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# Light Intensity Analysis Using Smartphone's Light Sensor

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**Abstract.** Light is a form of electromagnetic energy radiation emitted in the visible part of the spectrum. This study was aimed to analyze the intensity of dynamic train light that moves constantly on a linear track using a smartphone light sensor. The method used in this research was the experimental method. The light sensor application used is available freely in the Physics Toolbox Suite on the smartphone. Experimental equipment was built using linear tracks, dynamic trains, flash light and lamp. Light sensor output produces luminosity (Ev) value versus time (s). The experimental results show that the light intensity at 3 volts with a distance of 5, 10, and 15 cm are 100, 250 and 300 cd, respectively. Whereas the intensity of light at 4.5 volts, the intensity of the light at distances of 5, 10, and 20 cm are 800 cd, 950 cd and 1200 cd, respectively. It is expected that the use of smartphones can increase students' interest in learning physics concepts.

## 1. Introduction

Light is a form of electromagnetic energy radiation emitted in the visible part of the spectrum. According Kapucu (2017) and Sans (2017) that there are several terms in light, namely: (a) Light current (luminous flux) i.e. the amount of light emitted in all directions by a light source per unit of time (usually per second), measured by Lumen. (b). Luminous intensity i.e. the amount of light emitted by a light source in a particular direction, measured by Candela. (c) Illuminance i.e. the amount of light current that arrive in one unit of the field, measured by Lux or Lumen / m<sup>2</sup>; the process is called illumination, which means the arrival of light to an object. (d). Luminance i.e. the intensity of light emitted, reflected and passed on by one unit of the illuminated field, measured by Candela / m<sup>2</sup>; while the process is called lamination, that is the departure of light from an object [1], [2]. Because of the importance of light analysis, measurement of light intensity needs to be done. One of the ways to analyze the light intensity of an object is by using smartphone technology.

Smartphone technology is a technology that can produce information and information for all fields, one of which is the field of education [3]. The impact given from the development of this smartphone is the change in the educational process related to the learning media used during classroom instructions. According to Sans (2017), smartphone can make it easier for students to understand the concept of a lesson [2]. Several studies are related to the use of smartphone for classroom learning media, for example (a) acceleration sensors have been used to analyze radial acceleration [4], Measuring the speed of sound in air [5], Detecting interferences with iOS applications to measure speed of sound [6], free and damped harmonic oscillations [7] the rolling motion of a hollow cylinder [8], Measurement of the magnetic field of small magnets with a smartphone: a very economical



laboratory practice for introductory physics courses [9] and impulse [10]; (b) ambient light sensors have been proven to measure the intensity of LED light using constant dynamism trains [11] and simple or damped oscillation motion analysis [2,11]; and (c) the magnetometer sensor measures the value of gravitational acceleration using a magnetic pendulum and a smartphone magnetometer [12]. Recently another team also reported that magnetometer sensors can measure and analyze the average speed of a car that is in constant motion [13,14]. A recent study in advanced physics has also succeeded in measuring the magnetic field due to the current of the coil carrier [15]. However, measurements of light intensity with different voltage sources and distance have not been made. This study aims to analyze the intensity of light with variations in voltage and distance. To determine the intensity of the light, we have used a smartphone light sensor.

## 2. Method

### 2.1 Analytical Approach

Photometry is the study of the measurement of the amount of light. The light in question is visible light, which is one type of electromagnetic wave. Electromagnetic waves have the intensity of light, which is a basic measurement in physics that states the power emitted by a light source in a certain direction per unit angle. The International Unit (SI) for light intensity is Candela (Cd). The standard definition for 1 Candela is the intensity of light in a specific direction from a light source with a frequency of  $540 \times 10^{12}$  Hz with radiants intensity in the direction of  $1/682$  watts per steradian. Measuring instruments that are often used to measure light intensity include light meters, luminance, luxmeter, etc. To measure the intensity of the light the following equation is used [14,16]:

$$I = \frac{\Phi}{\omega} \quad (1)$$

where  $I$  is Light Intensity,  $\Phi$  is Light Flux and  $\omega$  is the angle of space. If in one experiment the lights are in a device that moves away from the object, then the inverse square law can measure the relationship of lighting ( $E_v$ ) and intensity ( $I_v$ ) as follows [2].

$$E_v = \frac{I_v}{d^2} \quad (2)$$

where  $d$  is the distance from the light source.

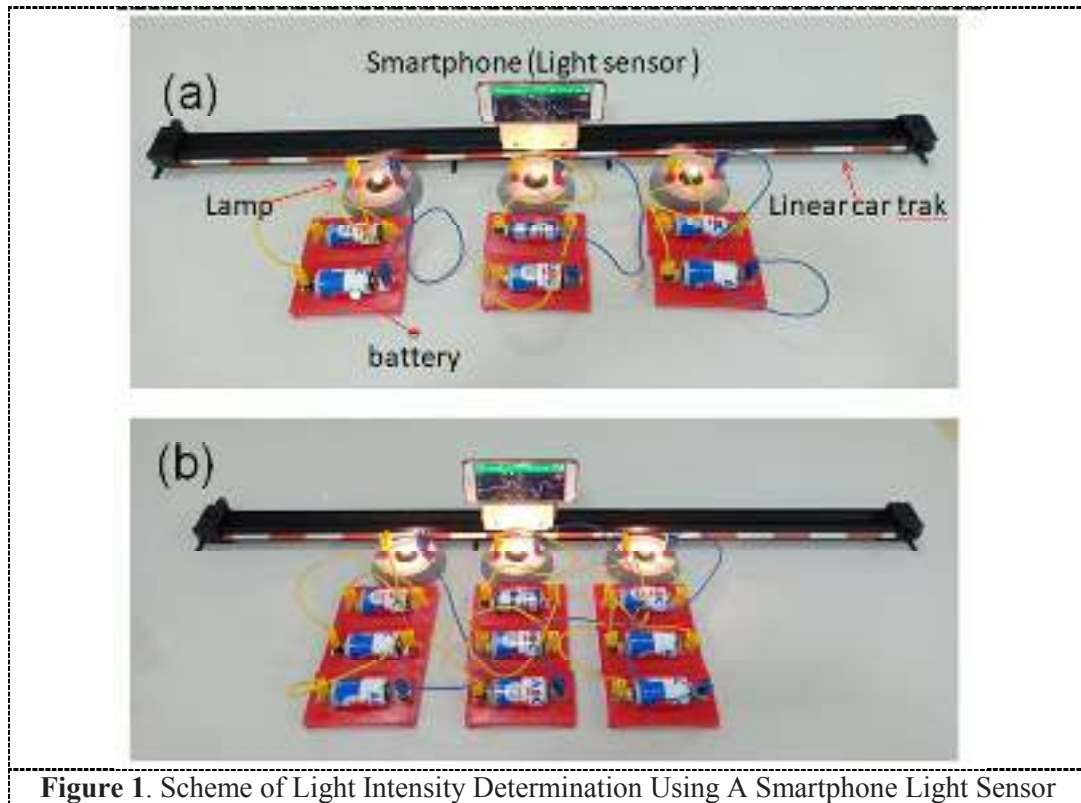
### 2.2 Experimental set up and measurements

**Tools and Materials:** The tools and materials used in the study include: mobile phones that have been installed with the application "Physics Tollbox Light Sensor" (Vivo Y55 S), Precision rails (Pudak Scientific), rail connectors (Pudak Scientific), rail legs (Pudak Scientific), pinned stacks (Pudak Scientific), dynamics train (Pudak Scientific), 1.5 volt 2.5 Ampere light source (GEC Light The Way), voltage of 1.5 volt, 3.0 volt, and 4.5 volt (ABC Battery and Panasonic), connecting cable (Pudak Scientific), battery holder (Pudak Scientific), lamp holder (Pudak Scientific), masking tape (Davis), scissors and ruler. Data were collected at the Physical Education Laboratory of Sriwijaya University, Palembang.

**Research Procedure:** The application used is Physics Toolbox Light Sensor, which is obtained for free on smartphone. Smartphone light sensors are very sensitive to light because it is designed to increase and reduce the brightness of the user's smartphone screen so that it aims to lower its power consumption and make the user's eyes comfortable.

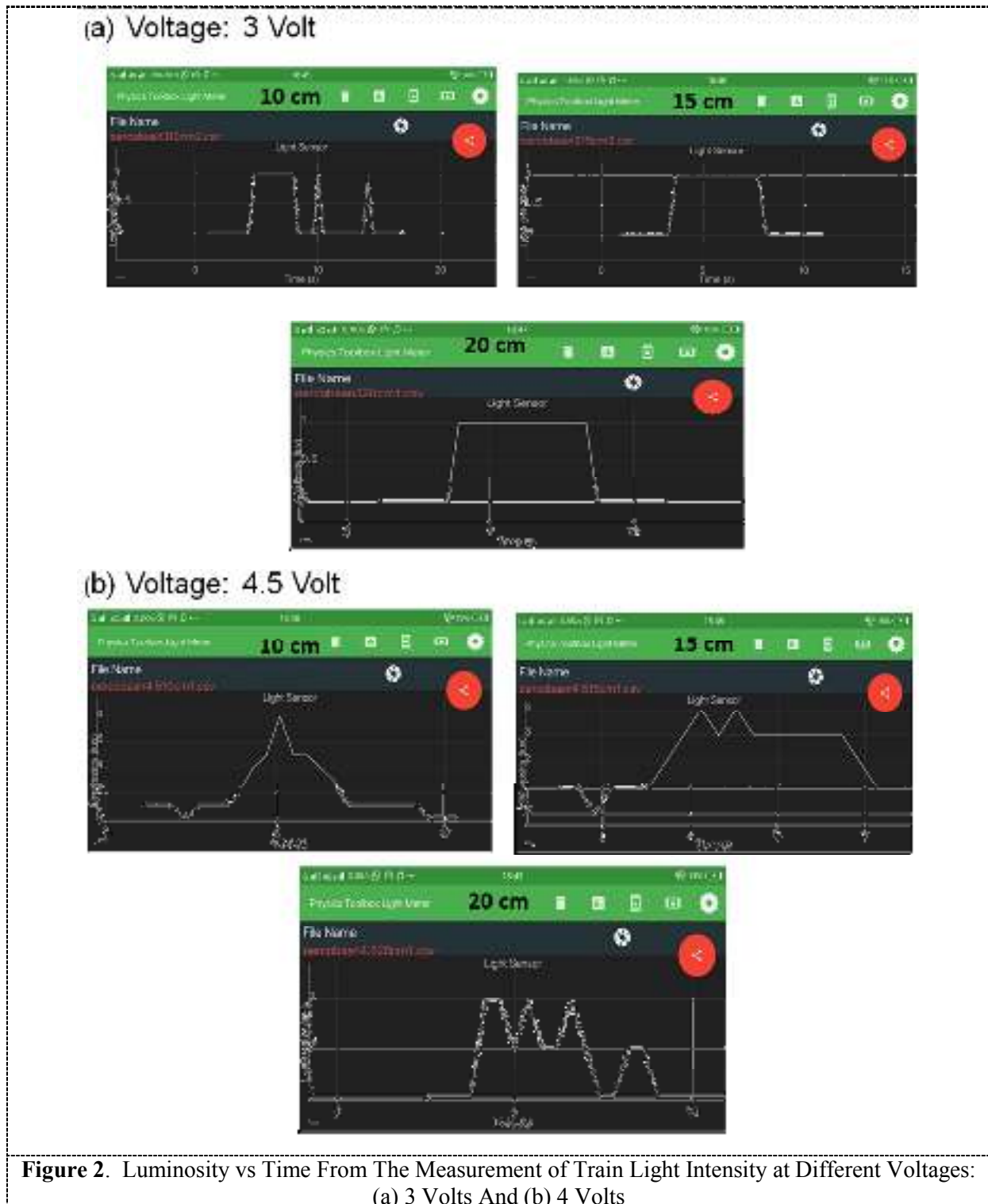
The scheme for determining the amount of light intensity using a smartphone light sensor is shown in Figure 1. The experimental equipment was built using a train track that was 2 meters long. Dynamics and smartphone trains were placed on a straight rail (track), while two light sources with different voltages of 3 Volts and 4 Volts were turned on and mounted next to the rail at a distance of 10 cm, 15cm and 20 cm. A dynamic car was glued together with a smartphone. When a dynamic car and smartphone ran with a constant speed linearly and passed through a light source, the smartphone light sensor would measure the value of luminosity ( $E_v$ ) versus time (s). The luminosity value

increased when passing a light source with a greater voltage. To analyze the intensity of light on a dynamic train with boarding speed, luminosity data was used. The physics equation used is equation 2.



### 3. Result and Discussion

The intensity of the light with different voltages of 3 Volts and 4.5 Volts at distances of 10,15, and 20 cm are determined using a smartphone light sensor which is obtained for free. The smartphone's light sensor output displays the luminosity (Ev) value versus time (t). Smartphone light sensors measure luminosity (Ev) every 0.5 s, but because the time is so short, the luminosity (Ev) value taken is at its highest peak. This is consistent with previous research that measured light intensity with constant voltage and distance sources. Smartphone light sensor output is shown in Figure 2. It can be seen that when a light source with a greater voltage is passed through the train and smartphone light sensor, the peak luminosity (Ev) versus time (t) is greater. This is due to the intensity of light proportional to fluk (lum) and electrical energy. The greater the electrical energy is given, the greater the intensity of the light would be. This corresponds to physics equation  $I = E/(A.t)$ , where I is the intensity of light, E is Electric energy, A is the surface area of the object and t is time [17], [18], [19], [20] .



To measure light intensity with different voltages, the equation  $I_v = E_v \cdot d$  [2,3] is used. At the 3 Volt voltage source, the illumination value recorded by the Physics Toolbox Light Suite is between 0-1 lux. The obtained intensity of light ranges from 100 candela - 400 candela. While at 4.5 volts, the illumination is recorded at 0-8 lux and the intensity of the light is passed by a dynamical train with a speed of about 800 candela - 1200 candela. These results are shown in Table 1 and Table 2. It is clear

that the amount of light proportional to the intensity of the light. The greater the light flux (lum) results in greater intensity of light.

**Table 1.** Measurement of Dynamic Train Luminosity on Linear Tracks With 3 Volt Voltage

Distance (d)	10 cm	15 cm	20 cm
Luminosity (Ev)	1 lux	1 lux	1 lux
Light Intensity (Id)	100 cd	225 cd	400 cd

**Table 2.** Measurement of Dynamic Train Luminosity on Linear Tracks With A 4.5 Volt Voltage

Distance (d)	10 cm	15 cm	20 cm
Luminosity (Ev)	8 lux	4 lux	3 lux
Light intensity(Id)	800 cd	900 cd	1200 cd

#### 4. Conclusion

This study showed that the light intensity from different voltages can be measured with a light sensor from a smartphone. These results showed that the light sensor from a smartphone can be used to measure light intensity. The experimental results showed that the light intensity at 3 volts with a distance of 5, 10, and 15 cm is 100, 250 and 300 cd, respectively. Whereas the intensity of light at 4.5 volts at distances of 5, 10, and 20 cm are 800 cd, 950 cd and 1200 cd, respectively. The results showed that the greater the fluk of light (lum), the greater the intensity of light is obtained. Hopefully this activity will be used by a teacher or lecturer to add the use of smartphones for learning in classroom or in the laboratory.

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