Extra Credit (up to 34pts) ECE 2210 / 00 homework BattSol b

Name _____

**Batteries**

1. As a battery discharges, the source voltage ($V_S$) _____
   and the internal resistance ($R_{int}$) _____

2. a) The nominal voltage of a lead acid battery is _____ per cell.
   Is this $V_S$ or $V_{term}$ ? _____

   b) Over-charging a flooded, or wet-cell lead acid battery creates what danger?

   c) How many cells does a 12-V car battery ?

3. a) The nominal voltage of a li-ion battery is _____ per cell.

   b) How many cells does a $14.4\text{-V}$ laptop battery have?

4. A $14.4\text{-V}$ laptop battery is rated at $3\text{Ah}$.
   a) How much energy does it store? Give the answer in two different units.

   b) The battery is dischared at $0.28\text{C}$. How much current is that?

   c) How long should a full charge last at this rate of discharge?

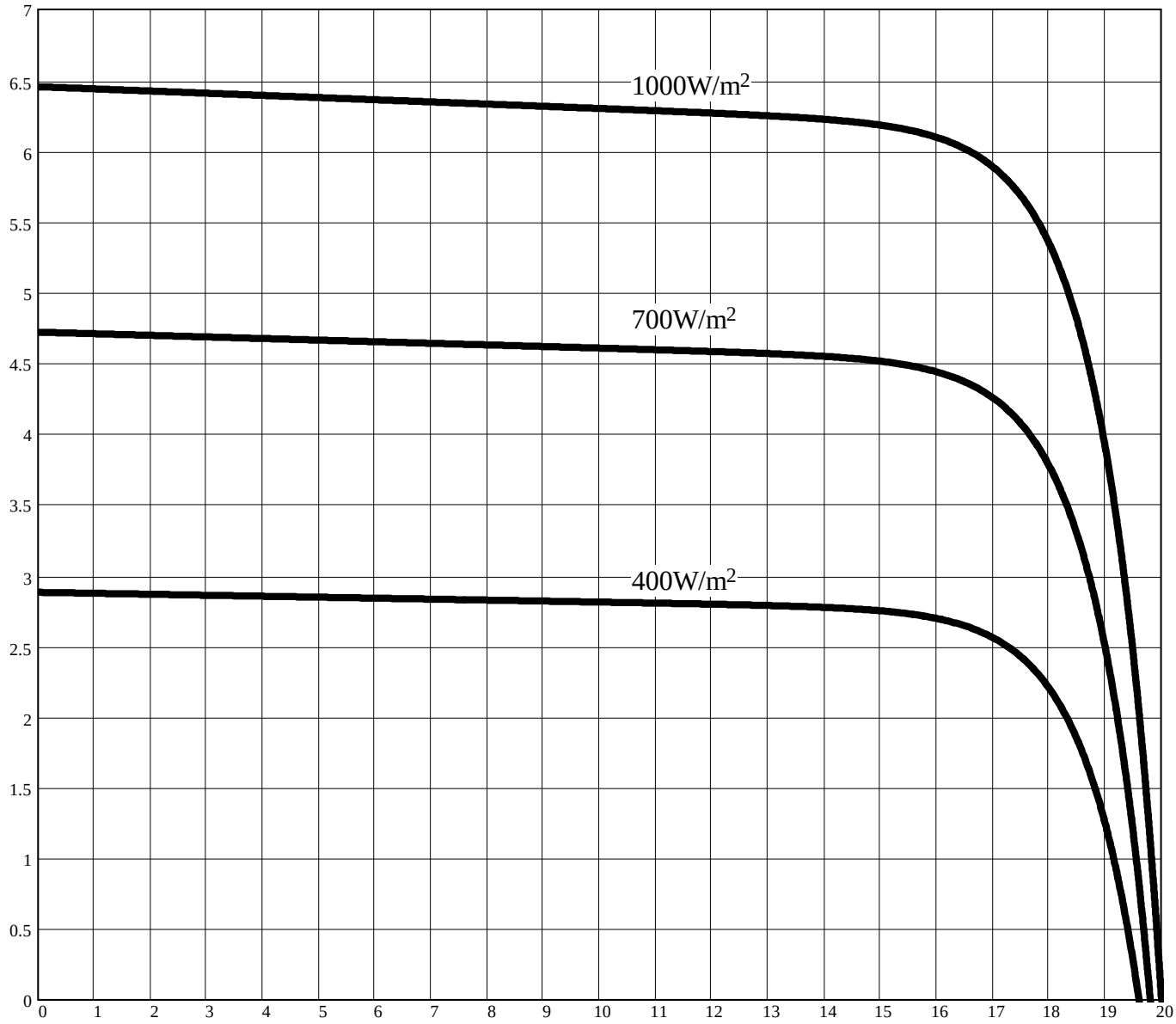
5. You have 6 18650 li-ion cells, each rated at 2800mAh.
   a) The 6 cells are wired in series. What's the rated voltage?
   What's the rated mAh?
   b) The 6 cells are wired in parallel. What's the rated voltage?
   What's the rated mAh?
   c) Could you wire them up to get a 10.8V battery? If yes how?

   What's the rated mAh?

6. a) How does a CC-CV power supply operate?

   b) Is it OK to leave a CC-CV power supply hooked to a lead acid or li-ion battery indefinitely? If not, why not?

Problems 7 - 14 refer to the IV curves for a solar panel shown below.




7. Find $I_{SC}$ Find $V_{OC}$

8. Do your best to estimate the maximum-power point for the $1000 W/m^2$ curve. Find the current ($I_{MPP}$), voltage ($V_{MPP}$), and power ($P_{MPP}$) and the load resistor ($R_{load}$) that could be hooked to the panel to make it operate at this point.

9. The panel measurements are $0.8m$ x $0.8m$, find the efficiency of this panel

10. What is the likely rated power of this panel?

11. Do your best to estimate the maximum-power point for the other two curves and find that maximum power.

12. The optimum load resistor ($R_{load}$) you found above is left in place while the irradiance is reduced to $700 W/m^2$ . Estimate the power produced by the panel.

    Note: there isn't a nice mathematical way to calculate this, so use this graphical method:
    1. Draw a current vs voltage line for the resistor, a line that starts at 0,0 and has a slope of $1/R_{load}$ . Incidentally, this line passes through the maximum-power point for the $1000 W/m^2$ curve.

    2. With an irradiance of $700 W/m^2$ the panel will operate where this line crosses the $700 W/m^2$ curve. Find the voltage, current and power at that point.

13. Using the same load resistor ($R_{load}$) and irradiance of $400 W/m^2$ . Estimate the power power produced by the panel.

14. Compare your answers to problems 12 and 13 to your answers to problem 11.

15. & 16. Are on the next page.

**Answers**

1. decreases increases
2. a) $2 \cdot V$ $V_{tern}$ b) fire c) 6
3. a) $3.6 \cdot V$ b) 4
4. a) $43.2 \cdot Wh$ $1.56 \cdot 10^5 \cdot J$ b) $0.84 \cdot A$ c) $3.57 \cdot hr$
5. a) $21.6 \cdot V$ $2800 \cdot mAh$ b) $3.6 \cdot V$ $16800 \cdot mAh$
   c) Two sets of 3 in series. The two sets are then wired in parallel. $5600 \cdot mAh$
6. a) A CC-CV source acts like a constant current source up to a set voltage level. Then it acts as a constant voltage source at that level.
   b) No, a charger needs to shut off once the current decreases to some small value.
7. $6.45 \cdot A$ $20 \cdot V$
8. $5.87 \cdot A$ $17.1 \cdot V$ $100 \cdot 4 \cdot W$ $2.91 \cdot \Omega$
9. $15.7 \cdot \%$
10. $100 \cdot W$
11. $72.5 \cdot W$ $43.8 \cdot W$
12. $60.5 \cdot W$
13. $23.4 \cdot W$
14. Powers are significantly lower because the panel is not operating at the maximum power points.

15. A fully-charged Li-ion battery supplies $0.8A$ for $2$ hours and then $0.5A$ for $3$ more hours.
After that it is empty (fully discharged).
a) What is the capacity ($C$) of this battery?

b) How many Joules of energy does this battery store?

16. The sicker on the back of a solar panel is shown below.
Since it may be difficult to read, I've repeated much of the information next to the image.


**AS55**
Electrical Data at Standard Test Conditions
(STC: 1000W/m$^2$, 25ºC, AM1.5)

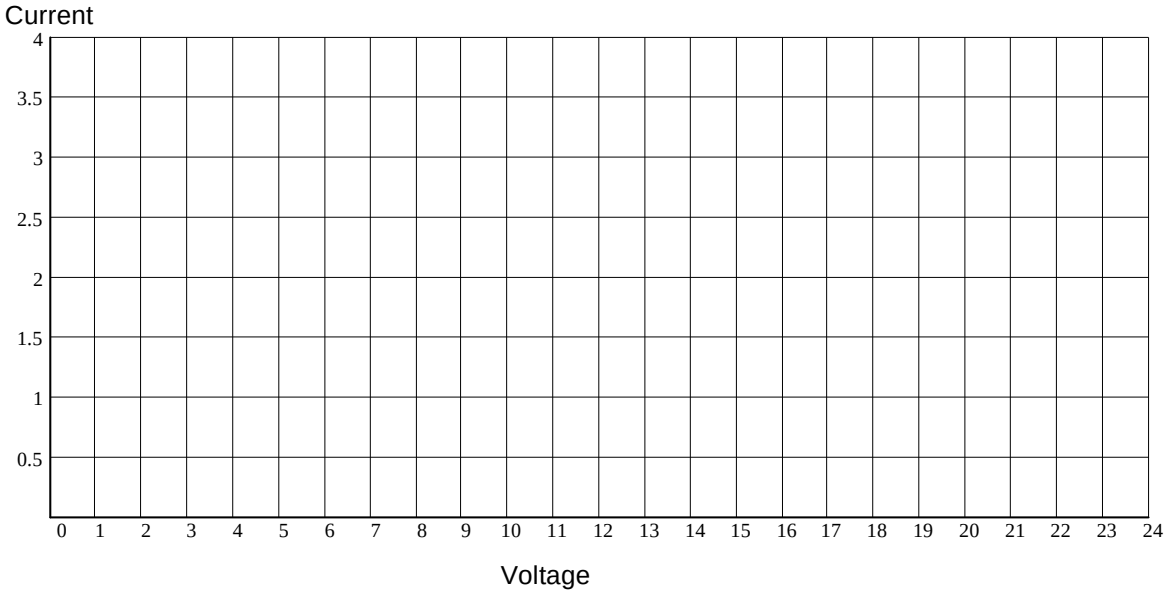
$P_{MPP} := 55 \cdot W$

$V_{MPP} := 18.5 \cdot V$ $V_{OC} := 21.2 \cdot V$

$I_{MPP} := 3.0 \cdot A$ $I_{SC} := 3.4 \cdot A$

Maximum System Voltage: $50 \cdot V_{DC}$

a) Plot 3 important points on the Current vs Voltage grid below, clearly identify the points as they are normally labeled.




b) Using the important points to guide you, draw the Current vs Voltage (IV) curve above.

c) This panel is hooked directly to a lead-acid battery. The charging voltage is $14.5$ volts.
Draw a 4th point on the curve above where the solar panel is operating.
Estimate the power provided by the panel to the battery.