ECE 1250 homework # 4

1. A Lithium-Ion battery pack is used to power an MP3 Player. When the player is switched on the battery pack voltage drops from 3.80 V to 3.75 V and the player draws 10 mA.

   a) Draw a simple, reasonable model of the battery pack using ideal parts. Find the value of each part.

   b) When MP3 player is used to play loud music it draws 40 mA. What is the battery pack voltage now?

   c) The battery pack is placed in a charger. The charger supplies 4.50 V. How much current flows into the battery pack?

2. A rechargeable battery is shorted with an ideal ammeter. The ammeter reads 1.5 A. (By the way, this is generally a very bad thing to do and will not usually work well in practice. It is not a good idea to assume linearity all the way down to zero.) The ammeter is replaced with an ideal voltmeter. The voltmeter reads 12 V.

   a) Draw a simple, reasonable model of the battery pack using ideal parts. Find the value of each part.

   b) The battery is hooked to a load resistor and the terminal voltage drops to 10 V. Find the value of the load resistor.

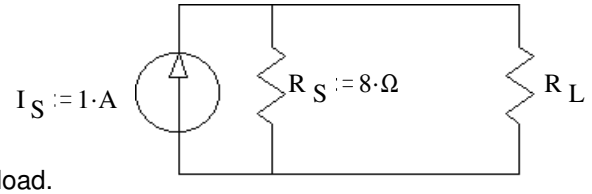
   c) What voltage would be required to charge this battery at 200 mA?

   d) What is the maximum power this battery can supply to a load resistor (R_L)? You may use whatever R_L you want.

3. Consider the circuit at right.

   a) What value of load resistor (R_L) would you choose if you wanted to maximize the power dissipation in that load resistor.

   b) With that load resistor (R_L) find the power dissipation in the load.



4. The terminal voltage of a car's battery drops from 12.5 V to 8.5 volts when starting. The starter motor draws 60 A of current.

   a) Draw the voltage-source model (like Thevenin equivalent) of this battery. Include the values of V_S and R_S.

   b) The lights on this car may be modeled as a 1.6 Ω resistor. What battery terminal voltage would you expect if the lights are left on without the engine running?

   c) If the lights are left on without the engine running, how much power would be required from V_S? (This includes the power dissipated by R_S.)

   d) If the lights are left on without the engine running and assuming R_S represents all the losses, what is the discharge-efficiency of the battery? Note: the efficiency of a system is the power out (delivered to the lights) divided by the power in (required from V_S).

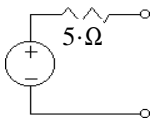
   e) If the lights are left on without the engine running for half an hour, how much energy would be required from V_S? Include the energy dissipated by R_S.

   f) What terminal voltage would you expect if this battery were being charged at 20 A?

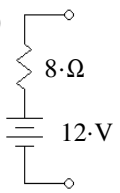
   g) How long would you have to charge this battery at the 20 A rate to replace the energy used by leaving the lights on for half an hour? Assume R_S represents all the losses.

   h) What is the efficiency of charging the battery at this rate?

Answers

1. a) 

b) 3.6·V c) 140·mA

2. a) 

b) 40·Ω c) 13.6·V d) 4.5·W

3. a) 8·Ω b) 2·W

4. a) V_S = 12.5·V $R_S := 0.0667 \cdot \Omega$ b) 12.0·V c) 93.75·W
   d) 96·% e) 169·kJ f) 13.83·V g) 11.25·min h) 90.4·%