12:06pm

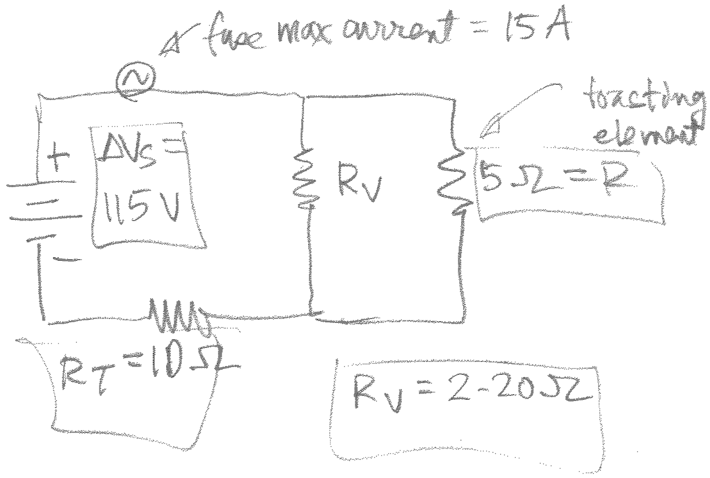
General Problem Solving Guide

Date:	
Recorder:	
Skeptic:	
Timekeeper:	
Psychic:	

(+1) (+2) (+1)

List given information, define variables, sketch picture:

(+6)



Simplify question, list target quantity:

(+2) Find P_{max} from heating element

List all related quantitative relationships:

+6

$P = I\Delta V$, | $P = I^2R$ (useful for elements in series, since I = same)

$= \frac{V^2}{R}$ (" parallel, where ΔV = same)

Resistors $\Delta V = IR$

+2

$R_{parallel} = \frac{R_1R_2}{R_1+R_2}$ | $R_{series} = R_1 + R_2$

Outline approach, sketch diagrams if needed (or sketch next to pictures above):

+2 o Find condition for max current through 5 Ω

+2 o Find current through 5 Ω

+2 o Then find $P = I_{max}^2 R$

(+6)

Obtain a general solution:

(+1)

- Find P_{max} through R

  $P_{max} = I_{max}^2 R$

  $I_{max} = ?$

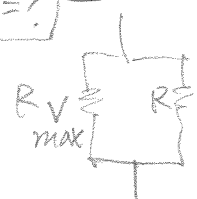
- Most current flows through $5\Omega \equiv R$ when R_V is as large as possible ("current takes path of least resistance")

- Thus $R_V = R_{Vmax}$ .... (1)

- Then $P_{max} = I_{max}^2 \cdot R$ .... (2)

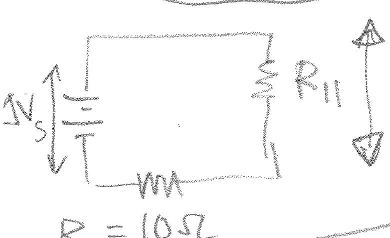
- So find $I_{max} = \frac{\Delta V_{max}}{R}$, $\Delta V_{max} = ?$ .... (3)

$\Delta V_{max} = ?$



These are in parallel, so...

- $R_{\parallel} = \frac{R_{Vmax} \cdot R}{R_{Vmax} + R}$ .... (4)



$\Delta V_{max} \overset{?}{=} I \cdot R_{\parallel}$ .... (5)

To find I, $I = \frac{\Delta V_S}{R_T + R_{\parallel}}$ .... (6)

So $\Delta V_{max} = \frac{\Delta V_S}{R_T + R_{\parallel}} \cdot R_{\parallel}$ .... (7)

$I_{max} = \frac{\Delta V_{max}}{R}$ .... (8)

$\rightarrow P_{max} = I_{max}^2 \cdot R = \frac{\Delta V_{max}^2}{R}$

General formula: $R_{\parallel} = \frac{R_{Vmax} \cdot R}{R_{Vmax} + R}$

$$P_{max} = \frac{\left(\frac{\Delta V_S}{R_T + R_{\parallel}} \cdot R_{\parallel}\right)^2}{R}$$

(+1)

Check Units:

$$\left[\frac{J}{s}\right] \overset{?}{=} \frac{\left(\frac{V}{\Omega} \cdot \Omega\right)^2}{\Omega} = \frac{V^2}{\Omega} = W$$

(+2)

Check Limiting Cases:

Expect as $\Delta V_S \to \infty$, $P_{max} \to \infty$:

$$\lim_{\Delta V_S \to \infty} \frac{\left(\frac{\Delta V_S}{R_T + R_{\parallel}} \cdot R_{\parallel}\right)^2}{R} \to \infty,$$ so it works

(+2)

Obtain a numeric solution:

(i.e. plug in the numbers)

$\Delta V_S = 115V$

$R_T = 10\Omega$

$R = 5\Omega$

$R_{\parallel} = \frac{5\Omega \cdot 20\Omega}{5\Omega + 20\Omega} = 4\Omega$ (+1)

$$P_{max} = \frac{\left(\frac{115V}{10\Omega + 4\Omega} \cdot 4\Omega\right)^2}{5\Omega} = 216W$$

(+1)

Why is solution reasonable? Explain.

216 W makes sense; 100 W lightbulb feels really hot! 216 W makes sense for a toaster