



**SCIENCE OLYMPIAD**  
— AT THE —  
**UNIVERSITY OF FLORIDA**

Northern Regional: January 19<sup>th</sup>, 2019

# Circuit Lab C Test

**Name(s):** \_\_\_\_\_

**Team Name:** \_\_\_\_\_

**School Name:** \_\_\_\_\_

**Team Number:** \_\_\_\_\_

**Rank:** \_\_\_\_\_

**Score:** \_\_\_\_\_

**DO NOT write on the test.**

**Section 1:**

(1 point each) For # 1-8, match the scientist to their invention(s)/achievement(s):

- A. Volta
- B. Ohm
- C. Tesla
- D. Hertz
- E. Faraday

- 1. Voltaic Pile
- 2. AC Induction Motor
- 3. Wirelessly-Controlled Boat
- 4. Improved and popularized electrophorus
- 5. Discovered magnetism could affect rays of light
- 6. Photoelectric Effect
- 7. Proved the existence of electromagnetic waves
- 8. Proved that electricity could be generated chemically

**Section 2**

- 9. (3 points) This is a cat covered in styrofoam packing peanuts. This shows static electricity, but what is the effect that causes this called?

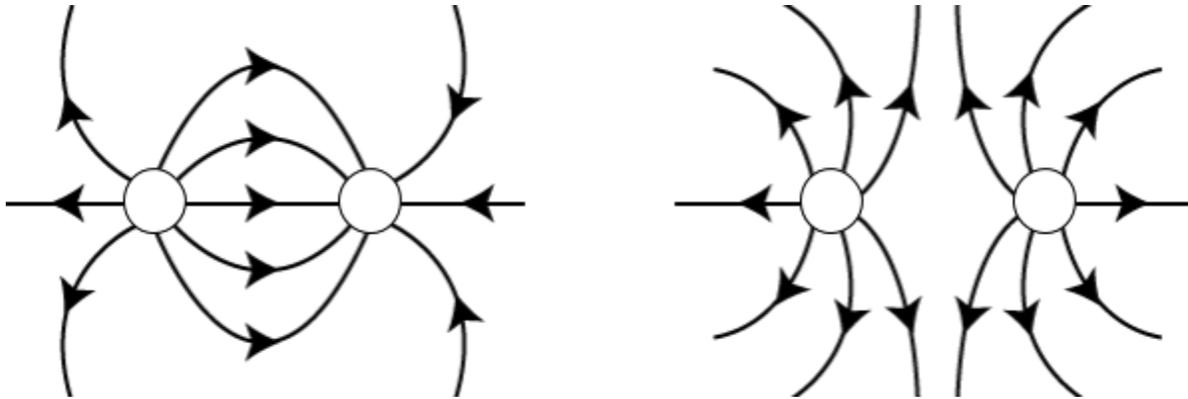


10. (4 points) Static electricity can be caused by four types of charge separation. Choose the four types from the list below: (Note: you cannot lose points for guessing so might as well choose four at random if you have no clue)

- a. Contact-Induced
- b. Movement-Induced
- c. Charge-Induced
- d. Structure-Induced
- e. Kinetic-Induced
- f. Heat-Induced
- g. Volume Reduction-Induced
- h. Pressure-Induced
- i. Bond-Induced
- j. Gas-Induced

11. (5 points, Tiebreaker 3) Imagine two point charges, one of which has the same charge as  $10^{20}$  electrons and the other having the same charge as  $10^{17}$  protons. At the instant that the point charges are 24 cm apart, what is the force between them (please state your answer in scientific notation)?

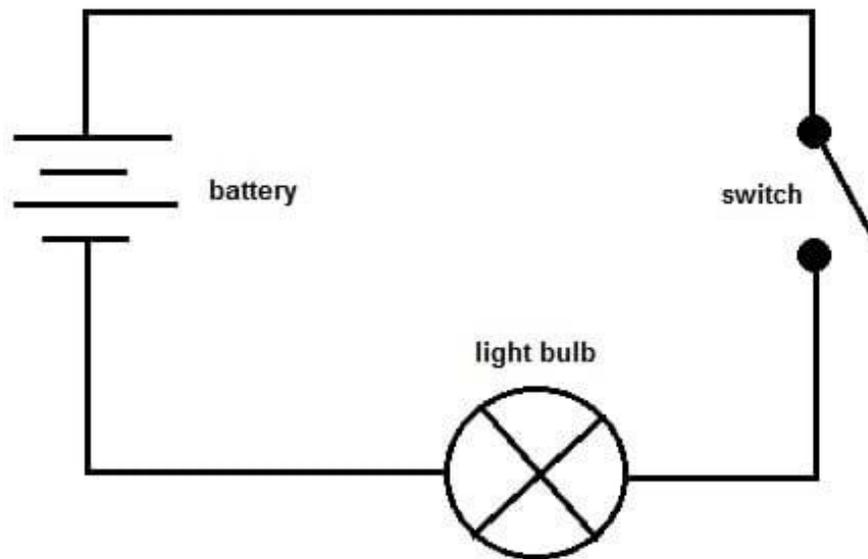
12. (4 points) Label each circle on the diagram below as either a positive or negative charge on your answer sheet.



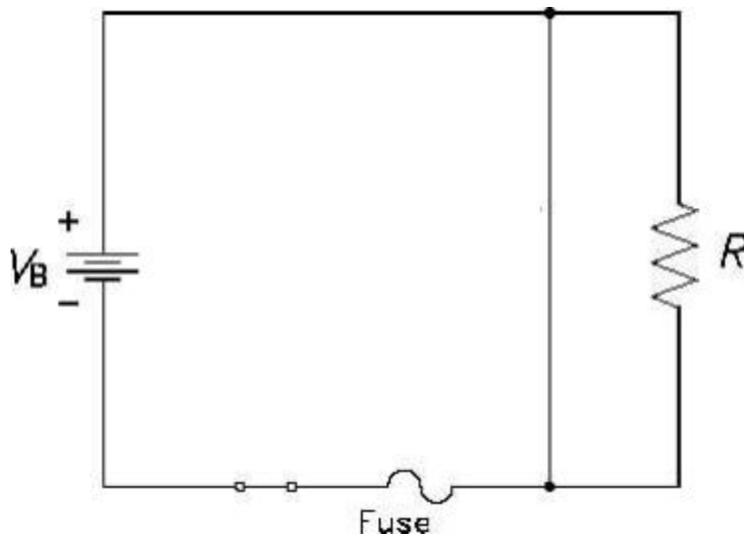
13. (5 points) A capacitor in air has two plates of area  $0.02\text{m}^2$ . Given that the plates are  $0.005\text{m}$  apart and are supplied with a voltage of  $20\text{V}$  from a battery, how much energy is stored in the capacitor when it is fully charged?

### Section 3

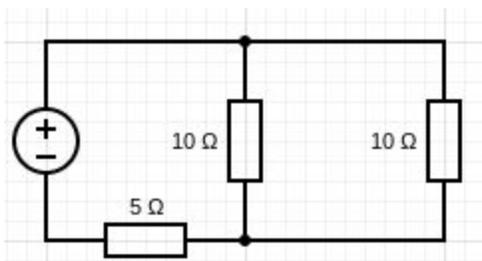
14. (3 points) Moth wants light. If in the circuit below, when the switch is close the bulb gives off 50W of power and the battery has a voltage of 20V, what is the resistance of the bulb?



15. (4 points) What is dangerous about this circuit?



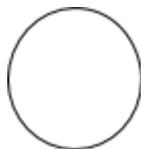
16. (4 points) The voltage source has a voltage of 10V. How much power is dissipated through the 5 Ohm resistor?



17. (2 points) If someone is shocked with a high voltage DC Current, what condition will occur pertaining to the heart?
18. (1 point) What is the most common household source of DC Current?

#### Section 4

19. (3 points) Imagine the circle below is a wire that you are facing head-on. Draw where electron flow would be if AC current was flowing through it.



20. (2 points) If someone is shocked with a high voltage AC Current, what condition will occur pertaining to the heart?
21. (1 point) True/False: AC Current comes out of wall sockets.
22. (1 point) True/False: Photocells produce AC Current.

#### Section 5

(2 points each) For numbers 23-27, express the following units in terms of SI base units

23. Amperes  
24. Volts  
25. Ohms  
26. Watts  
27. Joules

28. (1 point) State Ohm's Law in words.

## Section 6

29. (3 points) Draw the magnetic field lines around these two bar magnets:



30. (1 point) Are the magnets in Question 29 attracted or repulsed?

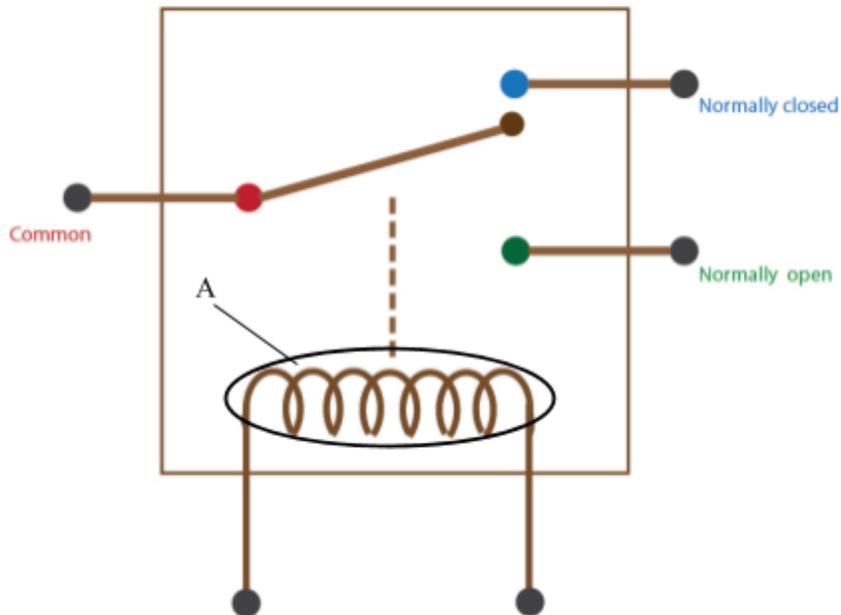
31. (1 point) A transformer puts out a voltage 3x more than was put in. Suggest what the number of coils in the primary loop could be if the secondary loop had 9 coils.

32. (4 points) What are the four types of DC motors?

33. (1 point) Magnetic field lines wrap counterclockwise around a vertical wire carrying current. What direction does the current move in?

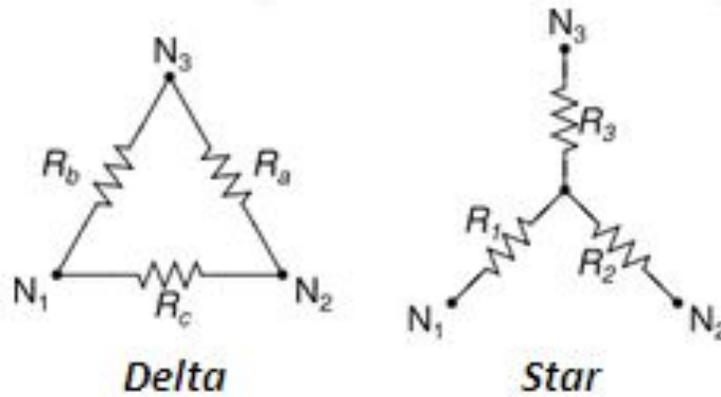
## Section 7

34. (6 points) What type of electrical control device is this? What is the structure labeled 'A'?

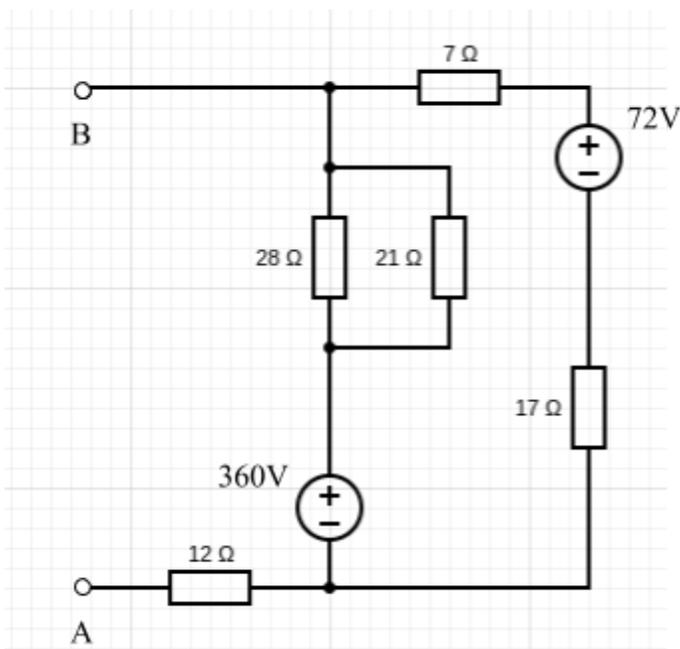


## Section 8

35. (6 points) Convert a delta configuration to a star configuration given that  $R_a=100\Omega$ ,  $R_b=250\Omega$ ,  $R_c=150\Omega$ .

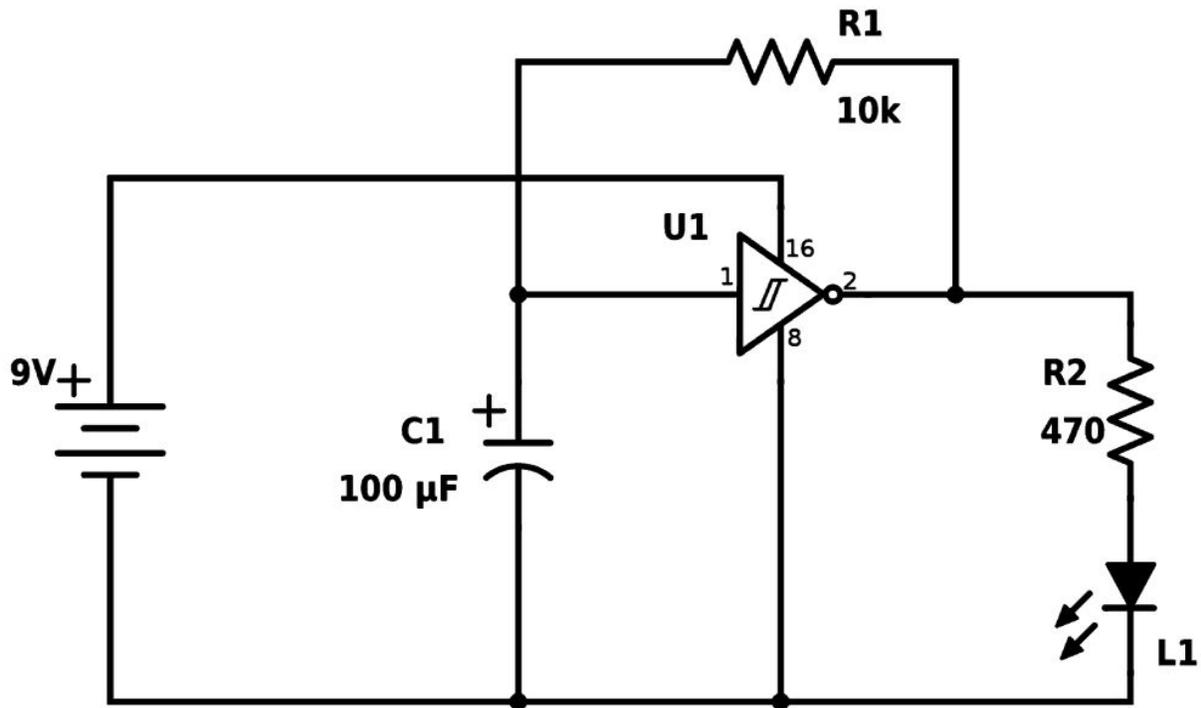


36. (8 points, Tiebreaker 2) Draw the Norton and Thevenin equivalent of the circuit below:



## Section 9

37. (2 points) On your answer sheet, circle the symbol that represents a LED.

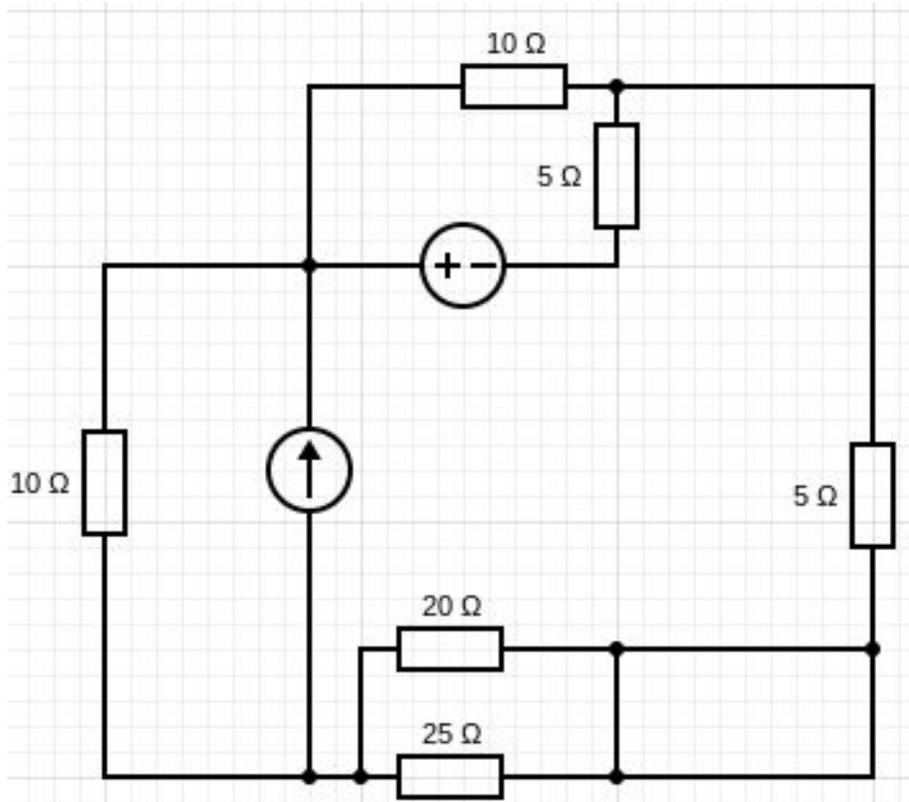


38. (1 point) What does LED stand for?

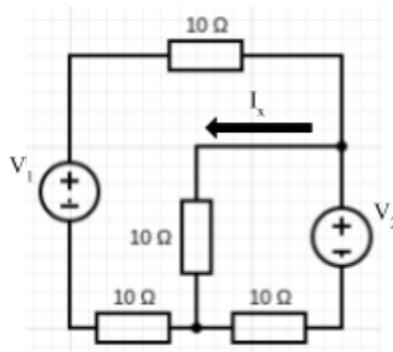
39. (2 points) What is the maximum current for a standard 5mm LED?

### Section 10

40. (15 points, Tiebreaker 1) The voltage source has a voltage of 50V and the current source has a current of 10A. How much current is flowing through the 20 Ohm resistor in the circuit shown below? (round to one decimal place)

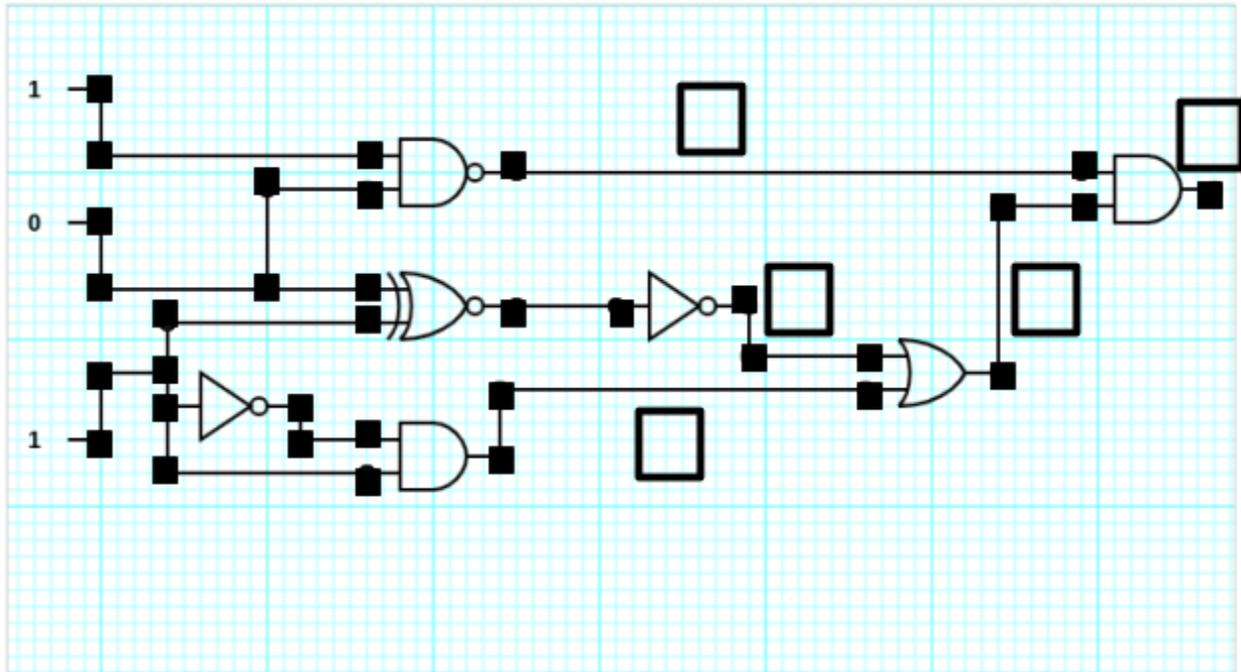


41. (8 points) If  $I_x = 3A$  and  $V_1 = V_2$ , what is the value of  $V_1$  and what is the value of  $V_2$ ?



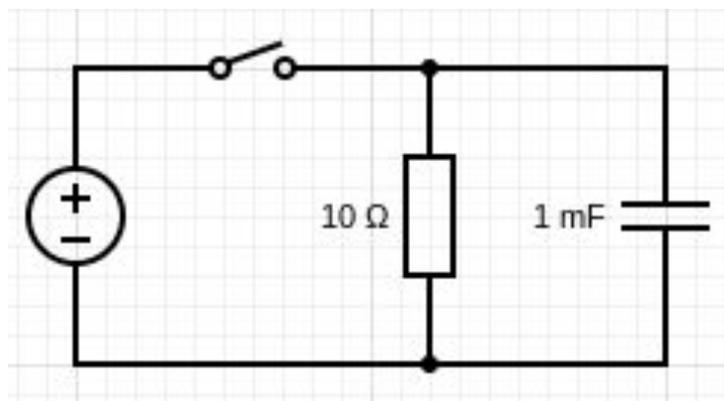
### Section 11

42. (10 points) Fill in the boxes with either 0 or 1 (true or false) to show what the input of each wire is.



### Section 12

43. (3 points) Imagine the switch in the circuit below has been open a very long time. When it is closed, how long will it take the capacitor to charge to 63% its maximum charge?

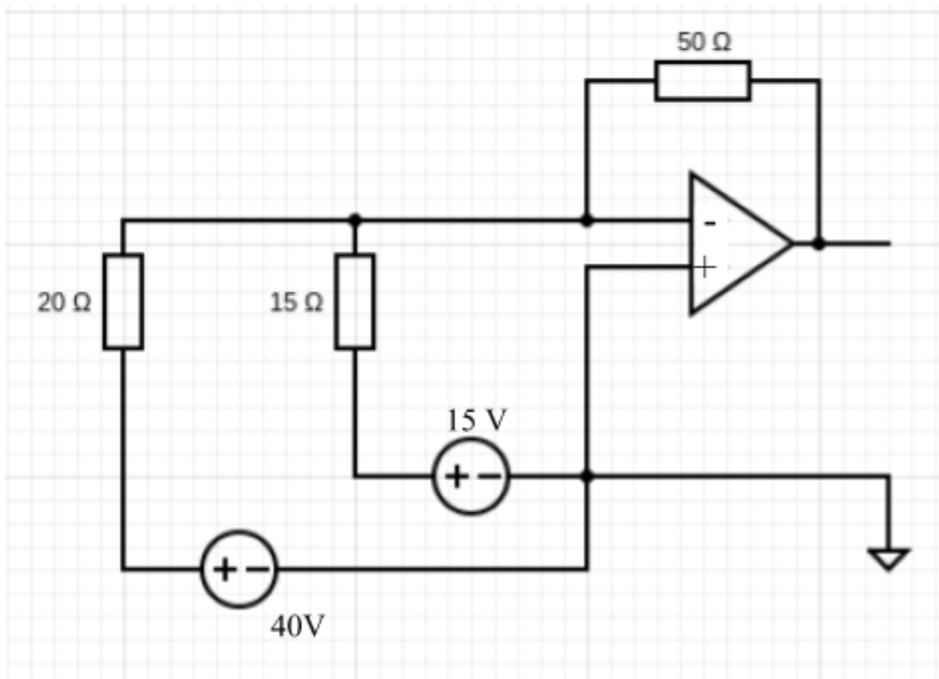


### Section 13

44. (12 points) Describe the terms “forward bias” and “reverse bias” in respect to a PN Junction.

### Section 14

45. (6 points) What is the output of this ideal op-amp circuit?



## Practical

You may do these questions in any order, however, Question 2 must be done prior to Question 3. If you choose to skip directly to Question 3, then **YOU WILL FORFEIT ALL POINTS FOR QUESTION 2.**

1. (15 points) With the nail and wire, create an electromagnet. Once you have completed it, bring it to an event supervisor or volunteer. They will provide you with a battery and 10 paper clips. You must test the electromagnet in front of them. Each paperclip picked up by the magnet (meaning it is lifted so that it has no contact with any surface for at least 3 seconds) is worth one point. You will have only 10 seconds, and the maximum number of paperclips during this interval will be your score for this question.
2. (25 points) You are provided with a set of 5 resistors and 3 batteries. Given these materials, create a circuit that would have approximately .000257 Amperes of current flowing through it. You should be able to determine the batteries' voltages by their shapes and sizes, and the resistors by their colored bands, so **DO NOT** use the multimeter for this question. The colored bands may be difficult to distinguish, so they are listed below. Imagine all sources and resistors are ideal.
  - Smaller blue resistor (1): Brown, black, black, red, gold
  - Larger tan resistors (4): Brown, black, yellow, gold

Note: When attempting to determine the total resistance you need, round to the nearest **thousand**, i.e.  $50V/.000257A = 194,552.5\dots\Omega$  would be rounded to  $195k\Omega$ .

After completing Question 2, please deliver the circuit you created to an event supervisor or volunteer. If you can't finish this question, go to an event supervisor or volunteer if you would like to move on to the next question. Please note, if you decide to skip to the second question, **YOU WILL BE FORFEITING THE POINTS FOR QUESTION 2.** This is because you will be provided with materials that may provide help in Question 2.

3. (10 points) You will be handed a battery and a set of resistors. **DO NOT** break apart the resistors, and **DO NOT** attempt to remove the tape from the second resistor. If you break apart the resistors, this may cause a delay due to limited supplies, but if you attempt to remove the tape, **YOU WILL BE PENALIZED.** The uncovered resistor is of the same variety as the tan resistor from Question 2, that is, its colored bands are brown, black, yellow, and gold in that order. Using the multimeter to measure **VOLTAGE ONLY**, determine the value of the mystery resistor. The multimeter should be taped so that it is only reading voltage, and again, if you attempt to remove the tape, **YOU WILL BE PENALIZED.** If you can't determine the value of the uncovered resistor from the given information, tell an event supervisor or volunteer. They will provide you with the value, but **YOU WILL LOSE HALF THE POINTS FOR THIS QUESTION.**