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(October)

PHYSICS

(Elective/Honours)

(Thermal Physics, Waves)

[PHY–03 (T)]

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** which is compulsory and *any* **four** from the rest

1. *(a)* The efficiency of a Carnot engine is $\frac{1}{6}$. On reducing the temperature of the sink by 65 °C the efficiency becomes $\frac{1}{3}$. Find the temperature between which the engine initially work. 3

   (b) A blackbody at 1227 °C emits maximum energy of wavelength 2000 nm. If the sun emits maximum energy of wavelength 550 nm, what is the temperature of the sun? 3

   (Turn Over)

(2)

(c) A string of length 0·4 m and mass 10^{-2} kg is tightly fixed at its ends. Identical wave pulses are produced at one end at equal interval of time Δt. Find the minimum value of Δt for constructive interference between successive pulses if the tension on the string is 1·6 N.   3

(d) The de Broglie wavelength of a non-relativistic electrons is 2·0 Å. What is its energy?   3

2. (a) What are transport phenomena?   1

(b) Derive an expression for the viscosity η of a gas in terms of mean free path of its molecules.   5

(c) Discuss the effect of temperature and pressure on the coefficient of viscosity of a gas.
$1\frac{1}{2}+1\frac{1}{2}=3$

(d) Calculate the mean free path of a gas molecule. Given that the molecular diameter is 2×10^{-8} cm and the number of molecules per cc is 3×10^{19}.   2

3. (a) What is entropy?   1

(b) Show that for an irreversible process the entropy increases.   4

(Continued)

(3)

(c) Explain thermodynamic scale of temperature.   6

4. (a) Define Boyle temperature and inversion temperature.   1+1=2

(b) Explain regenerative cooling for liquefaction of gases.   6

(c) Show that the volume of a phase cell in quantum statistics cannot be less than h^3, where h is Planck's constant.   3

5. (a) State Planck's postulates on quantum theory of radiation.   2

(b) Derive Planck's radiation law.   7

(c) Explain the distribution of energy of a blackbody radiation at two different temperatures by drawing the graph.   2

6. (a) Define simple harmonic motion. Set up the differential equation of motion of a simple harmonic oscillator and solve the equation.   1+1+2=4

(b) What are damped and forced oscillations? Obtain an expression for the energy of a damped SHM.   1+1+2=4

(Turn Over)

(c) Distinguish between 'transient' and 'steady state' oscillations. Define 'sharpness of resonance' and 'quality factor'.

1+1+1=3

7. *(a)* What are spherical waves? Show that the amplitude of a spherical wave falls off as $\frac{1}{r}$ with distance.

1+3=4

(b) State the conditions that a function must satisfy so that it can be expanded in Fourier series.

2

(c) A function $f(t)$ is given by

$$f(t) = A\frac{t}{T} \quad \text{for } 0 < t < T$$
$$f(t+T) = f(t)$$

Find the Fourier expansion of $f(t)$.

5

8. *(a)* State uncertainty principle and explain its significance.

1+3=4

(b) For which pair of dynamical variables is the principle valid?

1

(c) Discuss the normalization of a wave function with an example.

6

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