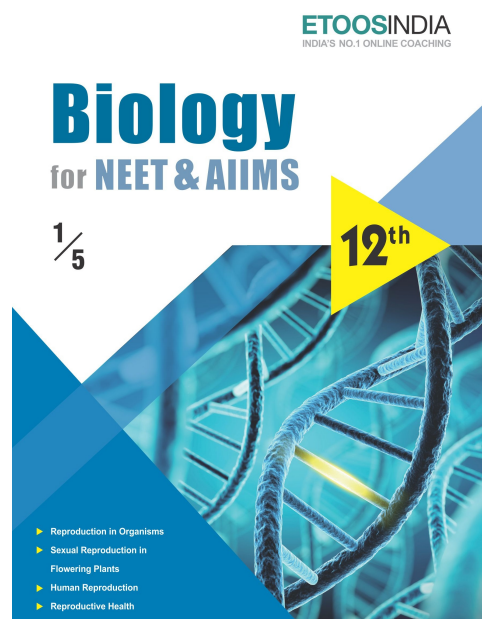
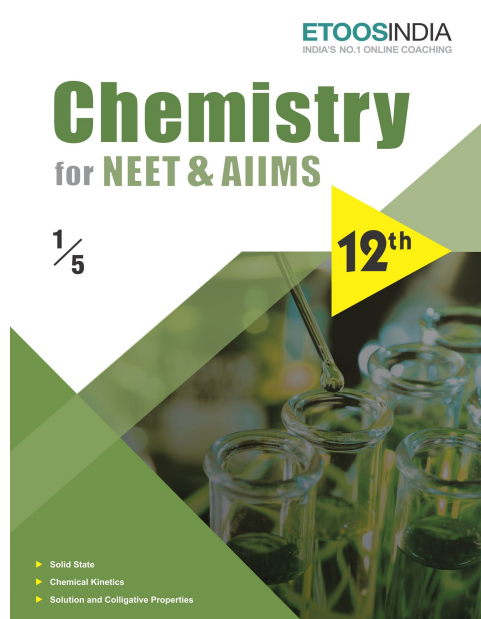
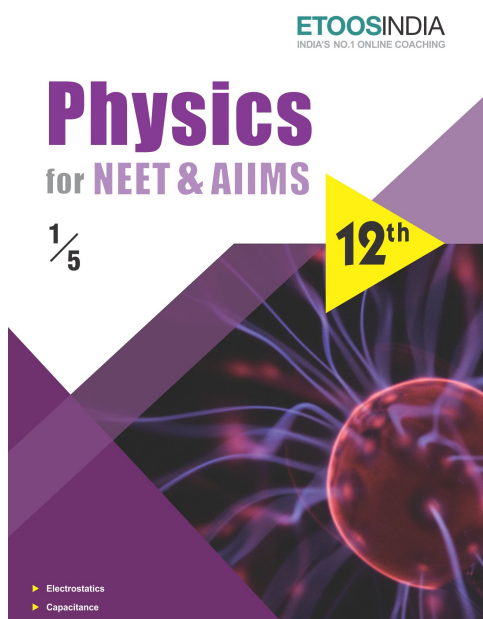
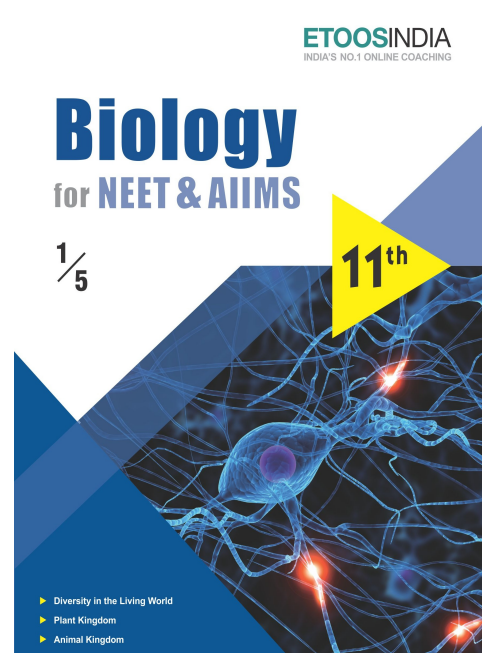
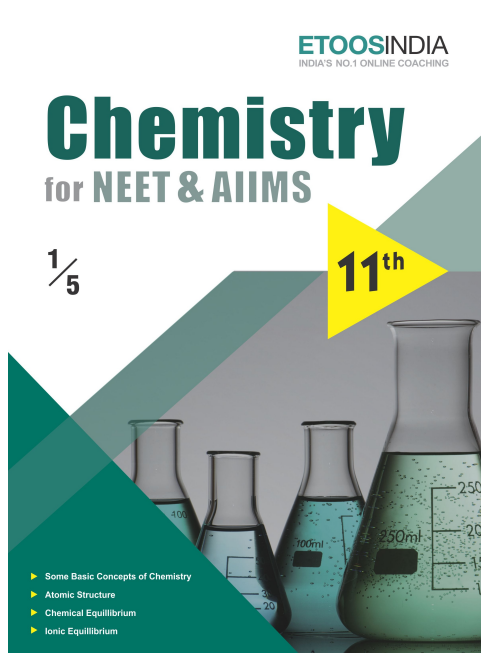
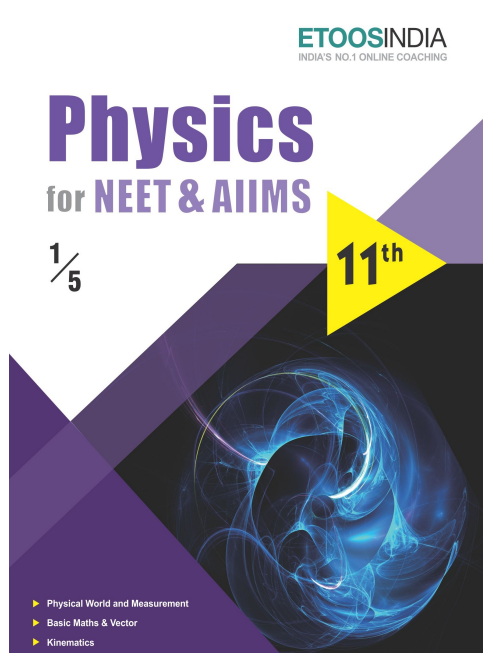


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# THERMODYNAMICS AND THERMICHEMISTRY

*The production of motion in the steam engine always occurs in circumstances in which it is necessary to recognize, namely when the equilibrium of caloric is restored or when caloric passes from the body at one temperature to another body at a lower temperature.*

“SADICARNOT”

## INTRODUCTION

**T**hermodynamics is the branch of chemistry that deals with energy changes occurring during various physical & chemical processes. It also deals with the transformation between different forms of energy. Chemical energy stored by molecules can be released as heat during chemical reaction when a fuel like methane, cooking gas or coal burns in air. The chemical energy may also be used to mechanical work when a fuel burns in an engine or to provide electrical energy through a galvanic cell like dry cell. Thus, various forms of energy are interrelated and under certain conditions, these may be transformed from one form into another. The study of these energy transformation forms the subject matter of thermodynamics. The laws of thermodynamic deals with energy changes of macroscopic systems involving a large number of molecules rather than microscopic systems containing a few molecules.

In thermochemistry, chemical processes are associated with energy changes in chemical reactions.

Also  $P = \frac{F}{A}$   
 $F = PA$   
 $dW = PA \cdot dx$   
 $\Rightarrow \therefore dV = -A \cdot dx$  (-ive sign indicates work is done by the system i.e. gas is expanding against  $P_{\text{ext}}$ )  
 $\Rightarrow dW = -P_{\text{ext}} \cdot dV$   
 $\Rightarrow w = -\int P_{\text{external}} dV$

**Sign Convention**

**Work done by the system is -ive.**

**Work done on the system is +ive**



**ETOOS KEY POINTS**

- (1) During expansion  $dV$  is +ive and hence sign of  $w$  is -ive i.e. work is done by the system and hence Expansion Work is always negative.
- (2) During compression,  $dV$  is -ive which gives +ive value of  $w$  i.e. work is done on the system and hence Compression work is always positive.

(II) **Non-PV Work** - Following are some examples of Non-PV work.

Stretching	Tension ( $\gamma$ ), length ( $l$ )	$w = -\int \gamma dl$	$N m = J$
Surface expansion	Surface tension ( $\gamma$ mm), area ( $\sigma$ )	$w = -\int \int \gamma d\sigma$	$(N m^{-1}) (m^2) = J$
Electrical	Electrical potential ( $\phi$ ),	$w = q \times V$	$V \times C = J$

**Units of heat & work :**

**Calorie :** It is defined as the quantity of heat required to raise the temperature of 1g of water by 1°C (14.5 to 15.5°C)

1 cal = 4.184 J = 4.2 J

1 L-atm = 101.3 J = 24.206 cal =  $101.3 \times 10^7$  erg

1 L-atm > 1 cal. > 1 J. > 1 erg

**Ex.** Find the work done, when one mole of ideal gas in 10 litre container at 1 atm. is allowed to enter a vacuated bulb of capacity 100 litre.

**Sol.** (a)  $W = -P\Delta V$

But since gas enters the vacuum bulb and pressure in vacuum is zero.

$W = 0$

**Ex.** If 1 mole of gas expands from 1 litre to 5 litre against constant atmospheric pressure than calculate the work done.

**Sol.** (b)  $W = -P\Delta V = -1(5 - 1) = -4$  litre-atm.

**Ex.** Calculate the work done when 1 mol of zinc dissolves in hydrochloric acid at 273 K in :

(a) an open beaker

(b) a closed beaker at 300 K.

**Sol.** (a) From one mole of zinc, the no. of moles of  $H_2$  gas evolved = 1

Hence volume of hydrogen gas evolved = 22.4 litre (when  $P = 1$  atm and  $T = 273$  K)

$\therefore w = -P\Delta V = -1 \times 22.4$  litre atm

$= -22.4 \times \frac{8.314}{0.082} J = -2271.14 J$

(b) For a closed system  $P_{\text{ext}} = 0$ , therefore,  $w = 0$ .

*Etoos Tips & Formulas*

THERMODYNAMICS

**1. First law of Thermodynamics**

For a finite change :  $q = \Delta E - w = \Delta E - P\Delta V$

where  $q$  is heat given to system,  $\Delta E$  is change in internal energy and  $-w$  is work done by the system.

$$dq = dE - dw = dE - PdV$$

**2. Work Done in an Irreversible Process**

$$w = -P_{\text{ext}} \times \Delta V = -P_{\text{ext}} \times (V_2 - V_1) = -P_{\text{ext}} \times R \left[ \frac{P_1 T_2 - P_2 T_1}{P_1 P_2} \right]$$

$P_{\text{ext}}$  is the pressure against which volume changes from  $V_1$  to  $V_2$

**3. Work Done in Reversible Process, i.e., Maximum Work**

**Isothermal Conditions**

$$w_{\text{rev}} = -2.303 nRT \log_{10} (V_2/V_1)$$

$$w_{\text{rev}} = -2.303 nRT \log_{10} (P_1/P_2)$$

$w_{\text{rev}}$  is maximum work done.

**Adiabatic Conditions**

$$w_{\text{rev}} = [nR/(\gamma - 1)] [T_2 - T_1]$$

$\gamma$  is poisson's ratio.

Also for adiabatic process, following conditions hold good :

$$PV^\gamma = \text{constant}$$

$$T^\gamma P^{1-\gamma} = \text{constant}$$

$$V^{\gamma-1} = \text{constant}$$

**4. Heat Capacities**

At constant pressure  $C_p = (\delta H/\delta H)_p$

$C_p$  is molar heat capacity at constant pressure.

At constant volume  $C_v = (\delta E/\delta T)_v$

$C_v$  is molar heat capacity at constant volume.

$$C_p \times c_p \times M \text{ and } C_v = c_v \times M$$

$$\text{and } C_p - C_v = R/M$$

$$C_p/C_v = c_p/c_v = \gamma \quad (\text{The poisson's ratio})$$

$c_p$  and  $c_v$  are specific heats at constant pressure and volume respectively.

**SOLVED EXAMPLE**

**Ex. 1** During 200J work done on the system, 140 J of heat is given out. Calculate the change in internal energy.

**Sol.**  $w = 200 \text{ J}$ ;  $q = -140 \text{ J}$ ;  
 $\therefore q = \Delta E + (-w)$ ; where  $-w$  is work done by the system  
 $\Delta E = q + w$   
 $\Delta E = -140 + 200 = +60 \text{ J}$

**Ex. 2** A gas absorbs 200 J of heat and expands against the external pressure of 1.5 atm from a volume of 0.5 litre. Calculate the change in internal energy.

**Sol.**  $w = -P\Delta V = -1.5 \times (1.0 - 0.5) = -0.75 \text{ litre atm}$   
 $= -0.75 \times 101.3 \text{ J} = -75.975 \text{ J}$   
 $\therefore 1 \text{ litre atm} = 101.3 \text{ J}$   
 Now,  $\Delta E = 200 - 75.975 = +124.025 \text{ J}$

**Ex. 3** Two litre of  $\text{N}_2$  at  $0^\circ\text{C}$  and 5 atm pressure are expanded isothermally against a constant external pressure of 1 atm until the pressure of gas reaches 1 atm. Assuming gas to be ideal, calculate work of expansion.

**Sol.** Since the external pressure is greatly different from the pressure of  $\text{N}_2$  and thus, process is irreversible.  
 $w = -P_{\text{ext}}(V_2 - V_1)$   
 $w = -1 \times (V_2 - V_1)$   
 Given  $V_1 = 2 \text{ litre}$        $V_2 = ?$        $T = 273 \text{ K}$   
 $P_1 = 5 \text{ atm}$        $P_2 = 1 \text{ atm}$   
 $\therefore P_1 V_1 = P_2 V_2$   
 $\therefore V_2 = \frac{2 \times 5}{1} = 10 \text{ litre}$   
 $\therefore w = -1 \times (10 - 2) = -8 \text{ litre atm}$   
 $= -\frac{8 \times 1.987}{0.0821} \text{ calorie}$   
 $= -\frac{8 \times 1.987 \times 4.184}{0.0821} \text{ J} = -810.10 \text{ joule}$

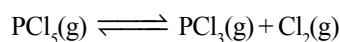
**Ex. 4** The enthalpy of vaporisation of liquid diethyl ether  $(\text{C}_2\text{H}_5)_2\text{O}$ , is  $26.0 \text{ kJ mol}^{-1}$  at its boiling point ( $35.0^\circ\text{C}$ ). Calculate  $\Delta S$  for conversion of: (A) liquid to vapour, and (B) vapour to liquid at  $35^\circ\text{C}$ .

**Sol.** (A)  $\Delta S_{\text{vap.}} = \frac{\Delta H_{\text{vap.}}}{T} = \frac{26 \times 10^3}{308} = +84.41 \text{ JK}^{-1} \text{ mol}^{-1}$   
 (B)  $\Delta S_{\text{cond.}} = \frac{\Delta H_{\text{cond.}}}{T} = -\frac{26 \times 10^3}{308}$  ( $\because H_{\text{cond}} = -26 \text{ kJ}$ )  
 $= -84.41 \text{ JK}^{-1} \text{ mol}^{-1}$

**Ex. 5** Calculate the free energy change when 1 mole of NaCl is dissolved in water at  $25^\circ\text{C}$ . Lattice energy of NaCl =  $777.8 \text{ kJ mol}^{-1}$ ;  $\Delta S$  for dissolution =  $0.043 \text{ kJ mol}^{-1}$  and hydration energy of NaCl =  $-774.1 \text{ kJ mol}^{-1}$ .

**Sol.**  $\Delta H_{\text{dissolution}} = \text{Lattice energy} + \text{Hydration energy}$   
 $= 777.8 - 774.1 = 3.7 \text{ kJ mol}^{-1}$   
 Now  $\Delta G = \Delta H - T\Delta S$   
 $= 3.7 - 298 \times 0.043 = 3.7 - 12.814$   
 $\Delta G = -9.114 \text{ kJ mol}^{-1}$

**Ex. 6** The equilibrium constant for the reaction given below is  $2.0 \times 10^{-7}$  at 300 K. Calculate the standard free energy change for the reaction;



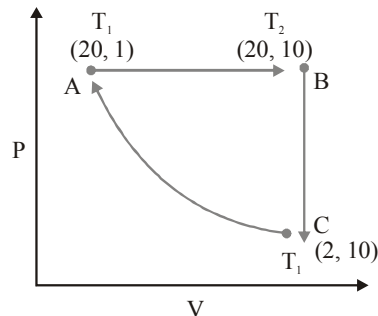
Also, calculate the standard entropy change if  $\Delta H^\circ = 28.40 \text{ kJ mol}^{-1}$ .

**Sol.**  $\Delta G^\circ = -2.303 \times 8.314 \times 300 \log [2.0 \times 10^{-7}]$   
 $= +38479.8 \text{ J mol}^{-1} = +38.48 \text{ kJ mol}^{-1}$   
 Also,  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$$\therefore \Delta S^\circ = \frac{\Delta H^\circ - \Delta G^\circ}{T} = \frac{28.40 - 38.48}{300}$$

$$= -0.0336 \text{ kJ} = -33.6 \text{ JK}^{-1}$$

**Ex. 7** One mole of a perfect monoatomic gas is put through a cycle consisting of the following three reversible steps :



(CA) Isothermal compression from 2 atm and 10 litres to 20 atm and 1 litre.

(AB) Isobaric expansion to return the gas to the original volume of 10 litres with T going from  $T_1$  to  $T_2$ .

(BC) Cooling at constant volume to bring the gas to the original pressure and temperature.

The steps are shown schematically in the figure shown.

(A) Calculate  $T_1$  and  $T_2$ .

(B) Calculate  $\Delta E$ ,  $q$  and  $w$  in calories, for each step and for the cycle.

**Exercise # 1**

**SINGLE OBJECTIVE**

**NEET LEVEL**

1. Internal energy of an ideal gas depends on  
(A) Volume (B) Temperature  
(C) Pressure (D) None of these
2. Any series of operations so carried out that at the end, the system is back to its initial state is called  
(A) Boyle's cycle (B) Reversible process  
(C) Adiabatic process (D) Cyclic process
3. One calorie is equal to  
(A) 0.4184 Joule (B) 4.184 Joule  
(C) 41.84 Joule (D) 418.4 Joule
4. The total internal energy change for a reversible isothermal cycles is  
(A) Always 100 calories per degree  
(B) Always negative  
(C) 0  
(D) Always positive
5. The first law of thermodynamics is only  
(A) The law of conservation of energy  
(B) The law of conservation of mass  
(C) The law of conservation of momentum  
(D) Both (A) and (B)
6. A mixture of two moles of carbon monoxide and one mole of oxygen, in a closed vessel is ignited to convert the carbon monoxide to carbon dioxide. If  $\Delta H$  is the enthalpy change and  $\Delta E$  is the change in internal energy, then  
(A)  $\Delta H > \Delta E$   
(B)  $\Delta H < \Delta E$   
(C)  $\Delta H = \Delta E$   
(D) The relationship depends on the capacity of the vessel
7. Which of the following is always negative for exothermic reaction?  
(A)  $\Delta H$  (B)  $\Delta S$   
(C)  $\Delta G$  (D) None of these
8. The relation between  $\Delta E$  and  $\Delta H$  is  
(A)  $\Delta H = \Delta E - P \Delta V$  (B)  $\Delta H = \Delta E + P \Delta V$   
(C)  $\Delta E = \Delta V + \Delta H$  (D)  $\Delta E = \Delta H + P \Delta V$
9. At constant T and P, which one of the following statements is correct for the reaction,  
$$\text{CO(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$$
  
(A)  $\Delta H$  is independent of the physical state of the reactants of that compound  
(B)  $\Delta H > \Delta E$   
(C)  $\Delta H < \Delta E$   
(D)  $\Delta H = \Delta E$
10. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter,  $\Delta U$  and  $w$  correspond to  
(A)  $\Delta U < 0, w = 0$  (B)  $\Delta U = 0, w < 0$   
(C)  $\Delta U > 0, w = 0$  (D)  $\Delta U < 0, w > 0$
11. Which is not the correct relation between enthalpy ( $\Delta H$ ) and intrinsic energy ( $\Delta E$ )  
(A)  $\Delta H = \Delta E + P \Delta V$  (B)  $\Delta H = \Delta E + n RT$   
(C)  $\Delta H = \Delta E - P \Delta V$  (D)  $\Delta E = \Delta H - P \Delta V$
12. The law of Lavoisier and Laplace illustrates  
(A) The principle of conservation of energy  
(B) Equivalence of mechanical and thermal energy  
(C) The principle of conservation of matter  
(D) Equivalence of mechanical and chemical energy
13. For the reaction  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3; \Delta H =$   
(A)  $\Delta E - RT$  (B)  $\Delta E - 2RT$   
(C)  $\Delta E + RT$  (D)  $\Delta E + 2RT$
14. If  $\Delta H$  is the change in enthalpy and  $\Delta E$  the change in internal energy accompanying a gaseous reaction  
(A)  $\Delta H$  is always greater than  $\Delta E$   
(B)  $\Delta H < \Delta E$  only if the number of moles of the products is greater than the number of the reactants  
(C)  $\Delta H$  is always less than  $\Delta E$   
(D)  $\Delta H < \Delta E$  only if the number of moles of the products is less than the number of moles of the reactants
15. "The resultant heat change in a reaction is the same whether it takes place in one or several stages." This statement is called  
(A) Lavoisier and Laplace law  
(B) Hess's law  
(C) Joule's law  
(D) Le-chatelier's principle

## Exercise # 2

### SINGLE OBJECTIVE

### AIIMS LEVEL

1. A system containing real gas changes its state from state-1 to state-2.  
State-1 (2 atm, 3L, 300 K)  
State-2 (5 atm, 4L, 500 K)  
If change in internal energy = 30 L atm then calculate change in enthalpy.  
(A) 44 L atm                      (B) 35 L atm  
(C) 40 L atm                      (D) None of these
2. Mixing of non-reacting gases is generally accompanied by  
(A) Decrease in entropy  
(B) Increase in entropy  
(C) Change in enthalpy  
(D) Change in free energy
3. Which of the following reactions is associated with the most negative change in entropy ?  
(A)  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{SO}_3(\text{g})$   
(B)  $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_6(\text{g})$   
(C)  $\text{C}(\text{s, graphite}) + \text{O}_2 \longrightarrow \text{CO}_2(\text{g})$   
(D)  $3\text{C}_2\text{H}_2(\text{g}) \longrightarrow \text{C}_6\text{H}_6(\ell)$
4. Predict which of the following reaction (s) has a positive entropy change ?  
I.  $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \longrightarrow \text{AgCl}(\text{s})$   
II.  $\text{NH}_4\text{Cl}(\text{s}) \longrightarrow \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$   
III.  $2\text{NH}_3(\text{g}) \longrightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$   
(A) I and II                      (B) III  
(C) II and III                      (D) II
5. Which one of the following has  $\Delta S^0$  greater than zero  
(A)  $\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightleftharpoons \text{CaCO}_3(\text{s})$   
(B)  $\text{NaCl}(\text{aq}) \rightleftharpoons \text{NaCl}(\text{s})$   
(C)  $\text{NaNO}_3(\text{s}) \rightleftharpoons \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$   
(D)  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
6. For the gas - phase decomposition,  $\text{PCl}_5(\text{g}) \xrightarrow{\Delta} \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ :  
(A)  $\Delta H < 0, \Delta S < 0$                       (B)  $\Delta H > 0, \Delta S > 0$   
(C)  $\Delta H > 0, \Delta S < 0$                       (D)  $\Delta H < 0, \Delta S > 0$
7. When 2 moles of an ideal gas  $\left(C_{p,m} = \frac{5}{2}R\right)$  heated from 300 K to 600 K at constant volume, the change in entropy of gas  $\Delta S_{\text{gas}}$  is :  
(A)  $5R \ln 2$                       (B)  $\frac{3}{2}R \ln 2$   
(C)  $3R \ln 2$                       (D)  $-3R \ln 2$
8. When one mole of an ideal gas is compressed to half of its initial volume and simultaneously heated to twice its initial temperature, the change in entropy of gas ( $\Delta S$ ) is :  
(A)  $C_{p,m} \ln 2$                       (B)  $C_{v,m} \ln 2$   
(C)  $R \ln 2$                       (D)  $(C_{v,m} - R) \ln 2$
9. When two mole of an ideal gas  $\left(C_{p,m} = \frac{5}{2}R\right)$  heated from 300 K to 600 K at constant pressure. The change in entropy of gas ( $\Delta S$ ) is :  
(A)  $\frac{3}{2}R \ln 2$                       (B)  $-\frac{3}{2}R \ln 2$   
(C)  $5R \ln 2$                       (D)  $\frac{5}{2}R \ln 2$
10. If one mole of an ideal gas  $\left(C_{p,m} = \frac{5}{2}R\right)$  is expanded isothermally at 300 K until its volume is tripled, then change in entropy of gas is :  
(A) zero                      (B) infinity  
(C)  $\frac{5}{2}R \ln 3$                       (D)  $R \ln 3$
11. The entropy change when two moles of ideal monoatomic gas is heated from 200 to 300°C reversibly and isochorically ?  
(A)  $\frac{3}{2}R \ln\left(\frac{300}{200}\right)$                       (B)  $\frac{5}{2}R \ln\left(\frac{573}{273}\right)$   
(C)  $3R \ln\left(\frac{573}{473}\right)$                       (D)  $\frac{3}{2}R \ln\left(\frac{573}{473}\right)$
12. 1 mole of an ideal gas at 25°C is subjected to expand reversibly and adiabatically to ten times of its initial volume. Calculate the change in entropy during expansion (in  $\text{J K}^{-1} \text{mol}^{-1}$ )  
(A) 19.15                      (B) -19.15  
(C) 4.7                      (D) zero
13. What is the change in entropy when 2.5 mole of water is heated from 27°C to 87°C ? Assume that the heat capacity is constant. ( $C_{p,m}(\text{H}_2\text{O}) = 4.2 \text{ J/g}\cdot\text{K}$  In (1.2) = 0.18)  
(A) 16.6 J/K                      (B) 9 J/K  
(C) 34.02 J/K                      (D) 1.89 J/K

**Exercise # 3**

**PART - 1**

**MATRIX MATCH COLUMN**

- |  |  |
|--|--|
| <p>1. <b>Column-I</b></p> <p>(A) Reversible isothermal expansion of an ideal gas</p> <p>(B) Reversible adiabatic compression of an ideal gas</p> <p>(C) Irreversible adiabatic expansion of an ideal gas</p> <p>(D) Irreversible isothermal compression of an ideal gas</p>  | <p><b>Column-II</b></p> <p>(p) <math>w = -2.303 nRT \log \left( \frac{V_2}{V_1} \right)</math></p> <p>(q) <math>PV^\gamma = \text{constant}</math></p> <p>(r) <math>w = \frac{nR}{(\gamma-1)} (T_2 - T_1)</math></p> <p>(s) <math>\Delta H = 0</math></p>              |
| <p>2. <b>Column I</b></p> <p>(A) A process carried out infinitesimally slowly</p> <p>(B) A process in which no heat enters or leaves the system</p> <p>(C) A process carried out at constant temperature</p> <p>(D) A process in equilibrium</p> <p>(E) <math>A(s) \longrightarrow A(g)</math></p> <p>(F) Cyclic process</p>             | <p><b>Column II</b></p> <p>(p) Adiabatic</p> <p>(q) <math>\Delta G = 0</math></p> <p>(r) Sublimation</p> <p>(s) <math>\Delta E = 0, \Delta H = 0</math></p> <p>(t) Reversible</p> <p>(u) Isothermal</p>  |
| <p>3. <b>Column - I</b></p> <p>(A) <math>(\Delta G_{\text{system}})_{T,P} = 0</math></p> <p>(B) <math>\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} &gt; 0</math></p> <p>(C) <math>\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} &lt; 0</math></p> <p>(D) <math>(\Delta G_{\text{system}})_{T,P} &gt; 0</math></p> | <p><b>Column - II</b></p> <p>(p) Process is in equilibrium</p> <p>(q) Process is nonspontaneous</p> <p>(r) Process is spontaneous</p> <p>(s) System is unable to do useful work</p>  |
| <p>4. <b>Column - I</b></p> <p>(A) Reversible adiabatic compression</p> <p>(B) Reversible vaporisation of liquid</p> <p>(C) <math>2N(g) \longrightarrow N_2(g)</math></p> <p>(D) <math>MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)</math></p>  | <p><b>Column - II</b></p> <p>(p) <math>\Delta S_{\text{system}} &gt; 0</math></p> <p>(q) <math>\Delta S_{\text{system}} &lt; 0</math></p> <p>(r) <math>\Delta S_{\text{surrounding}} &lt; 0</math></p> <p>(s) <math>\Delta S_{\text{surrounding}} = 0</math></p>       |
| <p>5. <b>Column - I</b></p> <p>(A) <math>C(s, \text{graphite}) + O_2(g) \longrightarrow CO_2(g)</math></p> <p>(B) <math>C(s, \text{graphite}) \longrightarrow C(g)</math></p> <p>(C) <math>CO(g) + \frac{1}{2} O_2(g) \longrightarrow CO_2(g)</math></p> <p>(D) <math>CH_4(g) \longrightarrow C(g) + 4H(g)</math></p>                    | <p><b>Column - II</b></p> <p>(p) <math>\Delta H^\circ_{\text{combustion}}</math></p> <p>(q) <math>\Delta H^\circ_{\text{formation}}</math></p> <p>(r) <math>\Delta H^\circ_{\text{atomization}}</math></p> <p>(s) <math>\Delta H^\circ_{\text{sublimation}}</math></p> |



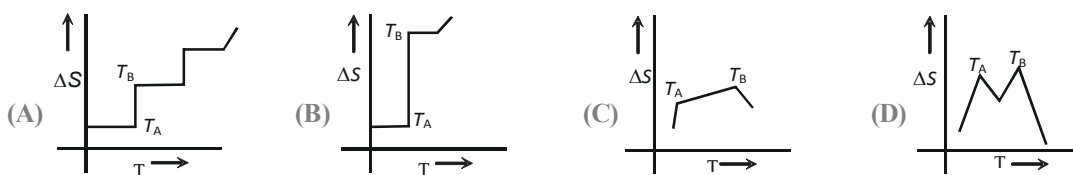
**Exercise # 4**

**PART - 1**

**PREVIOUS YEAR (NEET/AIPMT)**

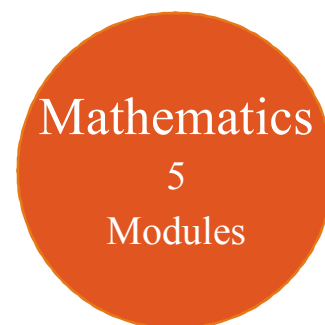
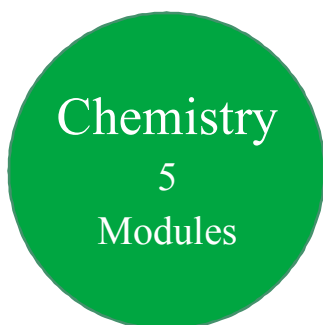
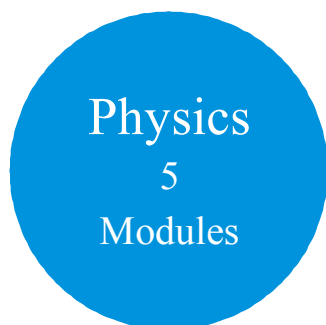
1. If  $\Delta E$  is the heat of reaction for  
 $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$   
 at constant volume, the  $\Delta H$  (heat of reaction at constant pressure), then the correct relation is  
[CBSE AIPMT 2000]  
 (A)  $\Delta H = \Delta E + RT$       (B)  $\Delta H = \Delta E - RT$   
 (C)  $\Delta H = \Delta E - 2RT$       (D)  $\Delta H = \Delta E + 2RT$
  
2. The entropy change in the fusion of one mole of solid melting at  $27^\circ C$  (latent heat of fusion is  $2930 J mol^{-1}$ ) is  
[CBSE AIPMT 2000]  
 (A)  $9.77 JK^{-1} mol^{-1}$       (B)  $10.73 JK^{-1} mol^{-1}$   
 (C)  $2930 JK^{-1} mol^{-1}$       (D)  $108.5 JK^{-1} mol^{-1}$
  
3. The factor of  $\Delta G$  values is important in metallurgy. The  $\Delta G$  values for the following reactions at  $800^\circ C$  are given as  
[CBSE AIPMT 2000]  
 $S_2(s) + 2O_2(g) \rightarrow 2SO_2(g), \Delta G = -544 kJ$   
 $2Zn(s) + S_2(s) \rightarrow 2ZnS(s), \Delta G = -293 kJ$   
 $2Zn(s) + O_2(g) \rightarrow 2ZnO(s), \Delta G = -480 kJ$   
 the  $\Delta G$  for the reaction,  
 $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$  will be  
 (A)  $-357 kJ$       (B)  $-731 kJ$   
 (C)  $-773 kJ$       (D)  $-229 kJ$
  
4.  $PbO_2 \rightarrow PbO, \Delta G_{298} < 0$   
 $SnO_2 \rightarrow SnO, \Delta G_{298} > 0$   
 Most probable oxidation state of Pb and Sn will be  
[CBSE AIPMT 2001]  
 (A)  $Pb^{4+}, Sn^{4+}$       (B)  $Pb^{4+}, Sn^{2+}$   
 (C)  $Pb^{2+}, Sn^{2+}$       (D)  $Pb^{2+}, Sn^{4+}$
  
5. Change in enthalpy for reaction,  
 $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$   
 if heat of formation of  $H_2O_2(l)$  and  $H_2O(l)$  are  $-188$  and  $-286 kJ/mol$  respectively is  
[CBSE AIPMT 2001]  
 (A)  $-196 kJ/mol$       (B)  $+196 kJ/mol$   
 (C)  $+948 kJ/mol$       (D)  $-948 kJ/mol$
  
6. When 1 mole gas is heated at constant volume, temperature is raised from  $298$  to  $308 K$ . Heat supplied to the gas is  $500 J$ . Then, which statement is correct?  
[CBSE AIPMT 2001]  
 (A)  $q = W = 500 J, \Delta E = 0$   
 (B)  $q = \Delta E = 500 J, W = 0$   
 (C)  $q = -W = 500 J, \Delta E = 0$   
 (D)  $\Delta E = 0, q = w = -500 J$
  
7. Enthalpy of the reaction  $CH_4 + \frac{1}{2}O_2 \rightarrow CH_3OH$ , is negative. If enthalpy of combustion of  $CH_4$  and  $CH_3OH$  are  $x$  and  $y$  respectively, then which relation is correct?  
[CBSE AIPMT 2001]  
 (A)  $x > y$       (B)  $x < y$   
 (C)  $x = y$       (D)  $x \geq y$
  
8. Unit of entropy is  
[CBSE AIPMT 2002]  
 (A)  $JK^{-1} mol^{-1}$       (B)  $J mol^{-1}$   
 (C)  $J^{-1} K^{-1} mol^{-1}$       (D)  $JK mol^{-1}$
  
9. In a closed insulated container a liquid is stirred with a paddle to increase the temperature, which of the following is true?  
[CBSE AIPMT 2002]  
 (A)  $\Delta E = W \neq 0, q = 0$   
 (B)  $\Delta E = W = 0, q \neq 0$   
 (C)  $\Delta E = 0, W = q, q \neq 0$   
 (D)  $W = 0, \Delta E = q, q \neq 0$
  
10. 2 moles of an ideal gas at  $27^\circ C$  temperature is expanded reversibly from  $2 L$  to  $20 L$ . Find entropy change ( $R = 2 cal/mol K$ ).  
[CBSE AIPMT 2002]  
 (A)  $92.1$       (B)  $0$   
 (C)  $4$       (D)  $9.2$
  
11. Heat of combustion  $\Delta H^\circ$  for  $C(s), H_2(g)$  and  $CH_4(g)$  are  $-94, -68$  and  $-213 kcal/mol$ . Then,  $\Delta H^\circ$  for  $C(s) + 2H_2(g) \rightarrow CH_4(g)$  is  
[CBSE AIPMT 2002]  
 (A)  $-17 kcal/mol$       (B)  $-111 kcal/mol$   
 (C)  $-170 kcal/mol$       (D)  $-85 kcal/mol$
  
12. The densities of graphite and diamond at  $298 K$  are  $2.25$  and  $3.31 g cm^{-3}$ , respectively. If the standard free energy difference ( $\Delta G^\circ$ ) is equal to  $1895 J mol^{-1}$ , the pressure at which graphite will be transformed into diamond at  $298 K$  is  
[CBSE AIPMT 2003]  
 (A)  $9.92 \times 10^6 pa$       (B)  $9.92 \times 10^5 pa$   
 (C)  $9.92 \times 10^8 pa$       (D)  $9.92 \times 10^7 Pa$
  
13. What is the entropy change (in  $J K^{-1} mol^{-1}$ ) when one mole of ice is converted into water at  $0^\circ C$ ? (The enthalpy change for the conversion of ice to liquid water is  $6.0 kJ mol^{-1}$  at  $0^\circ C$ )  
[CBSE AIPMT 2003]  
 (A)  $2.198 JK^{-1} mol^{-1}$       (B)  $21.98 JK^{-1} mol^{-1}$   
 (C)  $20.13 JK^{-1} mol^{-1}$       (D)  $2.013 JK^{-1} mol^{-1}$
  
14. For which one of the following equations  $\Delta H_f^\circ$  equal to  $\Delta H_f^\circ$  for the product?  
[CBSE AIPMT 2003]  
 (A)  $Xe(g) + 2F_2(g) \rightarrow XeF_4(g)$   
 (B)  $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$   
 (C)  $N_2(g) + O_3(g) \rightarrow N_2O_3(g)$

- In an isobaric process, the ratio of heat supplied to the system ( $dQ$ ) and work done by the system ( $dW$ ) for diatomic gas is  
 (A) 1 : 1                      (B) 7 : 2                      (C) 7 : 5                      (D) 5 : 7
- The enthalpy change for the reaction of 50.00 ml of ethylene with 50.00 ml of  $H_2$  at 1.5 atm pressure is  $\Delta H = -0.31$  kJ. The value of  $\Delta E$  will be  
 (A) -0.3024 kJ                      (B) 0.3024 kJ                      (C) 2.567 kJ                      (D) -0.0076 kJ
- Enthalpy of solution of NaOH (solid) in water is  $-41.6$  kJ mol $^{-1}$ . When NaOH is dissolved in water, the temperature of water  
 (A) Increase                      (B) Decreases                      (C) Does not change                      (D) Fluctuates indefinitely
- In which of the following entropy decreases ?  
 (A) Crystallization of sucrose from solution                      (B) Rusting of iron  
 (C) Melting of ice                      (D) Vaporization of camphor
- For conversion C (graphite)  $\rightarrow$  C (diamond) the  $\Delta S$  is  
 (A) Zero                      (B) Positive                      (C) Negative                      (D) Unknown
- For a reaction  $\Delta H = 9.08$  kJ mol $^{-1}$  and  $\Delta S = 35.7$  JK $^{-1}$ mol $^{-1}$   
 Which of the following statements is correct for the reaction  
 (A) Reversible and Isothermal                      (B) Reversible and Exothermic  
 (C) Spontaneous and Endothermic                      (D) Spontaneous and Exothermic
- For a reaction to occur spontaneously  
 (A)  $(\Delta H - T\Delta S)$  must be negative                      (B)  $(\Delta H + T\Delta S)$  must be negative  
 (C)  $\Delta H$  must be negative                      (D)  $\Delta S$  must be negative
- The total amount of energy in the universe is fixed, but  
 (A) Disorder is increasing                      (B) Lightning is increasing  
 (C) Matter is increasing                      (D) Gravitation is decreasing
- If for a given substance melting point is  $T_B$  and freezing point is  $T_A$ , then correct variation shown by graph between entropy change and temperature is



- Which of the following would be expected to have the largest entropy per mole  
 (A)  $SO_2Cl_2$  (s)                      (B)  $SO_2Cl_2$  (g)                      (C)  $SO_2Cl_2$  (l)                      (D)  $SO_2$  (g)
- The enthalpies of formation of  $Al_2O_3$  and  $Cr_2O_3$  are  $-1596$  kJ and  $-1134$  kJ respectively.  $\Delta H$  for the reaction  $2Al + Cr_2O_3 \rightarrow 2Cr + Al_2O_3$  is  
 (A)  $-2730$  kJ                      (B)  $-462$  kJ                      (C)  $-1365$  kJ                      (D)  $+2730$  kJ

# 11<sup>th</sup> Class Modules Chapter Details



PHYSICS	CHEMISTRY	BIOLOGY
<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Physical World &amp; Measurements</li> <li>2. Basic Maths &amp; Vector</li> <li>3. Kinematics</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Law of Motion &amp; Friction</li> <li>2. Work, Energy &amp; Power</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Motion of system of particles &amp; Rigid Body</li> <li>2. Gravitation</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Mechanical Properties of Matter</li> <li>2. Thermal Properties of Matter</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Oscillations</li> <li>2. Waves</li> </ol>	<p><b>Module-1(PC)</b></p> <ol style="list-style-type: none"> <li>1. Some Basic Concepts of Chemistry</li> <li>2. Atomic Structure</li> <li>3. Chemical Equilibrium</li> <li>4. Ionic Equilibrium</li> </ol> <p><b>Module-2(PC)</b></p> <ol style="list-style-type: none"> <li>1. Thermodynamics &amp; Thermochemistry</li> <li>2. Redox Reaction</li> <li>3. States Of Matter (Gaseous &amp; Liquid)</li> </ol> <p><b>Module-3(IC)</b></p> <ol style="list-style-type: none"> <li>1. Periodic Table</li> <li>2. Chemical Bonding</li> <li>3. Hydrogen &amp; Its Compounds</li> <li>4. S-Block</li> </ol> <p><b>Module-4(OC)</b></p> <ol style="list-style-type: none"> <li>1. Nomenclature of Organic Compounds</li> <li>2. Isomerism</li> <li>3. General Organic Chemistry</li> </ol> <p><b>Module-5(OC)</b></p> <ol style="list-style-type: none"> <li>1. Reaction Mechanism</li> <li>2. Hydrocarbon</li> <li>3. Aromatic Hydrocarbon</li> <li>4. Environmental Chemistry &amp; Analysis Of Organic Compounds</li> </ol>	<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Diversity in the Living World</li> <li>2. Plant Kingdom</li> <li>3. Animal Kingdom</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Morphology in Flowering Plants</li> <li>2. Anatomy of Flowering Plants</li> <li>3. Structural Organization in Animals</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Cell: The Unit of Life</li> <li>2. Biomolecules</li> <li>3. Cell Cycle &amp; Cell Division</li> <li>4. Transport in Plants</li> <li>5. Mineral Nutrition</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Photosynthesis in Higher Plants</li> <li>2. Respiration in Plants</li> <li>3. Plant Growth and Development</li> <li>4. Digestion &amp; Absorption</li> <li>5. Breathing &amp; Exchange of Gases</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Body Fluids &amp; Its Circulation</li> <li>2. Excretory Products &amp; Their Elimination</li> <li>3. Locomotion &amp; Its Movement</li> <li>4. Neural Control &amp; Coordination</li> <li>5. Chemical Coordination and Integration</li> </ol>

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# 12<sup>th</sup> Class Modules Chapter Details

Physics  
5  
Modules

Chemistry  
5  
Modules

Mathematics  
5  
Modules

PHYSICS	CHEMISTRY	BIOLOGY
<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Electrostatics</li> <li>2. Capacitance</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Current Electricity</li> <li>2. Magnetic Effect of Current and Magnetism</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Electromagnetic Induction</li> <li>2. Alternating Current</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Geometrical Optics</li> <li>2. Wave Optics</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Modern Physics</li> <li>2. Nuclear Physics</li> <li>3. Solids &amp; Semiconductor Devices</li> <li>4. Electromagnetic Waves</li> </ol>	<p><b>Module-1(PC)</b></p> <ol style="list-style-type: none"> <li>1. Solid State</li> <li>2. Chemical Kinetics</li> <li>3. Solutions and Colligative Properties</li> </ol> <p><b>Module-2(PC)</b></p> <ol style="list-style-type: none"> <li>1. Electrochemistry</li> <li>2. Surface Chemistry</li> </ol> <p><b>Module-3(IC)</b></p> <ol style="list-style-type: none"> <li>1. P-Block Elements</li> <li>2. Transition Elements (d &amp; f block)</li> <li>3. Co-ordination Compound</li> <li>4. Metallurgy</li> </ol> <p><b>Module-4(OC)</b></p> <ol style="list-style-type: none"> <li>1. HaloAlkanes &amp; HaloArenes</li> <li>2. Alcohol, Phenol &amp; Ether</li> <li>3. Aldehyde, Ketone &amp; Carboxylic Acid</li> </ol> <p><b>Module-5(OC)</b></p> <ol style="list-style-type: none"> <li>1. Nitrogen &amp; Its Derivatives</li> <li>2. Biomolecules &amp; Polymers</li> <li>3. Chemistry in Everyday Life</li> </ol>	<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Reproduction in Organisms</li> <li>2. Sexual Reproduction in Flowering Plants</li> <li>3. Human Reproduction</li> <li>4. Reproductive Health</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Principles of Inheritance and Variation</li> <li>2. Molecular Basis of Inheritance</li> <li>3. Evolution</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Human Health and Disease</li> <li>2. Strategies for Enhancement in Food Production</li> <li>3. Microbes in Human Welfare</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Biotechnology: Principles and Processes</li> <li>2. Biotechnology and Its Applications</li> <li>3. Organisms and Populations</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Ecosystem</li> <li>2. Biodiversity and Conservation</li> <li>3. Environmental Issues</li> </ol>

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