Electricity Program of Study Reasoning Assessment: Explanations for Current Electricity Items

This document is part of an
Inquiry-based Science Curriculum from
The *Guided Inquiry supporting Multiple Literacies* Project
at the *University of Michigan*

Project Co-Directors:

Annemarie Sullivan Palincsar, Ph.D
Literacy and Special Education

Shirley Magnusson, Ph.D
Science Education

This project was supported, in part,
by the
National Science Foundation
Opinions expressed are those of the authors
and not necessarily those of the Foundation

Explanations for Items on the Reasoning Assessment about Current Electricity

Question 1: The important thing to notice is that this question asks how Kareem could see if *both* batteries have energy, implying that he will need to test them separately. For this reason, he will need to separately test each battery in a circuit with a light bulb to see if they each still have energy. If only one has energy, putting them both in a circuit or flashlight may still cause the light bulb to light. The "dead" battery will just act as a conductor, instead of an energy source. Putting different batteries in the flashlight may show if the flashlight itself is working, but still not show whether the original batteries still have energy.

Question 2: Answer choice c), "Electricity cannot flow through plastic", points out the important result of the tests shown in this question. It is a more general statement that simply saying that electricity cannot flow through the handle of a screwdriver. While "Electricity cannot flow through some circuits" is true, it does not get at the heart of the result of the test shown.

Question 3: In this question, all of the answer choices are correct. The students should understand that there are many reasons why a light bulb does not go on in a circuit. The batteries may be both out of energy. If the two batteries are facing the same direction, they will cancel each other out and the bulb will not light. If the light bulb does not have a good connection in its holder there will not be electricity in the circuit because there won't be a complete conductive path. Another reason why the circuit may not be complete is that the wires may not be connected at all points in the circuit.

Question 4: The purpose of this problem is to teach the students about how to use a brightness meter. For this question, the students are told that the number of layers of paper through which the light could last be seen is the brightness of the light bulb. So they should look in the table and see that the last time Ramone could see the light was with 3 layers.

Question 5: Answer choices a, c and e are all correct. Each of these choices presents a question that could be investigated with the brightness meter. Choice b is not a correct response as it presents a simple yes-no question that can be determined without the aid of a brightness meter. Choice d is also not a correct response as the question is not about the brightness and does not require measurement with a brightness meter to answer it.

Question 6: This question is designed to test whether students understand how best to put their data in a table for the purpose of examining those data. Answer choice a) does not give any information about what the numbers represent. Answer choice b) is not organized in a way that would be useful for seeing patterns. Answer choice c) shows the data listed in the way that she collected it, but it is not convenient for looking for patterns in the data. By listing the data in terms of increasing number of light bulbs, Helen can look to see if the brightness depends on the number of light bulbs.

Question 7: Choice d is the appropriate scientific notation. This is how a scientist would record the investigation so that others could look at and either critique or duplicate the investigation.

Question 8: This, again, is a question to test the students' ability to read a table.

Explanations for Items on the Reasoning Assessment about Current Electricity

Question 9: If you look at the data in the table you will notice that as the number of batteries in the circuit increases, the brightness increases as well. So you might think that choosing answer choice c) is the correct answer. However, answer correct choice d) has this same idea in terms of voltage, is which is a more general way to make that same claim. We try to make the most general statement we think we have evidence fore, when we state a claim. Answer choice a) is not an interesting claim. Answer choice b) is simply not applicable to the data presented in this problem – only one light bulb was used in the tests.

Question 10: Choice b is the correct answer. Since Jarod successfully completed the first observation, choices a and d are not correct. It is likely that Jarod added weakened batteries to his circuit.

Question 11: This question is testing to see if the student can read the table given for this problem.

Question 12: In this question, the students are asked to use the information given in the problem (the experimental set-up and the data) to determine what is the best claim. In this problem, the data shows that as each group added more light bulbs, the brightness decreased. So, answer choice c) seems like a good claim: With more light bulbs in a circuit, the light bulbs are not as bright. But, answer choice d) puts this same claim in terms of resistance, which is a better claim considering that it is the resistance of the filament of the light bulbs that causes the decrease in brightness. Answer choice a) is not an interesting claim, scientifically, and answer choice b) does not pertain to the data given in the problem.

Question 13: One important thing to notice in answering this question is that the brightness of Circuit A for Jada's group is 10 layers. This should be a tip off that Jada's group did not use enough layers since they stopped at the last layer on one brightness meter (each brightness meter has 10 layers). Also, a brightness of10 layers is significantly lower than the brightness of the other four groups, while their measurements for Circuit B and C are similar to the other groups. Thus they might have a measurement that is too low (another tip off that they should have used more than one brightness meter).

If they had used a brightness meter that was too narrow, they most likely would not have been able to block the light completely, and should have noticed this anyway. If the brightness meter had been missing sheets, they would have been more likely to over estimate the brightness, than underestimate it. If Jada's group had used thinner paper, they would have over estimated the brightness, not underestimated, compared to the other groups.

Question 14: Here the students are asked to examine four sets of circuits that could be used to test the idea: The brightness of a light bulb decreases as more light bulbs are added to a circuit. It is important for the student to recognize that, in order to test this idea the only thing that can change between each of the circuits used in the test is the number of light bulbs. Answer choice b) shows this – each of the three circuits has two batteries, but a different number of light bulbs. Answer choice a) changed the number of light bulbs, but it also changes the number of batteries at the same time, so this would not be a fair test. Answer choice c) shows multiple circuits for

the second and third tests which would not be useful in testing this idea. Answer choice d) changes the number of batteries, not the number of light bulbs.

Question 15: This question is similar to question 14, except we are now testing the idea: Adding batteries to an electric circuit increases the brightness of a light bulb in that circuit. Thus in this problem, the students need to pick out the set of tests that changes the number of batteries but not the number of light bulbs. Answer choice c) shows this.

Question 16: A diode allows current to flow in only one direction, in the direction that the schematic arrow points. Therefore, choice (b) is a correct response: the diode in Side B would allow current to flow from the bulb to the battery.

Question 17: Christa's model predicts that electricity flows from the battery to the bulb in both wires. The position of the diode in Side B would only allow electricity to flow if its direction were *opposite* to what is in Christa's model. Thus, if her model is correct, she would not expect the bulb to light, and the correct answer choice is (b).

Question 18: The diodes are placed in both wires to allow electricity to flow from the battery to the bulb. This is consistent with Christa's model, therefore choice (a) is a correct response.

Question 19: With two diodes in the circuit, if one or the other is placed in a direction that is opposite to the actual flow of electricity, the bulb would not light. Thus, when the bulb does not light, it is not possible to tell whether it is due to the diode on Side A, Side B, or both. Thus, the best answer choice is that there is not enough data to draw a conclusion at this time.

Question 20: The reasoning in Question 19 provides a clue to thinking about this question. As long as Christa keeps two diodes in the circuit, she will be unable to tell about the behavior of electricity until she tries all the possible arrangements of the diodes relative to one another, and analyzes the data together. Thus, her best next step is to simplify, and remove one of the diodes. That means that choices (b), (c), and (d) are all possibilities to consider. Choices (b) and (c) are quite similar, and either observation may lend support to her model. However, choice (d) is the best answer because it is very useful in problem solving to seek to rule possibilities out. Thus, Christa should test her model by trying a diode in a position that is *opposite* to her hypothesis. That way she will know by her initial data whether she needs to revise her hypothesis. The observation proposed in (d) is the only observation that could potentially provide such information, known as disconfirming evidence. If Christa conducted the test proposed in (d), and the bulb lit, she would have evidence that her model (or at least a part of it) was not correct. *NOTE: Christa's first idea, shown in the figure for Questions 16 and 17, is a better idea than her second idea, shown in the figure for Questions 18, 19, and 20.*