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2 SEM TDC PHY M 1

2018

(May)

PHYSICS

(Major)

Course : 201

(Thermal Physics and Waves and Oscillations)

Full Marks : 80
Pass Marks : 32/24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose and write the correct answer : 1×8=8

(a) The surface temperature of the stars is determined using

(i) Planck's law

(ii) Wien's displacement law

(iii) Rayleigh-Jeans law

(iv) Kirchhoff's law

(b) Which of the following is/are unique function(s) of initial and final states of a thermodynamic system?

(i) dQ

(ii) dW

(iii) dU

(iv) ΔQ and ΔW

(c) The change in internal energy of one mole of the gas, when the volume changes from V to $2V$ at constant pressure P, is

(i) $\frac{\gamma - 1}{PV}$

(ii) PV

(iii) $\frac{PV}{\gamma - 1}$

(iv) $\frac{PV}{\gamma}$

(d) According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is

(i) greater than the mean velocity

(ii) equal to the mean velocity

(iii) equal to the root mean square velocity

(iv) less than the root mean square velocity

(Continued)

(e) When gas in a vessel expands, its internal energy decreases. The process involved is

(i) isothermal

(ii) isobaric

(iii) adiabatic

(iv) isochoric

(f) The efficiency of a Carnot engine working between 800 K and 500 K is

(i) 0·4

(ii) 0·63

(iii) 0·38

(iv) 0·5

(g) Sound waves transfer

(i) only energy not momentum

(ii) energy

(iii) momentum

(iv) both energy and momentum

(Turn Over)

(h) The displacement of a particle in a medium can be expressed as

$$y = 10^{-6} \sin\left(100t + 20x + \frac{\pi}{4}\right) m$$

where t is in second and x in metre. The speed of the wave is

(i) 2000 m/sec

(ii) 5 m/sec

(iii) 20 m/sec

(iv) 5π m/sec

2. (a) What are the critical constants of a gas? State and explain van der Waals' equation. Calculate the critical constants of gas in terms of constants of this equation. 1+2+3=6

(b) Write the expression of Maxwell's law of distribution of velocities in terms of the kinetic energy of the molecules. Use the law to prove the theorem of equipartition of energy among various degrees of freedom of the molecules. 2+4=6

(c) 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 cubic centimetre is 3×10^{19}. 3

(Continued)

(d) Explain what are meant by diffusion and Brownian movement. Write Einstein theory of translational Brownian motion in fluid. 2+5=7

(e) Calculate the average kinetic energy of a molecule of any gas at a temperature of 300 K. 3

Or

At what temperature, pressure remaining constant, will the r.m.s. velocity of a gas be half its value at 0 °C?

3. (a) Write short notes on the following : 3+3=6

(i) Second law of thermodynamics

(ii) Principle of increase of entropy

(b) Deduce the following Maxwell's thermodynamical equations : 3+3=6

(i) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

(ii) $\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$

(Turn Over)

(c) Calculate the change in entropy, when 5 kg of water at 100 °C is converted into steam at the same temperature. Given, latent heat of steam = 540 cal/g. 2

(d) Deduce the Clausius-Clapeyron latent heat equation from Maxwell's thermo-dynamical relations. 6

4. State the basic postulates on which Planck's law of blackbody radiation is based. Write down Planck's formula and show that Wien's and Rayleigh-Jeans laws are particular cases of it. 2+1+3+3=9

Or

Write notes on the following : 3×3=9

(a) Spectral distribution of blackbody radiation

(b) Ultraviolet catastrophe

(c) Pressure due to radiation

5. (a) Discuss the theory of a forced vibration and obtain the condition of resonances. 5

(b) Obtain the differential equation for the motion of a transverse wave along a string. 5

(Continued)

(c) Deduce the expression of velocity of propagation of plane longitudinal wave in a gaseous medium and Newton's formula for velocity of sound wave from it. What is the correction suggested by Laplace and why? 3+2½+2½=8

Or

Find the displacement at a given point at any instant of a stretched string which is plucked at a point. How do the harmonics present depend upon the point of plucking? 5+3=8

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