**What does math have to do with paint?**

**Video Link:** [**https://youtu.be/fXKpgsVSB10**](https://youtu.be/fXKpgsVSB10)

**Lesson Plan**

**Teacher Note:** Please preview the entire video and pre-work the questions in order to anticipate students’ needs, misconceptions, and materials unique to your classroom.

You will also need to determine the background knowledge of your students regarding the following topics and decide the best method for providing that background in order to support the conceptual understanding of the mathematics shown in the video.

* Area of Rectangles
* Surface Area of a rectangular prism
* Rounding a decimal to the nearest whole number

**Common Core Mathematical Content Standards**

* **[5.NBT.A.4](http://www.corestandards.org/Math/Content/5/NBT/A/4/)** Use place value understanding to round decimals to any place.

* **[6.EE.A.2.B](http://www.corestandards.org/Math/Content/6/EE/A/2/b/)** Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity.

* **[6.EE.A.3](http://www.corestandards.org/Math/Content/6/EE/A/3/)** Apply the properties of operations to generate equivalent expressions.

* **[7.G.B.6](http://www.corestandards.org/Math/Content/7/G/B/6/)** Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

**Common Core Mathematical Practice Standards**

 1. Make sense of problems and persevere in solving them.

 2. Reason abstractly and quantitatively.

 3. Construct viable arguments and critique the reasoning of others.

 4. Attend to precision.

**Company Information**

Robinson, Inc. is a single-source metal solutions provider based in De Pere, Wisconsin.  Robinson offers manufacturing and design expertise in fabrication and machine; pipe and vessel; custom enclosures; product handling and portable fuel solutions.  The company employs more than 550 people at three locations comprising 500,000 square feet of manufacturing space.

**Summary**

Companies that manufacture large products like those provided by Robinson often require painting. Robinson also provides this service to complete a product. The painting department uses both liquid paint and powder paint. Each product has characteristics such as thickness, durability, application waste, fire resistance, etc. This video shows how someone from the sales team might consult with a department in order to advise her customer.

**Differentiation**

* The questions on the student handout are scaffolded to meet the needs of students who may need extra support.
* The mathematics in this lesson is not higher than a 6th grade level. Students are not likely to struggle with the math itself. The concepts and vocabulary, however, may require additional discussion or clarification.
* More capable students will benefit from researching some of the concepts in more depth. Some possible extension options are provided in the lesson.

**Pre-Activity Discussion**

* This video begins with a person from the sales team meeting with the supervisor of the paint department. She has a client that needs a painted product and needs to advise them on how to proceed. The customer has provided some specifications regarding their needs, but needs to know what product will meet their needs best.
* Discuss the vocabulary related to the problem ahead of time as many of these terms will not be explained in detail during the video.
* Discuss formulas used in the video to make sure students are aware that some are abbreviated.
* Possible discussion may include asking students what they know about paint. Many will not be familiar with powder paint. Discuss any advantages or disadvantages they might anticipate when comparing liquid and powder.
* **Vocabulary**
* **Mil Thickness** – One mil is 1/1000 of an inch and is often used in manufacturing to describe the thickness of products that are very thin such as paint or plastic.
* **Specific Gravity** – Represents the ratio of the density of a substance to the density of some standard (water in the case of liquids). Vegetable oil, for instance, has a specific gravity of about .92 and will float on water. Molasses, however, has a specific gravity of around 1.4 and will sink in water.
* **Transfer Efficiency** – This represents the percentage of the paint that actually sticks to the surface when compared to the total amount of paint used. As an example, if the efficiency were 87% that means 87% of the paint sprayed on the surface actually adheres. The other 13% is waste in the air and elsewhere.
* **Electrostatic** **Painting** – Powder paint particles are given an electric charge and the object being painted is grounded. The charged powder particles are attracted to the surface like a balloon to a ceiling. The product is then baked at a high temperature and melts the coating and cures it to the surface.
* **Ionization** – Any process in which electrically neutral atoms or molecules are converted to electrically charged atoms or molecules.

**Information Needed to Solve:**

* Dimensions of the enclosure: 40 feet long, 12 feet wide, and 10 feet high.
* Coverage rate for one pound of powder coat at 1 mil thickness and 1 specific gravity is 193.2 sq. ft.
* The specific gravity of the customer’s powder coat (RAL7035) is 1.46.
* The mil thickness required for the job is 3 mil.
* The transfer efficiency of the equipment is .70.
* It costs $8.99 per pound of the powder coating
* Coverage rate for a gallon of liquid paint at 1 mil thickness is 1,139 sq. ft.
* The mil thickness for the liquid paint is also 3 mil.
* Transfer efficiency for liquid paint equipment is .35.
* It costs $45.00 per gallon of the liquid paint.
* ACR stands for Actual Coverage Rate.
* The ACR for powder is calculated using the formula:

***ACR=(Coverage Rate Per lb.)***$÷$***(Specific Gravity)***$÷$***(mil thickness) x (Transfer Efficiency as a Decimal)***

* The ACR for liquid is calculated using the formula:

***ACR=(Coverage Rate Per Gal.)***$÷$***(mil thickness) x (Transfer Efficiency as a Decimal)***

**NOTE:** Prior to beginning the lesson students will need a copy of the ***Paint Information Sheet***. It is important that they fill in the information as they watch the video.

**Part 1 (0:00 – 1:24)**

BREAK 1

* Begin by having students create a list of as many different factors that might affect what is chosen for characteristics of paint. It may be helpful for students to do this in small groups. Remind them that we are assuming they do not know what will be put in the enclosure and we do not know where the enclosure will be located. Discuss as a class.
* Have students calculate the lateral area (walls only) of the enclosure.
* Prior to the next portion of the video, small groups or the whole class should try to come up with factors that might need to be considered when pricing the job. Examples might be paint price, thickness of paint applied, waste, etc. This is recommended, but can be optional if time is an issue.

**Part 2 (3:52 – 3:56)**

BREAK 2

* Be sure that the vocabulary has been discussed prior to this portion of the calculations so that students have a clearer understanding of what the numbers refer to.
* Students should refer to their notes on the Paint Information Sheet for calculations in this section.
* Have students calculate the ACR (Actual Coverage Rate) for powder coat.
* Have students calculate the ACR (Actual Coverage Rate) for liquid paint.

**Part 3 (4:45 – 4:49)**

BREAK 3 (Mislabeled as break 2 in the video)

* Have students calculate the cost of the job for powder coat as well as liquid paint. A formula is given in the video, but it may be good for students to think about how to calculate the cost without it.
* Students should make a decision as to how to advise the customer.

**Extension**

* The mathematics itself is not challenging. It would be worth having more capable students research several of the ideas that are connected to the powder painting.
* Find out more about how the powder is charged and attracted to the surface.
* Find out how the powder coat is cured to the surface.
* Find out about the environmental differences between liquid paint and powder paint.
* Prior to painting, the powder is highly flammable. After curing it is not. Find out about the dangers of this kind of application.

**Student Handout – What does math have to do with paint?**

Name(s):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Pre-Activity Discussion:** *Notes on necessary background information.*

**Problem:**  *What is the cost of liquid paint versus powder coat for the proposed job?*

 **Note:** During the video you need to fill in the information on the Paint Information Sheet.

**Break 1**

* In your small groups make a list of factors that you think may be important when choosing the characteristics of paint.
* Calculate the lateral area of the enclosure in the video. This is the portion to be painted. Show all work and appropriate units.
* In your small groups make a list of factors that might need to be considered when determining the price of the job. You may need to draw from some of the vocabulary that was discussed before the lesson.

**Break 2**

* Use the information from the video to calculate the ACR (Actual Coverage Rate) for the powder coating.

***Powder Coat ACR­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

* Use the information from the video to calculate the ACR (Actual Coverage Rate) for the liquid paint.

***Liquid Paint ACR\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

**Break 3** (Mislabeled as break 2 in the video)

* Determine the cost of completing the job using the powder coat.

***Powder Coat Cost\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

* Determine the cost of completing the job using the liquid paint.

***Powder Coat Cost\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

* Which paint process will you recommend to the client and why?

**Answer Key – What does math have to do with paint?**

**Pre-Activity Discussion:** *Notes on necessary background information.*

**Problem:**  *What is the cost of liquid paint versus powder coat for the proposed job?*

 **Note:** During the video you need to fill in the information on the Paint Information Sheet.

**Break 1**

* In your small groups make a list of as many factors that you think may be important when choosing the characteristics of paint.

**Sample Ideas:** *What is the thickness of the paint? Will the enclosure be stored indoors or outdoors? How durable does it need to be? What colors? What type of finish? What wear will the enclosure receive? Fire resistance? Specific gravity? Liquid or powder?*

* Calculate the lateral area of the enclosure in the video. This is the portion to be painted. Show all work and appropriate units.

**(40 x 10) x 2 + (12 x 10) x 2 = 1040 square feet**

* In your small groups make a list of as many factors that might need to be considered when determining the price of the job. You may need to draw from some the vocabulary that was discussed before the lesson.

**Sample Ideas:** *What type of paint will be used? How thick of a coat of paint needs applied? Are there any special finishes? How much labor to apply the paint? How much paint will be wasted? How long will it take?*

**Break 2**

* Use the information from the video to calculate the ACR (Actual Coverage Rate) for the powder coating.

 **(Coverage Rate Per Pound ÷ Specific Gravity ÷ Mil Thickness) x Transfer Efficiency As A Decimal**

 **(193.2 ÷ 1.46 ÷ 3) x .70 = 30.876 square feet per pound**

* Use the information from the video to calculate the ACR (Actual Coverage Rate) for the liquid paint.

**(Coverage Rate Per Gallon ÷ Mil Thickness) x Transfer Efficiency As A Decimal**

 **(1139 ÷ 3) x .35 = 133 square feet per gallon**

**Break 3** (Mislabeled as break 2 in the video)

* Determine the cost of completing the job using the powder coat.

**(Square Feet ÷ ACR) x Cost Per Pound**

 **(1040 ÷ 30.876) x 8.99 = $302.78**

* Determine the cost of completing the job using the liquid paint.

**(Square Feet ÷ ACR) x Cost Per Gallon**

 **(1040 ÷ 133) = 8 (rounded up) x 45.00 = $360**

* Which paint process will you recommend to the client and why?

**Assuming that cost is the only factor, the powder coat would be the way to go. If there are other factors that the customer needs, they may wish to consider the liquid paint.**

**Robinson Painting Information**

***Use this document to keep track of the information in the video. You will be asked to use this information in order to solve the problems posed in the lesson.***

**Part 1**

1. Enclosure dimensions: 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Type of paint finish: 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Color number: 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Number of square feet to be painted: 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2**

1. The two types of paint are: 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Property used to get dry paint to stick: 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Coverage rate per 1 pound of powder at 1 mil and

 1 specific gravity: 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Specific gravity for RAL-7065: 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. Required mil thickness: 5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. Transfer efficiency of spray equipment: 6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. Cost per pound of powder coat: 7. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. Coverage rate per gallon at 1 mil: 8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9. Mil thickness required: 9. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Transfer efficiency of spray equipment: 10. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. Cost per gallon of liquid paint: 11. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12. ACR stands for: 12. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13. Formula for calculating ACR for dry powder paint:

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. Formula for calculating ACR for liquid paint:

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 3**

1. Cost per pound of powder paint: 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Project cost using powder paint: 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Cost per gallon of liquid paint: 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Project cost using liquid paint: 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Extra notes, info, or thoughts**