# Unit #7 Review Sheet: Circuits

- There must be a potential difference across a conductor for current to flow.
- Current: $I = \Delta Q/\Delta t$ (units: C/sec = Amperes)
- Conventional current (taken as positive) IS OPPOSITE THE DIRECTION ELECTRONS MOVE.
- Electrons move at a drift velocity on the order to $10^{-5}$ m/sec within a circuit.
- Ohm's Law: $V = IR$
- Power (for all devices) = $P = IV$ (in Watts)
- Power (heat dissipated by a resistor due to current flow) = $V^2/R = I^2R$ (in Watts)
- Resistance in a wire = $R = \rho L/A$ where $\rho$ is the resistivity of the material (in $\Omega$-m).
- Equivalent resistance of resistors in series = $R_T = R_1 + R_2 + R_3 + \ldots\ldots$
- Equivalent resistance of resistors in parallel = $1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + \ldots\ldots$
- *Junction Rule*: The sum of the currents entering any junction of a circuit must equal the sum of the currents leaving the junction.
- *Loop Rule*: The algebraic sum of the potential increases (taken as positive) and the potential decreases (taken as negative) must always be zero for any loop within a circuit.
- $Q = CV$
- Equivalent capacitance of capacitors in parallel = $C_T = C_1 + C_2 + C_3 + \ldots\ldots$
- Equivalent capacitance of capacitors in series = $1/C_T = 1/C_1 + 1/C_2 + 1/C_3 + \ldots\ldots$
- When circuits contain both capacitors and resistors, initially the resistance of a capacitor is zero (all of the current can go through the capacitor). After steady state has been achieved and the capacitor has been fully charged, the resistance of a capacitor is infinite (no current moves through the capacitor).
- Time constant of an RC circuit: $\tau = RC$
- It takes five time constants for a capacitor in an RC circuit to fully charge or discharge
- Cutoff frequency of an RC circuit: 1/(2 x pi x RC)

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REFER TO THE DIAGRAM SHEET FOR DIAGRAMS OF THE CIRCUITS FOR SOME OF THE FOLLOWING PROBLEMS.

1. A 12-V battery is connected to a 24Ω resistor. What power does the resistor dissipate? [6.0 W]

2. The power output of the 3Ω is 12 Watts. What is the power output of the 5Ω and the 2Ω resistors? [7.2 W; 20.5 W]

3. The potential across the 8Ω resistor is 12 V. Find the following: $I_8$, $I_{11}$, $V_{24}$, $I_{24}$, $I_4$, $V_4$, $V_7$, $I_3$, $V_T$. Here the subscript denotes that value associated with the specified resistor. [1.5A, 1.5A, 28.5V, 1.19A, 2.69A, 10.8V, 18.8V, 2.02A, 64.1V]

4. Find the equivalent resistances. [26.41 Ω]

5. Find the equivalent resistances. [18.82 Ω]

6. What is the current in the 4Ω resistor? [.65 A]

7. Find $I_1$, $I_2$, and $I_3$. [2.5A, 6.0A, 11.5xA]

8. Find the current in the 2KΩ resistor. [9.75 mA]

9. If the potential on the 4-μF capacitor is 10 V, what is the potential on the 8-μF capacitor? [5.0 V]

10. Find the combined capacitance of the circuit shown. [7.88 μF]

11. Find the combined capacitance for the network shown. All capacitances are in μF. [5.23 μF]

12. Given the charges stored on the capacitors shown, find the unknown charge. [2μC]

13. For the given diagram, determine the charge stored on the 150-μF and the 40-μF capacitors. [.0171C; .0114C]

14. Find the potential across the 6-μF capacitor. [27.1 V]

15. Find the currents through each resistor the instant the switch is closed, and after the circuit has reached an equilibrium state (e.g. the capacitor has become fully charged). [Initially: $I_{20}$ = 0.0A, $I_{16}$ = 1.5A; final equilibrium $I_{20}$ = $I_{16}$ = .667A]

16. What will be the final charge on the capacitor after the switch is closed and equilibrium has been reached? (Hint: How much current will be flowing through the capacitor after it has been charged?) [99.7μC]

17. Find the currents through the 8Ω resistor the instant the switch is closed, and after the circuit has reached an equilibrium state. [Initially: .545A; at equilibrium: 0.0A]

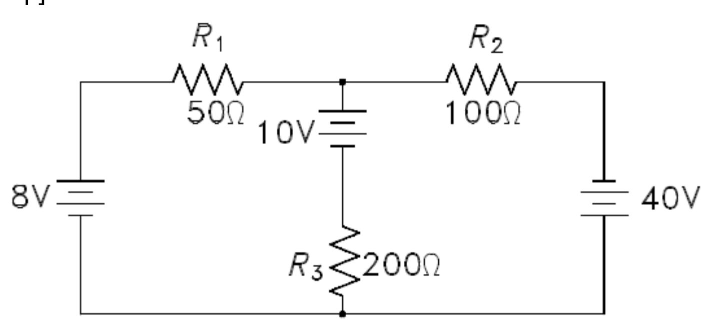
18. Find the currents through the 8Ω resistor the instant the switch is closed, and after the circuit has reached an equilibrium state. [Initially: 0.0A; at equilibrium: .5A]

19. Find the charge on the capacitor after the switch is closed and equilibrium has been established. [312μC]

20. A 4.5 μF capacitor is wired in series with a light bulb of negligible resistance. A 140 Ohm resistor is wired in parallel with the lightbulb. If this circuit is powered by an unstable AC power source (one that produces uneven voltage that is a combination of many different frequencies), which frequencies will be filtered out so they don't affect the light bulb? [All frequencies below about 253 Hz]

21. An LED is designed to produce its maximum brightness at 20 mA, when it will have a resistance of about 175 Ohms. Its lifespan will be greatly reduced if it is run at a current more than 20 mA for an extended time. It is hooked to a DC power source of 3.5 V. When the power is turned on, the LED briefly glows, then burns out. What happened and why? What could be changed to prevent this problem, and how might that affect the brightness of the LED? [The LED has variable resistance. While it will have a resistance of 175 Ohms at 20 mA, it won't stay at that resistance. As the resistance drops, the current increases until the LED is broken. A resistor could be put in series with the LED – but that would make it impossible to achieve a current of exactly 20 mA through the LED, which would mean the LED will either be receiving too much current (thus shortening its lifespan) or not enough current (in which case it won't be at its maximum brightness). Another option would be to add a resistor and increase the voltage of the power supply, in which case the ideal current could be maintained.]

22. Find the current through $R_1$, $R_2$, $R_3$ in the circuit below. [$R_1$ = 268.6 mA to the right, $R_2$ = 345.8 mA to the right, $R_3$ = 77.2 mA up]



# Diagrams for Unit #7 Review Sheet

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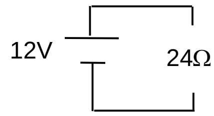
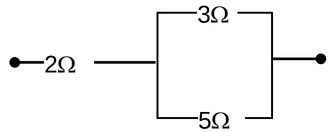
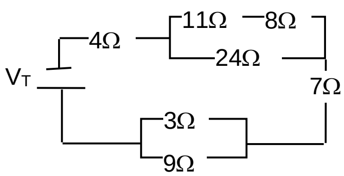
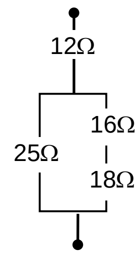
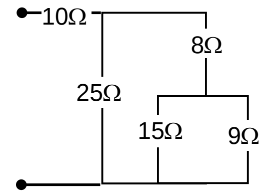
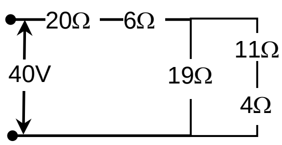
1. 

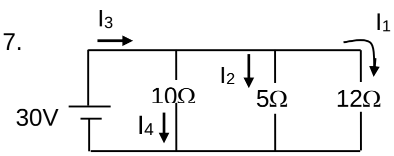

2. 

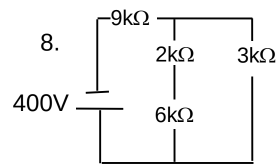

3. 

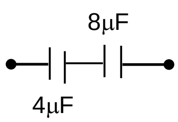

4. 

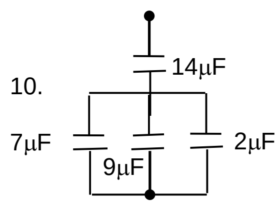

5. 

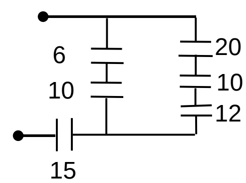

6. 

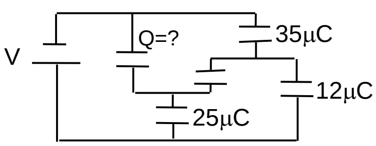

7. 

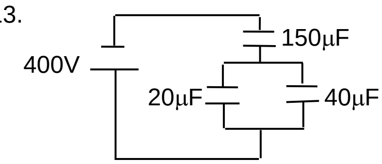

8. 

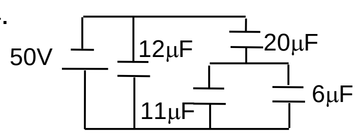

9. 

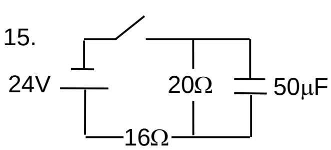

10. 

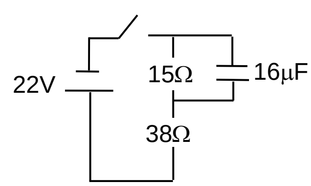

11. 

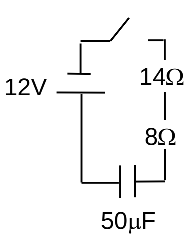

12. 

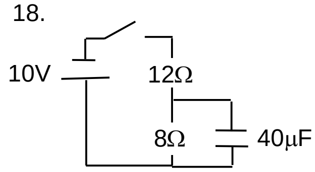

13. 


14. 


15. 


16. 


17. 


18. 


19.