

Duration: 2 Hrs.

Total Marks:60

- N.B.: 1) All questions are compulsory.
 2) Figures to the right indicate full marks.
 3) Symbols have their usual meanings.
 4) Use of non-programmable calculator is allowed.

Q.1 Attempt any TWO. 16

1. Explain the center of mass coordinate system and show that the center of mass frame of reference is also called zero-momentum frame of reference.
2. Set the equation of motion for rocket motion and derive an expression for the maximum velocity attained by a rocket.
3. What is the center of suspension and center of oscillation? Discuss their interchangeability. Show that if the two are equidistant from the pendulum's center of mass, then the time period becomes minimum.
4. Set up the equation of motion of a lightly damped harmonic oscillator and solve the equation for the displacement.

Q.2 Attempt any TWO. 16

1. Prove the unattainability of absolute zero and the heat capacities tending to zero are the consequence of the third law of thermodynamics.
2. Explain Kelvin's absolute scale of temperature.
3. Derive Maxwell's four Thermodynamical relations.
4. Carnot's Theorem: State and Prove.

Q.3 Attempt any TWO. 16

1. Explain the construction and working of Otto's Engine? Draw Indicator diagram of Otto's Engine?

2. Explain Cooling by sudden adiabatic expansion of compressed gases. Find the temperature of the CO₂ gas after suddenly being released to normal atmospheric pressure from 200 atmospheric pressure. Given For CO₂ gas $\gamma = 1.5$.

3. Derive an expression Joule-Thomson coefficient μ for the Throttling Process?

4. Describe the Kamerlingh Onnes method of Helium liquefaction with a schematic diagram.

Q.4 (A) Attempt any ONE. 4

1. Three particles in a system have position vectors in meters specified as $\vec{r}_1 = 3t \hat{i} + 4 \hat{j} + 2 \hat{k}$, $\vec{r}_2 = 3 \hat{i} + 6t \hat{j} + 6 \hat{k}$ and $\vec{r}_3 = \hat{i} + \hat{j} + \hat{k}$. If the masses of particles are 2 kg each, find the centre of mass of the system.

2. A thin circular metal ring of radius 25 cm is suspended from a knife edge and made to oscillate. Find its period. $g = 980 \text{ cm/s}^2$.

(B) Attempt any ONE.

4

1. When 100 gm of water is heated from 10°C to 90°C , find by how much does the entropy of water changes.
2. Explain in detail: concept of an increase in entropy.

(C) Attempt any ONE.

4

- In an Otto cycle engine, petrol vapor mixed with air is sucked in at the atmospheric temperature of 300 K. After compression, the temperature of the fuel mixture becomes 600 K. Immediately after combustion of fuel, the temperature is 2040 K. If $\gamma = 1.4$.
- 1.

Calculate a) the adiabatic expansion ratio ρ , and

b) the efficiency of the engine.

2. Write a difference between Otto and Diesel cycles.
