IB Physics
FA 18.1 - Current, Voltage, Power

Name________________________

Best Reason to Miss School/Work________________________________

Show your work, and make quiet chicken noises to receive full credit.

1. How much current flows if you connect a 2.34 ohm resistor to a 12.0 volt battery?

2. If 0.129 amps of current flow through a 45 ohm resistor, what is the power dissipated?

3. If a current of 345 mA flows, how much charge will pass by in one (1.00) minute?

4. An 85 ohm heating element is connected to 120 volts. In what **time** can the heating element raise the temperature of 2.4 kg of water initially at 12 ^oC to 85 ^oC? (The specific heat of water is 4186 J/kg^oC)

5. A 1200 Watt heater runs on alternating current with a peak voltage of 134 Volts. What is its **resistance**?

Practice problems from 18.1 - Current, Voltage, Power (Do these on your own paper)

1

a) How much current flows if you connect a 56.4 Ω resistor to a 12.0 volt battery? (0.213 A)
b) If 0.129 amps of current flow through a 13.7 Watt heater. What is its resistance? (823 Ω)
c) In what time will a 563 mA current carry 2.15 C of charge? (3.82 s)
d) An 85 Ω heating element is connected to 120 volts. What will be the final temperature of 3.78 kg of water initially at 21.0 ^oC if it heats the water for 27.1 minutes? (The specific heat of water is 4186 J/kg^{o}C) (Assume 100% efficiency) (38 ^oC)
e) A 340 Ω heater is connected to an alternating current with a peak voltage of 670 V. What is the power dissipated? (660 W)

2

a) How much current flows if you connect a 1.78 Ω resistor to a 9.0 volt battery? (5.1 A)
b) A 500. W heater plugs into a 120 V source. What must be its resistance? (29 Ω)
c) If a current of 140 mA flows, what time will it take to put 5.6 C of charge on a capacitor? (40. s)
d) You want your electric go-cart to accelerate from rest to 4.7 m/s in 5.0 seconds. If it has a mass of 92 kg, what current does the motor need to draw on the average from the 24.0 V battery? (Assume 100% efficiency) (8.5 A)
e) A heater runs on alternating current. The peak voltage across the heater is 153 V, and the peak current through the heater is 1.67 A. What is the power consumption of the heater? (128 W)

3

a) What resistor must you use if you want to limit the current to 0.150 A from a 5.0 V source? (33 Ω)
b) Your hair dryer is 1200 Watts, and operates on 117 Volts. What must be the current flowing in it? (10. A)
c) If a current of 250 mA flows, how much charge will pass by in 4.0 minutes? (60. C)
d) A winch motor can draw 27 A from a 12 V battery. What vertical distance can it raise a 2130 kg car in 5.0 minutes? (Assume 100% efficiency) (4.7 m)
e) A heater operates with a peak current of 22.79 A and has a resistance of 5.76Ω. What is its power? (1496 W)

4

a) A 340 Ω resistor has 0.238 A of current flowing through it. What must be the voltage across it? (81 V)
b) If 0.783 amps of current flow through a heater connected to 48 V, what is the power dissipated? (38 W)
c) If a current of 212 mA flows, how much charge will pass by in one (1.00) hour? (763 C)
d) A motor runs on 240 V. If it can lift a 560 kg elevator 12 meters in 15 seconds, what current does it draw? (Assume 100% efficiency) (18 A)
e) A 670 Watt heater runs on alternating current at 120 V (RMS). What is the peak current flowing through it? (7.9 A)

5

a) A 150 Ω resistor has 0.518 A of current flowing in it, what is the potential across the resistor? (78 V)
b) A 52 W heater has a resistance of 67 Ω. At what voltage must it operate? (59 V)
c) 4.51 C of charge passes in 3.5 minutes. What is the current? (0.021 A)
d) A 12 V motor can draw an average of 67 A from the battery. In what time can it accelerate an 82 kg cart from rest to 3.7 m/s? (Assume 100% efficiency) (0.70 s)
e) A 450 Ω heater is dissipating 210 W of power. What must be the peak voltage if it operates on an alternating current source? (430 V)

IB Physics
FA 18.2 - Resistivity and Electron Drift

Name__________________________

Best Snow Day Activity____

Show your work, and bark like a yappy dog to receive full credit.

1. What is the resistance of an Aluminium wire that is 2.59 mm in diameter (10 gauge) and 12.0 m long? The resistivity of Aluminium is 2.65×10^{-8} Ωm. (0.0604 Ω)

2. A 25.0 m long copper wire (resistivity = 1.68×10^{-8} Ωm) has a resistance of 0.127 ohms. What is its diameter? (2.05 mm)

3. A film resistor is made of a thin film of material that is 1.01×10^{-8} m thick, 3.50 cm wide, and 15.0 cm long. What is its resistivity if it has a resistance of 221 ohms? (The current flows a distance of 15.0 cm through the film) (52.1×10^{-8} Ωm)

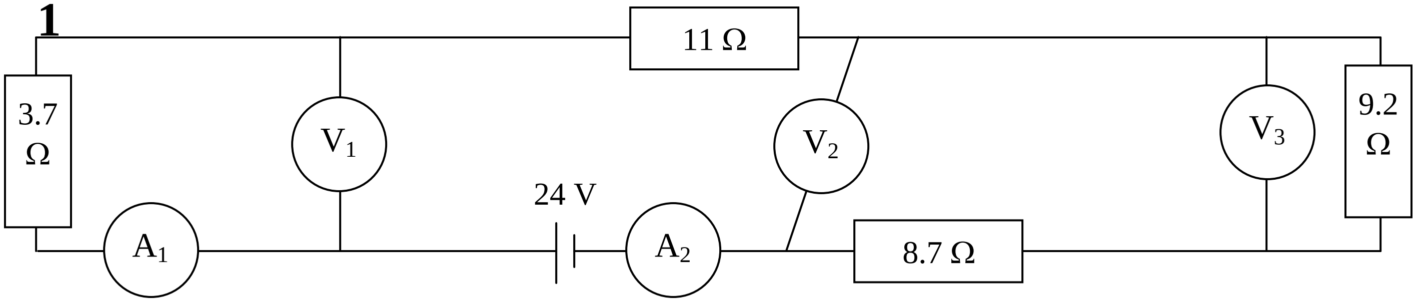
4. With what speed do electrons travel down a 0.240 mm diameter copper wire that is carrying 140. mA of current. (n for Cu is 8.50×10^{28} electrons m^{-3}) (2.27×10^{-4} m/s)

5. A 85.0 cm long copper (resistivity = 1.68×10^{-8} Ωm, n = 8.50×10^{28} electrons m^{-3}) wire is 2.10 mm in diameter, and has a potential of 0.0150 V across it. What time does it take an electron to travel the length of the wire? (hint - find R, then I, then v, then t) (1.10×10^{4} s or 3.06 hours)

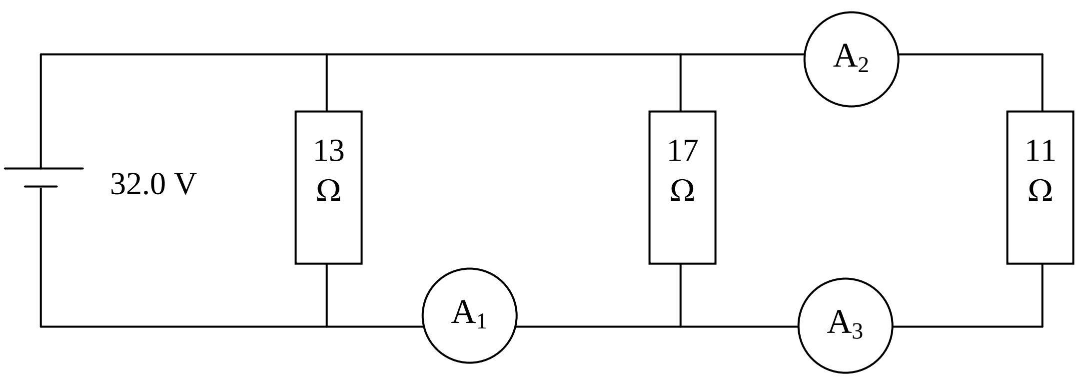
Practice for 19.1: Name___________________________

Round your answers to three sig figs (retain five), and show your work.

1

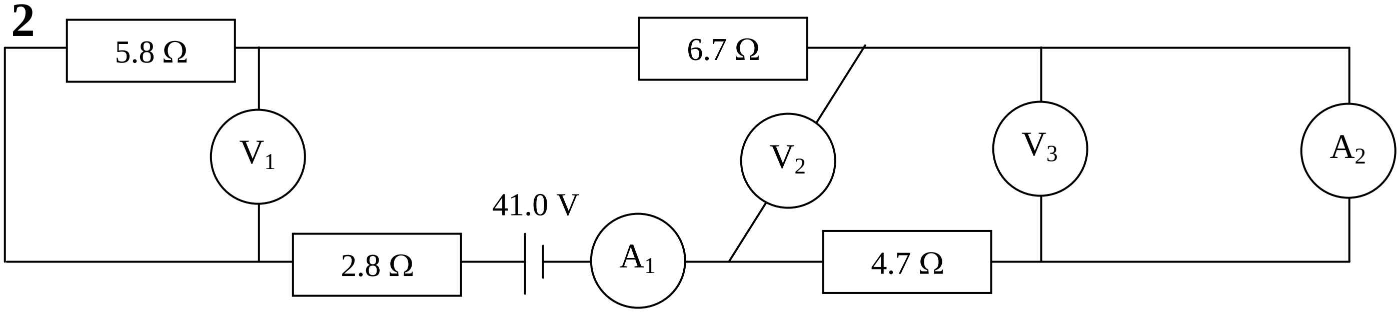


A_1 (0.736 A)	A_2 (0.736 A)	V_1 (2.72 V)
V_2 (13.2 V)	V_3 (6.77 V)	Least power dissipated by a resistor: (the 3.7 ohm: 2.01 W)

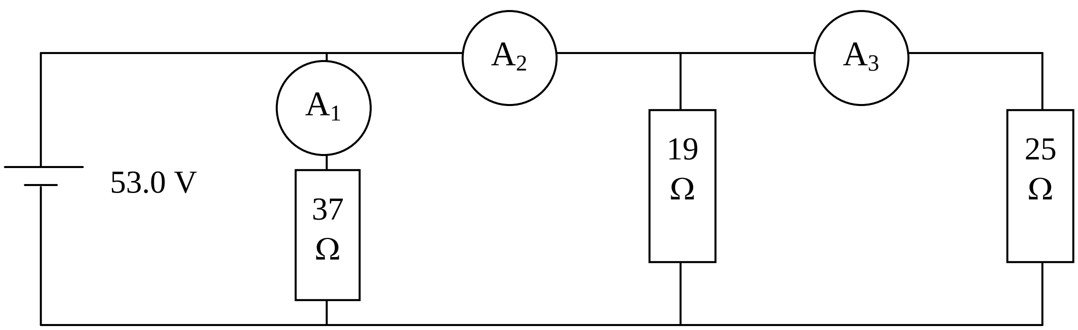


A_1 (4.79 A)	A_2 (2.91 A)	A_3 (2.91 A)	Greatest power dissipated by a resistor (the 11 ohm: 93.1 W)

2

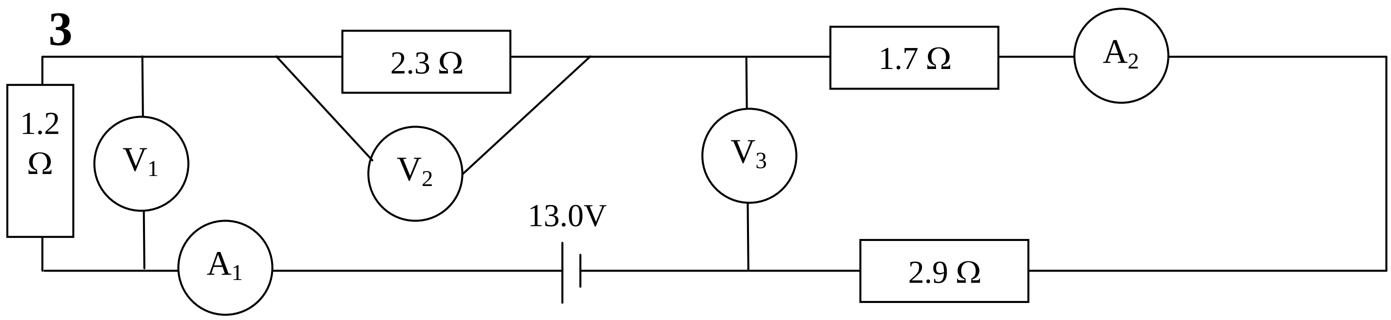


A_1 (2.05 A)	A_2 (2.05 A)	V_1 (11.9 V)
V_2 (9.64 V)	V_3 (0.00 V)	Greatest power dissipated by a resistor: (the 6.7 ohm: 28.2 W)

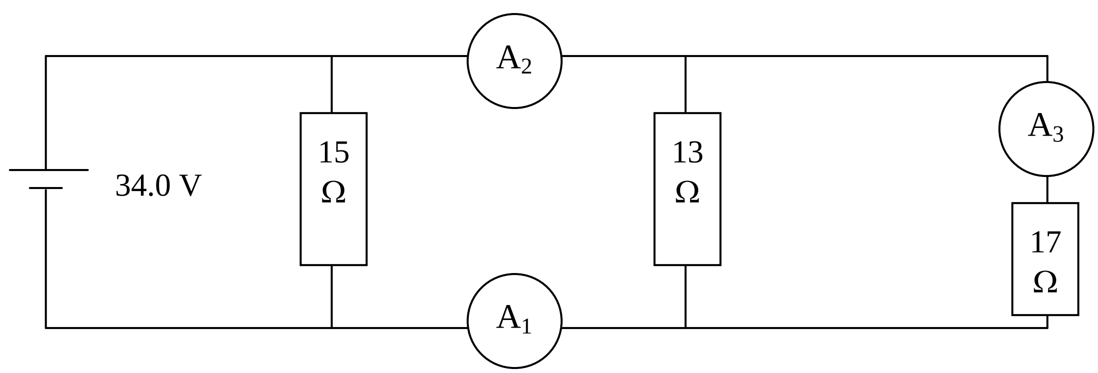


A_1 (1.43 A)	A_2 (4.91 A)	A_3 (2.12 A)	Least power dissipated by a resistor (the 37 ohm: 75.9 W)

3

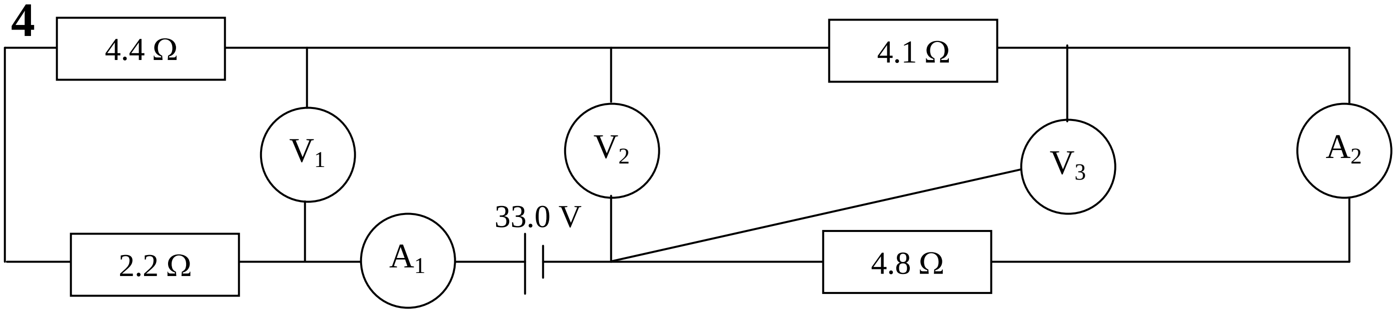


A_1 (1.60 A)	A_2 (1.60 A)	V_1 (1.93 V)
V_2 (3.69 V)	V_3 (7.38 V)	Least power dissipated by a resistor: (the 1.2 ohm: 3.09 W)

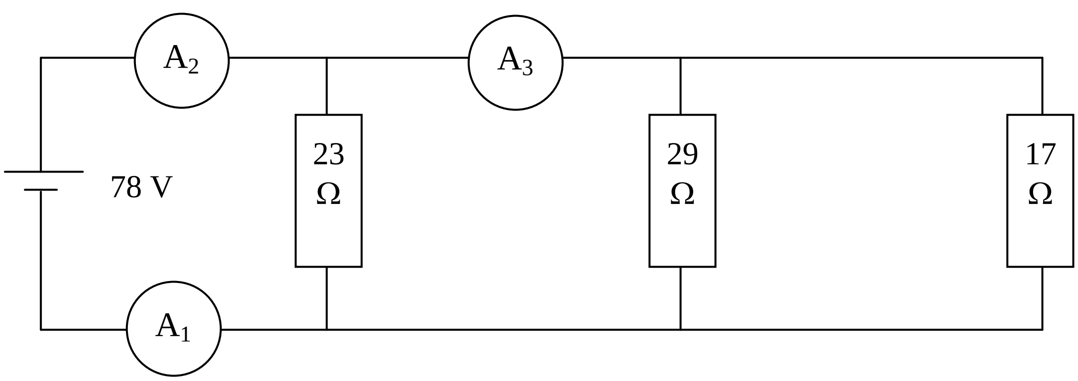


A_1 (4.62 A)	A_2 (4.62 A)	A_3 (2.00 A)	Greatest power dissipated by a resistor (the 13 ohm: 88.9 W)

4



A_1 (2.13 A)	A_2 (2.13 A)	V_1 (14.1 V)
V_2 (18.9 V)	V_3 (10.2 V)	Greatest power dissipated by a resistor: (the 4.8 ohm: 21.8 W)



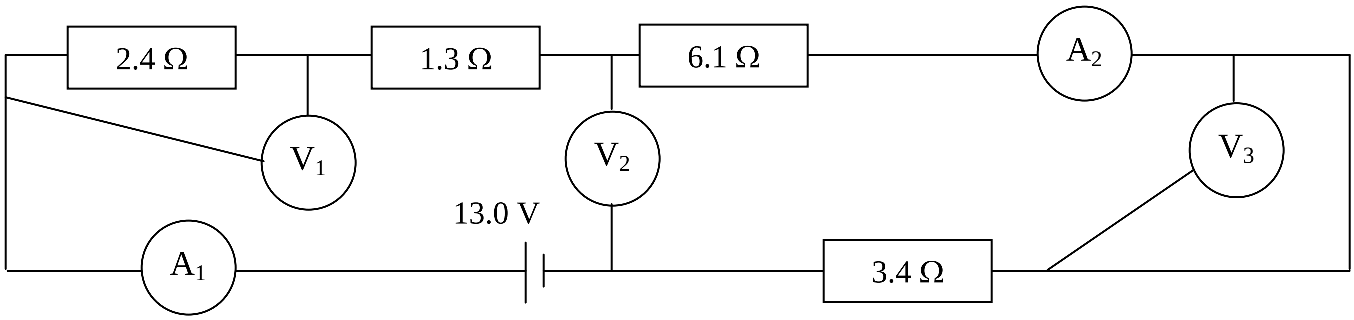
A_1 (10.7 A)	A_2 (10.7 A)	A_3 (7.28 A)	Least power dissipated by a resistor (the 29 ohm: 210. W)

IB Physics
FA 19.1 - Series and Parallel

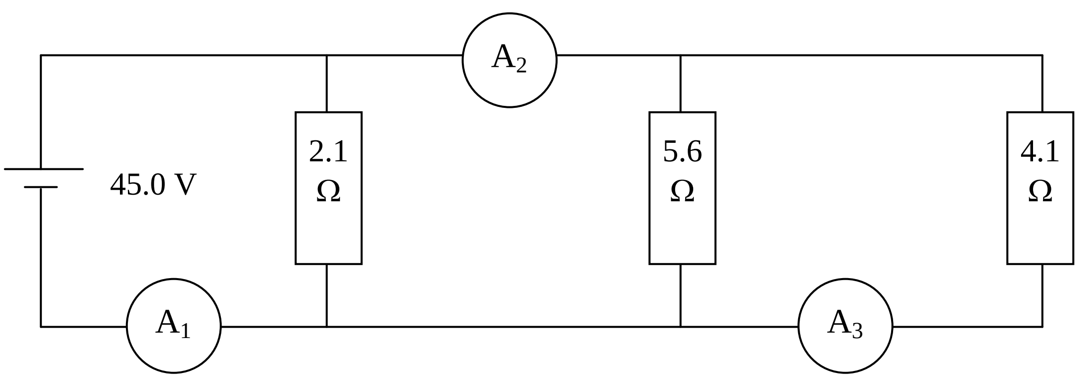
Name____________________________

Favorite TikTok________________________________Favorite TikTok Fail____________________________

Find the meter readings. Round your answers to three sig figs, and show your work.



A_1	A_2	V_1
V_2	V_3	Greatest power dissipated by a resistor:

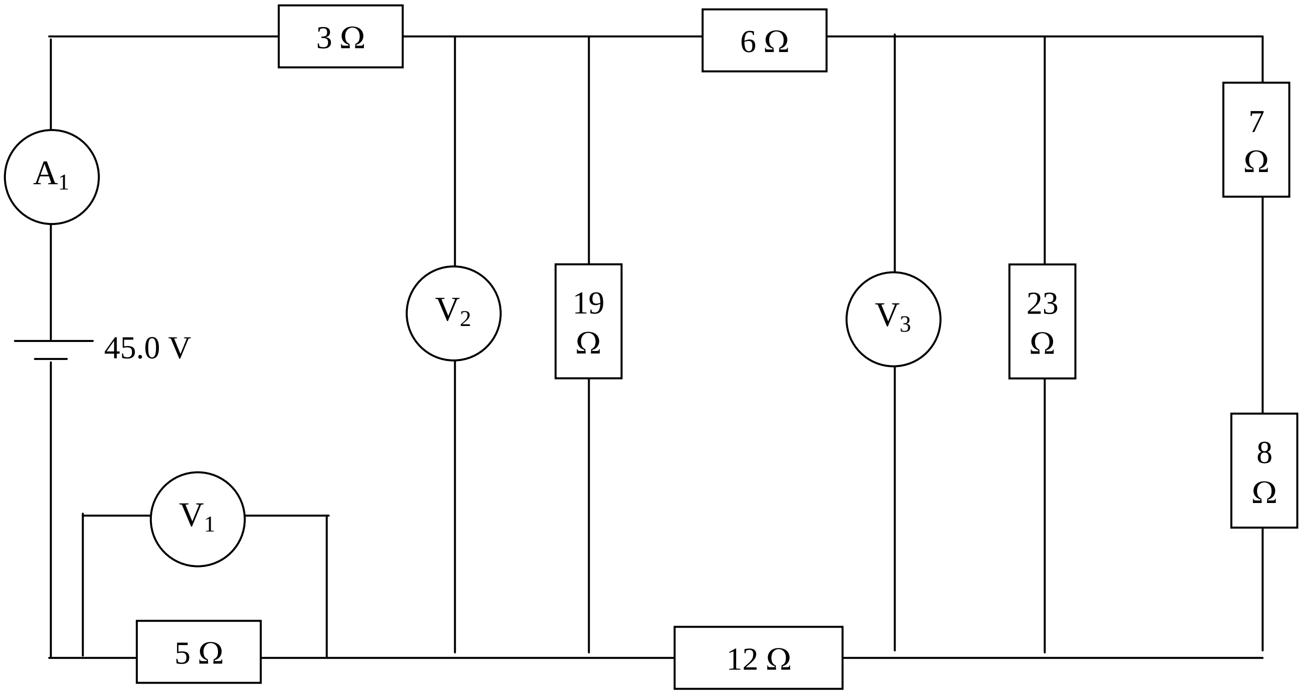


A_1	A_2	A_3	Least power dissipated by a resistor

Practice for 19.2: Name____________________________

Round your answers to three sig figs (retain five), and show your work.

1



Find:

A_1 =_______________

V_1 =_______________

V_2 =_______________

V_3 =_______________

Find the current through:

19 Ω_______________

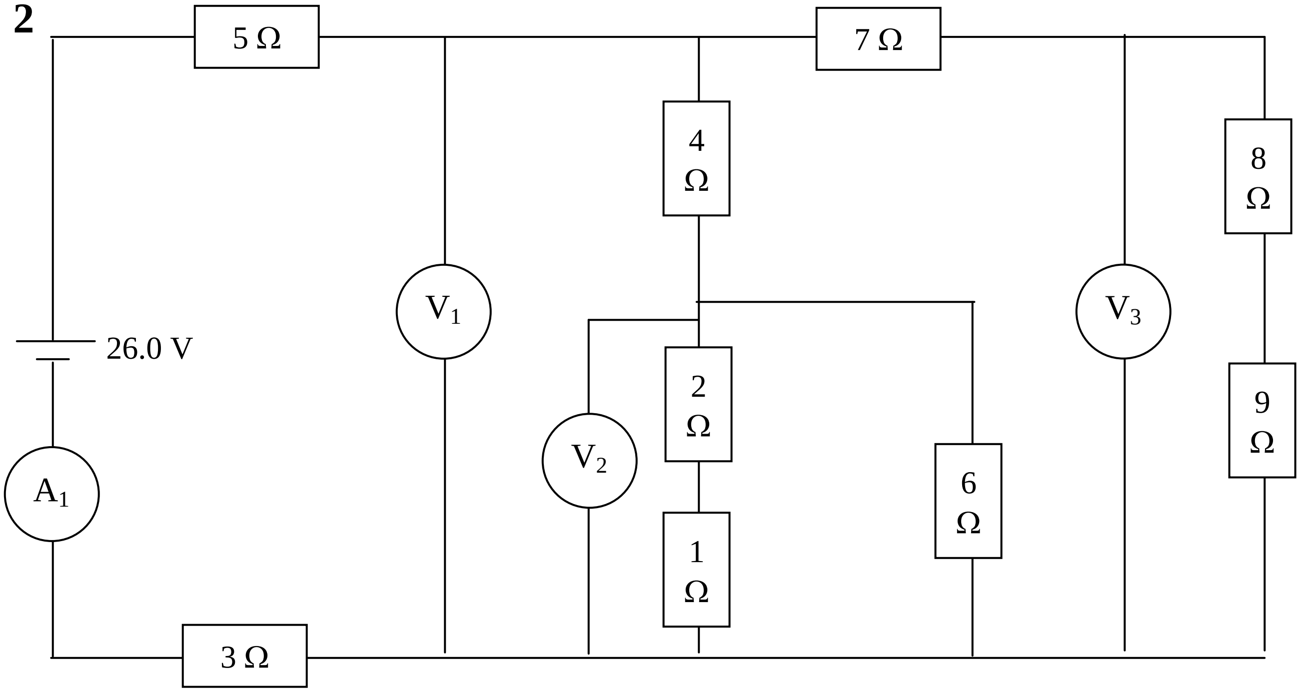
6 Ω_______________

23 Ω_______________

7 Ω_______________

	9.078947	ohms
	27.07895	ohms
	11.16562	ohms
Net R	19.16562	ohms
A1	2.347954	A
V1	11.73977	V
V2	26.21637	V
I19	1.379809	A
I6	0.968146	A
V3	8.789743	V
I23	0.382163	A
I7	0.585983	A

2



Find:

A_1 =_______________

V_1 =_______________

V_2 =_______________

V_3 =_______________

Find the current through:

4 Ω_______________

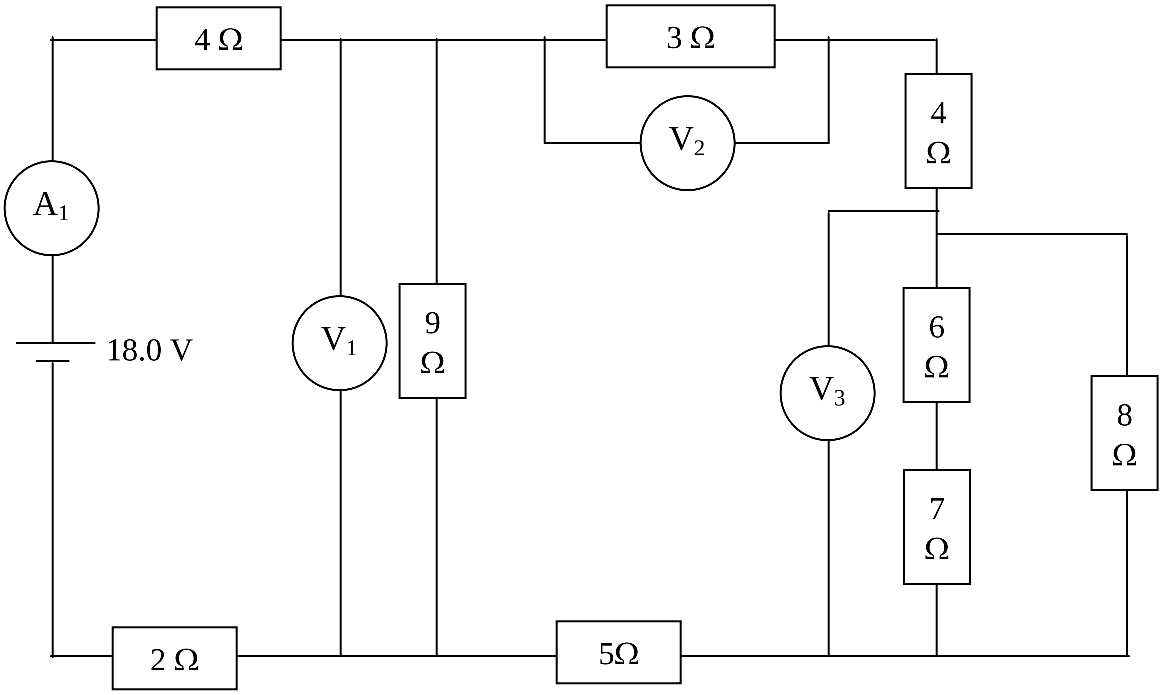
2 Ω_______________

6 Ω_______________

7 Ω_______________

	24	ohms
	2	ohms
	6	ohms
	4.8	ohms
Net R	12.8	ohms
A1	2.03125	
V1	9.75	
I7	0.40625	
V3	6.90625	
I4	1.625	
V2	3.25	
I2	1.083333	
I6	0.541667	

3



Find:

A_1 =________________

V_1 =________________

V_2 =________________

V_3 =________________

Find the current through:

9 Ω________________

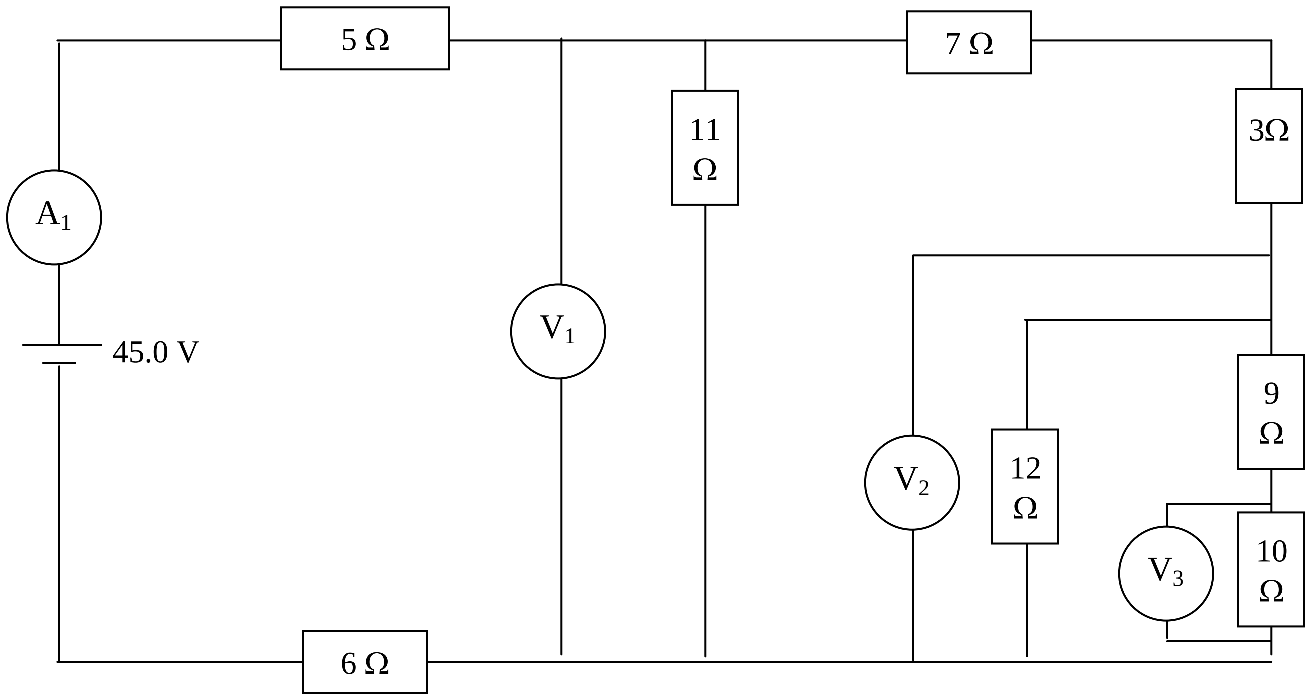
3 Ω________________

6 Ω________________

8 Ω________________

	4.952381	ohms
	16.95238	ohms
	5.878899	ohms
Net R	11.8789	ohms
A1	1.515292	A
V1	8.908248	V
I9	0.989805	A
I3	0.525487	A
V2	1.57646	V
V3	2.60241	V
I6	0.200185	A
I8	0.325301	A

4



Find:

A_1 =________________

V_1 =________________

V_2 =________________

V_3 =________________

Find the current through:

11 Ω________________

7 Ω________________

12 Ω________________

9 Ω________________

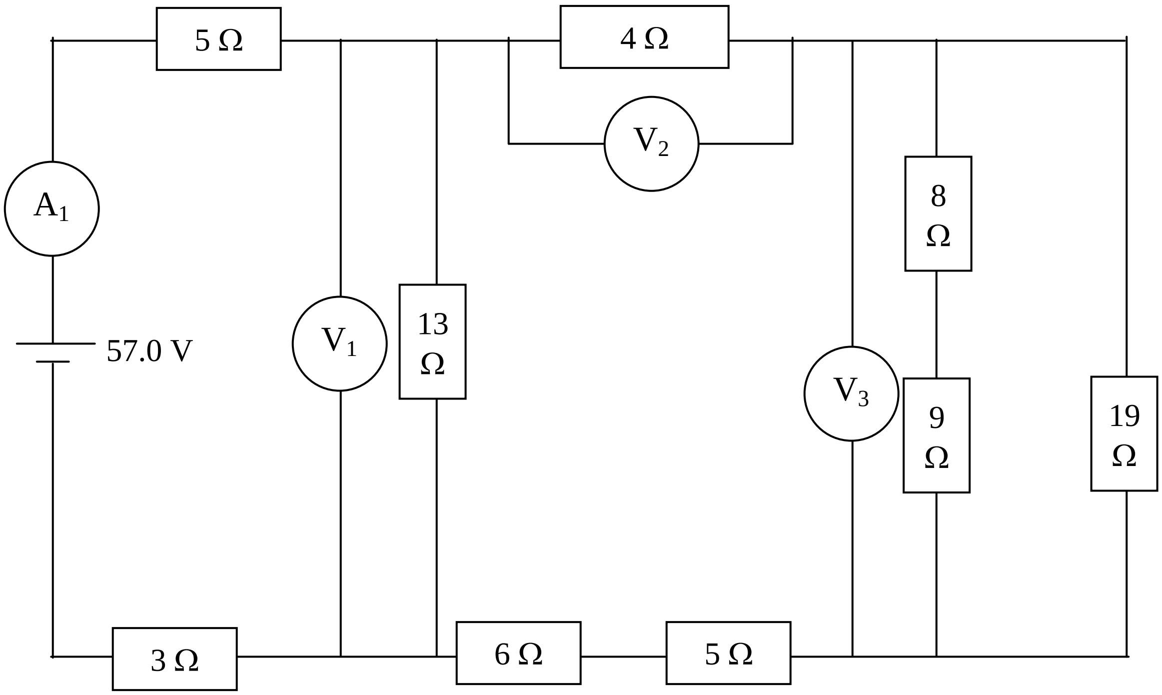
	7.354839	ohms
	17.35484	ohms
	6.732651	ohms
Net R	17.73265	ohms
A1	2.537692	A
V1	17.08539	V
I11	1.553217	A
I7	0.984474	A
V2	7.240649	V
I12	0.603387	A
I9	0.381087	A
V3	3.810868	V

IB Physics
FA 19.2 - Network Circuits

Name___________________________

Favorite Snotty Retort to Parents____

Round your answers to three sig figs (retain five), and show your work.



Find:

A_1 =________________

V_1 =________________

V_2 =________________

V_3 =________________

Find the current through:

13 Ω________________

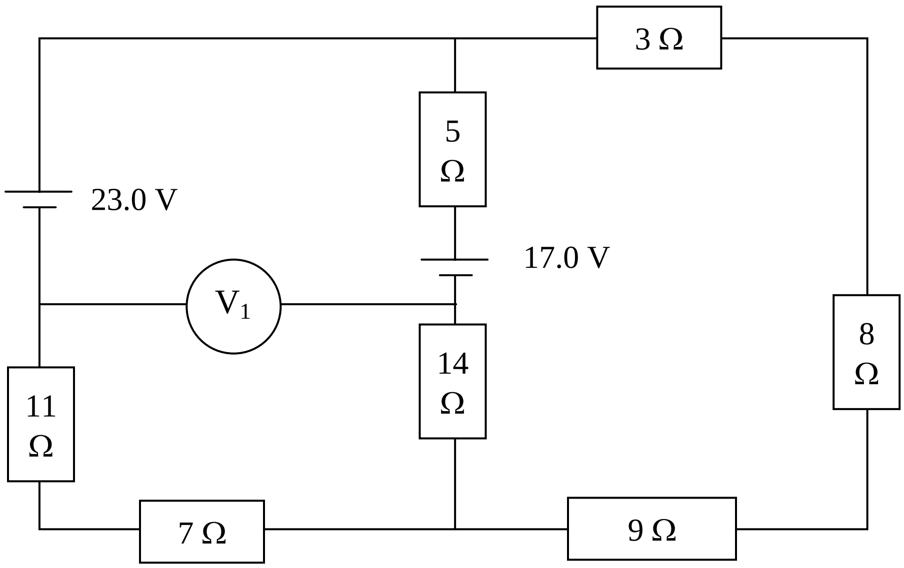
4 Ω_________________

9 Ω_________________

19 Ω________________

Practice for 19.3 - Kirchhoff's Laws!!!!! Name___________________________

1



Find the current and direction (up or down) through:

11 Ω_______________ (0.515 A, up)

14 Ω_______________ (0.172 A, up)

8 Ω________________ (0.687 A, down)

Find the voltage across:

7 Ω________________ (3.60 V)

3 Ω________________ (2.06 V)

Find power dissipated by:

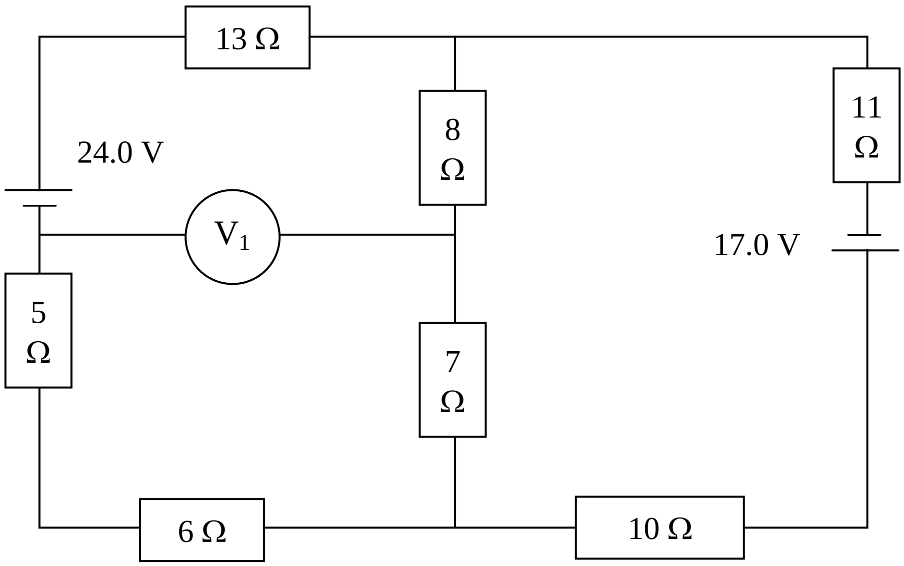
9 Ω________________ (4.24 W)

5 Ω________________ (0.148 W)

Find:

$|V_1|$ =_______________ (6.86 V)

2



Find the current and direction (up or down) through:

5 Ω_________________(0.949 A, up)

7 Ω_________________(0.0814 A, down)

11 Ω________________(0.868 A, down)

Find the voltage across:

13 Ω________________(12.3 V)

10 Ω________________(8.68 V)

Find power dissipated by:

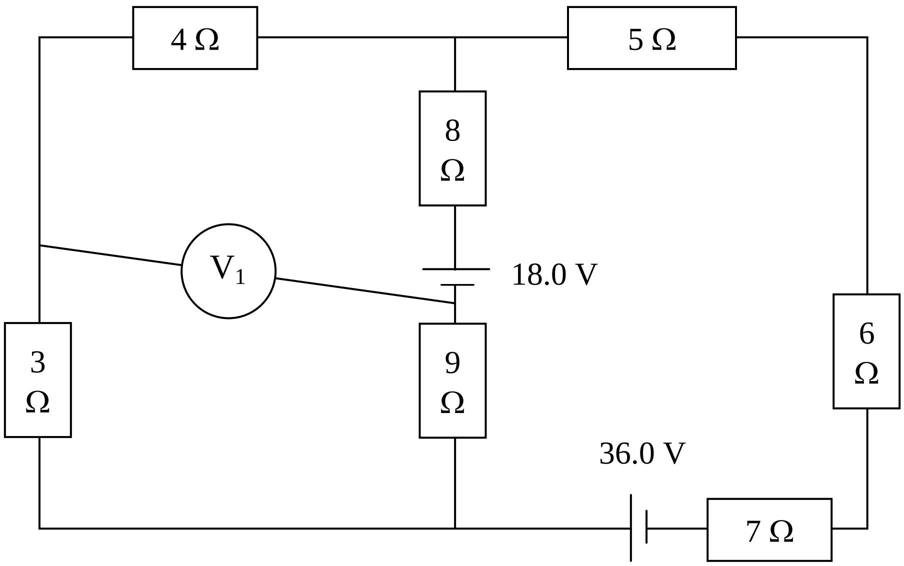
8 Ω_________________(0.0530 W)

6 Ω_________________(5.40 W)

Find:

$|V_1|$ =________________(11.0 V)

3



Find the current and direction (up, down) through:

3 Ω_________________(0.523 A up)

9 Ω_________________(1.27 A up)

6 Ω_________________(1.80 A down)

Find the voltage across:

4 Ω_________________(2.09 V)

7 Ω_________________(12.6 V)

Find power dissipated by:

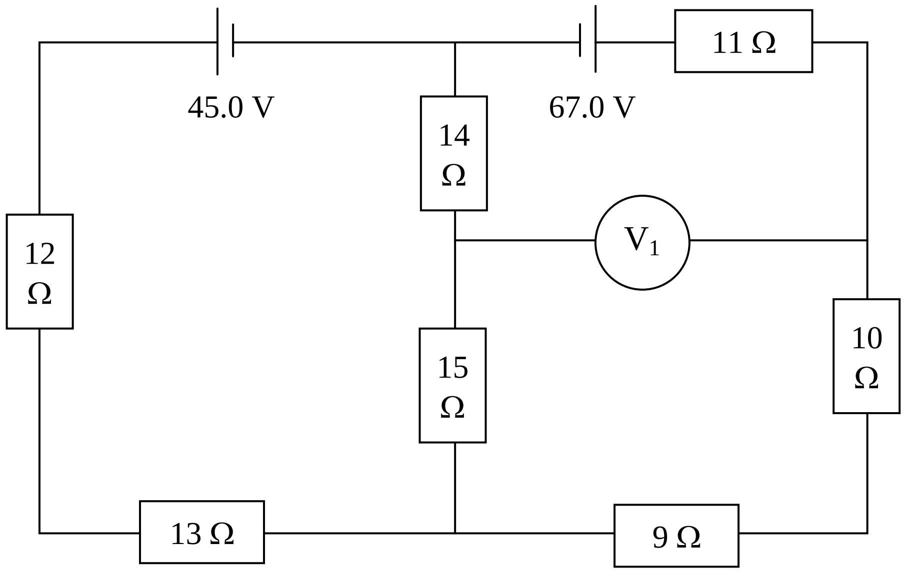
8 Ω_________________(13.0 W)

5 Ω_________________(16.1 W)

Find:

$|V_1|$ =________________(9.90 V)

4



Find the current and direction (up, down, left, right) through:

12 Ω________________(0.304 A down)

15 Ω________________(1.29 A up)

10 Ω________________(0.986 A down)

Find the voltage across:

11 Ω________________(10.8 V)

14 Ω________________(18.1 V)

Find power dissipated by:

9 Ω_________________(8.76 W)

13 Ω________________(1.20 W)

Find:

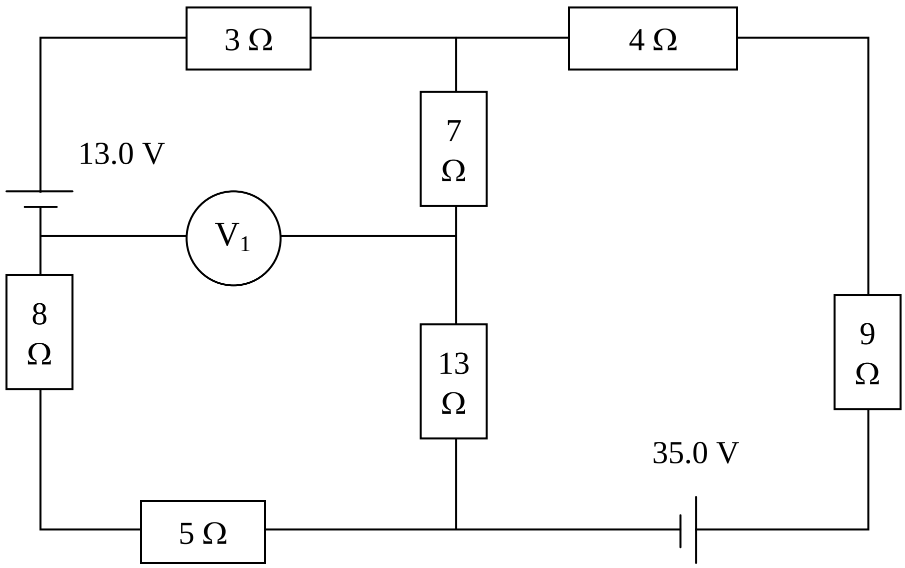
$|V_1|$ =________________(38.1 V)

IB Physics
FA 19.3 - Kirchhoff's Laws

Name________________________

Favorite Punchline____

Round your answers to three sig figs (retain five), and show your work.



Find the current and direction (up or down) through:

8 Ω______________

13 Ω_____________

9 Ω______________

Find the voltage across:

4 Ω______________

5 Ω______________

Find power dissipated by:

3 Ω______________

7 Ω______________

Find:

$|V_1|$ =_____________

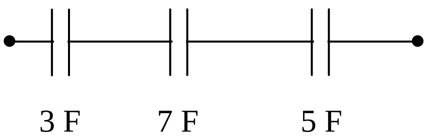
FA 19.4 - Capacitors in Parallel and Series

Name_________________________

Favorite Punchline____

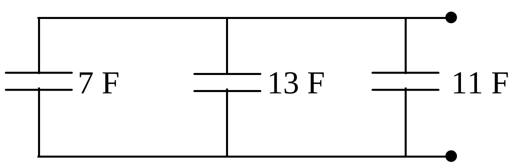
Round your answers to three sig figs (retain five), and show your work.

Find the capacitance:



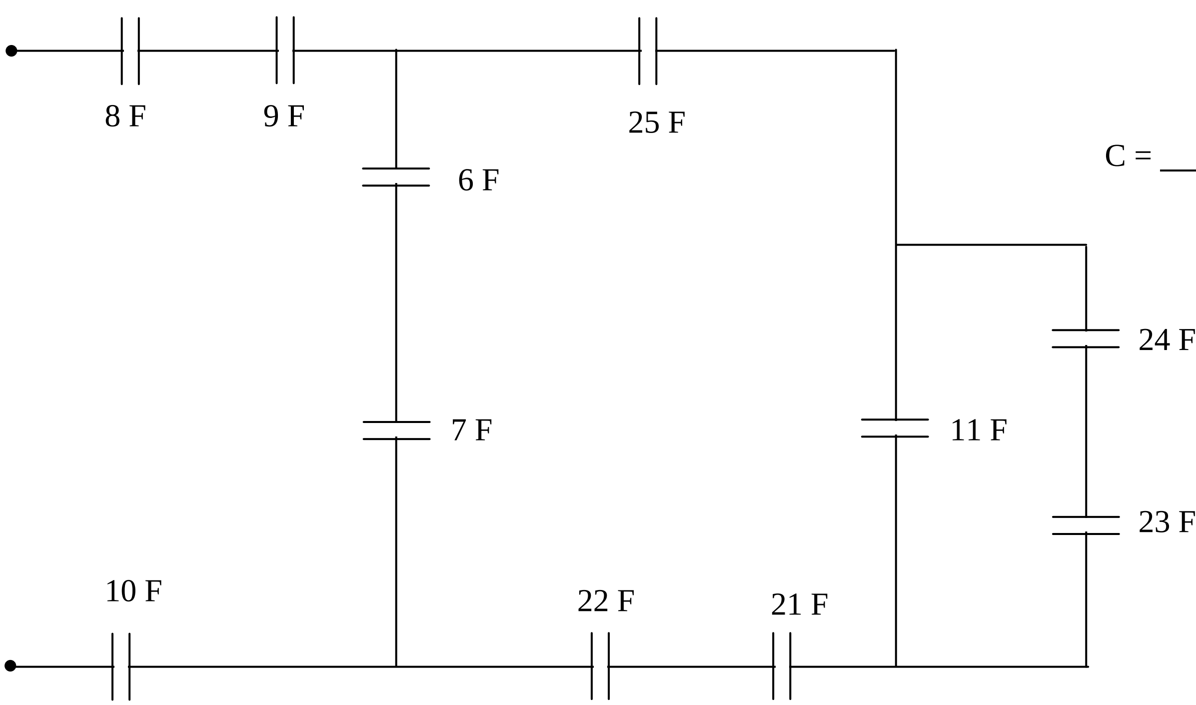
C = __________(1.48 F)

Find the capacitance



C = __________(31 F)

Find the freakin' capacitance:

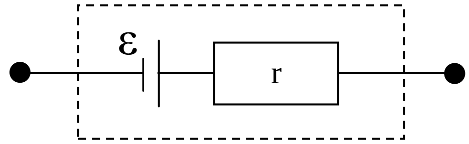


C = __________(2.228 F)

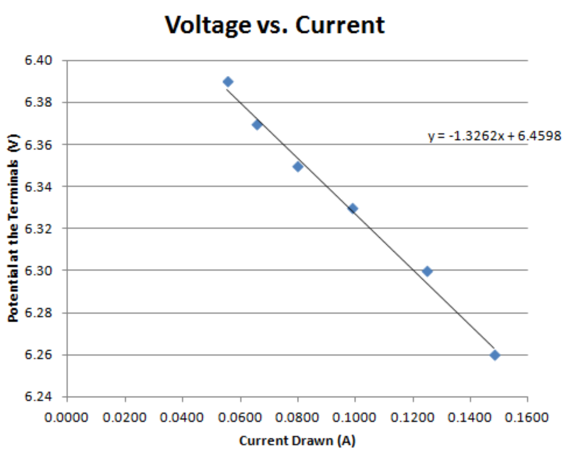
Internal Resistance of a Battery

When you draw current from a battery, the terminal voltage drops because all batteries or cells have an internal resistance which we can imagine as a small resistor in series with the cell. The formula then for the EMF, ε, is $\varepsilon = (R + r)$ where I is the current leaving the battery, R is the external resistance, and r the internal.

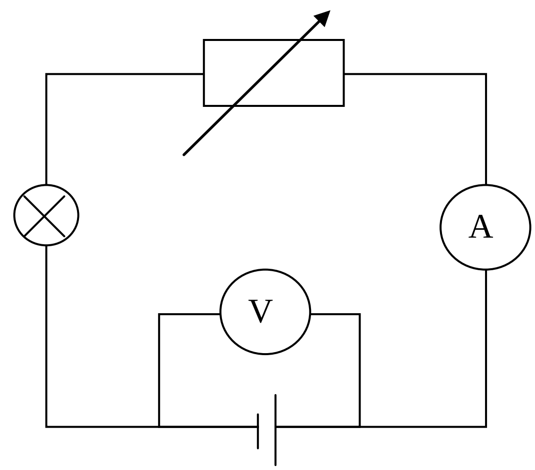
The model for a battery with internal resistance is this:



What this means is that the terminal voltage of the battery (The voltage you would measure if you did so from the black dot to the black dot in the diagram above) will drop as you draw more and more current from the battery. In fact, if we look at the relationship between the current and the terminal voltage, it should be $V_t = \varepsilon - Ir$, where ε is the battery's EMF, I is the current we are drawing from it, and r is its internal resistance. If we graph V_t vs I, we will get a graph with a y intercept of ε, and a slope of -r, so that is the plan, to get the internal resistance from the slope of the best fit line.



Notice how the terminal voltage is dropping as the current increases



The circuit you will use to measure voltage across and current drawn from the battery.

Directions -

0. With the light bulb unscrewed, read the unloaded terminal voltage of the battery, then screw it in.
1. Choose 5 - 10 different currents by sliding the variable resistor, and record for each the current in amps (mA/1000) and the potential in volts.
2. Graph V_t vs I, and put a trendline through the points, displaying the equation for the trendline.
3. Unscrew the light bulb, and turn off the meters unless there is someone waiting right there to do the lab.
4. Answer these questions:
    a. What was the internal resistance of the battery?
    b. How does the unloaded voltage you measured in step 0. compare to the y intercept of your equation?
    c. As batteries wear out, their voltage drops more severely with current drawn. What is happening to their internal resistance? (why do you know?)

Light Bulb and Diode

For an Ohmic conductor, a graph of I vs. V is a straight line with a slope of I/V (1/R) that goes through the origin. Here you will test a light bulb and a diode which decidedly aren't ohmic.

1. You will need two multimeters, one set up to read current, and the other, voltage.
2. Notice that the ammeter is connected so that it is reading the current through whatever it is you are testing, and the voltmeter is reading the voltage across the device. (Ammeters are in series - voltmeters in parallel)
3. For each of the devices you will be by manipulating the voltage, and measuring the current.

<u>Use the voltage ranges posted at the lab station.</u>

<u>Light Bulb:</u> Turn your voltage down, and adjust slowly, don’t burn out my bulb. (Don’t go over 6 V)

<u>Diode:</u> These will do nothing in one direction (don't go beyond about 6 volts looking) and in the other direction they will do something dramatic around about **<u>.6</u>** volts current-wise. Be ready for it. Do not exceed **<u>1</u>** Amp and your diode should be fine. If you get no response in either direction, then the diode is no more. You will collect all of your data points in the direction that something happens.

As you gather data, try to record exactly what the meters say simultaneously, and don't worry about getting exactly the value you are supposed to. (i.e. if you are trying to get the current for 0.200 volts, and it says 0.206 volts that's close enough - just record 0.206, and the exact current)

4. Make two nice I vs V graphs using Excel. Put your data and your graph on the same sheet as the graph. (Maybe use landscape) Your graph should have vertical gridlines as well as horizontal.
5. On the graph of the light bulb you will see that there are really two different slopes (more or less) so draw two different straight lines to represent these two resistances, and using the end points of the line, keeping in mind that you collected current in mA (1000 mA = 1 A), and that resistance is the inverse of the slope, calculate the differential resistance for these two regimes. For the diode, do the same thing for the points where the current takes off. Just do one line for the diode.
6. Answer these •2 questions •citing data or referring to specific regions of your graph to back up what you say:

   A. •What happens to the resistance of the light bulb as the current or voltage increases? (On an I vs V graph, the slope is the inverse of resistance) •Why does it change the way it does? (What happens to the resistivity of a metal as the temperature increases????)

   B. Look at your data from the diode. Isn't it wacky? •What would a diode be useful for?