

How to Make  
an LED-Illuminated  
Integrating Sphere for the  
Demonstration of Color,  
Vision, and Wavelength.

by  
Mark Helmlinger

[hellwinger@hotmail.com](mailto:hellwinger@hotmail.com)

## Integrating Sphere Parts List:

Sphere Sports Ball Pan (cake pan) from wilton.com or retail at Michael's.com  
Tool 2" dia. Carbide grit hole saw for ceramic tile  
Paint Rustoleum flat white spray paint  
Tape Scotch Super 33+ black electrical tape  
Epoxy JB Weld 5min 2-part epoxy  
Glue Clear hot glue (most common type)  
R LED superbrightleds.com 5mm clear epoxy RL5-R8030 Red LED or equiv.  
Use with 100 ohm resistor  
G LED superbrightleds.com 5mm clear epoxy RL5-G7532 Green LED or equiv.  
Use with 68 ohm resistor  
B LED superbrightleds.com RL5-B5515 or RL5-B4630 Blue LED or equiv.  
Use with 75 ohm resistor  
Holder mouser.com 12BH431-GR 3AAA cell holder or 3AA cell holder  
Switches mouser.com 108-0001-EVX SPST mini toggle switch  
Pots mouser.com 31CN301-F 1K linear potentiometer  
Knobs mouser.com 5164-1100 knob for 1/4" shaft  
Wood Oak, Teak, Mahogany, Ash work well  
Use 3/4" stock for base  
1/8" plywood for control panel

(& misc. other minor materials as described)



Sphere is made using a Sports Ball Pan used for baking cakes. This is what the box looks like - if buying retail, inspect for dents before purchase



## Integrating Sphere Prep

Use oil when drilling exit aperture

Use tapered reamer to size snug holes for LEDs



Be careful not to dent or scratch - aluminum is thin

Use a cardboard box as a spray booth - nothing should fall into the upended sphere halves



Apply many light coats - allow paint to dry to flat sheen before applying next coat



This is the stuff - actually any quality flat white spray paint will work



## Sphere Painting

Do not glue control panel onto base quite yet - this is how the parts fit together



Use hot glue to affix feet - and sign the bottom for posterity



Use hot glue quickly - do it like you mean it - hot glue works very well with unfinished wood

Mahogany plywood and Oak



## Base Construction



More parts

Drill holes for pots and switches in control panel



Leave room for wires at the back, room for knobs and fat fingers at the front

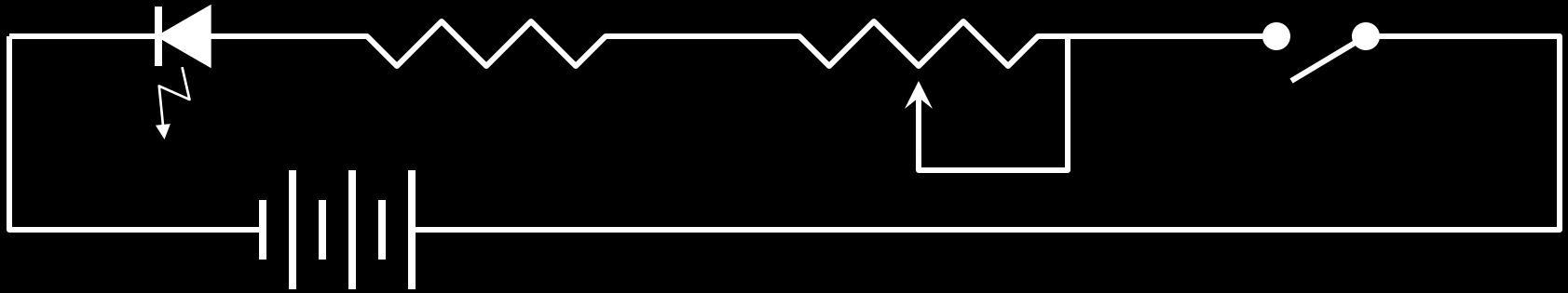
## Control Panel

Use hot glue to secure parts from spinning in the holes



Before inserting parts, label switch and potentiometer pairs - in this case, a stencil and pencil was used

DO NOT CONNECT LEDs DIRECTLY TO BATTERY  
(`Struth, you should know why this is so before attempting to build this project!)



Verify LED operation  
before prep

LED Prep

Above is the circuit diagram for the sphere. The LED has a nonlinear current response and will not be dark unless the current is full off - hence the switch. The 1K pot will produce a wide range of LED brightness. A 2K (or more) pot would only decrease overall sensitivity of adjustment. The fixed resistor limits max current through the LED - 20mA. The value used can be optimized by inserting an ammeter into the circuit and swapping various values. For full range of LED control, consider using a variable duty cycle circuit using a 555 IC.

Using a belt sander or file or sandpaper on a flat surface, sand the end of the LEDs flat - this acts as an optical diffuser and is very important

Do not get carried away - remove too much epoxy and you might break the cat's whisker

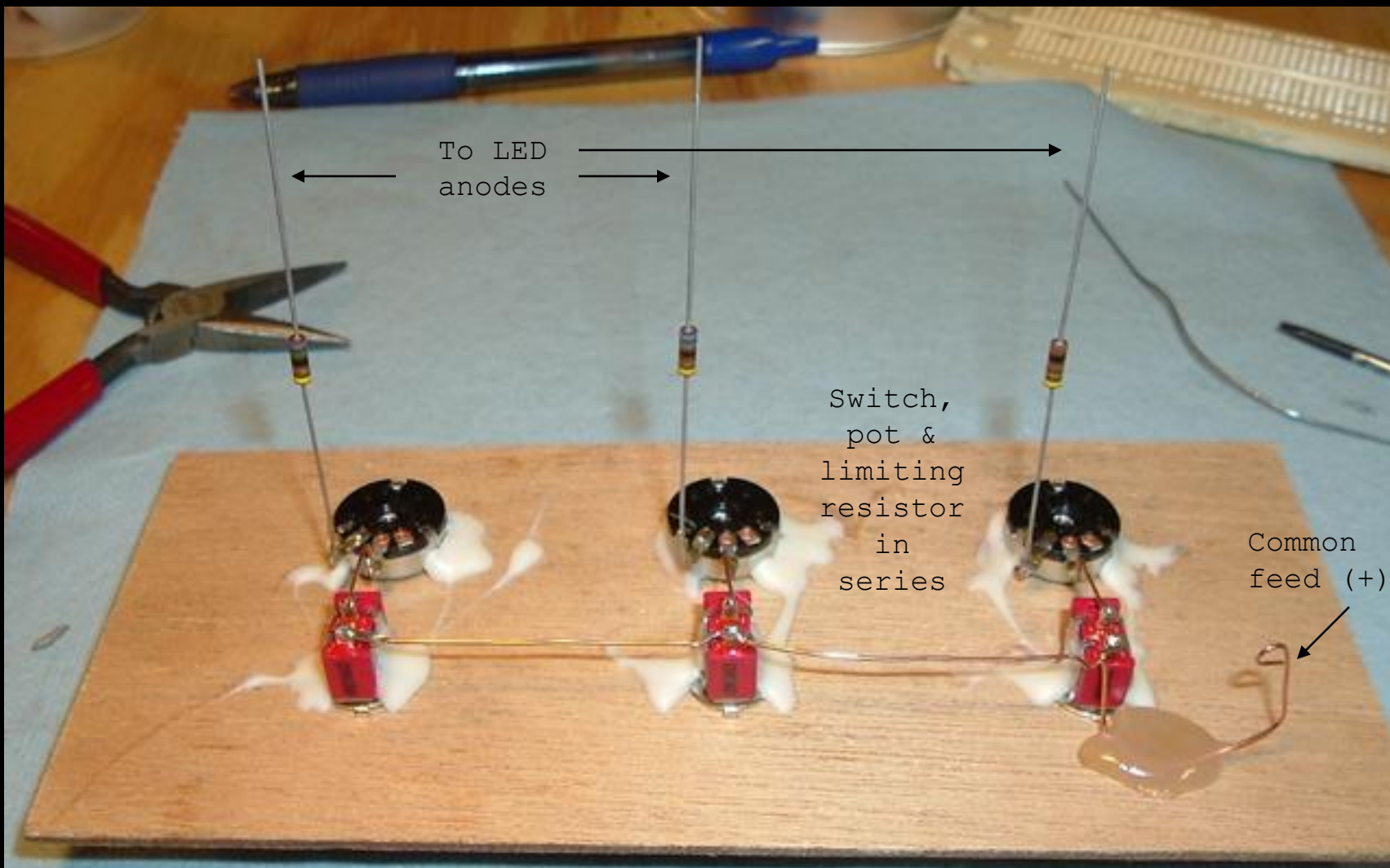
## LED Prep

Identify the anode (long lead for these LEDs)

Shown are before and after-sanding pairs



Before gluing panel, solder as many wires as possible - anchor with hot glue



To LED  
anodes

Switch,  
pot &  
limiting  
resistor  
in  
series

Common  
feed (+)

**Control Panel**

Some solder skill is required...

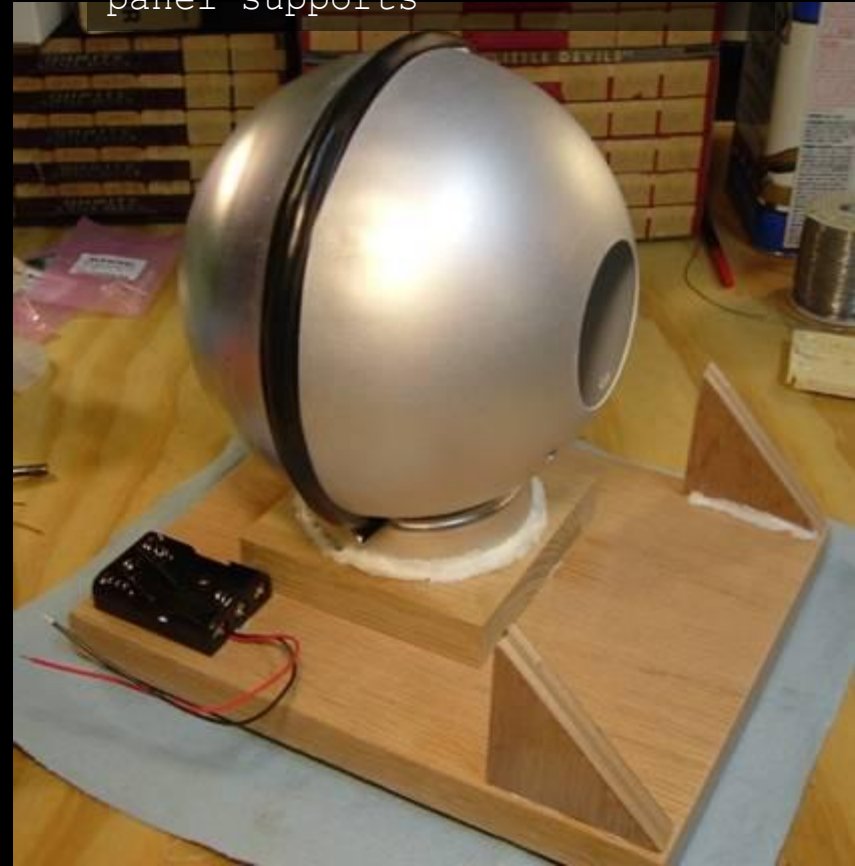
Use epoxy to glue two halves of sphere together - cover with electrical tape



Use base that comes with cake pan - notch accordingly



Attach battery holder and panel supports



## Sphere Assembly

In this case, a wood block was needed to clear the exit aperture over the top of the control panel

[hellwinger@hotmail.com](mailto:hellwinger@hotmail.com)

Insert LEDs with anode up



# LED Assembly

Use dark epoxy to glue LEDs in place with no light leaks

Solder negative battery wire to cathode common



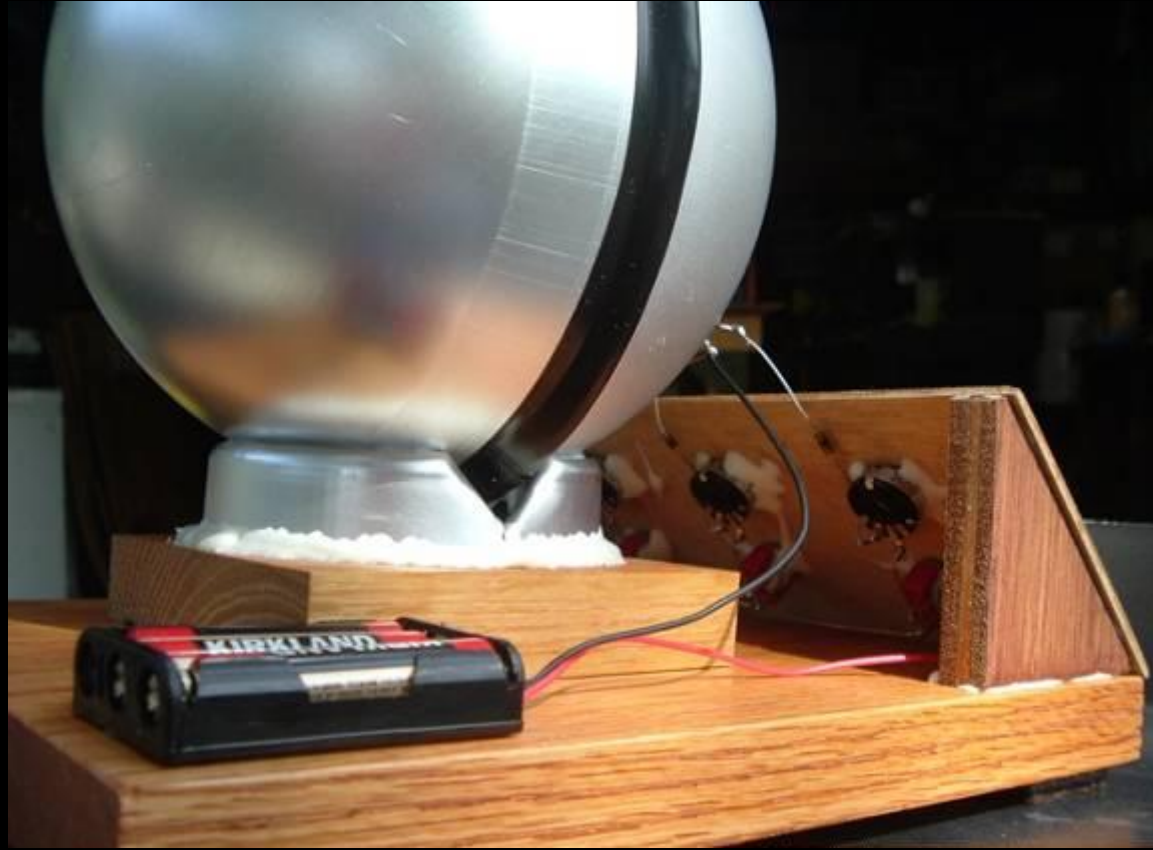
Battery (+) to be connected to panel

Cathode Common (-)

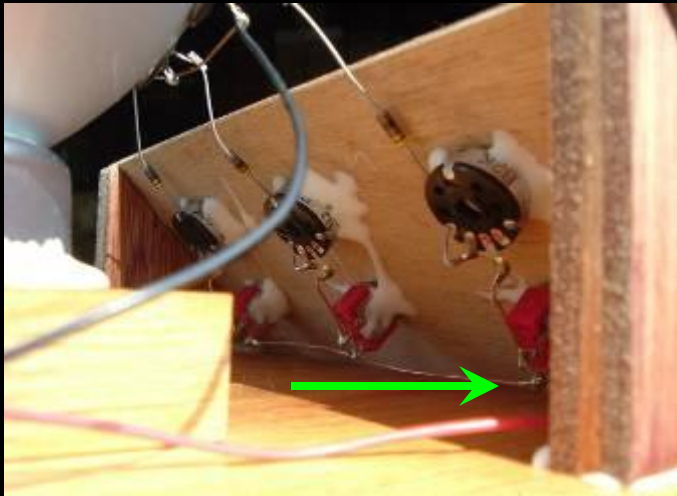
Glue panel on, solder resistors to LED anodes



## Final Assembly



Solder positive battery wire to common feed (green arrow)



This wooden base has been treated with teak oil - it's a nice finish - apply paint or stain to the wood after gluing

# Finished Project & Results



Red

Green

Blue



Magenta

Yellow

Cyan



White

There is no magenta, yellow, cyan or white colored LED inside. How do these colors appear?