**Subject area/course:** Science/Chemistry

**Grade level/band**: 9-11

**Task source**: Stanford Center for Assessment, Learning, and Equity (SCALE); author: Susan Schultz

**Relieve IT?**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students will work in teams and use their current knowledge about acids, bases, and neutralization reactions. They will design and conduct an experiment to determine the pH of a fictional drug (Relieve IT) intended to relieve cold/flu symptoms and the pH of four unknown solutions. Then students will determine which solution or combination of solutions can be used to neutralize any excess acid or base. After analyzing their data, each team will generate recommendations as to which solution or solutions should be used to neutralize Relieve IT. Each team will make an oral presentation to share their procedures, findings, and recommendations to the Food and Drug Administration (FDA) panel. Each student will prepare an individual lab report including recommendations for “fixing” the pH levels of Relieve IT.

1. **Aligned standards:**
2. **Common Core State Standards**

[CCSS.ELA-Literacy.RST.9-10.7](http://www.corestandards.org/ELA-Literacy/RST/9-10/7/) Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

[CCSS.ELA-Literacy.WHST.9-10.4](http://www.corestandards.org/ELA-Literacy/WHST/9-10/4/) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

[CCSS.ELA-Literacy.WHST.9-10.5](http://www.corestandards.org/ELA-Literacy/WHST/9-10/5/) Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CCSS.ELA-Literacy.WHST.9-10.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

1. **Critical abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

Analysis of Information: Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Experimentation and Evaluation: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Communication in Many Forms: Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience.

Use of Technology: Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information.

Interpersonal Interaction and Collaboration: Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

Modeling, Design, and Problem Solving: Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

1. **Next Generation Science Standards**

Science and Engineering Practices

*Planning and Carrying Out Investigations*

* Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
* Select appropriate tools to collect, record, analyze, and evaluate data.

*Analyzing and Interpreting Data*

* Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution
* Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data

*Constructing an Explanation*

* Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects

1. **Ohio State Science Standards**

CHM.912.5a. Use litmus paper and other indicators to test and determine the pH of a substance.

CHM.912.5b. Given a pH indicator determine the pH of a variety of solutions.

1. **Time/schedule requirements:**

The following schedule is an estimate of the number of school days required for students to complete this task. Time requirements will vary based on grade level, schedule constraints, class size, class length, and academic readiness.

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| **Day** | **What Students Need To Do** | **Product** |
| Day 1 | Intro: Get familiar with the task requirements, expectations, and due dates |  |
| Part 1: Prepare an introduction for the FDA application (lab report) that includes background information about acids, bases, and how to neutralize a solution | Team Activity |
| Day 2 | Part 2: Design an experiment to determine the pH of Relieve IT and four unknown solutions to determine which solution or combination of solutions will neutralize Relieve IT |
| Days 3-5 | Part 3: Conduct the experiment |
| Part 4: Analyze and interpret findings |
| Part 5: Draw your conclusions |
| Part 6: Reflect on the findings |
| Days 6-7 | Part 7: Prepare to present experimental procedures, representation of data, findings, and recommendations to the FDA. | Oral Presentation |
| Part 8: Group presentation to the Federal Drug and Administration board |
| Days 3-8 | Part 9: Each team member prepares a draft application to FDA (lab report) | Individual  Lab Report |
| Day 9 | Part 10: Get peer feedback on your draft application (lab report) |
| Day 10 | Part 11: Prepare and turn in final application (lab report) |

1. **Materials/resources:**

Students will need:

* Access to the Internet
* Presentation software and/or poster-making supplies
* Lab equipment as requested by students and approved by you. A suggested list of lab materials can be found in Appendix C.
* Relieve IT samples, pH indicators, and the other 4 solutions students will need for the investigation. A suggested list of indicators to be used and the directions for making the solutions can be found in Appendix B and Appendix F.
* Copies of the *Laboratory Report Criteria* and *Criteria for Oral Presentations* documents.

1. **Prior knowledge:**

Students need to be able to:

* Identify characteristics of acids and bases.
* Be familiar with methods for changing the pH of a solution.
* Understand that a solution needs to be tested and then modified on the basis of the test results in order to change/improve it.
* Engage in the iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results, leading to greater refinement and ultimately to an optimal solution.
* Know how to plan an investigation individually and collaboratively and in the design identify what tools are needed, how measurements will be recorded, and how many and what type of data are needed to support a claim.

Students may have prior knowledge that is incorrect. The following misconceptions were adapted from Making Sense of Secondary Science‐Research Into Children’s Ideas, by Rosalind Driver, Ann Squires, Peter Rushworth, and Valerie Wood‐Robinson (Routledge Falmer, 2000):

* Students often remember acids as substances only related to their daily lives, such as sour milk, lemon juice, vinegar, antacids, acid rain, etc.
* Students often believe that acids only destroy or burn materials; thus, stronger acids will “eat away” substances faster than weak ones.
* Students often confuse the terms “acid strength” and “acid concentration”.
* Students often believe that bases are either the opposite of acids or bases are actually components of acids.

1. **Connection to curriculum:**

This performance assessment could be used as a culminating project at the end of a unit on acids and bases.

1. **Teacher instructions:**

Below is a comprehensive list of *suggested* ways to facilitate, organize, and scaffold student work, based on pilot implementation conducted by SCALE in real classrooms. You will, of course, need to choose which ideas meet the needs of your students, their previous experience with open-ended projects, and practicalities of your classroom/school, and adapt them accordingly.

You’ll notice that throughout we have tried to provide students with opportunities to make choices and take the lead in decision-making to complete the task. In this same vein, we encourage the use of peer-review and revision.

Possible Engagement Activity (The Hook)

If you are using this at the beginning of a unit on acids and bases, it is important for students to be introduced to the fact that everyday substances can be acidic, basic, or neutral. You can set up lab stations where students test these everyday substances (milk, vinegar, soda, water from the school drinking fountain, apple juice, etc.) with litmus paper and a number of other indicators to learn how to determine the relative pH range of a particular liquid.

Even if your students are already familiar with acids and bases, they will need to have an opportunity to work with the different indicators to determine the pH. For this task students will not be allowed to use pH probes.

Introduce the Task

* After the introductory activity, review the task description and respond to any student questions.
* Suggest students design a template to be used to collect information and record references at the time data is being collected.
* Tell students that personal reflections should be written in a journal/log throughout the project.

Review Expectations

* Review the due dates/task timeline.
* Review expectations for working together in a group – the roles students should take on and the norms for behavior (for more details, see “Student Support” section).
* Allow students time to look at the rubric(s), clarify the *Laboratory Report Criteria* and *Criteria for Oral Presentations* documents, and respond to student questions.
* Explain that, as they work in their groups, students will be responsible for gathering information and making their own decisions. As the teacher, you will provide help/resources only when everyone in the group agrees that they need help or if there is information they can’t find themselves.
* Clarify that students will work with lab partners or in small groups to design and conduct the investigation and to make an oral presentation, but that all students will also need to complete an individual lab report. Therefore, they will need to record information so they will be able to write their final individual lab report.

Part 1: Research (Partner Activity)

Students will collect, analyze, and synthesize information from at least four credible and reliable sources. For each source they will indicate any potential sources of bias and take into account the perspective of the author. Based on their research, their lab report introduction should:

* Explain the significance of acids and bases.
* Describe what they learned about acids and bases and what it means to neutralize an acid from previous experimentation.

*Individual Task*: Students will prepare an introduction to their lab report sharing what they have learned about acids and bases and the process of neutralization.

Part 2: Design experiment (Partner Activity)

During this initial design phase, students should refer to the *Laboratory Report Criteria* to plan and write their design. They should:

* Prepare detailed procedures for testing the pH levels of the Relieve IT product and the four unknown solutions based on what they have learned about acids, bases, and the neutralization process.
* Propose a procedure to determine which solution or combination of solutions might help their team to neutralize Relieve IT.
* Address any safety issues and how you want students to dispose of their solutions at the end of the experiment.

Students should not start Part 3 until you review their design.

*Individual Task*: Each student will need to write the design of the experiment section in their lab report and they should refer to the *Laboratory Report Criteria*.

Part 3: Conduct the experiment (Partner Activity)

Once student plans have been approved, students will conduct the experiments that they have designed to test the pH levels of the unknowns and the product and then they will move on to their designs for the neutralization process. They should refer to the *Laboratory Report Criteria* when conducting and writing their experiment and results.

At this point, teachers may want to begin to share unique data or procedures that student groups have utilized during the pH testing phase of the unknown solutions and Relieve IT before students move on to the neutralization process. You might conduct a whole class discussion to share class results regarding the pH levels of the four unknown solutions and the product. By sharing data, lab groups will be able to retest any of the unknown solutions to verify the results. Once the results have been verified, lab groups will be able to move on to their designs for the neutralization process. Continue to monitor the design plans in order to make sure that students stay focused on the goal of finding a way to neutralize the Relieve IT solution.

Part 4: Analyze and interpret findings (Partner Activity)

Students will carefully examine the data they have collected and determine what they can say about the results of the experiment based on the evidence.

*Individual Task*: Students should refer to the *Laboratory Report Criteria* when writing their individual analysis and interpretations of the data.

Part 5: Draw conclusions and generate recommendations (Partner Activity)

Students will review their analysis and interpretations of the data, state a conclusion of what they have learned from the experiment, and generate recommendations to the FDA on how to neutralize Relieve IT.

*Individual Task*: Students should refer to the *Laboratory Report Criteria* when writing their conclusion section for their lab reports.

Part 6: Reflect on findings (Partner Activity)

As part of the approval process, students need to create a report to send to the FDA of the results from their experimental tests conducted on the pH of Relieve IT. The FDA also wants to know what they did to “fix” the product through the process of neutralization before beginning human trials. This report will need to address potential implications and concerns of their findings (e.g., applications, policy decisions, and implications for the new product, etc.).

*Individual Task*: Students should refer to the *Laboratory Report Criteria* when writing this section of the lab.

Parts 7 & 8: Prepare and present to FDA (Partner Activity)

Students will make an oral presentation using PowerPoint or a poster to a Federal Drug Administration panel sharing their experimental procedures, explaining what they learned through their investigations, and making recommendations on which solution or combination of solutions(s) can be used to address the FDA’s concern about the pH level of Relieve IT. When preparing their presentation, students should refer to the *Criteria for Oral Presentations* document.

Part 9: Prepare lab report to the FDA panel (Individual Activity)

Students will pull from their notes and lab write-ups to produce a final lab report to the FDA panel that follows the requirements described in the *Laboratory Report Criteria*. Ideally, each student will be working on their lab report throughout the group activity process so they will have a preliminary draft to revise into a draft for review by peers and the teacher.

Part 10: Feedback and revisions to draft lab reports

This is a great opportunity for peer review of draft lab reports using the *Laboratory Report Criteria* and rubric. Students can exchange draft lab reports and use the *Laboratory Report Criteria* and *Science and Engineering Practices Rubric* to critique and make suggestions for revision. Each student will make revisions to their lab report based on peer and teacher feedback. Each student will submit a final lab report.

1. **Student support:**

Planning for Group Interaction

Most chemistry courses have labs that are designed to accommodate groups of two lab partners. For this task student grouping may easily vary, but group sizes of two to four work best. It may help group dynamics to assign students to specific roles (e.g., facilitator, materials manager, reporter, recorder, etc.) in order to promote student learning and/or utilize student skills. No matter what the team size, it is critical that each group keeps detailed records, and thus there must be at least one recorder for each team. As a classroom norm, encourage students to share their ideas, make a plan of action, and participate in the experimental design to analyze the unknown solutions and to neutralize Relieve IT.

Other possible accommodations for learning-disabled or ELL students

* Provide students with graphic organizers to help them organize information while gathering information about the unknowns.
* You might decide to reduce the number of unknowns to be tested.
* You can provide students with sentence starters or section starters to help them organize their lab reports.

1. **Extensions or variations:**

There could be an FDA panel (teachers and/or students) that would determine which report(s) help determine whether or not to move on to the human trial phase of testing.

1. **Scoring:**

Student work can be scored using the SCALE Science and Engineering Practices Rubric and the SCALE Effective Communication Oral Presentation Rubric.

NOTE: Do not score students on the shaded (grey) dimensions of the Science and Engineering Practices Rubric (9–12). The shaded dimensions are not being assessed by this task.