Example Application
Juice from Juice: Berry Solar Cells
EYH 2012 Cornell University

I. *What is the main goal of your workshop? In 2-3 sentences describe what the participants should know, be able to do, etc., after attending.*

By constructing their own dye sensitized solar cells, students will gain a basic understanding of the processes and components necessary to generate electricity with sunlight.

Through controlled variation of solar cell components, measuring how such variations affect solar cell performance, and sharing these results with their peers, students will gain experience with the scientific method and the nature of scientific research.

II. *Please provide us with a bulleted summary of your planned activities during the workshop and the learning objectives for each one. We would like to use these to get an idea as to what the exact content of the workshop would be, please be as detailed as possible. Remember, you will have an entire hour.*

Workshop will consist of three parts:

1. Workshop leaders will describe basics of solar cells, including the role of each component in a berry solar cell. We will motivate this introduction by engaging participants as they arrive with observations about a working solar cell at the front of the room (block light and show that the cell stops working, etc).
(15 minutes total)

   Learning objectives: Students will be able to identify
   a. *Motivation for solar cells (clean energy; lots of sun to go around).*
   b. *Processes necessary for solar cell operation: light absorption, charge generation, charge separation, and charge collection.*
   c. *Components of berry solar cell that facilitate above processes: anthocyanine in berry juice (light absorption); TiO2 nanoparticles, I-/ I3-, and carbon layer (charge separation); indium doped tinoxide (ITO) (charge collection)*

2. Hands on assembly of solar cells (in small groups with workshop leaders).
(30 minutes total)

   a. Students discuss and choose a component of the solar cell to vary. (6 min)

      Possible parameters to vary include: Type of dye/berry (black, blue, and raspberry); type of carbon layer (soot vs. graphite); solar cell active area; amount of electrolyte; wavelength of irradiation (i.e. colored glass over solar cell; room light vs. sunlight); soaking time in berry juice.

Learning objective: Students will gain experience with the scientific method by hypothesizing which parameters could affect solar cell performance and choosing a parameter to vary while keeping other parameters constant.

b. Students will each construct a solar cell using the parameters discussed above. In general, solar cell construction follows these steps (based on a procedure used by the CCMR Education Office):

   i. Squish berries to collect juice. (4 min)
   ii. Soak TiO2 coated ITO electrode (premade by workshop leaders) in berry juice (10 min)
   iii. While electrode soaks in berry juice, determine conductive side of second ITO electrode and coat that side with carbon layer by either scribbling graphite pencil on electrode or by holding electrode over candle flame.
   iv. Assemble solar cell by clipping two electrodes together with binder clips and adding I -/I3- electrolyte between two electrodes. (4 min)

   Learning objective: Students will gain hands on lab experience!

c. Students measure performance of solar cell (open circuit voltage) with multimeter. (6 min)

   Learning objective: Students explore how/whether measurement technique can affect measured value (i.e. importance of taking measurement more than once).

3. Sharing and discussion of results
   (15 minutes total)

   a. Students will share their solar cell performance with the entire workshop by plotting the open circuit voltage of their solar cell on chalkboard chart to be maintained for all three workshop sessions. (We are envisioning y-axis = volts, x-axis = person, with shape and color of the point plotted representing the variables chosen.)

      Learning objectives: Students will gain experience communicating scientific results.

   b. Workshop leaders will conclude session by discussing broad similarities in students' experiments to solar cell research at Cornell.

      Learning objectives: Students will gain exposure to real research being done by real people (workshop leaders)!

III. *What prior knowledge (if any) do you expect the girls to have to complete your workshop?*

None; concepts will be explained as needed.

Previous exposure to Bohr model of atom wouldn't hurt.

IV. *What materials do you anticipate needing to obtain to make the workshop as interactive and engaging as possible?*

Workshop consists of students assembling a dye sensitized solar cell using berry juice as the dye.

Workshop preparation (TiO_2 coated conductive slides):

- TiO_2 nanoparticles (1 kg @ $47)
- Indium doped tin oxide-coated transparent slides ($0.50/slide, 2 slides/cell)
- Clear plastic tape (2 @ $3 = $6)
- Vinegar (donated by participants)
- Mortar and pestle (provided by research groups)
- Non- consumables needed for day of workshop:
- Demonstration solar cell samples (provided by research groups)
- Multimeters with alligator clips and point probes (provided by research groups)
- Tweezers (provided by research groups)
- Votive candles, matches (lent by CCMR)
- Graphite sticks (lent by CCMR)
- Containers and plastic forks for mashing berries (donated by participants)
- Consumables needed for day of workshop:
- Frozen berries (12 oz needed per workshop session @ $4 = $12)
- I^-/I_3^- solution
- Small binder clips ($8/144pk.)
- Isopropanol (70% rubbing alcohol, 2 @ $1.50 = $3)