

Notes on series and parallel connections

- Two objects (capacitors or resistors) are connected in **series** if the **positive** end of one object is connected to the **negative** end of the other object without anything in between. In other words, they share only 1 node.
- Two objects are connected in **parallel** if the **positive** end of one object is connected to the **positive** end of the other object, and the two negative ends are also connected with each other. In other words, they share 2 nodes.

	Capacitor		Resistor	
Series	V	Add: $V = V_1 + V_2$	V	Add: $V = V_1 + V_2$
	Q	The same throughout the connection $Q = Q_1 = Q_2$	I	The same throughout the connection $I = I_1 = I_2$
	C	So $\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2}$ $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$	R	So: $IR = IR_1 + IR_2$ $R = R_1 + R_2$
Parallel	V	The same throughout the connection $V = V_1 = V_2$	V	The same throughout the connection $V = V_1 = V_2$
	Q	Add: $Q = Q_1 + Q_2$	I	Add: $I = I_1 + I_2$
	C	So: $CV = C_1V + C_2V$ $C = C_1 + C_2$	R	So: $\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2}$ $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

Answers to WS6

#1

- (a) Same, because the water would build up somewhere in the pipe otherwise.
- (b) Same as above, current doesn't build up inside the wire/circuit, so $I_A = I_B = I_C = I_D = I_E$. Voltage, on the other hand, varies: $V_A = V_C = V_D < V_B < V_E$. Think of voltage as steepness of a hill, it's harder to walk over a steep hill than level land, so it's harder for current (electrons) to pass through something with high voltage. Resistance is a measure of that something's opposition to the passage of a steady current.

(c) No.

#2

- (a) Potential energy
- (b) Potential energy turns into kinetic energy at the bottom of the fall, then turns into rotational kinetic energy of the wheel
- (c) Bulb 1
- (d) When talking about light, we mean energy of the photons. Heat is the transferring of energy. Therefore the only correct choice is electric potential energy.

#3 Use $R = \rho l/A$ and $P = IV = I^2R = V^2/R$ in this problem.

- (a) $R = 5.35 \times 10^{-2} \Omega$
- (b) $P = 7.7 W$
- (c) l increases, ρ and A are the same. $R_{new} = 4R_{old}$, $P_{new} = 4P_{old}$
- (d) l increases, but volume stays the same, so A decreases proportionally, i.e. $l_{new} = 4l_{old}$, $A_{new} = A_{old}/4$
 $R_{new} = 16R_{old}$; $P_{new} = 16P_{old}$

#4 (d) When the resistor heats up, the molecules inside the resistor gain kinetic energy and rattle around more. This makes it harder for the electrons of the current to get through, i.e. the resistor has more resistance against current. So R increases as T increases.

(e) R increases, V stays the same, so $P = V^2/R$ decreases.

NOTES ON UNITS:

Don't get confused between *Coulomb* (C) – unit of charge (Q), and the letter C for Capacitance – measured in *Farad* (F).

Likewise, distinguish between *Ampere* (A) – unit of current (I), and the letter A for Area.