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MAIN EXAMINATION

JANUARY – APRIL 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

REGULAR PROGRAMME

PHY 203: THERMODYNAMICS II

Date: APRIL 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any other Two Questions	

Q1. a) Define heat as used in thermodynamics **(1 Mark)**

b) An ideal gas undergoes an isothermal expansion at 77ºC increasing its volume from 1.3 to 3.4 L. The entropy change of the gas is 24 J/K. Find how many moles of gas are present. **(4 Marks)**

c) Compute the absolute pressure of a fluid at a gauge pressure of 1.5 bar if atmospheric pressure is 1.01 bar. (Give your answer in Pascals) **(2 Marks)**

d) Convert -72^{o}C to a temperature in degrees Kelvin. **(1 Mark)**

e) Calculate the increase in internal energy of a gas in a closed system during a process in which -100 J of heat transfer and 400 J of work transfer take place. **(2 Marks)**

f) Find how much work must be done to extract 10.0 J of heat from a reservior at7ºC and transfer it to one at 27ºC by means of a refrigerator using a Carnot cycle. **(5 Marks)**

g) Two blocks of Aluminum A and B are brought into contact with each other. Block A has a higher temperature than B. Discuss what is observed with respect to temperature, relaxation time and thermal equilibrium. **(6 Marks)**

h) With the aid of a diagram, state Zeroth “Law” of Thermodynamics

(3 Marks)

i) Define temperature and give any two units for it. **(2 Marks)**

j) A perfect gas at a pressure of 58 bar and a temperature of 450K has a density of 50kg/m^3. The ratio of specific heats γ is 1.48.Calculate the change in specific entropy of the gas if the pressure is raised to 100 bar and the temperature is lowered to 400K. **(4 Marks)**

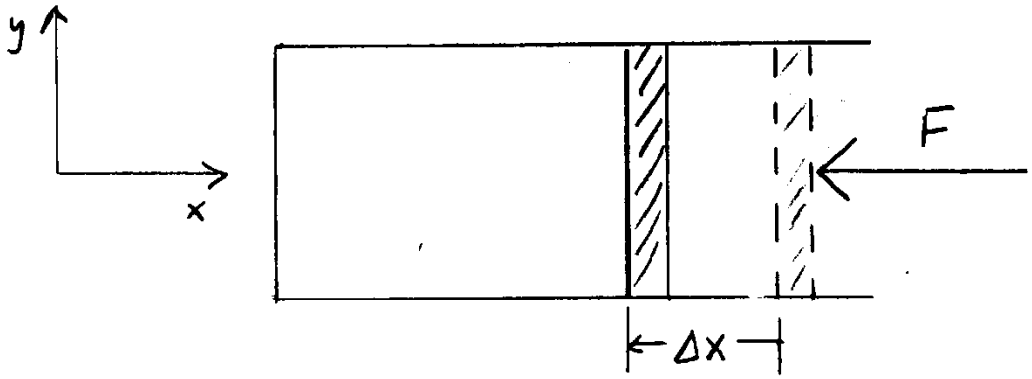
Q2. a) A mixture of 1.78 kg of water and 262 g of ice at 0ºC is, in a reversible process, brought to a final equilibrium state where the water/ice ratio, by mass is 1:1 at 0ºC,

i) Calculate the entropy change of the system during this process. **(6 Marks)**

ii) The system is then returned to the first equilibrium state, but in an irreversible way (by using a Bunsen burner, for instance). Calculate the entropy change of the system during this process. **(6 Marks)**

iii) Show that your answer is consistent with the second law of thermodynamics. **(3 Marks)**

b) Consider a system enclosed in a cylinder oriented along the x-axis, with a moveable piston of contact area A at one end as shown in the diagram below:



Required:

i) Draw a PV diagram to depict the scenario when a force F is applied on the system. **(2 Marks)**

ii) Show that the work done for this system is given by the expression:

$W = PA\,\Delta x = -P\Delta V$. **(3 Marks)**

Q3. a) Define Enthalpy and show how its formula can be given in terms of Heat energy. **(4 Marks)**

b) Derive the expression for the Internal energy for the following processes for an ideal gas:

i) Isothermal process **(5 Marks)**

ii) Adiabatic process **(5 Marks)**

c) Show that for an ideal gas, the internal energy is given by the equation

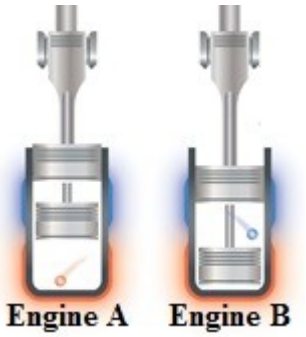
$$U = \frac{3}{2} NkT$$

Where N is the number of particles. K is the Boltzmann constant and T is temperature. **(6 Marks)**

Q4. a) State the four Thermodynamic Potentials. **(4 Marks)**

b) A perfectly insulated, rigid tank with a volume of 0.2 m^3 contains a perfect gas which has a molar mass of 18 kg/mol and a ration of specific heats of 1.45. Initially the pressure and temperature in the tank are 9 bar and 320 K respectively. A fan inside the tank is spun at 3600 rev/min for 20 seconds. The torque required to turn the fan is 30 Nm. Calculate the R, c_p and c_v values of the gas and the mass of gas in the tank. **(6 Marks)**

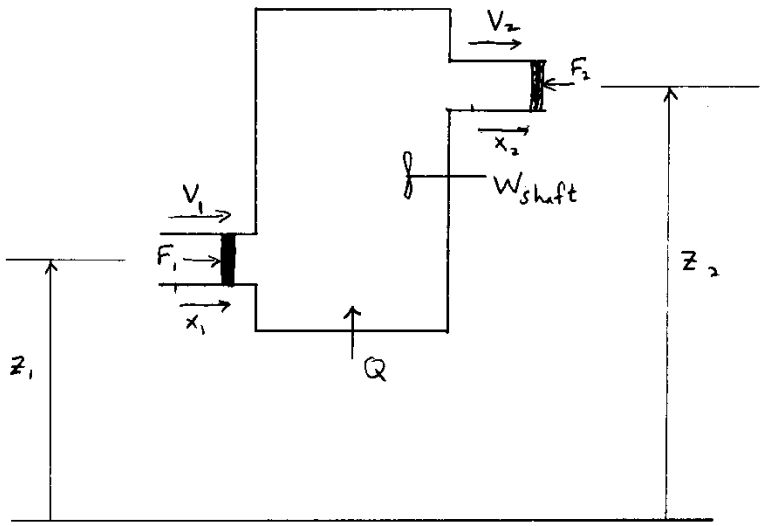
c) Consider two Engines A and B as shown below.Engine A, compared to engine B, produces, per cycle, five times the work but receives three times the heat input and exhausts out twice the heat.



Required: Determine the efficiency of each engine. **(10 Marks)**

Q5. a) An ideal gas undergoes an isothermal expansion at 77ºC increasing its volume from 1.3 to 3.4 L. The entropy change of the gas is 24 J/K. Show how many moles of gas are present. **(5 Marks)**

b) Consider a steady flow process in which a fluid is flowing steadily without friction, but with heat flow into the fluid and a change in elevation and changes in volume and pressure and some stirring as shown in the diagram below:



Required:
Show the expression for the total energy of the system **(6 Marks)**

c) To make some ice, a freezer extracts 185 kJ of heat at -12.0ºC. The freezer has a coefficient of performance of 5.70. The room temperature is 26.0ºC.

i) Calculate the amount of heat delivered to the room **(6 Marks)**

ii) Find how much work is required to run the freezer **(3 Marks)**

END