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2 SEM TDC PHY M 2

2012

(May)

PHYSICS

(Major)

Course : 201

(Thermal Physics and Waves and Oscillation)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×8=8

(a) At very low temperatures, the coefficient of viscosity of a gas

(i) decreases with decrease of pressure

(ii) increases with increase of pressure

(iii) is independent of pressure

(iv) is equal to pressure

(b) The molecular density in a gas is n and diameter of its molecule is d, the mean free path of molecule is

(i) $\frac{\pi}{nd^2}$ (ii) $\frac{1}{\pi nd}$

(iii) $\frac{1}{\sqrt{2}\pi nd^2}$ (iv) $\frac{1}{3\sqrt{2}\pi nd^3}$

(c) The temperature of inversion of a gas is given by

(i) $T_i = \frac{a}{Rb}$ (ii) $T_i = \frac{2a}{Rb}$

(iii) $T_i = \frac{2b}{aR}$ (iv) $T_i = \frac{2ab}{R}$

(d) An ideal gas is heated from 20 °C to 40 °C under constant pressure. The change in internal energy is

(i) zero

(ii) double the original value

(iii) proportional to change in volume

(iv) proportional to change in temperature

(e) In a reversible cycle, the value of the integral $\oint \frac{dQ}{T}$ is

(i) $\oint \frac{dQ}{T} > 0$ (ii) $\oint \frac{dQ}{T} < 0$

(iii) $\oint \frac{dQ}{T} = 0$ (iv) $\oint \frac{dQ}{T}$ = constant

(f) The absolute temperature of a perfectly blackbody is increased to twice its value. The rate of emission of energy per unit area will be

(i) 2 times

(ii) 4 times

(iii) 8 times

(iv) 16 times

(g) The equation of transverse wave is given by $y = 20\sin\pi(0{\cdot}02x - 2t)$, where x and t are in cm and sec respectively. The wavelength of the wave in cm will be

(i) 50

(ii) 100

(iii) 200

(iv) 5

(h) A string stretched at both ends emits harmonics given by the ratio

(i) 1 : 2 : 3

(ii) 1 : 3 : 5

(iii) 1 : 2 : 9

(iv) unrelated

2. *(a)* Obtain an expression for thermal conductivity of an ideal gas on the basis of kinetic theory. Discuss its dependence on pressure and temperature. 3+2=5

(b) State and prove Carnot's theorem. 2+3=5

(c) What do you mean by pressure of radiation? 2

(d) Illustrate graphically the resultant path of two simple harmonic motions of same frequency but different amplitudes when the phase difference between them is *(i)* zero and *(ii)* $\pi/4$. 2+2=4

3. *(a)* Give an account of Andrews' experiment on carbon dioxide. Discuss the results obtained. What is the importance of these results in the liquefaction of gases? 4+3+2=9

Or

What are critical constants of a gas? Evaluate these constants in terms of the constants in van der Waals' equation of state. Deduce the reduced equation of state and state the law of corresponding state. 3+4+2=9

(b) What is Brownian motion? Given an account of Einstein's theory of translational Brownian motion. Describe how the experimental study of this method helps to evaluate the value of Avogadro's number. 1+6+2=9

4. *(a)* Describe the working of a Carnot's reversible heat engine. Show how the work done in each operation represented on a *P-V* diagram. Calculate the efficiency of this engine in terms of the temperature of the source and the sink. Why it cannot be realised in practice? 2+2+4+1=9

Or

Show that entropy remains constant in reversible process but increases in irreversible process. Derive an expression for change in entropy of a perfect gas. Calculate the change in entropy when 1 gm of water is heated from 0 °C to 50 °C. [Take specific heat of water as 1 at all temperatures.] 4+3+2=9

(b) Derive Maxwell's thermodynamical relation

$$\left(\frac{dS}{dV}\right)_T = \left(\frac{dP}{dT}\right)_V$$

and establish Clausius-Clapeyron equation $\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$. 6+2=8

5. Derive Planck's formula of energy distribution in blackbody radiation. From the Planck's radiation formula show that it reduces to Wien's law when $h\nu >> kT$ and Rayleigh-Jeans law when $h\nu << kT$. 4+1½+1½=7

6. *(a)* Deduce Newton's formula for velocity of propagation of longitudinal waves in a gaseous medium. What correction was suggested by Laplace and why? 3+3=6

(b) What are damped and forced vibrations? Give the theory of forced vibration and discuss the condition of resonance. 2+4+2=8

Or

A light and flexible string stretched under tension over two bridges at a distance l apart is plucked at a distance a from one of the bridges. Find the displacement at a given point x at subsequent time. How do the harmonics present depend upon the point of plucking? 5+3=8

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