



MACHAKOS UNIVERSITY

University Examinations 2022/2023 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF ENVIRONMENTAL SCIENCES

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SPECIAL NEEDS)

BACHELOR OF EDUCATION (SCIENCE)

SPH 351: PHYSICS OF ENVIRONMENT AND ENERGY

ENS 240: FUNDAMENTALS OF ENERGY SCIENCE

DATE: 18/4/2023

TIME: 2:00 – 4:00 PM

INSTRUCTIONS

Answer Question One And Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Solar PV cell is a significant source of renewable energy, Describe
- i) application of photoelectric effect in the solar cell. (2 marks)
 - ii) the three step process involved in the conversion of solar light to electric current. (6 marks)
- b) The sun is a gaseous body composed mostly of hydrogen, explain how energy in this average star is generated. (2 marks)
- c) Almost all known physical and biological cycles in the Earth system are driven by the solar radiation reaching the Earth. Explain how (3 marks)
- d) Ozone layer protects us from excessive levels of harmful ultraviolet (UV) radiation.
- i. Define what is ozone layer depletion (3 marks)
 - ii. With aid of chemical equations, explain how chlorofluorocarbons result to ozone layer depletion, include chemical equations (4 marks)
 - iii. Explain why chlorofluorocarbons are more dangerous as far as destruction of ozone layer is concerned. (2 marks)

- e) Figure 1 shows IV characteristics curves of a solar PV cell.
- Describe how to determine the short circuit current (I_{sc}) and open circuit voltage (V_{oc}). (4 marks)
 - Show the maximum power point and state its significance (2 marks)
 - Draw IV characteristics curve for three solar panels arranged in parallel (2 marks)

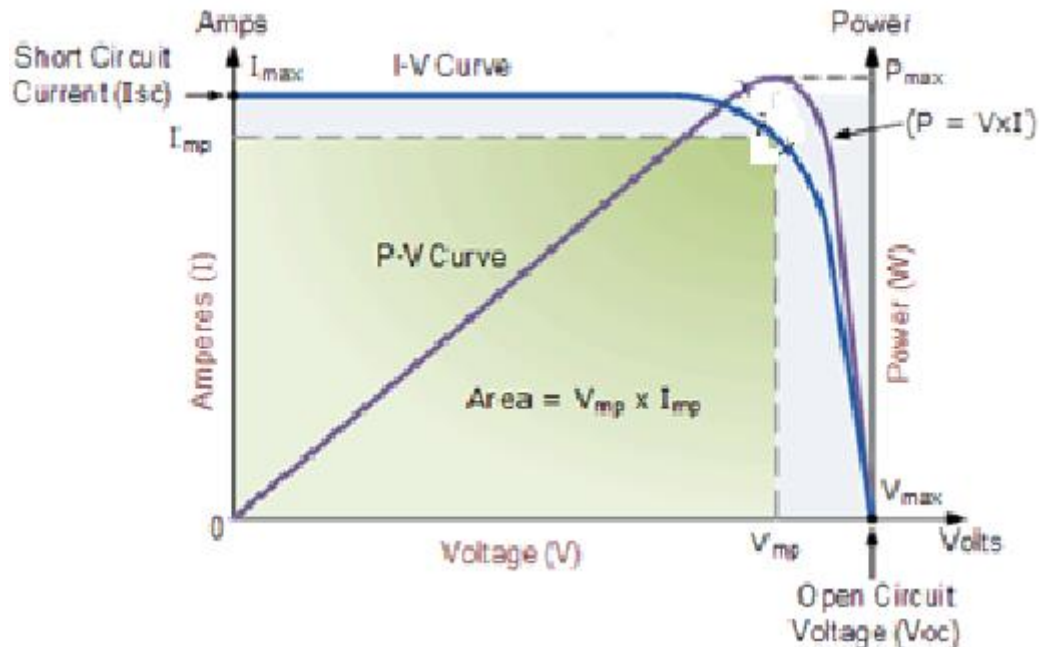


Figure 1: I-V characteristics of Solar PV cell

SECTION B

QUESTION TWO (20 MARKS)

- Suppose you are installing a water pump rated 400 W 48 V and 8 A for a customer. The solar panels in the market are rated 250 W, 12 V, 8 A and 250 W 24 V 8 A
 - State the rating of the solar panels you will advise the customer to buy (2 marks)
 - Show a circuit on how you would install the pump using the
 - 12 V panels (4 marks)
 - 24 V panels (4 marks)
- Illustrate with a well labelled diagram a design of a setup that can be used to generate electricity from solar thermal energy. (4 marks)
- Air conditioners are rated by their COP at 80 °F inside temperature and 95 °F outside temperature. An efficient but realistic air conditioner has a COP of 3.2. Calculate the maximum possible COP? (6 marks)

QUESTION THREE (20 MARKS)

- a) You have been hired by Tropical Power Company to install a wind energy power plant in North Kinangop. The density of air is 1.3 kg/m^3 and the speed of wind is 20 m/s in that place. Calculate the wind's kinetic energy. (6 marks)
- b) Name four examples of a heat pump (4 marks)
- c) A newly proposed device for generating electricity from the sun is a heat engine in which the hot reservoir is created by focussing sunlight on a small spot on one side of the engine. The cold reservoir is at ambient air temperature of 20°C . The designer claims that the efficiency will be 60 %. Determine maximum hot reservoir temperature would she require to produce this efficiency?. (10 marks)

QUESTION FOUR (20 MARKS)

- a) The device shown in figure 2, transfers heat energy from a heat source to a destination called heat sink. Study the diagram (Figure 2) and answer the following questions. Explain
- the role of expansion device and why the fluid outside the room is at low pressure (7 marks)
 - whether the device warms or cools the room (3 marks)

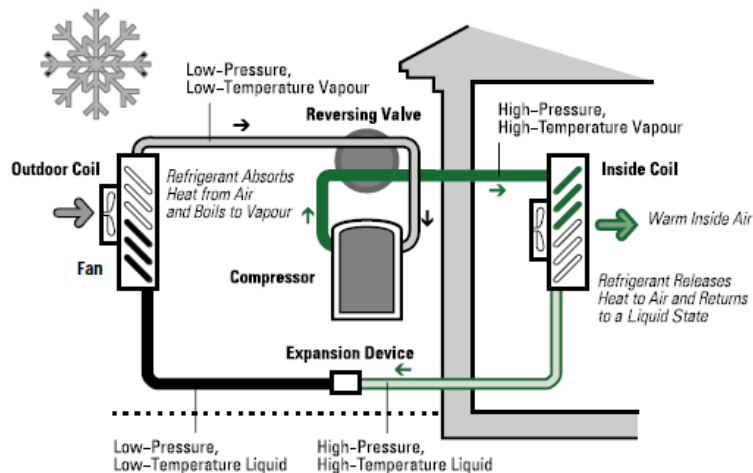


Figure 2

- b) During hydrologic cycle, $2.3 \times 10^{18} \text{ kg}$ of water is evaporated from the oceans to form clouds in the troposphere $1.0 \times 10^4 \text{ m}$ high. Calculate
- Energy used to evaporate the water (5 marks)
 - Potential energy gained by the water that forms the clouds (5 marks)

QUESTION FIVE (20 MARKS)

- a) An internal combustion motor vehicle engine converts heat into work and dissipates excess heat into a heat sink.
- i. In a motor vehicle engine, which part is the heat sink (2 marks)
 - ii. Illustrate with a drawing
 - A. The intake stroke, (2 marks)
 - B. The compression stroke, (2 marks)
 - C. The ignition stroke, (2 marks)
 - D. The exhaust stroke of the engine. (2 marks)
- b) A nuclear reactor produce high pressure steam of 290°C . After the steam is used to spin a turbine, it is condensed (by using water from nearby river) back to water at 20°C . The excess heat is deposited in the river. What is the maximum possible efficiency can this plant achieve (6 marks)
- c) A refrigerator takes in 20 J of work and exhausts 50 J of heat. What is the refrigerant's COP? (4 marks)