LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **PHYSICS**

SECONDSEMESTER – APRIL 2017

PH 2505- MECHANICS & STATISTICAL PHYSICS

Date: 04-05-2017 Dept. No. Max. : 100 Marks
01:00-04:00

Part – A **Answer ALL Questions** **(10 x 2 = 20 marks)**

1. State the theorem of conservation of angular momentum.
2. Water flowing with a velocity of 3 m s^{-1} in a 4 cm diameter pipe enters a narrow pipe having a diameter of only 2 cm. Calculate the velocity of water in the narrow pipe.
3. What are generalized coordinates?
4. Distinguish between Lagrangian and Hamiltonian formulations.
5. Define thermal conductivity.
6. Calculate the mean free path of a gas molecule, given that the molecular diameter is 2 x 10^{-8} cm and the number of molecules per cc is 3 x 10^{19}.
7. State the significance of thermodynamic potentials.
8. What is the significance of entropy?
9. Distinguish between micro and macro states.
10. What is the advantage of phase space over configuration space?

Part – B **Answer ANY FOUR Questions** **(4 x 7.5 = 30 marks)**

11. (a) With necessary theory arrive the expression for period of oscillation of a compound pendulum. **(6)**
    (b) Show that points of suspension and oscillations are interchangeable. **(1.5)**
12. (a) State and prove D'Alembert's principle. **(5)**
    (b) Describe Atwood's machine and obtain its Lagrangian. **(2.5)**
13. (a) Derive Clausius' expression for mean free path. **(4)**
    (b) Show that the mean free path varies directly with the absolute temperature. **(3.5)**
14. Obtain Ehrenfest's equation for second order phase transformation.
15. Explain Doppler broadening of spectral lines on the basis of Maxwell's distribution law of velocities.
16. (a) State Fick's laws of diffusion and its analogy with heat conduction. **(4)**
    (b) Show that the rate of diffusion of gas in inversely proportional to the square of its density. **(3.5)**

Part – C **Answer ANY FOUR Questions** **(4 x 12.5 = 50 marks)**

17. (a) State and prove Bernoulli's theorem. **(10)**

(b) A fire engine pumps water from a hydrant at the rate of 1000 litres per second. The pump ejects it from a nozzle 5 m above the surface of water in the hydrant with a velocity of 10 m s^{-1}. Calculate

(i) the pressure difference between the water at the pump and the nozzle and

(ii) power of the engine. **(2.5)**

18. Set up the Lagrangian function for a charged particle moving in an electromagnetic field and hence deduce Hamiltonian function and Hamilton's equations of motion.

19. (a) Derive the expression for coefficient of viscosity (η) of a gas and establish its dependence on temperature and pressure. **(6)**

(b) Derive the expression for coefficient of thermal conductivity (K) of a gas and establish its dependence on temperature and pressure. **(6)**

(c) Establish the relation between η and K. **(0.5)**

20. Obtain the general expression for Maxwell's thermodynamical relations and hence deduce the Maxwell's thermodynamical relations for the mechanical and thermal variables.

21. Deduce the general form of Maxwell-Boltzmann energy distribution law.

22. (a) Explain the principle of take-off of an aeroplane. **(5)**

(b) If **F** = (2xy + z2) **i** + x2 **j** + 2xz **k** newton, then show that it is conservative. Calculate the amount of work done by this force in moving a particle from (0,1,2) to (5, 2, 7) m. **(5)**

(c) For oxygen at standard conditions, (i) collision frequency of the molecules and (ii) the mean free path. (Given : the number of molecules per cubic metre is 3×10^{25} and diameter of oxygen molecule is 3.6×10^{-10} m). **(5)**

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