EXPERIMENT TEST – PART 1

Total time: 120 minutes (02 parts)

Printed name: ……. *ID:* ……

Instructions:

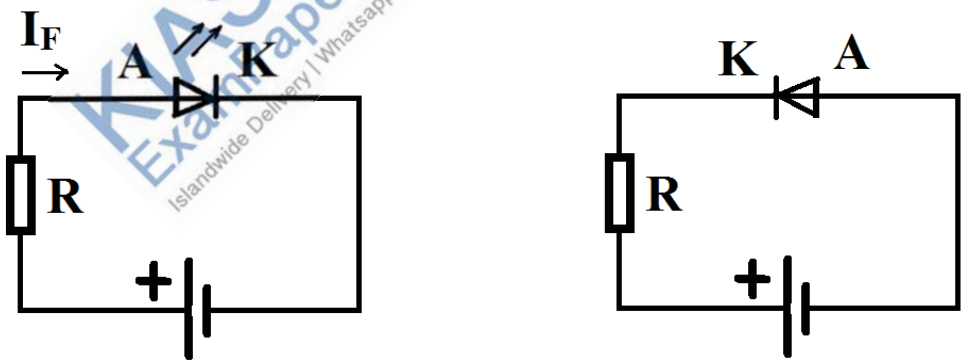
- Do not open the test booklet until you are told to do so.
- Be sure that your name and ID are written on spaces provided.
- **Only write your answers in the ANSWER SHEET provided.**
- Use blue / black pens or pencils to write your answers.
- Diagrams are not drawn to scale. They are intended as aids only.
- After the contest, the invigilator will collect all the contest papers.

Lighting in 21st century

The Nobel Prize in Physics 2014 was awarded jointly to three scientists who invented the efficient X – color[1] light-emitting diodes (LED) in the early 1990s. Their inventions were revolutionary because they triggered a fundamental transformation of lighting technology which has enabled bright and energy-saving white light sources. Incandescent light bulbs lit the 20th century, but the 21st century will be lit by LED lamps.

THEORY

LED is a two-lead semiconductor light source. One lead is called “anode” - A and “cathode” - K for the other. The LED allows the flow of current in the forward direction from anode to cathode and blocks the current in the reverse direction (figure 1). When a suitable voltage is applied to the leads in forward direction, the LED will be lit with a monochromatic light. Minimum voltage which applied to turn LED on is called “threshold voltage”.



a) Forward current (light on) Reverse current (light off)

Figure 1: How LED turns on

Physicist has found that wavelength is inversely proportional to the threshold voltage.

[1] You have to find out what color is X in this experiment.

Table 1: Wavelength of some colors

Color	Wavelength - λ
Purple	400nm-435nm
Blue	435nm-480nm
Patina	480nm-490nm
Blue green	490nm-500nm
Green	500nm-560nm
Yellow green	560nm-580nm
Yellow	580nm-595nm
Orange	595nm-610nm
Red	610nm-750nm

Note: 1 nanometer (nm) = 10^{-3} micrometer = 10^{-9} meter (m)

White LED is a standout of the special LED. It is the combination of X - color LED and yellow phosphoric material coating in a single package. The X - color light is generated by LED, one part of this light travels through the phosphor layer and others are converted into yellow light in the phosphor layer. The X - color and yellow light combine to generate white light. Therefore, the threshold voltage of white LED is equal to that of X - color LED.

Objective

Assume that the threshold voltage and the wavelength λ of LED have a relation as follow:

$$V_{threshold} = \frac{k}{\lambda}$$

Where, *k* is a constant with all types of LED.

In this experiment, candidate will determine what color is X, and the wavelength of X - color LED.

Materials

1 Digital Multimeter

2 1 pair of Multimeter leads (red and black)

3 LED experiment box

4 PVC tube that may be used to blocks the ambient light (if needed)

Attention: Do not look at LED light too long to avoid eyestrain

Procedure

Assemble the circuit:

(1) Check the LED experiment box: Set all switches to "OFF" position, gently adjust potentiometer P1 counterclockwise until end.

(2) On the multimeter, rotate clockwise the selection knob to "V" position to measure the potential difference, you could see "DC", "AUTO" and "V" on screen as shown in figure 2.

Figure 2: Multimeter

(3) Plug two multimeter's leads into terminals signed + and – (red to "+" and black to "-") on the LED experiment box.

(4) Set switch S1 to "ON" position

(5) Set switch A to "ON" position

(6) Gently adjust potentiometer P1 clockwise until LED A emits light, record the color of emitted light to the table 2.

(7) Slowly adjust P1 counterclockwise or vice-versa to find the position where the LED begins to emit light. Record the multimeter reading to the table 2. Repeat this step three times. You can use the PVC tube to block out the ambient light if needed.

(8) Set switch A to OFF position and gently adjust potentiometer P1 counterclockwise until end.

(9) Repeat steps 5 to 8 with LED B, C, D and E

If you are done, set all switches to OFF position, gently adjust potentiometer P1 counterclockwise until end and turn off the multimeter.