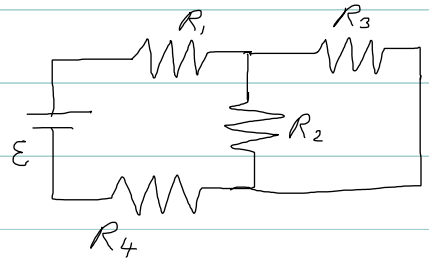

$R_1 = R_2 = 20\Omega$, $R_3 = 30\Omega$, $R_4 = 80\Omega$

IF $\mathcal{E} = 12V$ (a) USE KIRCHHOFF'S LAWS TO FIND THE CURRENT THROUGH THE BATTERY (b) SIMPLIFY PART OF THE CIRCUIT USING THE RULES FOR RESISTORS IN PARALLEL AND CHECK YOUR RESULT FOR PART (a), (c) IF $R_1 = R_2 = R_3 = R_4$ WHICH ONE RESISTOR SHOULD BE REMOVED TO MAXIMIZE THE LIFETIME OF THE BATTERY?

(a) (i) DRAW 2 LOOPS IN THE SAME DIRECTION IN THE CIRCUIT THAT WE WILL USE TO APPLY KIRCHHOFF'S LOOP RULE (ii) DRAW THE DIRECTION IN WHICH THE EMF INCREASES (iii) DRAW THE DIRECTION OF THE CURRENT IN EACH "WIRE" PART OF THE CIRCUIT. THE ONLY THING TO ENSURE IS THAT NO JUNCTION ONLY HAS CURRENT LEAVING OR ENTERING IT (iv) WRITE DOWN AN EQUATION DESCRIBING LOOP 1 (v) WRITE DOWN AN EQUATION FOR LOOP 2 (vi) CHOOSE A 3-WAY JUNCTION AND WRITE DOWN AN EQUATION RELATING THE CURRENT ENTERING AND LEAVING THE JUNCTION (vii) SOLVE THE 3 SIMULTANEOUS EQUATIONS FROM (iv), (v) AND (vi) TO DETERMINE THE CURRENT THROUGH THE BATTERY.

(b) (i) CAN YOU REMOVE ONE LOOP FROM THE CIRCUIT USING THE RULE FOR RESISTORS IN PARALLEL? (ii) CAN YOU REPEAT THE PROCESS FROM (a) TO FIND A SIMPLER WAY TO DETERMINE THE CURRENT THROUGH THE BATTERY?

(c) (i) TO MAXIMIZE THE BATTERY'S TIME, WE MUST MINIMIZE THE POWER IN THE CIRCUIT, WHY? (ii) TO MINIMIZE THE POWER WE MUST MAXIMIZE THE EQUIVALENT RESISTANCE. WHY?

(iii) WRITE DOWN EXPRESSIONS FOR R_{EQ} REMOVING R_1, R_2, R_3 AND R_4, REMEMBERING THAT, FOR THIS QUESTION, $R_1 = R_2 = R_3 = R_4 = R$, DO YOU HAVE TO WRITE DOWN EQUATIONS FOR EACH CASE, OR ARE SOME OF THEM THE SAME?! (iv) REMOVING WHICH RESISTOR MAXIMIZES R_{EQ}?!