

RESISTANCE IN WIRE

Performance Standard 6C/6D.J

This task uses electrical resistance in a wire as a context for finding the constant of proportionality and applying it to a new situation using electrical resistance in a wire:

- *Mathematical knowledge:* determine the constant of proportionality and percentage of error between measurement and prediction.
- *Strategic knowledge:* set up the variation equation and apply the constant.
- *Explanation:* explain what was done and why it was done.

Procedures

1. ***In order to compute and estimate using mental mathematics, paper and pencil methods, calculators and computers (6C) and solve problems using comparison of quantities, ratios, proportions and percents (6D),*** provide students with sufficient learning opportunities to develop the following:
 - Set up and solve proportions for direct and inverse variation of quantities involving powers and multiple variables.
 - Determine the level of accuracy needed for computation involving measurements and irrational numbers. A technician may need to run an electrical circuit a very long distance. The type of wire, its diameter and the length of the wire are related to resistance. Resistance drops voltage and decreases current which means the amount of power supplied is not all delivered to the load at the other end of the circuit. If the technician knows the resistance between the source and load, he/she can find the amount of voltage that is not getting to the load and can either increase the power supplied or change the diameter of the wire to solve the problem.
2. Students are given a copy of the task to complete and submit. It is assumed that students have studied direct and inverse variation in single and compound situations. It is assumed that student have studied Ohms law for simple electrical circuits, have an understanding of resistivity of electrical conductors and have the ability to use a digital multimeter to measure resistance of a conductor. It is also assumed that students can size wire from the American Wire Gage (AWG) Table. For example: The students should be able to measure the resistance of a coil of sold telephone wire, using a digital multimeter and the following procedures.

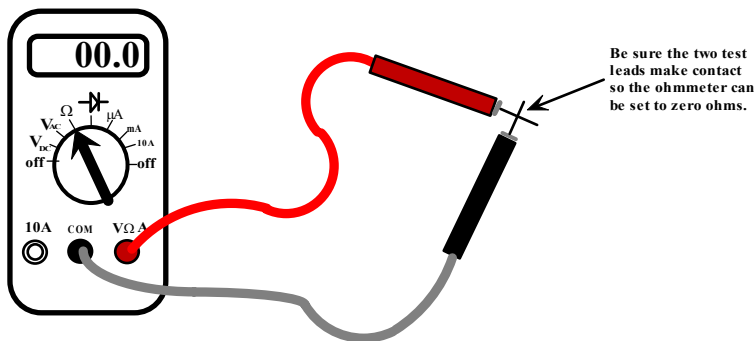


Figure 1*

1. Turn the function switch to ohm (Ω)
2. Set the ohms function to the lowest range.
3. Make contact with the two test probes as shown in Figure 1. The ohmmeter should read 00.0.
4. Make contact with the two test probes to each end of the sold telephone wire as shown in Figure 2.
5. Record your results.

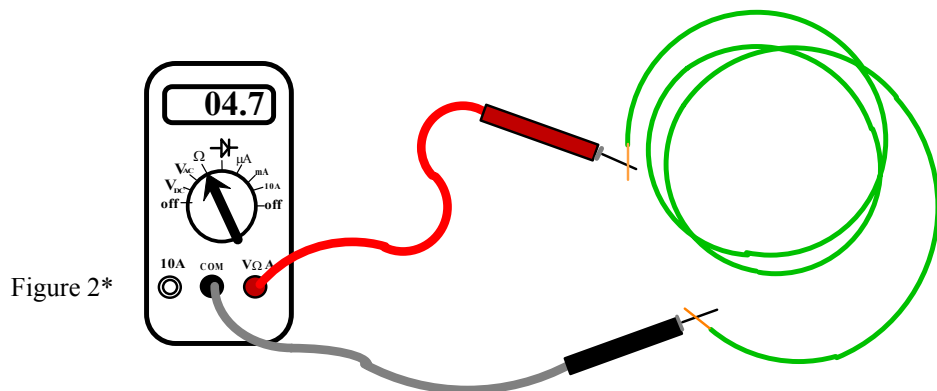


Figure 2*

*Permission to reprint requested.

3. Have the student complete the following task:
Resistance of a wire carrying an electrical current is directly proportional to the length and inversely proportional to the square of its diameter. You have been provided with two lengths of solid core telephone wire. Complete each of the following, explaining your procedures, any calculations and your accuracy as you complete each part.
 - a. Measure the length of each piece of wire, and record the measurement being as accurate as possible.
 - b. Measure the diameter of each wire using a Precision Vernier Caliper, and record your results.
 - c. Calculate the value of the constant of proportionality for each wire.
 - d. Using this information, predict the length of the larger diameter wire that will have the same resistance as the full coil of the smaller diameter wire.
 - e. Measure and cut that length of the larger diameter wire, and measure its resistance with the multimeter.
 - f. Calculate the percent of error present between your measured and desired resistance. Discuss why this error is present and what can be done to minimize this error in the future.
4. Evaluate the students' work using the mathematics rubric:
 - A 4 in mathematical knowledge would require a correct answer for the constant of proportionality for the given wire coil and an accurate measurement of the diameter of each wire. Using this information, the students will predict the length of the piece of thicker wire you will need to produce the same voltage drop as the thinner piece. It would also require the calculation of the percent of error.
 - A 4 in strategic knowledge would require a correct set up of the variation equations in part c and correct application of the constant, diameter and length to make the prediction in part d. It should also include information on the presence of error and how to minimize it.
 - A 4 in explanation would require a complete explanation of the process used and the reason for each step.

Examples of Student Work

- [Meets](#)
- [Exceeds](#)

Time Requirements

- Two class period

Resources

- Copies of the “Resistance in Wire” task sheets
- Access to a scientific calculator
- Digital multimeter
- Precision Vernier Caliper
- Two coils of sold telephone wire, between 50 to 500 ft.
- Wire cutters
- Mathematics Rubric

NAME _____ DATE _____

RESISTANCE IN WIRE

Student Task Sheet

Resistance of a wire carrying an electrical current is directly proportional to the length and inversely proportional to the square of its diameter. You have been provided with two lengths of solid core telephone wire. Complete each of the following, explaining your procedures, any calculations and your accuracy as you complete each part.

- a. Measure the length of each piece of wire, and record the measurement being as accurate as possible.
- b. Measure the diameter of each wire using a Precision Vernier Caliper, and record your results.
- c. Calculate the value of the constant of proportionality for each wire.
- d. Using this information, predict the length of the larger diameter wire that will have the same resistance as the full coil of the smaller diameter wire.
- e. Measure and cut that length of the larger diameter wire, and measure its resistance with the multimeter.
- f. Calculate the percent of error present between your measured and desired resistance. Discuss why this error is present and what can be done to minimize this error in the future.

MATHEMATICS RUBRIC

NAME _____ DATE _____

- Exceeds standard (must receive a 4 in each area)
- Meets standard (must receive all 3's or a combination of 3's and 4's)
- Approaches standard (must receive all 2's or any combination which may include a 3 or a 4)
- Begins standard (has no 3's or 4's but not all 1's)
- Absent (has all 1's and 0's)

	Mathematical Knowledge	Strategic Knowledge	Explanation
4	<ul style="list-style-type: none"> • Wrote the right answer. • Used math words correctly to show understanding of how math works. • Worked it out with no mistakes. • Used the right math words and labeled the answers. 	<ul style="list-style-type: none"> • Identified all the important parts of the problem, and knew how they went together. • Showed all the steps used to solve the problem. 	<ul style="list-style-type: none"> • Wrote what was done and why it was done. • If a drawing was used, all of it was explained in writing.
3	<ul style="list-style-type: none"> • Knew how to do the problem, but made small mistakes. 	<ul style="list-style-type: none"> • Identified most of the important parts of the problem. • Showed most of the steps used to solve the problem. 	<ul style="list-style-type: none"> • Wrote mostly about what was done. • Wrote a little about why it was done. • If a drawing was used most of it was explained in writing.
2	<ul style="list-style-type: none"> • Understood a little, but made a lot of big mistakes. 	<ul style="list-style-type: none"> • Identified some of the important parts of the problem. • Showed some of the steps used to solve the problem. 	<ul style="list-style-type: none"> • Wrote some about what was done or why it was done but not both. • If a drawing was used, some of it was explained in writing.
1	<ul style="list-style-type: none"> • Tried to do the problem, but didn't understand it. 	<ul style="list-style-type: none"> • Identified almost no important parts of the problem. • Showed almost none of the steps used to solve the problem. 	<ul style="list-style-type: none"> • Wrote or drew something that didn't go with the answer. • Wrote an answer that was not clear.
0	<ul style="list-style-type: none"> • No answer attempted. 	<ul style="list-style-type: none"> • No strategy shown. 	<ul style="list-style-type: none"> • No written explanation.
Score			