SSSS Circuit Lab Test

Multiple choice: 1 point each

1. d
2. c
3. b
4. a
5. d
6. c
7. d
8. c
9. a
10. d
11. b
12. a
13. d
14. a

Short answer:

1. This is a voltaic cell, the earliest battery, invented by Alessandro Volta. Label the components and their composition
   a. Blue: Electrolyte; saltwater brine or sulfuric acid (either is acceptable)
   b. Orange: Cathode, copper
   c. Gray: Zinc, anode

2. Use the diagram below. All the charges are equidistant from each other, with a distance of d:
   a. Magnitude: 9.37 N, Direction: 16.1° or .281 radians (either is acceptable)
   b. -3 V
   c. Magnitude: 32.55 V/m (or N/C), Direction: 32.76° or .572 radians (either is acceptable)

3. 4 points, 1 per question: Given a cylindrical graphite (ρ=3*10⁻³ Ω*m) wire with radius r and height l, answer the following. Assume the wire is ohmic:
   a. 0.038 Ω
   b. 2.62 A
c. 26.18 C  
d. 2.62 J

4. 6 points, 1 per question: Give the threshold for current in order for one to experience these:  
   a. 1 mA  
   b. 5 mA  
   c. 6-16 mA  
   d. 17-99 mA  
   e. 100 mA and above

5. A hydroelectric power plant transmits electricity at 100 kV. When it reaches my house, the voltage is now 99 kV, before getting transformed to 120 V.  
   a. 16500 coils  
   b. 169.71 V  
   c. 480 W

6. Write a simplified Boolean expression for O in terms of A, B, and C  
   \(!B + !A*!C\)

7. Two electrons are 5 nm apart. What is the magnitude of force experienced by them?  
   \(9.24 \times 10^{-24}\) N

8. What is the internal resistance of the battery if the current at node A is 7 mA?:  
   \(100.3 \, \Omega\)

9. The magnitude of an electric field at a distance x (in meters) from a point P is given by the equation: \(E = 3x-1\)  
   a. \(4.25 \times 10^{-9}\) N  
   b. Potential = \((-3/2)x^2 + x\)

10. Consider a large charged conductive plate  
   a. 0  
   b. 1129 N/C or V/m

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

<table>
<thead>
<tr>
<th>Resistor</th>
<th>V</th>
<th>I</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>3</td>
<td>.015</td>
<td>.045</td>
</tr>
</tbody>
</table>
12. A parallel-plate capacitor (5 nF) with a dielectric made of air has a separation of .5 mm.
   a. .28 m²
   b. 20000 N/C or V/m
   c. 2.5 E-7 J

13. Charge Q (5 nC) is moving at 5 µm/s when it encounters a magnetic field of 0.02 T, as shown below.
   a. Magnitude: 5 E-16   Direction: down
   b. .025 m

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

   225 Ω (also acceptable: resistance ≥ 225Ω)

15. Given the following circuit, answer the following:
   a. 8 E-5 C
   b. .03 s
   c. 1.11 E-15

16. What are the values of I₁, I₂, and I₃ in the circuit below?

   I₁ = .0175 A, I₂ = .0085 A, I₃ = -.009 A

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

<table>
<thead>
<tr>
<th>Resistance (Ω)</th>
<th>kgm²s⁻³A⁻²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (V)</td>
<td>kgm²s⁻³A⁻¹</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>----------------</td>
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</tr>
<tr>
<td><strong>Coulombs (C)</strong></td>
<td>sA</td>
</tr>
<tr>
<td><strong>Teslas (T)</strong></td>
<td>kgs⁻²A⁻¹</td>
</tr>
<tr>
<td><strong>Watts (W)</strong></td>
<td>kgm²s⁻³</td>
</tr>
<tr>
<td><strong>Farad (F)</strong></td>
<td>s⁴A²m⁻²kg⁻¹</td>
</tr>
</tbody>
</table>

18. 2 wires are placed parallel to each other.
   a. Same direction: attract; different directions: repel
   b. 2 E⁻⁵ N/m
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)

![Schematic of a circuit](image)

20. A solenoid with an iron core (μ=.25 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?

312.5 Tesla

21. Use this circuit to answer the following questions:
   a. 400 Ω
   b. 937.5 Ω
   c. Wheatstone bridge, used to measure unknown resistances (or capacitances, inductance, impedance, etc), soil analysis, etc.
22. How much power does R6 dissipate in the following circuit?

0.17 W

23. Given the following diagram of a motor:
24. Draw a schematic for the thevenin equivalent of this circuit (from point A to point B).

Lab:

1. Multimeter should take 2 measurements and a calculation should be done to get approximately 6.6 mW from the measurements.

2. Build a circuit that fully charges (5\( \tau \)) the 470 \( \mu \)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.
3. Construct a circuit using the provided op-amp and various resistors to have an output voltage 2 times the input voltage.

Both resistors can be any value as long as they are equal.

(Make sure supply voltage and ground are connected to respective parts of a power supply)