

5E Integrated STEM Lesson Plan – Template

Lesson Title: Blinded By The Light!

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Topic: *Percentages, Decimals, Fractions, Mean, Reflectivity*

Targeted Grade Level: *7th Grade*

Time Needed: *3 days (6 - 40 minute class periods)*

Subject Integration: *Math, Science, Technology, Engineering*

Justification: By this lesson, students have begun to further their understanding on decimals, fractions, and percentages. During this lesson, students will be taking part in a 3 day cross-curricular lesson in Science & Math class. In this lesson, students will start out by learning vocabulary about reflectivity and the components thereof. During this, students will begin to make connections about how reflectivity and math are very easily connected. On day one, students will be viewing the live concert clip and complete the “Identifying Materials By Their Reflectivity” activity sheet and be exposed to real world examples of percentages, fractions, and decimals, as well as being able to calculate the mean. This will get their wheels turning for the next two days where they will be using fraction bars to visually model fractions as well as constructing their own model to test the percentage of light absorbed and reflected off of their material.

Standards: NGSS 07-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
<p>Developing and Using Models <i>Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</i></p> <ul style="list-style-type: none"> • <i>Develop and use a model to describe phenomena.</i> 	<p>PS4.A: Wave Properties</p> <ul style="list-style-type: none"> • <i>A sound wave needs a medium through which it is transmitted.</i> <p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> • <i>When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object’s material and the frequency (color) of the light.</i> • <i>The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.</i> • <i>A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.</i> • <i>However, because light can travel through space, it cannot be a matter wave, like sound or water waves.</i> 	<p>Structure and Function</p> <ul style="list-style-type: none"> • <i>Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</i>

Common Core State Standards:

Math: *KY.7.RP.3 Use percents to solve mathematical and real-world problems. a. Find a percent of a quantity as a rate per 100; solve problems involving finding the whole, a part and a percent, given two of these.*

KY.8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

ITEEA Standards *(If applicable)*

Other Standards *(as needed)*

Measurable Student Learning Objectives:

Students will be able to accurately and correctly write percentages, fractions, and decimals.

Students will be able to calculate correct percentages based on a real-world application involving Science and Engineering.

Students will be able to effectively develop a model to show how light waves are reflected off surfaces.

Nature of STEM: *This lesson will address the Nature of Math, Science, Technology, and Engineering. Students will be using Math to discover the percent of reflectivity for certain items listed on an activity sheet (ex. Concrete, vegetation, etc.) and will be using this data to compare what they think the percent of reflectivity will be for other items. They will also be using percentages to calculate the percentage of light absorbed and reflected from their created model. The Nature of Science will be addressed in a way that students will be discovering what reflectivity is, and make the connection with waves and how they reflect. The Nature of Engineering will be addressed when students have to construct their own “model” to show how light waves reflect off of certain surfaces. The Nature of Technology will be addressed when students utilize a luminance meter to detect the amount of light that is reflected off of their model.*

Engaging Context/Phenomena: *Students will watch a video of a concert and list things that they observed during the video that would help them be able to better create their own ideas. The phenomena will be centered around how artists like Shawn Mendes utilize lights during a live performance.*

Data Integration: *Students will start out by using data that was already collected to discover the percentage of reflectivity for a set of pre-chosen materials. Then, when students create their own model to test the reflectivity, they will collect this data for each of the materials their classmates chose. Students will also collect data based on the luminance that their and their classmates created models emit using a luminance meter.*

Differentiation of Instruction: *All students will be viewing the live concert clip because there are some students who have never attended a concert. Intentional grouping will be utilized to group students based on their previous mastery of related concepts. There will be scaffolding throughout the lesson that will help to guide students in the right direction.*

Real-life Connection: *Students will be watching a clip from a live concert and connecting reflection and waves to the real world using this. Students that have attended concerts in the past can also use anything that they remember for their ideas as well. Students will be creating a model based on which material they think would be the best for a concert stage.*

Possible Misconceptions: *Students may possibly misconceive how closely related decimals, percentages, and scientific notation are related. I could foresee students seeing the scientific notation and not being able to instantly see the connection to*

percentages. Students could also misconceive that darker surfaces always reflect less light, when in turn it depends on the materials.

Lesson Procedure:

5E Model	5E Objectives
<p><u>Engage</u></p> <p><i>Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.</i></p>	<p>Procedure: <i>Students are viewing a live concert clip and will be listing observations that they make that will help them develop a sufficient model for their own concert stage.</i></p> <p>Modifications <i>Closed captioning will be utilized during the video so all students can see/hear as the video plays.</i></p> <p>Standards Addressed <i>N/A</i></p> <p>Formative/Summative Assessments <i>By monitoring as they list their observations, and by also having a class discussion at the end of the video about their observations.</i></p> <p>Resources <i>Concert video and blank paper for their list.</i></p>
<p><u>Explore</u></p> <p><i>Plan for students to engage in hands-on activities that are designed to facilitate</i></p>	<p>Procedure: <i>Students are completing an activity sheet that highlights many different materials and discusses their percentage of reflectivity. During the Explore process, students will become familiar with how to measure reflectivity and how to use the given equation to produce a percentage of reflectivity, based on data that is already collected for them. This will prepare them to collect their own data based on a material of their choosing, so they can not only be able to complete the Nature of Science behind the activity, but to be able to see how Math relates to this as well.</i></p> <p>Modifications <i>The activity sheet will be modified for certain students to already have the equation given with the data filled in</i></p>

<p><i>conceptual change.</i></p>	<p><i>to where those students can simply use their calculators to get the percentage instead of having to substitute the data in for a variable.</i></p> <p>Standards Addressed <i>7.RP.3</i></p> <p>Formative/Summative Assessments <i>The activity sheet will act as its own formative assessment. Student answers will be graded and measured on a 70% mastery.</i></p> <p>Resources <i>The attached worksheet and calculators.</i></p>
<p><u>Explain</u></p> <p><i>Facilitate opportunities for students to explain their understanding of concepts and processes and make sense of new concepts.</i></p>	<p>Procedure: <i>Students will be completing a mini lesson using fraction strips and fraction towers and answering the questions provided in their activity sheet.</i></p> <p>Modifications <i>Students will be intentionally grouped by previous observations from the Explore stage of this lesson.</i></p> <p>Standards Addressed <i>7.RP.3</i></p> <p>Formative/Summative Assessments <i>Students will be completing the worksheet for a grade. Instructor will also observe students using their modeling of fraction strips and fraction towers.</i></p> <p>Resources <i>Fraction bars, fraction towers, and the attached worksheet.</i></p>

<p><u>Elaborate</u></p> <p><i>Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.</i></p>	<p>Procedure: <i>Students will be constructing their own model to visually observe how light reflects differently from various materials and colors. During this, students are able to choose what materials they want to use as well as paper in different shades of colors. Students will be collecting data from each student's model and charting it on the chart provided. While doing this, students will be responsible for calculating the percentage of light reflected and the percentage of light absorbed and charting it as well.</i></p> <p>Modifications <i>Scaffolding will be taking place throughout the entire lesson to help students that seem to be struggling with their model. For some students, a list of materials will be made available to help guide them to their choices.</i></p> <p>Standards Addressed <i>NGSS 07-PS4-2 & 7.RP.3</i></p> <p>Formative/Summative Assessments <i>Students will be collecting data while viewing each classmate's luminance test.</i></p> <p>Resources <i>Luminance meter, data chart, various materials (cardboard, metal, paper, etc.).</i></p>
<p><u>Evaluate</u></p> <p><i>Assess students knowledge, skills and abilities.</i></p>	<p>Procedure: <i>Students will construct a C.E.R. based on which material they think would be best to construct a concert stage from. The C.E.R. will be written on the board for students to go by.</i></p> <p>Modifications <i>Some students will be graded on a different rubric than other students.</i></p> <p>Standards Addressed <i>NGSS 07-PS4-2 & 7.RP.3</i></p> <p>Formative/Summative Assessments <i>Grading the C.E.R. based on a rubric.</i></p> <p>Resources <i>C.E.R., calculator, blank piece of paper.</i></p>

Teacher Background: *Teachers will need to be able to effectively teach how to convert fractions to decimals and vice versa. Teachers will also need to have a foundational knowledge of how light waves work and how to model that.*

Resources & Links:

Concert Video: <https://spacemath.gsfc.nasa.gov/Grade67/MMM1.pdf>

Space Math - Identifying Reflectivity by Material:

<https://spacemath.gsfc.nasa.gov/Grade67/MMM1.pdf>

Source for “Explain” Manipulative Questions:

http://mightymath.weebly.com/uploads/5/8/5/7/5857657/using_math_manipulatives_full_file_print_with_markups1.pdf

Identifying Materials by their Reflectivity

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50%	78%
3%	30%

Material	Reflectivity
Snow	80%
White Concrete	78%
Bare Aluminum	74%
Vegetation	50%
Bare Soil	30%
Wood Shingle	17%
Water	5%
Black Asphalt	3%

When light falls on a material, some of the light energy is absorbed while the rest is reflected. The absorbed energy usually contributed to heating the body. The reflected energy is what we use to actually see the material! Scientists measure reflectivity and absorption in terms of the percentage of energy that falls on the body. The combination must add up to 100%.

The table above shows the reflectivity of various common materials. For example, snow reflects 80% of the light that falls on it, which means that it absorbs 20% and so $80\% + 20\% = 100\%$. This also means that if I have 100 watts of light energy falling on the snow, 80 watts will be reflected and 20 watts will be absorbed.

Problem 1 - If 1000 watts falls on a body, and you measure 300 watts reflected, what is the reflectivity of the body, and from the Table, what might be its composition?

Problem 2 - You are given the reflectivity map at the top of this page. What are the likely compositions of the areas in the map?

Problem 3 - What is the average reflectivity of these four equal-area regions combined?

Problem 4 - Solar radiation delivers 1300 watts per square meter to the surface of Earth. If the area in the map is 20 meters on a side; A) how much solar radiation, in watts, is reflected by each of the four materials covering this area? B) What is the total solar energy, in watts, reflected by this mapped area? C) What is the total solar energy, in watts, absorbed by this area?

Answer Key

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Problem 1 - If 1000 watts falls on a body, and you measure 300 watts reflected, what is the reflectivity of the body, and from the Table, what might be its composition?

Answer: The reflectivity is $100\% \times (300 \text{ watts}/1000 \text{ watts}) = 30\%$. From the table, Bare Soil has this same reflectivity and so is a likely composition.

Problem 2 - You are given the reflectivity map at the top of this page. What are the likely compositions of the areas in the map?

Answer: 50% = Vegetation
 78% = White Concrete
 30% = Bare Soil
 3% = Black Asphalt

Problem 3 - What is the average reflectivity of these four equal-area regions combined? Answer: Because each of the four materials cover the same area, we just add up their reflectivities and divide by 4 to get $(50\% + 78\% + 30\% + 3\%)/4 = 40\%$.

Problem 4 - Solar radiation delivers 1300 watts per square meter to the surface of Earth. If the area in the map is 20 meters on a side; A) how much solar radiation, in watts, is reflected by each of the four materials covering this area? B) What is the total solar energy, in watts, reflected by this mapped area? C) What is the total solar energy, in watts, absorbed by this area?

Answer: Each material covers 10 meters x 10 meters = 100 square meters:

A) Vegetation: $0.5 \times 1300 \text{ watts/m}^2 \times 100 \text{ m}^2 = 65,000 \text{ watts}$.

Concrete: $0.78 \times 1300 \text{ watts/m}^2 \times 100 \text{ m}^2 = 101,400 \text{ watts}$.

Bare Soil: $0.30 \times 1300 \text{ watts/m}^2 \times 100 \text{ m}^2 = 39,000 \text{ watts}$.

Black Asphalt: $0.03 \times 1300 \text{ watts/m}^2 \times 100 \text{ m}^2 = 3,900 \text{ watts}$.

B) $65,000 + 100,000 + 39,000 + 3,900 = 209,300 \text{ watts}$.

C) The total wattage entering this area is $1,300 \text{ watts/m}^2 \times 100 \text{ m}^2 \times 4 = 520,000 \text{ watts}$. Since 209,300 watts are reflected, that means that $520,000 \text{ watts} - 209,300 \text{ watts} = 310,700 \text{ watts are being absorbed}$.

Fraction Strips & Fraction Towers

1. Using the towers explore and look for relationships between the various fraction pieces. List 2 observations that you find!
2. Using the fraction strips and fraction towers, determine which fraction is larger and model it. $\frac{1}{2}$ or $\frac{3}{4}$?
3. Find fractions that are equivalent to $\frac{4}{12}$ and model them.
4. If you added two fractions together and got $\frac{6}{10}$, what could the two fractions be? Model them and show as many solutions as possible.
5. Model, compare, and order the following fractions: $\frac{1}{2}$, $\frac{3}{8}$, $\frac{2}{5}$, and $\frac{6}{10}$.
6. James, Gursh and Allan all get the same amount of money for their monthly allowance. If James spent 20%, Gursh spent $\frac{1}{3}$ and Allan spent 0.4 of his allowance, who has the most money left over at the end of the month?

Endeavor STEM Teaching Certificate Project

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