Chapter 14
DC Electric Circuits

Homework # 114

Resistivity and Temperature Coefficients (at 20°C)

Substance	Resistivity, ρ (Ω•m)	Temperature Coefficient, α $(C°)^{-1}$
Conductors		
Silver	1.59×10^{-8}	0.0061
Copper	1.68×10^{-8}	0.0068
Aluminum	2.65×10^{-8}	0.00429
Tungsten	5.6×10^{-8}	0.0045
Iron	9.71×10^{-8}	0.00651
Platinum	10.6×10^{-8}	0.003927
Mercury	98×10^{-8}	0.0009
Nichrome (alloy of Ni, Fe, Cr)	100×10^{-8}	0.0004
Semiconductors		
Carbon (graphite)	$(3\text{-}60) \times 10^{-5}$	-0.0005
Germanium	$(1\text{-}500) \times 10^{-5}$	-0.05
Silicon	0.1 - 60	-0.07
Insulators		
Glass	10^{9} - 10^{12}	
Hard Rubber	10^{13} - 10^{15}	

American Wire Gauge

AWG Gauge	Diameter (Inches)	Diameter (mm)	Cross Sectional Area (mm^2)
10	0.0109	2.58826	5.26145
12	0.0808	2.05232	3.30811
14	0.0641	1.62814	2.08196
16	0.0508	1.29032	1.30763
18	0.0403	1.02362	0.82294
20	0.0320	0.81280	0.51887
22	0.0254	0.64516	0.32691
24	0.0201	0.51054	0.20471
26	0.0159	0.40386	0.12810
28	0.0126	0.32004	0.08044
30	0.0100	0.25400	0.05067
32	0.0080	0.20320	0.03243
34	0.0063	0.16002	0.02011

Resistor Color Code

Color	Number	Multiplier	Tolerance
Black	0	1	
Brown	1	10^{1}	
Red	2	10^{2}	
Orange	3	10^{3}	
Yellow	4	10^{4}	
Green	5	10^{5}	
Blue	6	10^{6}	
Violet	7	10^{7}	
Gray	8	10^{8}	
White	9	10^{9}	
Gold		10^{-1}	5%
Silver		10^{-2}	10%
No Color			20%

Chapter 14
DC Electric Circuits
14.1 Voltage, Current, Resistance, and Ohm's Law Homework #115

See Homework #114 in this chapter for the tables on "Resistivity and Temperature Coefficients (20 °C)" and "American Wire Gauge".

I

01. A battery charger charges a battery with a current of 3.25 A for 3.00 h.
    a.) How much charge passes through the battery?
    b.) How many electrons are transferred to the battery?

02. Nerve cells "communicate" with each other via varying the potential difference between the two sides of a neuron's (nerve cell) cell wall. What is the current if 1200 Na^+ ions flow across a cell membrane in 4.25 μs? A sodium ion has 11 protons, 11 neutrons, and 10 electrons so it has one more proton than electrons.

03. What is the resistance of a heater if it produces a current of 15.0 A when plugged into a household outlet that is wired for 120 V?

04. A 1.50-V flashlight battery (D cell) is placed in a flashlight whose bulb has a resistance of 1.35 Ω. How many electrons leave the battery if the flashlight is left on for 10.0 minutes?

05. What is the resistance of a 14-Gauge copper wire that is 4.75 m long?

06. What is the diameter of a 75.0-cm length of tungsten wire whose resistance is 0.350 Ω?

II

07. An electrical device draws 2.65 A at 120 V. In the summertime, demand for power in the community can cause the voltage to drop by 10.0%. If the voltage drops by this amount, how much current will this device draw?

08. A bird stands on an electric transmission line carrying 1500 A. The line has 1.85×10^{-5} Ω resistance per meter. If the bird's feet are 3.00 cm apart, how much voltage does it feel.

09. A 50.0-m long wire with a diameter of 1.60 mm has a resistance of 5.6 Ω. What is the resistance of a 90.0-m length of wire with a diameter of 4.10 mm made of the same material?

10. What diameter of tungsten wire must be made to have the same resistance as an equal length of 2.40-mm-diameter copper wire?

11. How much would the temperature of a copper wire, initially at 20.0 °C, have to be raised to increase its resistance by 35%?

12. A 100-W light bulb has a resistance of 12.0 Ω when cold and 140 Ω when on (hot). If the average temperature coefficient of resistivity, α, is $0.0060(C°)^{-1}$, approximate the temperature of the filament when the bulb is "on".

III

13. Copper has approximately 10^{29} free electrons per cubic meter. What is the approximate average velocity of electrons in a 1.00 mm radius wire carrying 1.00 A?

ANSWERS: **01.** a.) 35,100 C b.) 2.19×10^{23} **02.** 4.52×10^{-11} A **03.** 8.00 Ω **04.** 4.17×10^{21}
05. 0.0383 Ω **06.** 0.391 mm **07.** 2.39 A **08.** 8.33×10^{-4} V **09.** 1.54 Ω **10.** 4.38 mm **11.** 51.5 °C
12. 1800 °C **13.** 1.99×10^{-5} m/s

Chapter 14
DC Electric Circuits

14.2 Electric Power — Homework # 116

I

01. What is the current through a 60.0-W light bulb wired (via a lamp to an outlet) to a 120-V power source (American household)?

02. The element of an electric oven that is designed to produce 3.00 kW of heat when wired to a 240-V source. What is the resistance of this element?

03. A 9.00-V transistor radio draws a maximum of 300 mA of current. What is the maximum power consumption of this radio?

04. If the starter motor in an automobile draws 150 A from the 12.0-V battery, how much power is being consumed?

05. What is the maximum voltage that can be applied across a 500-Ω resistor rated at ½ W?

II

06. A woman vacuums the house for 45.0 minutes using a vacuum cleaner rated at drawing 12.0 A on 120-V line.
    a.) How many kWh does a vacuum cleaner use?
    b.) If the electric company charges $0.0984 per kWh, how much did this activity cost?

07. A physics student wishes to see how many 100-W light bulbs will be required to blow the 15.0-A fuse for the room in which his experiment is conducted. Assuming he has unlimited lamps, 120-V outlets, and 100-W light bulbs, what is the maximum number of bulbs that can be used without blowing the fuse? Assume the room is wired in series so the current drawn from each outlet arithmetically adds to the current drawn from the other outlets.

08. What is the total amount of energy stored in a 12.0-V, 40.0-A·h car battery that is fully charged?

09. What is the efficiency of a 5.00-hp electric motor that draws 18.8 A from a 240-V line?

10. A power station delivers 520 kW of power to a town through power lines that have a net resistance of 2.85 Ω.
    a.) How much power is wasted as heat generated in the power lines if the power is delivered at 2400 V?
    b.) How much power is wasted as heat generated in the power lines if the power is delivered at 48,000 V?

III

11. The current in an electromagnet connected to a 240-V line is 8.25 A. At what rate must cooling water pass over the coils of the electromagnet if the water temperature is to rise by no more than 8.00 °C?

12. A small immersion heater is designed to plug into the lighter accessory of a car and heat a cup of water for coffee. If the temperature of 220 mL of water increases from 6.00 °C to 93.5 °C in 7.50 minutes, how much current does it draw from the 12.0-V car battery?

ANSWERS: **01.** 0.500 A **02.** 19.2 Ω **03.** 2.70 W **04.** 1800 W **05.** 15.8 V
06. a.) 1.08 kWh b.) $0.106 (10.6 cents) **07.** 18.0 bulbs **08.** 1.73×10^6 J **09.** 83.1%
10. a.) 134 kW b.) 0.334 kW **11.** 0.0592 kg/s (213 kg/h) **12.** 14.9 A

Chapter 14
DC Electric Circuits
14.3 Alternating Current — Homework # 117

I

01. An ac voltage supply with a peak voltage of 180 V is applied across a 480-Ω resistor.
    a.) What is the value of the peak current in the resistor?
    b.) What is the value of the rms current in the resistor?

02. What is the peak current in a 2.80-kΩ resistor connected to a 240-V ac power source?

03. Determine the resistance of the following 120-V_{rms} light bulbs.
    a.) 40.0 W b.) 60.0 W c.) 75.0 W d.) 100 W

II

04. What is the peak current passing through a 100-W light bulb connected to a 120-V ac line?

05. If the peak value of alternating current passing through a 1250-W electric device is 4.25 A, what is the rms voltage across it?

06. What is the maximum instantaneous value of the power dissipated by a 75.0-W light bulb?

07. A 15.0-Ω heater coil is connected to a 240-V ac line.
    a.) What is the average power used by this coil?
    b.) What is the maximum value of the instantaneous power?
    c.) What is the minimum value of the instantaneous power?

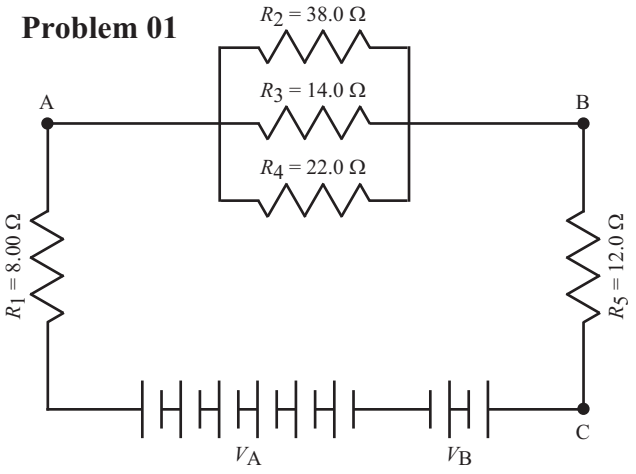
ANSWERS: **01.** a.) 0.375 A b.) 0.265 A **02.** 0.121 A **03.** a.) 360 Ω b.) 240 Ω c.) 192 Ω d.) 144 Ω
04. 1.18 A **05.** 416 V **06.** 150 W **07.** a.) 3840 W b.) 7680 W c.) 0 W

Chapter 14
DC Electric Circuits
14.4 Resistors in Series and Parallel — Homework # 118

II

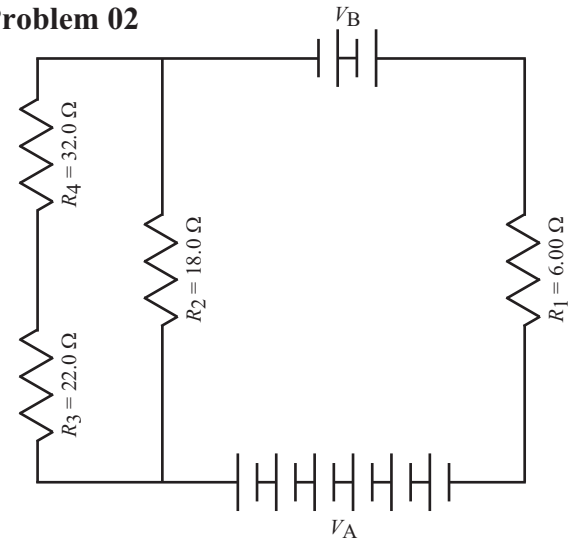
01. Each cell of the circuit shown to the right has an emf of 1.50 V.
    a.) What is the net emf of the circuit?
    b.) What is the net resistance of the circuit?
    c.) What is the current through each cell of the battery?
    d.) Determine the current through each resistor.
    e.) What is the voltage, V_2, across resistor R_2?
    f.) What is the power generated by the battery V_A?
    g.) What is the power generated by the battery V_B?
    h.) What is the power generated by this combination of batteries?
    i.) What is the power consumption of resistor R_3 in this circuit?
    j.) At what rate is energy transformed by resistor R_4?
    k.) What is potential difference between points A and B?
    l.) What is the potential difference between points A and C?

Problem 01



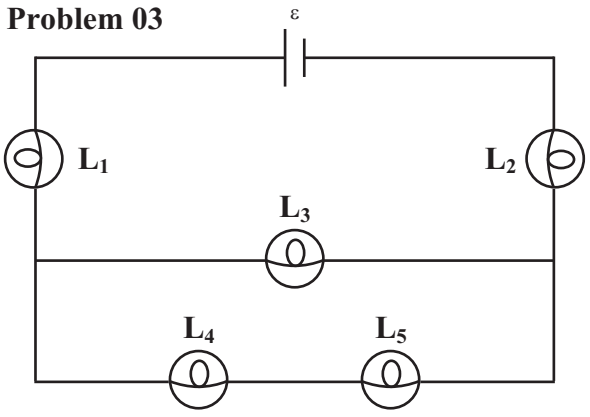
02. Each cell of the circuit shown to the right has an emf of 1.50 V.
    a.) What is the net emf of the circuit?
    b.) What is the net resistance of the circuit?
    c.) Determine the current through each resistor.
    d.) What is the voltage, V_2, across resistor R_2?
    e.) What is the power consumption of resistor R_3 in this circuit?

Problem 02



03. Assume all of the light bulbs in the circuit shown below are identical, each with a resistance of R.
    a.) What is the net resistance of the circuit?
    b.) Determine the current through each light bulb.
    c.) What is the voltage, V_4, across light bulb L_4?
    d.) What is the power consumption of light bulb L_3 in this circuit?

Problem 03



ANSWERS: **01.** a.) 6.00 V b.) 27.0 Ω c.) 0.222 A
01. d.) $I_1 = I_5 = 0.222$ A, $I_2 = 0.0409$ A, $I_3 = 0.111$ A, $I_4 = 0.0707$ A e.) 1.56 V f.) 2.00 W g.) 0.667 W
01. h.) 1.33 W i.) 0.172 W j.) 0.110 W k.) 1.56 V l.) 4.22 V **02.** a.) 12.0 V b.) 19.5 Ω
02. c.) $I_1 = 0.615$ A, $I_2 = 0.461$ A, $I_3 = I_4 = 0.154$ A d.) 8.30 V e.) 0.520 W **03.** a.) $\frac{8}{3}R$
03. b.) $I_1 = I_2 = \frac{3}{8}\frac{\varepsilon}{R}$, $I_3 = \frac{1}{4}\frac{\varepsilon}{R}$, $I_4 = I_5 = \frac{1}{8}\frac{\varepsilon}{R}$ c.) $V_4 = \frac{1}{8}\varepsilon$ d.) $P_3 = \frac{1}{16}\frac{\varepsilon^2}{R}$

Chapter 14
DC Electric Circuits
14.5 EMF and Terminal Voltage — Homework # 119

I

01. In an experiment to determine the internal resistance of a battery, a physics student measures the voltage of the battery with no load to be 12.00 V. When connected a circuit drawing a current to measured to be 0.850 A, the voltage is now recorded as 11.60 V. What is the internal resistance of the battery?

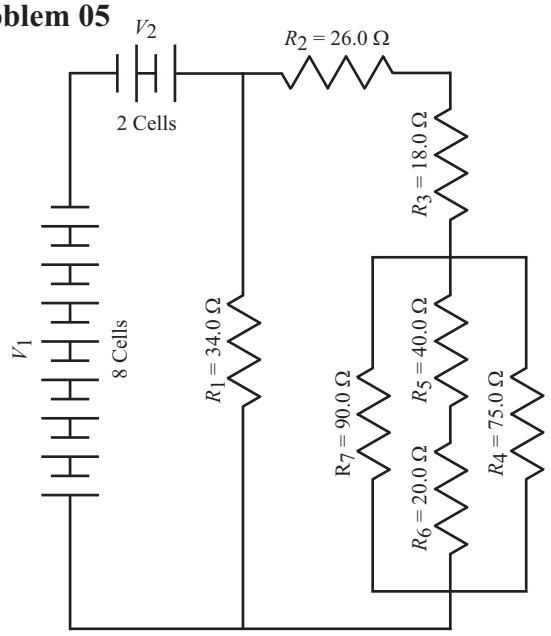
02. A battery with an emf of 18.0 V and an internal resistance of 0.650 Ω is connected to a circuit with a net resistance of 23.8 Ω. What will the current be through the load?

03. A battery with an emf of 6.00 V and an internal resistance of 0.350 Ω is wired to a circuit with a net resistance of 10.80 Ω (not including the internal resistance of the battery). What is the terminal voltage of the battery.

II

04. A battery charger with an emf of 30.0 V and an internal resistance of 0.800 Ω is used to charge a 12.0-V car battery with an internal resistance of 0.900 Ω for 40.0 minutes. [Note: To charge the battery, the charger and battery are wired in series with their negative terminals wired together and their positive terminals wired together. In other words, the voltage of each power source is driving current in opposite directions in the circuit.]
    a.) How much charge will the battery have received from the charger?
    b.) How many electrons will the battery have received?

Problem 05



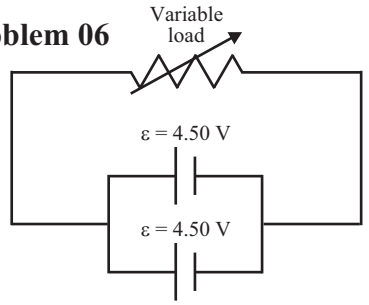
05. Each cell of the circuit shown to the right has an emf of 2.20 V and an internal resistance of 0.6 Ω.
    a.) What is the net emf of the circuit?
    b.) What is the total internal resistance of the batteries in this circuit?
    c.) What is the net resistance of the loads in the circuit (exclude the internal resistance of the batteries)?
    d.) What is the net resistance of the circuit?
    e.) What is the voltage, V_5, across resistor R_5.
    f.) What is the power consumption of resistor R_7.

06. Assume both batteries (bottom-right circuit) are identical, each with an emf of 4.50 V and an internal resistance of 0.800 Ω. The load is a variable resistor (can be adjusted to any resistance).

For parts a.) through f.), assume the load is 9.60 Ω.
    a.) What is the net emf of the circuit?
    b.) What is the current to the load?
    c.) How much power would be consumed by the load?
    d.) How much power is being supplied by the batteries?
    e.) How much power is being consumed by the internal resistance of the batteries?
    f.) With what efficiency is power being delivered to the load?

For parts g.) and h.), adjust the resistance to one that will provide maximum power to the load.
    g.) What resistance would provide the maximum power to the load?
    h.) What would be this maximum power delivered to the load?

Problem 06



ANSWERS: **01.** 0.471 Ω **02.** 0.736 A **03.** 5.81 V **04.** a.) 2.54×10^4 C b.) 1.59×10^{23}
05. a.) 13.2 V b.) 6.00 Ω c.) 22.7 Ω d.) 28.7 Ω e.) 2.48 V f.) 0.153 W
06. a.) 4.50 V b.) 0.450 A c.) 1.94 W d.) 2.03 W e.) 0.0810 W f.) 96.0% g.) 0.400 Ω h.) 12.7 W

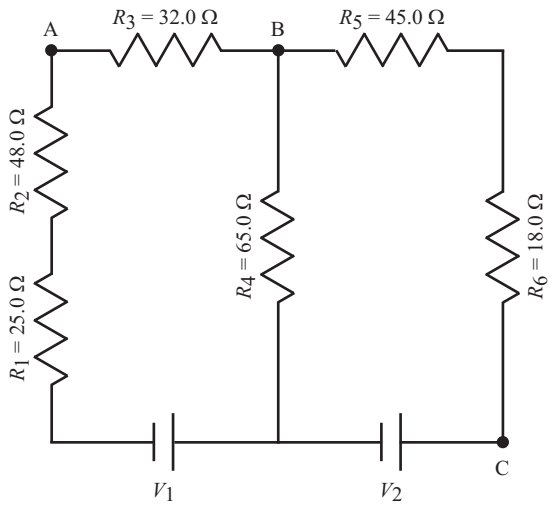
Chapter 14
DC Electric Circuits

14.6 Kirchhoff's Rules — Homework # 120

II

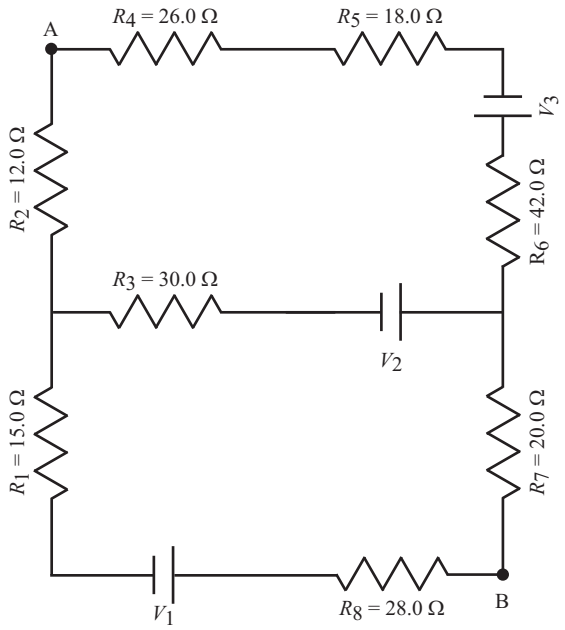
01. In the circuit shown to the right, $V_1 = 80.0$ V and $V_2 = 120.0$ V. Ignore any internal resistance in the power supplies.
    a.) What is the current through resistor R_1?
    b.) What is the current through resistor R_2?
    c.) What is the current through resistor R_3?
    d.) What is the current through resistor R_4?
    e.) What is the current through resistor R_5?
    f.) What is the current through resistor R_6?
    g.) What is the voltage across resistor R_4?
    h.) What is the power consumption of resistor R_6?
    i.) What is the power generated by battery V_1?
    j.) What is the potential difference between points A and C?
    k.) What is the potential difference between points B and C?

Problem 01



02. In the circuit shown to the right, $V_1 = 60.0$ V, $V_2 = 45.0$ V and $V_3 = 75.0$ V. Ignore any internal resistance in the power supplies.
    a.) What is the current through resistor R_1?
    b.) What is the current through resistor R_2?
    c.) What is the current through resistor R_3?
    d.) What is the current through resistor R_4?
    e.) What is the current through resistor R_5?
    f.) What is the current through resistor R_6?
    g.) What is the current through resistor R_7?
    h.) What is the current through resistor R_8?
    i.) What is the voltage across resistor R_3?
    j.) What is the power consumption of resistor R_6?
    k.) What is the power generated by battery V_1?
    l.) What is the potential difference between points A and B?

Problem 02



ANSWERS: **01.** a.) 1.03 A b.) 1.03 A c.) 1.03 A d.) 0.431 A e.) 1.46 A f.) 1.46 A g.) 28.0 V
01. h.) 38.4 W i.) 82.3 W j.) 125 V k.) 92.0 V **02.** a.) 0.0927 A b.) 0.213 A c.) 0.305 A
02. d.) 0.213 A e.) 0.213 A f.) 0.213 A g.) 0.0927 A h.) 0.0927 A i.) 9.16 V j.) 1.90 W
02. k.) 5.56 W l.) 58.6 V

Chapter 14
DC Electric Circuits
14.7 Capacitors in Series and Parallel — Homework # 121

I

01. Six 7.20-μF are to be used in a circuit.
    a.) What is their equivalent capacitance if they are connected in series?
    b.) What is their equivalent capacitance if they are connected in parallel?

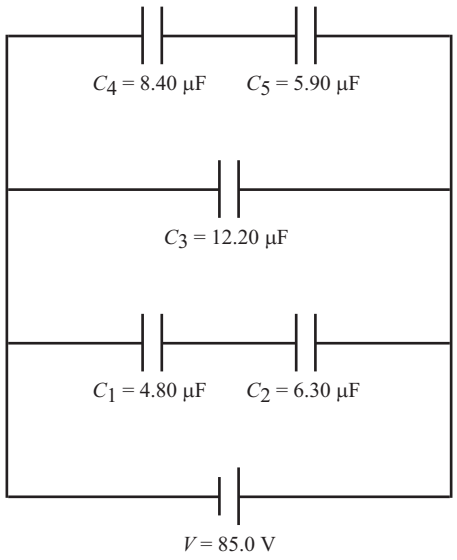
02. A technician wants to change a circuit containing a 6400-pF capacitor to one with a capacitance of 8850 pF.
    a.) How should an additional capacitor be added (in series or parallel) to achieve this goal?
    b.) What size capacitor should be added to the circuit to achieve this goal?

03. The capacitance of a portion of a circuit is to be reduced from 0.3400-μF to 0.1800-μF.
    a.) How should an additional capacitor be added (in series or parallel) to achieve this goal?
    b.) What size capacitor should be added to the circuit to achieve this goal?

II

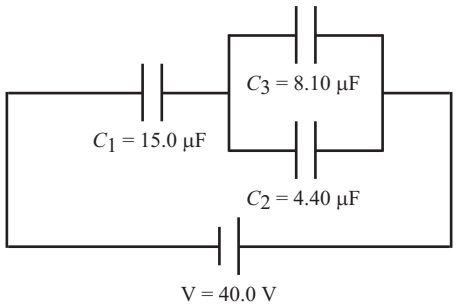
04. A circuit is constructed as shown in the diagram to the right.
    a.) What is the equivalent capacitance of the circuit?
    b.) What is the total charge stored on the capacitors of this circuit?
    c.) What is the total energy stored on the capacitors of this circuit?
    d.) What is the charge, Q_1, stored on capacitor C_1?
    e.) What is the voltage, V_1, across capacitor C_1?
    f.) What is the energy stored, E_1, on capacitor C_1?
    g.) What is the charge, Q_2, stored on capacitor C_2?
    h.) What is the voltage, V_2, across capacitor C_2?
    i.) What is the energy stored, E_2, on capacitor C_2?
    j.) What is the charge, Q_3, stored on capacitor C_3?
    k.) What is the voltage, V_3, across capacitor C_3?
    l.) What is the energy stored, E_3, on capacitor C_3?
    m.) What is the charge, Q_4, stored on capacitor C_4?
    n.) What is the voltage, V_4, across capacitor C_4?
    o.) What is the energy stored, E_4, on capacitor C_4?
    p.) What is the charge, Q_5, stored on capacitor C_5?
    q.) What is the voltage, V_5, across capacitor C_5?
    r.) What is the energy stored, E_5, on capacitor C_5?

Problem 04



05. Three capacitors of capacitance 1800 pF, 0.02 μF, and 3400 pF are available to be used in a circuit in any arrangement desirable.
    a.) Describe arrangement and amount for maximum capacitance.
    b.) Describe arrangement and amount for minimum capacitance.

Problem 06



06. A circuit is constructed as shown in the diagram to the right.
    a.) Determine the equivalent capacitance for the circuit.
    b.) What is the charge and voltage on each capacitor?

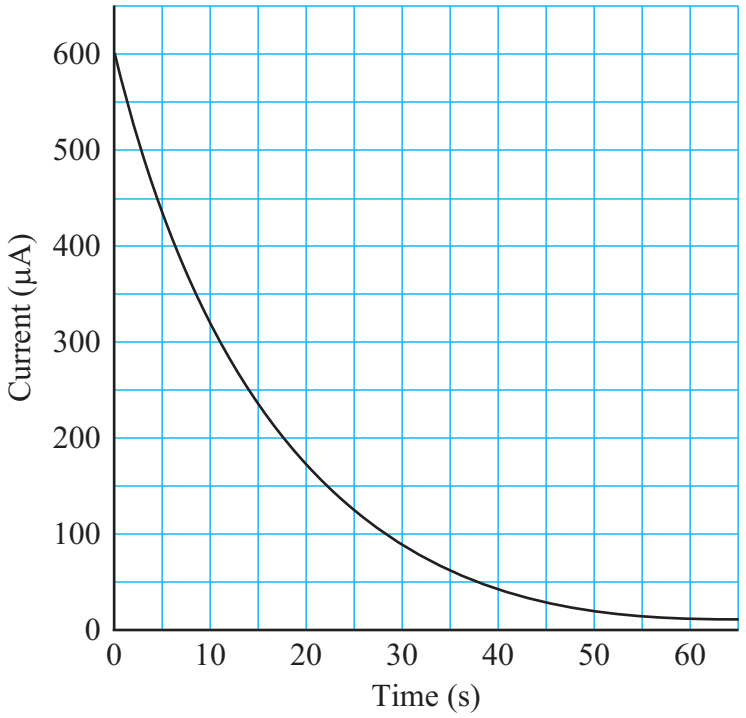
ANSWERS: **01.** a.) 1.20 μF b.) 43.2 μF **02.** a.) parallel b.) 2450 pF **03.** a.) series b.) 0.3825 μF
04. a.) 18.39 μF b.) 1.56 mC c.) 66.4 mJ d.) 231 μC e.) 48.2 V f.) 5.57 mJ g.) 231 μC h.) 36.7 V
04. i.) 4.24 mJ j.) 1.03 mC k.) 85.0 V l.) 44.1 mJ m.) 295 μC n.) 35.1 V o.) 5.18 mJ p.) 295 μC
04. q.) 50.0 V r.) 7.37 mJ **05.** a.) parallel (25,200 pF) b.) series (1112 pF) **06.** a.) 6.82 μF
06. b.) Q_1 = 273 μC, V_1 = 18.2 V; Q_2 = 96.0 μC, V_2 = 21.8 V; Q_3 = 177 μC, V_3 = 21.8 V

Chapter 14
DC Electric Circuits
14.8 Resistor-Capacitor (RC) Circuits — Homework # 122

II

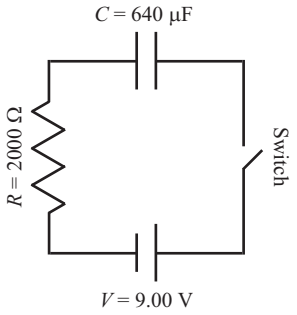
01. A fully-charged capacitor is wired, in series, to a switch (initially open), a galvanometer, and an 18.0-kΩ resistor. The galvanometer is actually a computer, connected to the above circuit via sensors and an interface box, with software that measures current sensitive to the scale of a μA. The switch is closed and the computer generates a graph of current discharging from the capacitor as a function of time as shown below.
    a.) What is the initial current out of the capacitor?
    b.) Graphically estimate the total charge initially stored on the capacitor.
    c.) What is the time constant for this circuit?
    d.) Write an equation that describes the current out of the capacitor as a function of time.
    e.) What is the current at 80.0 s?
    f.) What is the initial voltage across the capacitor?
    g.) Write an equation that describes the voltage across the capacitor as a function of time.
    h.) What is the voltage across the capacitor at 20.0 s?
    i.) What is the capacitance of this capacitor?
    j.) Calculate the total charge initially on the capacitor.
    k.) Write an equation that describes the charge on the capacitor as a function of time.
    l.) What is the charge on the capacitor at 20.0 s?
    m.) What is the initial energy stored on the capacitor?

Discharging Current as a Function of Time



02. A 1000-Ω resistor is connected in parallel to the capacitor in the circuit below and to the right. The switch is closed and the circuit eventually reaches equilibrium. At equilbrium, determine _____.
    a.) the current in the 1000-Ω resistor
    b.) voltage across the 1000-Ω resistor
    c.) the charge on the capacitor

Problems 02 and 03



03. A circuit is constructed as shown to the right. Initially, the capacitor has no charge on it. The moment the switch is closed, a stopwatch is started.
    a.) What is the time constant for this circuit?
    b.) What is the initial current flow in this circuit?
    c.) Write an equation that describes the current out of the capacitor as a function of time.
    d.) What is the current flow after 2.40 s?
    e.) How long will it take for the current to drop to 1.00% of its original value?
    f.) What charge will have accumulated on the capacitor after 2.40 s?
    g.) What will be the voltage across the capacitor after 4.80 s?

ANSWERS: **01.** a.) 600 μA b.) 9.50 mC c.) 16.0 s d.) $I = (600\ \mu\text{A})e^{-t/16.0}$ e.) 4.04 μA f.) 10.8 V
01. g.) $V = (10.8\ \text{V})e^{-t/16.0}$ h.) 3.09 V i.) 889 μF j.) 9.60 mC k.) $Q = (9.60\ \text{mC})e^{-t/16.0}$ l.) 2.75 mC
01. m.) 0.0518 J **02.** a.) 3.00 mA b.) 3.00 V c.) 1.92 mC
03. a.) 1.28 s b.) 4.50 mA c.) $I = (4.50\ \text{mA})e^{-t/1.28}$ d.) 0.690 mA e.) 5.89 s f.) 4.88 mC g.) 8.79 V

Chapter 14
DC Electric Circuits
14.9 DC Ammeters and Voltmeters — Homework # 123

I

01. What is the resistance on a 10.0-V scale if the meter sensitivity is 25,000 Ω/V?

02. An ammeter has a sensitivity of 10,000 Ω/V and a full-scale deflection when 100 mV is across it. What minimum current passing through the galvanometer causes full-scale deflection?

II

03. A galvanometer has a full-scale deflection of 160 μA when 10 mV are across it.
    a.) How could this galvanometer be used to make an ammeter with a full-scale deflection of 1.00 A?
    b.) How could this galvanometer be used to make an ammeter with a full-scale deflection of 10.0 A?
    c.) How could this galvanometer be used to make a voltmeter with a full-scale deflection of 5.00 V?
    d.) How could this galvanometer be used to make a voltmeter with a full-scale deflection of 15.0 V?

04. A galvanometer has a sensitivity of 40,000 Ω/V and an internal resistance of 24.0 Ω.
    a.) How could this galvanometer be used to make an ammeter with a full-scale deflection of 10.0 mA?
    b.) How could this galvanometer be used to make an voltmeter with a full-scale deflection of 10.0 mV?

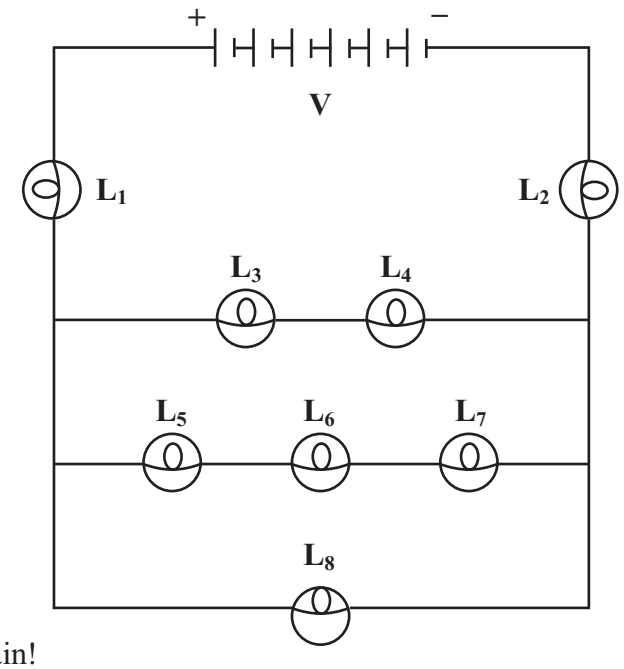
05. A milliammeter consists of a 0.250 Ω resistor in parallel with a 40.0 Ω galvanometer. It has a full-scale deflection of 50.0 mA.
    a.) How can this ammeter be used to construct a voltmeter with full-scale deflection of 10.0 V with out changing the structure of the ammeter (taking it apart)?
    b.) What will be the sensitivity of the voltmeter constructed in part a.) above?

ANSWERS: **01.** 250 kΩ **02.** 100 μA **03.** a.) 0.0100 Ω (shunt resistor) b.) 0.00100 Ω (shunt resistor)
03. c.) 31.1 kΩ (series resistor) d.) 93.6 kΩ (series resistor)
04. a.) 0.0601 Ω (shunt resistor) b.) 376 Ω (series resistor) **05.** a.) 200 Ω b.) 20 Ω/V (terrible sensitivity)

Chapter 14
DC Electric Circuits
DC Electric Circuits Review — Homework # 124

II

01. Each of the following questions refers to the diagram to the right. Assume all light bulbs are identical (equal resistances of R) and the battery has a **NET** voltage of V (ignore internal resistance). For each of the following, supply a clear explanation! Mathematically support your answers!



a.) How will the currents (I_1, I_2, I_3, I_6, and I_8) through light bulbs L_1, L_2, L_3, L_6, and L_8, respectively, compare? Explain!

b.) How will the readings on a voltmeter (V_3, V_4, and V_5) connected across each of light bulbs L_3, L_4, and L_5 compare? Explain!

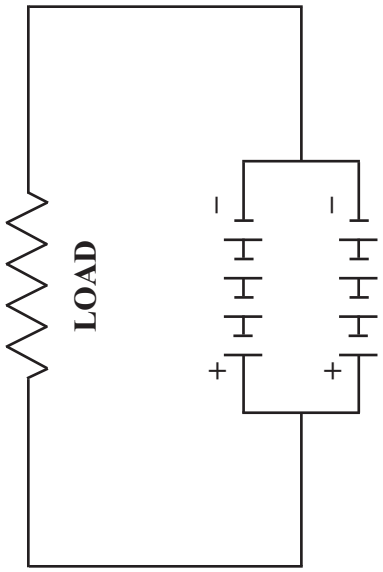
c.) How will the readings on a voltmeter (V_1, V_2, and V_8) connected across each of the light bulbs L_1, L_2 and L_8 be related? Explain!

d.) Suppose that an ammeter is connected in parallel with light bulb L_6. Describe **exactly** what will happen to all of the light bulbs in the circuit and why! Be sure to describe **ALL** changes in the circuit!

e.) Suppose that an ammeter is connected in parallel with light bulb L_6 as in part d.) above. How will the voltages (V_1, V_2, V_5, V_7, and V_8) across light bulbs L_1, L_2, L_5, L_7, and L_8 compare? Explain!

f.) Suppose that a voltmeter is connected in series with light bulb L_8. Describe **exactly** what will happen to all of the light bulbs in the circuit and why! Be sure to describe **ALL** changes in the circuit!

02. Consider a battery, made up of 4 cells connected in series, which is in turn connected in parallel with 4 other cells in series as shown in the diagram to the right. **Each** cell has an internal resistance of 0.250 Ω and an EMF of 2.02 Volts. This battery, in turn, is connected to a load resistance *R*. Assume the load resistance consists of 4.85 meters of wire with a diameter of 0.356 mm and a resistivity, ρ, of 3.60×10^{-7} Ω•m.



a.) What is the resistance of this load?

b.) What will be the magnitude of the current flowing through **each** cell of the battery? Justify!

c.) What will be the reading on a voltmeter connected across each battery? Explain!

d.) With what efficiency is power being delivered to this load?

Suppose that this load is replaced with some other load such that the power delivery in this circuit is maximized.

e.) How much power will be delivered to this new load?

ANSWERS: **01.** a.) $I_1 = I_2 = \frac{11}{28}\frac{V}{R} > I_8 = \frac{6}{28}\frac{V}{R} > I_3 = I_4 = \frac{3}{28}\frac{V}{R} > I_5 = I_6 = I_7 = \frac{2}{28}\frac{V}{R}$

01. b.) $V_3 = V_4 = \frac{3}{28}V > V_5 = \frac{2}{28}V$ c.) $V_1 = V_2 = \frac{11}{28}V > V_8 = \frac{6}{28}V$

01. d.) $I_1 = I_2 = \frac{2}{5}\frac{V}{R} > I_8 = \frac{1}{5}\frac{V}{R} > I_3 = I_4 = I_5 = I_7 = \frac{1}{10}\frac{V}{R} > I_6 = 0$

01. e.) $V_1 = V_2 = \frac{2}{5}V > V_8 = \frac{1}{5}V > V_5 = V_7 = \frac{1}{10}V$

01. f.) $I_1 = I_2 = \frac{5}{16}\frac{V}{R} > I_3 = I_4 = \frac{3}{16}\frac{V}{R} > I_5 = I_6 = I_7 = \frac{2}{16}\frac{V}{R} > I_8 = 0$

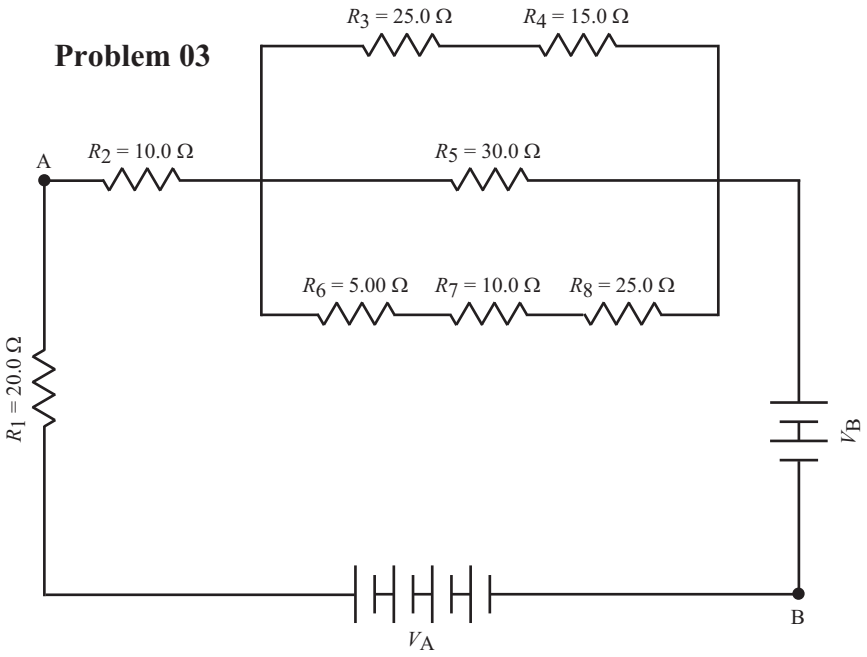
02. a.) 17.5 Ω b.) 0.225 A c.) 7.855 V d.) 97.5% e.) 32.6 W

Chapter 14
DC Electric Circuits
DC Electric Circuits Review — Homework # 125

II

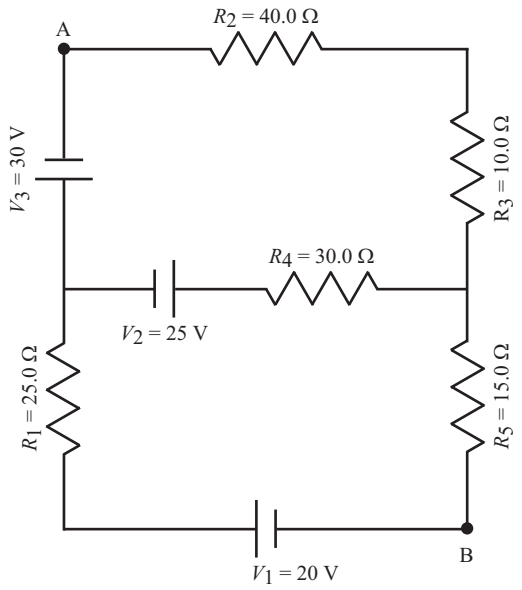
03. In the circuit shown to the right, each cell of battery V_A has an emf of 2.00 V and each cell of battery V_B has an emf of 1.50 V.
    a.) What is the net emf of the circuit?
    b.) What is the net resistance of the circuit?
    c.) What is the current through each cell of the battery V_A?
    d.) What is the current through each cell of the battery V_B?
    e.) Determine the current through each resistor.
    f.) What is the voltage across resistor R_2?
    g.) What is the power generated by the battery V_A?
    h.) What is the power generated by the battery V_B?
    i.) What is the power generated by this combination of batteries?
    j.) What is the power consumption of resistor R_3 in this circuit?
    k.) At what rate is energy transformed by resistor R_4?
    l.) What is potential difference between points A and B?

Problem 03



04. Ignore any internal resistance in the power supplies in the circuit shown to the right.
    a.) What is the current through resistor R_1?
    b.) What is the current through resistor R_2?
    c.) What is the current through resistor R_3?
    d.) What is the current through resistor R_4?
    e.) What is the current through resistor R_5?
    f.) What is the voltage across resistor R_4?
    g.) What is the power consumption of resistor R_2?
    h.) What is the power generated by battery V_1?
    i.) What is the potential difference between points A and B?

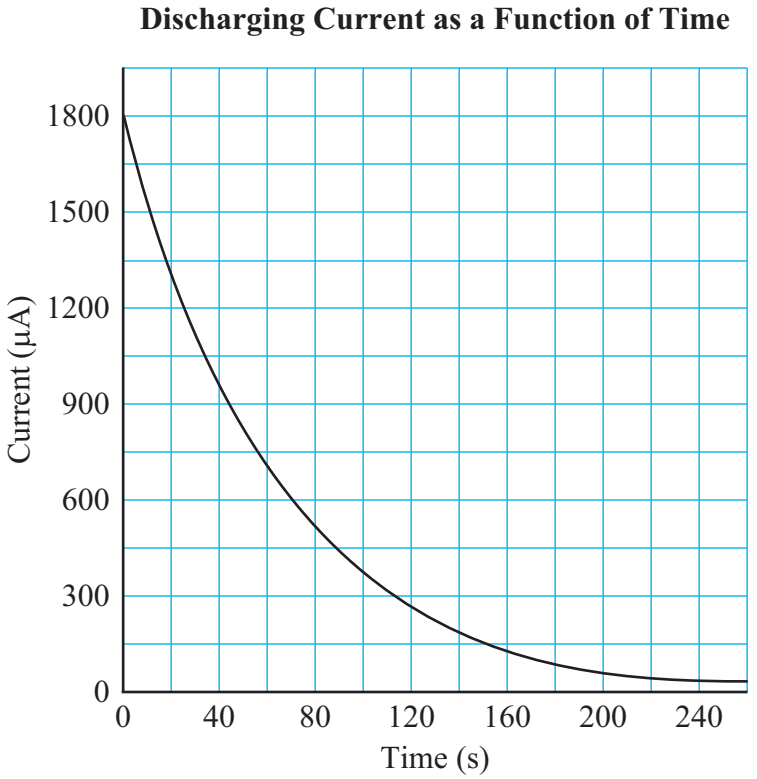
Problem 04



ANSWERS: **03.** a.) 5.00 V b.) 42.0 Ω c.) 0.119 A d.) 0.119 A
03. e.) $I_1 = I_2 = 0.119$ A, $I_3 = I_4 = 0.0357$ A, $I_5 = 0.0476$ A, $I_6 = I_7 = I_8 = 0.0357$ A f.) 1.19 V g.) 0.952 W
03. h.) 0.357 W i.) 0.595 W j.) 0.0319 W k.) 0.0194 W l.) 5.62 V **04.** a.) 0.415 A b.) 0.532 A
04. c.) 0.532 A d.) 0.947 A e.) 0.415 A f.) 28.4 V g.) 11.3 W h.) 8.30 W i.) 20.4 V

Chapter 14
DC Electric Circuits
DC Electric Circuits Review — Homework # 126

05. A capacitor is connected in series with a 2500-Ω resistor and a galvanometer. The capacitor is initially charged up to a potential of 4.50 Volts. The source of EMF is then removed and the capacitor is allowed to discharge. The current flowing out of the capacitor as a function of time is shown in the graph to the right.
    a.) What is the time constant for this circuit?
    b.) What is the capacitance of this capacitor?
    c.) How much charge is initially stored on the capacitor?
    d.) Write an equation that describes the charge on the capacitor as a function of time.
    e.) What is the charge on the capacitor at 400.0 s?
    f.) Write an equation that describes the current out of the capacitor as a function of time.
    g.) What is the current at 400.0 s?
    h.) Write an equation that describes the voltage across the capacitor as a function of time.
    i.) What is the voltage across the capacitor at 400.0 s?
    j.) What is the initial energy stored on the capacitor?



06. Answer each of the following questions as clearly and concisely as possible. [It is intended that no answer to this portion should exceed 1/3 page in length!]
    a.) What is internal resistance of a battery, how can it be experimentally measured and how is the magnitude of this resistance determined by the internal characteristics of the battery?
    b.) Discuss the circuitry of an ammeter. Should an ammeter be connected in series or parallel when measuring the current of a resistance and why?
    c.) Discuss the circuitry of a voltmeter. Should an voltmeter be connected in series or parallel when measuring the voltage drop across a resistance and why?
    d.) What are the three characteristics which determine the resistance of a wire? How does each characteristic affect the resistance and why?
    e.) You have two light bulbs which are designed to be connected to 120 Volt household current, 100 Watts and 60 Watts. Which light bulb will have the higher resistance? Support your answer!!!
    f.) What is Kirchoff's loop rule and why does it work?
    g.) What is Kirchoff's junction rule and why does it work?

ANSWERS: **05.** a.) 64.0 s b.) 0.0256 F c.) 0.115 C d.) $Q = (0.115\text{ C})e^{-t/64}$ e.) 2.22×10^{-4} C
05. f.) $I = (1800\ \mu\text{A})e^{-t/64}$ g.) 3.47 μA h.) $V = (4.5\text{ V})e^{-t/64}$ i.) 8.69 mV j.) 0.259 J