MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS
2018/2019 ACADEMIC YEAR
FIRST YEAR *FIRST* SEMESTER

SCHOOL OF SCIENCE
BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHY 1105

COURSE TITLE: INTRODUCTION TO THERMODYNAMICS

DATE: 5th December 2018 **TIME: 0830-1030**

INSTRUCTIONS TO CANDIDATES

1. Attempt Question **ONE** and any other **TWO** questions
2. Use of sketch diagrams where necessary and brief illustrations are encouraged.
3. Read the instructions on the answer booklet keenly and adhere to them.

*This paper consists of **four** printed pages. Please turn over.*

You may use
Atmospheric pressure =101.325 kPa
Gravitational acceleration = 9.81 m/s^2
SHC of water is 4186 J/kg.^oC,
Latent heat of fusion of ice is $3.33x10^5$ J/kg

QUESTION ONE: [30 marks]

a) Briefly describe the term "Thermodynamics" **(3mks)**

b) (i) The rate of heat convection from a surface of area A is given by $\dot{Q}_{cov.} = h_c A \Delta T$ what does the term h_c mean? (**1mk**)
(ii). What factors determine the value of h_c in b(i) **(4mks)**

c) What is the smallest temperature you can have in

i. Degrees Celsius? (**1mk**)

ii. Kelvin? (**1mk**)

iii. What is the name given to this temperature (**1mk**)

d) You dive 5 m down in the ocean. What is the absolute pressure there if the density of the water during that season is 997 kg/m^3? (**4mks**)

e) State the laws of thermodynamics. (**4mks**)

f) What is a quasistatic process? (**1mk**)

g) show that for an expanding gas, the total work done is $W = -\int_{V_i}^{V_f} PdV$ (**5mks**)

h) What is a reversible process? Give the working conditions for a reversible process (**5mks**)

QUESTION TWO: [20 marks]

a) State what is meant by thermal expansion (**1mk**)

b) Explain thermal expansion from the atomic point of view. (**2mks**)

c) Show that the change in area of a rectangular plate during thermal expansion is given by $\Delta A = 2\alpha A_i \Delta T$, where the symbols have their usual meaning. (**6mks**)

d) State and explain three uses of thermal expansion in solids (**3mks**)

e) i. Find the rate of conduction during heat transfer through a 1.5 cm thick hardwood board, k = 0.16 W/mK, with a temperature difference between the two sides of 20 ^{o}C. (**3mks**)

ii. A 2 m^2 window has a surface temperature of 15^{o}C and the outside wind is blowing air at 2^{o}C across it with a convection heat transfer coefficient of h_c = 125 W/m2K. What is the total heat transfer loss? (**3mks**)

iii. An object is at a temperature T and its surroundings are at an average temperature T_0, state the equation for calculating the net rate of energy gained or lost by the object as a result of radiation. What is the general name given to the stated equation? (**2mks**)

QUESTION THREE: [20 marks]

a) i. Explain each term in the conservation equation, $\left(\Delta K + \Delta U + \Delta E_{\text{int}} = W + Q + T_{MW} + T_{ET} + T_{ER}\right)$. (**5mks**)

ii. What does the left and right hand sides of the equation in 3a(i) above, mean?

(**2mks**)

b) Differentiate between meter and reservoir as used in thermodynamics(**3mks**)

c) Differentiate between temperature and heat (**2mks**)

d) At what temperature does the numerical value in degree Fahrenheit match the numerical value in degree Celsius? (**4mks**)

e) A spray can containing a propellant gas at twice atmospheric pressure (202 kPa) and having a volume of 125.00 cm^3 is at 22 ^{o}C. It is then tossed into an open fire. When the temperature of the gas in the can reaches 195 ^{o}C, what is the pressure inside the can? (**4mks**)

QUESTION FOUR: [20 marks]

a) i. What is a heat engine (**1mk**)

ii. State the cycles of working of an ideal heat engine work (**3mks**)

b) i. Show that the efficiency of a heat engine always less than 100% (3**mks**)

ii. What is the difference between the 1st and 2nd laws of thermodynamics from the heat engine perspective (**2mks**)

c) An engine transfers 2.00x10^3 J of energy from a hot reservoir during a cycle and transfers 1.50x10^3 J as exhaust to a cold reservoir.

i. Find the efficiency of the engine. (2**mks**)

ii. How much work does this engine do in one cycle? (2**mks**)

d) **i.** How is a refrigerator an unconventional heat transfer pump (**1mk**)

ii. A certain refrigerator has a Coefficient of performance (COP) of 5.00. When the refrigerator is running, its power input is 500 W. A sample of water of mass 500 g and temperature 20.0°C is placed in the freezer compartment. How long does it take to freeze the water to ice at 0°C? Assume all other parts of the refrigerator stay at the same temperature and there is no leakage of energy from the exterior, so the operation of the refrigerator results only in energy being extracted from the water. (**6mks**)