

## THE CHECKS LAB

### Teacher Notes

This exercise is designed to help students understand the idea that science is built on evidence that can be observed or deduced from the natural world. We gather evidence through the use of our senses. However, the evidence can be confusing, seemingly conflicting, and apparently random. Data is not always consistent nor even readable. Furthermore, all of the evidence may not be available. This is why scientific explanations are "tentative" explanations of natural phenomena.

In this simulation, there are several independent types of clues that may be used to develop an explanation (a hypothesis). This illustrates the concept that scientists use a variety of criteria to compare explanations and select the better ones. Scientists may even have to connect seemingly unrelated lines of evidence, always looking for patterns, to form tentative hypotheses.

Evidence in science, as in this simulation, is not of equal value. Scientists must learn to discern between useful and useless data. In this simulation, the value of each check is affected by the order in which it is selected, and by the relative importance placed upon it by the various group members. Individuals with strongly held opinions or with strong personalities may have a major effect on their group's opinions. This aspect of the activity illustrates that human values, biases and experiences can deeply influence science.

This lab is open-ended. There is not enough information to say with certainty what the storyline is and each new check may create more questions than answers. This is a dynamic of both this lab and science. In addition, the participants should recognize that not everyone reaches the same conclusion when observing the same data, and why that is.

Furthermore, this simulation encourages participants to equate the solving of a mystery with the search for scientific explanations. At the same time, this simulation reinforces the collaborative nature of science: scientists often work together to solve problems.

Finally, students may not notice this, but this "investigation" is *not* an experiment! Students seldom learn that great science can be done on events of the past, unobserved by anybody, and unrepeatable. Therefore, they must search for clues to explain a series of past events, looking for patterns and connections. This type of science is usually referred to as "historical science." When you are pointing this out (probably in post-lab discussion), ask students if they can think of any type of science that would be called "historical science." [Hopefully, students will think of forensic science (CSI), geology, paleontology, and astronomy. If not, give them hints!]

### Procedure

1. Arrange students into groups (four works well). Each group is given an envelope containing checks written by fictitious characters in a fictitious scenario (don't tell them this!). You can say something like "These envelopes contain a bunch of checks found in different drawers in the home of a family that no longer lives there." Tell students not to peek in the envelopes!

2. After reading the Lab Introduction, each team draws **four** checks from the envelope at random. Using the information on the checks, each group attempts to determine the circumstances that surrounded the writing of the checks. In other words, each group tries to come up with a storyline for the character(s) based on the information on the checks. This leads them to formulate their **tentative explanation #1** for the checks – or a "storyline" that fits the checks. [This could be called a "hypothesis" if you like, but it's recommended to *not* do this – yet. Some students may recognize the "tentative explanation" as a

hypothesis, but it's best to have them experience this explanation-building process before attaching a fancy word to it (hypothesizing). You can do this during class discussion (see their worksheets). Allow students to record this original tentative explanation.

3. Then, instruct them to reach in the envelope without looking, and randomly select **four more** checks from the envelope. If you like, you can contrive a situation in which students are detectives using some checks found as partial evidence in some sort of crime; after a period of time, some more checks are found, perhaps in another drawer of the evacuated house. Observe the groups for insights as to how the new information affects their previous storyline. Once again, allow each group to work until it appears that most have exhausted their individual lines of thought, and have recorded their **tentative explanation #2**.

4. Now each team should draw only **two** more checks and proceed as before, recording **tentative explanation #3**. After a few minutes, suggest that the different groups collaborate by sharing their information. The groups should realize that others may have one or two different pieces of data. Unused checks must stay in envelopes (in the real world, we *never* have ALL of the desired information).

5. At the conclusion of this "share time", ask each group to select its strongest hypothesis (likeliest storyline) and record this as their **final tentative explanation**.

6. After giving the groups time to formulate and record their final explanation, ask a group spokesperson to stand and report the group-selected explanation (storyline) to the class, so that all may hear different conclusions from similar data.

7. Lead a follow-up discussion on the value of **collaboration**, **tentativeness** of scientific explanations, the effects of **limited data**, and the influence of **personal biases** and **experiences** on their ideas and ultimate selection of a most likely explanation. Even if scientists have a strong explanation of a natural phenomenon, they can never be absolutely sure that new data won't eventually appear and show the explanation to be wrong. You might also use this experience as a springboard to a closer look at some of the criteria scientists use to determine which storyline (explanation) is "best" (probably closest to reality).

8. Also, again point out that this Checks Lab experience simulates the scientific process of investigating an unwitnessed historical event (or even pre-historical event), and tests hypotheses by looking for clues that could confirm or deny a given hypothesis, not by doing experiments.

9. Allow students to answer the Discussion Questions, individually, or (probably better) collaboratively within each team. If time runs out, they can finish this as homework (if they have individual worksheets). If they do this, give all teams a chance to share answers and come up with preferred "Team" answers.

10. When students have answered all (or most) of the questions, engage the class in sharing and discussing their answers, guiding their understanding toward the concepts generally indicated in the key (below).

Name\_\_\_\_\_

Period\_\_\_ Date\_\_\_\_\_

### THE CHECKS LAB WORKSHEET **KEY**

1. Tentative Explanation #1: [Any reasonable explanation that involves all selected checks is OK]
2. Tentative Explanation # 2:
3. Tentative Explanation # 3:
4. Final Tentative Explanation: [Don't tell students this, but there is no actual story here; all checks are fictitious. Therefore, the class can decide which team's explanation seems like the most likely one - for now. That's what scientists do!]

#### Questions for Discussion:

1. What bits of information on the checks were **valuable** to your group in formulating a tentative explanation?  
Students should notice and consider such things as dates (for sequence and season), whose checks they were, who signed each check, who the checks were made out to, the amount, and reason (if given).
2. What information was **useless**?
3. List any **misleading** information that was presented.
4. Why do we say that an explanation in science is "**tentative**"?  
[Something like:] Because new data/information may not fit previous explanation, so new one must be developed.
5. What 's another word for a "**tentative explanation**"? [Depending on age or experience, some students should recognize "Hypothesis" as the word for this.]
6. Could your **hypothesis** become a **theory**? If so, how? [Not all students may know this yet]  
Usually not directly. For a hypothesis to contribute to a theory, it must be tested (challenged) many times and be combined with other observations and tested hypotheses.
7. What's the difference between a **hypothesis** and a **theory**? [Not all students may know this yet]  
A hypothesis is a very tentative explanation, relatively untested, for something puzzling.  
A theory is a much better established explanation, based on tested hypotheses, and more observations.  
A theory is still "tentative," still subject to change, but less likely than a hypothesis. It's more durable.
8. Is your final hypothesis "**correct**"? Explain. [Not all students may know this yet]  
Hypotheses are never correct, but some are better than others. The best hypotheses must account for all known data, be logical, and be testable.
9. How could you "test" your hypothesis – i.e., what could you do to show your hypothesis is *not* correct?  
Look for more clues to see if they fit the current hypothesis, or not.
10. Besides science being **tentative** and scientists **collaborating**, what other characteristic of science not often realized did you experience? [Not all students may know this yet]  
Students may notice that bias, opinions and personal experiences do influence hypothesis formation.  
They may also recognize that hypotheses must be tested (challenged) to arrive at best hypothesis. They may also notice that this was not experimental. Scientists often have to use clues to figure out what happened in the past, and gather more clues to test those ideas.