Total No. of printed pages = 6

3 (Sem 2) PHY M2

2015

PHYSICS

(Major)

Theory Paper : 2.2

Full Marks – 60

Time – 2½ hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct option : $1 \times 7 = 7$

(a) A gas at 200K has average velocity v. If the gas is heated to 400K, its new average velocity becomes

(i) v (ii) $\sqrt{2}v$

(iii) 2v (iv) 4v

(b) Maxwell's mean free path of a gas molecules (λ) is given by

(i) $^{1}/_{\pi\sigma^2 n}$ (ii) $^{m}/_{\pi\sigma^2 \rho}$

(iii) $^{1}/_{\sqrt{2}\pi\sigma^2 n}$ (iv) $^{3}/_{4\pi\sigma^2 n}$

[Turn over

(c) In Andrew's experiment on CO_2 the critical isothermal was obtained at temperature

(i) 13.1°C (ii) 21.5°C

(iii) 31.1°C (iv) 32.5°C

(d) The Zeroth law of thermodynamics signifies the concept of _____ of a system.

(i) Pressure

(ii) Temperature

(iii) Volume

(iv) Internal energy

(e) A process that can be reversed without energy input from outside source takes place at constant

(i) Pressure (ii) Temperature

(iii) Velocity (iv) Density

(f) If W and W_{irr} are the work done in isothermal reversible and irreversible expansion respectively, then

(i) $W-W_{irr} > 0$ (ii) $W-W_{irr} < 0$

(iii) $W = W_{irr}$ (iv) None of above

(g) The entropy of a substance at absolute zero (0°K) is

(i) maximum

(ii) minimum

(iii) undefined

(iv) None of above

2. Answer the following questions : 2×4=8

(a) Show that $\delta = \frac{C_p}{C_v} = 1 + \frac{2}{f}$

where f is the number of degrees of freedom.

(b) If the platinum temperature corresponding to 60°C on the gas scale is 60.25°C, then find the temperature in platinum scale corresponding to 120°C on the gas scale.

(c) State the Stefan-Boltzmann law.

(d) The sun emits a maximum intensity of radiation at wavelength 475 nm. Calculate the surface temperature of sun. (Given Wien's constant = 2.898×10^{-3}mk)

3. Answer any *three* of the following :

(a) Describe the principle of platinum resistance thermometer. What are its main advantages and disadvantages ? 3+2=5

(b) Establish the coefficient of viscosity as

$$\eta = \frac{m\bar{c}}{3\sqrt{2}\pi\sigma^2}$$

where the symbols have their usual meanings. Show that the coefficient of viscosity is independent of pressure. 4+1=5

(c) (i) What are the characteristics of a reversible and irreversible processes ?

(ii) State the limitation of first law of thermodynamics. 2+2+1=5

(d) A Carnot engine absorbs 10^4 calories of heat from a reservoir at 627°C and rejects heat to a sink at 27°C. What is its efficiency ? How much work does it perform ? (Given J=4.2J/calorie) 2+3=5

(e) Find the work done during a reversible adiabatic expansion. How you compare it with that of work done in isothermal expansion ? 3+2=5

(f) Using Maxwell's relation, establish

$$C_p - C_v = T\left(\frac{\delta P}{\delta T}\right)_V \left(\frac{\delta V}{\delta T}\right)_P$$

Show that for a perfect gas, this relation becomes $C_p - C_v = R$. 4+1=5

4. (a) Derive Maxwell's law of distribution of velocities of the molecules of an ideal gas. Find the ratio of the average velocity to rms velocity of the molecules. 7+3=10

Or

(i) Define critical constants and find their values in terms of Van der Waals' constants. 3+4=7

(ii) Show that at the critical temperature the departure of Van der Waals' gas law from ideal gas law is 62.5%. 3

(b) Deduce Plank's theory of black-body radiation and show analytically how the formula is used in longer as well as shorter wavelength ranges. 10

Or

Derive Einstein's formula regarding Brownian motion of suspended tiny particles. 10

(c) (i) 'Entropy is the measure of disorder or randomness of a system'. – Explain. How you relate entropy with the probability ? 3+2=5

(ii) Find the change in entropy when 0.1 kg of water at 15°C is mixed with 0.16 kg of water at 60°C. (Given specific heat of water S = 4.2×10^3J/Kg). 5

Or

Write short notes (any *two*) : 5×2=10

(i) Carnot theorem.

(ii) Adiabatic demagnetisation.

(iii) Thermodynamic potentials.