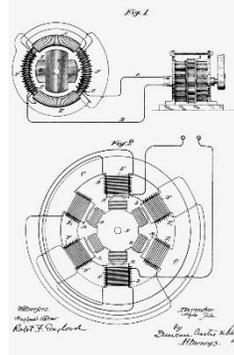


# SSSS Circuit Lab Test

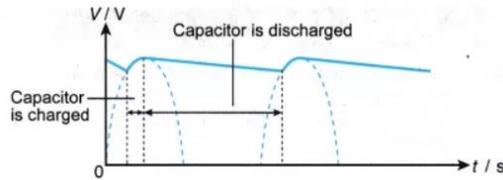
Multiple choice: 1 point each

1. Who invented this device?
  - a. Alessandro Volta
  - b. Georg Ohm
  - c. Michael Faraday
  - d. Nikola Tesla
  - e. Heinrich Hertz
2. Which is NOT something that Faraday discovered?
  - a. Electromagnetic induction
  - b. The relationship between electromagnetism and light
  - c. A set of differential equations to describe electromagnetism
  - d. Diamagnetism in certain materials
3. A comb is rubbed with hair. A separation of charges occurs. Which object gains a net positive charge?
  - a. The comb
  - b. The hair
  - c. Cannot be determined
4. What happens when a LED is in reverse bias?
  - a. No current flows, depletion layer is widened
  - b. No current flows, depletion layer is narrowed
  - c. Current flows, depletion layer is widened
  - d. Current flows, depletion layer is narrowed
  - e. A small amount of current flows, about 1/10 of the current that would flow if the LED was in forward bias. The depletion layer stays about the same size
5. Which is not a characteristic of an ideal op-amp?
  - a. In a closed loop (negative feedback), the current is 0 at  $V_+$  and  $V_-$ .
  - b. Infinite open-loop gain
  - c. Infinite input impedance
  - d. In a closed loop (negative feedback), the voltage at  $V_+$  is greater than  $V_-$ .
  - e. Zero output impedance



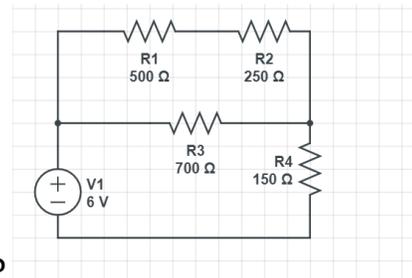
6. What will happen if you bring a charged object to a conductor that is grounded?
- The conductor will have a separation of charge but no overall net charge
  - Both the original object and the conductor will be charged with the same magnitude and sign of charge
  - The conductor will gain a charge opposite to the charged object
  - Nothing will happen

7. The following graph is a plot of a device's voltage over time. What is the



device?

- Single phase, full wave rectifier
- DC to AC inverter
- 3-phase, full wave rectifier
- Single phase, half wave rectifier
- AC generator



8. Which resistor dissipates the most power?

- R1
- R2
- R3
- R4

9. What part of a PN junction is doped with elements from group 13, has more holes than free electrons, and when in an LED, is the anode?

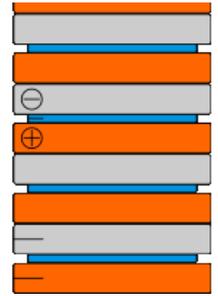
- P
- N
- Depletion layer
- Conduction band
- Valence band

10. What type of meter should be used to measure small amounts of current (<1 mA)
- Oscilloscope
  - Voltmeter
  - Ohmmeter
  - Galvanometer
  - Ammeter
11. Which of the following is NOT used in a dimmer switch (used to change how bright a light is)
- Variable resistor
  - Variable capacitor
  - Triac
  - Autotransformer
12. In a home, two switches are hooked up to a light so that both can control it. What type of digital logic switch is this analogous to? Assume both switches are in position "0" when off and position 1 when on.
- XOR
  - NAND
  - OR
  - XNOR
13. What is an advantage of AC over DC in transmission lines?
- AC allows power to be transmitted at a much lower voltage, which is more efficient
  - It is much safer
  - Electricity moves faster than it would in a DC system
  - Power can be transmitted at a high voltage which minimizes current and maximizes efficiency
14. What type of battery would one use if they want a non-rechargeable, dry battery?
- Alkaline
  - Lead-acid
  - Lithium-ion
  - Nickel cadmium

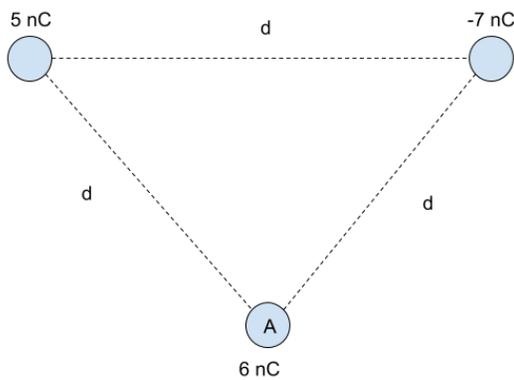
Short answer:

- 3 points, 1 per component: This is a voltaic cell, the earliest battery, invented by Alessandro Volta. Label the components and their composition

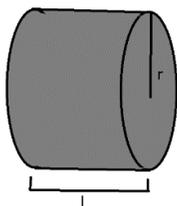
- Blue:
- Orange:
- Gray:



- Use the diagram below. All the charges are equidistant from each other, with a distance of  $d = 6 \text{ m}$ :

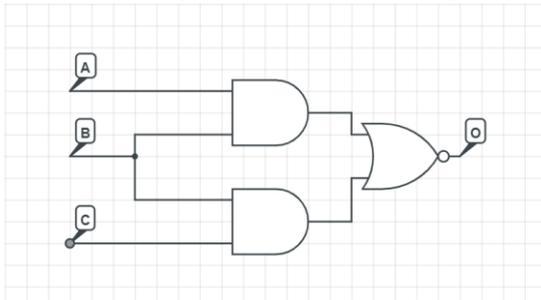


- 2 points: What the magnitude and direction of the force on charge A? The direction should be an angle counterclockwise from a horizontal line to the right starting from A
  - 1 point: If charge A is removed, what is the electric potential of the point where it used to be located?
  - 3 points: What is the magnitude and direction of the electric field in the center of the triangle? The direction should be an angle counterclockwise from a horizontal line to the right starting from the center.
- 4 points, 1 per question: Given a cylindrical graphite ( $\rho = 3 \cdot 10^{-3} \Omega \cdot \text{m}$ ) wire with radius  $r$  and height  $l$ , answer the following. Assume the wire is ohmic:



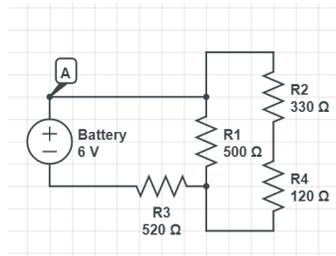
- a. With  $r = 5 \text{ cm}$  and  $l = 10 \text{ cm}$ , what is the resistance of this wire?
  - b. If the voltage drop across this wire is  $0.1 \text{ V}$ , how much current is flowing through the wire?
  - c. Using the answer from the previous question, how much coulombs of charge have moved through the wire in 10 seconds?
  - d. How much energy does this wire output in 10 seconds?
4. 5 points, 1 per question: Give the threshold for current in order for one to experience these:
- a. Slight tingling sensation
  - b. Slight shock, disturbing but not painful
  - c. Painful shock, begin to lose muscular control
  - d. Extreme pain, Muscular contractions (cannot let go)
  - e. Likely death
5. A hydroelectric power plant transmits electricity at  $100 \text{ kV}$ . When it reaches my house, the voltage is now  $99 \text{ kV}$ , before getting transformed to  $120 \text{ V}$ .
- a. If the transformer has 20 coils on the  $120 \text{ V}$  side, how many coils does it have on the  $99 \text{ kV}$  side?
  - b. Imagine an appliance is plugged into a  $120 \text{ V}$  outlet in your house. What is the *peak* voltage that the appliance uses?
  - c. If the appliance draws  $2 \text{ A}$  of current, what is the *peak* power that it draws?

6. Write a simplified Boolean expression with for O in terms of A, B, and C



7. Two electrons are  $5 \text{ nm}$  apart. What is the magnitude of force experienced by them?

8. What is the internal resistance of the battery if the current at node A is 7 mA?:



mA?:

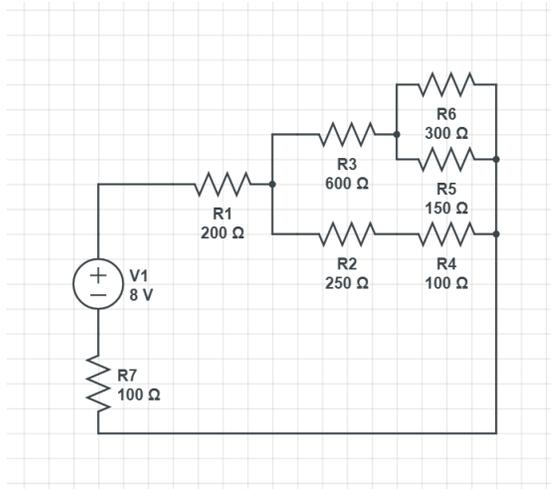
9. The magnitude of an electric field at a distance  $x$  from a point P is given by the equation:  $E = 3x - 1$

- If a charge of 5 nC is placed 5 cm from P, what is the magnitude of the force that it feels?
- Write an equation for the electric potential at a distance  $x$  from point P

10. Consider a large charged conductive plate

- What is the electric field inside the plate?
- If the plate has an area of  $100 \text{ m}^2$  and has a total charge of  $2 \mu\text{C}$ , what is the approximate electric field at close to but not on the plate?

11. What is the voltage drop, current, and power dissipated for each resistor?

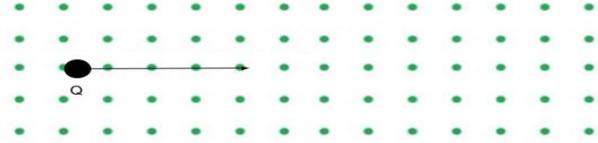


12. A parallel-plate capacitor (5 nF) with a dielectric made of air has a separation of .5 mm.

- What is the area of the plates in the capacitor?
- If the capacitor is charged to 10 V, what is the electric field inside the capacitor?

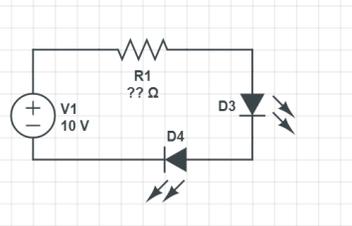
c. How much energy is stored in the capacitor when it is charged to 10 V?

13. Charge  $Q$  ( $5 \text{ nC}$ ) is moving at  $5 \text{ }\mu\text{m/s}$  when it encounters a magnetic field of  $0.02 \text{ T}$ , as shown below.



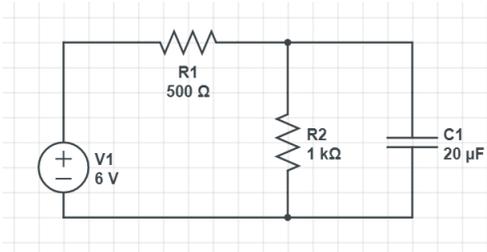
- What is the magnitude and direction of the force exerted by the magnetic field on the charge?
- Assuming no losses and the particle having a mass of  $5 \times 10^{-7} \text{ kg}$ , what is the radius of the particle's circular path as it travels through the magnetic field?

14. What value of  $R1$  should be used for the following circuit if  $D1$  has a forward voltage of  $2.5\text{V}$  and  $D2$  has a forward voltage of  $3\text{V}$ , and both LEDs use a current of  $20 \text{ mA}$ ?



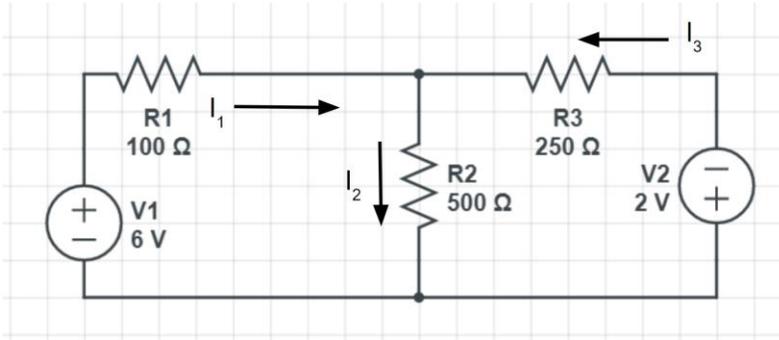
use a current of  $20 \text{ mA}$ ?

15. Given the following circuit, answer the following:



- In this scenario, what is the maximum amount of charge  $C1$  can hold?
- How long does it take for  $C1$  to charge within 99% of its maximum charge?
- Once  $C1$  is fully charged, we remove  $R1$  from the circuit (without reconnecting the wire). How much charge will remain in the capacitor after 0.5 seconds from when it starts discharging?

16. What are the values of  $I_1$ ,  $I_2$ , and  $I_3$  in the circuit below?



17. Fill in the table with the correct base SI units

Resistance ( $\Omega$ )	
Voltage (V)	
Coulombs (C)	
Teslas (T)	
Watts (W)	
Farad (F)	

18. 2 wires are placed parallel to each other.

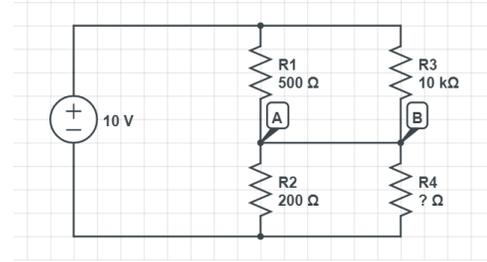
- If both of their current runs in the same direction, how do they move? What if the currents go in different directions?
- If one wire carries a current of 2 A, and another carries a current of 0.5 A, and the distance between them is 10 mm, what is the force per unit length on either of the wires?

19. Draw a schematic of a circuit that can be used to change the direction of current through a load (such as controlling the direction of a motor)

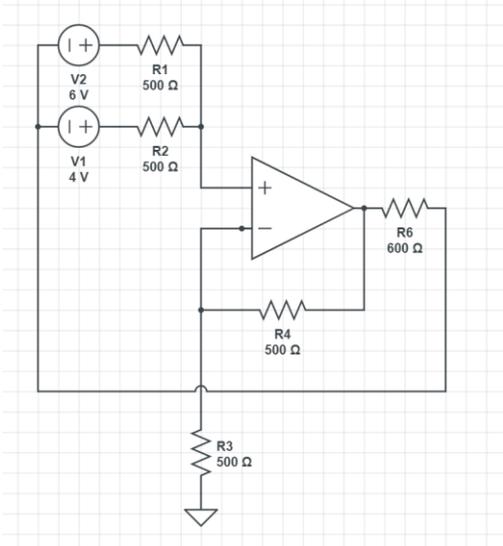
20. A solenoid with an iron core ( $\mu = 25 \text{ H/m}$ ) with 25 turns, a length of 3 cm, and has a current of 1.5 A flowing through it. What is the magnetic field inside the solenoid?

21. Use this circuit to answer the following questions:

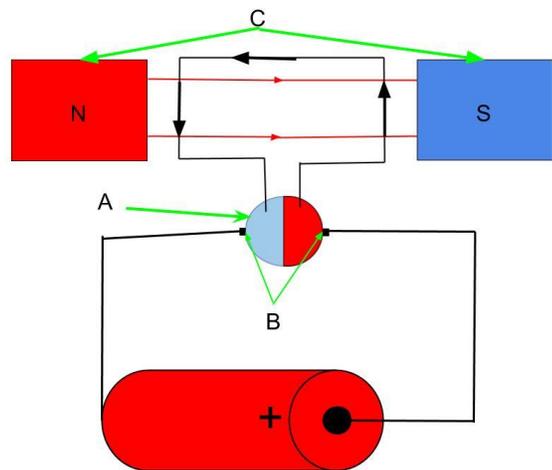
- If the voltage from B to A is 0, what is the value of  $R_4$ ?
- If the voltage from A to B is 2 V, what is the value of  $R_4$ ?
- What is this device called and what are some of its primary uses?



22. How much power does  $R_6$  dissipate in the following circuit?

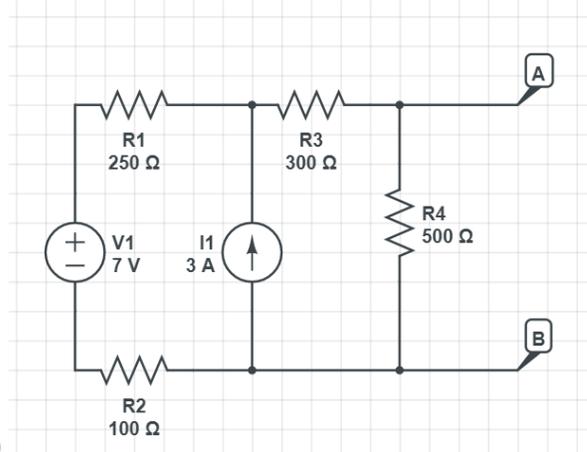


23. Given the following diagram of a motor:



- What are parts A, B, and C known as?
- What direction (clockwise or anti-clockwise) will the coil turn?

24. Draw a schematic for the thevenin equivalent of this circuit (from point A



to point B)

Lab:

- Using a 330  $\Omega$ , 220  $\Omega$ , and 100  $\Omega$  resistor, along with a lamp with resistance 500  $\Omega$ , and a 3V battery, construct a circuit so that the power dissipated by the lamp is 6.6 mW, and verify this by using a multimeter
- Build a circuit that fully charges ( $5\tau$ ) the 470  $\mu\text{F}$  capacitor in 1.34 seconds using the following resistors of 100, 250, and 500  $\Omega$ , and the given battery. Use a stopwatch to check.
- Construct a circuit using the provided op-amp and various resistors (several of 100 $\Omega$ , 200 $\Omega$ , 500 $\Omega$ ) to have an output voltage 2 times the input voltage

