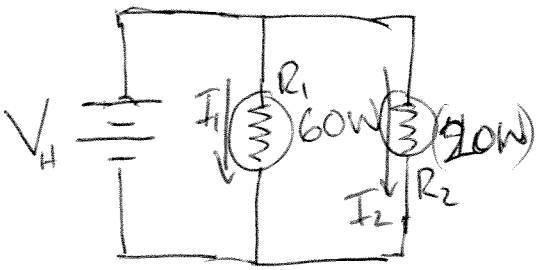
General Problem Solving Guide

Name:	KEY
Lab Time:	
Date:	APRIL 14 2011
Test Code:	EXAM 3
Problem #:	PROBLEM 22

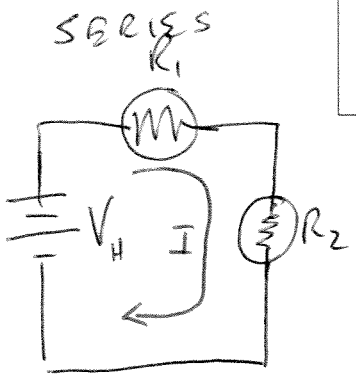
List given information, define variables, sketch picture:

PARALLEL



$V_H = 120V$

SERIES



[2] -

NOTE: HOUSEHOLD VOLTAGE IS AC ~ NOT DC ⏚ BUT EFFECTIVELY ACTS IT

Simplify question, list target quantity:

[1/2] WHICH LIGHT IS BRIGHTEST (USES MOST POWER) WHEN WIRED IN SERIES

List all related quantitative relationships:

$P = VI$ and $V = IR$ *ASSUME LIGHTBULBS ARE RESISTORS

[2] $\therefore P = \frac{V^2}{R}$ $P = I^2R$

$R_{TOT} = \sum_i R_i$ (SERIES) $R_{TOT} = \left[\sum_i \frac{1}{R_i}\right]^{-1}$ PARALLEL

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

[1/2] (1) FIND RESISTANCES OF EACH BULB WHEN IN PARALLEL USING KNOWN POWER RATINGS

(2) USE BULB RESISTANCES TO FIND CURRENT AND HENCE POWER USED BY EACH BULB IN SERIES

I

Obtain a general solution:

① VOLTAGE ACROSS EACH BULB IS SAME IN PARALLEL.

$P = \frac{V^2}{R}$ $V = 120V$

$R_1 = \frac{(120V)^2}{60W} = 240\Omega$

$R_2 = \frac{(120V)^2}{20W} = 720\Omega$

② CURRENT THROUGH EACH RESISTOR IS THE SAME IN SERIES.

$R_{TOT} = R_1 + R_2 = 960\Omega$

$\frac{V_{TOT}}{R_{TOT}} = I_{TOT} = 0.125\,A$

$P_r = I^2 R$

$P_1 = (0.125A)^2 \cdot 240\Omega = 3.75W$

$P_2 = (0.125A)^2 \cdot 720\Omega = 11.25W$

↑ REQUIRES MORE VOLTAGE

$V_2 = I R_2 = 90V$

$V_1 = I R_1 = 30V$

$V_{TOT} = V_1 + V_2$ ✓

↳ $\Sigma V = 0$ around any loop

Check Units:

$\Omega = \frac{V^2}{W} = \frac{V^2}{VA} = \frac{V}{A} = \Omega$ ✓

II

$\frac{V}{\Omega} = A$ ✓

$W = A^2\Omega = A(A\Omega) = AV$ ✓

Check Limiting Cases:

I

① $P\uparrow$ $R\downarrow$ ✓ PATH OF LEAST RESISTANCE

$V\uparrow$ $R\uparrow$ ✓ EASIER TO PUSH THROUGH BIG R WITH BIG V

② $R_{TOT}\uparrow$ $I_{TOT}\downarrow$ ✓

$I\uparrow$ $P\uparrow$ ✓

$R\uparrow$ $P\uparrow$ ✓

Obtain a numeric solution:
(i.e. plug in the numbers)

I

PARALLEL		SERIES
60W	→	3.75W
20W	→	11.25W ← BRIGHT

"DIM" BULB IS NOW THE BRIGHT ONE

Why is solution reasonable? Explain.

II

- UNITS CHECK
- LIMITING CASES CHECK
- BIGGER RESISTANCE IN SERIES USES MORE OF THE VOLTAGE AND HENCE POWER
- BIGGER POWER USED IN PARALLEL IS PATH OF LEAST RESISTANCE (LOWEST R)