

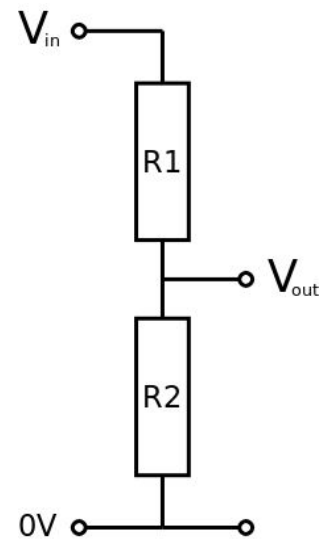
# Potential Divider Exercises

Consider a potential divider (voltage divider) made from a pair of resistors

The resistors have values  $R_1$  and  $R_2$

The input voltage ( $V_{in}$ ) is from 0V and across both resistors as shown

The output voltage ( $V_{out}$ ) is measured across  $R_2$



## Question 1

The input voltage is set to  $V_{in} = 12V$ .  $R_1$  and  $R_2$  are both  $220\Omega$ .

What is the output voltage?

## Question 2

The input voltage is set to  $V_{in} = 9V$ .  $R_1 = 470\Omega$  and  $R_2 = 390\Omega$ .

What is the output voltage?

## Question 3

The input to a potential divider is 9V and the output voltage needs to be 5V.

If  $R_2 = 100k\Omega$ , what is the value of  $R_1$ ?

## Question 4

The input to a potential divider is 20V and the output voltage needs to be 12V.

If  $R_2 = 15\Omega$ , what is the value of  $R_1$ ?

## Question 5

The input to a potential divider is 1.5V and the output voltage needs to be 0.7V.

If  $R_1 = 24,000\Omega$ , what is the value of  $R_2$ ?

## Question 6

The input to a potential divider is 6V and the output voltage needs to be 3.8V.

If  $R_1 = 1800\Omega$ , what is the value of  $R_2$ ?

## Question 7

A potential divider has two resistors,  $R_1 = 2\text{k}\Omega$  and  $R_2 = 1\text{k}\Omega$ .

If  $V_{\text{out}} = 3\text{V}$ , what is the input voltage,  $V_{\text{in}}$  ?

## Question 8

A potential divider has two resistors,  $R_1 = 27\text{k}\Omega$  and  $R_2 = 91\text{k}\Omega$ .

If  $V_{\text{out}} = 30\text{V}$ , what is the input voltage,  $V_{\text{in}}$  ?

## Question 9

A potential divider has an input voltage of  $V_{\text{in}} = 12\text{V}$  and needs to have an output voltage,  $V_{\text{out}} = 5\text{V}$ .

What pair of resistors can be used to make the potential divider?

## Question 10

A potential divider has an input voltage of  $V_{\text{in}} = 230\text{V}$  and needs to have an output voltage,  $V_{\text{out}} = 12\text{V}$ .

What pair of resistors can be used to make the potential divider?

# Potential Divider Answers

## Question 1

The input voltage is set to  $V_{in} = 12V$ .  $R1$  and  $R2$  are both  $220\Omega$ .

What is the output voltage?

$$V_{out} = 12 \times 220 / (220 + 220) = 6V \quad \text{or} \quad 1:1 \text{ ratio so } 12/2 = 6V$$

## Question 2

The input voltage is set to  $V_{in} = 9V$ .  $R1 = 470\Omega$  and  $R2 = 390\Omega$ .

What is the output voltage?

$$V_{out} = 9 \times 390 / (470 + 390) = 4.1V \quad \text{ratios are not obvious}$$

## Question 3

The input to a potential divider is  $9V$  and the output voltage needs to be  $5V$ .

If  $R2 = 100k\Omega$ , what is the value of  $R1$ ?

$$\text{If } V1 \text{ is the voltage across } R1 \text{ then } V1 = 4V \text{ and } V1:V_{out} = 4:5$$

$$R2 = 100k\Omega \text{ and so } R1 = \frac{4}{5} \text{ of } 100k\Omega = 80k\Omega$$

## Question 4

The input to a potential divider is  $20V$  and the output voltage needs to be  $12V$ .

If  $R2 = 15\Omega$ , what is the value of  $R1$ ?

$$V1 = 8V. \text{ The ratio } V1:V_{out} = 8:12 = 2:3 \quad R2 = 15\Omega \text{ gives } R1 = \frac{2}{3} \text{ of } 15\Omega = 10\Omega$$

## Question 5

The input to a potential divider is  $1.5V$  and the output voltage needs to be  $0.7V$ .

If  $R1 = 24,000\Omega$ , what is the value of  $R2$ ?

$$V1 = 0.8V \text{ so ratio } R1:R2 = 8:7 \quad R2 = \frac{7}{8} \text{ of } 24k\Omega = 21k\Omega$$

## Question 6

The input to a potential divider is 6V and the output voltage needs to be 3.8V.

If  $R_1 = 1800\Omega$ , what is the value of  $R_2$ ?

$$V_1 = 6.0 - 3.8 = 2.2V \text{ so the ratio } R_1:R_2 = 2.2:3.8 \quad R_2 = (3.8/2.2) \times 1800\Omega = 3100\Omega$$

## Question 7

A potential divider has two resistors,  $R_1 = 2k\Omega$  and  $R_2 = 1k\Omega$ .

If  $V_{out} = 3V$ , what is the input voltage,  $V_{in}$  ?

$$V_1:V_{out} = R_1:R_2 = 2:1 \quad V_{out} = 3V \text{ gives } V_1 = 6V \text{ and therefore } V_{in} = 9V$$

## Question 8

A potential divider has two resistors,  $R_1 = 27k\Omega$  and  $R_2 = 91k\Omega$ .

If  $V_{out} = 30V$ , what is the input voltage,  $V_{in}$  ?

$$V_1:V_{out} = V_1:30 = R_1:R_2 = 27:91 \quad V_1 = (27/91) \times 30 = 8.9V \text{ and therefore } V_{in} = 38.9V$$

$$\text{Alternatively } V_{in} = V_{out} \times (R_1 + R_2) / R_2 = 30 \times (27 + 91) / 91 = 38.9V$$

## Question 9

A potential divider has an input voltage of  $V_{in} = 12V$  and needs to have an output voltage,  $V_{out} = 5V$ .

What pair of resistors can be used to make the potential divider?

$$V_1 = 7V \text{ and } V_{out} = 5V \text{ meaning } R_1:R_2 = 7:5$$

Any pair with this ratio e.g.  $R_1 = 7k\Omega$  and  $R_2 = 5k\Omega$

## Question 10

A potential divider has an input voltage of  $V_{in} = 230V$  and needs to have an output voltage,  $V_{out} = 12V$ .

What pair of resistors can be used to make the potential divider?

$$V_1 = 230 - 12 = 218V \text{ meaning } R_1:R_2 = 218:12 \quad \text{Use } R_1 = 218k\Omega \text{ and } R_2 = 12k\Omega$$

Any combination with the right ratio will work