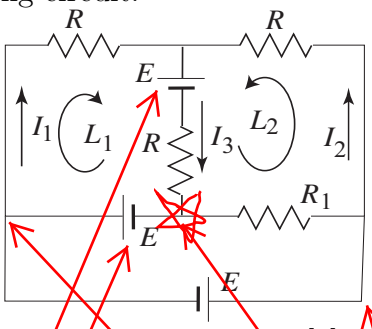
Physics 102 (F16)

Q6B

Name: _____ **Section:** _____ **Score:** _____/20

1. Consider the following circuit.



(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].

current direction going down

I1 goes down.
E goes down
I3 goes down
E goes up.
Hence, -I1R -E - I3R + E = (I1 + I3)R.

Assume this is 0 V

4 V here

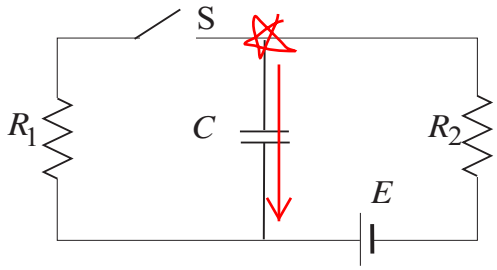
8 V here.

(3) Find the current through R_1. Assume all resistors are 6 Ω and all the batteries supply 4 V. [4].

Ohm's law

Thus, the voltage across R1 is 8 V.
Therefore, I = 8/R1 = 8/6 = 1.33 A.

2. The voltage $E = 20$ V, $R_1 = R_2 = 1$ kΩ and the capacitance $C = 3$ μF. Initially, the switch S is open for a long time.



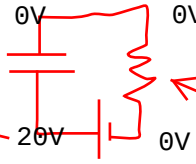
Principle:
The voltage across C cannot change immediately.

(1) What is the charge stored in capacitor C? [3]

Try to draw an effective circuit.

After a long time there is no current across C.

Thus, there is no current, so no voltage drop across R2. Thus, the voltage across C is E. Hence. Q = CV = 3x10^{-6} x 20 = 60 microC.

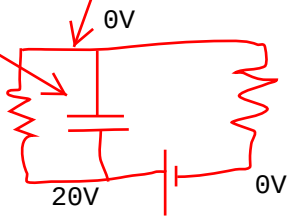


no current
no voltage drop

(2) Immediately after switch S is closed, what are the current I_1 through R_1 and the current I_2 through R_2? [4]

Thus, the voltage across C is 20 V with the red arrow as the direction ascending voltage.
There. there is no voltage across R2 -> I2 = 0.
20 V across R1 -> I1 = 20/R1 = 20/1000 = 0.02 A.

0 V across R2



(3) Long time after switch S is closed, what is the charge stored in capacitor C? [3]

C is full, and no current through it.

The voltage at the red star is E/2.
Thus 10 V across C -> Q = CV = 3x10^{-6} 1- = 30 microC.

no current through C, so you can remove this to consider the circuit