

CIRCUITS DAY 2: POWER & ENERGY

WARMUP Volts Times Amps

A volt is a joule per coulomb; an ampere is a coulomb per second. Multiply them and cancel: $(\text{J/C})(\text{C/s}) =$ _____. What quantity has those units?

POWER IN CIRCUITS

$P = IV = I^2R = V^2/R$ — three equivalent forms; pick by what you know.

Every resistor converts electrical energy to heat at rate P ; the energy over time is $E = \int P \, dt$ ($= Pt$ when steady). Utilities bill in **kWh**: $1 \text{ kWh} = (1000 \text{ W})(3600 \text{ s}) = 3.6 \times 10^6 \text{ J}$.

WE DO Exercise 1: All Three Forms

A $6.0 \, \Omega$ resistor across 12 V. **(a)** $I =$ _____. **(b)** P by all three forms: $IV =$ _____, $I^2R =$ _____, $V^2/R =$ _____ (they must agree).

ENERGY OVER TIME

WE DO Exercise 2: The Bill

A 1500 W space heater runs 4.0 hours every day. **(a)** Energy per day in kWh: _____. **(b)** At \$0.15/kWh, the monthly (30-day) cost: \$_____.

YOU DO Exercise 3: Same Volts, Different Bulbs

A 60 W bulb and a 100 W bulb both run at 120 V. Which has the LARGER resistance? Compute both R values (V^2/P) to settle it.

CALC Exercise 4: Decaying Power

During a discharge, a resistor dissipates $P(t) = 8e^{-(t/2)}$ W. Find the TOTAL heat: $E = \int_0^\infty P \, dt = P_0 \tau =$ _____ J. (Preview: this is where a capacitor's $\frac{1}{2}CV^2$ goes on day 5.)

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Pick a Formula

A resistor carries 3.0 A while dropping 8.0 V. Find P.

P2 From R

A $20\ \Omega$ resistor carries 2.0 A. Find the power dissipated.

P3 Steady Energy

A 40 W resistor runs for 5.0 minutes. Find the heat produced, in joules.

P4 Design Constraint

A toaster must draw 1200 W from a 120 V outlet. Find the required resistance and the current — then check the current against a 15 A household breaker.