Physics Challenges for Teachers and Students

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Here we present the solutions to the April 2002 *Challenges:*

Incapacitated!

Consider a system with N capacitors whose capacitance is C_N. Let us connect the measuring device to points 1 and 2 and then add one more point to the system. Let us find $C_N + 1$. All points except for 1 and 2 have the same potential, from the symmetry of the situation. Therefore, the only capacitors that affect the change from C_N to $C_N + 1$ are the two capacitors connecting the "extra point" to points 1 and 2. This is equivalent to connecting a series pair of capacitors C in parallel with C_N. Therefore, $C_N + 1 = C_N + 0.5C$. Since $C_2 = C$, by induction, $C_N = 0.5NC$.

(Contributed by Alain Maruani, Ecole Nationale Supérieure des Télécommunications, Paris, France)

Ohm, I!

When the current is at a maximum, $\epsilon_I = V_L = 0$, so $|V_C| = |V_R| = iR$. Therefore, the initial energy in the circuit is

$$U_i = 0.5(LI^2 + CV^2) = 0.5[LI^2 + C(IR)^2].$$

Similarly, the final energy is

$$U_f = 0.5[L(0.5I)^2 + C(0.5IR)^2].$$

Finally, $dU = Ui - U_f = 0.375I^2(L + CR^2)$.

(Submitted by the column editor)

V-A-R-iables

First, one can connect the voltage source, the unknown resistor r and the ammeter in series. The voltmeter should be connected in parallel with the ammeter. The ratio of the readings, (V/I) equals the resistance of the ammeter. Then the voltmeter should be reconnected in parallel with both the ammeter and the unknown resistor. The ratio of the new readings (V'/I') now equals the total resistance of the ammeter and the unknown resistor. The unknown resistance r is, therefore, given by $r = (V'/I') - (V/I)$.

(Contributed by Carl Mungan, United States Naval Academy, Annapolis, Md.)

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