Q. P. Code: 59323

SET – V *ANSWER KEY*

Q.1. A) **Select the correct alternative**

(i)	b. strain	**2**
(ii)	c. No Change in pressure	2
(iii)	d. 08cm	2
(iv)	a. Zero	2
(v)	a. Collisions of the molecules with the wall of the container.	2
(vi)	a. a/V^2	

B) **Answer in one sentence**

(i)	dv/dy	1
(ii)	It is defined as the reciprocal of focal length of lens measured in meters.	1
(iii)	It is the volume which unit mass of the gas occupies at critical temperature and critical pressure.	1

C) **Fill in the blanks**

(i)	Longitudinal strain	1
(ii)	Elasticity	1
(iii)	High	1
(iv)	straight	1
(v)	*(V-b)*	1

Q. 2 A) **Attempt ANY ONE**

(i)	Diagram and description	**2**
	Description and equation: $A_1\delta x_1 = m / \rho = A_1\delta x_1 = m / \rho$ Total work done = change in potential and kinetic energy.	**1**
	$W = ½ m_2v_2^2 - ½ m_2v_2^2 + mgh_2 - mgh_1$	**2**
	$W = P_1A_1 \delta x_1 - P_1A_1 \delta x_1$ equating and simplifying $P + \rho gh + 1/2 \rho v^2 = \text{constant}$.	**3**
(ii)	Description and diagram	**2**
	$Y = 2\eta (1+ \sigma)$, η = shear stress / shear strain = F / θ.	**3**
	Shear strain = $\theta = 2F/Y(1+ \sigma)$, $Y = 2\eta (1+ \sigma)$	**3**

B) **Attempt ANY ONE**

(i) $T_1 \cos\alpha = T_2 \cos\beta$..........(1) 2

$T_1 \sin\alpha + T_2 \sin\beta = mg$..........(2) 2

$\therefore T_1 = \dfrac{mg\cos\beta}{\sin(\alpha+\beta)} = \dfrac{2x9.8x\cos45^0}{\sin(45^0+45^0)} = 13.86\,N$........(3) 2

From equations (1) &(3) we get

$\therefore T_2 = \dfrac{mg\cos\alpha}{\sin(\alpha+\beta)} = \dfrac{2x9.8x\cos45^0}{\sin(45^0+45^0)} = 13.86\,N$........(3) 2

(ii) Definitions: Young's modulus, Bulk modulus, modulus of rigidity and Poisson's ratio with limiting values of Poisson's ratio. **2 mark each**

C) **Attempt ANY ONE (Unit I)** 4

(i) Ax = fx / m = 20 /10 = 2 cm/s^2 2

Ay = fy / m = 10 /10 = 1 cm /s^2. 2

Ax = 2i + j

(ii) $Y = 2\eta(1+\sigma) \therefore \dfrac{Y}{2\eta} = (1+\sigma) \therefore \sigma = \dfrac{Y}{2\eta} - 1$ 2

$\therefore = \dfrac{2x10^{11}}{2x7x10^{10}} - 1$ **i.e. =1.4 – 1 = 0.4** 2

Q. 3 A) **Attempt ANY ONE**

(i) Diagram 2

Description 2

μ = sin i / sin r path diff = 2 t μ cos θ 4

(ii) Diagram of plano convex lens and glass plate. 2

Derive $t = r^2_n / 2R$ 3

Radius of dark ring $r_n \propto \sqrt{n}$ Or $r^2_n = nR\lambda$ 3

B) **Attempt ANY ONE**

(i) Magnification $m = \dfrac{\text{(Size of image)}}{\text{(Size of object)}}$ 1

Ray Diagram-Refraction thro thin lens & description 3

Derive expression: $1/f = (1/v - 1/u) = (\mu - 1)[1/R_1 - 1/R_2]$ 4

(ii) Ramsden's eyepiece: Ray diagram showing images 3

Description & working 3

Expression of equivalent focal length F =3f/4 2

C) **Attempt ANY ONE**

(i) $\lambda = 2\mu\beta\theta = \dfrac{2 \times 1.4 \times 0.25 \times 20 \times 3.14}{180 \times 3600}$ 2

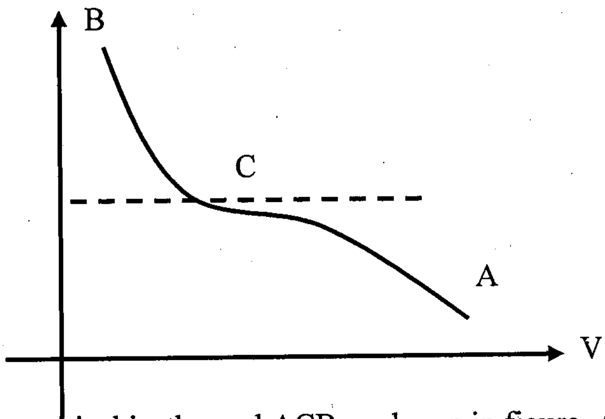
$= 6784 \times 10^{-8}$ cm 2

(ii) $\alpha = dF / f_2$ $\beta = dF / f_1$ 2

$\alpha = 13.3$ cm $\beta = 3.3$cm 2

Q. 4 A) **Attempt ANY ONE**

(i) 2



Consider the critical isothermal ACB as shown in figure. At critical point C, curve is horizontal. At this point 6

$$\frac{dP}{dV} = 0$$

Point C is called point of Inflexion.

At this point

$$P_c = \frac{RT_C}{V_C - b} - \frac{a}{V_C^2}$$

Also

$$\frac{d^2P}{dV^2} = \frac{2RT}{(V-b)^3} - \frac{6a}{V^4}$$

$$V_C = 3b$$

$$T_C = \frac{8a}{27bR}$$

$$P_C = \frac{a}{27b^2}$$

(ii) From the first law of thermodynamics,

$$dQ = dU + PdV \ldots\ldots\ldots (i)$$

$$dU = C_V dT \ldots\ldots\ldots (ii)$$

For one mole

$$PV = RT$$

Differentiating

$$PdV + VdP = RdT \ldots\ldots\ldots (iii)$$

For adiabatic process, $dQ = 0$.

$$\therefore \frac{C_V}{R}(PdV + VdP) + PdV = 0$$

$$C_V(PdV + VdP) + (C_P - C_V)PdV = 0$$

$$Let\frac{C_P}{C_V} = \gamma$$

$$\frac{dP}{P} + \gamma\frac{dV}{V} = 0$$

$$therefore\ PV^{\gamma} = constant.$$ 5

But $PV = RT$ for unit mole

$$P = \frac{RT}{V}$$

$$\therefore TV^{\gamma-1} = constant$$ 1

$$Use\ PV^{\gamma} = constant$$ 2

$$\gamma = 1.81$$

B) **Attempt ANY ONE** 2

(i)

$$W = \int_{V_1}^{V_2} PdV$$

But $PV^{\gamma} = constant = K$ 4

$$W = K\int_{V_1}^{V_2}\frac{dV}{V^{\gamma}} = \frac{1}{1-\gamma}\,(P_2V_2 - P_1V_1)$$

$$W = RT \times 2.303\log_{10}\left(\frac{V_2}{V_1}\right)$$ 2

$$W = 556.69\,J$$

(ii) from the first law of thermodynamics,

$$dQ = dU + PdV$$

Substituting for dU,

$$dQ = \left(\frac{\partial U}{\partial T}\right)_V dT + \left(\frac{\partial U}{\partial V}\right)_T dV\ + PdV$$

$$\therefore \frac{dQ}{dT} = \left(\frac{\partial U}{\partial T}\right)_V + \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\frac{dV}{dT} \ldots\ldots\ldots (ii)$$

If the gas is heated at constant volume,

$$\frac{dQ}{dT} = C_V$$

And

$$\frac{dV}{dT} = 0$$ 4

$$\left(\frac{\partial U}{\partial V}\right)_T = C_V \ldots\ldots\ldots\ldots (iii)$$

When the gas is heated at constant pressure,

$$\frac{dQ}{dT} = C_P$$

$$\therefore C_P = \left(\frac{\partial U}{\partial T}\right)_V + \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$$

$$\therefore C_P = C_V + \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$$

$$C_P - C_V = \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$$

Since internal energy depends only on temperature,

$$\left(\frac{\partial U}{\partial V}\right)_T = 0$$

Using $PV = RT$ we can show, $P\left(\frac{\partial V}{\partial T}\right)_P = R, \therefore C_P - C_V = R$ 4

C) **Attempt ANY ONE**

(i) (i) $P_1 = 1$ atm

$V_1 = V$ and $V_2 = V/4$

The sudden compression is an adiabatic process

For an adiabatic process

$PV^\gamma = constant, \therefore P_1V_1^\gamma = P_2V_2^\gamma, \therefore P_2 = P_1\left(\frac{V_1}{V_2}\right)^\gamma = 6.96atm$

(ii) Also for adiabatic process 4

$TV^{\gamma-1} = constant, \therefore T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$,

$\therefore T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1} = 579.78\ K$ 4

(ii) For 1[st] partition:

$$P_1V_1 = n_1RT_1 \ldots\ldots (1)$$

For 2[nd] partition

$$P_2V_2 = n_2RT_2 \ldots\ldots. (2)$$

When the partition is removed

$$PV = nRT \ldots\ldots. (3)$$

Where P is equilibrium pressure, V is final volume, T is equilibrium temperature. 4

$$V = V_1 + V_2 \ldots\ldots (4), n = n_1 + n_2 \ldots. (5)$$

assume, $T_1 < T_2, \therefore$

$(Heat\ lost\ by\ molecules\ in\ compartment\ 2) =$

$(Heat\ gained\ by\ the\ molecules\ of\ compartment\ 1)$

$\therefore C_{V_2}(T_2 - T) = C_{V_1}(T - T_1), \therefore T = \frac{C_{V_1}T_1 + C_{V_2}T_2}{C_{V_1} + C_{V_2}} \ldots\ldots\ldots (6)$ 4

Q5 **Attempt any four** 2

(i) Diagram and explanation

Mass of liquid flowing through the each ends of the liquid is

$\Delta m_1 = A_1v_1\rho\Delta t$, $\Delta m_2 = A_2v_2\rho\Delta t$, $\Delta m_1 = \Delta m_2$, AV = constant.

3

(ii) using equations y = 3k (1-2σ). And y = 2η (1+σ), Derive this equation.. 5

(iii) Chromatic aberration - Prismatic action of Lens 2

Methods of Reduction: Two lens in contact, Use of one convex and other concave, Lenses of different materials 3

(iv) For destructive interference : **2**

$2\mu t\cos r = n\lambda = \lambda \quad \ldots n=1$

$t = \dfrac{6.5 \times 10^{-7}}{2 \times 1.5 \times \cos 60} = 4.33 \times 10^{-7}$ cm **3**

(v) The external energy supplied to the system is used to increase the internal energy of the system and to perform the external work. **5**

$$dQ = dU + dW$$

$$dQ \text{ is external energy supplied}$$

$$dU \text{ is change in internal energy}$$

$$dW \text{ is the external work performed}$$

Explanation:

This law is statement of conservation of energy.

(vi) Isothermal **5**

Adiabatic

Isochoric

Isobaric