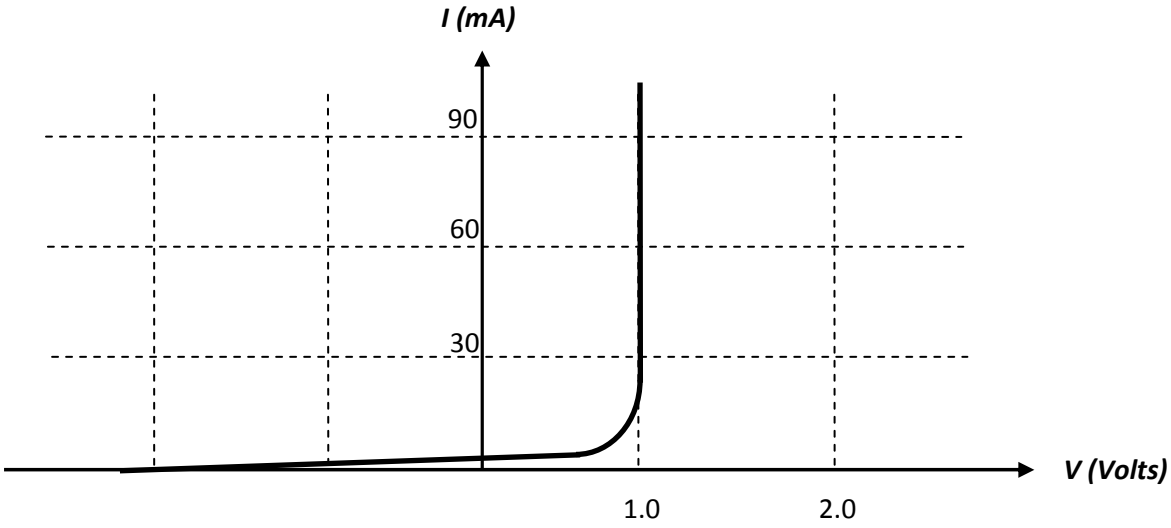
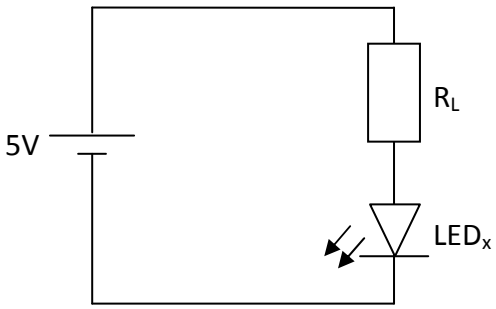
Exam Style Questions – Photonics

The following information relates to questions 1-2

The following graph shows the I-V characteristics of a particular light emitting diode (LED_x)



The LED is placed in the circuit below.



Question 1

Calculate the current through the LED if the resistance of R_L is 2 kΩ

4 V across the resistor

$$\boldsymbol{I = \frac{V}{R}}$$

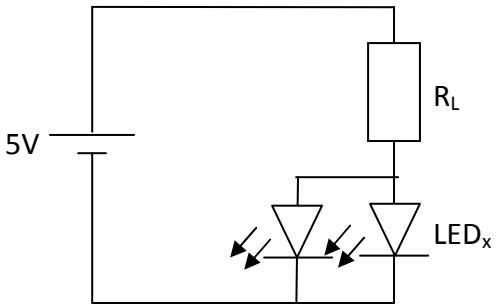
$$\boldsymbol{I = \frac{4}{2 \times 10^3}}$$

$$\boldsymbol{I = 0.002\ A}$$

$$\boldsymbol{I = 2\ mA}$$

2 marks

A second identical LED is placed in parallel with the first LED



Question 2

Will the light output of the first LED increase, decrease or remain the same? Justify your response.

The light output of the first LED would decrease.

Both LED's would have voltage drop of 1 V across them.

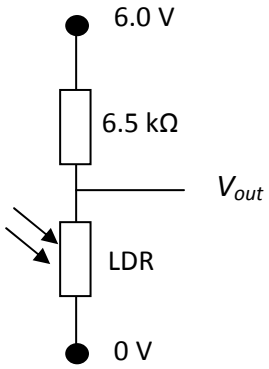
Leaving 5 Volts across the Resistor which means 2 mA of current being drawn from the battery

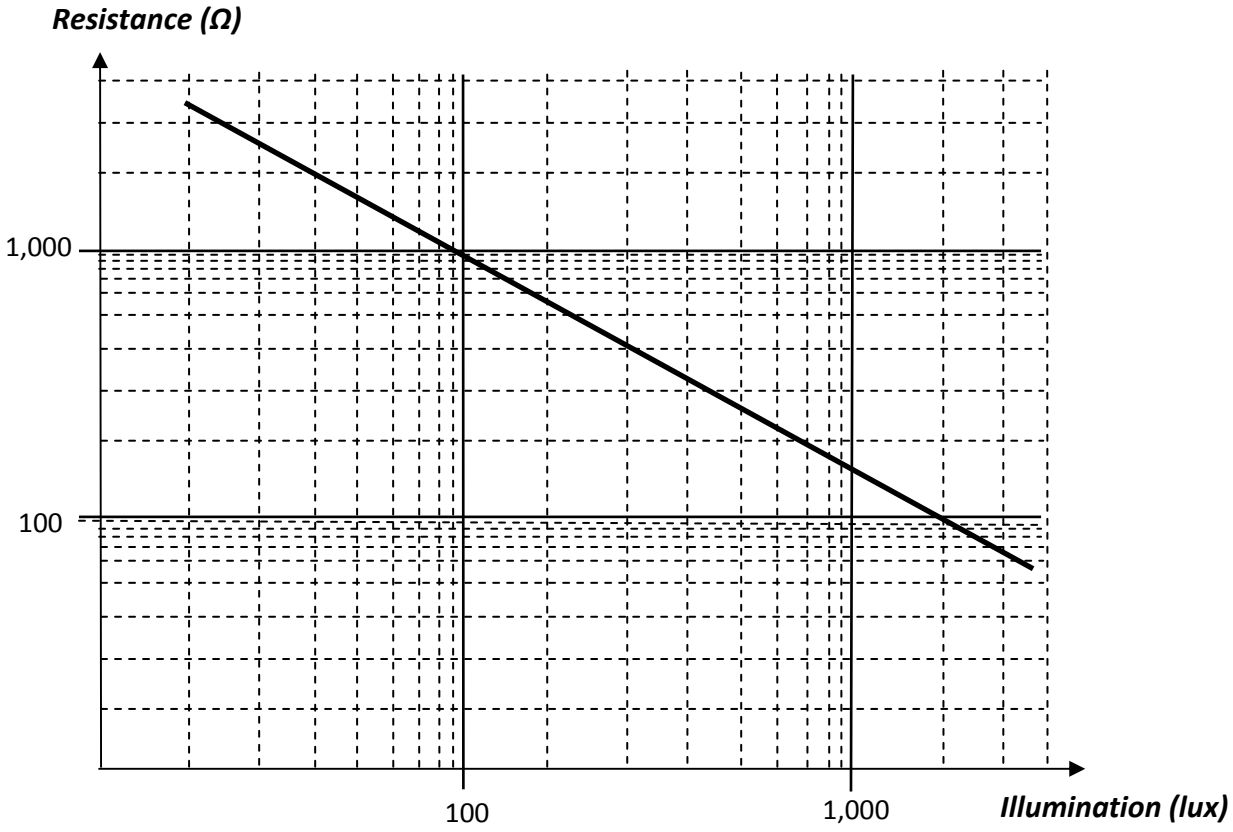
Since that current is split between both LED's, only 1 mA is through both LED's.

3 marks

The following information relates to questions 3-4.

A light dependant resistor is connected in series with a 6.5 kΩ resistor to form a voltage dividing circuit. The circuit and the illumination – resistance characteristics of the LDR is shown below.





Question 3

What is the resistance of the LDR when the illumination is 300 lux.

400 Ω

1 mark

Question 4

Determine the illumination when the V_{out} is 1.41 V.

$$\boldsymbol{R_{LDR} = \frac{R_1 \times V_{in}}{(V_{in} - V_{out})} - R_1}$$

$$\boldsymbol{R_{LDR} = \frac{6.5 \times 6}{(6 - 1.41)} - 6.5}$$

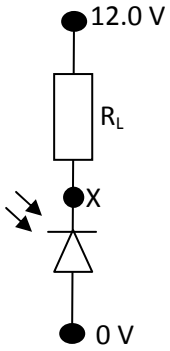
$$\boldsymbol{R_{LDR} = 2.0\ k\Omega}$$

From the graph, 40 Lux

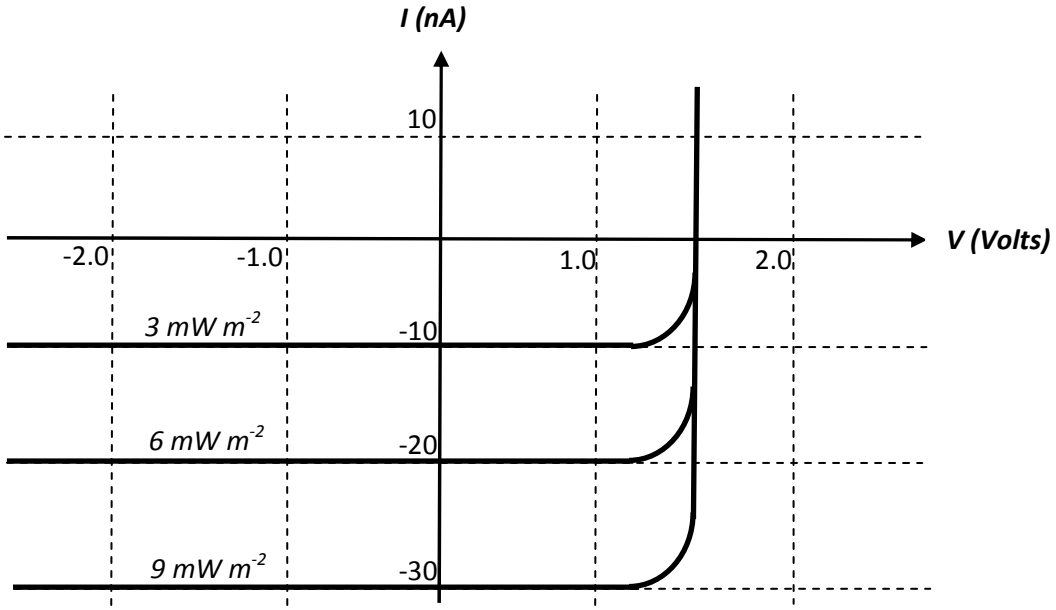
3 marks

The following information relates to Questions 5 - 7.

A photodiode is placed in series with the load resistor as shown in the diagram below.



The following graph shows the I-V characteristics for the photodiode is shown below.



Question 5

Is the photodiode in photoconductive or photovoltaic mode?

Photoconductive Mode

Question 6

Calculate resistance of the load if we measure the light intensity at the photodiode to be 9 mW m^{-2} and the voltage between point X and earth is 5.0 V.

$$\boldsymbol{R = \frac{V}{I}}$$

$$\boldsymbol{R = \frac{7}{30 \times 10^{-9}}} \qquad \boldsymbol{R = 2.3 \times 10^{8}\ \Omega}$$

3 marks

Question 7

What is illumination of the photodiode and if the potential difference across the load is 2.33 V.

$$\boldsymbol{I = \frac{V}{R}}$$

$$\boldsymbol{I = \frac{2.33}{2.3 \times 10^{8}}}$$

$$\boldsymbol{I = 1 \times 10^{-8}}$$

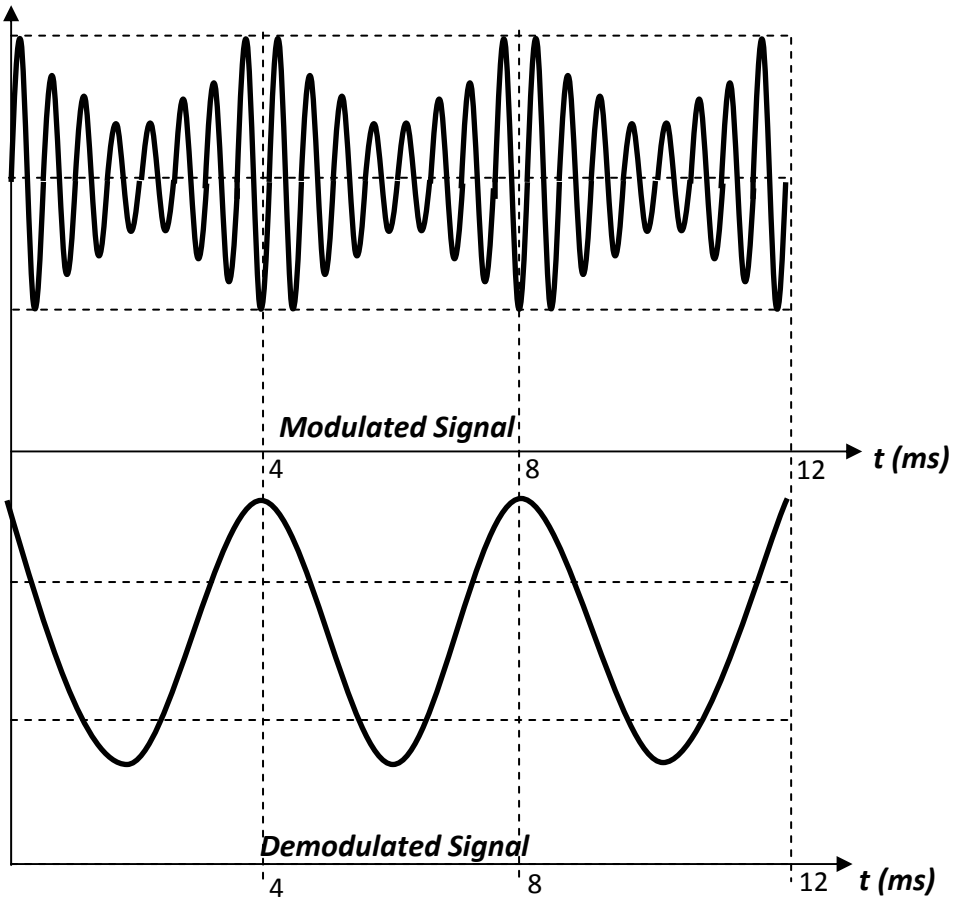
$$\boldsymbol{I = 10 \times 10^{-9}}$$

From graph, illumination is 3 mW m^{-2}.

3 marks

The following information relates to questions 8 and 9.

The graph below represents an optical carrier wave that has been modulated by a sound wave.



Question 8

In the space provided above, sketch the corresponding demodulated signal.

2 marks

Question 9

What is the frequency of the sound wave?

$$f = \frac{1}{T}$$

$$f = \frac{1}{4 \times 10^{-3}}$$

$$f = 250 \text{ Hz}$$

2 marks