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B.Sc./3rd Sem (H)/PHSH/22(CBCS)

2022

3rd Semester Examination

PHYSICS (Honours)

Paper : C 6-T

[Thermal Physics]

[CBCS]

Full Marks : 40 Time : Two Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

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

(a) State and explain the Zeroth law of Thermodynamics.

(b) Define entropy. What is its significance ?

(c) Show that, the entropy of one mole of an ideal gas is $S = C_V \ln T + R \ln V + Constant$ where, symbols have their usual meanings.

(d) What are the differences between first order and second order phase transitions ?

(e) Which thermodynamic potential remains constant when ice melts into water ? Explain why ?

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(f) What is the ratio of specific heats $\left(\gamma = \frac{C_P}{C_V}\right)$ for linear triatomic molecule ?

(g) State the 'equipartition theorem of energy'.

(h) What are the effects of temperature and pressure on coefficient of viscosity of gas ?

2. Answer any ***four*** questions : 5×4=20

(a) Starting from the first law of thermodynamics, show that

$$C_P - C_V = \left\{P + \left(\frac{\partial U}{\partial V}\right)_T\right\}\left(\frac{\partial V}{\partial T}\right)_P$$

Where symbols have their usual meaning. Hence find out the value of $(C_P - C_V)$ for one mole of an ideal gas. 3+2

(b) Prove that, using Maxwell's relation

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$$

where symbols have their usual meaning. Hence find out $\left(\frac{\partial U}{\partial V}\right)_T$ for one mole of a van der Waals' gas. 3+2

(c) Two identical bodies of equal heat capacity C_P and at absolute temperatures T_1 and T_2 respectively are

used as reservoirs for a heat engine. If the bodies are at constant pressure without any change of phase, show that the amount of work obtained is $W = C_P\left(T_1 + T_2 - 2T_f\right)$, where T_f is the final temperature attained by both bodies. Show that, when W is maximum $T_f = \sqrt{T_1 T_2}$. 3+2

(d) Express van der Waals' equation of state in virial form. Hence find out the Boyle temperature. What is the significance of Boyle temperature ? 2+2+1

(e) Assuming Maxwell's velocity distribution, find an expression for the most probable velocity (C_m). Find the fraction of molecules having speed in the range C_m to $1.2\,C_m$. 3+2

(f) Deduce an expression for the Joule-Thomson co-efficient in terms of C_P and other thermodynamic parameters. 5

Answer any ***one*** question : 10×1=10

3. (a) What is the more effective way to increase the efficiency of a Carnot's engine ? 2

(b) When two gases at the same temperature and pressure diffuse in to each other, show that there is an increase in entropy in the process. Show that entropy of the universe is always increasing. 4+2

(c) What are the differences between reversible adiabatic expansion and JT expansion ? 2

P.T.O.

4. (a) Calculate the RMS velocity of Argon gas molecule at 200K (molecular weight of Argon 40). 2

(b) Find out the critical temperature of van der Waals' gas. 3

(c) The co-efficient of viscosity of nitrogen gas is 16.6×10^{-6} Ns/m^2, mean velocity $\overset{v}{C} = 450 ms^{-1}$, density $\rho = 1.25\ kgm^{-3}$ and number density of molecule $n = 2.7\times10^{25}$ m^{-3}. Calculate the mean free path, collision frequency and the diameter of nitrogen molecules. 5
