



MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF ENVIRONMENTAL SCIENCES

SPH 351: PHYSICS OF ENVIRONMENT AND ENERGY/

ENS 130: ENVIRONMENTAL PHYSICS

DATE:

TIME: 2 Hours

Instructions

Answer question ONE and any other TWO questions

Useful information

-All symbols have their usual meaning

- Stefan-Boltzmann $\sigma = 5.67 \times 10^{-8} \text{ W.m}^{-2}\text{K}^{-4}$, Wien's constant $W = 2897 \mu\text{m K}$, density of air 1.3 kg/m^3 , Latent heat of vaporisation of water 2250 J/g

QUESTION ONE (30 MARKS)

- Write down the SI units of ozone layer depletion and hence define an ozone hole.
(2 marks)
- Illustrate with a diagram the ignition stroke of a diesel internal combustion engine and explain application of the first law of thermodynamics during this stroke.
(4 marks)
- Explain what happens during the power stroke in an internal combustion engine.
(2 marks)
- A thermometer is based on expansion and Geiger Muller tube is based on ionisation, Sun's measuring instruments are based on two technologies, Explain the technologies.

(4 marks)

- e) Solar radiation reaching the Earth drives all biological and physical cycles. Explain how solar radiation influence formation of:
- i) Winds that blow to the land from oceans (2 marks)
 - ii) Rainfall (2 marks)
- f) Define a
- i) Heat pump (2 marks)
 - ii) Heat engine (2 marks)
- g) The diagram in Figure 1 shows a solar PV cell,
- i) Show direction of current in the conducting path (2 marks)
 - ii) What would happen if the conducting path is removed (2 marks)
 - iii) Hence by a diagram show how six PV cells of 0.86 V each, can be connected in series to form a battery (3 marks)

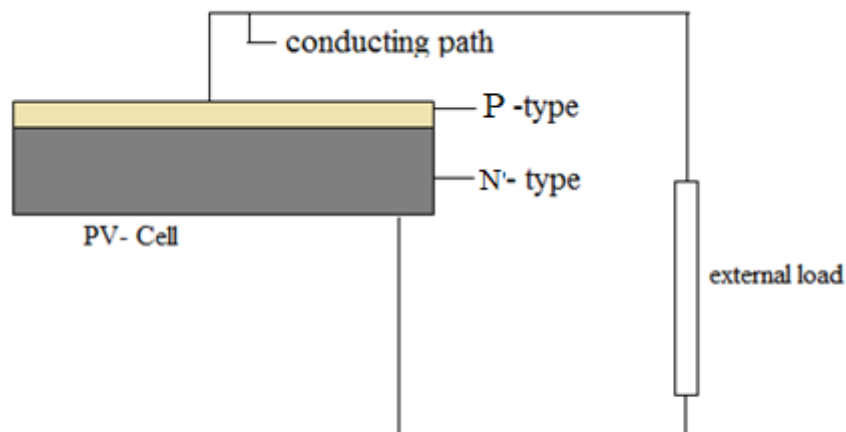


Figure 1; Solar PV cell

- h) An electrical generator running at 800°K delivers heat energy to the water in its cooling radiator at 430°K . Calculate its maximum efficiency (3 marks)

QUESTION TWO (20 MARKS)

- a) Nuclear fusion seems to be a choice of energy for the future, but so far have not been exploited. What could be the reason? (2 marks)
- b) Hydrogen for fuel use can be extracted from water but this is a challenge. Explain why? (2 marks)
- c) Solar energy is an environmentally friendly energy but with challenges. Explain the challenges (3 marks)

- d) What does the acronym “PV” in solar cells stand for in full (2 marks)
- a) State one advantage of hydrogen as a fuel. Hence state two problems that make hydrogen, as energy for the future, unrealistic (3 marks)
- e) Ozone layer protects us from excessive levels of harmful ultraviolet (UV) radiation.
- Define what is ozone layer depletion (2 marks)
 - With aid of chemical equations, explain how chlorofluorocarbons result to ozone layer depletion, include chemical equations (4 marks)
 - Chlorofluorocarbons are dangerous than dust particles as far as ozone layer depletion is concerned. Why? (2 marks)

QUESTION THREE (20 MARKS)

- a) Hand held digital pyranometers, as the ones shown in figure 2 are available in the market.
- State what they are used to measure (1 mark)
 - On which principle is there operation based on (2 marks)



Figure 2

- b) Figure 3a shows the most common pyranometer, while figure b shows the components of the device in a simplified manner.
- What is the name of such a pyranometer (1 mark)
 - Why the black coating? (1 mark)
 - Why cover with a transparent glass plate (1 mark)
 - Why is glass cover hemispherical (2 marks)
 - What is the purpose of the heat sink (1 mark)

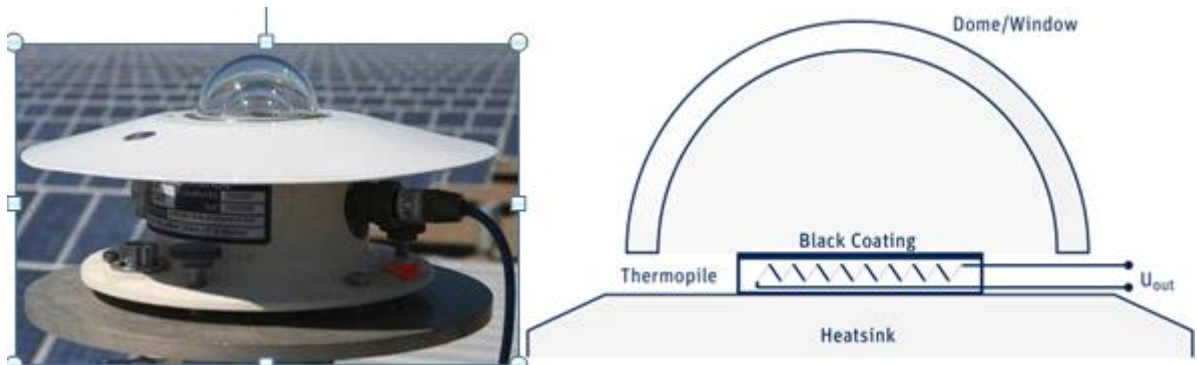


Figure 3 a and b

- c) An expert investigating wind power, finds out that, on average, wind per square meter flows at 80 m/s in Turkana and at 40 m/s in Nanyuki.
- i. By calculation, show which among the two areas is best candidate for tapping wind energy (4 marks)
 - ii. Suppose the wind speed in Turkana doubles, what happens to its power (3 marks)
- d) A windmill cannot extract all of the kinetic energy available in the wind, explain why this is so (4 marks)

QUESTION FOUR (20 MARKS)

- a) What is a perpetual motion machine? Give an example and illustrate with a diagram. (4 marks)
- b) Study the diagram in figure 4 and answer the following questions. The system is used to warm or cool the house. Explain.
- i. What is the system called. (1 mark)
 - ii. the role of expansion device and why the fluid outside the room is at low pressure (2 marks)
 - iii. state whether the system warms or cools the room. (2 marks)

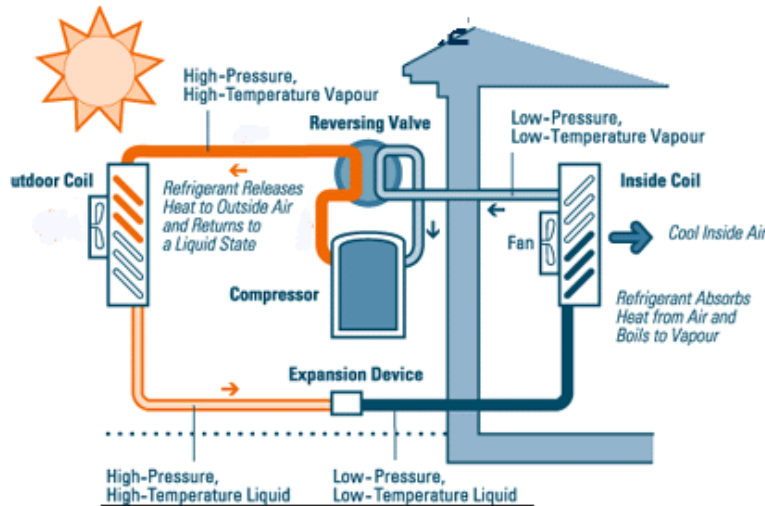


Figure 4

- c) It is recommended that PV solar cells be connected in series always. Give a reason to justify this reasoning. (2 marks)
- d) The figure 4 shows two I-V curves, both have equivalent circuits with infinite parallel resistances. One circuit includes a series resistance while the other one does not. They are for a typical single solar panel. Calculate maximum power output for $R_s = 0$ and $R_0 = ?$ (4 marks)

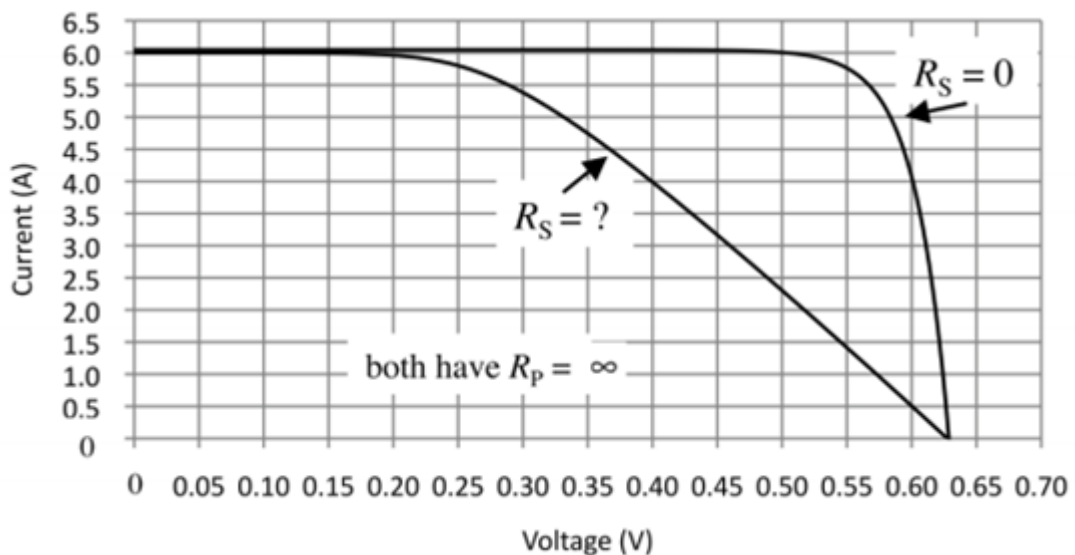


Figure 4

- e) The earth's and sun's temperature are stated as 5727 °C and 299 K. Show that the sun emits about 160,000 times more radiation per unit area than the Earth. Give a reason why this is so. (5 marks)

QUESTION FIVE (20 MARKS)

- a) The hydrologic cycle, 6.3×10^9 kg of water is evaporated from the oceans to form clouds in the troposphere 41.0×10^4 m high. Calculate
- Energy used to evaporate the water (2 marks)
 - Potential energy gained by the water that forms the clouds (2 marks)
 - Let 30 % of this water rain and collect in a hydroelectric dam at an altitude of 3000 metres above sea level, What is the potential energy possessed by the water relative to the point of turbines, if the turbines are at an altitude 2000 meters above sea level (3 marks)
 - Kinetic energy of a wind traversing a square meter at a speed of 12 m/s is 2200 joules. Calculate the density of the wind. (3 marks)
- b) Water flow rate in Kipevu Hydroelectricity Dam at 300 m head, is $80000 \text{ m}^3/\text{s}$.
- Calculate the power that the dam delivers per second. (3 marks)
 - Suppose the actual electrical power generated at the output by the power plant is 6 GW, what is the efficiency (3 marks)
 - List four problems of hydroelectricity (4 marks)