DPP – 1 (Thermodynamics)

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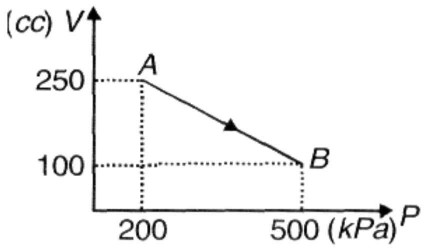
Q 1. A monoatomic gas is taken along path AB as shown. Calculate change in internal energy of system ?



(a) 279.8 J
(b) 341 J
(c) 241 J
(d) None of these

Q 2. Internal energy of ideal diatomic gas at 300 K is 100 J. In this 100 J
(a) Potential energy = 0
(b) Rotational kinetic energy = 40 J
(c) Translational kinetic energy = 60 J
(d) Translational kinetic energy = 100 J

Q 3. The average degrees of freedom per molecule for a gas is 6. The gas performs 25 J of work when it expands at constant pressure. The change in internal energy of gas is
(a) 75 J
(b) 100 J
(c) 150 J
(d) 125 J

Q 4. One mole of an ideal gas whose pressure changes with volume as P = αV, where α is a constant, is expanded so that its volume increases η times. Find change in internal energy in terms of initial volume V and degree of freedom f ?
(a) $f\alpha V^2(\eta^2-1)/8$
(b) $f\alpha V^2(\eta^2-1)/4$
(c) $f\alpha V^2(\eta^2-1)/2$
(d) None of these

Q 5. 5 mole of O_2 is heated at constant volume from 10°C to 20°C. What is the change in its internal energy?
(a) 250 cal
(b) 200 cal
(c) 100 cal
(d) 400 cal

Q 6. The internal energy U of the air in an open room is
(a) Higher in day
(b) Higher in night
(c) Equal in day and night
(d) None of the above

Q 7. For an ideal gas,

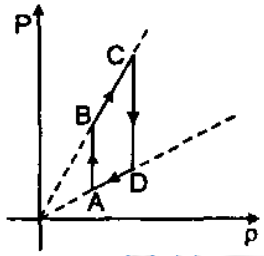
(a) the change in internal energy in a constant-pressure process from temperature T_1 to T_2 is equal to $nC_v(T_2 - T_1)$
(b) the change in internal energy of the gas and the work done by the gas are equal in magnitude in an isobaric process
(c) the internal energy does not change in an isothermal process
(d) Change in internal energy in isochoric process from temperature T_1 to T_2 is equal to $nC_v(T_2 - T_1)$.

Q 8. Slope of internal energy vs temperature graph will be highest for
(a) O_2 (b) H_2
(c) NH_3 (d) He

Q 9. Volume of a gas is decreased to half of its initial volume. Magnitude of change in internal energy will be minimum in process
(a) Isobaric
(b) Isothermal
(c) Process having equation PV^{-1} = constant
(d) Process having equation PV^{-2} = constant

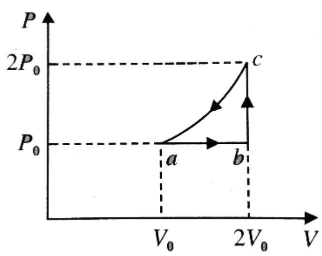
Q 10. Relation between U, P and V for ideal gas is U= 2 + 2PV then gas is
(a) Mono-atomic (b) Diatomic
(c) Poly-atomic (d) Mixture of mono and diatomic

Q 11. Pressure versus density graph of an ideal gas is shown in figure:



(a) during the process DA work done by the gas is positive
(b) during the process DA work done by the gas is negative
(c) during the process BC Internal energy of the gas is increasing
(d) none of the above

Q 12. One mole of an ideal monatomic gas (initial temperature T_0) is made to go through the cycle abc a shown in the figure. If U denotes the internal energy, then choose the correct alternatives :

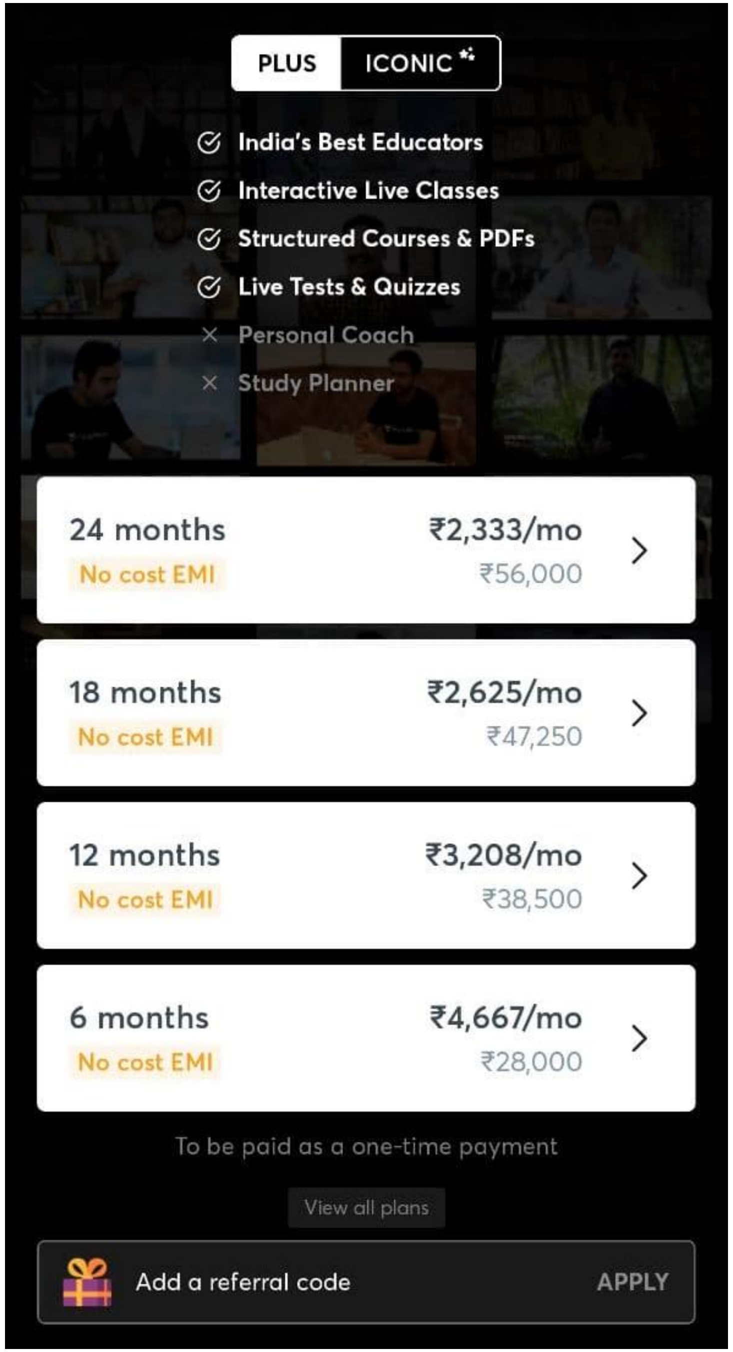


(a) $U_c - U_a = 10.5\ RT_0$
(b) $U_b - U_a = 4.5\ RT_0$

(c) $U_c > U_b > U_a$
(d) $U_C - U_b = 6\ RT_0$

Answer Key

Q.1 d	**Q.2 a,b,c**	**Q.3 a**	**Q.4 c**	**Q.5 a**
Q.6 c	**Q.7 a,c,d**	**Q.8 c**	**Q.9 b**	**Q.10 d**
Q.11 a	**Q.12 a,b,c,d**			



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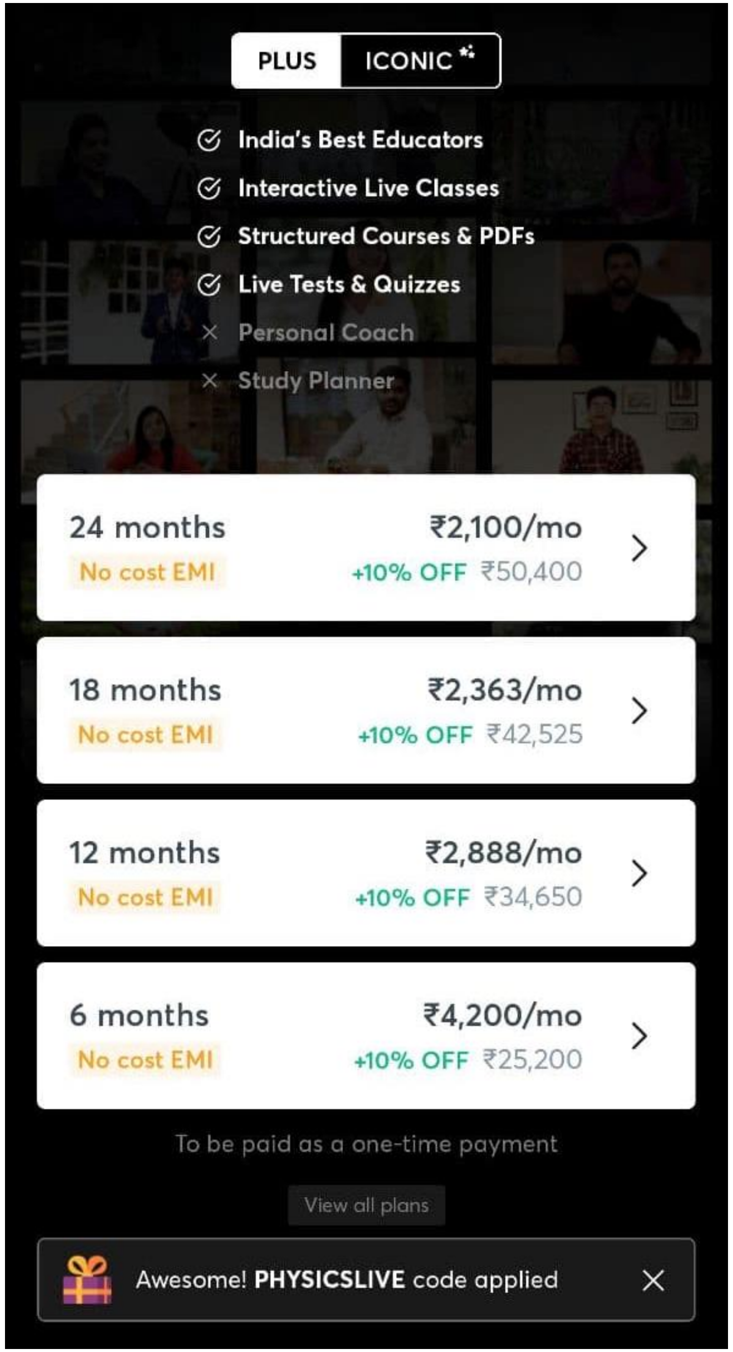

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Written Solution

DPP- 2 Thermodynamics- Internal energy

By Physicsaholics Team

1)

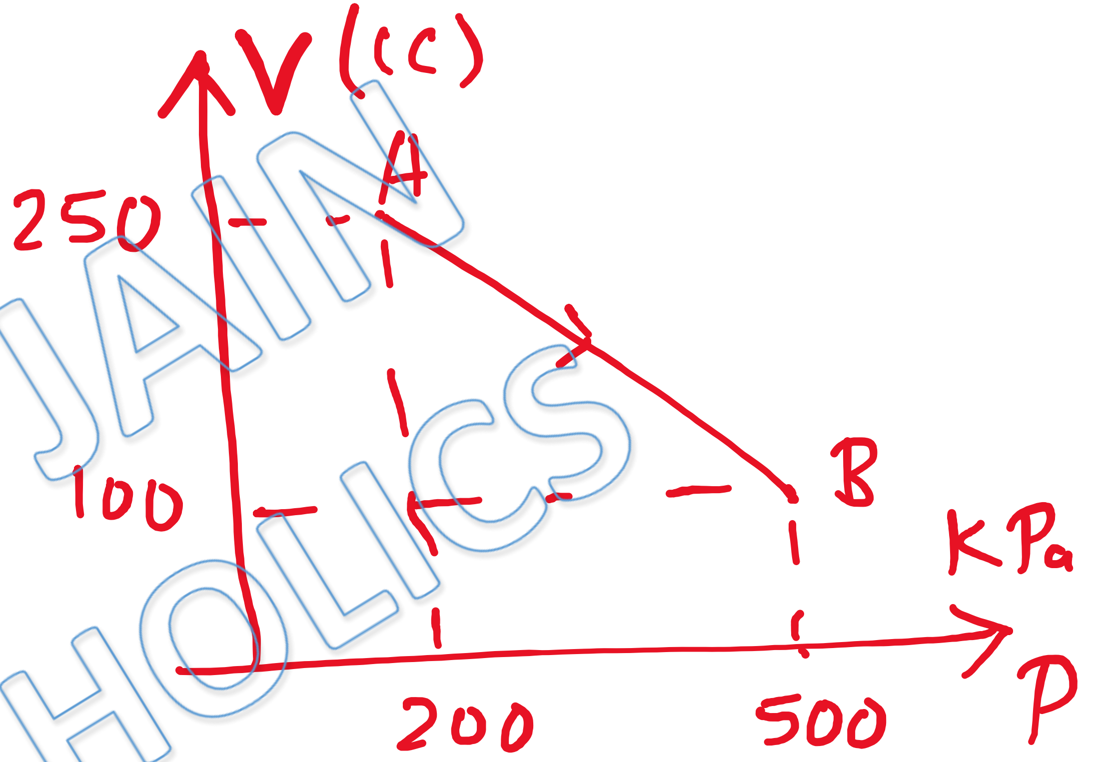
$$\Delta U = \frac{f}{2} nR\Delta T$$

$$= \frac{3}{2}\left[nRT_B - nRT_A\right]$$

$$= \frac{3}{2}\left[V_B P_B - V_A P_A\right]$$

$$= \frac{3}{2}\left[500\times10^3 \times 100\times10^{-6} - 200\times10^3\times250\times10^{-6}\right]$$

$$= 0$$



ANS (d)

2) $U = 100J$

$$\frac{\text{Rotational KE}}{\text{Translational KE}} = \frac{2}{3}$$

$$R.K.E = \frac{2}{2+3} \times 100 = 40J$$

$$T.K.E. = \frac{3}{2+3} \times 100 = 60J$$

$$P.E. = 0$$

ANS(a, b, c)

3)

$$W_{gas} = P\Delta V = 25\,J$$

$$\Delta U = \frac{f}{2} nR\Delta T = \frac{f}{2} P\Delta V$$

$$= \frac{6}{2} \times 25 = 75\,J$$

ANS(a)

4) $P = \alpha V \Rightarrow \frac{RT}{V} = \alpha V \Rightarrow T = \frac{\alpha V^2}{R}$

$U = \frac{f}{2} nR [T_f - T_i] = (RT_f - RT_i) f/2$

$= \frac{f}{2}(\alpha V_f^2 - \alpha V_i^2) = (\alpha \eta^2 V^2 - \alpha V^2)\frac{f}{2}$

$= [\alpha V^2 \eta^2 - \alpha V^2] \frac{f}{2}$

ANS (c)

5)

$$U = \frac{f}{2} nR\Delta T$$

$$= \frac{5}{\cancel{2}} \times 5 \times \cancel{2} \times (20-10)$$

$$= 250 \text{ Cal}$$

Ans (a)

6)

$$U = U_0 + \frac{f}{2} nRT$$

$$= U_0 + \frac{f}{2} PV$$

$PV \rightarrow$ Constant

$P \downarrow$ 1 atm (Constant)

U = Equal in day & night

ANS(C)

7)

$\Delta U = \frac{f}{2} nR\Delta T = nC_v\Delta T$ in any process

$\Rightarrow$ (a) & (d) are Correct

In isothermal process $\Delta T = 0$

$\Rightarrow \Delta U = 0$

(C) is Correct

Ans. a,c,d

8)

$$U = \frac{f}{2} nRT$$

$$\Rightarrow \frac{dU}{dT} = \frac{f}{2} nR$$

$\Rightarrow$ Slope of U–T Curve $= \frac{f}{2} nR \propto f \rightarrow$ maximum for NH_3

ANS (c)

9) In isobaric process $V \propto T$

" Isothermal " $T =$ Constant

In $PV^{-1} = C \Rightarrow TV^{-2} = C \Rightarrow V \propto T^2$

In $PV^{-2} = C \Rightarrow TV^{-3} = C \Rightarrow V \propto T^3$

|Change in temperature| is maximum in option (d)

$\Rightarrow$ |Change in internal energy| " " " "

ANS(d)

10)

$$U = 2 + 2PV$$

but we know that

$$U = U_0 + \frac{f}{2} nRT$$

$$= U_0 + \frac{f}{2} PV$$

$$\Rightarrow \frac{f}{2} = 2$$

$$\Rightarrow f = 4$$ → mixture of monoatomic & Diatomic

Since $3 < f < 5$

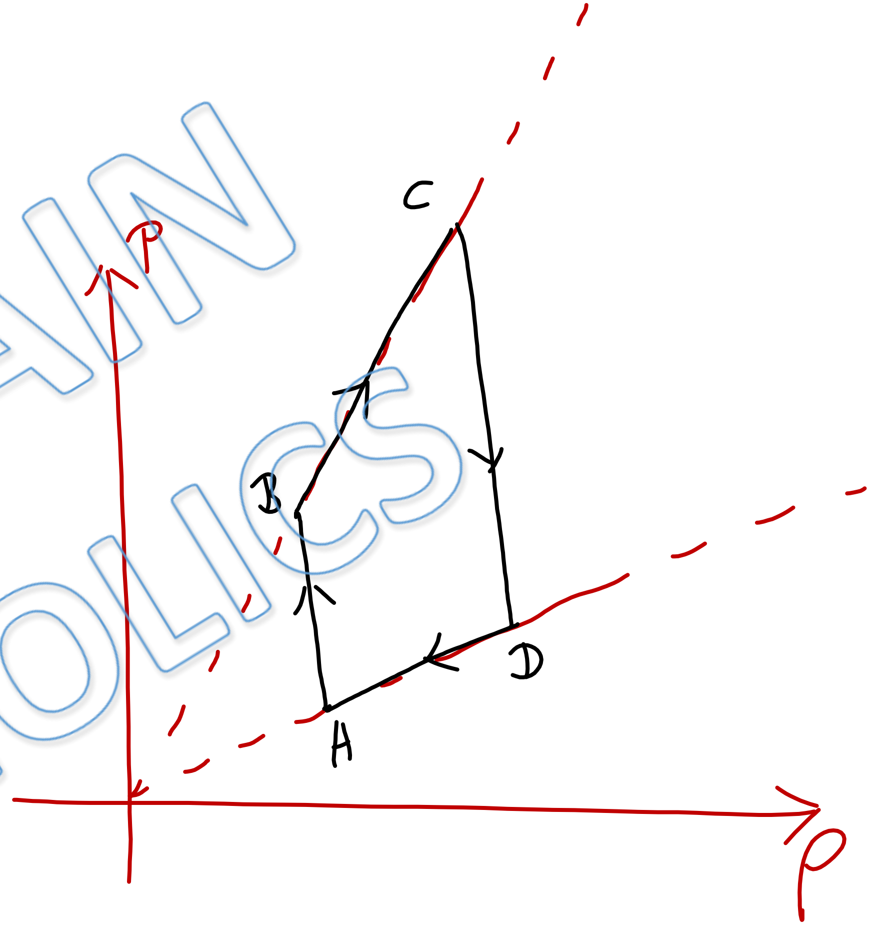
ANS (d)

11) In DA, $\frac{P}{\rho} = \text{Constant} \Rightarrow PV = c$

$\Rightarrow$ isothermal with decreasing ρ

$\Rightarrow$,, ,, increasing V

$\Rightarrow$ $W = +ve$



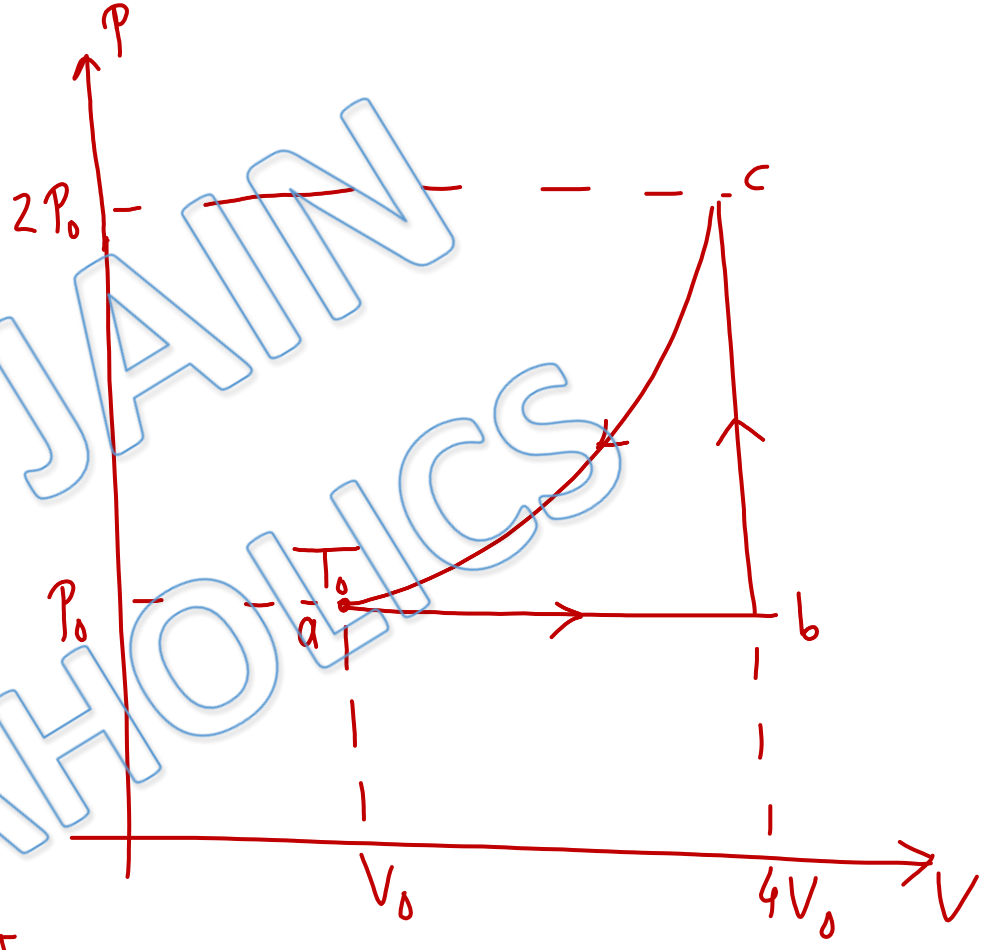
BC is also isothermal $\Rightarrow \Delta U_{BC} = 0$

ANS(a)

12) $T_a = T_0 = \frac{P_0 V_0}{nR}$

$T_b = \frac{4P_0V_0}{nR} = 4T_0$

$T_c = \frac{8P_0V_0}{nR} = 8T_0$



$U_c - U_A = \frac{f}{2}(nRT_c - nRT_A)$

$= \frac{3R}{2}[8T_0 - T_0] = \frac{21}{2}RT_0$

$= 10.5\, RT_0$

$U_b - U_a = \frac{f}{2}(nRT_b - nRT_a) = \frac{3R}{2}[4T_0 - T_0] = 4.5\, RT_0$

$T_c > T_b > T_a \Rightarrow U_c > U_b > U_a$

ANS(a, b, c, d)

$U_c - U_b = \frac{f}{2}(nRT_c - nRT_b) = \frac{3R}{2}(8T_0 - 4T_0] = 6RT_0$

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