Lumens without an integrating sphere.   
  
The correct way to measure total light output from a bicycle headlight   
or flashlight is with an integrating sphere:   
<<https://www.google.com/search?q=integrating+sphere&tbm=isch>>   
<<https://www.youtube.com/watch?v=mvyptpA-BmY>>   
These are not cheap, although they can be home built. There are also   
other ways to do it (lumen tube):   
<<http://s1074.photobucket.com/user/mrsdnf/media/stuff/IMG_3226.jpg.html>>   
<<https://www.youtube.com/watch?v=xOE1ykJ5WAU>>   
  
My method is far from accurate, but good enough for estimating and   
comparing the light output of flashlights and bicycle headlights. To   
make it work, you'll need a tape measure and a lux meter. I'm using   
this one:   
<<http://www.ebay.com/itm/381903904643>>   
It's main advantages are that it does auto ranging, has a max hold   
feature, and is cheap.   
  
First, the math:   
1 lux = 1 lumen per square meter.   
That means if I project a circular spot on the wall, with an area of 1   
square meter, the indicated brightness in lux equals the approximate   
lumens output, which can be read directly from the lux meter. Notice   
that it is NOT important to know the beam width or the distance   
between the light source and the wall.   
  
How big is a 1 square meter spot?   
Area = Pi \* radius^2   
For Area = 1 square meter the radius of the spot is:   
r = sqrt(1/Pi) = 0.564 meters   
The diameter of the spot is 1.12 meters (44 inches).   
  
Find a darkened room with a suitable wall, and put two pieced of   
masking tape on the wall separated by 1.12 meters (44 inches). Notice   
that the wall does not need to be flat or painted white. Half way   
between the two markers, hang the lux meter.   
  
To measure, turn on the lux meter and punch the max hold button. This   
will display and hold the highest reading. Start well back from the   
wall, turn on the flashlight, and slowly move towards the wall until   
the edge of the light spot lands on top of the two markers. Turn off   
the light and read the meter. The meter reading in lux will be equal   
to the lumens output of the flashlight or bicycle headlight.   
  
I bought various flashlights on eBay and tested them at maximum   
brightness with new batteries.   
This one claims 5000 lumens but delivers 200 lumens.   
<<http://www.ebay.com/itm/322447023467>>   
This one claims 300 lumens but delivers 97 lumens.   
<<http://www.ebay.com/itm/391639378962>>   
This one claims 6000 lumens, but delivers 212 lumens.   
<<http://www.ebay.com/itm/201457081072>>   
  
There are plenty of problems with this method. Putting the lux meter   
at the center of the circle causes the meter to favor lights with hot   
spots in the middle. A properly designed bicycle light or flashlight   
should have an even and equal brightness distribution across the spot   
on the wall, but this is rarely the case. I'm working on a more   
accurate way to measure and calculate the average light output.   
Probably, it will be measuring the light in the center and along the   
edge, and taking an average or estimating the total based on a   
gaussian light distribution. Or maybe not putting the lux meter in   
the center of the circle. That's for later.   
  
Another error is the color temperature of the light. LED's come in a   
variety of color temperatures. The lux meter has a different   
sensitivity at each of these colors where the sensitivity curve   
follows the sensitivity of the human eye.   
<<https://image.slidesharecdn.com/ivanperrepresentationfor24-141008071626-conversion-gate02/95/pls-2014-is-measuring-led-illuminance-with-a-lux-meter-accurate-19-638.jpg>>   
Comparing lights with different color temperatures will be a problem.   
  
There is also a problem in dealing with the 1 square meter area when   
the spot is not a perfect circle, but rather an ellipse as in many   
bicycle headlights.   
Area = Pi \* major\_axis\_radius \* minor\_axis\_radius   
This can be easily measured, but will be different for each headlight   
with an elliptical beam pattern and will therefore be a bit more   
complicated to measure.