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2 SEM TDC PHY M 1

2017

(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) If V_a be the average velocity of the molecules of a gas in equilibrium state, then

(i) $V_a \propto T^2$

(ii) $V_a \propto T$

(iii) $V_a \propto \sqrt{T}$

(iv) $V_a \propto \frac{1}{\sqrt{T}}$

(Turn Over)

(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) attractive forces between the gas molecules and the wall of the container

(iv) finite volume of the gas

(c) The first evidence in favour of the molecular structure of gas comes from the experimental observation of

(i) gas equation

(ii) tracks of particles in cloud chamber

(iii) motion of molecules in a conduction phenomenon

(iv) Brownian movement of colloidal particles

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

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

(ii) decreasing the difference $(T_1 - T_2)$

(iii) decreasing the ratio (T_2 / T_1)

(iv) increasing the ratio (T_2 / T_1)

(Continued)

(e) Internal energy of a real gas depends upon

(i) both temperature and volume

(ii) temperature only

(iii) volume only

(iv) pressure

(f) Zeroth law of thermodynamics is related to

(i) internal energy

(ii) heat

(iii) temperature

(iv) work

(g) The amplitude resonance in forced vibration occurs, when the frequency of the applied force is

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

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

(iii) equal to the natural frequency of the body

(iv) twice the natural frequency of the body

(Turn Over)

(h) The velocity of sound (V) in a gaseous medium is related to its pressure (P) by the relation

(i) $V \propto P$

(ii) $V \propto \frac{1}{P}$

(iii) $V \propto \frac{1}{\sqrt{P}}$

(iv) $V \propto \sqrt{P}$

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

(b) What is meant by mean free path of the molecules of a gas? Find an expression for it. How is the mean free path related to the pressure and absolute temperature of the gas? 1+4+2=7

Or

What are transport phenomena? Deduce an expression for the viscosity of a gas in terms of mean free path of molecules of the gas. 2+5=7

(c) In what respect a real gas differs from an ideal gas? Describe Andrews' experiment on carbon dioxide and draw the curves at different temperatures. Give a discussion on the results. 1+2+3+2=8

(Continued)

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

(b) What is an adiabatic process? Explain why the temperature of a gas drops in an adiabatic expansion. 1+2=3

(c) One gram molecule of a diatomic gas at 27 °C expands adiabatically until its volume is doubled. Calculate the work done.
(Given $R = 8{\cdot}3$ joule degree^{-1}mol^{-1}.) 3

4. (a) Describe Carnot's reversible heat engine and calculate its efficiency. 2+4=6

(b) Derive the following Maxwell's thermodynamical equations : 4×2=8

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

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

5. (a) State Stefan-Boltzmann law of radiation. Derive this law by applying thermodynamical relations. 1+4=5

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

(Turn Over)

6. *(a)* Derive an expression for the velocity of sound in a gaseous medium. On what factors, the velocity of sound in such medium depends? 4+2=6

(b) What are Lissajous figures? Show that the shape of these figures depends upon the phase difference and amplitudes of the component motions. 1+5=6

(c) Deriving necessary expressions, state under what conditions, a body can vibrate about its mean position of equilibrium in presence of damping forces. What happens if the damping force is totally withdrawn from the system? 5+1=6

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