PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 48

Total Marks : 33

Max. Time : 36 min.

Topic : Thermodynamics & Thermochemistry

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.7	(3 marks, 3 min.)	[21, 21]
Subjective Questions ('–1' negative marking) Q.8 to Q.10	(4 marks, 5 min.)	[12, 15]

1. A monoatomic ideal gas ($C_V = \frac{3}{2}R$) is allowed to expand adiabatically and reversibly from initial volume of 8L at 300 K to a volume of V_2 at 250 K. V_2 is : (Given $(4.8)^{1/2} = 2.2$)

(A) 10.5 L
(B) 23 L
(C) 8.5 L
(D) 50.5 L

2. A gas is expanded from volume V_0 to $4V_0$ by following two ways : (from same initial state)

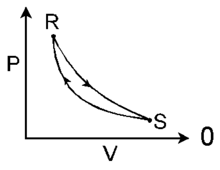
(a) I^{st} using reversible isothermal expansion from V_0 to $2V_0$, then using reversible adiabatic expansion from $2V_0$ to $4V_0$.

(b) I^{st} using reversible adiabatic expansion from V_0 to $2V_0$, then from $2V_0$ to $4V_0$ using reversible isothermal expansion.

Then which of the following options is correct :

(A) Work done in (a) process > work done is (b) process
(B) Work done in (b) process > work done is (a) process
(C) Work done in (b) process = work done is (a) process
(D) cannot be predicted

3. Consider the cyclic process R → S → R as shown in the Fig. You told that one of the path is adiabatic and the other one isothermal. Which one of the following is(are) true :



(A) Process R → S is isothermal
(B) Process S → R is adiabatic
(C) Process R → S is adiabatic
(D) Such a graph is not possible

4. A sample of gas is compressed from an initial volume of $2v_0$ to v_0 using three different processes.

First : Using reversible isothermal

Second : Using reversible adiabatic

Third : Using irreversible adiabatic under a constant external pressure

Then :

(A) Final temperature of gas will be highest in third process.

(B) Final temperature of gas will be highest in second process.

(C) Enthalpy change of sample will be highest in isothermal process. (magnitude wise)

(D) Final pressure of gas will be highest in second process.

5. The magnitude of enthalpy changes for irreversible adiabatic expansion of a gas from 1L to 2L is ΔH_1 and for reversible adiabatic expansion for the same expansion, it is ΔH_2. Then :

(A) $\Delta H_1 > \Delta H_2$

(B) $\Delta H_1 < \Delta H_2$

(C) $\Delta H_1 = \Delta H_2$, enthalpy being a state function

(D) $\Delta H_1 = \Delta E_1$ & $\Delta H_2 = \Delta E_2$

6. In which process, net work done by gas is zero :

(A) Cyclic (B) Isobaric (C) Free expansion (D) Adiabatic

7. The ratio of slopes of P–V plots for reversible adiabatic process and reversible isothermal process of an ideal gas is equal to :

(A) γ (B) $1 - \gamma$ (C) $(\gamma - 1)$ (D) $1/\gamma$

8. 2 moles of an ideal gas A ($\gamma = 4/3$) and 4 moles of an ideal gas B ($\gamma = 5/3$) are taken together in a container and expanded reversibly and adiabatically from 2 L to 8 L starting from initial temperature of 320 K. Calcualte the work done by the gas (in calories) in the above process. (R = 2 calories/K/mol)

9. 1 mole of an ideal gas, initially at 400 K and 10 atm is first expanded at constant pressure till the volume is doubled. Then the gas is made to undergo an isochoric process, in which its temperature is found to decrease. In the last final step, gas was compressed reversibly and adiabatically to initial state. Determine the net work involved in this cyclic process (in terms of R). Given, C_V for gas = 1.5 R, $(4)^{-1/3} = 0.63$.

10. Polytropic process for ideal gas is given as PV^n = constant. Show that for polytropic process for an ideal gas, the expression for work obtained is :

$$W = \frac{P_1V_1\left[\left(\frac{V_2}{V_1}\right)^{1-n} - 1\right]}{(n-1)}$$

Answer Key

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1.	(A)	**2.**	(A)	**3.**	(D)	**4.**	(A)	**5.**	(B)
6.	(C)	**7.**	(A)	**8.**	3840 calories	**9.**	– 178 R		

Hints & Solutions

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

$$\gamma = \frac{5}{3} \qquad \therefore \qquad \gamma - 1 = \frac{2}{3}$$

$$\therefore \qquad 300 \times (8)^{2/3} = 250 \times (V_2)^{2/3} \qquad \Rightarrow \qquad (V_2)^{2/3} = 4.8$$

$$\Rightarrow \qquad V_2 = (4.8)^{3/2} \cong 4.8 \times 2.2 = 10.5 \text{ L}$$

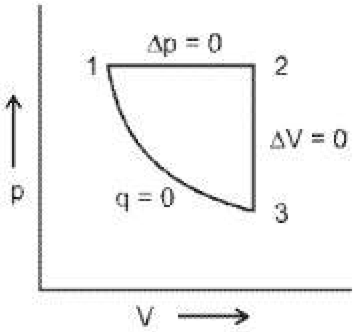
8. $$\gamma_{mix} = \frac{n_A C_{P_A} + n_B C_{P_B}}{n_A C_{V_A} + n_B C_{V_B}} = \frac{2(4R) + 4(5R/2)}{2(3R) + 4(3R/2)} = \frac{18R}{12R} = \frac{3}{2}$$

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} \qquad (\gamma = \gamma_{mix} = 1.5)$$

$$\therefore \qquad T_2 = 320\left(\frac{2}{8}\right)^{1.5-1} = 320 \times \frac{1}{2} = 160 \text{ K}$$

$$\therefore \qquad W = \frac{nR}{\gamma - 1}(T_2 - T_1) = \frac{6R}{1.5-1}(160 - 320) = -1920\text{ R} = 1920 \times 2 = -3840 \text{ calories.}$$

9. The process can be described on a p-V diagram as



At 1 : $p = 10$ atm $T = 400$ K $V = V_1$

At 2 : $p = 10$ atm $T = 800$ K $V = V_2 = 2V_1$

At 3 : $p = ?$ $T = T_3$ $V = V_3 = V_2 = 2V_1$

Therefore,

$$W_{12} = -p\Delta V = -nRT = -400\,R$$

$$W_{23} = 0 \qquad [\because \Delta V = 0]$$

Between 3 and 1 ; $TV^{\gamma-1} =$ constant

$$T_3\,(2V_1)^{\gamma-1} = 400(V_1)^{\gamma-1}$$

$$\Rightarrow \quad T_3 = 400\left(\frac{1}{2}\right)^{2/3} = 252\text{ K}$$

$$\Rightarrow \quad W_{31} = \Delta E_{31} = nC_V(T_1 - T_3) = \frac{3}{2}R(400 - 252) = 222\,R$$

$$\Rightarrow \quad W_{12-31} = W_{12} + W_{23} + W_{31} = -178\,R$$

10. $W = -\int PdV$

$$= -\int \frac{K}{V^n}dV = -\frac{K}{1-n}\left[V^{-n+1}\right]_{V_1}^{V_2} = \frac{K}{n-1}[V_2^{1-n} - V_1^{1-n}]$$

$$= \frac{P_1V_1^n}{n-1}\left[V_2^{1-n} - V_1^{1-n}\right] = \frac{P_1V_1^{n+1-n}}{n-1}\left[\left(\frac{V_2}{V_1}\right)^{1-n} - 1\right]$$