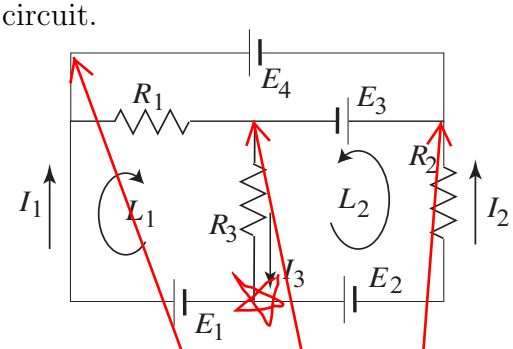
Physics 102 (F16) Q5A

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

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Consider the red star junction: I3 comes in, but I1 and I2 go out.  Hence
I3 - I1 - I2 = 0.
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(2) Write down the loop equation for loop L_2 [3].

current direction going down

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I2 goes down.
E3 goes down
I3 goes down
E2 goes down.
Hence, -I2R2 -E3 - I3R3 - E2 = 0
```

Let us assume this is 0V. Then

5 V here

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

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Thus, the voltage across R1 is 10 V.
Therefore, I = 10/R1 = 10/2 = 5 A.
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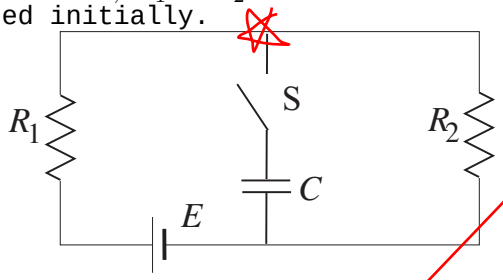
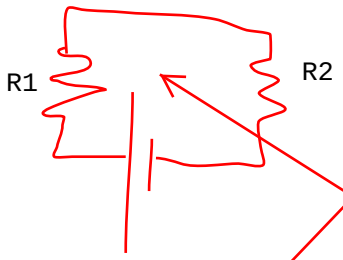
Try to draw an effective circuit.

2. The voltage $E = 20$ V, $R_1 = R_2 = 1$ kΩ and the capacitance $C = 5$ μF.
C is uncharged initially.



Principle:
The voltage across C cannot change immediately.

(1) Switch S has been open for a long time. What is the current through resistor R_1? [3]



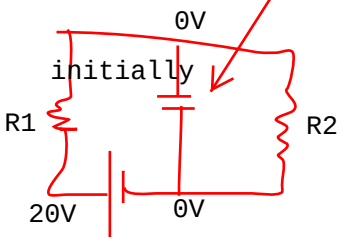
series connection; Ohm's law

I = E/(R1 + R2) = 20/2000 = 0.01 A.

The middle branch has no current initially,
so even if you remove it, nothing happens.

(2) Now, at $t = 0$ switch S is closed. What are the current I_1 through R_1 and current I_2 through R_2 immediately after the switch is closed? [4]

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 = 20/1000 = 0.02 A.



(3) After a long time what is the charge stored in the capacitor C? [3]

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

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 = 5 x 10^{-6} x 10 = 50 microC.