



## CHEMISTRY

### BOOKS - NCERT CHEMISTRY (HINGLISH)

### THERMODYNAMICS

#### Multiple Choice Questions

1. Thermodynamics is not concerned about

- A. energy changes involved in a chemical reaction
- B. the extent to which a chemical reaction proceeds
- C. the rate at which a reaction proceeds
- D. the feasibility of a chemical reaction

**Answer: C**



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2. Which of the following statement is correct ?

- A. The presence of reacting species in a covered beaker is an example of open system
- B. There is an exchange of energy as well as matter between the system and the surroundings in a closed system
- C. The presence of reactants in a closed vessel made up of copper is an example of a closed system
- D. The presence of reactants in a thermos flask or any other closed insulated vessel is an example of a closed system

**Answer: C**

3. The state of gas can be described by quoting the relationship between

- A. pressure, volume, temperature
- B. temperature, amount, pressure
- C. amount, volume, temperature
- D. pressure, volume, temperature, amount

**Answer: D**



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4. The volume of gas is reduced to half from its original volume. The specific heat will be

- A. reduce to half
- B. be double
- C. remain constant
- D. increase four times

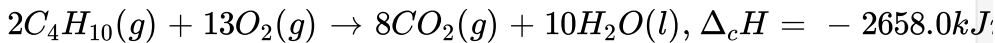
Answer: C



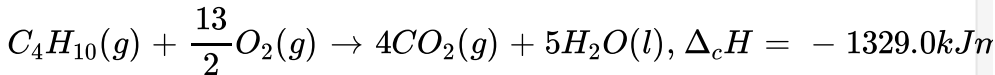
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5. During complete combustion of one mole of butane ,2658Kj of heat is released. The thermochemical reaction for above change is

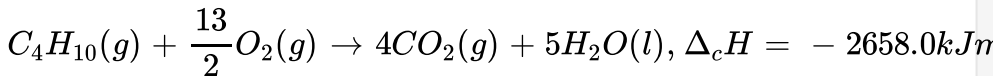
A.



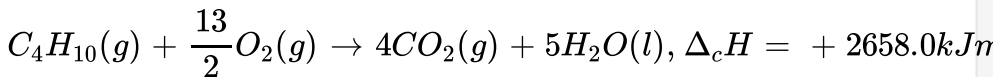
B.



C.



D.



Answer: C



6.  $\delta_f U^{\ominus}$  of formation of  $CH_4(g)$  at a certain temperature is  $-393 J mol^{-1}$ . The value of  $\delta H^{\ominus}$  is:

A. zero

B.  $< \Delta_f U^{\ominus}$

C.  $> \Delta_f U^{\ominus}$

D. equal to  $\Delta_f U^{\ominus}$

**Answer: B**

7. In an adiabatic process, no transfer of heat takes place between system and surroundings. Choose the correct option for free expansion of an ideal gas under adiabatic conditions from the following :

A.  $q = 0, \Delta T \neq 0, W = 0$

B.  $q \neq 0, \Delta T = 0, W = 0$

C.  $q = 0, \Delta T = 0, W = 0$

D.  $q = 0, \Delta T < 0, W \neq 0$

**Answer: C**



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8. The pressure volume work for an ideal gas can be calculated by using the expression  $w = - \int_{V_i}^{V_f} P_{ex} dV$ . The work can also be calculated from the pV-plot by using the area under the curve within the specified limits. When an ideal gas is compressed (a) reversibly or (B) irreversibly from volume  $V_i$  to  $V_f$  choose the correct option.

A.  $W$  (reversible) =  $W$  (irreversible)

B.  $W$  (reversible) <  $W$  (irreversible)

C.  $W$  (reversible) =  $W$  (irreversible)

D.  $W$  (reversible) =  $W$  (irreversible) +  $p_{ex} \cdot \Delta V$

**Answer: B**

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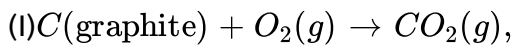
9. The entropy change can be calculated by using the expression  $\Delta S = \frac{q_{rev}}{T}$ . When water freezes in a glass beaker, choose the correct statement amongst the following:

- A.  $\Delta S$  (system) decreases but  $\Delta S$  (surroundings) remains the same
- B.  $\Delta S$  (system) increases but  $\Delta S$  (surroundings) decreases
- C.  $\Delta S$  (system) decreases but  $\Delta S$  (surroundings) increases
- D.  $\Delta S$  (system) decreases but  $\Delta S$  (surroundings) also decreases

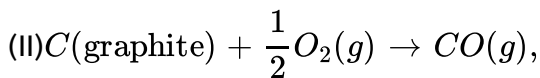
**Answer: C**

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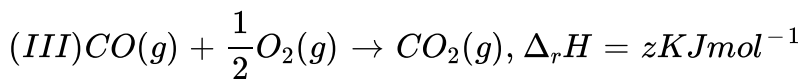
10. On the basis of thermochemical equations (I),(II)and (III), Find out which of the algebraic relationships given in options (a)to (d) is correct ?



$$\Delta_r H = xKJmol^{-1}$$



$$\Delta_r H = yKJmol^{-1}$$



A.  $z = x + y$

B.  $x = y - z$

C.  $x = y + z$

D.  $y = 2z - x$

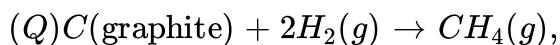
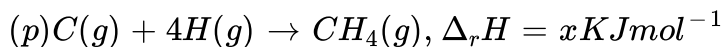
**Answer: C**



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11. Consider the reactions given below .On the basis of these reactions ,Find out which of the algebraic relations given in options (a) to(d) is correct?



$$\Delta_r H = yKJmol^{-1}$$

A.  $x = y$

B.  $x = 2y$

C.  $x > y$

D.  $x < y$

**Answer: C**



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12. The enthalpy of elements in their standard states are taken as zero .The enthalpy of formation of a compound:

- A. is always negative
- B. is always positive
- C. may be positive or negative
- D. is negative negative

**Answer: C**

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**13.** Enthalpy of sublimation of a substance is equal to :

- A. enthalpy of fusion + enthalpy of vaporisation
- B. enthalpy of fusion
- C. enthalpy of vaporisation
- D. twice the enthalpy of vaporisation

**Answer: B**

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14. Which of the following is not correct ?

- A.  $\Delta G$  is zero for a reversible reaction
- B.  $\Delta G$  is positive for a spontaneous reaction
- C.  $\Delta G$  is negative for a spontaneous reaction
- D.  $\Delta G$  is positive for a non-spontaneous reaction.

**Answer: A::D**



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15. Thermodynamics mainly deals with:

- A. interrelation of various forms of energy and their transformation from one form to another

- B. energy changes in the processes which depends only on initial and final states of the microscopic system containing a few molecules
- C. how and at what rate these energy transformations are carried out
- D. the system in equilibrium state or moving from one equilibrium state to another equilibrium state

**Answer: A::D**

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**16.** In an exothermic reaction heat is evolved and system loses heat to the surrounding. For such system

- A.  $q_p$  will be negative
- B.  $\Delta_r H$  will be negative
- C.  $q_p$  will be positive
- D.  $\Delta_r H$  will be positive

**Answer: A::B**



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17. The spontaneity means having the potential to proceed without assistance of external agency. The processes which occur spontaneously are

- A. flow of heat from colder to warmer body
- B. gas in a container contracting into one corner
- C. gas expanding to fill the available volume
- D. burning carbon in oxygen to give carbon dioxide

**Answer: C::D**



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18. For an ideal gas, the work of reversible expansion under isothermal condition can be calculated by using expression  $= -nRT \ln. \frac{V_f}{V_i}$ . A sample containing 1.0 mol of an ideal gas is expanded isothermally and reversible to ten times of its original volume, in two separate experiments. The expansion is carried out at 300 K and at 600 K respectively. Choose the correct option

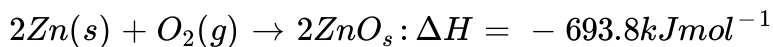
- A. work done at 600 K is 20 times the work done at 300 K
- B. work done at 300 K is twice the work done at 600 K
- C. work done at 600 K is twice the work done at 300 K
- D.  $\Delta U = 0$  in both cases.

**Answer: C::D**



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19. Consider the following reaction between zinc and oxygen and choose the correct options out of the options given below



- A. The enthalpy of two moles of  $ZnO$  is less than the total enthalpy of two moles of  $Zn$  and one mole of oxygen by  $693.8\text{ kJ}$
- B. The enthalpy of two moles of  $ZnO$  is more than the total enthalpy of two moles of  $Zn$  and one mole of oxygen by  $693.8kJ$
- C.  $693.8kJmol^{-1}$  energy is evolved in the reaction
- D.  $693.8kJmol^{-1}$  energy is absorbed in the reaction

**Answer: A::C**

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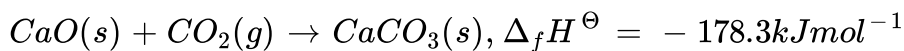
**20.**  $18.0\text{ g}$  of water completely vaporises at  $100^\circ\text{C}$  and  $1\text{ bar}$  pressure and the enthalpy change in the process is  $40.79kJmol^{-1}$ . What will be the enthalpy change for vaporising two moles of water under the same conditions ? What is the standard enthalpy of vaporisation for water ?

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21. One mole of acetone requires less heat to vaporise than 1 mole of water. Which of the two liquids has higher enthalpy of vaporisation ?

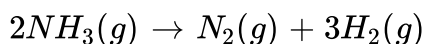
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22. Standard molar enthalpy of formation,  $\Delta_f H^\ominus$  is just a special case of enthalpy of reaction,  $\Delta_r H^\ominus$ . Is the  $\Delta_r H^\ominus$ ? Given reason for your answer.



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23. The value of  $\Delta_f H^\ominus$  for  $NH_3$  is  $-91.8 kJ mol^{-1}$ . Calculate enthalpy change for the following reaction.



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24. Enthalpy is an extensive property. In general, if enthalpy of an overall reaction  $A \rightarrow B$  along one route is  $\Delta_r H$  and  $\Delta_r H_1, \Delta_r H_2, \Delta_r H_3, \dots$ . Represent enthalpies of intermediate reactions leading to product B. What will be the relation between  $\Delta_r H$  overall reaction and  $\Delta_r H_1, \Delta_r H_2$  ... etc for intermediate reaction.

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25. The enthalpy of atomisation for the reaction :  $CH_4(g) \rightarrow C(g) + 4H(g)$  is  $1665 \text{ kJ mol}^{-1}$ . What is the bond enthalpy of C-H bond? (Keep your answer in KJ/mol and three digits only)

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26. Use the following data to calculate  $\Delta_{\text{lattice}} H^\circ$  for NaBr.  $\Delta_{\text{sub}} H^\circ$  for sodium metal =  $108.4 \text{ kJ mol}^{-1}$ , ionization enthalpy of sodium =  $496 \text{ kJ mol}^{-1}$ , electron gain enthalpy of bromine =  $-325 \text{ kJ mol}^{-1}$

bond dissociation enthalpy of bromine =  $192\text{kJmol}^{-1}$ ,  $\Delta_f H^\circ$  for  $\text{NaBr}(s) = -360\text{kJmol}^{-1}$ .

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27. Given that  $\Delta H = 0$  for mixing of two gases. Explain whether the diffusion of these gases into each other in a closed container is a spontaneous process or not?

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28. Heat has randomising influence on a system and temperature is the measure of average chaotic motion of particles in the system. Write the mathematical relation which relates these three parameters.

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29. Increase in enthalpy of the surroundings is equal to decrease in enthalpy of the system. Will the temperature of system and surroundings be the same when they are in thermal equilibrium?

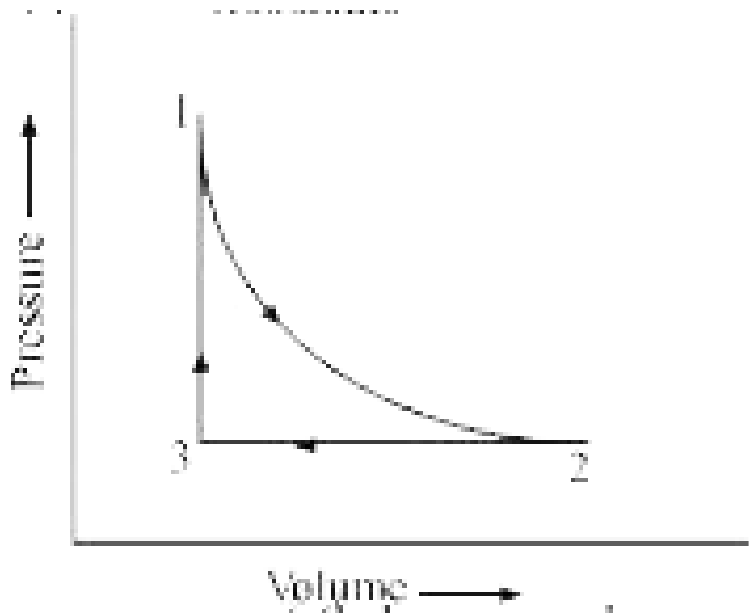
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30. At 298 K,  $K_p$  for the reaction :  $N_2O_4(g) \rightleftharpoons 2NO_2(g)$  is 0.98. Predict whether the reaction is spontaneous or not.

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31. (a) A sample of 1.0 mol of a monoatomic ideal gas is taken through a cyclic process of expansion and compression as shown in figure. What will be the value of  $\Delta H$  for the cycle as a whole?

(b) Which quantity out of  $\Delta_r G$  and  $\Delta_r G^\ominus$  will be zero at equilibrium?



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32. The standard molar entropy of  $H_2O(l)$  is  $70JK^{-1}mol^{-1}$ . Will the standard molar entropy of  $H_2O(s)$  be more or less than  $70JK^{-1}mol^{-1}$ ?

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33. Identify the state functions and path functions out of the following:  
enthalpy, entropy, heat, temperature, work, free energy.



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34. The molar enthalpy of vapourisation of acetone is less than that of water. Why?



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35. Which quantity out of  $\Delta_r G$  or  $\Delta_r G^\circ$  will be zero at equilibrium?



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36. Predict the change in internal energy for an isolated system at constant volume.



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37. Although heat is a path function but heat absorbed by the system under certain specific conditions is independent of path. What are those conditions? Explain.

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38. Expansion of a gas in vacuum is called free expansion. Calculate the work done and the change in internal energy when 1 litre of ideal gas expands isothermally into vacuum until its total volume is 5 litre?

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39. Heat capacity ( $C_p$ ) is an extensive property but specific heat ( $C$ ) is an intensive property. What will be the relation between  $C_p$  and  $C$  for 1 mol of water? (Keep your answer in J/K and in two digits only)

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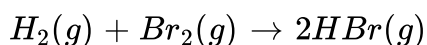
40. The difference between  $C_p$  and  $C_v$  can be derived using the empirical relation  $H = U + pV$ . Calculate the difference between  $C_p$  and  $C_v$  for 10 moles of an ideal gas.

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41. If the combustion of 1 g of graphite produces -20.7 kJ of heat, what will be molar enthalpy change? Give the significance of sign also.

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42. The net enthalpy change of a reaction is the amount of energy required to break all the bonds in reactant molecules minus amount of energy required to form all the bonds in the product molecules. What will be the enthalpy change for the following reaction.



Given that bond energy of  $H_2$ ,  $Br_2$  and HBr is  $435 \text{ kJ mol}^{-1}$ ,  $192 \text{ kJ mol}^{-1}$

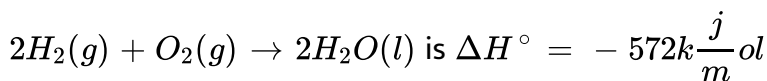
and  $368\text{kJmol}^{-1}$  respectively. (Keep your answer in magnitude and in KJ/mol)

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43. The enthalpy of vaporisation of  $\text{CCl}_4$  is  $30.5\text{kJmol}^{-1}$ . Calculate the heat required for the vapourisation of 284 g of  $\text{CCl}_4$  at constant pressure. (Molar mass of  $\text{CCl}_4 = 154\text{u}$ ). (Keep your answer in KJ and two digits only)

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44. The enthalpy of reaction for thr equation

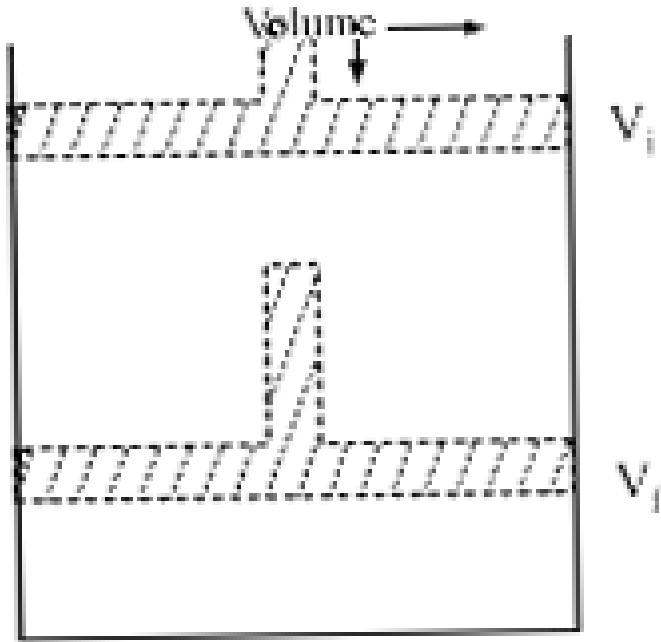


what will be the standard enthalpy for the formation of  $\text{H}_2\text{O}(\text{l})$ ?

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45. What will be the work done on an ideal gas enclosed in a cylinder, when it is compressed by a constant external pressure  $p_{ext}$ , in a single step as shown in figure? Explain graphically.



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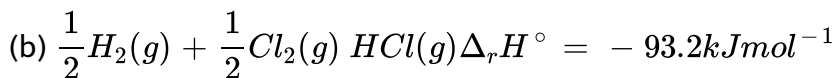
46. How will you calculate work done on an ideal gas in a compression, when change in pressure is carried out in infinite steps?



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47. Represent the potential energy/enthalpy change in the following process graphically

(a) Throwing a stone from the ground to roof.

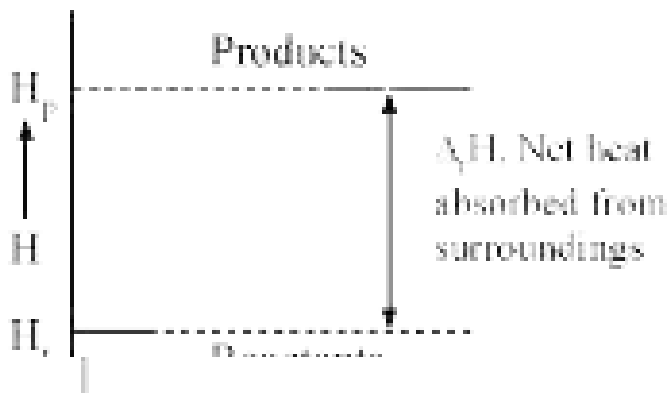


In which of the process potential energy/enthalpy change is contributing factor to the spontaneity?



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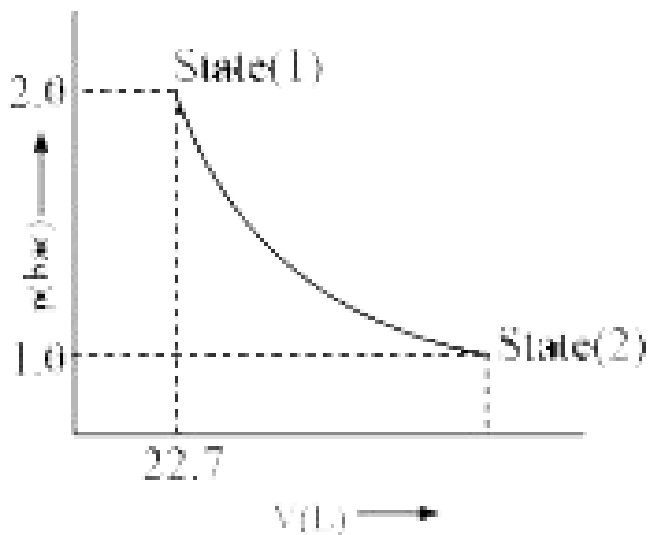
48. Enthalpy diagram for a particular reaction is given in figure. Is it possible to decide spontaneity of a reaction from given diagram. Explain



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**49.** 1.0 mol of a monoatomic ideal gas is expanded from state (1) to state (2) as shown in figure. Calculate the work done for the expansion of gas

from state (1) to state (2) as 298 K.



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50. An ideal gas is allowed to expand against a constant pressure of 2 bar from 10 L to 50 L in one step. The amount of work done by the gas is  $x$ . If the same expansion were carried out reversibly, what is the relation of work done with the earlier case?

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## 51. Match the following

with the following.

List I

- A. Adiabatic process
- B. Irreversible process
- C. Reversible process
- D. Path function
- E. State function
- F.  $\Delta U = q$
- G. Law of conservation of energy
- H. Reversible process
- I. Free expansion
- J.  $\Delta H = q$
- K. Intensive property
- L. Extensive property

List II

- 1.  $\Delta U = q + w$
- 2.  $\Delta U = 0$
- 3.  $\Delta H = q + w$
- 4.  $\Delta H = q$
- 5.  $\Delta U = q$
- 6.  $\Delta H = q$
- 7. Internal energy
- 8.  $\Delta U = 0$
- 9. At constant pressure
- 10. Infinitely slow process which proceeds through a series of equilibrium states
- 11. Entropy
- 12. Pressure
- 13. Specific heat

A → (1) B → (1) C → (1) D → (1) E → (7, 11, 12) F → (2) G → (3) H



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## 52. Match the following processes with entropy change

Reaction	Entropy change
A. A liquid vaporises	1. $\Delta S = 0$
B. Reaction is non-spontaneous at all temperatures and $\Delta H$ is positive	2. $\Delta S = \text{positive}$
C. Reversible expansion of an ideal gas	3. $\Delta S = \text{negative}$



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53. Match the following parameters with description for spontaneity

$\Delta$ (Parameters) $\Delta_r H^\ominus$ $\Delta_r S^\ominus$ $\Delta_r G^\ominus$	Description
A. + - +	1. Non-spontaneous at high temperature
B. - - + at high T	2. Spontaneous at all temperatures
C. - + -	3. Non-spontaneous at all temperatures

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54. Match the following

A. Entropy of vaporisation	1. decreases
B. $K$ for spontaneous process	2. is always positive
C. Crystalline solid state	3. lowest entropy
D. $\Delta U$ in adiabatic expansion of ideal gas	4. $\frac{\Delta H_{\text{vap}}}{T_b}$

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55. Assertion (A). Combustion of all organic compounds is an exothermic reaction.

Reason (R). The enthalpies of all elements in their standard state are zero

- A. Both A and R are true and R is the correct explanation of A
- B. Both A and R are true but R is not the correct explanation of A
- C. A is true but R is false
- D. A is false but R is true

**Answer: B**



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**56.** Assertion (A). Spontaneous process is an irreversible process and may be reversed by some external agency.

Reason (R). Decrease in enthalpy is a contributory factor for spontaneity

- A. Both A and R are true and R is the correct explanation of A
- B. Both A and R are true but R is not the correct explanation of A
- C. A is true but R is false

D. A is false but R is true

**Answer: B**

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57. Assertion (A). A liquid crystallises into a solid and is accompanied by decrease in entropy.

Reason (R). In crystals, molecules organise in an ordered manner.

- A. Both A and R are true and R is the correct explanation of A
- B. Both A and R are true but R is not the correct explanation of A
- C. A is true but R is false
- D. A is false but R is true

**Answer: A**

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58. Derive the relationship between  $\Delta H$  and  $\Delta U$  for an ideal gas.

Explain each term involved in the equation.

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59. Extensive properties depends on the quantity of matter but intensive properties do not. Explain whether the following properties are extensive or intensive.

Mass internal energy, pressure, heat capacity, molar heat capacity, density, mole fraction, specific heat, temperature and molarity

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60. The lattice enthalpy of an ionic compound is the enthalpy when one mole of an ionic compound present in its gaseous state, dissociates into its ions. It is impossible to determine it directly by experiment. Suggest and explain in indirect method to measure lattice enthalpy of  $\text{NaCl(s)}$ .

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61.  $\Delta G$  is energy available to do useful work and is thus a measure of "Free energy". Show mathematically that  $\Delta G$  is a measure of free energy. Find the unit of  $\Delta G$ . If a reaction has positive enthalpy change and positive entropy change, under what condition will the reaction be spontaneous ?

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62. Graphically show the total work done in an expansion when the state of an ideal gas is changed reversibly and isothermally from  $(p_i, V_i)$  to  $(p_f, V_f)$ . With the help of a pV plot compare the work done in the above case with that carried out against a constant pressure  $p_f$ .

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