MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES
SECOND YEAR SECOND SEMESTER special/SUPPLEMENTARY EXAMINATION
FOR BACHELOR OF ENVIRONMENTAL SCIENCE
ENS 240: FUNDAMENTALS OF ENERGY SCIENCE

DATE: 27/9 /2019   **TIMES: 2:00 – 4:00 PM**

INSTRUCTIONS:

1. Answer question No 1 and any other two questions.
2. Question No 1 carries 30 marks while the other two carry 20 marks each.
3. Use of sketches and brief illustrations where necessary.
4. Read the instructions on the booklet keenly and adhere to them.

QUESTION ONE [30 MARKS]

a)   Distinguish between reversible and irreversible processes   (2 marks)

b)   On the same axes, sketch to show the difference between each of the following processes

      i)   Isothermal and adiabatic processes   (2 marks)

      ii) Isovolumetric and isobaric   (2 marks)

c)   10 moles of oxygen (O_2) are allowed to expand isothermally (T=300K) from a volume of 10 litres to 30 litres. Calculate the work is done   (3 marks)

d)   (i) state the second law of thermodynamics thermodynamics   (1 mark)

      (ii) Find the change in entropy when 200g of ice at $0^{o}c$ melt into 200g of water at $0^{o}C$

                                                 (3 marks)

e)   Briefly discuss two ways in which a system can exchange energy with its surroundings (Use system illustrations)   (4 marks)

f)   i)   Distinguish between energy and power stating the S.I units of each   (2 marks)

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ii) A man whose weight is 800N climbs 10m upstair in 60 seconds. Calculate the power developed (3 marks)

g) Energy is a major resource in transforming any developing country. Discuss the challenges facing energy exploitation from renewable sources in Kenya. (6 marks)

h) Give two limitations of tidal power as a source of energy (2 marks)

QUESTION TWO (20 MARKS)

a) Discuss the reasons that have contributed to the upward spiral in demand for energy in Kenya (5 marks)

b) Calculate the ideal coefficient of performance (C.O.P.) For an air-to-air heat pump used to maintain the temperature of a house at 70 °F when the outside temperature is 30 °F. (4 marks)

c) A reversible heat engine reversible receives 12kj of heat from a thermal reservoir at a temperature of 1200K and 9kj of heat from another thermal reservoir at a temperature of 900k. If it rejects heat to a third reservoir of temperature 300K. Calculate the thermal efficiency of the engine. (5 marks)

d) Discuss three factors that should be considered when putting a nuclear plant in a site (6 marks)

QUESTION THREE (20 MARKS)

a) State any two wind energy plants in kenya connected to the national grid. (2 marks)

b) Investment and incubation centers are critical stakeholders in advancing the energy industry in Kenya. Discuss (6 marks)

c) Propane (C_3H_8) reacts with elemental oxygen gas to produce carbon dioxide while giving off 2,220 kJ of energy. $C_3H_8 + 5O_2 \rightarrow 4H_2O + 3CO_2 = 2220kj$. Determine the molar mass of propane and draw an energy level diagram stating with a reason whether the process is endothermic or exothermic. (5 marks)

d) A compound is 54.52% carbon, 9.17% hydrogen and 36.31% oxygen by weight.

    i. Determine empirical formula of the compound (4 marks)

ii. Find molecular formula of an unknown compound with molecular weight of 88.1 amu using the empirical formula determine in (i)   (3 marks)

QUESTION FOUR (20 MARKS)

a)   (i) State the first law of thermal dynamics   (1 mark)

(ii) By use of a well labelled diagram describe a system, boundary, surrounding and the universe   (3 marks)

(iii) A gas starts with 200j of internal energy. On adding 180j of heat, the gas does 70j of work. Calculate the final internal energy   (4 marks)

b)   A sample of a diatomic gas of volume 4 $litres$ at a pressure of 15 atm and a temperature of 25°c is allowed to expand to a final volume of 1 atm. Calculate the heat, work and change in internal energy if the gas expands isothermally and reversibly   (6 marks)

c)   Discuss three ways through which the solution to energy crisis problem can be achieved in Kenya   (6 marks)

QUESTION FIVE (20 MARKS)

a)   (i) Define the term entropy (1 mark)

(ii) Show that the change in entropy for an isothermal process is given by   (4 marks)

$$\Delta S = n\ R\ \ln\left(\frac{V_2}{V_1}\right)$$

b)   A spontaneous heat transfer from hot to cold system is an irreversible process. Calculate the total change in entropy if 6000j of heat transfer occurs from a hot reservoir at a temperature of 600K to a cold reservoir at a temperature of 250K assuming that there is no temperature change in either reservoir.   (5 marks)

c)   Show that the change in internal energy in isochoric and isobaric processes at same temperature change is equal.   (4 marks)

d)   Propane (C_3H_8) burns in this reaction: $C_3H_8 + 5O_2 \rightarrow 4H_2O + 3CO_2$. If 200 g of propane is burned, Determine the molar mass of propane and the mass in grams of H_2O produced.   (6 marks)