ELC 2320 Circuits, Test 1. One sheet of notes permitted. Show all work. Name:_____

Problem 1. Construct a circuit model for the battery as seen by the automobile. The battery model consists of a ideal voltage source and a series resistance.

Advanced Auto Parts

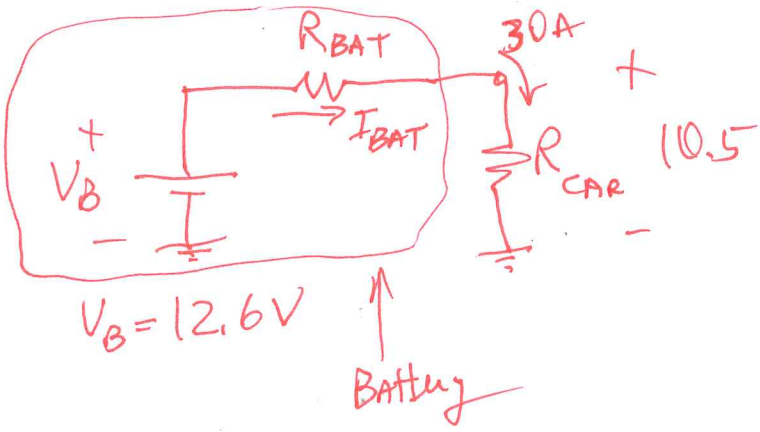
TEST THE BATTERY VOLTAGE

1. Turn off the ignition and any accessories like lights or the radio in the vehicle.
2. If your multimeter is not autoranging, set it to 20V DC.
3. Place the red lead on the positive battery terminal (indicated by a red cover or a + symbol).
4. Place the black lead on the negative terminal.
5. Read the measurement. If the reading is below 12.4 volts, you may need to charge your battery.
6. **BU Students, the battery is open circuited, and your voltage reading is 12.6V.**

PERFORM A CRANKING TEST

Monitoring the voltage during cranking can provide better insight into whether a battery simply needs to be charged or if it needs to be replaced.

1. Turn off the vehicle and all accessories.
2. Disable either the fuel or ignition system — whichever is easiest on your vehicle. This is necessary because the test is dependent on the vehicle cranking, but not starting.
3. Place the positive multimeter lead on the positive battery terminal and the negative lead on the negative terminal.
4. Have a helper turn the ignition on for no longer than 15 seconds and watch the multimeter. If the battery voltage drops below 9.6 volts, this is an indicator of a weak battery.
5. **BU Students. Your battery voltage drops to 10.5 volts, and the current is 30 amps.**



KVL, $-V_B + I_B R_B + 10.5 = 0$

$-12.6 + 30R_B + 10.5 = 0$

$30R_B = 12.6 - 10.5 = 2.1$

$R_B = \frac{2.1}{30} = 0.0700\,\Omega$

ELC 2320 Circuits, Test 1. One sheet of notes permitted. Show all work. Name:_____

Problem 1. Construct a circuit model for the battery as seen by the automobile. The battery model consists of a ideal voltage source and a series resistance.

Advanced Auto Parts

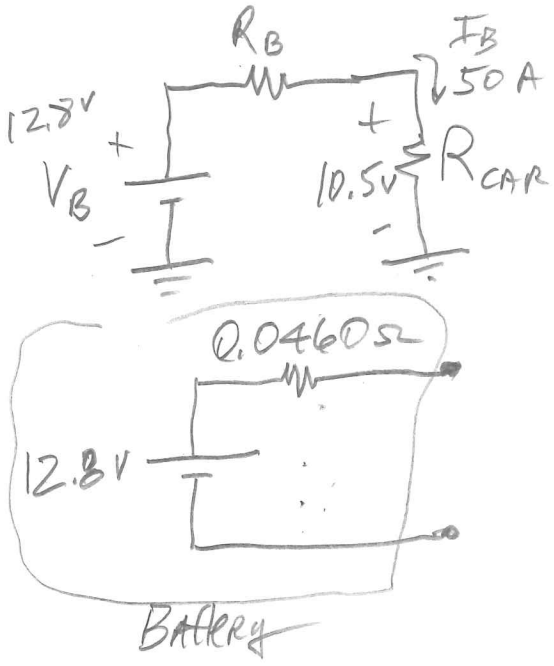
TEST THE BATTERY VOLTAGE

1. Turn off the ignition and any accessories like lights or the radio in the vehicle.
2. If your multimeter is not autoranging, set it to 20V DC.
3. Place the red lead on the positive battery terminal (indicated by a red cover or a + symbol).
4. Place the black lead on the negative terminal.
5. Read the measurement. If the reading is below 12.4 volts, you may need to charge your battery.
6. **BU Students, the battery is open circuited, and your voltage reading is 12.8V.**

PERFORM A CRANKING TEST

Monitoring the voltage during cranking can provide better insight into whether a battery simply needs to be charged or if it needs to be replaced.

1. Turn off the vehicle and all accessories.
2. Disable either the fuel or ignition system — whichever is easiest on your vehicle. This is necessary because the test is dependent on the vehicle cranking, but not starting.
3. Place the positive multimeter lead on the positive battery terminal and the negative lead on the negative terminal.
4. Have a helper turn the ignition on for no longer than 15 seconds and watch the multimeter. If the battery voltage drops below 9.6 volts, this is an indicator of a weak battery.
5. **BU Students. Your battery voltage drops to 10.5 volts, and the current is 50 amps.**



KVL $-V_B + I_B R_B + V_{CAR} = 0$

$$R_B = \frac{V_B - V_{CAR}}{I_b} = \frac{12.8 - 10.5}{50}$$

$$R_B = \frac{2.3}{50} = 0.0460\ \Omega$$

ELC 2320 Circuits, Test 1. One sheet of notes permitted. Show all work. Name:_____

Problem 1. Construct a circuit model for the battery as seen by the automobile. The battery model consists of a ideal voltage source and a series resistance.

Advanced Auto Parts

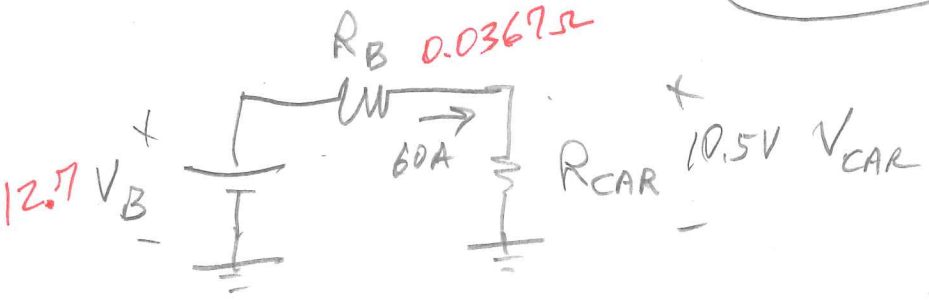
TEST THE BATTERY VOLTAGE

1. Turn off the ignition and any accessories like lights or the radio in the vehicle.
2. If your multimeter is not autoranging, set it to 20V DC.
3. Place the red lead on the positive battery terminal (indicated by a red cover or a + symbol).
4. Place the black lead on the negative terminal.
5. Read the measurement. If the reading is below 12.4 volts, you may need to charge your battery.
6. **BU Students, the battery is open circuited, and your voltage reading is 12.7V.**

PERFORM A CRANKING TEST

Monitoring the voltage during cranking can provide better insight into whether a battery simply needs to be charged or if it needs to be replaced.

1. Turn off the vehicle and all accessories.
2. Disable either the fuel or ignition system — whichever is easiest on your vehicle. This is necessary because the test is dependent on the vehicle cranking, but not starting.
3. Place the positive multimeter lead on the positive battery terminal and the negative lead on the negative terminal.
4. Have a helper turn the ignition on for no longer than 15 seconds and watch the multimeter. If the battery voltage drops below 9.6 volts, this is an indicator of a weak battery.
5. **BU Students. Your battery voltage drops to 10.5 volts, and the current is 60 amps.**



KCL $-V_B + I_B R_B + V_{CAR} = 0$

$$R_B = \frac{V_B - V_{CAR}}{I_B} = \frac{12.7 - 10.5}{60} = \frac{2.2}{60} = 0.0367\,\Omega$$

ELC 2320 Circuits, Test 1. One sheet of notes permitted. Show all work. Name:_____

Problem 1. Construct a circuit model for the battery as seen by the automobile. The battery model consists of a ideal voltage source and a series resistance.

Advanced Auto Parts

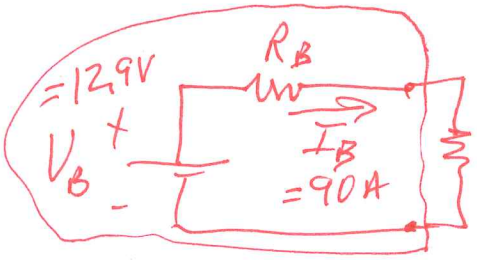
TEST THE BATTERY VOLTAGE

1. Turn off the ignition and any accessories like lights or the radio in the vehicle.
2. If your multimeter is not autoranging, set it to 20V DC.
3. Place the red lead on the positive battery terminal (indicated by a red cover or a + symbol).
4. Place the black lead on the negative terminal.
5. Read the measurement. If the reading is below 12.4 volts, you may need to charge your battery.
6. **BU Students, the battery is open circuited, and your voltage reading is 12.9V.**

PERFORM A CRANKING TEST

Monitoring the voltage during cranking can provide better insight into whether a battery simply needs to be charged or if it needs to be replaced.

1. Turn off the vehicle and all accessories.
2. Disable either the fuel or ignition system — whichever is easiest on your vehicle. This is necessary because the test is dependent on the vehicle cranking, but not starting.
3. Place the positive multimeter lead on the positive battery terminal and the negative lead on the negative terminal.
4. Have a helper turn the ignition on for no longer than 15 seconds and watch the multimeter. If the battery voltage drops below 9.6 volts, this is an indicator of a weak battery.
5. **BU Students. Your battery voltage drops to 10.5 volts, and the current is 90 amps.**



$$-V_B + I_B R_B + V_{CAR} = 0$$

$$I_B = \frac{V_B - V_{CAR}}{R_B}$$

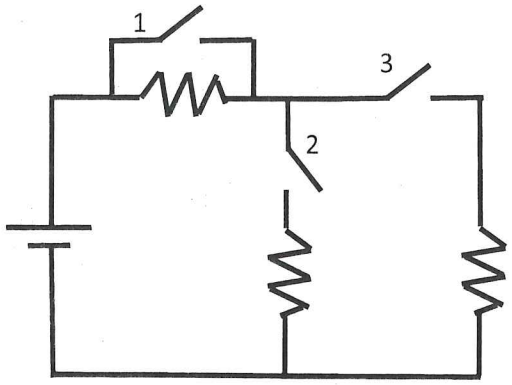
$$R_B = \frac{12.9 - 10.5}{90} = \frac{2.4}{90}$$

$$= 0.0267\,\Omega$$

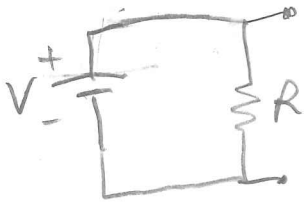
ELC 2320 Circuits, Test 1. One sheet of notes permitted. Show all work. Name:_____

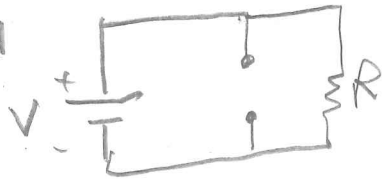
The circuit shown is composed of three identical resistors and one fixed voltage source. Each resistor has a switch. The switches have a 3-second repeating pattern.

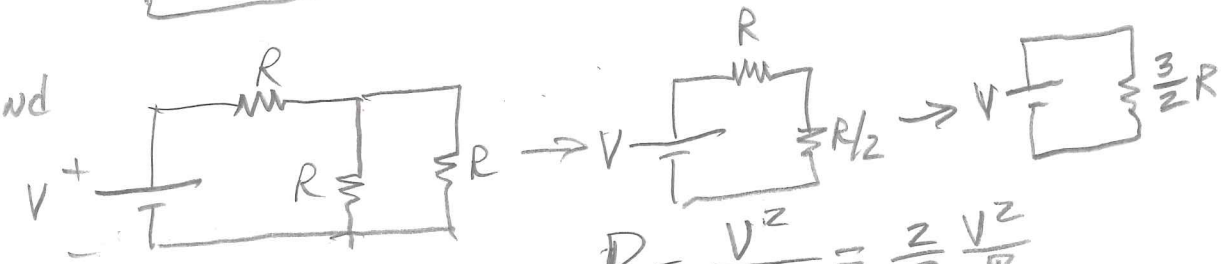
The state of each switch in the repeating 3-second pattern is shown. Develop an expression for the 3-second average power provided by the voltage source. Hint – first, determine the average power for each second. Next, average the three seconds.



	0 sec	1 sec	2 sec	3 sec ....
Switch 1	CLOSED	CLOSED	OPEN	
Switch 2	CLOSED	OPEN	CLOSED	
Switch 3	OPEN	CLOSED	CLOSED	

1st Second,  , $P_1 = \frac{V^2}{R}$

2nd Second  , $P_2 = \frac{V^2}{R}$

3rd Second 

$P_3 = \frac{V^2}{\frac{3}{2}R} = \frac{2}{3}\frac{V^2}{R}$

$$P_{AVG} = \frac{P_1(1\,sec) + P_2(1\,sec) + P_3(1\,sec)}{3\,sec}$$

$$P_{AVG} = \frac{1}{3}\left[\frac{V^2}{R} + \frac{V^2}{R} + \frac{2}{3}\frac{V^2}{R}\right] = \frac{V^2}{3}\left[\frac{1}{R} + \frac{1}{R} + \frac{2}{3R}\right]$$

$$= \frac{V^2}{3R}\left[1 + 1 + \frac{2}{3}\right] = \frac{V^2}{3R}\left[\frac{8}{3}\right] = \frac{V^2}{R}\left(\frac{8}{9}\right)$$