

**Teacher’s Guide**

**What is Hand Sanitizer,
 and Does it Keep Your Hands Germ Free?**

***October 2020***

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

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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 5](#_Graphic_Organizer)

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.

[Additional Resources 8](#_Additional_Resources)

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

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**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. Hand sanitizer works better against viruses than soap and water.
 |
|  |  | 1. Doctors knew that handwashing was important for health before they fully understood the effects of germs.
 |
|  |  | 1. SARS-CoV-2 virus is soluble in water.
 |
|  |  | 1. Both soap molecules and alcohols have a polar and a nonpolar region.
 |
|  |  | 1. Hydrogen peroxide is in hand sanitizer to kill viruses.
 |
|  |  | 1. Gel is added to hand sanitizer to slow the evaporation of alcohol.
 |
|  |  | 1. Alcohol-free hand sanitizers are not effective.
 |
|  |  | 1. Lipid fragments can be washed away by using soap and water, but not hand sanitizer.
 |
|  |  | 1. Hand sanitizers work on noroviruses like those that cause the stomach flu.
 |
|  |  | 1. Hand sanitizers work well when your hands are dirty or greasy.
 |

# Student ReadingComprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. Briefly describe the meaning behind each part of the term COVID-19 (i.e. CO, VI, D, 19).
2. Explain why alcohol is used in hand sanitizer?
3. Give two examples of chemicals other than ethanol or isopropanol found in hand sanitizer and give their purpose.
4. Briefly explain the difference between polar and nonpolar molecules.
5. Explain why soap is more effective than hand sanitizer in protecting individuals from bacterial and viruses.
6. Suppose you went to all the local stores in your area and the premade hand sanitizer were completely sold out. How could you create your own hand sanitizer?
7. The efficacy of masks has become a very polarizing topic. Design a simple experiment you could perform to prove or disprove the idea that masks help prevent the spread of viruses.
8. Another popular chemical used as a disinfectant is bleach. What is the chemical formula of the main ingredient in bleach and how does it work to kill viruses?
9. Draw the chemical structure of soap and label the polar and nonpolar parts. Briefly explain why soap is an effective substance for cleaning and disinfecting surfaces, citing particular properties of its structure.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. The unfortunate reality is that another pandemic will most likely happen sometime in the not so distant future. Suppose you were tasked with creating a pandemic kit. Based on your experiences, what items would you include in the kit and why?
2. Create a 30 second to 1 minutes commercial video explaining benefits of soap and handwashing. Be sure to include the chemistry behind how soap works in your video. You may also explain why soap is more beneficial than hand sanitizer.

# Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to describe ingredients in hand sanitizers.

|  |  |  |
| --- | --- | --- |
| **Ingredients** | **Formula** | **Purpose** |
| **Ethanol** |  |  |
| **Isopropanol** |  |  |
| **Hydrogen peroxide** |  |  |
| **Water**  |  |  |
| **Glycerol** |  |  |
| **Polyacrylate**  | (no formula given in the article) |  |

**Summary:** Write a sentence or two stating what you would tell a friend who wanted to use hand sanitizer instead of soap and water to protect against SARS-CoV-2 viruses.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. **Briefly describe the meaning behind each part of the term COVID-10 (i.e. CO, VI, D, 19)**

*CO is Covid*

*VI is Virus*

*D is Disease*

*19 is the year the virus originated – 2019*

1. **Explain why alcohol is used in hand sanitizer?**

*Alcohols have a polar and nonpolar region which allows them to effectively dissolve the lipid membranes of viruses, killing the virus.*

1. **Give two examples of chemicals other than ethanol or isopropanol found in hand sanitizer and give their purpose.**

*Glycerol and propylene glycol both act as moisturizers to prevent the alcohols in the hand sanitizer from drying out your skin.*

1. **Briefly explain the difference between polar and nonpolar molecules.**

*Polar molecules have permanent net dipole which is caused by an unequal sharing of electrons in the molecules. Permanent net dipole cause electrostatic attraction between adjacent molecules. Nonpolar molecules lack a permanent net dipole due to the equal sharing of electrons within the molecule. The electronegativities of the elements within the molecule determines if a polar or nonpolar bond covalent bond will form.*

1. **Explain why soap is more effective than hand sanitizer in protecting individuals from bacterial and viruses.**

*Similar to alcohols, soap has both a polar and nonpolar end. However, soap molecules form spheres called micelles, with the nonpolar region of the molecules facing outwards which attracts and disrupts the lipid membrane of the virus, both killing the virus and washing it away when you rinse your hands. If not used effectively hand sanitizer can leave live virus on your skin because they are unable to “wash” them off. The combined attraction, dissolving, and rinsing by using soap makes it more effective.*

1. **Suppose you went to all the local stores in your area and the premade hand sanitizer were completely sold out. How could you create your own hand sanitizer?**

*Homemade hand sanitizer can be made by combining two parts rubbing alcohol with one part aloe vera, both of which are commonly in stock at stores in which hand sanitizers are sold out.*

1. **The efficacy of masks has become a very polarizing topic. Design a simple experiment you could perform to prove or disprove the idea that masks help prevent the spread of viruses.**

*Answers may vary, but a very simple test could involve trying to blow out a candle with and without a mask on. More complex tests could use sensors to measure the flow of air or pressure through the mask. Bacteria samples and swabs could also be used by having someone breath on a petri dish with and without a mask on.*

1. **Another popular chemical used as a disinfectant is bleach. What is the chemical formula of the main ingredient in bleach and how does it work to kill viruses?**

*Bleach is NaClO (sodium hypochlorite). Bleach kills bacteria and viruses by reacting with the proteins and destroying them.*

1. **Draw the chemical structure of soap and label the polar and nonpolar parts. Briefly explain why soap is an effective substance for cleaning and disinfecting surfaces, citing particular properties of its structure.**

*Students should use the diagram of soap in the article to guide their response. The polar and nonpolar regions of soap make it a good chemical to wash both polar and nonpolar substances.*

**Questions for Further Learning**

1. **The unfortunate reality is that another pandemic will most likely happen sometime in the not so distant future. Suppose you were tasked with creating a pandemic kit. Based on your experiences, what items would you include in the kit and why?**

*Answers will vary, but some items may include masks, toilet paper, sanitizing wipes, etc.*

1. **Create a 30 second to 1 minute commercial video explaining benefits of soap and handwashing. Be sure to include the chemistry of soap in your video. You may also explain why soap is more beneficial than hand sanitizer.**

*Answers will vary*

**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 |

# Additional Resources

**Labs and demos**

The Chemistry of Hand Sanitizer and Soap: In this lab, students will model the interaction between hand sanitizer particles and virus particles, as well as between soap particles and virus particles.

<https://teachchemistry.org/classroom-resources/the-chemistry-of-hand-sanitizer-and-soap>

Hand Sanitizer Lab related to the Mole: It’s Mole Time! In this lab, students determine the number of moles of chalk used to write their name, the moles of sucrose ingested while chewing gum, and the moles of alcohol evaporated when using hand sanitizer.
<https://teachchemistry.org/classroom-resources/it-s-mole-time>

Designing an Effective Respiratory Cloth Mask: In this activity students will use unit conversion to help compare sizes of molecules, viruses, and droplets and then use them to interpret graphical data. They will then use their findings to design a cloth mask that helps protect its wearer against infection by SARS-CoV-2, the coronavirus that causes COVID-19.

<https://teachchemistry.org/classroom-resources/designing-an-effective-respiratory-cloth-mask>

Modeling Polarity: In this activity, students will model the pull of electrons in a bond between two elements, demonstrating covalent bonding. In particular differentiating between polar and nonpolar bonds.

<https://teachchemistry.org/classroom-resources/modeling-bond-polarity>

**Simulations**

Intermolecular Forces Simulation: Students will review the three major types of intermolecular forces – London dispersion forces, dipole-dipole interactions, and hydrogen bonding – through short video clips and accompanying text. The simulation is designed as a five question quiz for students to use multiple times.

<https://teachchemistry.org/classroom-resources/simulation-activity-intermolecular-forces-2>

Comparing Attractive Forces: In this activity, students will use a simulation to investigate different types of intermolecular forces (London dispersion and dipole-dipole). In the analysis that follows the activity, they will relate IMFs (including hydrogen bonding) to physical properties (boiling point and solubility).

<https://teachchemistry.org/classroom-resources/simulation-activity-intermolecular-forces>

**Lessons and lesson plans**

This lesson plan is a review of intermolecular forces concepts.

<https://teachchemistry.org/classroom-resources/intermolecular-forces-review>

**Other Resources:**

Infographic – Coronavirus: How hand sanitizers protect against infections: <https://www.compoundchem.com/tag/hand-sanitizer/>

World Health Organization’s formula for creating your own hand sanitizer: <https://www.who.int/gpsc/5may/Guide_to_Local_Production.pdf?ua=1>

# Chemistry Concepts, Standards, and Teaching Strategies

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Molecules & bonding
* Molecular structure
* Intermolecular forces

**Correlations to Next Generation Science Standards**

This article can be used to achieve the following performance expectations and dimensions of 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-ETS1-3**

Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraint, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**Disciplinary Core Ideas:**

* PS1.A: Structure and Properties of Matter
* ETS1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Cause and Effect: Mechanism and explanation
* Structure and Function

**Science and Engineering Practices:**

* Analyzing and interpreting data
* Constructing explanations and designing solutions

**Nature of Science:**

* Science addresses questions about the natural and material world.

**Correlations to Common Core State Standards**

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

**Teaching Strategies**

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

* **Alternative to Anticipation Guide:** Before reading, ask students if they use hand sanitizer, and how they think it works to protect them from getting sick. As they read, students can find information to confirm or refute their original ideas.
* After they read, ask students what they learned about the efficacy of using hand sanitizers.
* There are several good ACS Reactions videos that complement the information in this article. Consider showing one or more of these after students have read the article:
	+ How Do Hand Sanitizers Work? <https://youtu.be/245jz3ZqZqM>
	+ You’re Using Disinfectants Wrong: <https://youtu.be/kbScdUwo7K4>
	+ Can Soap REALLY “Kill” the Coronavirus? <https://youtu.be/K2pMVimI2bw>