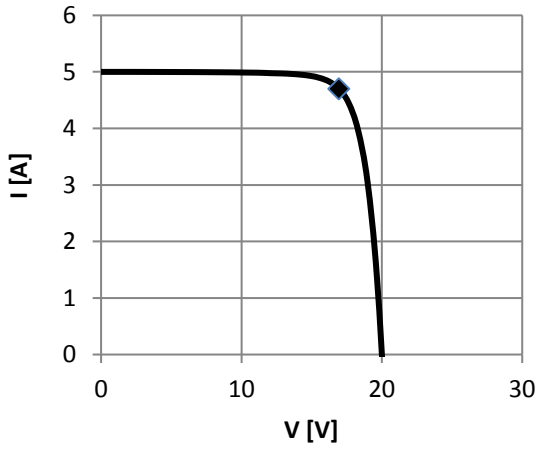
You have 60 minutes to solve this test. You may answer in English or Portuguese. Assume reasonable data for any relevant parameters that are not presented

1. Please indicate if these statements are true or false.

   [*A right answer yields 1 point while a wrong answer loses 1 point so avoid lottery! Total value for this question is 5. Minimum value for the question is 0 (zero) points.*]

   a) For one given crystalline silicon module, its efficiency in the Sahara Desert is higher than in central Europe.
   b) The atmosphere of Mars makes solar radiation reaching the Martian surface to be much richer in red and infrared. This means that a solar cell designed for a land mission in Mars should have a lower bandgap.
   c) A PV system will never generate the electricity used for its manufacturing.
   d) In Solar Home Systems (SHS) in tropical areas, the battery should be store in a closed case to protect it from humidity.
   e) AC modules are useful because they reduce the risk of mismatch between PV modules in a string.

2. The following figure shows the IV curve of a 0.6m^2 solar panel which consists of 24 crystalline silicon solar cells in STC conditions.



   a) Determine I_{sc}, V_{oc}, V_{max}, I_{max}, P_{max}, efficiency and fill factor of the module. [3]

   b) Estimate the series and the shunt resistance of the module. [2]

   c) If NOCT = 45ºC, determine I_{sc}, V_{oc}, V_{max}, I_{max}, P_{max}, of the module for a day with 800 W/m^2 and 32ºC. [3]

   d) Consider a PV system with 3 strings of 5 modules as above, connected to an inverter.

      i. Determine the minimum value of the maximum input current to the inverter. [2]

      ii. Discuss the most appropriate inverter nominal power. [2]

3. What is the required PV power for a PV water pumping system with a 40m head and daily water volume of 15 m^3, if the local average solar irradiation is 4.5 kWh/m^2/day. [3]