MATERIALS

Teacher copy of:

- [Teacher Resource: Math Behind A+](#)

Student copies of:

- [A+ Math Connections](#) worksheet

PROCESS

Familiarize yourself with the [Teacher Resource: Math Behind A+](#).

The student worksheet, [A+ Math Connections](#), walks students through the steps to do the same math Thomas Duffy did as he conceived of the piece. This worksheet may be used as homework or as individual quiet work during class time.

TEACHER RESOURCE: THE MATH BEHIND A+

How good does something have to be to be considered excellent? The dictionary says that something has to be outstandingly good or of exceptional merit to be excellent.

If you were to get at 97% on a math test, you'd probably consider that an excellent performance and would proudly show off you're A+. But, is 97% accuracy good enough to be considered excellent in music performance?

How does even one wrong pitch or an incorrect rhythm affect our assessment of the performance? We expect to hear perfection in music! A+: A "*Precise*" *Prelude* and An "*Excellent*" *March* makes a case for the high quality of music performance.

The *Prelude*, if performed well, is precisely imprecise, with tendrils of harmonic material floating around at the whim of the woodwinds.

The *March* is a simple little commencement-like procession, which is repeated. The players are instructed to make one mistake in the repetition... a mistake of pitch, or dynamics, or rhythm, or articulation; it's their choice.

There are 8,665 notes in this piece. If the ensemble consists of 60 players, all of who make one pitch mistake, the percent of error is 0.69 of 1%; that is not even 1%!

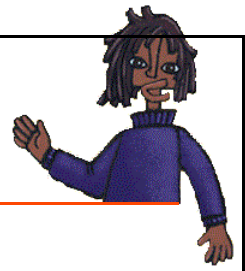
If one considers that each note has a dynamic, articulation and rhythm component (all of which can be mutilated!), the possible execution opportunities become 8,665 pitches x 3 (dynamics, rhythm, articulation) for a total of 25,995 possible errors!

One mistake by each member of a 60-piece ensemble now represents only .023 of 1%. In fact, a 3% error in this case would equal 779 mistakes... a rate of performance that would qualify for an A+ in the academic world but would probably results in the conductor of the ensemble being fired! Nevertheless, by all academic standards, the performance of this march, with anything less than 779 mistakes, will be "excellent."

Completed Permutations chart

Number of Objects	Number of Permutations	Permutations written as multiplication problem
1	1	1
2	2	2 x 1
3	6	3 x 2 x 1
4	24	4 x 3 x 2 x 1

A+ Math Connections



Percentage of Error

When determining the grade a teacher gives to a paper, these three steps are performed:

1. Divide the number of errors by the number of questions
2. Move the decimal point two places to the right to get the percentage of error
3. Subtract the percentage of error from 100%

1	
2	✓
3	
4	
5	
6	✓
7	
8	

1 $2/8 = .25$

2 25%

3 $100 - 25 = 75\%$

You are the teacher. What % would you give this paper?

1	11
2	12
3	13 ✓
4	14
5	15
6	16 ✓
7	17
8	18 ✓
9	19
10	20

Answer: _____ %

What grade, based on percentage of error, would your band receive on its performance of A+ if everyone made just one error, as Tom Duffy asks you to in the score?

There are 8,665 notes in this composition. Even if you play all the pitches correctly, you also have to play the proper **rhythm**, **dynamics** and **articulation**. So the total number of correct musical responses you have to make when playing this piece is 25, 995. (8,665 x 3 = 25,995)

How many players are in your ensemble? Use that number to fill in this equation to calculate the percentage of error your group will have when you play A+.

$$\frac{\text{Number of players}}{25,995} = \frac{x}{100}$$

Do you remember how to solve this equation?

Multiply the number of players by 100 and divide by 25,995. Then, subtract the number you calculated for “x” from 100. That will give you your percentage grade.

$$\text{_____} \times 100 = \text{_____} / 25,995 = \text{_____} \%$$

$$100\% - \text{_____} \% = \text{_____} \%$$

If your group has 60 players, you will come up with .23% error. That’s like getting a grade of 99.7%. Would you give your band an A+ from that performance if you were trying to make mistakes?



Permutations

A **permutation** is an arrangement of things in a definite order.

Let's try an example.

Suppose there are two oboe players in your band, Kate and Tim. How many ways can they be arranged in the band? (Answer = 2)



Suppose there are three flute players in the band, Seth, Sarah and Josh. How many ways can they be arranged? The number of permutations for 3 objects is 6.

1. Seth Sarah Josh
2. Seth Josh Sarah
3. Sarah Seth Josh
4. Sarah Josh Seth
5. Josh Seth Sarah
6. Josh Sarah Seth

To summarize, look at the chart below.

Number of Objects	Number of Permutations	Permutations written as multiplication problem
1	1	1
2	2	2×1
3	6	$3 \times 2 \times 1$
4	<input type="text"/>	<input type="text"/>

What do you think goes in the



?

