



SCIENCE OLYMPIAD
AT THE
UNIVERSITY OF FLORIDA

Northern Regional: January 19th, 2019

Circuit Lab B Test

Name(s): _____

Team Name: _____

School Name: _____

Team Number: _____

Rank: _____

Score: _____

Circuits Lab B Test

Instructions: Each team has 50 minutes to complete this test. This test paper may not be written on. For the matching section, each questions is worth 2 points. The points vary per question for all other sections. Show all work for the free response section.

Multiple Choice Questions

Questions 1-3 refer to the Image 1:

1. **(1 point)** If SW1 is closed, which light(s) turns on?
 - a. LAMP1
 - b. LAMP2
 - c. LAMP3
 - d. A and B
 - e. A, B, and C

2. **(1 point)** If SW2 is closed, which light(s) gets power?
 - a. LAMP1
 - b. LAMP2
 - c. LAMP3
 - d. B and C
 - e. A and B

3. **(1 point)** If only LAMP1 and LAMP2 are on, which of the following is true?
 - a. SW1 is closed
 - b. SW2 is closed
 - c. SW3 is closed
 - d. B and C
 - e. A and C

4. **(1 point)** Although the phenomenon of electromagnetic waves was theoretically predicted by Maxwell, it was founded experimentally by whom?
 - a. Ohm
 - b. Volta
 - c. Hertz
 - d. Tesla
 - e. Faraday

5. **(2 points)** There are two charges, q_1 and q_2 , that are a distance d apart. The electric force that each charge experiences is 100N . If the distance between them triples, what is the current electric force each charge experiences?
- 100 N
 - 11 N
 - 33 N
 - 67 N
 - 9 N
6. **(2 points)** If an solid conducting sphere is given a positive net charge, the electrostatic potential of the conductor is
- Constant throughout the volume
 - Entirely zero
 - Zero only on the surface
 - Largest on the surface
 - Largest at the center
7. **(1 point)** Which of the following is true about an electric field?
- It is a vector field.
 - It is always constant.
 - The units are $\text{N} \times \text{C}$
 - It is only defined for 2 or more charges.
 - It is zero inside a spherical conducting shell.
8. **(3 points)** A capacitor with an initial potential difference of 9 V is discharged through a resistor when a switch between them is closed at $t = 0$. At $t = 1.0\text{ s}$, the potential difference across the capacitor is 3 V . What is the potential difference across the capacitor at $t = 3.0\text{ s}$?
- 750 mV
 - 222 mV
 - 3 V
 - 1 V
 - 300 mV

9. **(3 points; Tiebreaker)** Look at **image 2**. All capacitors are identical in the figure. Capacitor C1 is charged by the ems source when the switch is in position 1. The switch is then moved to position 2 and the charge redistributes among all the capacitors. After this redistribution, the charge on C1 is 9 C. What was the charge on C1 when the switch was at position 1?
- 6 C
 - 3 C
 - 12 C
 - 8 C
 - 5 C
10. **(2 points)** Suppose a parallel plate capacitor is connected to a battery with potential of 35 V. If the plate separation is quadrupled, the energy stored in the plates will
- Decreases by factor of two
 - Increases by factor of two
 - Decreases by factor of four
 - Increases by factor of four
 - Remains the same
11. **(1 point)** Which chemical gives red light in LED?
- Gallium phosphide
 - Boron nitride
 - Zinc selenide
 - Gallium nitride
 - Gallium Arsenide
12. **(2 points)** A collection of 1.25×10^{19} electrons has the charge of
- 1 Coulomb
 - 1 Coulomb
 - 2 Coulomb
 - 4 Coulomb

13. **(2 points)** Two particles with oppositely signed charges are held a fixed distance apart. The charges are equal in magnitude and they exert a force on each other. Half of one of the charges is transferred to the other charge and the distance between them is unchanged. What happens to the force exerted on one charge by the other charge?
- The force is $\frac{1}{2}$ as large
 - The force is $\frac{1}{4}$ as large
 - The force is 4 times as large
 - The force is unchanged
 - The force is doubled
14. **(1 point)** What happens when a charged insulating object is brought near an uncharged conducting object without touching it?
- The conductor remains uncharged and a force is exerted on it.
 - The conductor becomes charged and no force is exerted on it
 - The conductor remains uncharged and no force is exerted on it.
 - The conductor remains charged and a force is exerted on it.
 - No change will occur if the charged object is not touching the conducting object.
15. **(2 points)** Which of the following materials is the poorest electrical conductor?
- Copper
 - Brass
 - Aluminum
 - Nichrome
 - Two of the materials are equally as poor
16. **(2 points)** Several wires of varying thickness are all made of the same material and all have the same length. If the wires are arranged in order of decreasing thickness, what can be said about the ordering of their resistance?
- The wires will be arranged in order of decreasing resistance.
 - The ordering of the resistances can not be determined because the length is not given.
 - The ordering of the resistances can not be determined because the resistivity is not given.
 - The resistances are the same because the wires are made out of the same material and have the same length.
 - The wires will be arranged in order of increasing resistance.

17. **(1 point)** An incandescent light bulb produces what kind of visible spectrum?
- Discrete
 - Blackbody
 - Infrared
 - Continuous
 - Ultraviolet
18. **(2 points)** Three charges are arranged in an equilateral triangle (side length m) as shown in **Image 3**. What direction is the force on the top charge?
- Up
 - Down
 - Left
 - Right
 - A combination of two directions in the list

True/False Questions

19. **(1 point)** Based on the **Image 4**, the current through the wire travels downwards.
20. **(1 point)** If the magnetic field lines from same figure in Question 1 were travelling clockwise, the current through the wire would travel downwards.
21. **(2 points)** A DC current produces a collapsing sine wave of electromagnetic energy.
22. **(1 point)** Between DC and AC, DC can generally be viewed as the more dangerous of the two currents.
23. **(2 points)** With a constant voltage, if power was doubled, resistance would decrease by factor of two.
24. **(1 point)** Kirchhoff's voltage law states that the product of the voltage drops in a series circuit is equal to the total applied voltage.
25. **(1 point)** Rubbing two objects together may cause large number of electrons to be transferred from one object to the other.

26. **(2 points)** Under electrostatic conditions, an electric field intersects the surface of a conductor at a right angle.
27. **(1 point)** Most conducting materials have different resistances at different temperatures.
28. **(2 points)** A charge is passing through a static magnetic field. The velocity of the charge makes a 30° angle with the field. The force exerted by the field changes the kinetic energy of the charge.
29. **(1 point)** The magnetic flux is changing as it passes through two coils that are exactly the same. The induced voltage is greatest in the coil whose flux is changing fastest.
30. **(1 point)** Electrostatic force is a vector directed along the line between two charges.
31. **(1 point)** The temperature at various locations does not fall under the definition of a field.
32. **(1 point)** Field lines never cross.

Matching

33. This relationship between the Voltage, Current and Resistance forms the basis of
34. Electrical resonant transformer circuit
35. Motors convert _____ into mechanical energy
36. The change of _____ stored in charge q is **equal** to the work done on q to bring it from point A to B.
- A. Potential energy
B. Electrical Energy
C. Ohm's Law
D. Tesla Coil

Written Response

37. **Image 5** shows a test charge q between the two positive charges. Find the force (in newtons) on the test charge for $q = 4 \mu\text{C}$. State whether the force is to the right or the left. Then, find the electric field (newtons per coulombs) at the position of the test charge and state the direction. **(12 points; tiebreaker)**
38. State the difference(s) between a rheostat and potentiometer. **(10 points)**
39. An object has a -6 C charge. The object breaks into two pieces. One piece has a charge of 2 C . What is the exact charge (in C) of the other piece? **(5 points)**
40. Three resistors are connected in series across a 13-V power supply. If the potential drops across resistors 1 and 2 are 3.3 volts and 4.8 volts , what is the exact potential drop (in volts) across resistor 3? **(5 points)**
41. What is Gauss's Law? **(3 points)**