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2 SEM TDC PHY M 1

2016

(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 the correct answer : 1×8=8

(a) E_o and E_h respectively represent the average kinetic energy of a molecule of oxygen and hydrogen. If the two gases are at the same temperature, which of the following statements is true?

(i) $E_o > E_h$

(ii) $E_o = E_h$

(iii) $E_o < E_h$

(iv) Nothing can be said about the magnitude of E_o and E_h as the information given is not sufficient

(b) Which of the following phenomena gives evidence of the molecular structure of matter?

(i) Brownian motion

(ii) Diffusion

(iii) Evaporation

(iv) All of the above

(c) The constant b in van der Waals' equation results due to the

(i) attractive forces between the gas molecules

(ii) repulsive forces between the gas molecules

(iii) finite volume of the gas molecules

(iv) None of the above

(d) The ratio of adiabatic bulk modulus and isothermal bulk modulus of a gas is ($\gamma = C_p / C_v$)

(i) 1

(ii) γ

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

(iv) $\frac{\gamma - 1}{\gamma}$

(Continued)

(e) When an ideal monoatomic gas is heated at constant pressure, the fraction of heat energy supplied which increases the internal energy of the gas is

(i) $\frac{2}{5}$

(ii) $\frac{3}{5}$

(iii) $\frac{3}{7}$

(iv) $\frac{3}{4}$

(f) According to Rayleigh-Jeans formula, the spectral energy density of blackbody radiation

(i) increases as ν^2

(ii) decreases as $\frac{1}{\nu^2}$

(iii) remains constant

(iv) increases as ν

where ν is frequency.

(Turn Over)

(g) A particle of a medium of wave propagation is acted upon by two simple harmonic motions at right angles simultaneously. The particle will trace a curve, the shape of which depends on

(i) the time period

(ii) the phase difference

(iii) the amplitude

(iv) All of the above

of the two constituent harmonic motions.

(h) The equation of motion of a particle is given as $x = ae^{-bt}\sin(\eta t - \phi)$, where $\eta = \sqrt{\omega^2 - b^2}$. The particle executes

(i) free oscillations

(ii) damped oscillations

(iii) forced oscillations

(iv) Cannot be said

2. (a) Starting from Maxwell-Boltzmann distribution law of velocities, obtain expressions for the (i) most probable velocity, (ii) average speed and (iii) root-mean-square speed. 2+2+3

(Continued)

(b) Obtain the critical constants in terms of the constants a and b of van der Waals' equation. Hence derive the reduced equation of state. 4+3=7

(c) What do you mean by thermal conductivity of a gas? Calculate the coefficient of thermal conductivity of a dilute gas. 2+6=8

Or

What are the special features of Brownian motion? Discuss the Einstein's theory of translational Brownian motion. 3+5=8

3. (a) What are the conditions for reversibility of a thermodynamic process? What is a quasistatic process? 1+2=3

(b) What do you mean by entropy? How does entropy change in (i) reversible processes, (ii) irreversible processes and (iii) cyclic processes? 3+3=6

(c) Write a short note on the thermodynamic temperature scale. 4

(Turn Over)

(d) Show that

$$C_p - C_v = \frac{TV\alpha^2}{k}$$

where,

α = volume coefficient of expansion;
k = isothermal compressibility.

Or

Show that the equilibrium between phases of a substance can be represented by Clausius-Clapeyron equation.

(e) Obtain an expression for the work done in an isothermal expansion of an ideal gas.

4. (a) What is ultraviolet catastrophe?

(b) Show that Wien's displacement law can be derived from Planck's radiation law.

5. (a) Show that the superposition of two simple harmonic oscillations of equal frequency at right angles to each other, in general, gives rise to an equation for an ellipse.

(Continued)

(b) Derive an expression for the speed of sound in a fluid. 6

(c) Show that the velocity of wave on a string is proportional to the restoring force and inversely proportional to the inertia. 6

Or

What is damped oscillation? What are *(i)* critical damping and *(ii)* overdamping conditions? 2+2+2=6

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