GRADE 12 PHYSICS - BUILDING A LASER TRANSMITTER/RECEIVER

The following activity is relevant to SPH 4U, The Wave Nature of Light. The Scientific Investigation Skills expectation A 1.5 is fulfilled in the completion of this activity; especially the skill of controlling variables and adapting or extending procedures as required. Expectation A1.11 is fulfilled, as students document their ideas, plans and procedures.

INDEPENDENT PROJECT: BUILDING A LASER TRANSMITTER/RECEIVER

Skills
Learn to troubleshoot using simple tools such as an ordinary multimeter. Trouble-shooting involves examining cause-and-effect while controlling as many other variables as possible. It involves the process of elimination; for this reason complete, concise and accurate lab notes must be taken while trouble-shooting.

Safety
Wear safety glass while working at home, especially if you decide to solder connections. Use hand tolls, not power tools. Do not look directly into laser light.

Instructions outside a laser lab: *"Do not stare into the beam with your remaining good eye"*

Learn from other people
The internet offers websites where laser "enthusiasts" have already carried out investigations with dollar store laser pointers. Check them out.

Check the electric potential difference
Remove the batteries and then disassemble a dollar store laser pointer. Prepare or modify a battery holder that will allow you to place batteries of any type in series so that VT is the same

as the batteries you removed from your laser pointer. An AA battery holder taken from a kids' toy could be modified for your purposes.

Check the currant
Measure the current in the laser circuit while it is operating normally with the batteries supplied when purchased. The laser pointer will burn out if this current level is exceeded. You may have to buy or salvage an appropriately sized resistor to ensure this does not happen. Resistors are colour coded, so check the web to find out more.

Take the laser pointer apart
Using a pipe cutter (which is normally used to cut 1/2" copper plumping pipe), cut the tube away from the circuit board and laser source. When finished, the circuit board will still be attached at the anterior end and a small spring may extend from its posterior end. The switch can be modified as needed.

Examine the battery connections
On some models the spring acts as one electrode and the anterior part of the light source itself is the other electrode. The + and – electrodes may be stamped on the circuit board. Later, you will find that it will not be possible to solder to the plastic housing of the anterior part of the light source, so consider making a connection using hot glue applied over a small piece of electrical tape holding the connecting wire.

Connect the audio output transformer
Connect a black negative lead from the battery holder to the negative location on the circuit board. Connect the red positive lead from the battery holder to one of the 1.2 kΩ coil wires from the audio output transformer. If there are three wires, don't use the middle one which is a 600 Ω centre tap. Connect to the other 1.2 kΩ coil wire to the positive location on the circuit board. Temporarily cover the laser with a rag and safely test the laser at this point to see if it is able to operate normally. You will pay close attention to the current, so ensure that a multimeter can be included in the laser circuit.

Investigate the wires used in a set of dollar store headphones
Cut the headphone wire in about the middle. Carefully strip the insulation from each wire. Decide which wires should be twisted together so that the headphones will work to give mono instead of stereo sound. When satisfied, discard the headphones because it is only the plug that will be used.

Make the connections to the headphone plugs
Connect the 8 Ω coil wires from the audio output transformer to a cut plug. Install alligator clips on the cut plug from another set of headphones and connect the clips to the + and – terminals of a solar cell. You and several friends may share the same solar cell...that's why you're being asked to use alligator clips.

Test
While monitoring the current in the laser circuit, plug the receiver into the microphone input jack of a computer or portable stereo. With the volume control set VERY LOW, plug the transmitter into the headphone jack of an mp3 player or equivalent such as an inexpensive radio. Aim the laser at the solar cell and troubleshoot until your laser transmitter/receiver works effectively. Secure your device so that the transmitter and receiver are independent and mobile.

Experiment
Experiment with your transmitter/receiver and document its effectiveness and limitations.

The logbook
Prepare a logbook that outlines your problem solving strategies. Scientists and engineers are detail oriented and they document everything. Headings will include Date, Time, Challenge/Problem, Solution, and Effectiveness of Solution.

This logbook will be graded subjectively. Your mark will be lower if there are unnecessary ramblings or entries that seem fictional. Your teacher can also tell when all of the entries were faked the night before the logbook was due.
(25%)

The technical report
Prepare a maximum two page typed technical report that explains how each aspect of this device words (ask for permission to use more than two pages). Expand upon its overall effectiveness and its limitations as determined through your experimentation and careful record keeping. Be sure to include in your report how your understanding of this device can be extended to the real world, and how topics from our class are applied. Include a hand drawn schematic circuit diagram(s) that you have scanned and pasted into your document. Attempt to use the correct symbols. This report will be graded subjectively. (50%)

The final product
Bring your securely mounted and mobile laser transmitter/receiver to class so that the quality of your work can be evaluated subjectively. Your logbook entries should help your teacher appreciate your efforts. (25%)