

STEAM Experiment #9

The Beauty of Reverse Engineering



Science

When you hear the term “reverse engineering,” it is typically referring to reversing code. However, in this section, we will be referring to reversing formulations. The dictionary definition of “reverse engineering” is “to disassemble and examine or analyze in detail (a product or device) to discover the concepts involved in manufacture usually in order to produce something similar.”

As a chemist, this means you analyze the ingredients in a product, copy the formulation, and “knock it off.” Lotions, eyeshadow, and perfumes are very popular “knock off” items which the chemists reversed engineered the formulations. Purses are also popular “knock off” items. As a scientist or engineer, it is important that you learn practical skills in reverse engineering to prepare you for a successful STEM career. Companies reverse engineer products because it is faster, easier to make, less risky, and less expensive. It is important to note that scientist and engineers analyze a product or device and find another ingredient that provide the same benefit as the ingredient that is in the competitors product. It is not the same as analyzing and using the exact same ingredients and design. There are laws in our society that protect products and designed from being copied and used without the owner’s permission.



Technology

In this section, we will “knock off” the packaging of three products and create a PowerPoint presentation to present those products as our new product line. You will need a computer with Internet and Microsoft PowerPoint access.

1. Create a new folder on your desktop. Rename it with your name.
2. Do an image search for a bottle of shower gel, shampoo, lotion, and perfume.
3. Save your images in your desktop folder. In most instances, you can right-click on the image and select “Save.”
4. Use Pixlr (www.pixlr.com) to edit the images and place your business name on each bottle.
5. Place the image back in your desktop folder.
6. Open PowerPoint and create a new presentation for your new product line.

NOTE! Have questions? Be sure to reference the B.O.S. Resource Folder for more information on PowerPoint and Pixlr.



Engineering

Now that you understand the importance of knowing how to “knock off” a product, we will compare the formulation that we used to make lip balm to the formulation of a popular lip balm that you buy from your favorite store.

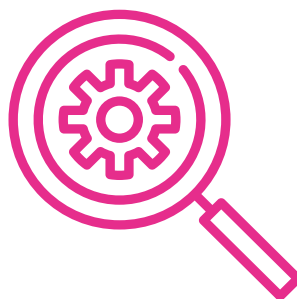
Your formulation:

MY INGREDIENTS	THE INGREDIENTS FROM THE COMPETITION
Soybean Oil	5% Coconut oil
Cocoa Butter	1% Lanolin
Shea Butter	3% Sunflower seed oil
Apricot Kernel Oil	89% Beeswax
Sweet Almond Oil	2% Peppermint oil

Follow the steps below to create a formula almost identical to the competition.

1. Analyze the ingredient list.
2. Put the ingredients in ascending order (lowest to highest).
3. Use the Internet to look up all the ingredients to learn what each ingredient does.
4. Create a formula for the competitor’s product using products that performs the same function.

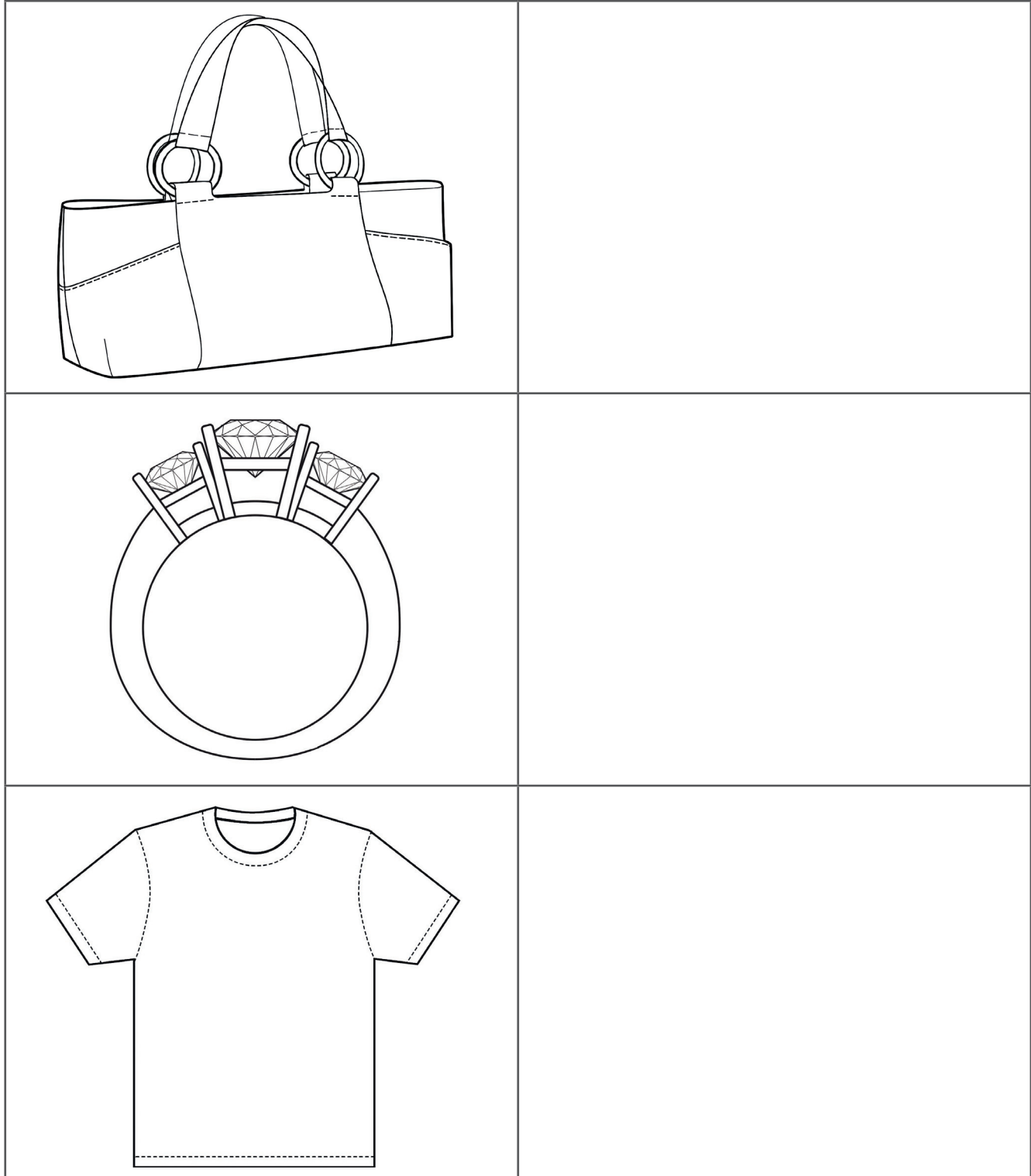
ORDER	INGREDIENT	WHAT IT DOES	FORMULA %





Art

Duplicate a Product Design - In the fashion industry, products like purses, jewelry, and clothes are popular “knock off” items. Look at the designer merchandise on the left and draw a design that looks very similar to the competitor’s more expensive version.





Mathematics

Part 1: Expressions

Great scientists have great mathematical skills that require understanding mathematics. In the engineering section, you were required to research and analyze the competitor's ingredients to create a formula to duplicate the product. One way to create a formula is to use expressions to group numbers, symbols and operators (such as "+" and "x") together to show the value of an ingredient. Example: 2×10 is a numerical expression or an arithmetic expression. However, when duplicating products, scientists combine numbers and variables to create a formula.

Let's say, during your research of the competitor's ingredients, you discovered that if you used four times the number of the main ingredient "a" in your list less twice the amount of ingredient "b" in the competitor's list, you would duplicate a perfect match of competitor's lip balm. How would you write the formula as an algebraic expression with both ingredients represented?

- ☑ **Example:**
1. Let "a" represent your main ingredient and "b" represent the competitor's ingredient.
 2. Write the variables: $4a$ and $2b$.
 3. Represent the mathematical operation (less) by its symbol "-."

- ☑ **The algebraic expression is:** $4a - 2b$.
 Four times the amount of ingredient **a**
 Less twice the amount of ingredient **b**

Part 2: Mathematical Operations

Complete the table below. Write the letter that represents the mathematical operation on the line in front of the corresponding words in the table.

A. Addition		B. Subtraction		C. Multiplication		D. Division	
_____	Increased by	_____	Minus	_____	Shared	_____	Plus
_____	Decreased by	_____	Times	_____	Product	_____	Quotient
_____	Sum	_____	Total	_____	Difference	_____	Twice
_____	Split between	_____	Reduced by	_____	Of	_____	Divided by
_____	More	_____	Less than				

Part 3: Variable Expressions

Let's look at an example of translating words into a variable expression.

Remember that a variable expression has one or more variables (letters) that represent an unknown quantity.

- ☑ **Example:** Write the following as a mathematical expression with one variable:

A number increased by four.

1. First, name the variable. Let "n" represent the number.
2. Next, represent the mathematical operation by its symbol "+."
3. Then, insert the constant (4) after the symbol.

The variable expression is $n + 4$.

Write a variable expression to represent each of the following:

1. The sum of a number and ten. _____
2. The difference between a number and five. _____
3. Four times a number. _____
4. A number squared plus three. _____
5. A number divided by seven plus seven. _____
6. Two times the quantity of an ingredient plus three. _____