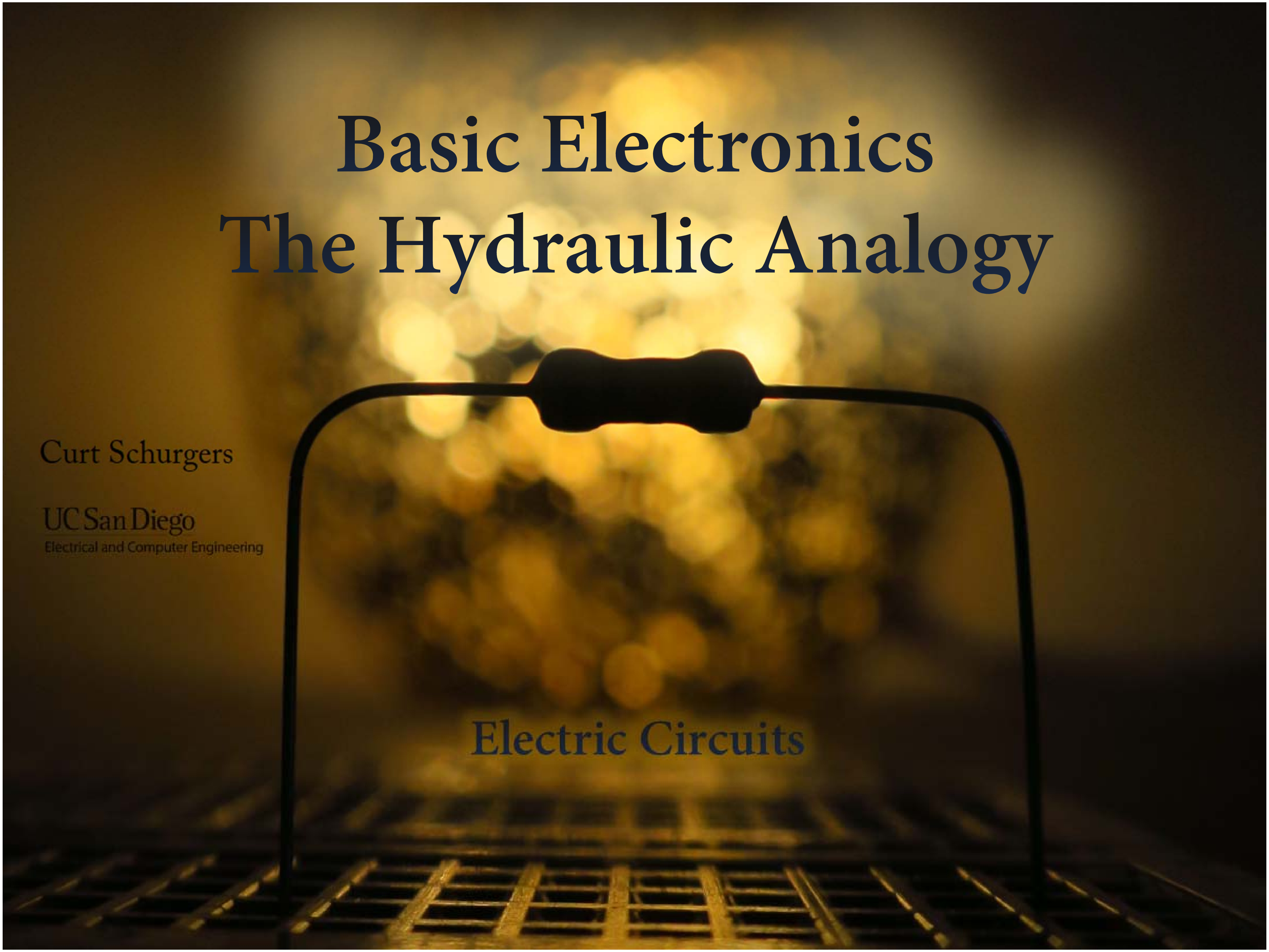
Basic Electronics
The Hydraulic Analogy



Electric Circuits

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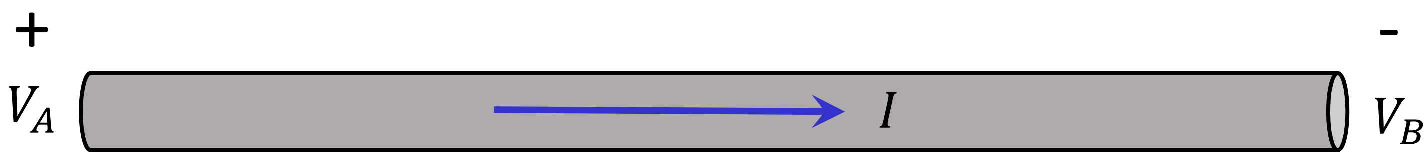
In the hydraulic analogy, electrical circuits are considered analogous to:

- [A] buckets of water
- [B] water flowing through pipes
- [C] water molecules subjected to heat, stirring and turbulence
- [D] hydroelectric ocean waves
- [E] I don’t know

Hydraulic analogy



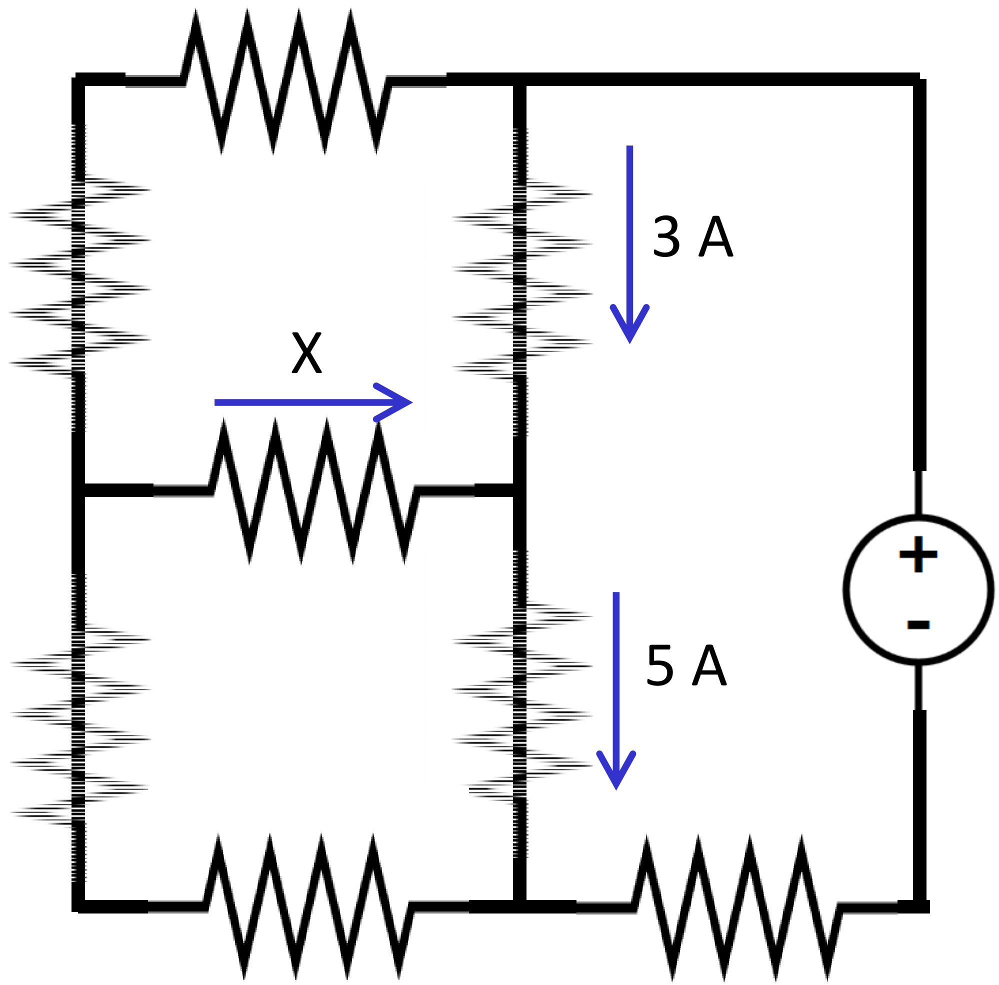
	Physical quantity	symbol	units
'the flow of particles'	current	I i	ampere (A)
'what pushes'	pressure/voltage	V v	volts (V)
Relationship between the push and the flow	resistance	R	ohm (Ω)

$V = I \cdot R$ Ohm's Law

$\sum_{in} I = \sum_{out} I$ Kirchhoff's Current Law (KCL)

$\sum_{up} \Delta V = \sum_{down} \Delta V$ Kirchhoff's Voltage Law (KVL)

If the currents in the various pipes are measured as indicated on the arrows, what is the value of the unknown current X?



[A] -2 A

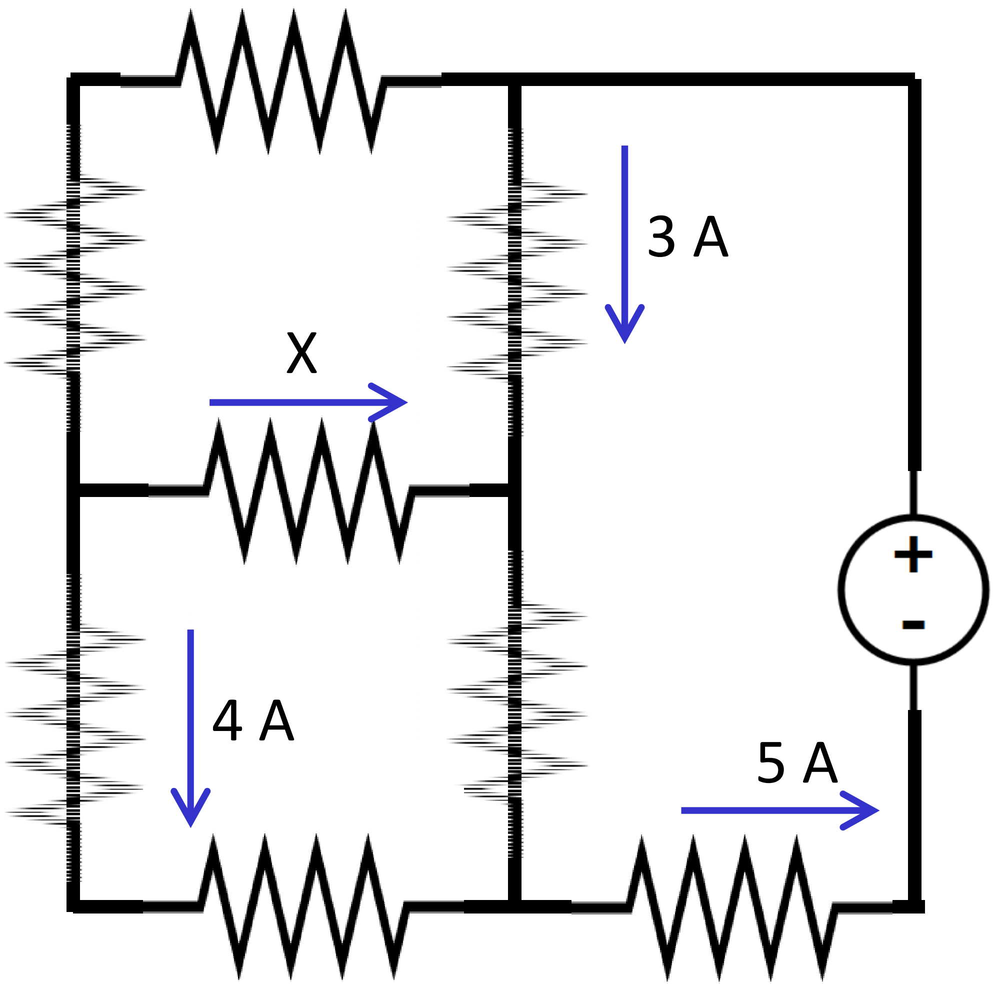
[B] 0 A

[C] 1 A

[D] 2 A

[E] I don’t know

If the currents in the various pipes are measured as indicated on the arrows, what is the value of the unknown current X?



[A] -2 A

[B] 0 A

[C] 1 A

[D] 2 A

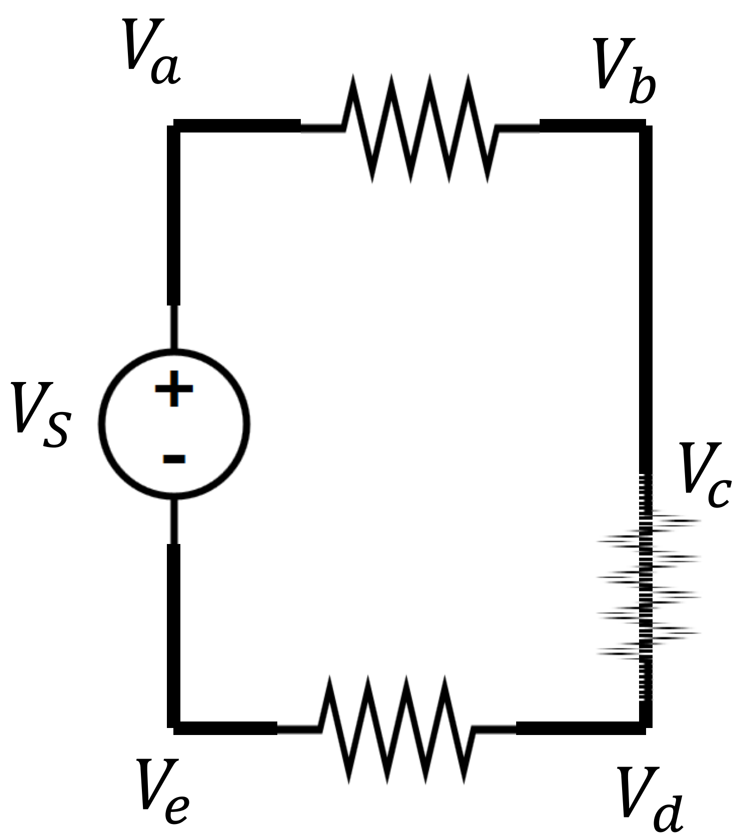
[E] I don’t know

$$V_a - V_b = 1\ V$$

$$V_d - V_e = 2\ V$$

$$V_S = 5\ V$$

What is the voltage $(V_c - V_d)$?



[A] -2 V

[B] 0 V

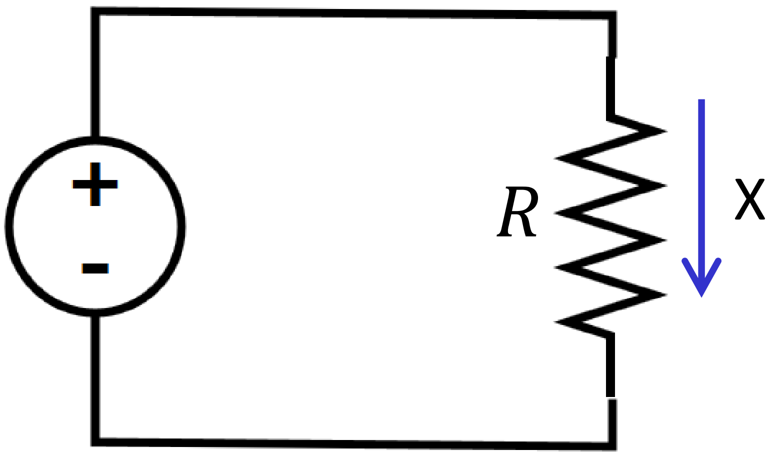
[C] 2 V

[D] Not enough info to calculate

[E] I don't know

If the resistance *R* of the pipe is 2 Ω, the current X is:

$V_S = 8\,V$



$V = I \cdot R$

[A] 0 A

[B] 2 A

[C] 4 A

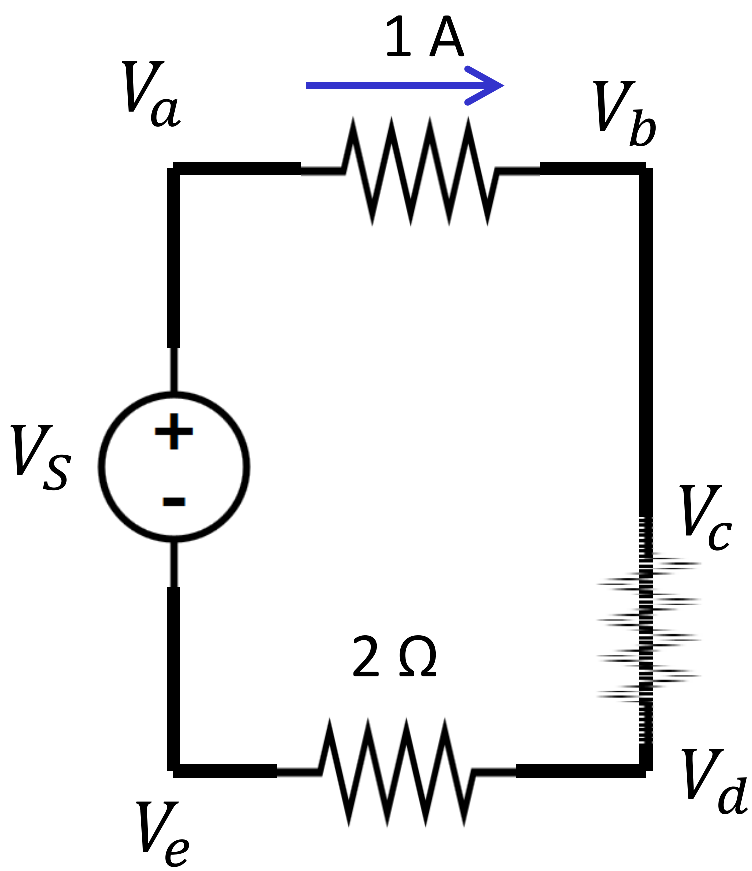
[D] 16 A

[E] I don't know

$V_a - V_b = 4\ V$

$V_S = 10\ V$

What is the voltage $(V_c - V_d)$?



[A] 2 V

[B] 4 V

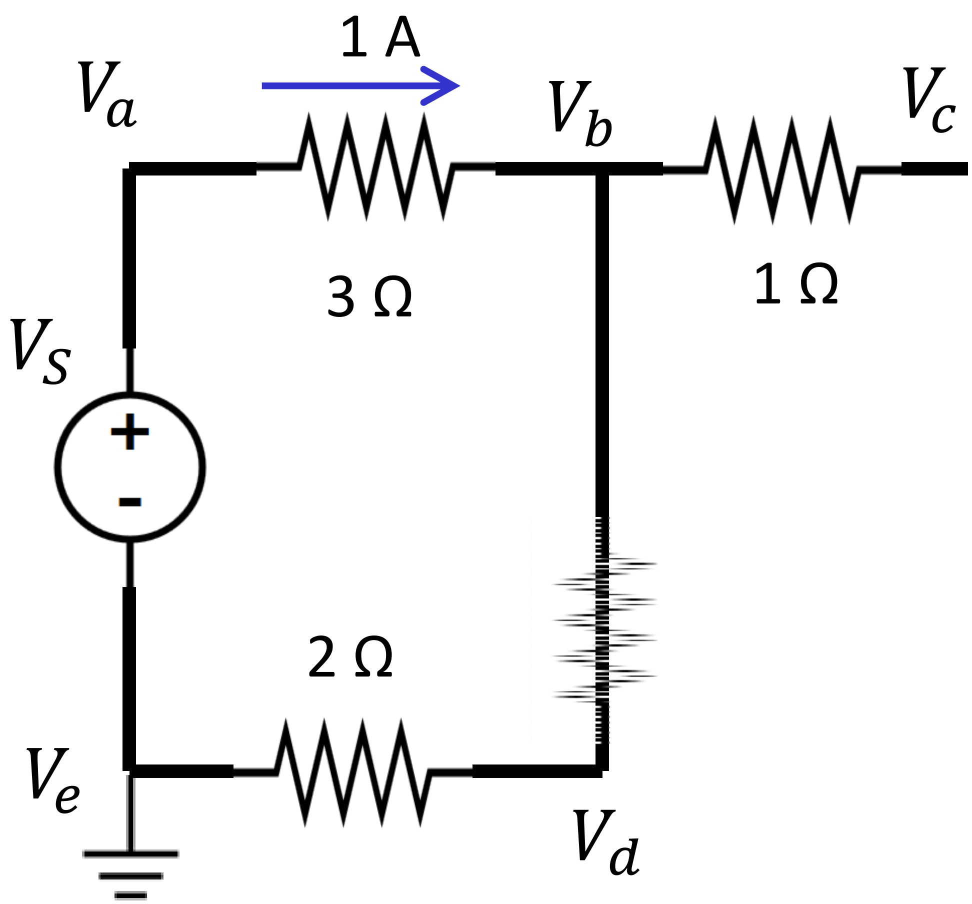
[C] 6 V

[D] Something else

[E] I don't know

$V_S = 10\ V$

What is the value of node voltage V_c?



[A] 0 V

[B] 4 V

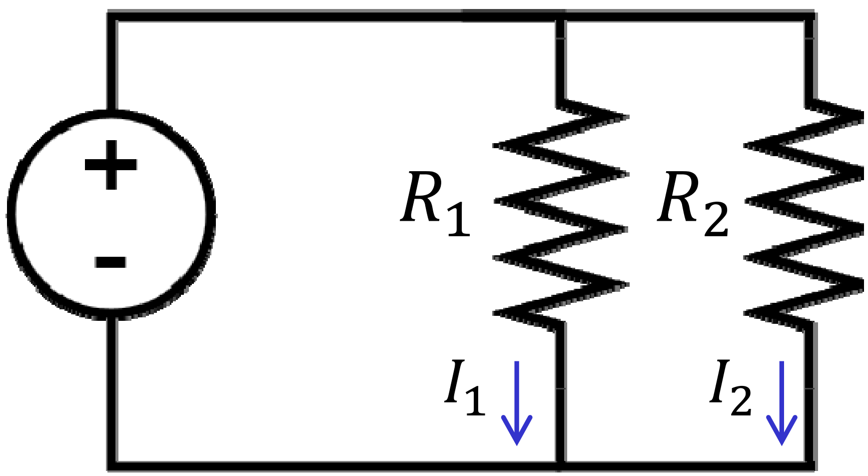
[C] 6 V

[D] 7 V

[E] I don't know

If the resistance R_1 of the first pipe is 2 Ω and the resistance R_2 of the second pipe is 4 Ω, the following is true:

$V_S = 8\ V$



$V = I \cdot R$

[A] $I_1 = I_2 = 0$

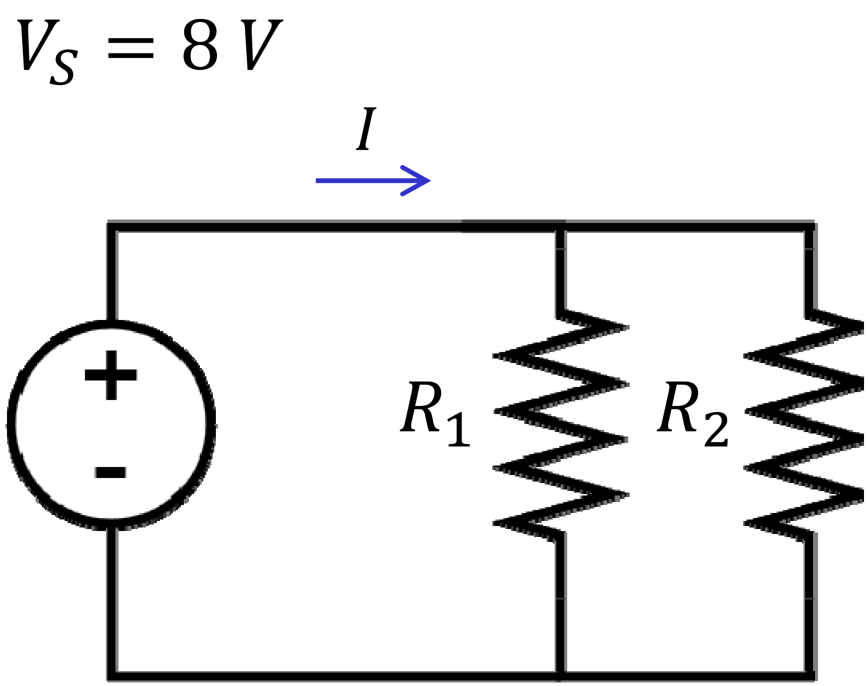
[B] $I_1 = I_2 > 0$

[C] $I_1 > I_2$

[D] $I_1 < I_2$

[E] I don’t know

If the resistance R_1 of the first pipe is 2 Ω and the resistance R_2 of the second pipe is 4 Ω, the total current I coming out of the source (pump) is:



$$V = I \cdot R$$

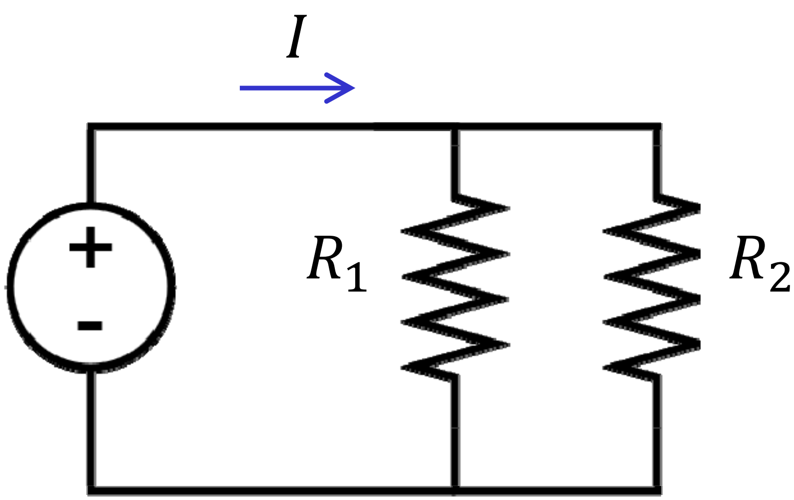
[A] 3 A

[B] 6 A

[C] 8 A

[D] 48 A

[E] I don't know



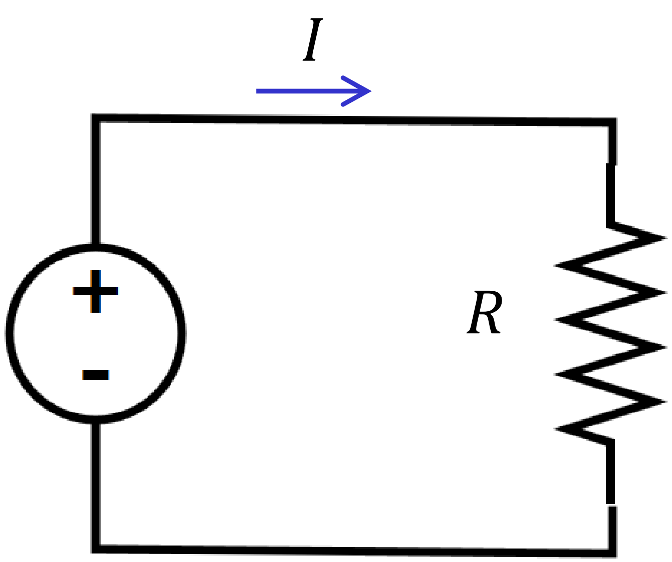
$V_S = 8\ V$

$R_1 = 2\ \Omega$

$R_2 = 4\ \Omega$

$I = 6\ \mathrm{A}$

Parallel connection

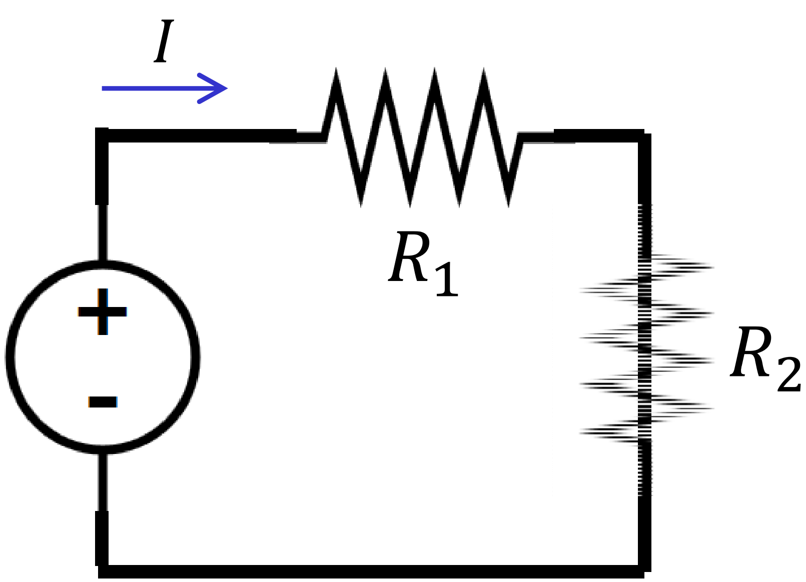


$V = I \cdot R$

If the resistance R_1 of the first pipe is 1 Ω and the resistance R_2 of the second pipe is 4 Ω, the current I coming out of the source (pump) is:

Series connection

$$V_S = 10\ V$$



$$V = I \cdot R$$

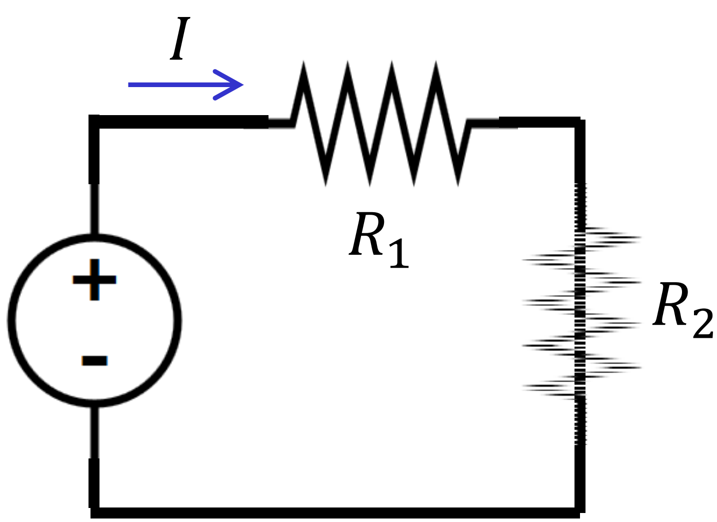
[A] 2 A

[B] 12.5 A

[C] 14 A

[D] 50 A

[E] I don't know



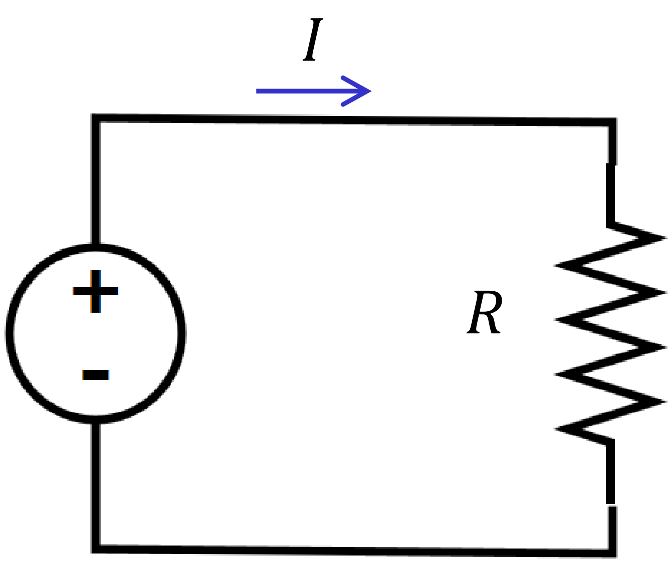
$V_S = 10\ V$

$R_1 = 1\ \Omega$

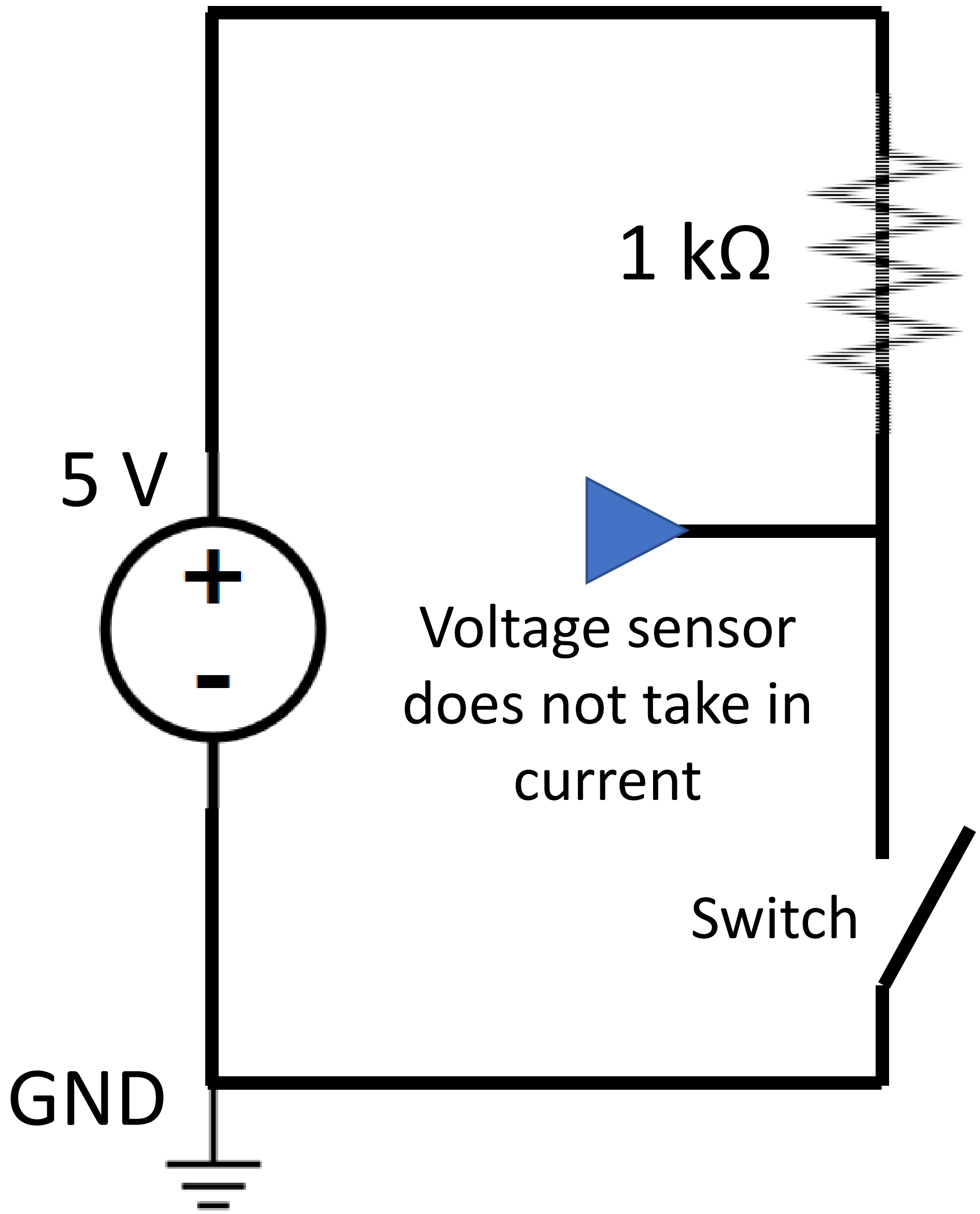
$R_2 = 4\ \Omega$

$I = 2\ \mathrm{A}$

Series connection



$$V = I \cdot R$$



When the switch is open, the voltage measured by the voltage sensor is:

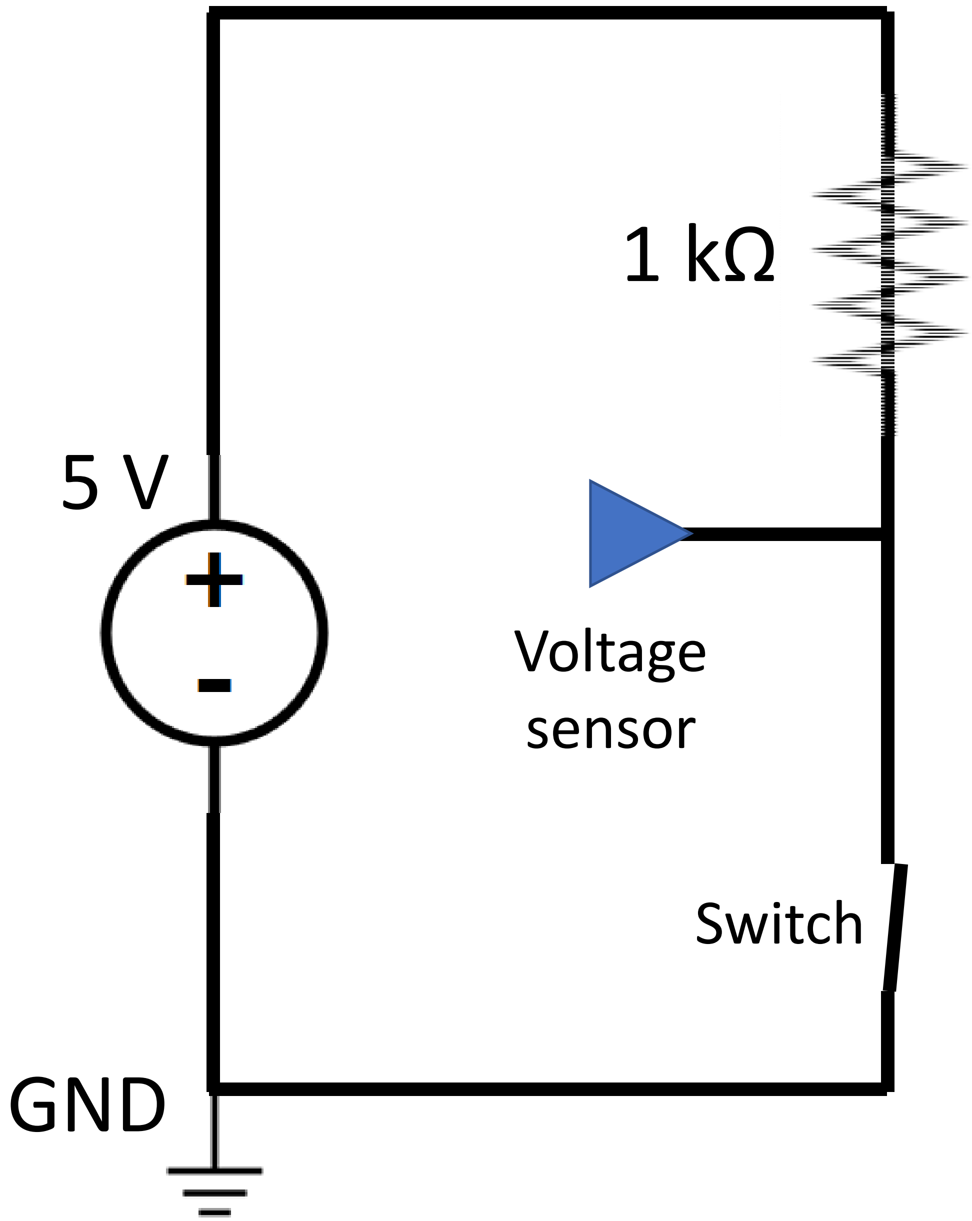
[A] 0 V

[B] 1 mV

[C] 1 V

[D] 4 V

[E] 5 V



When the switch is closed, the voltage measured by the voltage sensor is:

[A] 0 V

[B] 1 mV

[C] 1 V

[D] 4 V

[E] 5 V

What did we learn?

- Pipes correspond to resistors, with certain resistance R
- Wires correspond to ideal pipes, with R very small

- Current only flows in a closed loop
- Voltage over an element is what matters
- Current splits in branches
- Voltage gains and drops in a loop have to add to zero
- Ohm's law: $V = IR$