**Student Worksheet: Neutrino-detection issues? Time to tree-cruit!**

**Directions**: Read the online *Science News* article “[Forests might serve as enormous neutrino detectors](https://www.sciencenews.org/article/forests-neutrino-detectors-physics).” Then answer the following questions as directed by your teacher.

 **Before Reading**1. Electrons are an example of a “fundamental particle.” That means that you can’t break them down into anything smaller. And they’re small — about one-two-thousandth the size of a proton or neutron. The neutrino is another fundamental particle. How do you think the size of a neutrino might compare to a proton? Explain how you arrived at your answer.

2. Imagine you’re sitting next to a campfire with your eyes closed. You cannot see the fire, but you probably know it is there. Explain how at least two senses other than vision indicate the fire’s presence.

3. Consider the different ways scientists detect things invisible to our eyes. Give two examples of scientific tools or equipment that detect a force or some other such presence. State what each tool detects and give an example of a scientific discipline that might use such tools.

**During Reading**

1. In what way might trees act as “natural antennas?”

2. How do you think the “IceCube” Neutrino Observatory got its name?

3. What body of water will the Cubic Kilometre Neutrino Telescope study, once it’s complete?

4. Scientists aim to detect high-energy neutrinos, such as the tau neutrino. Explain the relationship between the tau neutrino and the tau lepton. How might the tau lepton help us to detect tau neutrinos?

5. Give one example of a question that scientists need to answer before they can determine whether this new tree-detecting method is plausible.

**After Reading**
1. Imagine you are a scientist who plans to investigate whether the proposed idea will work. The best place to start would be to pick one of the questions that need answering, as described in this article. Which question would you pick? Now summarize how you might design an experiment to address this question. Identify three variables that would be important to consider in this experiment. (Variables are factors that could change the outcome of an experiment, such as temperature.) Then, pick one of these variables and briefly explain how you might conduct an experiment that controls for this variable.

2. This article describes a scientific proposal, not a scientific study. Briefly describe how the goal of a proposal differs from that of a journal article presenting results of a scientific study. Which would provide more in the form of conclusions: a proposal or a study? Explain your answer.