EE302 –Spring 14 **Homework #1** **Due date: 29 January, 2014.**

Power and Energy

Problem 1. (Ulaby, Problem 1.6) The cross section of a certain conductor lies in the *x*-*y* plane. If 3×10^{20} electrons go through this cross-section in the *z*-direction in 4 seconds, and simultaneously, 1.5×10^{20} positive charges go through the same cross section in the negative z-direction, what is the magnitude and the direction of the current flowing through this cross-section.

Problem 2.

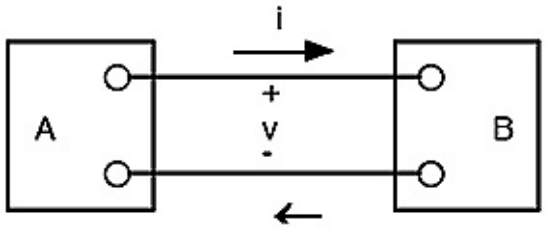
(a) Four 1.5 V batteries in series supply 100 mA to a portable CD player. How much energy do the batteries supply in 3 hours?

(b). The manufacturer of a 6 V flashlight battery says the battery will deliver 15 mA for 60 continuous hours. During that time the voltage will drop linearly from 6V to 3V. How much energy does the battery deliver in this time interval?

Problem 3.

(a) Two electric circuits, represented by black boxes A and B, are connected as shown. For each of the following values, calculate the power in the interconnection and state whether the power is flowing from A to B or vice versa.

1. i = 5 A v = 120 V
2. i = -8 A v = 250 V
3. i = 16 A v = -150 V
4. i = -10 A v = -480 V



(b). When a car has a dead battery, it can usually be started by connecting the battery from another car across its terminals. Assume the connection is made as shown, and the current I is 30 A.

1. Which car has the dead battery?
2. If the connection is maintained for 1 minute, how much energy is transferred to the dead battery?

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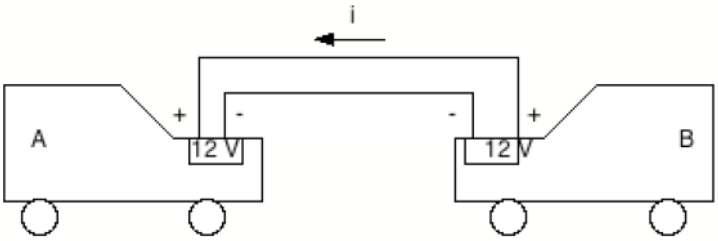
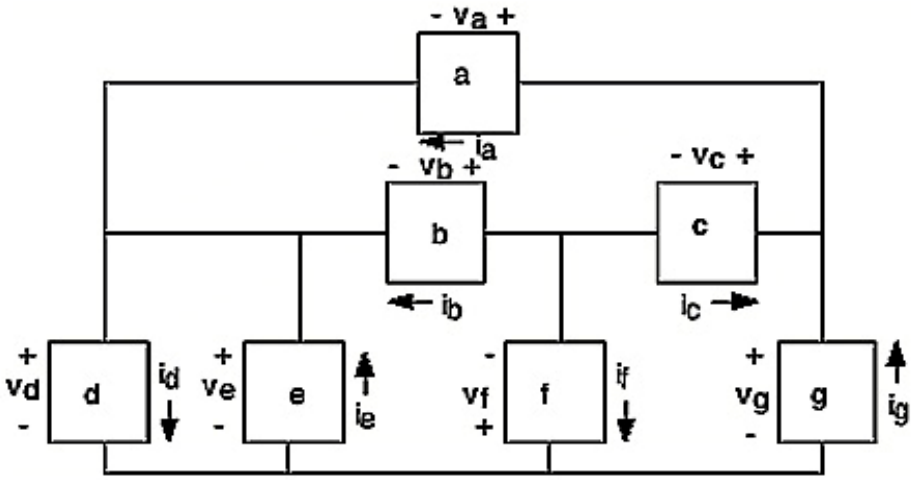
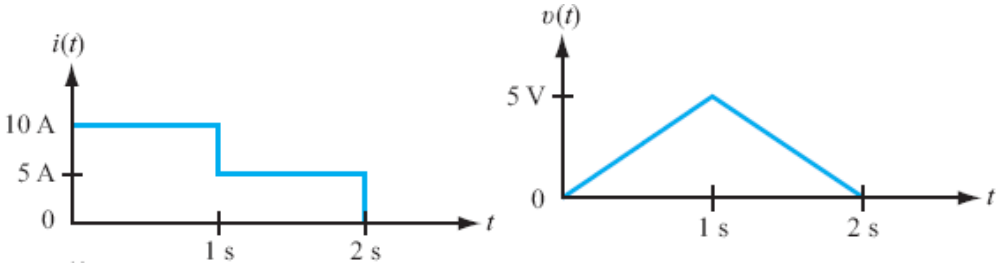


Problem 4. Consider a circuit consisting of seven 2-terminal circuit elements as shown. Check this circuit to see if the total power delivered by circuit elements equals the total power absorbed by the other circuit elements.

Element a:	v_a = 48 V	i_a = 12 A
Element b:	v_b = 18 V	i_b = -4 A
Element c:	v_c = 30 V	i_c = -10 A
Element d:	v_d = 36 V	i_d = 16 A
Element e:	v_e = 36 V	i_e = 8 A
Element f:	v_f = -54 V	i_f = 14 A
Element g:	v_g = 84 V	i_g = 22 A



Problem 5. (Ulaby 1.23). The voltage across a device and the current flowing through it are shown graphically as a function of time in the Figure below. Sketch the corresponding power delivered to the device as a function of time, and calculate the energy absorbed by it.



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Problem 6.

Consider an incandescent light bulb, represented as a resistor of resistance R, connected to a time-varying voltage source providing a voltage $v(t) = (3\text{V})\sin(2\pi f t)$ where f is the frequency of the voltage signal in Hz, or equivalently s^{-1}.

(a) Compute the power dissipated in the resistor as a function of time t, resistance R, and frequency f.

(b) Note that the light bulb will be bright when power dissipation is near its maximum, and will be dark when power dissipation is near its minimum. What is the frequency at which the light bulb will "blink"? Show mathematically, and explain in words, why the blinking frequency is not the same as the original frequency, f, of the voltage signal.