Section 2 - Output Devices

Identifying Output Devices

1. Which of the components in the list below are output devices?

bulb thermistor relay thermocouple solenoid loudspeaker
dynamo LED LDR buzzer motor microphone

2. Which output device could be used in a central locking system of a car?

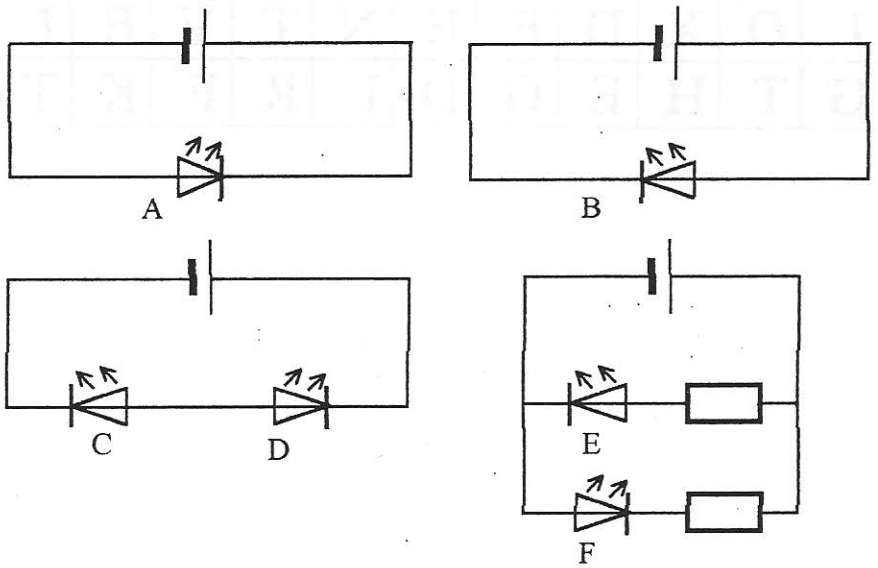
3. What would be an appropriate output device for a public address system?

4. Select an output device which could be used to raise and lower blinds automatically in a luxury flat.

5. Which output device is useful for digital displays on hi-fi systems?

The Light Emitting Diode (LED)

1. Which of the following LED's will light?



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Helpful Hint

When working with LED circuits you can use the equation:

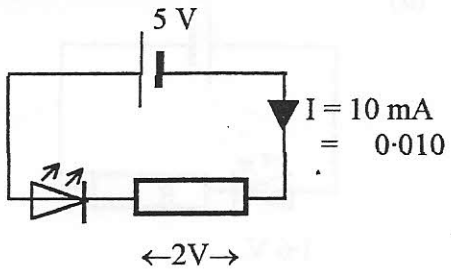
$$\mathbf{V = IR}$$

When applying this equation remember that the **supply voltage is shared** between the *LED* and the resistor.

Example

A certain LED takes a current of 10 mA and the voltage across it is 2 V. What should be the value of the series resistor when a supply voltage of 5 V is used?

1st. Sketch the circuit



2nd. Calculate the voltage across resistor R.

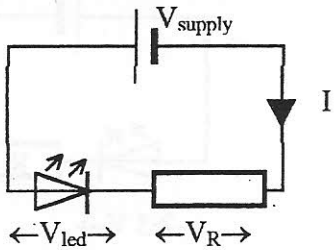
$V_R = V_{supply} - V_{led}$
$= 5 - 2$
$= 3$ V

3rd. Apply V = IR to find the value of R

$V_R = 3$ V
$I = 0{\cdot}01$ A
$R = ?$

$V_R = I R$
$3 = 0{\cdot}01 \times R$
$R = 3 / 0{\cdot}01$
$\mathbf{R = 300\ \Omega}$

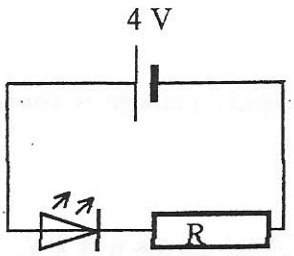
2. Use the stages outlined above to find the missing values in the following table.



	V_{supply} (V)	*Voltage across LED* (V)	*Current* (A)	*Voltage across R* (V)	*Resistance of R* (Ω)
(*a*)	6	2·0	0·010		
(*b*)	12	2·0	0·010		
(*c*)	8	1·8	0·016		
(*d*)	20	1·6	0·008		
(*e*)	4	1·5	0·020		
(*f*)	11	2·0	0·012		

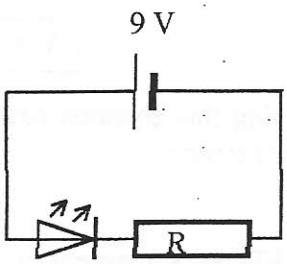
3. For each of the following circuits calculate the value of the series resistor which will enable the LED to operate at its ideal voltage and current.

(*a*)



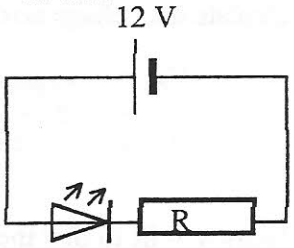
2·1 V,
10 mA

(*b*)



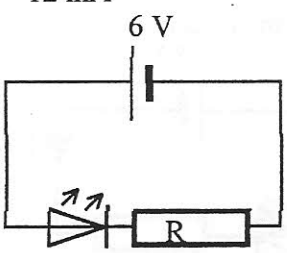
1·8 V,
12 mA

(*c*)



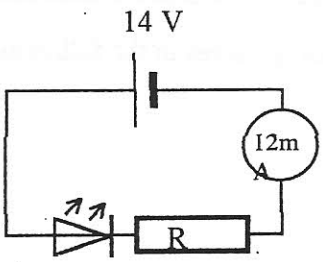
2·2 V,
10 mA

(*d*)



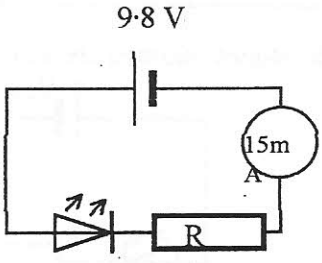
1·6 V,
11 mA

(*e*)



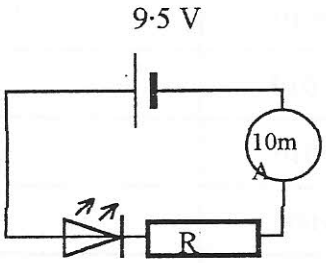
←2 V→

(*f*)



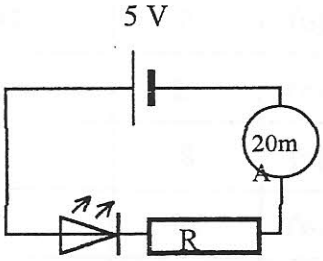
←2·3 V→

(*g*)



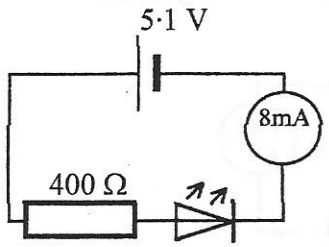
←3 V→

(*h*)



←4 V→

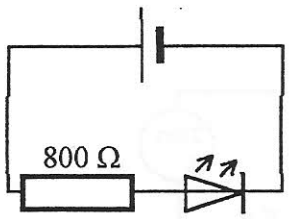
4. Consider the following circuit.



(*a*) Calculate the voltage across the 400 Ω resistor.

(*b*) Calculate the voltage across the LED.

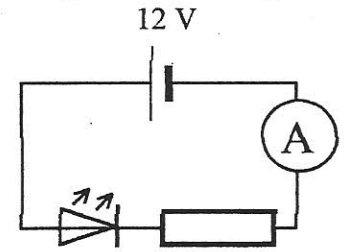
5. For the circuit shown below work out the value of the supply voltage which will enable the LED to operate at it's stated rating.



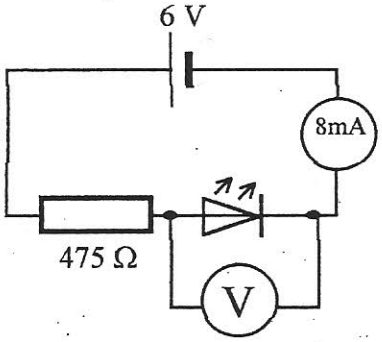
2·2 V,
11 mA

6. The voltage and current specifications for a certain LED are 1·75 V and 10 mA respectively. What should be the value of the series resistor if the LED is powered by a 6 V supply?

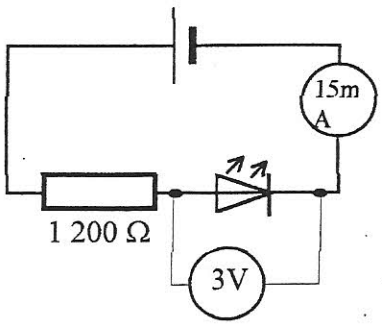
7. Calculate the ammeter reading in the following circuit.



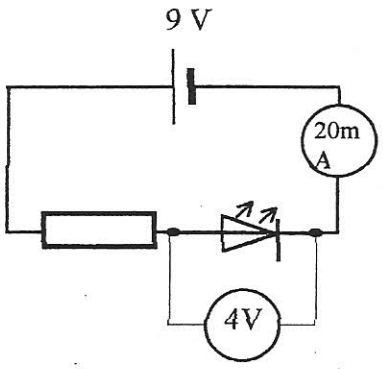
8. Calculate the voltmeter reading in the circuit shown below.



9. What is the supply voltage for the following circuit?



10. Calculate the value of resistor R in the circuit below.



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Binary to Decimal Conversion

Helpful Hint

Digital systems use binary because this can be represented by a series of 1's and 0's unlike decimal which requires the numbers 1,2,3,4,5,6,7,8& 9.

Numbers in binary are made up in the same way as numbers in decimal.
For example consider the number **6752**. The position of each number gives its value.

1000	100	10	1
6	7	5	2

6752 ***means*** 6 thousands 7 hundreds 5 tens 2 units

The position of each number in binary also gives its value.
Consider the binary number 1111

8	4	2	1
1	1	1	1

1111 ***means*** 1 eight 1 four 1 two 1 one
We can convert this to a decimal number by simply adding up the numbers.

$$8 + 4 + 2 + 1 = 15$$

so **1111** in binary is **15** in decimal

1. Convert each of the following binary numbers into a decimal number:

   (*a*) 0101 (*b*) 1001 (*c*) 1010 (*d*) 0110

   (*e*) 1101 (*f*) 1011 (g) 0111 (h) 1000

2. In an electronic counter the output is a binary number represented by a series of Light Emitting Diodes.

   ○ ● ○ ●
   ON OFF ON OFF

   The decoder chip converts the binary number into a decimal number which is displayed on a seven segment display.
   For each of the following binary outputs give the decimal number which would appear on the seven segment display.

   (*a*) ○ ○ ● ○ (*d*) ○ ● ○ ○

   (*b*) ○ ○ ● ● (*e*) ● ● ● ●

   (*c*) ● ● ● ○ (*f*) ○ ● ● ○

Section 3 - Input Devices

In this section you can use the equation:

$$V = IR$$

where **V** = voltage in volts (V)
I = current in amps (*A*)
R = *resistance in ohms* (Ω).

Helpful Hint
When choosing an input device for an electronic system, think about what type of energy the device has to detect.

Capacitor microphone thermistor solar cell
light dependent resistor (LDR) thermocouple

1. Select from the list above a suitable input device for each of the following:

   (*a*) Public address system in a railway station

   (*b*) Digital thermometer

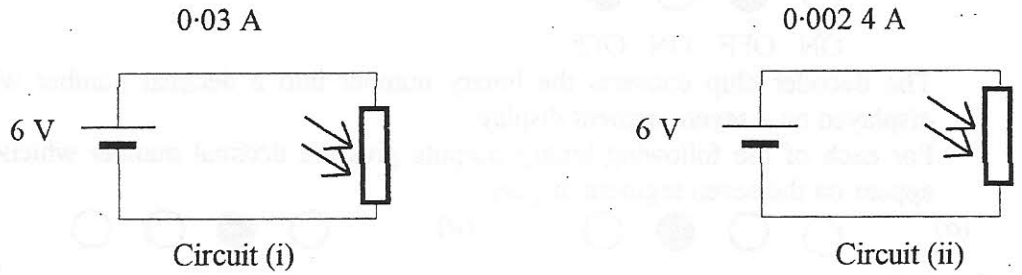
   (*c*) Photographers light meter

   (*d*) Time delay circuit for courtesy lights in a car

   (*e*) Pilot light flame detector in a gas central heating system

   (*f*) Sunlight hours recorder at a weather station.

2. The circuits below show two identical LDR's each connected to a 6 V supply. One LDR is placed in a cupboard and the other is placed beside a window.

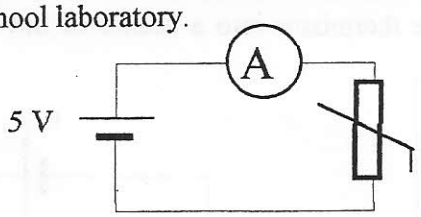


Circuit (i) Circuit (ii)

   (*a*) Calculate the resistance of each LDR.

   (*b*) Which circuit shows the LDR in the cupboard?

3. The following circuit shows a thermistor connected to a 5 V supply and placed in a school laboratory.



In the morning the ammeter gave a reading of 1·25 mA. Later in the same day the reading had risen to 2·5 mA.

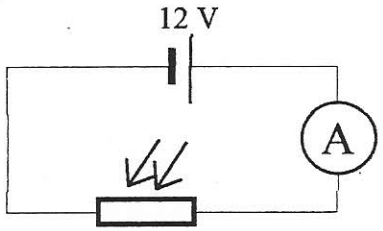
(*a*) Calculate the resistance of the thermistor in the morning.

(*b*) What happened to the temperature in the room during the day? Explain your answer.

4. The following information for an LDR was found in a components catalogue.

Light Source	*Illumination* (lux)	*Resistance* (kΩ)
moonlight	0·1	10 000
60 W bulb at 1m	50	2·4
fluorescent light	500	0·2
bright sunlight	30 000	0·02

This LDR is connected to a 12 V supply with an ammeter in series with it as shown in the diagram.



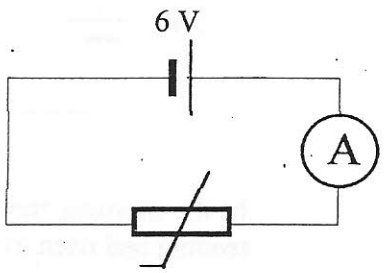
(*a*) What is the resistance in ohms of the LDR when exposed to fluorescent light?

(*b*) What would the ammeter read when a lamp with a 60 W bulb in it is placed 1 m away from the LDR?

(*c*) When the ammeter gives a reading of 0·6 A which light source is being used?

5. A pupil uses a thermistor as a simple electronic thermometer. She connects the thermistor to an ammeter and places the thermistor into a beaker of hot water. The ammeter gives a reading of 8 mA.

Temperature (°C)	*Resistance* (Ω)
20	3 750
40	198
60	750
80	350
100	200



(*a*) What is the temperature of the water in the beaker?

(*b*) The pupil adds some more water to the beaker and the ammeter gives a new reading of 1·6 mA. Did the pupil add hot or cold water to the beaker?

(*c*) What is the new temperature of the water?

(*d*) What will the ammeter read when the water is boiling?

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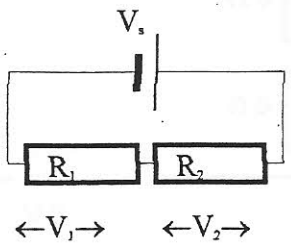
Voltage Dividers

In a series circuit the voltage **divides up** between the components in the circuit i.e.

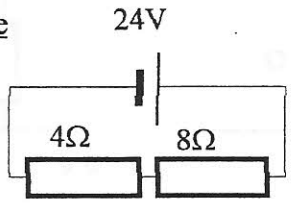


$V_s = V_1 + V_2$

where V_s = supply voltage
V_1 = voltage across R_1
V_2 = voltage across R_2

From Ohm's law we know that since current is constant in a series circuit, the higher the resistance of a component the greater the voltage across it.
This idea is used in the following example to calculate the voltage across components in a 'voltage divider' i.e. series circuit.

Example



Use the fact that the voltage 'split' across each component is in the same ratio as the resistance of each component.

$V_1 = \frac{R_1}{R_t} \times V_s = \frac{4}{12} \times 24 = 8V$

$V_2 = \frac{R_2}{R_t} \times V_s = \frac{8}{12} \times 24 = 16\ V$

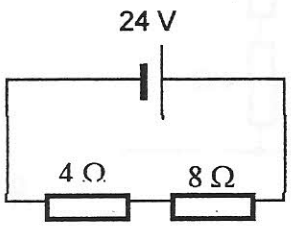
where R_t = total resistance

(Remember to check your answer e.g. does $V_1 + V_2 = V_s$)

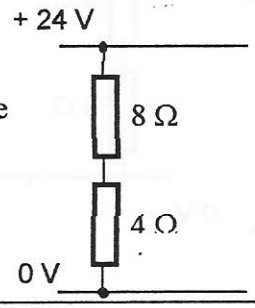
Lastly!

Circuit problems in electronics are usually drawn slightly differently than you are used to seeing.

e.g.



would be drawn as



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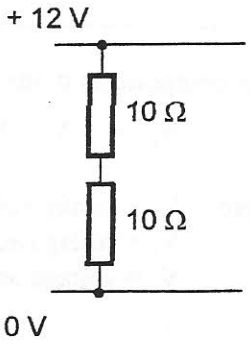
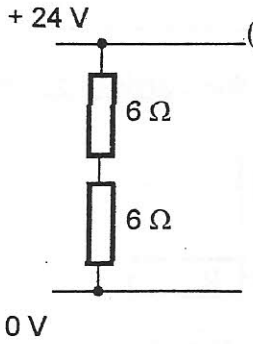
Find the voltage across each resistor in the following:

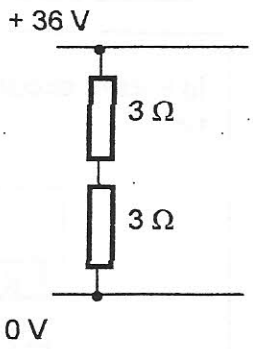
(1)



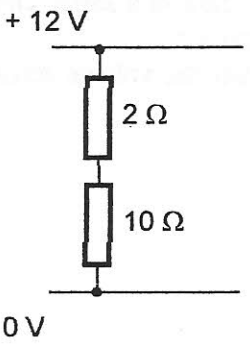
(2)



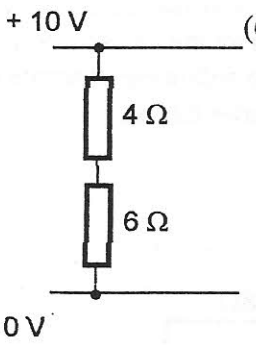
(3)



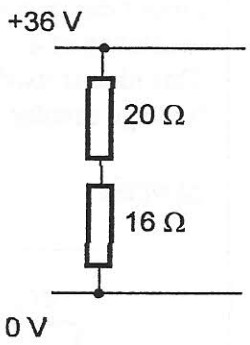
(4)



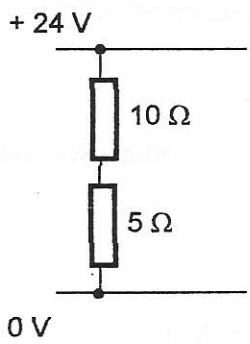
(5)



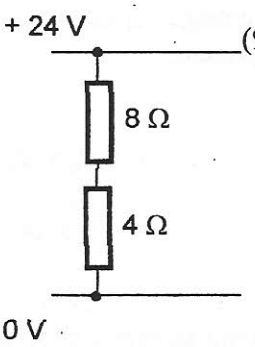
(6)



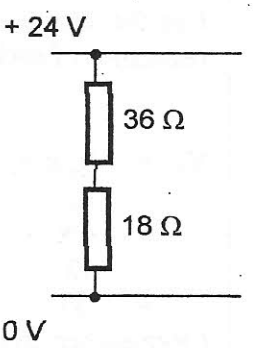
(7)



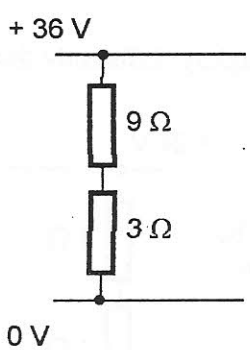
(8)



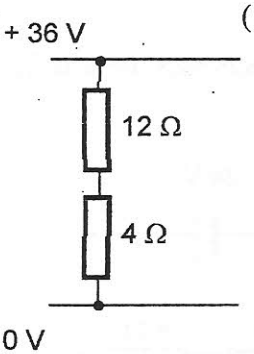
(9)



(10)



(11)



(12)