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2 SEM TDC PHY M 1

2019

(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 RMS speed for hydrogen at NTP is higher than oxygen because

(i) its specific heats are higher than oxygen

(ii) its density is lower than oxygen

(iii) its molecules are smaller than oxygen

(iv) its viscosity is less than oxygen

(b) The ratio of two specific heats and the number of degrees of freedom f is connected by which of the following relations?

(i) $\gamma = 2 + \frac{1}{f}$

(ii) $\gamma = f + \frac{1}{2}$

(iii) $\gamma = 1 + \frac{f}{2}$

(iv) $\gamma = 1 + \frac{2}{f}$

(c) The entropy remains constant in

(i) an adiabatic process

(ii) an isothermal process

(iii) every natural process

(iv) both isothermal and adiabatic processes

(d) The expression for Helmholtz free energy is

(i) $F = U + TS$

(ii) $F = U - TS$

(iii) $F = U + PV$

(iv) $F = U - PV$

where the symbols bear usual meanings.

(Continued)

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(e) The ultraviolet catastrophe is the error at short wavelength in the

(i) Wien's displacement law

(ii) Kirchhoff's law

(iii) Rayleigh-Jeans law

(iv) Planck's law

for the energy emitted by an ideal black body.

(f) The Fraunhofer lines are known as A, B, C, D_1, D_2, F, G, H and K. Here D_1 and D_2 stand for

(i) hydrogen

(ii) calcium

(iii) sodium

(iv) oxygen

(g) Two simple harmonic waves having similar properties can produce a stationary wave if they travel in a straight line in

(i) opposite directions

(ii) same directions

(iii) perpendicular directions

(iv) any direction

(Turn Over)

(h) The laws of transverse vibrations can be combined to give which of the following relations?

(i) $n = 2l\sqrt{\frac{T}{m}}$

(ii) $n = 2l\sqrt{\frac{m}{T}}$

(iii) $n = l\sqrt{\frac{T}{2m}}$

(iv) $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$

2. (a) What do you mean by transport phenomena? Deduce an expression for coefficient of viscosity from kinetic theory. 1+3=4

(b) Show that the average kinetic energy associated with each degree of freedom is $\frac{1}{2}kT$. 3

(c) Distinguish between a perfect gas and a real gas. Derive the van der Waal's equation of state. 2+3=5

(d) Describe Andrews' experiment on CO_2 and define the critical constants. 5+2=7

(e) Show that the mean free path varies directly as the absolute temperature and inversely as the pressure. 2+2=4

(Continued)

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Or

Discuss the effect of temperature and pressure on the coefficient of viscosity. 2+2=4

3. (a) Establish the relation $C_p - C_v = R$ by application of the first law of thermodynamics. Here the symbols bear usual meanings. 4

(b) Draw the *P-V* diagram for Carnot's cycle indicating different stages of operation. Calculate the efficiency of such an engine working between the steam point and the ice point. 2+2=4

Or

State and prove the Carnot's theorem. 4

(c) What do you mean by the term 'entropy'? Derive the expression for entropy of a perfect gas. 1+3=4

(d) Define extensive and intensive variables and give examples. Establish the first thermodynamical relation

$$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$$ 2+5=7

Or

What are the thermodynamical potentials? Show that $C_p - C_v = TE\alpha^2 V$, where α is the coefficient of volume expansion. 2+5=7

(Turn Over)

(e) For a perfect gas, show that $\left(\frac{\partial U}{\partial V}\right)_T = 0$ by application of Maxwell's relations. Here, U stands for internal energy. 4

4. (a) State Kirchhoff's law of black body radiations and establish its mathematical relation. Mention about its applications. 4+2=6

Or

State Stefan's law and show how it can be applied to derive Newton's law of cooling. 2+4=6

(b) What is solar constant? What is its unit in CGS system? 1+1=2

5. Answer any *three* questions of the following : 6×3=18

(a) For a simple harmonic wave, show that Particle velocity = Wave velocity × Slope of the displacement curve at that instant. 6

(b) Deduce the differential wave equation of transversely vibrating string. Find the expression of displacement at any time. 6

(Continued)

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(c) Given that $x = a\sin(\omega t + \alpha)$ and $y = b\sin\omega t$ representing the displacement of a particle along X and Y axes respectively. Under what circumstances can the combination of these two simple harmonic motions be represented by the equation of a circle? 6

(d) Distinguish between damped and forced vibration. Deduce the general solution of forced vibration. 2+4=6

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