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(February)

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) At what temperature the molecular velocity (r.m.s.) of oxygen will become half that of hydrogen at NTP? 3
- (b) A particle executes SHM with time period 8 seconds and amplitude 4 cm. Calculate the velocity and acceleration when the particle is 2 cm from the mean position. 3

- (c) A black body at 1500 K emits the maximum energy at wavelength 2000 nm. What is the maximum temperature of the Sun if it emits maximum energy at wavelength 550 nm? 3

- (d) The uncertainty in the velocity of an electron moving with a speed of 500 m/s is 0.004%. Calculate the uncertainty in the position of an electron. 3

2. (a) State the law of equipartition of energy. 1

- (b) Prove the above law and hence obtain the relation C_p / C_v , where the symbols have the usual significance. 6+4=10

3. (a) State and prove Carnot theorem. 1+4=5

- (b) Show that the work done in an adiabatic process depends only on the initial and final temperatures. 4

- (c) Explain the terms reversible process and irreversible process. 2

(3)

4. (a) What is temperature of inversion? Show that the temperature of inversion is

$$T_i = \frac{2a}{bR}$$

where a and b are van der Waals constants and R the universal gas constant. 1+2=3

- (b) What is Stefan-Boltzmann law? Give its thermodynamical deduction. 1+4=5
- (c) What is phase space? State the difference between micro canonical and canonical ensembles. 1+2=3
5. (a) Discuss the resultant due to two mutually perpendicular SHMs which are represented by $x = 3\sin t$ and $y = 4\cos t$. 5
- (b) Explain sharpness of resonance in forced vibration. Discuss the effect of damping on the sharpness of resonance. 2+2=4
- (c) Write down a differential equation representing damped simple harmonic motion and identify the terms. 2
6. (a) Define the terms 'group velocity' and 'phase velocity'. 2

(4)

- (b) Obtain the relation between group velocity and phase velocity. 4
- (c) Discuss the theory of plucked string. 5
7. (a) State and explain de Broglie hypothesis of matter waves. 1+2=3
- (b) Derive an expression for the de Broglie wavelength associated with an electron accelerated under a potential difference of V volts. 4
- (c) Obtain the Fourier series for the function $f(x) = x^2$ in the interval $x \in [0, \pi]$. 4
8. (a) State Heisenberg uncertainty principle. Use this principle to explain the non-existence of electrons in the nucleus of an atom. 1+4=5
- (b) What do you understand by the wave function ψ ? Give its physical significance. 1+2=3
- (c) Obtain the one-dimensional time-dependent Schrödinger equation. 3
