

**Teacher’s Guide**

 **The Ingredients in Your Cosmetics: What Do They Do?**

***April 2023***

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Activate students’ prior knowledge and engage them before they read the article.

[***Reading Comprehension Questions***](#_Student_Reading_Comprehension) ***3***

These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[***Graphic Organizer***](#_Graphic_Organizer) ***6***

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

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Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

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Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. The names of chemicals in cosmetics are standardized. |
|  |  | 2. Ingredients in cosmetics are listed in order of decreasing concentration. |
|  |  | 3. Usually the solvent in a cosmetic is listed last. |
|  |  | 4. The most common solvent in cosmetics is alcohol. |
|  |  | 5. Emulsifiers are used to make cosmetics homogeneous. |
|  |  | 6. Preservatives are rarely used in cosmetics. |
|  |  | 7. Cosmetics must list an expiration date. |
|  |  | 8. The FDA requires that cosmetics labels include directions and warnings. |
|  |  | 9. Nitrocellulose, a chemical widely used in nail polish, is highly flammable. |
|  |  | 10. The cosmetics industry employs many chemists. |

# Student ReadingComprehension Questions

**Directions**: Use the article to answer the questions below.

1. On a cosmetic label, how can you determine which ingredient makes up most of the product?
2. What is the role of a solvent in cosmetics? Compare this to the definition of solvent in chemistry.
3. Emulsifiers are molecules that can interact with two different types of molecules that can’t interact with each other. A single emulsifier molecule contains regions of bonded atoms that are different from each other. The different regions can interact with different kinds of substances. The molecule pictured below shows a typical structure for polysorbates, which are common emulsifiers in cosmetics. Circle the part of this molecule that would be able to interact with water and explain why the other part would not interact with water.



1. In the emulsifier image in the article, water is shown in light blue and oil is shown in yellow. Notice the shape that is drawn to represent the emulsifier molecules that surround the droplets. Use the above picture to explain why the shape is a good model for emulsifiers.
2. For an emulsion of water in oil, describe the intermolecular forces and explain the process involved in enabling the water to be dispersed throughout the oil without separating.
3. Guar gum (molecular structure pictured below) is a common thickening agent, particularly in water based cosmetics. Draw a few water molecules surrounding the image and refer to your drawing to explain why guar gum increases the viscosity (reduces the flow) of a water-based formulation.



1. List two minerals that are used to give color to cosmetics, and identify the color for each.
2. What is the difference between a wax and an oil? Why are both used in creating lipstick?
3. All cosmetics contain mixtures of different substances, called formulations. Compare and contrast the following types of mixtures: solution, colloid, emulsion
4. Some people add a small amount of nail polish remover to a bottle of nail polish when the polish has gotten too thick. Explain why the nail polish remover doesn’t ruin the nail polish.
5. Identify four different things that people with a degree in chemistry can do when working in the cosmetics industry.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Three types of ingredients used in skin lotions are humectants, emollients, and occlusives. Each has different benefits. Research these ingredients and make a claim for which you would want in your own lotion.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to describe the chemistry of cosmetics.

|  |  |  |
| --- | --- | --- |
| **Ingredient** | **Purpose** | **Chemicals used** |
| **Solvent** |  |  |
| **Emulsifiers** |  |  |
| **Preservatives** |  |  |
| **Thickeners** |  |   |
| **Skin Conditioners** |  |   |
| **Colorants** |  |   |
| **Fragrances** |  |   |

**Summary:** On the back of this sheet, write three interesting facts about cosmetics you learned from the article to share with a friend.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. On a cosmetic label, how can you determine which ingredient makes up most of the product?
The ingredients are listed in order of decreasing % weight, so the first ingredient has the highest percentage.
2. What is the role of a solvent in cosmetics? Compare this to the definition of solvent in chemistry.
A solvent in cosmetics is the ingredient that dissolves the other ingredients, allowing them to mix together and flow. This is the same as the definition in chemistry.
3. Emulsifiers are molecules that can interact with two different types of molecules that can’t interact with each other. A single emulsifier molecule contains regions of bonded atoms that are different from each other. The different regions can interact with different kinds of substances. The molecule pictured below shows a typical structure for polysorbates, which are common emulsifiers in cosmetics. Circle the part of this molecule that would be able to interact with water and explain why the other part would not interact with water.

The other part of this molecule will not mix together with water because it is nonpolar. The nonpolar portion of the molecule will interact with other nonpolar regions or molecules. Water is highly polar and will be attracted to areas of a molecule where it can participate in hydrogen bonding or dipole-dipole interactions, as are prevalent in the circled portion.

1. In the emulsifier image in the article, water is shown in light blue and oil is shown in yellow. Notice the shape that is drawn to represent the emulsifier molecules that surround the droplets. Use the above picture to explain why the shape is a good model for emulsifiers.
There is an area of the molecule containing many oxygen atoms and -OH groups that can interact with water molecules. This area is grouped together and is represented by an oval in the image. The other portion of the molecule is a long nonpolar carbon chain. The squiggly “tail” attached to the oval in the image represents the carbon chain. These are commonly referred to as the “polar head” and “nonpolar tail” of the molecule.
2. For an emulsion of water in oil, describe the intermolecular forces and explain the process involved in enabling the water to be dispersed throughout the oil without separating.
The polar heads of the emulsifier molecules will surround small water droplets, stopping the droplets from coalescing together. Since the polar heads are attached to a nonpolar tail, the nonpolar tails stick outward and can attract to the nonpolar oil molecules. This arrangement allows many water droplets to be spread throughout the oil, as they are protected from joining by the emulsifier molecules.
3. Guar gum (molecular structure pictured below) is a common thickening agent, particularly in water based cosmetics. Draw a few water molecules surrounding the image and refer to your drawing to explain why guar gum increases the viscosity (reduces the flow) of a water-based formulation.



(Water molecules should be drawn showing hydrogen bonding or dipole-dipole interactions in appropriate locations.) There are many areas throughout the guar gum molecule where hydrogen bonding can take place with water. Water’s small molecules can slip past each other easily when in liquid form, but when many molecules are stuck to a larger guar gum molecule, they are not able to move past each other as easily, thus the viscosity is increased.

1. List two minerals that are used to give color to cosmetics, and identify the color for each.
Any of: iron(III) oxide (red, orange, yellow, or black); chromium(III) oxide (green); titanium(IV) oxide (white)
2. What is the difference between a wax and an oil? Why are both used in creating lipstick?
Waxes have stronger intermolecular forces and are solid at room temperature. Oils are liquid at room temperature. The wax provides the structure so lipstick stays on the lips. The oil allows it to spread onto the lips easier and gives it a shine.
3. All cosmetics contain mixtures of different substances, called formulations. Compare and contrast the following types of mixtures: solution, colloid, emulsion
Solutions are mixtures at the molecular level. A solute is separated into its smallest particles, each surrounded by solvent molecules. A colloid contains larger particles, which can be large molecules or aggregates of small particles, surrounded by solvent molecules. Emulsions are mixtures of two immiscible liquids, but stabilized by a third substance such that droplets of one liquid are dispersed throughout the other.
4. Some people add a small amount of nail polish remover to a bottle of nail polish when the polish has gotten too thick. Explain why the nail polish remover doesn’t ruin the nail polish.
The solvent in nail polish is similar to the nail polish remover. The solvent allows the other parts of the nail polish to flow so they can be painted onto a nail. This solvent evaporates, leaving behind a film of the other ingredients. Therefore, the nail polish remover won’t ruin nail polish, but if you use too much of it, the polish will be too runny to stay on the nail.
5. Identify four different things that people with a degree in chemistry can do when working in the cosmetics industry.
Work with colors, work with skincare, work with fragrance, work with safety and compliance, work in marketing.

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

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# Additional Resources and Teaching Strategies

**Additional Resources**

* **Labs and demos**
* AACT Lab: What Type of Mixture is Paint?<https://teachchemistry.org/classroom-resources/what-type-of-mixture-is-paint>
* **Simulations**
* AACT Simulation Intermolecular Forces<https://teachchemistry.org/classroom-resources/intermolecular-forces-2020>
* AACT Simulation Comparing Attractive Forces<https://teachchemistry.org/classroom-resources/comparing-attractive-forces-simulation>
* **Lessons and lesson plans**
* AACT Lesson: The Evolution of Materials Science in Everyday Products<https://teachchemistry.org/classroom-resources/the-evolution-of-materials-science-in-everyday-products>
* **Projects and extension activities**
	+ ACS Science of Personal Care Products<https://www.acs.org/education/students/highschool/chemistryclubs/activities/personal-care-products.html>

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students what cosmetic products they use and what purpose they serve. Students may not realize that cosmetic products include hair products, moisturizers, deodorants, and fragrances in addition to makeup. Ask students if they read the labels on their cosmetic products and why. Ask them what information can be found on the labels. Their initial ideas can be collected electronically via Jamboard, Padlet, or similar technology.
	+ As they read, students can find information to confirm or refute their original ideas.
	+ After they read, ask students what they learned about the chemistry of cosmetics.
* After students have read and discussed the article, ask students what information they would like to share with friends and family about cosmetic products, and whether they will choose cosmetics differently based on the information in the article.
* This article could be used early in the year when talking about basic matter. It can jumpstart a lesson on the differences between various types of mixtures.
* This article could be used during a unit on intermolecular forces and could use more molecular structures to analyze the various interactions.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Physical properties
* Chemical change
* Mixtures
* Solutions
* Solute/solvent

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

**HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* ETS.1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Cause and effect
* Structure and function
* Stability and change

**Science and Engineering Practices:**

* Constructing explanations (for science) and designing solutions (for engineering)

**Nature of Science:**

* Science addresses questions about the natural and material world.

See how *ChemMatters* correlates to the[**Common Core State Standards** online](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html).