MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 351: PHYSICS OF ENVIRONMENT AND ENERGY

DATE: 10/11/2020 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

Useful information

-All symbols have their usual meaning
- Stefan-Boltzmann σ = 5.67 x 10-8 W.$m^{-2}K^{-4}$, Wien's constant W = 2897 μm K, density of air 1.3 kg/m^3, Latent heat of vaporisation of water 2250 J/g

QUESTION ONE (COMPULSORY) (30 MARKS)

Wien's constant W = 2897 μm K

a) The sun is a gaseous body composed mostly of hydrogen, explain how energy in this average star is generated. (2 marks)

b) Almost all known physical and biological cycles in the Earth system, are driven by the solar radiation reaching the Earth. Explain how (3 marks)

c) Using a diagram, Position the solar spectrum within the electromagnetic spectrum (3 marks)

d) Explain how planetary energy balance manage to keep the temperature of earth constant (3 marks)

e) Illustrate with a diagram how energy from the sun incident on the earth is utilised (5 marks)

f) i). State Wien's law (2 marks)
ii). Hence, show that if the sun's and earth's temperature are 6000 ℃ and 300 ℃ respectively, the sun radiates its maximum energy in the short wavelength than the earth (6 marks)

g) The wavelength of radiation emitted by a giant star in a neighbouring solar system is 0.096nm. Calculate the temperature of the star (3 marks)

h) State one advantage of hydrogen as a fuel. Hence state two problems that make hydrogen, as energy for the future, unrealistic (3 marks)

QUESTION TWO (20 MARKS)

a) In the hydrologic cycle, 6.3 x 10^{22} J of solar energy is used as water is evaporated from the oceans to form clouds in the troposphere 41.0 x 10^{4} m high. Calculate

i) Mass of water evaporated (2marks)

ii) Potential energy gained by the water that forms the clouds (2 marks)

iii) Let 30 % of this water rain and collect in a hydroelectric dam at an altitude of 4.0 x 10^{3} 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 1.5 x 10^{3}meters above sea level (3 marks)

b) 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)

c) Water flow rate in Kipevu Hydroelectricity Dam at 4.00x10^{2} m head, is 80000 m^3/s.

i) Calculate the power that the dam delivers per second. (3 marks)

ii) Suppose the actual electrical power generated at the output by the power plant is 7 GW, what is the efficiency (3 marks)

iii) List four problems of hydroelectricity (4 marks)

QUESTION THREE (20 MARKS)

a) i. Using a diagram illustrate the parts of a pyranometer, showing the transparent glass, heat sink and the sensor (3 marks)

ii. Explain the working principle of a pyranometer (2 marks)

iii. Describe how each part of the pyranometer is adapted to its function (3 marks)

b) Ozone layer protects us from excessive levels of harmful ultraviolet (UV) radiation.

i. Define what is ozone layer depletion (2 marks)

ii. With aid of chemical equations, explain how chlorofluorocarbons result to ozone layer depletion, include chemical equations (4 marks)

iii. Chlorofluorocarbons are dangerous than dust particles as far as ozone layer depletion is concerned. Why? (2 marks)

c) Describe the four strokes of a heat engine using well illustrated diagrams (4 marks)

QUESTION FOUR (20 MARKS)

a) A nuclear reactor produce high pressure steam of 290 ℃. After the steam is used to spin a turbine, it is condensed (by using water from nearby river) back to water at 20 ℃. The excess heat is deposited in the river. What is the maximum possible efficiency can this plant achieve (6 marks)

b) 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 ℃ . The designer claims that the efficiency will be 60 %. What maximum hot reservoir temperature would she require to produce this efficiency?. (6 marks)

c) 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. What is the max possible COP? (6 marks)

d) A windmill cannot extract all of the kinetic energy available in the wind, explain why this is so (2 marks)

QUESTION FIVE (20 MARKS)

a) A refrigerator takes in 20 J of work and exhausts 50 J of heat. What is the refrigerant's COP? (4 marks)

b) What is a perpetual motion machine? Give an example and illustrate with a diagram (4 marks)

c) Draw a well labelled diagram, illustrating a device that can be used to heat the inside of a car. (6 marks)

d) 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 (2 marks)

ii. the role of expansion device and why the fluid outside the room is at low pressure (2 marks)

iii. state weather the system warms or cools the room (2 marks)

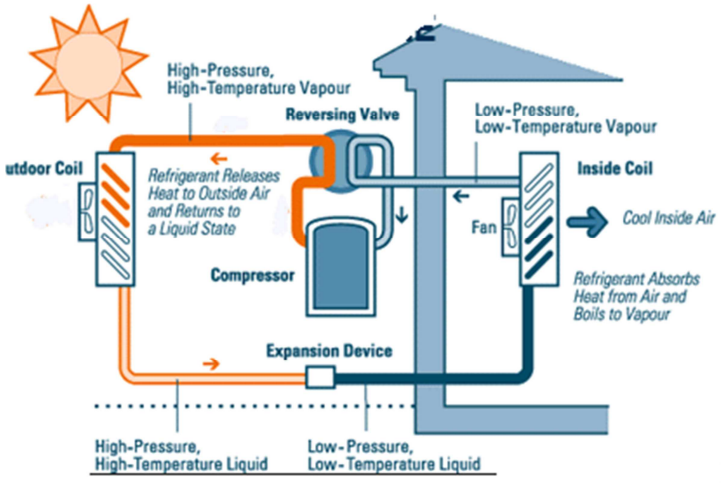

Figure 4