U.G. 3rd Semester Examination - 2020

PHYSICS

Course Code : BPHSCCHC302

Course Title : Thermal Physics

Full Marks : 30 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **ten** questions: 1×10=10

a) One mole of a gas $(\gamma = 1.4)$ initially at $17^{\circ}C$ is adiabatically compressed to 10 fold of its initial value. Find the value of the work done. [R=8.31 J/mol-K]

b) State whether the change in entropy during adiabatic expansion and isobaric expansion is zero, negative or positive.

c) What is the physical interpretation of Helmholtz free energy?

d) What is second order phase transition?

e) Mention importance of third law of thermodynamics.

f) What do you mean by 'degrees of freedom' of a dynamical system?

g) Which physical quantity is transported in case of viscosity of gas?

h) What do you mean by law of equipartition of energy?

i) Distinguish between free expansion and Joule-Thomson expansion.

j) Give the thermodynamic variables for the following syetsms:

i) Surface film

ii) Stretched wire

k) Show that the work done during a quasistatic adiabatic expansion of an ideal gas from a state (P_i, T_i, V_i) to a state (P_f, T_f, V_f) is

$$W = \frac{P_i V_i - P_f V_f}{\gamma - 1}.$$

l) An inventor claims to have developed an engine that works between 600 K and 300 K and has an efficiency of 52%, Comment on it.

m) Plot distribution curve of molecular speed at different temperatures.

n) What is Boyle temperature?

o) Give some features of Brownian motion.

2. Answer any **five** questions: 2×5=10

a) Show that for a van dar Waal's gas

$$C_P - C_V = R\left\{1 + \frac{2a}{RTV^3}(V-b)^2\right\},$$

where symbols have their usual meaning.

b) Find the change in entropy when 1 kg of water at 280 K is mixed with 2 kg of water at 310 K in a thermally insulated vessel (Sp. heat of water=4.2×10^3 joule/kg-deg).

c) Which is the more effective way to increase the efficiency of a Carnot engine: to increase T_1 (temperature of source) keeping T_2 (temperature of sink) constant or to decrease T_2 keeping T_1 constant.

d) The speed distribution function of N number of particles is given by

$$dN_v = k\,dv, \ (V > v > 0)$$
$$dN_v = 0, \ (v > V)$$

Find out the average and rms speed in terms of V.

e) Immediately on explosion of an atom bomb, the ball of fire produced has a radius of 100 m and a temperature of 10^5 K. What will be the temperature when the ball of fire expands adiabatically to 1000 m radius? $(\gamma = 1.66)$

f) 20 g of hydrogen gas at 27^{o}C are compressed isothermally to one-fourth of the original volume. Find the amount of work done.

g) 'The specific heat of saturated steam is negative'– Explain.

h) Establish reduced equation of state.

3. Answer any **two** questions: 5×2=10

a) What is Joule-Thomson effect? Show that Joule-Thomson coefficient for a gas is given by

$$\mu = \frac{1}{C_P}\left[T\left(\frac{\partial V}{\partial T}\right)_P - V\right],$$

where symbols have their usual meaning. 1+4

b) Briefly describe the operations of a Carnot cycle using P-V diagram. Compute the work done in each part of the cycle and hence find an expression for its efficiency.

c) A cylinder contains 1 mole of O_2 at a temperature of 27^{o}C. The cylinder is provided with a frictionless piston such that it maintains a pressure of 1 atm on the gas. The gas is heated until its temperature rises to 127^{o}C.

i) Draw a diagram representing the process in a P-V diagram

ii) Show that the work done is about 831 J and change in internal energy is about 2110 J

iii) Find the heat supplied to the gas

iv) What would have been the work done if the pressure had been 0.5 atms?

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