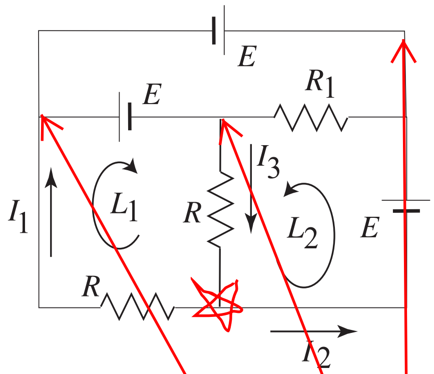
Physics 102 (F16) Q5C

Name: ____________ **Section:** ________ **Score:** ________/20

1. All the batteries have the same electromotive force E. Find the current I in terms of E and R.



(1) What is the relation among I_1, I_2 and I_3 [3]?

Kirchhoff junction rule

Consider the red star junction: I3 comes in, but I1 and I2 go out. Hence I3 - I1 - I2 = 0.

(2) Write down the loop equation for loop L_1 [3].

Assume this voltage is zero

current direction going down

5 V here

I1 goes down.
E goes down
I3 goes down
Hence, -IR -E - I3R = 0

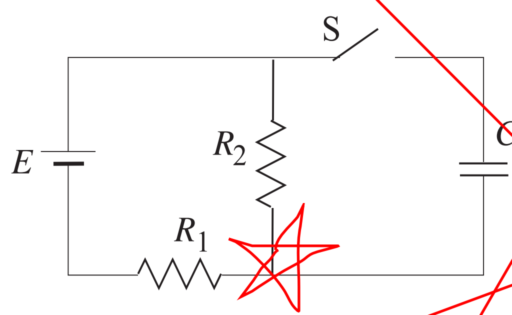
10 V here

(3) Find the current through R_1. Assume all resistors are 2 Ω and all the batteries supply 5 V. [4].

Ohm's law

Thus, the voltage across R1 is 10 V.
Therefore, I = 10/R1 = 10/2 = 5 A.

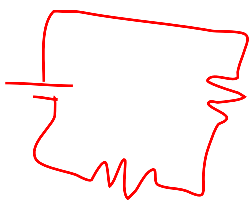
2. The voltage $E = 20$ V, $R_1 = R_2 = 4$ kΩ and the capacitance $C = 8$ μF. Initially, the switch S is open and the capacitor has no charge.



Principle:
The voltage across C cannot change immediately.

Try to draw an effective circuit.

(1) What is the current through R_1? [3]



series connection; Ohm's law

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I = E/(R1 + R2) = 20/8000 = 2.5 mA.
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(2) Now, at $t = 0$ switch S is closed. Immediately after the switch is closed, what are the current I_1 through resistor R_1 and the current I_2 through resistor R_2? [4]

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Thus, the voltage across C is zero. Therefore,
the voltage across R2  is 0, so I2 = 0.
Across R1 the voltage is E = 20 V. I_1 = E/R_1 = 20/4000 = 5 mA.
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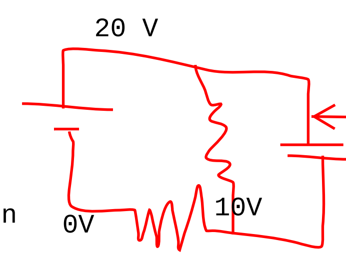
no voltage drop
no current

no charge
no voltage drop

(3) After a long time with switch S kept closed, what is the charge stored in capacitor C? [3]

After a long time, C is filled up.
No current through it



no current
you can remove it
to consider the
ciruit

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The effective circuit is just as (1).
Thus, the voltage at the star junction
is E/2 = 10 V.
Therefore, the voltage across C is 10 V.  Q = CV = 8x10^{-6} x 10 = 80 microC.
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