

Questions:

6. 25 watt 110 Volt bulb glows normally when connected across a bank of batteries but a 500-watt bulb glows only dimly under same circs. What gives?

Watts = Amps * Volts, the bulbs are designed to work while dissipating a certain amount of energy. The chemistry of the batteries doesn't change, so the EMF they provide doesn't change. What must be happening is that the batteries do not provide enough CURRENT for the 500 watt bulb. Need more batteries in parallel.

9. In incompressible fluids, the junction theorem says that fluid does not get created or disappear whenever pipes join or separate, and the loop theorem says that the change in water pressure around a closed loop is zero (else energy is coming or going from or two nowhere).

10. Of course the parallel resistance equation is same as the series capacitance, and vice-versa. What might be a little more interesting than parroting back this factoid is to look at why that is. What do the equations say? Is there an analogy with the mass-spring system, e.g.?

Problems:

7. The current is the sum of the EMF drops divided by the sum of the resistances, which implies that $1 / (6+R) = .001$ so $R = 994$ ohms. Joule heating is $i*i*R$, or $9.94 * 10^{** -4}$ Watts.

9. This is a simple exercise in adding up the emf drops across components along various paths in a circuit. To do this you figure out the currents flowing through each branch and work out the voltage drops from there. Ans = 1.25 Volts however you do it.

10. Another simple exercise in arithmetic like no. 9. 2.25 Volts

14. With single resistances of 4 and 12 you can make 3 with a parallel connexion and 16 with a series one.

15. Use voltage division rule (MIMMS) and knowledge that potentials are the same: just solve $R1/(R1+R2) = Rs/(Rx+Rs)$ for Rx .

19. Tricky. This is neither series nor parallel — we have to go back to first principles. Below is the basic solution, which deals with all the cases. They, of course, are topologically identical. The given resistances (all equal) make a special case for (a) and (c) that obscures the generality of the problem. For this I had a friend use Maple, a symbolic math package. Mathematica would do the same thing.

$R1 - R5$ are the known coefficients, $i1-i5$ the unknown currents, E the known emf.

$$\begin{aligned}
R_1 i_1 + R_4 i_4 &= E \\
R_2 i_2 + R_5 i_5 &= E \\
R_2 i_2 + R_3 i_3 + R_4 i_4 &= E \\
i_1 + i_3 &= i_4 \\
i_1 + i_2 &= i_4 + i_5
\end{aligned}$$

$$\begin{aligned}
D &= (R_2 R_3 R_1 + R_2 R_3 R_4 + R_2 R_4 R_1 \\
&\quad + R_5 R_3 R_1 + R_5 R_3 R_4 + R_5 R_4 R_1 \\
&\quad + R_5 R_4 R_2 + R_5 R_1 R_2) \\
i_1 &= \frac{E(R_2 R_3 + R_2 R_4 + R_5 R_3 + R_5 R_2)}{D} \\
i_2 &= \frac{E(R_3 R_1 + R_4 R_1 + R_5 R_1 + R_3 R_4)}{D} \\
i_3 &= \frac{E(R_5 R_1 - R_2 R_4)}{D} \\
i_4 &= \frac{E(R_2 R_3 + R_5 R_3 + R_5 R_1 + R_5 R_2)}{D} \\
i_5 &= \frac{E(R_2 R_4 + R_3 R_1 + R_4 R_1 + R_3 R_4)}{D}
\end{aligned}$$

20. This is the same thing as 9 and 10! Use the loop theorem to get: $6-5-4-i_2 R_2 = 0$, $5-i_1 R_1=0$, from which $i_1 = 5/100$, $i_2 = -3/50$. Voltage drop is pretty easy, you can just add up those battery voltages to get a as 9 volts higher than b.

29. We want x such that $\exp(-x) = 0.01$, or $-x = \ln(0.01) = -4.60517$ so between 4 and 5 time constants.

30. (a) Current through i_2 is constant. Current through i_1 falls exponentially to some value as capacitor charges. i_3 falls to zero as capacitor charges. Voltage across capacitor exponentially goes to some value, while V_3 drops to

zero as the current drops, V_2 stays constant and V_1 drops slightly as current drops.

(b) no action on V_1 and i_1 , which stay zero. current through r_2 and r_1 is the same, falling exponentially from some value to zero as capacitor discharges. Likewise their voltage drops, and that of the capacitor.