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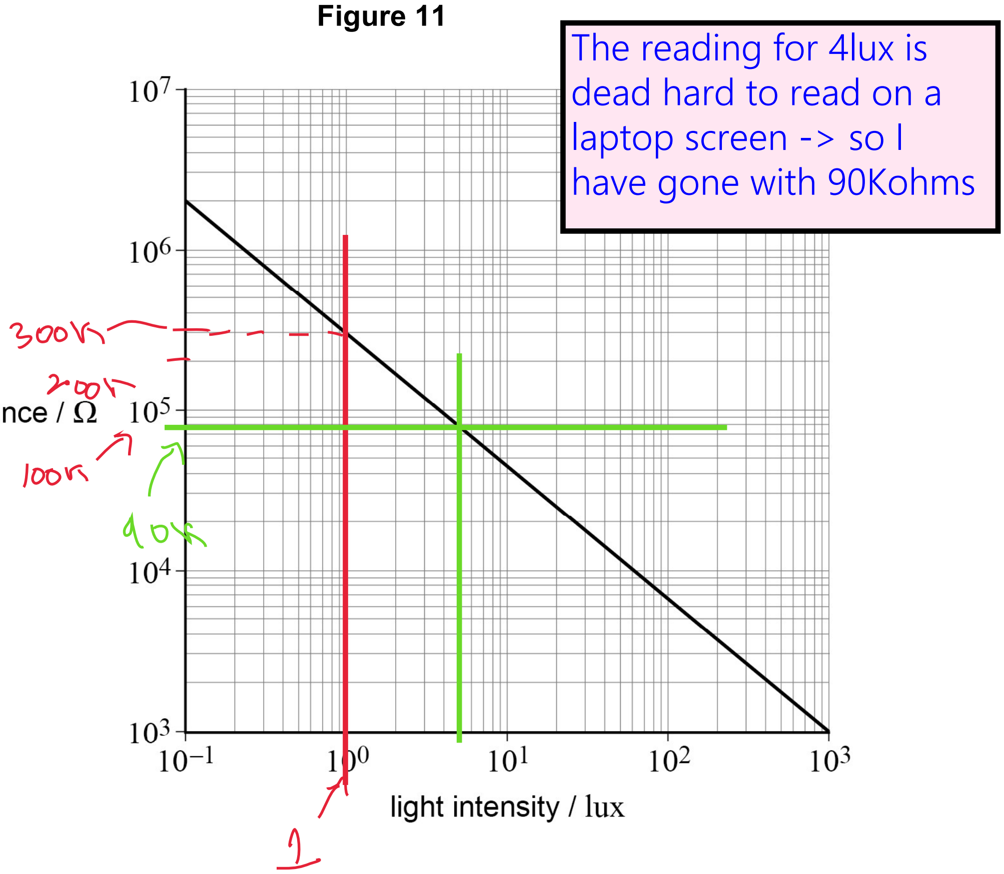
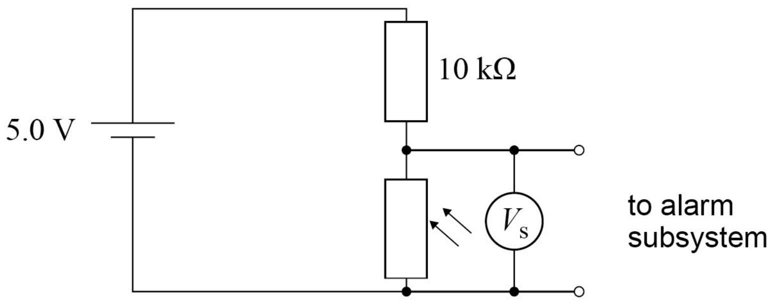
0 6 **Figure 11** shows how the resistance of an LDR varies with light intensity.

Figure 11



The LDR is used as part of an alarm system in a dim room. **Figure 12** shows one proposal for a sensor circuit for this system.

Figure 12



The power supply to the sensor has an emf of 5.0 V and a negligible internal resistance. A negligible current is drawn from the sensor circuit by the alarm subsystem.

A light beam illuminates the LDR. When the light beam is broken the LDR is not illuminated by the light beam. This causes the alarm to sound.

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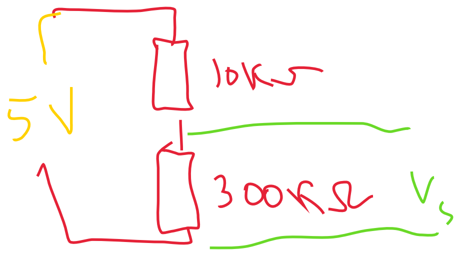
Table 3 shows how the light intensity at the LDR changes.

Table 3

	Light intensity / lux	R
LDR illuminated by light beam	4.0	90 kΩ
LDR **not** illuminated by light beam	1.0	300 kΩ

0 6 . 1 Show that the current in the sensor circuit when the LDR is **not** illuminated by the light beam is approximately $16\ \mu A$.

[2 marks]



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

$\frac{5}{310 \times 10^3} = 1.6 \times 10^{-5} = 16\ \mu A$

0 6 . 2 The alarm sounds when the potential difference V_S across the LDR changes by more than 25% of the power supply emf.

Discuss whether the circuit shown in **Figure 12** is suitable.
Support your answer with a calculation.

[3 marks]

$V_{S\,dark} = \frac{300}{310} \times 5$ $\qquad V_{S\,light} = \frac{90}{90+10} \times 5$

$4.8\ V \qquad 4.5\ V$

$\Delta V = 0.3\ V$ this is less than 25% of emf (25% of $5\ V = 1.25\ V$)

END OF SECTION A

5

Turn over ▶

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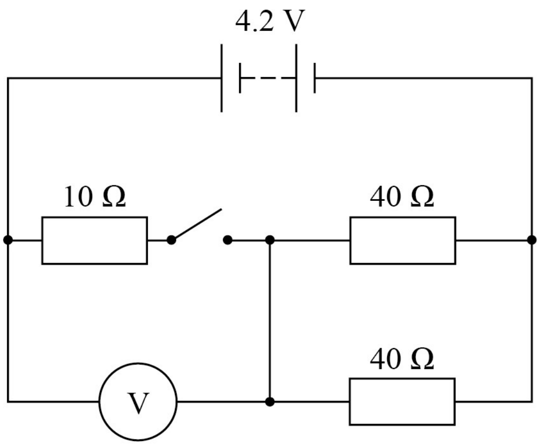
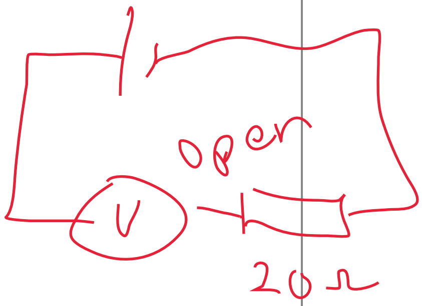
2 7 The battery in this circuit has an emf of 4.2 V and negligible internal resistance.





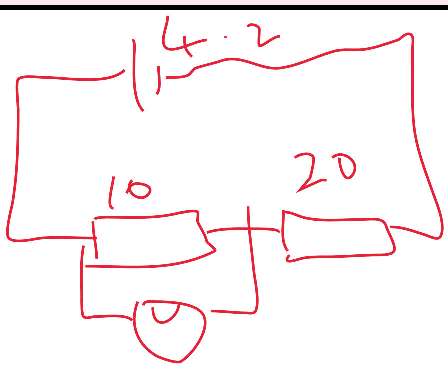
What are the readings on the voltmeter when the switch is open (off) and when the switch is closed (on)?

[1 mark]

	Open	Closed	
A	0 V	2.1 V	⬭
B	4.2 V	2.1 V	⬭
C	0 V	1.4 V	⬭
D	4.2 V	1.4 V	☒

Open is 4.2V because the voltmeter has an extremely high resistance and is connected in series with a 40s in parallel - it therefore takes all the voltage.

Closed. The two 40s are in parallel making a 20ohm. This twenty is in series with a 10ohm. Voltmeter is over the 10 so now we have a potential divider:



$$V_0 = \frac{4.2 \times 10}{10 + 20} = 1.4\,V$$

Turn over ►

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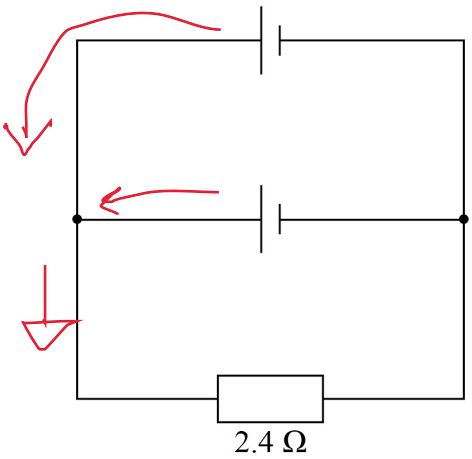
2 8 Two identical batteries each of emf 1.5 V and internal resistance 1.6 Ω are connected in parallel. A 2.4 Ω resistor is connected in parallel with this combination.



What is the current in the 2.4 Ω resistor?

[1 mark]

A 0.38 A

B 0.47 A

C 0.75 A

D 0.94 A

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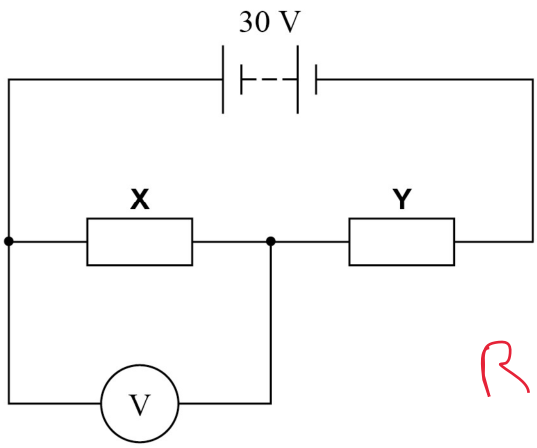
2 9 Two resistors **X** and **Y** are connected in series with a power supply of emf 30 V and negligible internal resistance.
The resistors are made from wire of the same material. The wires have the same length.
X uses wire of diameter d and **Y** uses wire of diameter $2d$.



$R = \frac{\rho L}{A}$

$R = \frac{\rho L}{\pi r^2}$

$R \propto \frac{1}{r^2}$

What is the reading on the voltmeter?

[1 mark]

A 10 V

B 15 V

C 20 V

D 24 V

radius y is twice radius x
Ay is 4Ax

So Ry is Rx/4

ie resistance of Y is 1/4 times resistance of x.

Rx=4Ry

$V_0 = V_{in} \frac{R_x}{R_x + R_y}$

Sub in $4R_y$ for R_x

$V_0 = V_{in} \frac{4R_y}{4R_y + R_y} \Rightarrow V_0 = V_{in} \frac{4R_y}{5R_y}$

$\therefore V_0 = \frac{30 \times 4}{5} = 24V$

Turn over ►