RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Second Year – Semester I Examination – April / May 2016

PHY 2101- THERMODYNAMICS AND RADIATION

Answer **All** Questions. Time allowed: One hour

Universal gas constant (R) = $8.314\ J\ K^{-1}\ mol^{-1}$

The use of a non-programmable electronic calculator is permitted.

1)

a) Prove that the work done on a system consisting of ideal gas in an isothermal and quasi-static expansion is given by; (I) $W = nRT \ln(V_1/V_2)$ and (II) $W = nRT \ln (p_2/p_1)$. The symbols have their usual meanings.

(40 marks)

b) Prove that the work done on a system consisting of ideal gas in an isobaric quasi-static expansion is given by; $W = p_1(V_1-V_2)$ The symbols have their usual meanings.

(20 marks)

c) 18. 5 kg of O_2 (assume O_2 as an ideal gas) occupy a volume of 10 m^3 at 300 K. Find the work necessary to halve the volume (a) at constant pressure, (b) at constant temperature.

i) What is the temperature at the end of process (a)?

ii) What is the pressure at the end of process (b)?

(40 marks)

2)

a) Describe the operation of the Carnot ideal gas heat engine step by step with help of relevant diagrams.

i) A 600 MW steam power plant, which is cooled by a nearby river, has a thermal efficiency of 40%. Determine the rate of heat transfer to the river water. Will the actual heat transfer rate be higher or lower than this value? Why?

(50 marks)

b) Write down Stefan-Boltzman law for the black body radiation.

i) Assume that the Earth is a black body of uniform temperature T = 300 K. Calculate the energy E received by unit area of the Earth's surface per minute. (Stefans constant, $\sigma = 5.67X10^{-8}$ W m^{-2} K^{-4}) (hint: At equilibrium the total heat Q received by Earth from the Sun is equal to the heat re-radiated by Earth)

(50 marks)