

61121

I Semester B.Sc. Examination, April/May 2023

(CBCS) (Repeaters)

PHYSICS

Mechanics – I, Heat and Thermodynamics

Time : 3 Hours

Max. Marks 70

Instruction : All Parts are compulsory.

PART – A

Answer **any five** questions. **Each** question carries **eight** marks. (8×5=40)

1. a) Define the terms static friction and kinetic friction. (2+6)
b) What is the angle of repose ? Derive the relation between the coefficient of static friction and the angle of repose.
2. a) State and explain the universal law of gravitation. (3+5)
b) Define the term orbital velocity and obtain an expression for the same.
3. a) What do you understand by the term center of mass ? Obtain an expression for the position vector of the center of mass. (4+4)
b) Show that the linear momentum of a system of particles is equal to the product of the mass of the system and the velocity of the center of mass.
4. Derive Planck's law of radiation. 8
5. a) Obtain an expression for the mean free path of gas. (5+3)
b) Mention the factors that affect the mean free path of gas molecules.
6. Derive the expression for the coefficient of thermal conductivity of gas on the basis of the kinetic theory of gases. 8
7. a) State and explain the zeroth law in thermodynamics. What is its significance ? (3+5)
b) Derive an expression for the work done in an adiabatic process.

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8. a) Obtain the general expression for the change in the entropy of a perfect gas. (5+3)
- b) Discuss the change of entropy in the free expansion of a gas.

PART – B

Answer **any five** questions. **Each** question carries **four** marks. (4×5=20)

9. A particle of mass 10 kg starts from rest and moves through a distance of 5 m in two seconds. Under the action of a constant force. What is the magnitude of the force ?
10. A box of mass 0.5 kg is sliding across a frictionless horizontal counter with a speed of 4 ms^{-1} . It compresses a spring of spring constant 750 Nm^{-1} . By what distance will the spring be compressed when the box is stopped by the spring momentarily ?
11. Find the acceleration due to gravity of the moon at a point 1000 km above the moon's surface. The mass of the moon is $7.4 \times 10^{22} \text{ kg}$ and its radius is 1740 km.
12. The temperature of a furnace is 3500 K. Calculate the heat radiated per unit area for 60 seconds from it. Assume σ to be $5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$.
13. Four molecules of a gas have speeds of 2000 ms^{-1} , 4000 ms^{-1} , 6000 ms^{-1} and 8000 ms^{-1} respectively. Calculate their average speed and root mean square speed.
14. Calculate the a and b constants for a gas obeying Van der Waals' equation of state if the critical temperature and critical pressure are 31°C and 72.8 atm. respectively.
15. A Carnot engine has an efficiency of 65% and the temperature of the sink is 500K. What will be the temperature of the source ? At what temperature of the source will the efficiency become 75% ?
16. 100 grams of ice at 0°C is first converted into water and then its temperature is raised to 50°C . What is the total change in entropy ? Given : Specific heat of water = $4,200 \text{ J/kg}^\circ\text{C}$ and the latent heat of vaporization of water = $2,260 \text{ kJ/kg}$.



PART – C

Answer **any five** questions. **Each** question carries **two** marks.

(2×5=10)

17. a) Why is it difficult to walk fast on sand ?
- b) Can the center of mass of a body lie outside the body ? Explain.
- c) The air pressure inside a car tyre increases while driving. Explain.
- d) Does a satellite need fuel to go around the earth ? Explain.
- e) Does the density of a liquid and its vapor become the same at a critical point ? Why ?
- f) If the temperature of a black body is increased, say from 400 K to 800 K by what factor does the rate of energy emission increase ?
- g) A refrigerator transfers heat from a cold body to a hot body. Does it violate the second law of thermodynamics ?
- h) An Otto engine is preferred to a Carnot engine. Why ?



(3+5)

(4+4)

(5+3)

(3+5)

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