Activity

Subject Area(s):	**Electricity, Power, Energy, Units, Rates**
Associated Unit:	***Nanotechnology and Electricity***
Associated Lesson:	***Ohm's, Battery Charge, Nanoreisen, Binary, Moore's***

- **Activity Title   :**   ***Powered by Fruit***

Grade Level:	**(6-8)**
Time Required:	**60-90 minutes**
Group Size:	**Classroom**
Summary:	***Students take prior lessons of electricity to construct their own battery from citrus fruits in order to power a broken calculator. The calculator is then used to answer questions regarding electrical properties of the fruit and system.***

Keywords:	**Electricity, Power, Energy, Units, Rates**

Educational Standards: [PA] *2.3.8B, 2.4.8C, 2.7.8BD, 3.1.7AE, 3.2.7BCD, 3.4.7AB, 3.7.7B*

Engineering Context: Batteries are one of the more important devices in today electronics market. They exist in items ranging from phones and cameras to vehicles. Their ability to store electrical charge makes them extremely versatile and valuable.

Materials List: Citrus Fruit (lemons, grapefruit work best), calculators, multimeter, gator clips, pennies, paperclips, aluminum foil, fruit powered worksheet.

Introduction/Motivation: *This is a great hands on experience for the kids after some lessons about electricity. The calculators have the batteries*

removed and the kids are told to fix them using the materials listed above. It really requires some thinking on their part and everyone has a good time.

Methods and Procedure:

1. ***First and foremost, the kids are not allowed to eat the fruit. Once connected, the copper from the pennies get into the acid of the juices and becomes toxic. The kids will get quite ill.***

2. That said, this is a real fun exercise. There is some necessary prep work for this. The dollar store should have plenty of very very cheap calculators (1.5V) which should be used for this. This is good for many reasons, mainly cost, and the fact you will destroy the calculators for the most part. Also, it would take an excessive amount of fruit to power anything more than a 2-3 dollar calculator. Once bought, follow these steps to prepare:

      a) Unscrew the back of the calculator. This should expose the circuit board.
      b) Remove the battery with the black and red leads; cut them with some scissors.
      c) Use the scissors or sharp blade to expose more of the wire so the clips work.
      d) Use a tiny piece of tape to help hold down the wire away from the battery, the   solder is cheap typically and the wires will break off completely with normal wear   and tear of a middle school kid.
      e) Put the screws back on the plate and shut the calculator.
      f) Leave one calculator in its original packaging (explained later)

3. At the grocery store, pick up any of the following citrus fruits:

      a) Lemons (you will need 3 per group)
      b) Grapefruits (you will need 2 per group)
      c) Limes (you will need 3 per group)
      d) Pineapples (I never tried it, but if you want to be exotic and have a group try)

4. The single unopened calculator can be opened in front of the class. To show that this isn't a magic trick, perform the same steps written above in front of the class. Beforehand you can turn on the calculator and do 9x9 or something to show it works. The cut the battery and show that it does not work. Their challenge is then to use the fruit and materials to make it work.

5. You will need as many penny/paperclip pairs per group as the fruit you gave them, so for lemons 3 pennies/3 paperclips. Since they lose everything I would make sure you have double that for each. They will also need one black and one red alligator

clip. Extra paper clips will help connect the fruits together along with one 8.5x11" or so size of aluminum foil.

      6. Students are asked to connect the gator clips to from the fruit to the calculator using the materials above. After the lesson about batteries, they should know that one clip needs to be attached to the penny (Copper) and one to the paper clip. Red goes with copper, black with the paperclip. I gave them quite a bit a time to work out different designs on their own. A diagram below shows you how grapefruit would actually work in series:
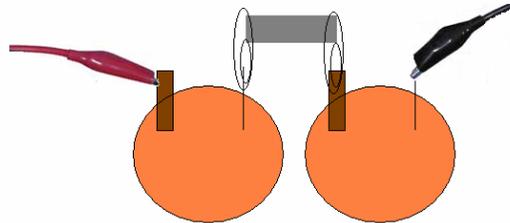
      In order to connect two grapefruits (or three lemons, etc), you will need to connect a paper clip to a penny using other paper clips and aluminum foil. This gives the electron charge a path to go through both fruit, increasing the amount of charge available to power the calculator.

      7. As students begin to work out their designs, it's important to have the multimeter (can buy one at Sears or any large hardware store) on hand to check the voltage through their fruit. As you know the calculator needs 1.5V normally, anything below say 1.15-1.25 won't work. You'll have to tell them to create a new solution. I would have the students write down their voltage on their worksheets and on the blackboard. A little competition to get the most voltage between groups really fuels them to work harder.

      8. A working design as shown above will most likely power the calculator with a dimly lit display. That's fine, the power is lower than normal batteries. If the calculator does work, have the students complete their sheets.

Assessment: *Questions follow at the end of the worksheet. Since this is such a tangible exercise I verbally asked many of the questions about their design and thought process. If your class keeps a notebook that a short write up concerning their design would be great.*

Attachments: Fruit Worksheet

References: N/a
Owner: Drexel University GK-12 Program

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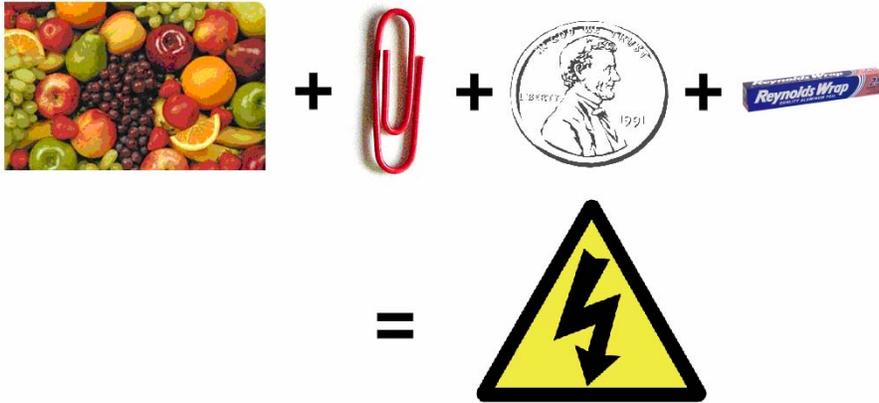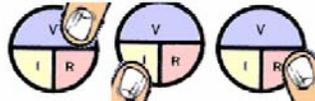betternano   date:

Name:_____

Group:_____

Powered by Fruit

Remember:

1. Figure out how to make the calculator work using only your fruit group, paper clips, pennies and some aluminum foil.

2. Use the multimeter to see how much voltage your fruit has:

   Fruit:_____   *Voltage*:_____

2. Try to connect to the calculator and see if it turns on or not. If no, back to the drawing board.

3. If your calculator works, use it to solve these problems.

Question 1: What is the percentage of your voltage compared to a fruit of a neighbor group?

Question 2: If I knew I could have .0064 amps going through your fruit, what is the resistance of your fruit?