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2 SEM TDC PHY M 1

2015

(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) The root-mean-square speed of gas molecules at absolute temperature T is given by

(i) $C_{rms} = \sqrt{\frac{3kT}{m}}$

(ii) $C_{rms} = \sqrt{\frac{2kT}{m}}$

(iii) $C_{rms} = \sqrt{\frac{kT}{m}}$

(iv) $C_{rms} = \sqrt{\frac{kT}{3m}}$

(b) The constant a in van der Waals' equation arises due to the

(i) attractive forces between the gas molecules

(ii) repulsive forces between the gas molecules

(iii) finite volume of the gas

(iv) None of the above

(c) The relation between thermal conductivity (K) and coefficient of viscosity (η) of a gas is given by

(i) $\frac{K}{\eta} = C_v$

(ii) $\frac{K}{\eta} = C_p$

(iii) $\frac{\eta}{K} = C_p$

(iv) $K\eta = C_v$

(d) The efficiency of Carnot engine operating between temperatures T_1 of source and T_2 of sink can be increased by

(i) increasing the ratio T_2 / T_1

(ii) decreasing the ratio T_2 / T_1

(iii) increasing the sum $(T_1 + T_2)$

(iv) increasing the product $(T_1 \times T_2)$

(e) Which of the following is not an irreversible effect?

(i) Joule-Thomson effect

(ii) Transfer of heat by radiation

(iii) Transfer of heat from hot body to cold body

(iv) Isothermal expansion of a gas

(f) When the temperature difference between the hot body and its surrounding is small, then Stefan-Boltzmann law reduces to

(i) Newton's law of cooling

(ii) Kirchhoff's law

(iii) Planck's law of radiation

(iv) None of the above

(g) In forced vibration, the amplitude resonance occurs when the applied frequency is

(i) slightly greater than the natural frequency of the body

(ii) slightly less than the natural frequency of the body

(iii) equal to the natural frequency of the body

(iv) equal to the square of the natural frequency of the body

(h) The velocity of sound in a gas is

(i) proportional to its density

(ii) inversely proportional to its density

(iii) inversely proportional to the square root of its density

(iv) inversely proportional to the square of its density

2. (a) State and prove the law of equipartition of energy. 2+5=7

(b) What are transport phenomena? On the basis of kinetic theory of gases deduce an expression for the viscosity of a gas in terms of mean free path of its molecules. 2+5=7

(c) In what respect a real gas differs from an ideal gas? Describing Andrew's experiment on CO_2, draw curves at different temperatures and discuss the result. What are critical temperature and critical pressure? 1+2+4+1=8

Or

What considerations led van der Waals to modify gas equation of state? Deduce van der Waals' gas equation. What are the limitations of this equation? 2+4+2=8

3. (a) State and explain zeroth law of thermodynamics. 1+2=3

(b) Explain why the temperature of a gas drops in adiabatic expansion. 2

(c) A certain mass of an ideal gas at 27 °C and at a pressure of 8 atmosphere is expanded suddenly to four times of its volume. Find the final pressure and temperature. (Given, $\gamma = 1{\cdot}5$) 3

4. (a) Describe Carnot's reversible heat engine and calculate the efficiency of this engine. 2+5=7

(b) Derive the following Maxwell's thermodynamical relations : 4+4=8

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

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

5. (a) State and prove Kirchhoff's law. 1+4=5

(b) State Wien's law of energy distribution and describe how this law can be verified experimentally. 1+3=4

6. *(a)* Derive an expression for a plane progressive harmonic wave. What are particle velocity and wave velocity? Find expressions for these two velocities and a relation between them. 3+1+2=6

(b) Derive an expression for the velocity of sound in gaseous medium. How is the velocity of sound affected by the temperature and pressure of the medium? 4+2=6

Or

Derive an expression for the velocity of transverse waves in a stretched string. Find out the laws of vibrating string from this expression. 4+2=6

(c) What is forced vibration? Derive an expression for the forced vibration of a body and solve it. Under what condition amplitude resonance occurs? 1+4+1=6

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