2025-2026 GullSO Invitational **Key**

Circuit Lab
KEY

December 13, 2025

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Exam Guidelines:

- You have 50 minutes to complete this exam, plus an extra 5-minute grace period at the end to organize your pages for submission. You will not be allowed to write anything during the grace period.
- You can take the test booklet apart (but you MUST put it back in order at the end).
- Point values are given for every question.
- Tiebreaker questions are denoted by the letters "TB".
- Write your answers on the provided answer sheet.
- **Grading notes:** Do *not* grade for significant figures unless specified. For any calculation whose answer is not a whole number, accept any value whose last digit is ±5 of the last digit of the answer.

DO NOT WRITE IN THIS TEST PACKET

DO NOT TURN THE PAGE UNTIL INSTRUCTED

For grading use only

Page:	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Points:	9	13	17	14	16	26	38	41	39	17	36	32	34	45	377

Multiple Choice Questions

1. (1 point) In which of the following charge configurations would the force between the two charges be attractive? (select all that apply)

   A. −/− **B. −/+** **C. +/−** D. +/+

2. (1 point) Consider a point charge of magnitude q. How does the strength of the electric field generated change as the distance r to the charge grows?

   A. It increases proportionally with r.
   B. It increases proportionally with r^2.
   C. It decreases proportionally with $1/r$.
   D. It decreases proportionally with $1/r^2$.
   E. It is 0.

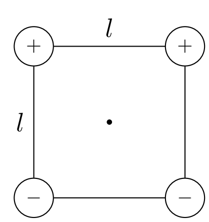
3. (2 points) Consider a solid *conducting* sphere of radius R and total charge Q. How does the strength of the electric field generated change as the distance $r < R$ from the center grows?

   A. It increases proportionally with r.
   B. It increases proportionally with r^2.
   C. It decreases proportionally with $1/r$.
   D. It decreases proportionally with $1/r^2$.
   E. It is 0.

4. (2 points) Consider a solid *insulating* sphere with uniform charge density of radius R and total charge Q. How does the strength of the electric field generated change as the distance $r < R$ from the center grows?

   A. It increases proportionally with r.
   B. It increases proportionally with r^2.
   C. It decreases proportionally with $1/r$.
   D. It decreases proportionally with $1/r^2$.
   E. It is 0.

5. Consider the following charge configuration. All charges are of magnitude q.



   (a) (1 point) What is the direction of the net electric field at the center due to the four charges?

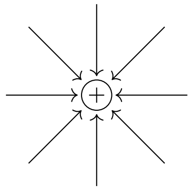
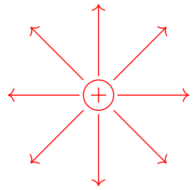
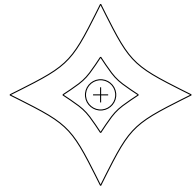
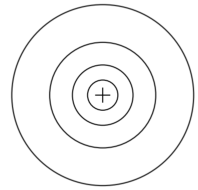
   A. ← B. → **C. ↓** D. ⊗ E. ⊙

   (b) (2 points) What is the electric potential at the center?

   A. 0 B. ∞ C. $-\infty$ D. $\frac{\sqrt{2}q}{\pi\epsilon_0 l^2}$ E. $\frac{\sqrt{2}q}{\pi\epsilon_0 l}$

6. Consider a single point charge with a charge of +1nC.

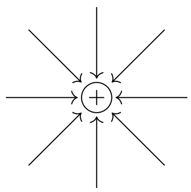
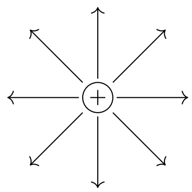
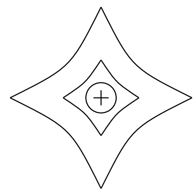
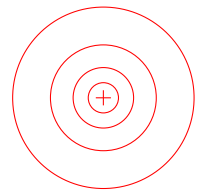
(a) (1 point) Which of the following is closest to the electric field lines of the charge?

A.  **B.**  C.  D. 

(b) (2 points) Which of the following is closest to the strength of the electric field 0.7 m away from the point charge?

A. $1.84 \cdot 10^{-1}$ N/C
B. $1.84 \cdot 10^{1}$ N/C
C. $1.84 \cdot 10^{4}$ N/C
D. $1.84 \cdot 10^{6}$ N/C
E. $1.84 \cdot 10^{10}$ N/C

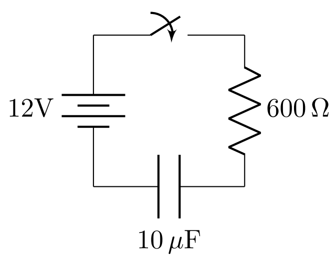
(c) (1 point) Which of the following is closest to the equipotential lines for this charge?

A.  B.  C.  **D.** 

(d) (2 points) What is the work done on a charge moved along an equipotential line?

A. 0 B. A nonzero constant C. ∞ D. Not enough information

7. Consider the following RC circuit with a fully discharged, ideal capacitor. The switch is closed at time $t = 0$.



(a) (2 points) At time $t = 0$, how much current flows between the plates of the ideal capacitor?

A. 0mA B. 7.36mA C. 12.6mA D. 20mA E. 50A

(b) (2 points) At time $t = 0$, how much current flows through the resistor?

A. 0mA B. 7.36mA C. 12.6mA **D.** 20mA E. 50A

(c) (2 points) Which of the following modifications would *increase* the capacitance of the parallel-plate capacitor? (select all that apply)

A. Increasing the area of the plates.
B. Increasing the separation of the plates.
C. Increasing the permittivity of the dielectric.
D. Increasing the thickness of the plates.
E. Increasing the conductivity of the plates.

8. (1 point) Which measurement device would be best suited for measuring the voltage across a DC voltage source?

A. Oscilloscope B. Ammeter C. Clamp meter D. Ohmmeter **E. Voltmeter**

9. (1 point) What is the resistance of an ideal ammeter?

   A. 0

   B. ∞

   C. Matched to the resistance of the circuit

   D. The resistance doesn't matter

   E. 50Ω

10. (1 point) Which of the following generators create a DC output?

    A. Magneto

    B. Induction generator

    C. Linear alternator

    D. Stirling engine

    E. Faraday disk

11. (1 point) What is the tolerance of a four band resistor whose bands are red yellow black gold (in this order)?

    A. $\pm 1\%$ B. $\pm 2.5\%$ **C.** $\pm 5\%$ D. $\pm 10\%$ E. $\pm 25\%$

12. (2 points) Given a square wave with an amplitude of 120 V, which of the following is closest to the RMS voltage of this wave? Note that this is a square wave where the voltage alternates between 120 V and -120 V and not a pulse wave.

    A. 0 B. 85 V **C. 120 V** D. 170 V E. 240 V

13. (2 points) Given a sinusoidal wave with an amplitude of 120 V, which of the following is closest to the RMS voltage of this wave?

    A. 0 **B. 85 V** C. 120 V D. 170 V E. 240 V

14. (2 points) Why aren't birds electrocuted whlie standing on power lines?

    A. Bird feet are excellent insulators.

    B. Birds can handle significantly larger currents running through their bodies than humans.

    C. There is no voltage difference between the feet of the birds.

    D. They are charging and absorbing the power on the lines.

15. (1 point) Which of the following is the SI unit for current?

    A. Ampere B. Joule C. Ohm D. Second E. Watt

16. (1 point) Which of the following is the SI unit for energy?

    A. Ampere **B. Joule** C. Ohm D. Second E. Watt

17. (2 points) Which of the following are equivalent to 1 ampere? Select all that apply.

    A. 1 $\mathrm{Cs^{-1}}$ B. $1\ \mathrm{C \cdot s}$ C. $1\ \mathrm{V \cdot \Omega}$ **D. 1** $\mathrm{V\Omega^{-1}}$ **E. 1** $\mathrm{JV^{-1}s^{-1}}$

18. (2 points) Which of the following is closest to the magnitude of the strength of the magnetic field of the Earth?

    A. 50 μT B. 1 μT C. 50 mT D. 1 mT E. 1 T

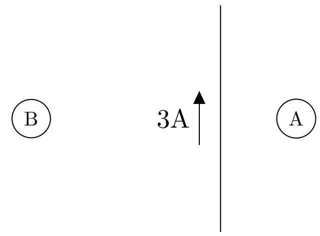
19. (2 points) Which of the following is closest to the magnitude of the strength of the magnetic field of an MRI?

    A. 50 μT B. 1 μT C. 50 mT D. 1 mT **E. 1** T

20. (3 points) Assuming that a constant current is running through an infinitely long solenoid, changing which of the following would change the magnetic field strength at the center of the solenoid (select all that apply)?

    A. Core material B. Coil diameter **C. Number of coils** D. Resistance of coils

21. Consider a solitary vertical wire with current running from the bottom of the page to the top as shown below. You may assume that it has infinite length.



   (a) (1 point) Which direction is the magnetic field facing at point A?

   A. → B. ↑ C. ↓ **D. ⊗** E. ⊙

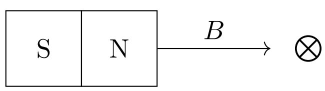
   (b) (1 point) Which direction is the magnetic field facing at point B?

   A. → B. ↑ C. ↓ D. ⊗ **E. ⊙**

   (c) (2 points) At which point is the magnetic field stronger?

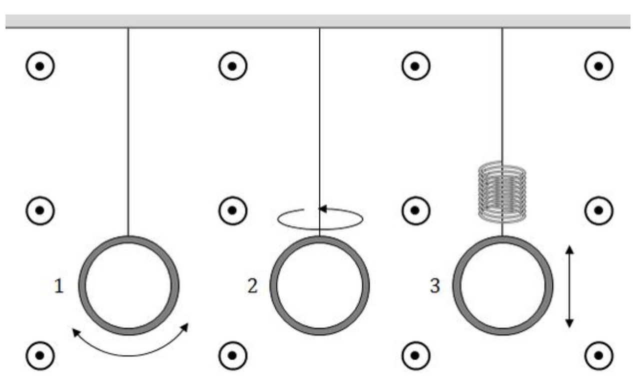
   A. A B. B C. Both are equal and zero D. Both are equal and nonzero

22. (3 points) A beam of electrons is going straight into the page. You bring a magnet perpendicular nearby such that the magnetic field B points to the right. Which way will the electron beam deflect?



   A. → **B. ↑** C. ↓ D. ← E. It does not deflect.

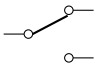
23. (2 points) Three loops of wire are shown in the figure below in the same uniform and unchanging magnetic field. Loop 1 swings back and forth like a pendulum in the plane of the page, loop 2 is rotating about its vertical axis, and loop 3 oscillates up and down with a spring. Which loop(s) have an induced emf?



   A. Loop 1 only **B. Loop 2 only** C. Loop 3 only D. Loops 1 and 3 E. None of them.

24. (2 points) What is the resistance (in Ω) of an ideal switch in its open and closed positions respectively?

    A. 0, 1 B. 1, 0 C. 1, ∞ D. 0, ∞ **E. ∞, 0**



25. (2 points) What type of switch is the image above?

    A. SPST **B. SPDT** C. DPST D. DPDT

26. (1 point) Which of the following is a circuit device that has a resistance that can be manually adjusted, usually by mechanical means, to control current flow?

    A. Photoresistor **B. Rheostat** C. Solenoid D. Thermocouple

27. (1 point) How long does it take a typical fuse to "reset" and begin functioning again? (i.e. after it is used, how long will it be until it can be used again)

    A. Almost instantaneously B. A few seconds C. A few minutes **D. Never**

Note: the terms "inventor" and "scientist" (and whatever other terms you might use to describe these individuals) are taken to be synonymous in these questions.

28. (1 point) Which scientist from the rules invented the solenoid?

    A. Ampère B. Faraday C. Ohm D. Tesla E. Volta

29. (1 point) The SI unit for capacitance is named after which scientist?

    A. Ampère B. Coulomb **C. Faraday** D. Kirchhoff E. Tesla

30. (1 point) During a feud with Luigi Galvani, which scientist invented the voltaic pile?

    A. Ampère B. Faraday C. Kirchhoff D. Ohm **E. Volta**

31. (2 points) Which scientist determined that electric signals in an ideal wire travel at the speed of light?

    A. Ampère B. Faraday **C. Kirchhoff** D. Ohm E. Volta

32. (2 points) Which scientist's inventions were licensed and used by George Westinghouse?

    A. Coulomb B. Faraday C. Ohm **D. Tesla** E. Volta

33. (1 point) Which scientist's law is an alternative to the now discredited Barlow's Law?

    A. Coulomb B. Faraday **C. Ohm** D. Tesla E. Volta

34. (1 point) Which scientist created the first remote-control boat?

    A. Coulomb B. Faraday C. Kirchhoff D. Ohm **E. Tesla**

35. (2 points) The law stating that a changing magnetic field can induce an electric current is named after which scientist?

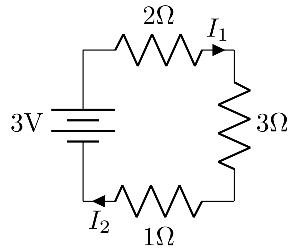
    A. Ampère **B. Faraday** C. Ohm D. Tesla E. Volta

36. (1 point) The law describing the strength of the force between two charges is named after which scientist?

    A. Ampère **B. Coulomb** C. Faraday D. Kirchhoff E. Tesla

Free Response Questions

37. Use the diagram below to solve the following question.



(a) (1 point) Are the resistors in this circuit in series or parallel?

(b) (1 point) If all of the resistors were replaced with a single equivalent resistor, what would the resistance of this equivalent resistor be (i.e. what is the equivalent resistance)?

(c) (1 point) What is the total current through the 2Ω resistor (I_1) in this circuit in mA?

(d) (1 point) What is the total current through the 1Ω resistor (I_2) in this circuit in mA?

(e) (3 points) If you wanted to replace the 3Ω resistor with a fuse, would a fuse rated for 1V be sufficient? Why or why not?

(f) (2 points) If you had to add another resistor in parallel with the 3Ω resistor, and have only a $1\,\mu\Omega$, $1\,\Omega$, and $1\,\text{M}\Omega$ resistor available, which one would you pick to minimize the increase in current? Why?

(g) Now consider adding two other 3Ω resistors in parallel with the 3Ω resistor (not shown). Use this modified circuit for the following subparts.

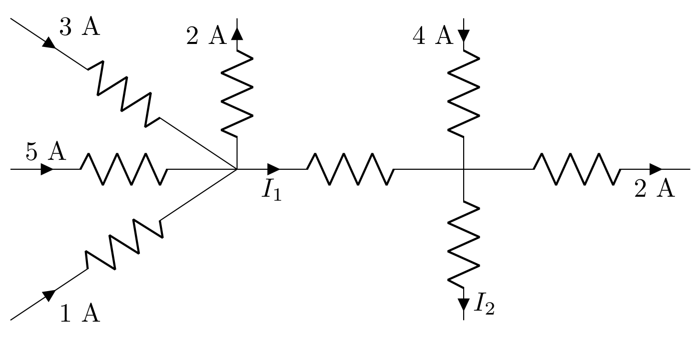
   i. (2 points) What is I_1?

   ii. (2 points) What is I_2?

   iii. (4 points) What is the current through each 3Ω resistor? Refer to the currents as I_L, I_C, and I_R for the 3Ω resistor that is on the left, center, and right respectively.

   iv. (2 points) Given what you just found, what is the equivalent resistance of n $m\,\Omega$ resistors placed in parallel with each other for any value of n? Your answer should be simple with no ellipses (...), using only m, n, and necessary constants.

38. Use the diagram below to solve the following question.



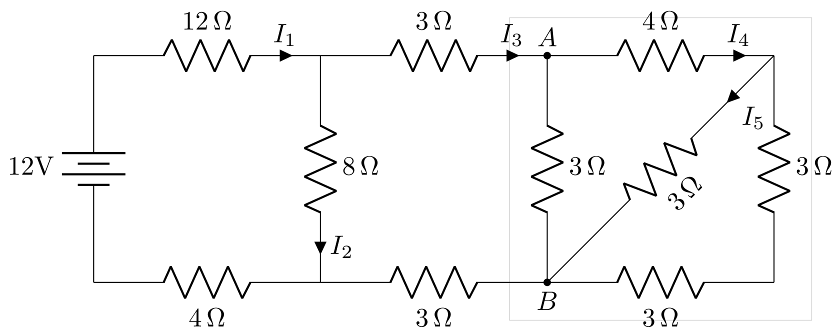
(a) (1 point) How many mA are in a single Ampere?

(b) (2 points) What law of circuits describes the current into and out of a node or junction?

(c) (2 points) What is I_1 (in Amperes)?

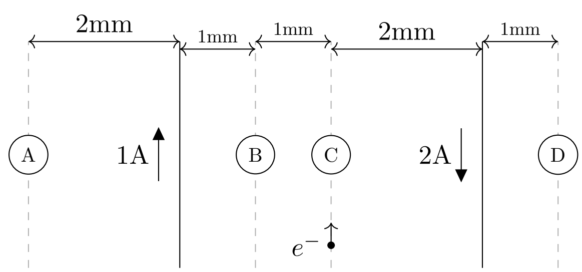
(d) (2 points) What is I_2 (in Amperes)?

39. Use the diagram below to solve the following question.



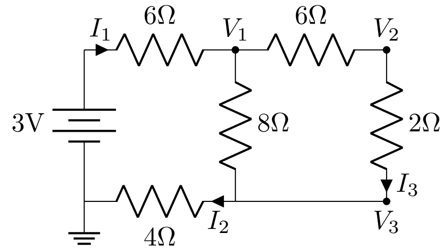
(a) (2 points) If you replaced the 8Ω resistor with a short, what would the new values of I_1 and I_2 be?
(b) (2 points) Consider only the part of the circuit in the gray box (it's everything to the right of nodes A and B). What is the equivalent resistance between points A and B?
(c) (3 points) What is the equivalent resistance of this circuit?
(d) (1 point) What is I_1 (in Amperes)?
(e) (1 point) What is I_2 (in Amperes)?
(f) (1 point) What is I_3 (in Amperes)?
(g) (1 point) What is I_4 (in Amperes)?
(h) (1 point) What is I_5 (in Amperes)?
(i) (2 points) What is the power dissipated by the 12 Ω resistor?

40. **(TB #3)** Use the diagram below to solve the following question. You may assume that both wires extend infinitely far in either direction. For all parts, disregard the magnetic field of the moving electron.



(a) (1 point) What is the SI unit for magnetic field?
(b) (2 points) Approximately how many gauss are in the SI unit for magnetic field?
(c) (1 point) At points B and C, are the magnetic fields pointing in the same direction or opposite directions?
(d) (2 points) At which of these points will the magnitude of the magnetic field be the strongest?
(e) (3 points) What is the magnitude and direction of the magnetic field at point A (in Gauss)?
(f) (3 points) What is the magnitude and direction of the magnetic field at point B (in Gauss)?
(g) (3 points) What is the magnitude and direction of the magnetic field at point C (in Gauss)?
(h) (3 points) What is the magnitude and direction of the magnetic field at point D (in Gauss)?
(i) (3 points) Consider an electron travelling upwards as shown with a velocity of 73 m/s. At this instant, what is the magnitude and direction of the force applied on the electron?
(j) (3 points) Now imagine the same electron, just travelling into the page instead of upwards (with the same speed). At this instant, what is the magnitude and direction of the force applied on the electron?

41. Use the diagram below to solve the following question. If a current is labelled as going in the wrong direction, write its value as negative in your answer.



(a) (3 points) Write the equation for the currents going into and out of the node/junction at V_1 in terms of V_1, V_2, and V_3.

(b) (2 points) What is the voltage at V_1 in volts?

(c) (2 points) What is the voltage at V_2 in volts?

(d) (2 points) What is the voltage at V_3 in volts?

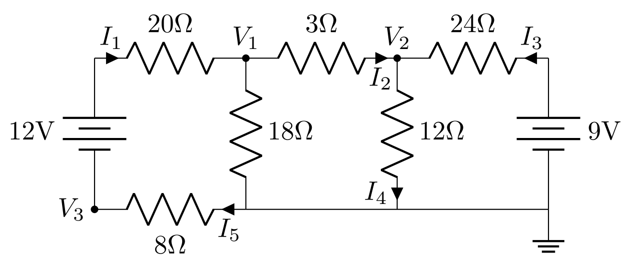
If you did not solve parts (b), (c), and (d), use $V_1 = 2V$, $V_2 = 1V$, and $V_3 = 0.5V$. Using these values to calculate the next three parts will not earn full credit, but you will earn some points if done correctly using these given values. (Note: yes, these values break circuit laws. Only the correct values will work).

(e) (2 points) What is I_1 in amperes?

(f) (2 points) What is I_2 in amperes?

(g) (2 points) What is I_3 in amperes?

42. **(TB #1)** Use the diagram below to solve the following question. If a current is labelled as going in the wrong direction, write its value as negative in your answer.



(a) (1 point) If you found a resistor with red, yellow, black, and gold bands (in that order), which resistor from this question could you replace with that resistor? If no resistor is sufficiently close to this mystery resistor, then say so.

(b) (1 point) What is the voltage at V_1 in volts?

(c) (1 point) What is the voltage at V_2 in volts?

(d) (1 point) What is the voltage at V_3 in volts?

(e) (2 points) What is I_1 in amperes?

(f) (2 points) What is I_2 in amperes?

(g) (2 points) What is I_3 in amperes?

(h) (2 points) What is I_4 in amperes?

(i) Treat the 18Ω resistor as the load for the following subparts.

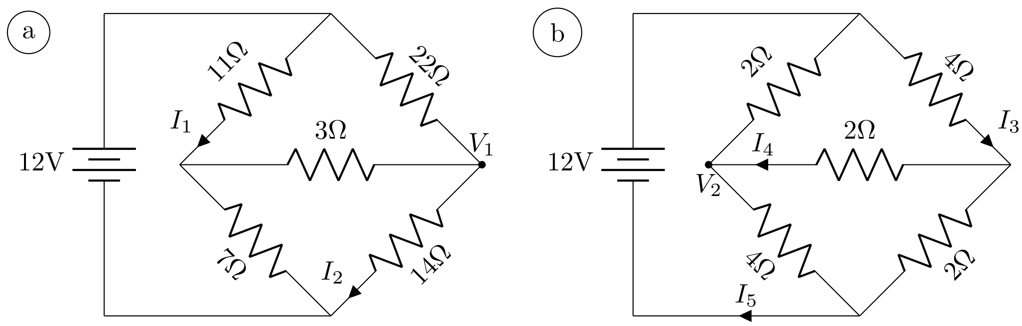
   i. (3 points) What is the Thevenin resistance?

   ii. (3 points) What is the Norton resistance?

   iii. (4 points) What is the Thevenin voltage?

   iv. (4 points) What is the Norton current?

43. Use the diagram below to solve the following question. If a current is labelled as going in the wrong direction, write its value as negative in your answer.



(a) (1 point) What is the name of this circuit?

(b) (2 points) Which of these circuits is balanced? Why?

(c) (1 point) What is the magnitude of the voltage drop across the 3Ω resistor in (a)?

(d) (1 point) What is the magnitude of the voltage drop across the 2Ω resistor in (b)?

(e) (2 points) What is the voltage at V_1?

(f) (2 points) What is the voltage at V_2?

(g) (2 points) What is I_1 in amperes?

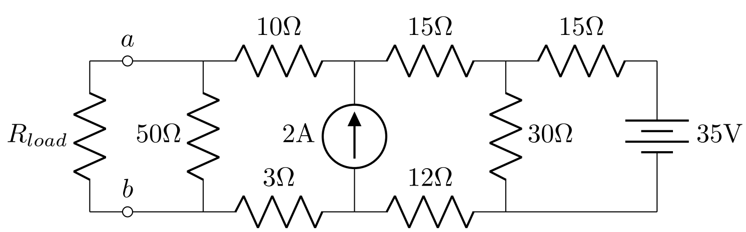
(h) (2 points) What is I_2 in amperes?

(i) (2 points) What is I_3 in amperes?

(j) (2 points) What is I_4 in amperes?

(k) (2 points) What is I_5 in amperes?

44. **(TB #2)** Use the diagram below to solve the following question. R_{load}, the load resistor, is located between nodes a and b.



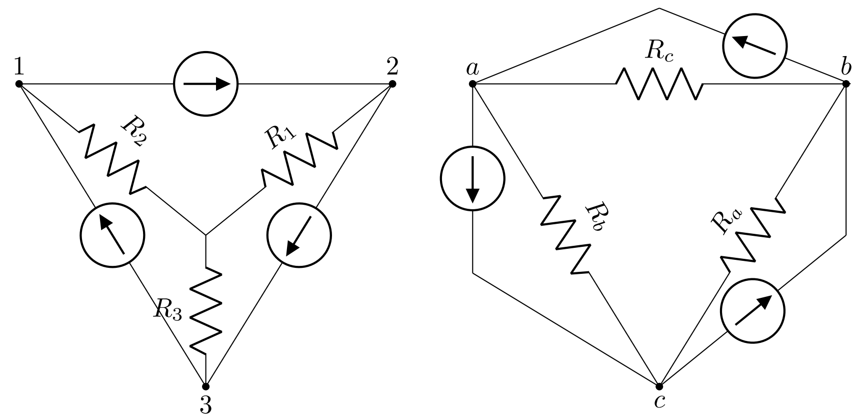
(a) (2 points) What is the Thevenin resistance?

(b) (2 points) What is the Norton resistance?

(c) (8 points) Draw the Thevenin equivalent circuit.

(d) (8 points) Draw the Norton equivalent circuit.

45. Use the diagram below to solve the following question. Assume all current sources are outputting 1 Ampere.



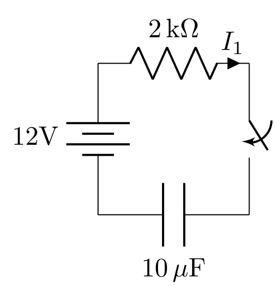
Your ultimate goal in this problem is to find an equivalence between the resistors of the wye shape and the delta shape. Keep this in mind as you are solving. Please simplify all answers into fractions (i.e. no inverses of sums of fractions).

(a) (1 point) Using the principle of superposition and considering only the topmost current source, what is the equivalent resistance between nodes 1 and 2.

(b) (1 point) Using the principle of superposition and considering only the topmost current source, what is the equivalent resistance between nodes a and b.

(c) (4 points) Now, write R_c in terms of R_1, R_2, R_3, R_a, and R_b.

46. Use the diagram below to solve the following question. Assume that the switch has been open for a long time and that the capacitor is fully discharged.



(a) (2 points) What is the time constant of this circuit?

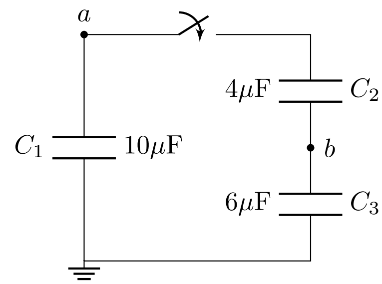
(b) (2 points) At the instant that the switch is flipped, how much current is passing through the resistor?

(c) (2 points) After exactly one time constant, approximately what percentage of the initial current will be passing through the resistor?

(d) (3 points) After exactly one time constant, how much charge will be stored by capacitor?

(e) (2 points) At the steady state, after the switch has been closed for a long time, what is the current through the resistor?

47. Now consider the following capacitor circuit. Before the switch is closed, C_1 is fully charged with a battery to 5V, while C_2 and C_3 are fully discharged. The switch is then closed and the circuit is allowed to reach a steady state.



(a) (2 points) Before the switch is closed, how much charge is on each capacitor?

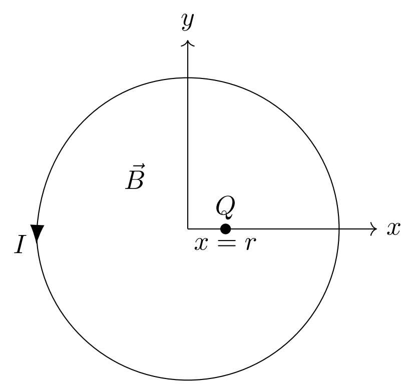
(b) (3 points) What is the voltage at node a at steady state?

(c) (4 points) How much charge is on each capacitor at steady state?

(d) (2 points) What is the voltage at node b at steady state?

(e) (5 points) Is the sum of the charge on all capacitors after steady state the same as the initial charge on C_1? If so, describe how charge flows after the switch is closed. If not, where are these extra charges coming from?

48. A very long continuous solenoid in a vacuum creates a uniform circular magnetic field in its center due to the counter-clockwise current I through it. A stationary positive charge $Q = +0.5\text{C}$ is placed in this magnetic field on the x-axis at a distance $r = 10\,\text{cm}$ from the center.



(a) (4 points) Given that the solenoid has a turn density of 500 turns/cm and is passing a constant current of 3A, what is the magnitude of the magnetic field B inside it?

(b) (2 points) What is the direction of the magnetic field?

(c) (2 points) In what direction does the positive charge Q feel a force, if at all?

(d) (2 points) What is the magnitude of this force?

(e) (4 points) Using the same solenoid configuration, we now *increase* the current through it at a rate of 2 A/s. What is the rate of change of the magnitude of the magnetic field B?

(f) (2 points) In what direction does the positive charge Q feel a force, if at all?

(g) (4 points) What is the magnitude of this force?

Hands-On Tasks

In this section, you have been given the components listed below to complete the following tasks.

- You may work on this section at any time.
- You may use any of the components for any of the tasks.
- Do not damage or destroy any of the components.
- For this section, **use correct significant figures** for all measurements and calculations derived from measurements.
- You will not be penalized for using an incorrect value from a previous part in following parts if you show your work.
- One resistor has been covered with tape to obscure its value. DO NOT REMOVE THIS TAPE AT ANY TIME!

Part	Count	Color Code
Multimeter	1	
3V Battery Pack	1	
AA Battery	2	
Red LED	1	
22 Ω Resistor	2	Red-Red-Black-Gold-Brown
47 Ω Resistor	2	Yellow-Violet-Black-Gold-Brown
220 Ω Resistor	2	Red-Red-Black-Black-Brown
4.7 kΩ Resistor	2	Yellow-Violet-Black-Brown-Brown
10 kΩ Resistor	2	Brown-Black-Black-Red-Brown
Mystery Resistor	1	?

49. Your kit contains a resistor that has been taped over so the value is unknown. Your task is to determine the value of the mystery resistor using ONLY *VOLTAGE* measurements.
   (a) (4 points) Build a circuit that will allow you to determine the mystery value. Once you have built it, let the ES know to get checked off for this step.
   (b) (4 points) Draw the schematic for the circuit that you built. Label all known, given values.
   (c) (6 points) Why did you pick this circuit? Include justification for the chosen component values, connections, etc. If you tried multiple arrangements or component values, discuss this here.
   (d) (4 points) What measurements did you take? Include them all here with correct sig-figs. Make it clear where these measurements are from – you may label this on your schematic if you wish.
   (e) (4 points) From your measurements, calculate the value of the mystery resistor with correct sig-figs.
   (f) (4 points) Use the multimeter to measure the mystery resistor and record it here. Calculate your percent error as $\frac{|actual - predicted|}{actual} \cdot 100\%$.
   (g) (6 points) Was your calculated value close to the actual value? Discuss any sources of potential error here. How might you increase the precision of your results?

50. Everyone likes an LED, but an LED can be picky about their power. Your task is to use the provided datasheet for your LED to determine the circuit parameters for optimal operation.
    (a) (1 point) What is the maximum continuous current the LED can handle?
    (b) (3 points) What is the maximum voltage across the LED at typical operating conditions? What are the conditions it was tested under?
    (c) (2 points) You want to light up your LED. Would it be a good idea to connect it directly to your battery pack? Why or why not?
    (d) (2 points) Draw a schematic of your circuit to correctly light up the LED. Components should be labeled but do not need numeric values.
    (e) (2 points) Briefly explain why you chose that circuit and the role of each component (besides the battery and LED).
    (f) (1 point) Let's say you wish to operate the LED with a 20mA forward current under typical behavior. What should the values of the components in your schematic be, assuming you could get any value you want?
    (g) (1 point) Unfortunately, we don't have every possible component. From what you have, which components would you use to build the circuit?
    (h) (4 points) Build the circuit you drew above using the components you chose. Once you have built it, let the ES know to get checked off.
    (i) (4 points) Your voltage source isn't ideal either. Assuming your battery voltage could be between 2.9V and 3.2V, and given the LED's typical and maximum forward voltage, what is the range of currents the LED could experience in the circuit that you built?
    (j) (2 points) Now you want your LED to be twice as bright. What current should you put through it to achieve this?
    (k) (2 points) Would it be okay to operate the LED at this current if the ambient temperature exceeded 70°C? Why or why not?
    (l) (2 points) What components should you use to achieve double brightness, if you could have one with any value? Which components do you have would you actually use?
    (m) (4 points) Build the circuit with your new component values. Measure the current through the circuit and record it here.
    (n) (4 points) Was the current what you expected? Why or why not? Is the LED actually twice as bright?

51. Voltage dividers are great and all, but what happens when you try to connect it to something? Your task is to design and build a voltage divider circuit that meets the following specifications. The "load" is what you have connected to your output; i.e. a 220Ω resistor connected to the output of your voltage divider will have 1.20V across it.

Input voltage	3.00V
Unloaded output voltage	1.25V
Minimum output voltage under 220Ω load	1.20V

(a) (5 points) Draw a schematic for your voltage divider circuit. Model the output load as a resistor R_L, and label your input/output voltages. Components should be labeled but do not need numerical values.

(b) (5 points) Derive a formula for your output voltage that depends on the values of the components in your schematic and any necessary constants.

(c) (4 points) Given the specifications above, choose ideal values for your components. Justify your choices.

(d) (6 points) Unfortunately, we (probably) don't have those exact resistor values. Using the resistors you have, come up with your best approximation for your ideal values. Draw a schematic of the circuit you will build on your breadboard, with input/output voltages labeled. If you were unable to find ideal values or their approximation, drawing and building any voltage divider circuit will earn points for the rest of this task.

(e) (4 points) Build the circuit you drew in the previous part. Do not include the load resistor. Once you have built it, let the ES know to get checked off for this step.

(f) (4 points) Use the multimeter to measure your input/output voltages and record it here using correct sig-figs.

(g) (2 points) Add the 220Ω load resistor and re-measure the output voltage, recording it here.

(h) (4 points) Use the multimeter to measure the voltage across each resistor in your loaded circuit. List all your measurements here.

(i) (5 points) Calculate the power consumed by each resistor and list them here. If your resistors were rated for 1/8W, would any of your resistors exceed their rating?

(j) (6 points) Does your circuit meet the design specification? Why or why not? What are some sources of error between the ideal model and your actual circuit?