Chapter E - Problems

Blinn College - Physics 2426 - Terry Honan

Problem E.1

A wire with diameter d feeds a current to a capacitor. The charge on the capacitor varies with time as $Q(t) = Q_0 \sin \omega t$. What are the current and current density in the wire as functions of time?

Problem E.2

The current as a function of time varies as $I(t) = 15 \sin(120 \pi t)$ in SI units. What is the total charge that flows between 0 and $\frac{1}{120}$ s. (This is half a cycle of a standard 60 Hz AC frequency.)

Problem E.3

The diameter of a standard 12 gauge wire is 2.05 mm. Suppose in standard houshold wiring a 15 A current flows through a 20 m length of copper wire.

(a) What is the resistance in the wire and what is the voltage drop across the wire?

(b) For each copper atom there is one free electron available for conduction. The density (mass/volume) of copper is $8920\,\mathrm{kg}/m^3$ and its atomic mass is 63.54 u. Use the conversion $6.02 \times 10^{26}\,\mathrm{u} = 1\,\mathrm{kg}$ to find the mass of each atom. From that find the number of atoms per volume; this for copper is the same as the number of charge carriers per volume. Calculate the drift velocity of the free electrons and find the total time it takes one electron to migrate the full length of the wire.

Problem E.4

Suppose a wire with restance R is stretched by 30% keeping the volume of the wire fixed. What is the new resistance of the wire?

Problem E.5

When the temperature of a wire is decreased by 10 C° its resistance decreases by 6 %. What is its temperature coefficient?

Problem E.6

The precise definition of the temperature coefficient is $\alpha = \frac{1}{\rho}\frac{d\rho}{d\mathrm{T}}$.

Show that if α is constant we get: $\rho = \rho_0\, e^{\alpha\,(\mathrm{T}-\mathrm{T}_0)}$.

Use the approximation that for small x ($x \ll 1$), $e^x \cong 1 + x$, to show that for small $\Delta T = T - T_0$:

$$\rho = \rho_0 \, e^{(\alpha \, \Delta T)} \cong \rho_0 \, [1 + \alpha \, (T - T_0)].$$

Problem E.7

A hair dryer desiigned for a standard US outlet has a power rating of 1500 W.
(a) How much current does it draw?
(b) What is its resistance?

Problem E.8

Suppose a purely resistive Ohmic device designed for a standard outlet (V = 120 V) is operated at too low a voltage, 105 V. By what percent would the power of the device be decreased?

Problem E.9

kW·hr is the unit of energy used in electric bills. What is 1 kW·hr in J? If the electric utility charges \$0 .09 per kW·hr, then what is the cost of running a 100 W bulb constantly for a 31 day month?

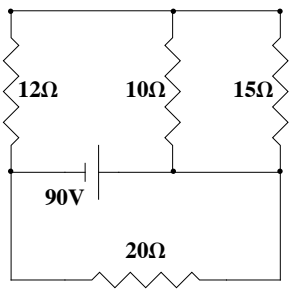
Problem E.10

A student tries to determine the internal resistance of a battery. A voltmeter connected across the battery without a load reads the EMF $\mathcal{E}$. When the battery is connected across a known load resistance R_0, the voltmeter reads across the battery reads V_0. What is the internal resistance r?

Problem E.11

An unknown resistance R is connected across a fixed voltage source. When a 200 Ω resistor is placed in parallel with it the current delivered by the source quadruples. What is the resistance?

Problem E.12



Complete the table below with the voltage across, the current through and the total power dissipated in each resistor.

	12 Ω	10 Ω	15 Ω	20 Ω
V				
I				
$\mathcal{P}$				

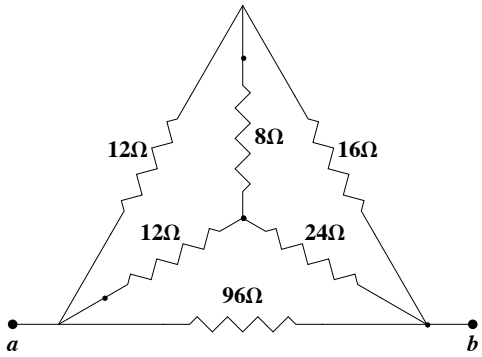
Also, give the total current and power delivered by the battery. How are these values related to those in the table?

Problem E.13

Suppose a resistance R is put on each edge of a cube. What is the equivalent resistance between opposite corners of the cube?

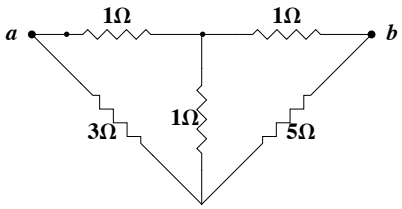
Problem E.14

What is the equivalent resistance between a and b?

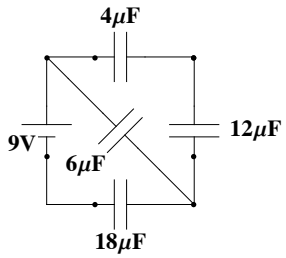


Problem E.15

What is the equivalent resistance between nodes a and b?



Problem E.16



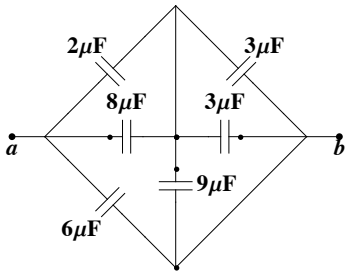
(a) What is the equivalent capacitance across the 9 V source?

(b) Complete the table below with the voltage across each capacitor and the charge on each.

	18 μF	6 μF	4 μF	12 μF
V				
Q				

Problem E.17

What is the equivalent capacitance between a and b?



Problem E.18

Give a set of 5 linear equations that can be solved for the currents. You need not solve the equations.