



## CHEMISTRY

### BOOKS - NARENDER AVASTHI CHEMISTRY (HINGLISH)

## THERMODYNAMICS

### Exercise

1. Out of molar entropy (I), specific volume (II), heat capacity (III), volume (IV), extensive properties are :

A. I, II

B. I, II, IV

C. II, III

D. III, IV

**Answer: D**



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2. Out of internal energy (I), boiling point (II), pH (III) and E.M.F. of the cell (IV) intensive properties are :

A. I, II

B. II, III, IV

C. I, III, IV

D. All of these

**Answer: B**



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3. Thermodynamic equilibrium involves

A. chemical equilibrium

B. mechanical equilibrium

C. thermal equilibrium

D. all the above simultaneously

**Answer: D**



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4. Which has maximum internal energy at  $290K$  ?

A. Neon gas

B. Nitrogen gas

C. Ozone gas

D. Equal for all

**Answer: C**



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5. A 10g piece of iron ( $C = 0.45\text{J/g}^\circ\text{C}$ ) at  $100^\circ\text{C}$  is dropped into 25g of water ( $C = 4.2\text{J/g}^\circ\text{C}$ ) at  $27^\circ\text{C}$ . Find temperature of the iron and water system at thermal equilibrium .

A.  $30^\circ\text{C}$

B.  $33^\circ\text{C}$

C.  $40^\circ\text{C}$

D. None of these

**Answer: A**



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6. When freezing of a liquid takes place in a system it:

A. may have  $q > 0$  or  $q < 0$  depending on the liquid

B. is represented by  $q > 0$

C. is represented by  $q < 0$

D. has  $q = 0$

**Answer: C**



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7. Mechanical work is specially important in systems that contain

A. gas-liquid

B. liquid-liquid

C. solid-solid

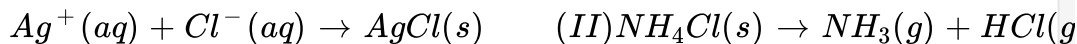
D. amalgam

**Answer: A**



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8. Determine which of the following reactions taking place at constant pressure represents system that do work on the surrounding environment



A. I

B. III

C. II and III

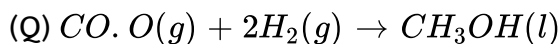
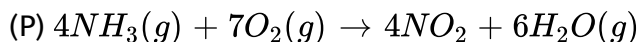
D. I and II

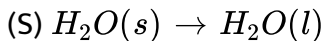
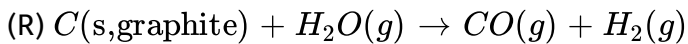
**Answer: C**



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9. Determine which of the following reactions at constant pressure represent surrounding that do work on the system environment :





A. III, IV

B. II and III

C. II, IV

D. I and II, IV

**Answer: D**



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**10.** A sample of liquid in a thermally insulated constant ( a calorimetre ) is stirred for 2 hr. by a mechanical linkage to motor in the surrounding ,for this process :

A.  $w < 0, q = 0, \Delta U = 0$

B.  $w > 0, q > 0, \Delta U > 0$

C.  $w < 0, q > 0, \Delta U = 0$

$$D. w > 0, q = 0, \Delta U > 0$$

**Answer: D**



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11. An ideal gas expand against a constant external pressure at 2.0 atmosphere from 20 litre to 40 litre and absorb  $10kJ$  of energy from surrounding . What is the change in internal energy of the system ?

- A. 4052 J
- B. 5948 J
- C. 14052 J
- D. 9940 J

**Answer: B**



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12. 2 mole of zinc is dissolved in HCl at  $25^{\circ}$  C. The work done in open vessel is :

- A.  $-2.477kJ$
- B.  $-4.955kJ$
- C.  $0.0489kJ$
- D. None

**Answer: B**



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13. A sample of an ideal gas is expanded  $1m^3$  to  $3m^3$  in a reversible process for which  $P = KV^2$ , with  $K = 6\text{bar}/m^6$ . What is work done by the gas (in kj) ?

- A. 5200 J
- B. 15600 kj

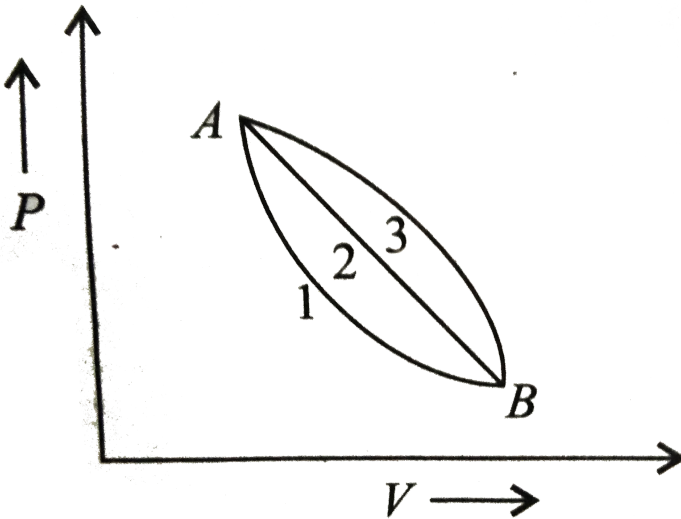
C. 52 kJ

D. 5267.6 kJ

**Answer: A**

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14. A given mass of gas expands from state  $A$  to state  $B$  by three paths 1, 2, and 3 as shown in the figure below. If  $w_1$ ,  $w_2$  and  $w_3$ , respectively, be the work done by the gas along three paths, then



A.  $w_1 > w_2 > w_3$

B.  $w_1 < w_2 < w_3$

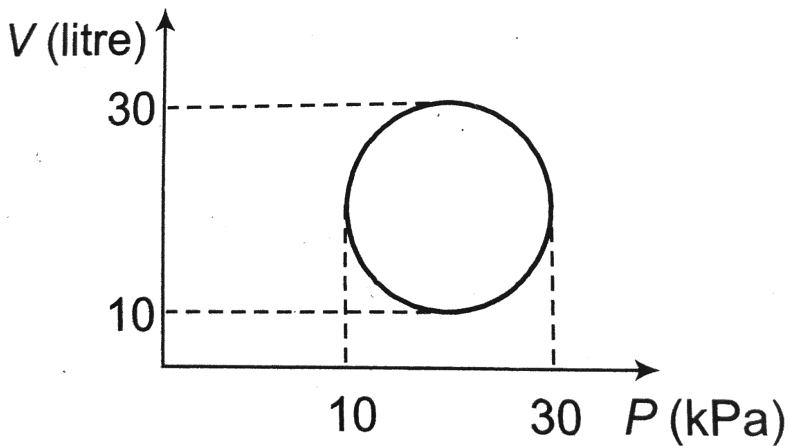
C.  $w_1 = w_2 = w_3$

D.  $w_2 < w_3 < w_1$

**Answer: B**

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15. Heat energy absorbed by a system in going through a cyclic process shown in figure is



A.  $10^7 \pi J$

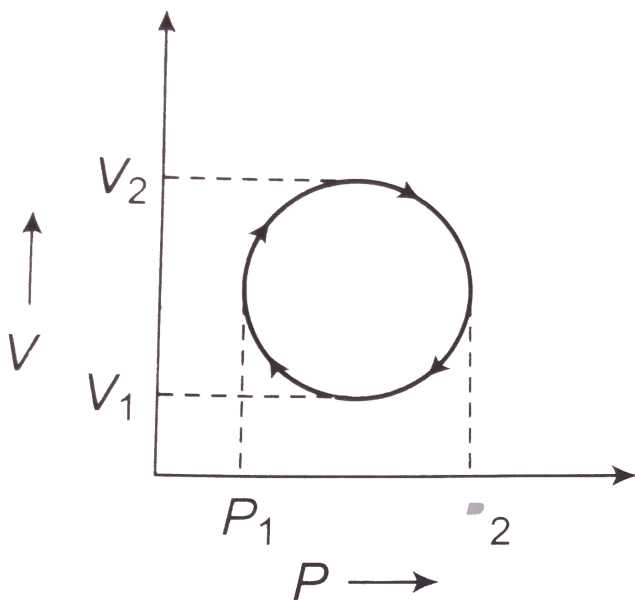
B.  $10^6 \pi J$

C.  $10^2 \pi J$

D.  $10^4 \pi J$

Answer: C

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16.

In the cyclic process shown in the  $V - P$  diagram the magnitude of the work is done is

A.  $\pi \left( \frac{P_2 - P_1}{2} \right)^2$

B.  $\pi \left( \frac{V_2 - V_1}{2} \right)^2$

C.  $\frac{\pi}{4} (P_2 - P_1)(V_2 - V_1)$

D.  $\pi (V_2 - V_1)^2$

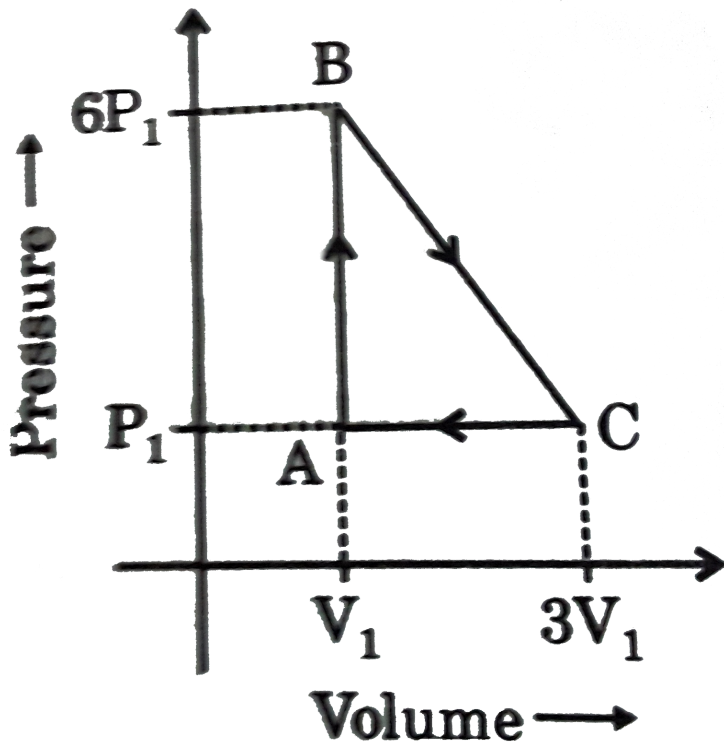
**Answer: C**



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17. An ideal gas is taken around the cycle ABCA as shown in P-V diagram.

The net work done by the gas during the cycle is equal to :



- A.  $12P_1V_1$
- B.  $6P_1V_1$
- C.  $5P_1V_1$
- D.  $P_1V_1$

Answer: C



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18. An ideal gas is at pressure  $P$  and temperature  $T$  in a box, which is kept in vacuum with in a large container. The wall of the box is punctured. What happens as the gas occupies entire container?

- A. It's temperature falls
- B. Its temperature rises
- C. Its temperature remains the same
- D. Unpredicatable

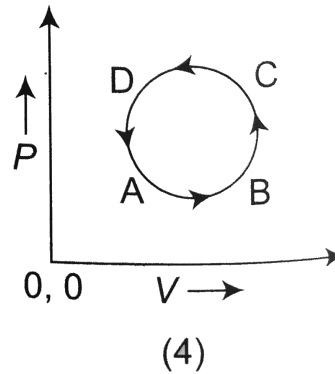
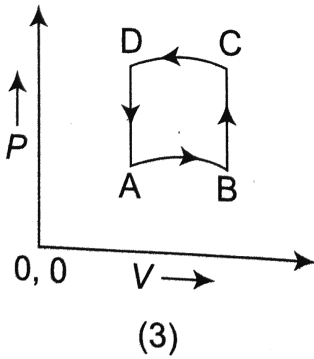
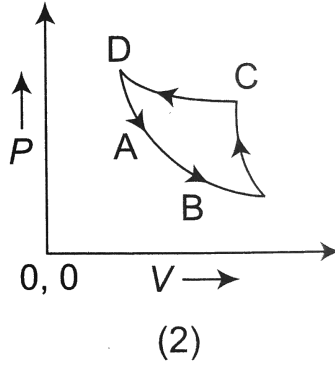
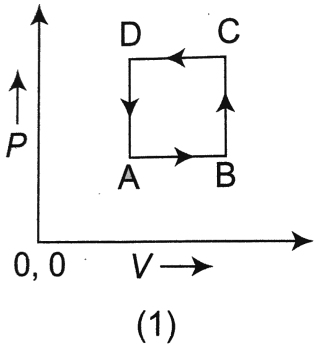
**Answer: C**



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19. In following figs. Variation of volume by change of pressure is shown in Fig. A gas is taken along the path  $ABCD A$ . The change in internal

energy of the tgas will be:



- A. Positive in all the cases (1) to (4)
- B. Positive in cases (1), (2), (3) but zero in case (4)
- C. Negative in cases (1), (2), (3) but zero in case (4)
- D. Zero in all the cases

**Answer: D**



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20. If the door of a refrigerator is kept open, then which of the following is true

A. gets cooled

B. gets heated

C. neither gets cooled nor gets heated

D. gets cooled or heated depending on the initial temperature of the room

**Answer: B**



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21. The temperature of an ideal gas increases in an:

A. adiabatic expansion

B. isothermal expansion

C. adiabatic compression

D. isothermal compression

**Answer: C**



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**22.** For two mole of an ideal gas :

A.  $C_v - C_p = R$

B.  $C_p - C_v = 2R$

C.  $C_p - C_v = R$

D.  $C_v - C_p = 2R$

**Answer: B**



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23. Which of the following expressions is true for an ideal gas ?

A.  $\left(\frac{\partial V}{\partial T}\right)_P = 0$

B.  $\left(\frac{\partial P}{\partial T}\right)_V = 0$

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

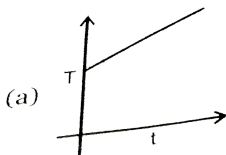
D.  $\left(\frac{\partial U}{\partial T}\right)_V = 0$

Answer: C

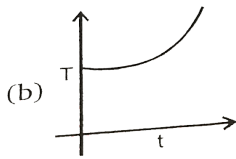


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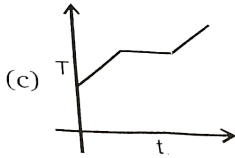
24. If liquefied oxygen at 1 atmospheric pressure is heated from 50K to 300k by supplying heat at constant rate. The graph of temperature vs time will be



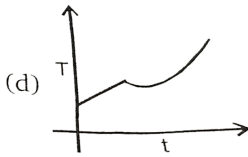
A.



B.



C.



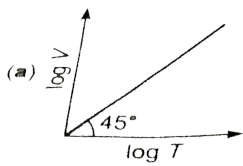
D.

**Answer: C**

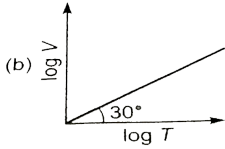
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25. For a closed container containing 100 mol of an ideal gas fitted with movable, frictionless, weightless piston operating such that pressure of gas remain constant at 8.21 atm, which graph represents correct variation of  $\log V$  vs  $\log T$  where  $V$  is in litre and  $T$  is in Kelvin ?

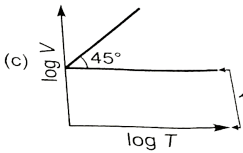
$$\left( R = 0.0821 \frac{\text{atmL}}{\text{molK}} \right)$$



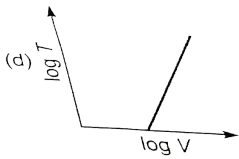
A.



B.



C.



D.

**Answer: A**



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26. 10 mole of ideal gas expand isothermally and reversibly from a pressure of  $10\text{atm}$  to  $1\text{atm}$  at  $300\text{K}$ . What is the largest mass which can be lifted through a height of 100 meter?

A. 31842 kg

B. 58.55 kg

C. 342.58 kg

D. None of these

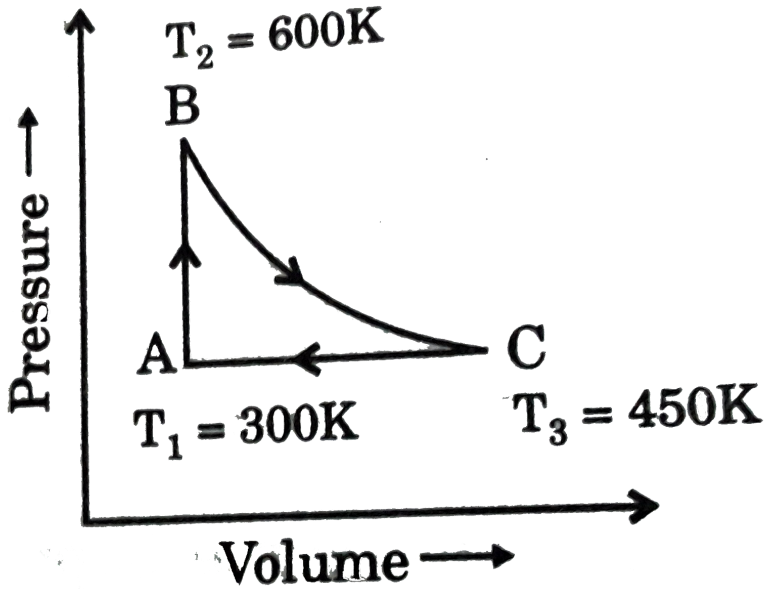
**Answer: B**



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27. A heat engine carries one mole of an ideal monoatomic gas around the cycle as shown in the figure, the amount of heat added in the process

AB and heat removed in the process CA are :



- A.  $q_{AB} = 450R$  and  $q_{CA} = -450R$
- B.  $q_{AB} = 450R$  and  $q_{CA} = -225R$
- C.  $q_{AB} = 450R$  and  $q_{CA} = -375R$
- D.  $q_{AB} = 375R$  and  $q_{CA} = -450R$

Answer: C



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28. What is the final temperature of 0.10 mole monoatomic ideal gas that performs  $75\text{cal}$  of work adiabatically, if the initial temperature is  $227^\circ\text{C}$  (use  $R = 2\text{cal}/\text{K} - \text{mol}$ )

- A. 250 K
- B. 300 K
- C. 350 K
- D. 750 K

**Answer: A**



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29. The work done by 1 mole of ideal gas during an adiabatic process is (are ) given by :

- A.  $\frac{P_2V_2 - P_1V_1}{\gamma - 1}$
- B.  $\frac{nR(T_1 - T_2)}{\gamma - 1}$



C.  $\frac{P_2V_2 - P_1V_1}{\gamma}$

D. None of these

**Answer: A**



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**30.** During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio  $C_P / C_V$  for the gas is

A.  $\frac{3}{2}$

B.  $\frac{5}{3}$

C.  $\frac{7}{2}$

D.  $\frac{4}{3}$

**Answer: A**



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31. A gas expands adiabatically at constant pressure such that  $T \propto V^{-1/2}$  The value of  $\gamma(C_{p,m}/C_{v,m})$  of the gas will be :

A. 1.3

B. 1.5

C. 1.7

D. 2

**Answer: B**



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32. For a reversible adiabatic ideal gas expansion  $\frac{dp}{p}$  is equal to

A.  $\gamma \frac{dV}{V}$

B.  $-\gamma \frac{dV}{V}$

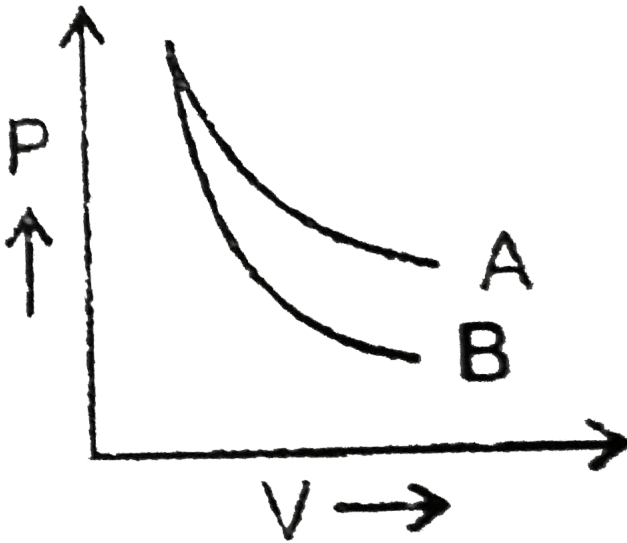
C.  $\left(\frac{\gamma}{\gamma - 1}\right) \frac{dV}{V}$

D.  $\frac{dV}{V}$

Answer: B

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33.  $P - V$  plot for two gases (assuming ideal) during adiabatic processes are given in the figure. Plot  $A$  and Plot  $B$  should correspond respectively to:



A. He and  $H_2$

B.  $H_2$  and He

C. He and Ne

D.  $H_2$  and  $Cl_2$

**Answer: B**

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**34.** Calculate the final temperature of a monoatomic ideal gas that is compressed reversible and adiabatically from  $16L$  to  $2L$  at  $300K$  :

A. 600 K

B. 1044.6 K

C. 1200 K

D. 2400 K

**Answer: C**

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35. 5 mole of an ideal gas expand isothermally and irreversibly from a pressure of 10 atm to 1 atm against a constant external pressure of 1 atm.

$w_{irr}$  at 300 K is :

- A.  $-15.921kJ$
- B.  $-11.224kJ$
- C.  $-110.83kJ$
- D. None of these

**Answer: B**

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36. With what minimum pressure (in kPa), a given volume of an ideal gas ( $C_{p,m} = 7/2R$ ) originally at 400 K and 100 kPa pressure can be compressed irreversibly adiabatically in order to raise its temperature to 600 K :

A. 362.5 kPa

B. 275 kPa

C. 437.5 kPa

D. 550 kPa

**Answer: B**



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37. The work done in adiabatic compression of 2 mole of an ideal monoatomic gas by constant external pressure of  $2\text{ atm}$  starting from initial pressure of  $1\text{ atm}$  and initial temperature of  $30\text{ K}$  ( $R = 2\text{ cal/mol-degree}$ )

A. 360 cal

B. 720 cal

C. 800 cal

D. 1000 cal

**Answer: B**

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**38.** One mole of an ideal gas  $\left(C_{v,m} = \frac{5}{2}R\right)$  at 300 K and 5 atm is expanded adiabatically to a final pressure of 2 atm against a constant pressure of 2 atm. Final temperature of the gas is :

- A. 270 K
- B. 273 K
- C. 248.5 K
- D. 200 K

**Answer: C**

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39. 10 litre of a non linear polyatomic ideal gas at  $127^{\circ}C$  and 2 atm pressure is suddenly released to 1 atm pressure and the gas expanded adiabatically against constant external pressure. The final temperature and volume of the gas respectively are.

A.  $T=350K, V = 17.5L$

B.  $T = 300 K, V = 15 L$

C.  $T = 250 K, V = 12.5 L$

D. None of these

**Answer: A**

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40. Calculate average molar heat capacity at constant volume of gaseous mixture contained 2 mole of each of two ideal gases  $A \left( C_{v,m} = \frac{3}{2}R \right)$  and  $B \left( C_{v,m} = \frac{5}{2}R \right)$ :



A.  $R$

B.  $2R$

C.  $3R$

D.  $8R$

**Answer: B**

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41. 0.5 mole each of two ideal gases  $A$  ( $C_{v,m} = \frac{5}{2}R$ ) and  $B$  ( $C_{v,m} = 3R$ ) are taken in a container and expanded reversibly and adiabatically, during this process temperature of gaseous mixture decreased from 350 K to 250 K. Find  $\Delta H$  (in cal/mol) for the process :

A.  $-100R$

B.  $-137.5R$

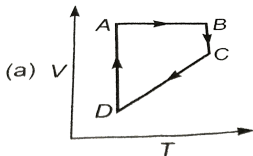
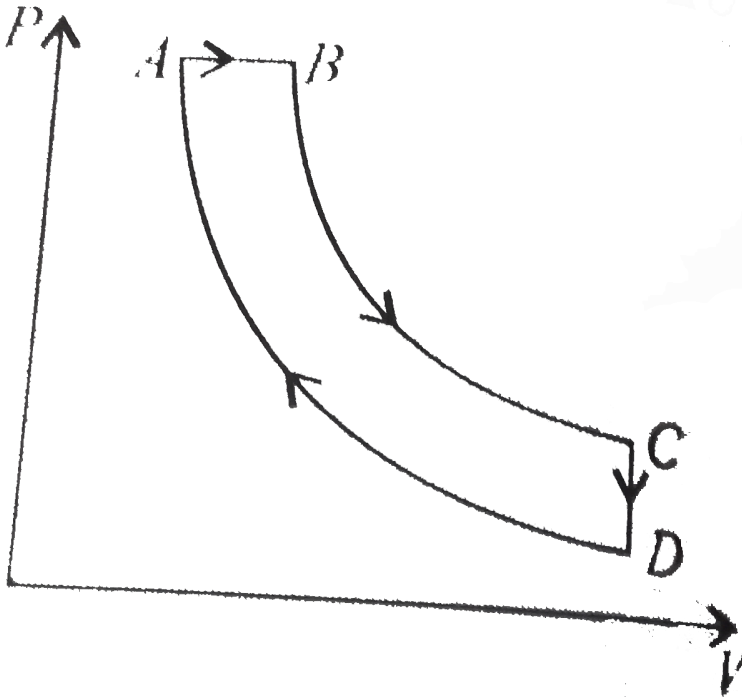
C.  $-375R$

D. None of these

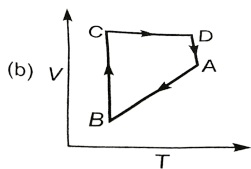
Answer: C

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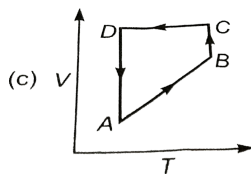
42. A cyclic process  $ABCD$  is shown in the  $P - V$  diagram. Which of the following curves represents the same process?



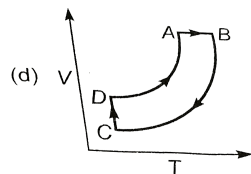
A.



B.



C.



D.

**Answer: A**

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43. 36 mL of pure water takes 100 sec to evaporate from a vessel when a heater of 806 watt is used. The  $\Delta H_{\text{vaporisation}}$  of  $H_2O$  is (density of water =  $1g/cc$ )

A.  $40.3kJ/mol$

B.  $43.2kJ/mol$

C.  $4.03\text{kJ/mol}$

D. None of these

**Answer: A**

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44. For the reaction :  $\text{PCl}_5(g) \rightarrow \text{PCl}_3(g) + \text{Cl}_2(g)$ :

A.  $\Delta H = \Delta U$

B.  $\Delta H > \Delta U$

C.  $\Delta < \Delta U$

D. None of the above

**Answer: B**

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45. Consider the reaction at 300 K



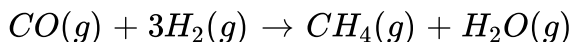
If 2 mole of  $H_2$  completely react with 2 mole of  $Cl_2$  to form  $HCl$ . What is  $\Delta U^\circ$  for this reaction ?

- A. 0
- B.  $-185kJ$
- C. 370 kJ
- D. None of these

Answer: D

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46. Which of the indicated relationship is correct for the following exothermic reaction carried out at constant pressure?



A.  $\Delta U = \Delta H$

B.  $\Delta U > \Delta H$

C.  $w < 0$

D.  $q > 0$

**Answer: B**



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**47.** One mole of an ideal gas undergoes a change of state (2.0 atm, 3.0 L) to (2.0 atm, 7.0 L) with a change in internal energy ( $\Delta U$ ) = 30 L-atm. The change in enthalpy ( $\Delta H$ ) of the process in L-atm :

A. 22

B. 38

C. 25

D. None of these

**Answer: B**

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**48.** What is the change internal energy when a gas contracts from 377 mL to 177 mL under a constant pressure of 1520 torr, while at the same time being cooled by removing 124 J heat ?

[*Take: (1Latm) = 100J*]

- A. 40.52 J
- B.  $-83.48J$
- C.  $-248J$
- D. None of these

**Answer: B**

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49. For the real gases reaction,

$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$ ,  $\Delta H = -560kJ$ . In 10 litre rigid vessel at 500 K the initial pressure is 70 bar and after the reaction it becomes 40 bar. The change in internal energy is :

A.  $-557kJ$

B.  $-530kJ$

C.  $-563kJ$

D. None of these

**Answer: B**



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50. One mole of non – ideal gas undergoes a change of state  $(1.0atm, 3.0L, 200K)$  to  $(4.0atm, 5.0L, 250K)$  with a change in internal energy  $(\Delta U) = 40L - atm$ . The change in enthalpy of the process in  $L - atm$ ,



A. 43

B. 57

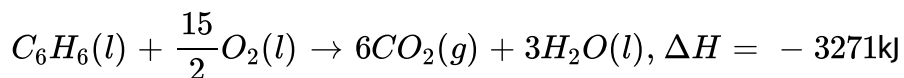
C. 42

D. None of these

**Answer: B**

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51. Consider the reacting at  $300K$



What is  $\Delta U$  for the combustion of 1.5 mole of benzene at  $27^\circ C$  ?

A.  $-3267.25\text{kJ}$

B.  $-4900.88\text{kJ}$

C.  $-4906.5\text{kJ}$

D.  $-3274.75\text{kJ}$

**Answer: B**



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52. For the reaction ,  $FeCO_3(s) \rightarrow FeO(s) + CO_2(g)$ ,  $\Delta H = 82.8kJ$  at  $25^\circ C$ , what is ( $\Delta E$  or  $\Delta U$ ) at  $25^\circ C$ ?

- A. 82.8 kj
- B. 80.32 kj
- C.  $- 2394.77kJ$
- D.  $- 3274.75kJ$

**Answer: B**



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53. At  $5 \times 10^4$  bar pressure density of diamond and graphite are  $3g/cc$  and  $2g/cc$  respectively, at certain temperature ' $T$ '. Find the value of

$\Delta U - \Delta H$  for the conversion of 1 mole of graphite to 1 mole of diamond at temperature ' $T$ ' :

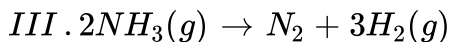
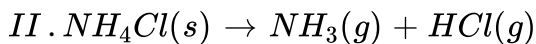
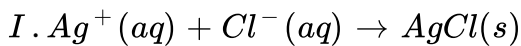
- A. 100 kJ/mol
- B. 50 kJ/mol
- C.  $-100\text{kJ/mol}$
- D. None of these

**Answer: A**



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54. Predict which of the following reaction ( $s$ ) has a positive entropy change?



- A. I and II

B. III

C. II and III

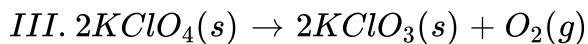
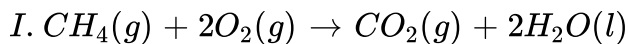
D. II

**Answer: c**



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55. Predict which of the following reaction(s) has a negative entropy change?



A. III

B. II

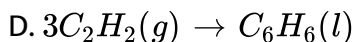
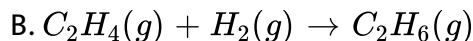
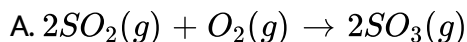
C. I and II

D. I

**Answer: C**

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56. Which of the following reactions is associated with the most negative change in entropy?



**Answer: D**

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57. When two moles of an ideal gas  $\left(C_{p.m.} = \frac{5}{2}R\right)$  heated from 300K to 600K 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.  $\frac{5}{2}R \ln 2$

**Answer: C**

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**58.** Which of the following expression for entropy change of an irreversible process ?

A.  $dS > \frac{dq}{T}$

B.  $dS = \frac{dq}{T}$

C.  $dS < \frac{dq}{T}$

D.  $dS = \frac{dU}{T}$

**Answer: A**

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59. Which of the following expression is known as Clausius inequality ?

A.  $\oint \frac{dq}{T} \leq 0$

B.  $\oint \frac{ds}{T} = 0$

C.  $\oint \frac{T}{dq} \leq 0$

D.  $\oint \frac{dq}{T} \geq 0$

**Answer: A**

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60. In a previous problem, calculate  $\Delta S_{gas}$  If process is carried out at constant volume:

A.  $5R \ln 2$

B.  $\frac{3}{2}R \ln 2$

C.  $3R \ln 2$

D.  $-3R \ln 2$

**Answer: C**



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61. If one mole of an ideal gas ( $C_{p.m.} = \frac{5}{2}R$ ) is expanded isothermally at 300K until its volume is tripled, then change in entropy of gas is:

A. zero

B. infinity

C.  $\frac{5}{2}R \ln 3$

D.  $R \ln 3$

**Answer: D**



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62. If one mole of an ideal gas  $C_p = \frac{5}{2}R$  is expanded isothermally at 300 K until its volume is tripled, if expansion is carried out freely ( $P_{ext} = 0$ ), then  $\Delta S$  is:

- A. zero
- B. infinity
- C.  $R \ln 3$
- D. None

**Answer: C**

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63. 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.  $(C_{v,m} - R) \ln 2$

**Answer: D**

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**64.** What is the change in entropy when 2.5 mole of water is heated from  $27^\circ C$  to  $87^\circ C$ ?

Assume that the heat capacity is constant

$$(C_p)_m(H_2O) = 4.2 J/g = k, \ln(1.2) = 0.18)$$

A. 16.6 J/K

B. 9 J/K

C. 34.02 J/K

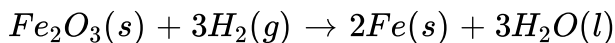
D. 1.89 J/K

**Answer: C**



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**65.** Calculate standard entropy change in the reaction



$$\text{Given : } S_{m0}(Fe_2O_3, S) = 87.4, S_m^\circ(Fe, S) = 27.3$$

$$S_m^\circ(H_2, g) = 130.7, S_m^\circ(H_2O, l) = 69.9 JK^{-1}mol^{-1}$$

A.  $-212.5 JK^{-1}mol^{-1}$

B.  $-215.2 JK^{-1}mol^{-1}$

C.  $-120.9 JK^{-1}mol^{-1}$

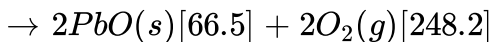
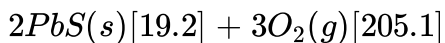
D. None of these

**Answer: B**



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66. Calculate the entropy change ( $J/molK$ ) of the given reaction. The molar entropies ( $J/K - mol$ ) are given in brackets after each substance:



A.  $-113.5$

B.  $-168.3$

C.  $+72.5$

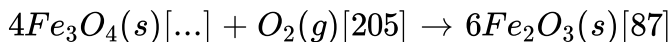
D.  $-149.2$

**Answer: B**

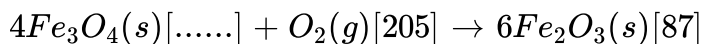


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67. Given  $\Delta_r S^\circ = -266$  and the listed [ $S_m^\circ$  value] Calculate  $S^\circ$  for  $Fe_3O_4(s)$



A. calculate  $S^\circ$  for  $Fe_3O_4(s)$  :



B. + 111.1

C. + 122.4

D. 145.75

**Answer: C**

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**68.** The entropy change for a phase transformation is :

A.  $\frac{\Delta U}{\gamma + dT}$

B.  $\frac{\Delta T}{\Delta H}$

C.  $\frac{\Delta H}{T}$

D.  $\frac{\Delta H + \Delta G}{T}$

**Answer: C**



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69. What is the melting point of benzene if  $\Delta H_{\text{fusion}} = 9.95 \text{ kJ/mol}$  and

$$\Delta S_{\text{fusion}} = 35.7 \text{ J/K} - \text{mol}$$

A.  $278.7^\circ \text{C}$

B.  $278.7^\circ \text{K}$

C. 300 K

D. 298 K

Answer: B



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70.  $\Delta S$  for freezing of 10 g of  $\text{H}_2\text{O}(l)$  (enthalpy of fusion is 80 cal/g) at

$0^\circ \text{C}$  and 1 atm is :

A.  $12.25 \text{ J/K}$

B.  $-0.244J/K$

C.  $-2.93J/K$

D.  $-12.25J/K$

**Answer: D**

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71. Chloroform has  $\Delta H_{\text{vaporization}} = 29.2kJ/\text{mol}$  and boils at  $61.2^{\circ}C$ .

What is the value of  $\Delta H_{\text{vaporization}} = 29.2kJ/\text{mol}$  for chloroform ?

A.  $87.3J/\text{mol} - K$

B.  $477.1J/\text{mol} - K$

C.  $-87.3J/\text{mol} - K$

D.  $-477.1J/\text{mol} - K$

**Answer: A**

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72. The entropy of vaporisation of benzene is  $85JK^{-1}mol^{-1}$ . When 117g benzene vaporizes at its normal boiling point, the entropy change in surrounding is:

A.  $-85JK^{-1}$

B.  $-85 \times 1.5JK^{-1}$

C.  $85 \times 1.5JK^{-1}$

D. None of these

**Answer: B**



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73. Identify the correct statement regarding entropy

A. At absolute zero temperature, the entropy of perfectly crystalline substances is  $+ve$



B. At absolute zero temperature entropy of perfectly crystalline substance is taken to be zero

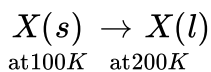
C. At  $0^{\circ}C$  the entropy of a perfectly crystalline substance is taken to be zero

D. At absolute zero temperature, the entropy of all crystalline substance is taken to be zero

**Answer: B**

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**74.** Calculate  $\Delta S$  for following process :



Given : Melting point of

$$X_s = 100K, \Delta H_{\text{Fusion}} = 20kJ/\text{mol}, C_{p.m}(X, l) = 10J/\text{mol} \cdot K$$

A.  $26.93J/K$

B.  $206.93J/K$

C.  $203J / K$

D.  $206.93kJ / K$

**Answer: B**

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75. For a perfectly crystalline solid  $C_{p.m.} = aT^3$ , where  $a$  is constant. If

$C_{p.m.}$  is  $0.42J/K\text{-"mol"}$  at  $10K$ , molar entropy at  $10K$  is:

A.  $0.42 J/k \text{ mol}$

B.  $0.14 J/K \text{ mol}$

C.  $1.12 J/K \text{ mol}$

D. zero

**Answer: C**

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76. Consider the following spontaneous reaction  $3X_2(g) \rightarrow 2X_3(g)$ .

What are the sign of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  for the reaction ?

A. +ve, +ve, +ve

B. +ve, -ve, -ve

C. -ve, +ve, -ve

D. -ve, -ve, -ve

**Answer: D**



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77. For the reaction  $2H(g) \rightarrow H_2(g)$ , the sign of  $\Delta H$  and  $\Delta S$  respectively are :

A. +, -

B. +, +

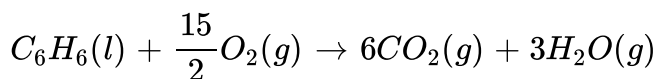
C. -, +

D. -, -

**Answer: D**

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**78.** Consider the following reaction.



signs of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  for the above reaction will be

A. +, -, +

B. -, +, -

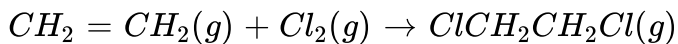
C. -, +, -

D. +, +, -

**Answer: B**

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79. Consider the following reaction at temperature T :



$$\Delta_r H^\circ = -217.5 \text{ kJ/mol}, \quad \Delta_r S^\circ = -233.9 \text{ J/K} - \text{mol}$$

Reaction is supported by :

- A. entropy enthalpy
- B. enthalpy
- C. both (a) & (b)
- D. neither

**Answer: B**

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80. For a process to be spontaneous,  $\Delta G$  must be..... .

- A.  $(\Delta G)_{\text{system}}$  must be negative
- B.  $(\Delta G)_{\text{system}}$  must be positive

C.  $(\Delta S)_{\text{system}}$  must be positive

D.  $(\Delta S)_{\text{system}}$  must be negative

**Answer: A**

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**81.** For a reaction to occur spontaneously

A.  $\Delta S$  must be negative

B.  $(-\Delta H + T\Delta S)$  must be positive

C.  $\Delta H + T\Delta S$  must be negative

D.  $\Delta H$  must be negative

**Answer: B**

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82. Which of the following conditions regarding a chemical process ensures its spontaneity at all temperature?

A.  $\Delta H > 0, \Delta S < 0$

B.  $\Delta H < 0, \Delta S > 0$

C.  $\Delta H < 0, \Delta S < 0$

D.  $\Delta H > 0, \Delta S < 0$

**Answer: B**



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83. The free energy change  $\Delta G = 0$ , when

A. the system is at equilibrium

B. catalyst is added

C. reactants are initially mixed thoroughly

D. the reactants are completely consumed

**Answer: A**

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**84.** Which of the following conditions may lead to a non-spontaneous change?

- A.  $\Delta H$  and  $\Delta S$  both  $+ve$
- B.  $\Delta H$  is  $-ve$  and  $\Delta S$  is  $+ve$
- C.  $\Delta H$  and  $\Delta S$  both  $-ve$
- D.  $\Delta H$  is  $+ve$  and  $\Delta S$  is  $-ve$

**Answer: D**

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**85.** Suppose that a reaction has  $\Delta H = -40kJ$  and  $\Delta S = -50J/K$ .  
At what temperature range will it change from spontaneous to non-



spontaneous?

- A. 0.8 K to 1 K
- B. 799 K to 800 K
- C. 800 K to 801 K
- D. 799 K to 801 K

**Answer: D**



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**86.** For isothermal expansion in case of an ideal gas :

- A.  $\Delta G = \Delta S$
- B.  $\Delta G = \Delta H$
- C.  $\Delta G = -T \cdot \Delta S$
- D. None of these

**Answer: C**



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87. What is the normal boiling point of mercury?

$$\text{Given : } \Delta H_f^\circ (Hg, l) = 0, S^\circ (Hg, l) = 77.4J/K - \text{mol}$$

$$\Delta H_f^\circ (Hg, g) = 60.8kJ/\text{mol}, S^\circ (Hg, g) = 174.4J/K - \text{mol}$$

A. 624.8 K

B. 626.8 K

C. 636.8 K

D. None of these

Answer: B



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88. 19 gm of ice is converted into water at  $0^\circ C$  and 1 atm. The entropies of  $H_2O(s)$  and  $H_2O(l)$  are 38.2 and  $60J/\text{mol } K$  respectively. The enthalpy change for this conversion is :

A.  $5951.4J/\text{mol}$

B.  $595.14J/\text{mol}$

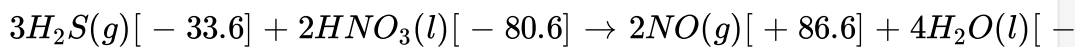
C.  $-5951.4J/\text{mol}$

D. None of these

**Answer: A**

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**89.** Using the listed [ $\Delta G_f^\circ$  values] calculate  $\Delta G^\circ$  for the reaction :



A.  $-513.2$

B.  $-1037.0$

C.  $+433.4$

D.  $+225.0$

**Answer: A**

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90. From the following  $\Delta H^\circ$  and  $\Delta S^\circ$  values, predict which of reactions I, II and III would be spontaneous at  $25^\circ\text{C}$ .

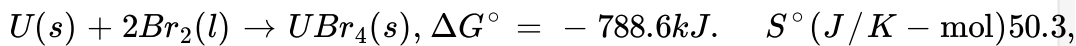
|      | $\Delta H^\circ$ (kJ) | $\Delta S^\circ$ (J/K) |
|------|-----------------------|------------------------|
| I.   | +10.5                 | +30                    |
| II.  | +1.8                  | -113                   |
| III. | -126                  | +84                    |

- A. III
- B. I
- C. II and III
- D. I and II

**Answer: A**

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91. Calculate  $\Delta H_f^\circ$  for  $\text{Ubr}_4$  from the  $\Delta G^\circ$  of reaction and the  $S^\circ$  values at 298 K.



A.  $-822.1 \text{ kJ/mol}$

B.  $-841.2 \text{ kJ/mol}$

C.  $-775.6 \text{ kJ/mol}$

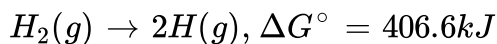
D.  $-804.3 \text{ kJ/mol}$

**Answer: A**



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**92.** The entropies of  $H_2$  (g) and H (g) are  $130.6$  and  $114.6 \text{ J mol}^{-1} \text{ K}^{-1}$  respectively at  $298 \text{ K}$ . Using the data given below calculate the bond energy of  $H_2$  (in  $\text{kJ/mol}$ ):



A.  $377.2$

B.  $436$

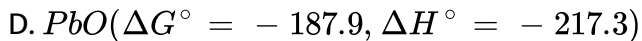
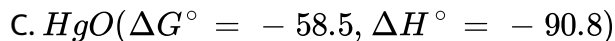
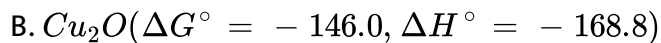
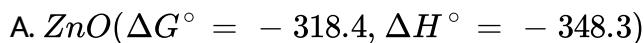
C.  $425.5$

D. 430.5

Answer: B

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93. Consider the  $\Delta G_f^\circ$  and  $\Delta H_f^\circ$  (kJ/mol) for the following oxides. Which can be most easily decomposed to form the metal and oxygen gas?



Answer: C

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94. Which of the following option is correct ?

A.  $\left[ \frac{\partial \ln K_p}{\partial T} \right] = \frac{\Delta H^\circ}{RT^2}$

B.  $\frac{\partial \ln K}{\partial T} = \frac{E_a}{RT^2}$

C.  $\left[ \frac{\partial \ln K_p}{\partial T} \right] = \frac{\Delta U}{RT^2}$

D. All of these

Answer: D



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95. Calculate  $\Delta G^\circ$  (kJ/mol) at  $127^\circ C$  for a reaction with

$K_{\text{equilibrium}} = 10^5$  :

A.  $-38.294$

B.  $-16.628$

C.  $-9.16$

D. None of these

**Answer: A**



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96. When reaction is at standard state at equilibrium, then

A.  $\Delta H^\circ = 0$

B.  $\Delta S^\circ = 0$

C. equilibrium constant  $K=0$

D. equilibrium constant  $K=1$

**Answer: D**



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97. For the auto-ionization of water at

$25^\circ\text{C}$ ,  $\text{H}_2\text{O}(l) \rightleftharpoons \text{H}^+(aq) + \text{OH}^-(aq)$  equilibrium constant is  $10^{-14}$ .

What is  $\Delta G^\circ$  for the process?



A.  $\cong 8 \times 10^4 J$

B.  $\cong 3.5 \times 10^4 J$

C.  $\cong 10^4 J$

D. None of these

**Answer: A**



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**98.** Hess's law states that

A. the standard enthalpy of an overall reaction is the sum of the enthalpy changes in individual reactions.

B. enthalpy of formation of a compound is same as the enthalpy of decomposition of the compound into constituent elements, but with opposite sign.

C. at constant temperature the pressure of a gas is inversely proportional to its volume

D. the mass of a gas dissolved per litre of a solvent is proportional to the pressure of the gas in equilibrium with the solution

**Answer: A**

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**99.** An imaginary reaction  $X \rightarrow Y$  takes place in three steps



If Hess's law is applicable, then the heat of the reaction ( $X \rightarrow Y$ ) is :

A.  $q_1 - q_2 + q_3$

B.  $q_2 - q_3 - q_1$

C.  $q_1 - q_2 - q_3$

D.  $q_3 - q_2 - q_1$

**Answer: B**

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**100.** The enthalpy change for a reaction does not depend upon:

- A. the physical states of reactants and products
- B. use of different reactants for the same product
- C. the number of intermediate reaction steps
- D. the differences in initial or final temperature of involved substances

**Answer: C**

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**101.** The standard enthalpy of formation of gaseous  $H_2O$  at 298 K is  $-241.82$  kJ/mol. Calculate  $\Delta H^\circ$  at 373 K given the following values of the molar heat capacities at constant pressure :

$$H_2O(g) = 33.58 \text{ JK}^{-1} \text{ mol}^{-1}, \quad H_2(g) = 29.84 \text{ JK}^{-1} \text{ mol}^{-1}, \quad O_2(g)$$

Assume that the heat capacities are independent of temperature :

A.  $-242.6 \text{ kJ/mol}$

B.  $-485.2 \text{ kJ/mol}$

C.  $-121.3 \text{ kJ/mol}$

D.  $-286.4 \text{ kJ/mol}$

**Answer: A**



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**102.** Which of the following value of  $\Delta H_f^\circ$  represent that the product is least stable ?

A.  $-94.0 \text{ kcal mol}^{-1}$

B.  $-231.6 \text{ kcal mol}^{-1}$

C.  $+21.4 \text{ kcal mol}^{-1}$

D.  $+64.8\text{kcalmol}^{-1}$

**Answer: D**

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**103.** For which of the following substances is the heat of formation in the standard state zero ?

A. Sucrose

B. Ethanol

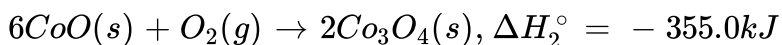
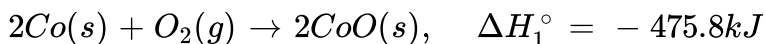
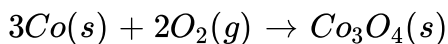
C. Aluminium

D. Calcium chloride

**Answer: C**

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**104.** Calculate the standard enthalpy of reaction for the following reaction using the listed enthalpies of reaction :



A.  $-891.2kJ$

B.  $-120.8kJ$

C.  $+891.2kJ$

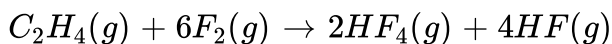
D.  $-830.8kJ$

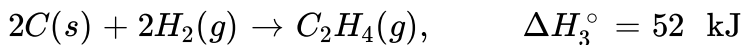
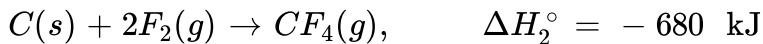
**Answer: A**



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**105.** Given the following equations and  $\Delta H^\circ$  values, determine the enthalpy of reaction at 298 K for the reaction :





A. -1165

B. -2486

C. +1165

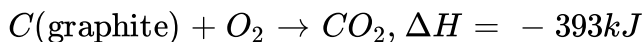
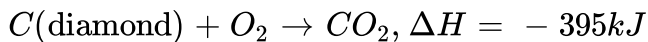
D. +2486

**Answer: B**



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**106.** Given :



The enthalpy of formation of diamond from graphite is

A. +2.0 kJ

B.  $-1.5\text{kJ}$

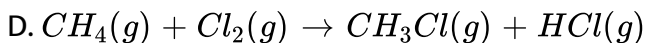
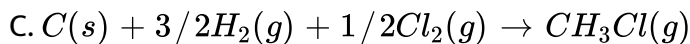
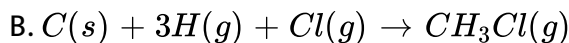
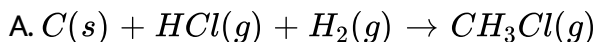
C.  $-788\text{kJ}$

D.  $788\text{kJ}$

**Answer: A**

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**107.** Which of the following equations represents a reaction that provides the enthalpy of formation of  $\text{CH}_3\text{Cl}$ ?

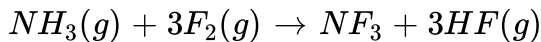


**Answer: C**

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**108.** Use the given standard enthalpies of formation (in kJ/mol) to determine the enthalpy of reaction of the following reaction :



$$\Delta H_f^\circ(NH_3, g) = -46.2, \quad \Delta H_f^\circ(NF_3, g) = -113.0, \quad \Delta H_f^\circ(HF, g) =$$

A.  $-335.8 \text{ kJ/mol}$

B.  $-873.8 \text{ kJ/mol}$

C.  $-697.2 \text{ kJ/mol}$

D.  $-890.4 \text{ kJ/mol}$

**Answer: B**

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**109.** The standard enthalpy of formation of octane ( $C_8H_{18}$ ) is  $-250 \text{ kJ/mol}$ . Calculate the enthalpy of combustion of  $C_8H_{18}$ . The

enthalpy of formation of  $CO_2(g)$  and  $H_2O(l)$  are  $-394kJ/mol$  and  $-286kJ/mol$  respectively.

A.  $-5200\text{ kJ/mol}$

B.  $-5726\text{ kJ/mol}$

C.  $-5476\text{ kJ/mol}$

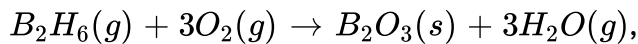
D.  $-5310\text{ kJ/mol}$

**Answer: C**



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**110.** Determine the enthalpy of formation of  $B_2H_6(g)$  in  $\text{kJ/mol}$  of the following reaction :



Given

:

$$\Delta_r H^\circ = -1941\text{ kJ/mol}, \quad \Delta H_f^\circ(B_2O_3, s) = -1273\text{ kJ/mol},$$

$$\Delta H_f^\circ(H_2O, g) = -241.8\text{ kJ/mol}$$

A.  $-75.6$

B.  $+75.6$

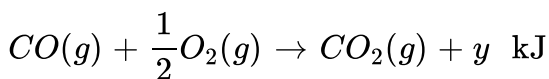
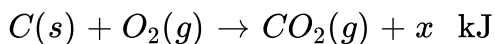
C.  $-57.4$

D.  $-28.4$

**Answer: C**

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**111.** Consider the following reactions:



The heat formation of  $CO(g)$  is :

A.  $-(x + y)$  kJ/mol

B.  $(x - y)$  kJ/mol

C.  $(y - x)$  kJ/mol

D. None of these

**Answer: C**



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112. If  $\Delta_f H^\circ(C_2H_4)$  and  $\Delta_f H^\circ(C_2H_6)$  are  $x_1$  and  $x_2$  kcal  $mol^{-1}$ , then heat of hydrogenation of  $C_2H_4$  is :

A.  $x_1 + x_2$

B.  $x_1 - x_2$

C.  $x_2 - x_1$

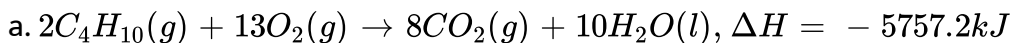
D.  $x_1 + 2x_2$

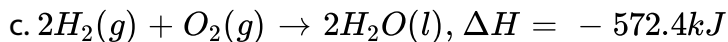
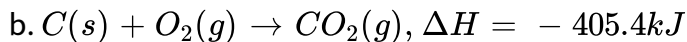
**Answer: C**



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113. Calculate the heat of formation of n butane from the following data:





A. 575.6

B. 287.8

C. 182

D. 57.56

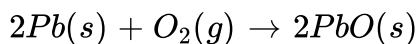
**Answer: B**



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**114.** The enthalpy of the reaction forming PbO according to the following equation is 438 kJ. What heat energy (kJ) is released in formation of 22.3 g PbO(s)?

(Atomic masses : Pb = 207, O = 16.0)



A. 21.9

B. 28.7

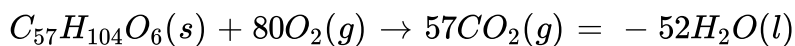
C. 14.6

D. 34.2

**Answer: A**

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**115.** The fat,  $C_{57}H_{104}O_6(s)$ , is metabolized via the following reaction. Given the enthalpies of formation, calculate the energy (kJ) liberated when 1.0 g of this fat reacts.



$$\Delta_f H^\circ(C_{57}H_{104}O_6, s) = -70870 \text{ kJ/mol}, \quad \Delta_f H^\circ(H_2O, l) = -285.8$$

,

$$\Delta_f H^\circ(CO_2, g) = -393.5 \text{ kJ/mol}$$

A. 37.98

B. 40.4

C. 33.4

D. 30.2

**Answer: A**

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**116.** The heat of formation of  $NH_3(g)$  is  $-46 \text{ kJ mol}^{-1}$ . The  $\Delta H$  (in  $\text{kJ mol}^{-1}$ ) of the reaction,  $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$  is

A. 46

B.  $-46$

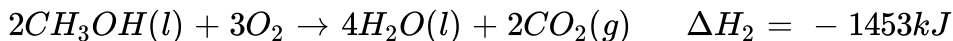
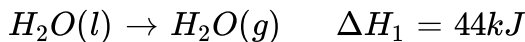
C. 92

D.  $-92$

**Answer: C**

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117. Consider the following reaction:



What is the value of  $\Delta H$  for second reaction if water vapour instead of liquid water is formed as product?

A.  $-1409kJ$

B.  $-1629kJ$

C.  $1277kJ$

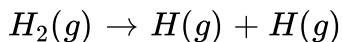
D. None of these

**Answer: C**



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118. The standard enthalpy change for the following reaction is 436.4 kJ :



What is the  $\Delta_f H^\circ$  of atomic hydrogen (H)?



A. 872.8 kJ/mol

B. 218.2 kJ/mol

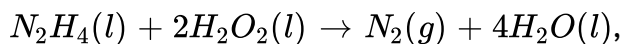
C. - 218.2 kJ/mol

D. - 436.9 kJ/mol

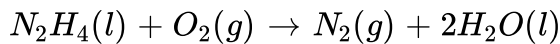
**Answer: B**

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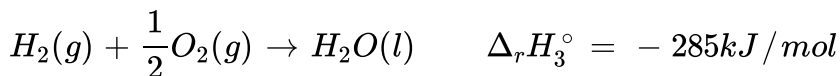
**119.** Determine enthalpy of formation for  $H_2O_2(l)$ , using the listed enthalpies of reaction :



$$\Delta_r H_1^\circ = - 818 \text{ kJ/mol}$$



$$\Delta_r H_2^\circ = - 622 \text{ kJ/mol}$$



A. - 383 kJ/mol

B.  $-187 \text{ kJ/mol}$

C.  $-498 \text{ kJ/mol}$

D. None of these

**Answer: B**



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**120.** Heat of combustion of ethanol at constant pressure and at temperature  $T$  K is found to be  $-q \text{ J mol}^{-1}$ . Hence, heat of combustion (in  $\text{J mol}^{-1}$ ) of ethanol at the same temperature and at constant volume will be :

A.  $RT - q$

B.  $-(q + RT)$

C.  $q - RT$

D.  $q + RT$

**Answer: A**



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**121.** Stearic acid  $[CH_3(CH_2)_{16}CO_2H]$  is a fatty acid the part of fat that stores most of the energy .1.0 g of Stearic acid was burnt in a bomb calorimeter . The bomb had capacity of  $652 J/^\circ C$ . If the temperature of 500 g water rose from  $25.0$  to  $39.3^\circ C$  how much heat is released when the stearic acid was burned?

[Given  $C_p(H_2O) = 4.18J/g^\circ c$ ]

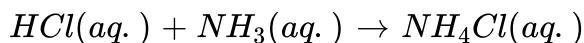
- A. 39.21 kj
- B. 29.91 kj
- C. 108 kj
- D. 9.32 kj

**Answer: A**



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122. A 0.05 L sample of 0.2 M aqueous hydrochloric acid is added to 0.05 L of 0.2 M aqueous ammonia in a calorimeter. Heat capacity of entire calorimeter system is 480 J/K. The temperature increase is 1.09 K. Calculate  $\Delta_r H^\circ$  in kJ/mol for the following reaction :



- A. - 52.32
- B. - 61.1
- C. - 55.8
- D. - 58.2

**Answer: A**



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123. a Coffee cup calorimeter initially contains 125 g of water , at a temperature of  $24.2^\circ\text{C}$  ,8 of ammonium nitrate ( $NH_4NO_3$ ) also at

24.2° C is added to the Water and the final temperature is 18.2° c What is the heat of solution of ammonium nitrate in KJ /mol? (The specific heat capacity of the solution is 4.2J /° c.)

A. 33.51 kJ/mol

B. 39.5 kJ/mol

C. 32.2 kJ/mol

D. 37.3 kJ/mol

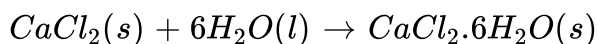
**Answer: A**



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**124.** Read following statement(s) carefully and select the right option :

(I) The enthalpy of solution of  $CaCl_2 \cdot 6H_2O$  in a large volume of water is endothermic to the extent of 3.5 kcal/mol. If  $\Delta H = -23.2$  kcal for the reaction,



then heat of solution of  $CaCl_2$  (anhydrous) in a large volume of water is -

19.7 kcal/mol

(II) For the reaction  $2Cl(g) \rightarrow Cl_2(g)$ , the sign of  $\Delta H$  and  $\Delta S$  are negative.

A. Statement I and II both are wrong

B. both are correct

C. only I is correct

D. only II is correct

**Answer: B**



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**125.** If the enthalpy of formation and enthalpy of solution of HCl (g) are  $92.3 \text{ kJ/mol}$  and  $-75.14 \text{ kJ/mol}$  respectively then find the enthalpy of  $Cl^-$  (aq):

A.  $-17.16 \text{ kJ/mol}$

B.  $-167.44 \text{ kJ/mol}$

C. 17.16 kJ/mol

D. None of these

**Answer: B**



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**126.** At  $25^{\circ}\text{C}$ , when 1 mole of  $\text{MgSO}_4$  was dissolved in water, the heat evolved was found to be 91.2 kJ. One mole of  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  on dissolution gives a solution of the same composition accompanied by an absorption of 13.8 kJ. The enthalpy of hydration, i.e.,  $\Delta H_h$  for the reaction  $\text{MgSO}_4(s) + 7\text{H}_2\text{O}(l) \rightarrow \text{MgSO}_4 \cdot 7\text{H}_2\text{O}(s)$  :

A.  $-105\text{kJ/mol}$

B.  $-77.4\text{kJ/mol}$

C. 105 kJ/mol

D. None of these

**Answer: A**



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127. The enthalpy of neutralization of weak base A OH and a strong base BOH by HCl are  $-12250 \text{ cal/mol}$  and  $-13000 \text{ cal/mol}$  respectively . When one mole of HCl is added to a solution containing 1 mole of A OH and 1 mole of BOH , the enthalpy change was  $-12500 \text{ cal/mol}$  . In what ratio is the acid distribution between A OH and BOH?

A. 2 : 1

B. 2 : 3

C. 1 : 2

D. None of these

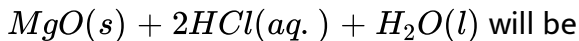
**Answer: A**



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**128.** The absolute enthalpy of neutralization of the reaction,



- A. less than  $57 \text{ kJ mol}^{-1}$
- B.  $-57 \text{ kJ mol}^{-1}$
- C. greater than  $57 \text{ kJ mol}^{-1}$
- D.  $57 \text{ kJ mol}^{-1}$

**Answer: C**



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**129.** Enthalpy of neutralization of HCl by NaOH is  $-55.84 \text{ kJ/mol}$  and by

$\text{NH}_4\text{OH}$  is  $51.34 \text{ kJ/mol}$ . The enthalpy of ionization of  $\text{NH}_4\text{OH}$  is :

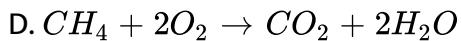
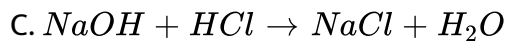
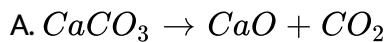
- A.  $107.18 \text{ kJ/mol}$
- B.  $4.5 \text{ kJ/mol}$
- C.  $-4.5 \text{ kJ/mol}$

D. None of these

**Answer: B**

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**130.** Which of the following reaction is endothermic?



**Answer: A**

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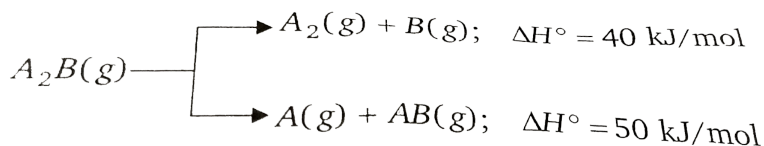
**131.** Which of the following is not correct ?

- A. Dissolution of a salt in excess of water may be endothermic process
- B. Neutralisation is always exothermic
- C. The absolute value of enthalpy (H) can be determined by calorimeter
- D. The heat of reaction at constant volume is denoted by  $\delta U$

**Answer: C**

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**132.** Substance  $A_2B(g)$  can undergoes decomposition to form two set of products :



If the molar ratio of  $A_2(g)$  to  $A(g)$  is 5 : 3 in a set of product gases, then the energy involved in the decomposition of 1 mole of  $A_2B(g)$  is :

- A. 48.75 kJ/mol

B. 43.73 kJ/mol

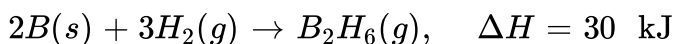
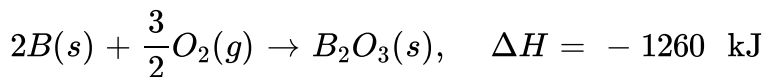
C. 46.25 kJ/mol

D. None of these

**Answer: B**

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**133.** Boron can undergo the following reactions with the given enthalpy changes :



Assume no other reactions are occurring.

If in a container (operating at constant pressure) which is isolated from the surrounding, mixture of  $H_2$  (gas) and  $O_2$  (gas) are passed over excess of B(s), then calculate the molar ratio ( $O_2 : H_2$ ) so that temperature of the container do not change :

A. 15:3

B. 42: 1

C. 1: 42

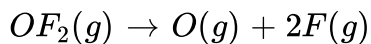
D. 1: 84

**Answer: D**



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**134.** The enthalpy change for the following reaction is 368 kJ. Calculate the average O-F bond energy.



A. 184 kJ/mol

B. 368 kJ/mol

C. 536 kJ/mol

D. 736 kJ/mol

**Answer: A**



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135. The enthalpy change for the reaction,  $C_2H_6(g) \rightarrow 2C(g) + 6H(g)$  is X kJ. The bond energy of C-H bond is :

A.  $\frac{X}{2}$

B.  $\frac{X}{3}$

C.  $\frac{X}{6}$

D. data insufficient

Answer: D



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136. The table given below lists the bond dissociation energy ( $E_{\text{diss}}$ ) for single covalent bonds formed between C and atoms A, B, D, E.

| Bond    | $E_{\text{diss}} \left( \text{kcal mol}^{-1} \right)$ |
|---------|---|
| $C - A$ | 240   |
| $C - B$ | 382   |
| $C - D$ | 276   |
| $C - E$ | 486   |

Which of the atoms has smallest size ?

A. D

B. E

C. A

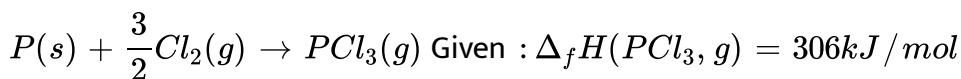
D. D

**Answer: B**



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**137.** Calculate  $P - Cl$  bond enthalpy



$$\Delta H_{\text{atomization}}(P, s) = 314 \text{ kJ/mol},$$

$$\Delta_r H(Cl, g) = 1231 \text{ kJ/mol}$$

A. 123.66 kJ/mol

B. 371 kJ/mol

C. 19 kJ/mol

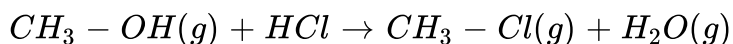
D. None of these

**Answer: A**

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**138.** Calculate the enthalpy for the following reaction using the given bond energies (kJ/mol) :

( $C - H = 414$ ,  $H - O = 463$ ,  $H - Cl = 431$ ,  $C - Cl = 326$ ,  $C - O = 335$ )



A.  $-23$  kJ/mol

B.  $-42$  kJ/mol

C.  $-59$  kJ/mol

D.  $-511$  kJ/mol



**Answer: A**

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**139.** Based on the values of B.E. given,  $\Delta_f H^\circ$  of  $N_2H_4$  (g) is :

Given :  $N - N = 159 \text{ kJ mol}^{-1}$ ,  $H - H = 436 \text{ kJ mol}^{-1}$

$N \equiv N = 941 \text{ kJ mol}^{-1}$ ,  $N - H = 398 \text{ kJ mol}^{-1}$

A.  $711 \text{ kJ mol}^{-1}$

B.  $62 \text{ kJ mol}^{-1}$

C.  $-98 \text{ kJ mol}^{-1}$

D.  $-711 \text{ kJ mol}^{-1}$

**Answer: B**

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**140.** A heating coil is immersed in a 100 g sample of  $H_2O$  (l) at a 1 atm and  $100^\circ$  C in a closed vessel. In this heating process, 60% of the liquid is converted to the gaseous form at constant pressure of 1 atm. The densities of liquid and gas under these conditions are  $1000 \text{ kg/m}^3$  and  $0.60 \text{ kg/m}^3$  respectively. Magnitude of the work done for the process is :  
(Take :  $1\text{L}\cdot\text{atm} = 100\text{J}$ )`

A. 4997J

B. 4970J

C. 9994 J

D. None of these

**Answer: C**



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**141.** A rigid and insulated tank of  $3\text{m}^3$  volume is divided into two compartments. One compartment of volume of  $2\text{m}^3$  contains an ideal gas

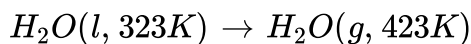
at 0.8314 Mpa and 400 K while the second compartment of volume of  $1\text{m}^3$  contains the same gas at 8.314 Mpa and 500 K. If the partition between the two compartments is ruptured, the final temperature of the gas is :

- A. 420 K
- B. 450 K
- C. 480 K
- D. None of these

**Answer: C**

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**142.** What is the value of change in internal energy at 1 atm in the process?



Given

:

$$C_{v,m}(H_2O, l) = 75.0 JK^{-1}mol^{-1}; \quad C_{p,m}(H_2O, g) = 33.314 JK^{-1}mol^{-1}$$

$$\Delta H_{vap} \text{ at } 373 \text{ K} = 40.7 kJ/mol$$

A.  $42.91 kJ/mol$

B.  $43086 kJ/mol$

C.  $42.6 kJ/mol$

D.  $49.6 kJ/mol$

**Answer: C**



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**143.** For an ideal gas  $\frac{C_{p,m}}{C_{v,m}} = \gamma$ . The molecular mass of the gas is  $M$ , its specific heat capacity at constant volume is :

A.  $\frac{R}{M(\gamma - 1)}$

B.  $\frac{M}{R(\gamma - 1)}$

C.  $\frac{\gamma RM}{\gamma - 1}$

D.  $\frac{\gamma R}{M(\gamma - 1)}$

**Answer: A**

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**144.** 1 mole of an ideal gas A ( $C_{v,m} = 3R$ ) and 2 mole of an ideal gas B are  $\left( \left( C_{v,m} = \frac{3}{2}R \right) \right)$  taken in a container and expanded reversible and adiabatically from 1 litre of 4 litre starting from initial temperature of 320 K.  $\Delta E$  or  $\Delta U$  for the process is :

A. 240 R

B. 240 R

C. 480 R

D. - 960 R

**Answer: D**

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**145.** Calculate the work done by the system in an irreversible (single step) adiabatic expansion of 2 mole of a polyatomic gas ( $\gamma = 4/3$ ) from 300 K and pressure 10 atm to 1 atm :

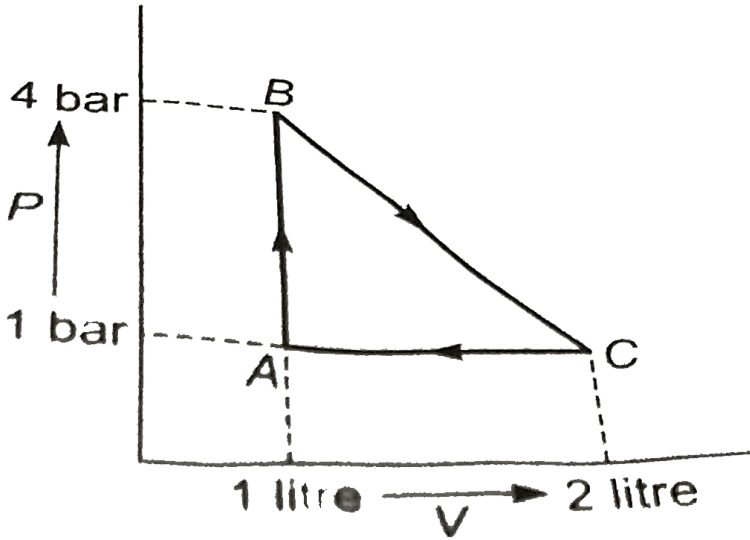
- A.  $-227$
- B.  $-205R$
- C.  $-405R$
- D. None of these

**Answer: C**

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**146.** One mole of an ideal gas is carried through the reversible cyclic process as shown in figure. The max. temperature attained by the gas

during the cycle



A.  $\frac{7}{6R}$

B.  $\frac{12}{49R}$

C.  $\frac{49}{12R}$

D. None of these

Answer: C



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147. A gas  $\left(C_{v.m} = \frac{5}{2}R\right)$  behaving ideally is allowed to expand reversibly and adiabatically from 1 litre to 32 litre. Its initial temperature is  $327^\circ C$ . The molar enthalpy change (in  $J/mol$ ) for the process is :

A.  $-1125R$

B.  $-675$

C.  $-1575R$

D. None of these

**Answer: C**

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148. Two mole of an ideal gas is heated at constant pressure of one atmosphere from  $27^\circ C$  to  $127^\circ C$ . If  $C_{v,m} = 20 + 10^{-2}T \text{ JK}^{-1} \cdot \text{mol}^{-1}$ , then  $q$  and  $\Delta U$  for the process are respectively:

A.  $6362.8J, 4700J$



B. 3037.2J, 4700J

C. 7062.8J, 5400J

D. None of these

**Answer: A**

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**149.** 10 mole of an ideal gas is heated at constant pressure of one atmosphere from  $27^{\circ}C$  to  $127^{\circ}C$ . If

$C_{v,m} = 21.686 + 10^{-3}T (JK^{-1}.mol^{-1})$ , then  $\Delta H$  for the process is :

A. 3000 J

B. 3350 J

C. 3700 J

D. 3181.4J, 2350J

**Answer: D**

150. For polytropic process  $PV^n = \text{constant}$ , molar heat capacity ( $C_m$ ) of an ideal gas is given by:

A.  $C_{v,m} + \frac{R}{(n-1)}$

B.  $C_{v,m} + \frac{R}{(1-n)}$

C.  $C_{v,m} + R$

D.  $C_{p,m} + \frac{R}{(n-1)}$

**Answer: B**

151. 2 mole of an ideal monoatomic gas undergoes a reversible process for which  $PV^2 = C$ . The gas is expanded from initial volume of 1 L to final volume of 3 L starting from initial temperature of 300 K. Find  $\Delta H$  for the process :

- A.  $-600 R$
- B.  $-1000 R$
- C.  $-3000 R$
- D. None of these

**Answer: B**

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**152.** Calculate  $\Delta S$  for 3 mole of a diatomic ideal gas which is heated and compressed from 298 K and 1 bar to 596 K and 4 bar: [Given:

$$C_{v,m}(gas) = \frac{5}{2}R, \ln(2) = 0.70, R = 2calK^{-1}mol^{-1}]$$

- A.  $-14.7cal K^{-1}$
- B.  $+14.7calK^{-1}$
- C.  $-4.9calK^{-1}$
- D.  $6.3 cal K^{-1}$

**Answer: D**



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**153.** One mole of an ideal monoatomic gas at  $27^\circ C$  is subjected to a reversible isentropic compression until the temperature reached to  $327^\circ C$ . If the initial pressure was  $1.0\text{atm}$ , then find the value of  $P_2$

( Given :  $\ln 2 = 0.7$  )

A. 1.75 atm

B. 0.176 atm

C. 1.0395 atm

D. 2.0 atm

**Answer: A**



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154. Two moles of an ideal gas is expanded irreversibly and isothermally at  $37^{\circ}C$  until its volume is doubled and  $3.41KJ$  heat is absorbed from surrounding.  $\Delta S_{\text{total}}(\text{system} + \text{surrounding})$  is:

A.  $-0.52J/K$

B.  $0.52J/K$

C.  $22.52J/K$

D. 0

**Answer: B**



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155. For a perfectly crystalline solid  $C_{p,m} = aT^3 + bT$ , where a and b are constant. If  $C_{p,m}$  is  $0.40 J/K \text{ mol}$  at  $10 K$  and  $0.92 J/K \text{ mol}$  at  $20 K$ , then molar entropy at  $20 K$  is :

A.  $0.92 J/K \text{ mol}$

B. 8.66 J/K mol

C. 0.813 J/K mol

D. None of these

**Answer: C**



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**156.** Which of the following statement (s) is correct?

Statement-1: The entropy of isolated system with P-V work only, is always maximized at equilibrium.

Statement-2: It is possible for the entropy of closed system to decrease substantially in an irreversible process.

Statement-3: Entropy can be created but not destroyed.

Statement-4  $\Delta S_{system}$  is zero for reversible process in an isolated system.

A. Statement i, ii, iii

B. Statement ii, iv

C. Statement I, ii, iii

D. None of these

**Answer: D**

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**157.** Combustion of sucrose is used by aerobic organisms for providing energy for the life sustaining process. If all the capturing of energy from the reaction is done through electrical process (non P-V work), then calculate, maximum available energy which can be captured by combustion of 34.2 g of sucrose :

(Given :  $\Delta H_{\text{combustion}}(\text{sucrose}) = -6000 \text{ kJ mol}^{-1}$

$\Delta S_{\text{combustion}} = 180 \text{ J/K - mol}$  and body temperature is 300 K)

A. 600 kJ

B. 594.6 kJ

C. 5.4 kJ

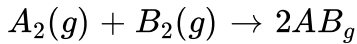
D. 605.4 kJ

**Answer: D**



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**158.** For the hypothetical reaction



$\Delta G_r^\circ$  and  $\Delta S_r^\circ$  are  $20\text{KJ/mol}$  and  $-20\text{JK}^{-1}\text{mol}^{-1}$  respectively at

$\Delta_r C_p$  is  $20\text{JK}^{-1}$  then  $\Delta H_r^\circ$  at  $400\text{K}$  is

- A. 20 kJ/mol
- B. 7.98 kJ/mol
- C. 28 kJ/mol
- D. None of these

**Answer: A**



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159. Calculate  $\Delta_r G^\circ$  for  $(NH_4Cl, s)$  at 310K.

Given :  $\Delta_r H^\circ (NH_4Cl, s) = -314 \text{ kJ/mol}$ ,  $\Delta_r C_p = 0$

$$S_{N_2(g)}^\circ = 192 \text{ JK}^{-1} \text{ mol}^{-1}, S_{H_2(g)}^\circ = 130.5 \text{ JK}^{-1} \text{ mol}^{-1},$$

$$S_{Cl_2(g)}^\circ = 233 \text{ JK}^{-1} \text{ mol}^{-1}, S_{NH_4Cl(s)}^\circ = 99.5 \text{ JK}^{-1} \text{ mol}^{-1}$$

All given data at 300K

A.  $-198.56 \text{ kJ/mol}$

B.  $-426.7 \text{ kJ/mol}$

C.  $-202.3 \text{ kJ/mol}$

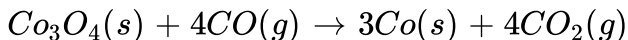
D. None of these

Answer: A



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160. Using listed informations, calculate  $\Delta_r G^\circ$  (in kJ/mol) at  $27^\circ \text{ C}$



Given : At 300 K  $\Delta H_f^\circ$  (kJ/mol) = 891, - 110.5, 0.0, - 393.5

$S^\circ$  (J/K - mol) 102.5, 197.7, 30.0, 213.7

A. - 214.8

B. - 195.0

C. - 200.3

D. -256.45

**Answer: D**



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**161.** Fixed mass of an ideal gas collected in a 24.64 litre sealed rigid vessel at 10 atm is heated from  $-73^\circ C$  to  $27^\circ C$  calculate change in gibbs free energy if entropy of gas is a function of temperature as

$$S = 2 + 10^{-2}T(J/K)(1atm = 0.1kJ)$$

A. 1231.5 J

B. 1281.5 J

C. 781.5 J

D. 0

**Answer: C**

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**162.** The molar heat capacities at constant pressure (assumed constant with respect to temperature ) of A,B and C are in ratio 3:1.5:2.0. the enthalpy change for the exothermic reaction  $A + 2B \rightarrow 3C$  at 300k and 310 K is  $\Delta H_{300}$  and  $\Delta H_{310}$  respectively then:

A.  $\Delta H_{300} > \Delta H_{310}$

B.  $\Delta H_{300} < \Delta H_{310}$

C.  $\Delta H_{300} = \Delta H_{310}$

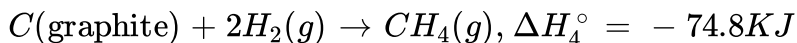
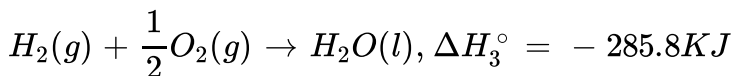
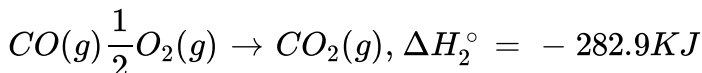
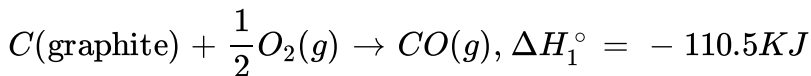
D. if

$T_2 > T_1$  then  $\Delta H_{310} > \Delta H_{300}$  and if  $T_2 < T_1$  then  $\Delta H_{310} < \Delta H_{300}$

Answer: C

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163. Determine  $\Delta U^\circ$  at 300K for the following reaction using the listed enthalpies of reaction :



A.  $-653.5$  kJ

B.  $-686.2$  kJ

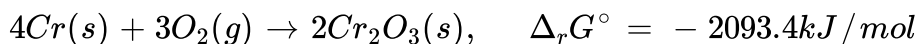
C.  $-747.4$  kJ

D. None of these

Answer: D



164. Calculate  $\Delta_f H^\circ$  (in kJ/mol) for  $Cr_2O_3$  from the  $\Delta_r G^\circ$  and the  $S^\circ$  values provided at  $27^\circ$



$$S^\circ (\text{J/K mol}) : S^\circ (Cr, s) = 24, \quad S^\circ (O_2, g) = 205, \quad S^\circ (Cr_2O_3, s) =$$

A.  $-2258.1 \text{ kJ/mol}$

B.  $-1129.05 \text{ kJ/mol}$

C.  $-964.35 \text{ kJ/mol}$

D. None of these

Answer: B



165. Calculate the heat produced (in kJ) when 224 gm of CaO is completely converted to  $CaCO_3$  by reaction with  $CO_2$  at  $27^\circ$  in a container of fixed

volume.

Given \_\_\_\_\_ :

$$\Delta H_f^\circ(\text{CaCO}_3, s) = -1207 \text{ kJ/mol}, \quad \Delta H_f^\circ(\text{CaO}, s) = -635 \text{ kJ/mol}$$

$$\Delta H_f^\circ(\text{CO}_2, g) = -394 \text{ kJ/mol}, \quad [\text{Use } R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}]$$

A. 702.04 kJ

B. 721.96 kJ

C. 712 kJ

D. 721 kJ

**Answer: A**



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**166.** When 1.0 g of oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) is burnt in a bomb calorimeter whose capacity is 8.75 KJ/K, the enthalpy of combustion of oxalic acid at  $27^\circ \text{C}$  is :

A.  $-245.7 \text{ kJ/mol}$

B.  $-244.452\text{kJ/mol}$

C.  $-241.5\text{kJ/mol}$

D. None of these

**Answer: D**

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167. Enthalpy of neutralization of  $H_3PO_3$  with  $NaOH$  is  $-106.68\text{kJ/mol}$ . If enthalpy of neutralization of  $HCl$  with  $NaOH$  is  $-55.84\text{kJ/mole}$ , then calculate enthalpy of ionization of  $H_3PO_3$  in to its ions in  $\text{kJ}$ .

A.  $50.84\text{kJ/mol}$

B.  $5\text{kJ/mol}$

C.  $2.5\text{kJ/mol}$

D. None of these

**Answer: B**



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**168.** The enthalpy of neutralization of a Weak monoprotic acid (HA) in 1 M solution with a strong base is  $-55.95 \text{ KJ/mol}$  . If the unionized acid required  $1.4 \text{ KJ/mol}$  heat for it's complete ionization and enthalpy of neutralization of the strong monobasic acid with a strong monoacidic base is  $-57.3 \text{ KJ/mol}$  . What is the % ionization of the weak acid in molar solution ?

- A. 1 %
- B. 3.57 %
- C. 35.7 %
- D. 0.1

**Answer: B**



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169. Determine C-C and C-H bond enthalpy (in  $\text{kJ/mol}$ )

Given

$$\Delta_f H^\circ(C_2H_6, g) = -85 \text{ kJ/mol}, \quad \Delta_f H^\circ(C_3H_8, g) = -104 \text{ kJ/mol}$$

$$\Delta_{\text{sub}} H^\circ(C, s) = 718 \text{ kJ/mol}, \quad \text{B. E. } (H - H) = 436 \text{ kJ/mol}$$

A. 414345

B. 345414

C. 287404.5

D. None of these

**Answer: B**



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170. Consider the following data :

$$\Delta_f H^\circ(N_2H_4, l) = 50 \text{ kJ/mol}, \quad \Delta_f H^\circ(NH_3, g) = -46 \text{ kJ/mol}$$

$$\text{B. E. } (N - H) = 393 \text{ kJ/mol} \text{ and } \text{B. E. } (H - H) = 436 \text{ kJ/mol}$$

$$\Delta_{\text{vap}}H(N_2H_4, l) = 18\text{kJ/mol}$$

The N-N bond energy in  $N_2H_4$  is :

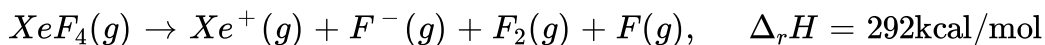
- A. 226 kJ/mol
- B. 154 kJ/mol
- C. 190 kJ/mol
- D. None of these

**Answer: C**



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**171.** What is the bond enthalpy of  $Xe - F$  bond ?



Given : Ionization energy of  $Xe = 279\text{kcal/mol}$

*B. E.* ( $F - F$ ) =  $30\text{kcal/mol}$ , Electron affinity of F =  $85\text{ kcal/mol}$

- A. 24 kcal/mol
- B. 34 kcal/mol

C. 8.5 kcal/mol

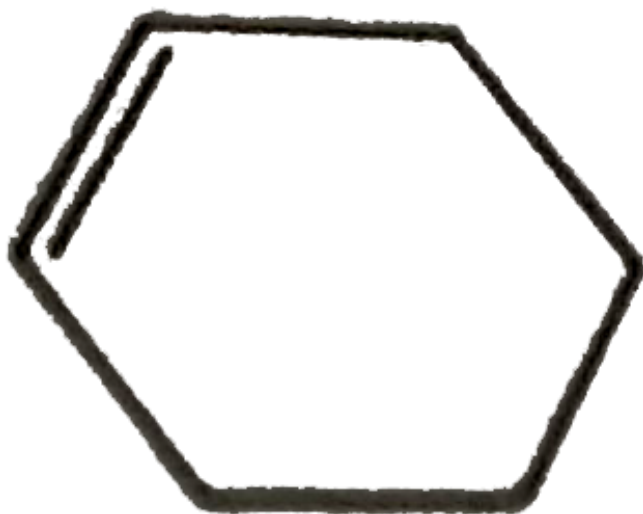
D. None of these

**Answer: B**



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172. If enthalpy of hydrogenation of  $C_6H_6(l)$  into  $C_6H_{12}(l)$  is  $-205\text{kJ/mol}$  and resonance energy of  $C_6H_6(l)$  is  $-152\text{kJ/mol}$  then enthalpy of hydrogenation of



Assume  $\Delta H_{\text{vap}}$  of  $C_6H_6(l)$ ,  $C_6H_8(l)$  all equal :

A.  $-535.5 \text{ kJ/mol}$

B.  $-238 \text{ kJ/mol}$

C.  $-357 \text{ kJ/mol}$

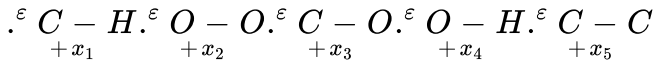
D.  $-119 \text{ kJ/mol}$

**Answer: D**



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173. The enthalpy of combustion of propane ( $C_3H_8$ ) gas in terms of given of given data is , Bond energy (kJ/mol)



[Resonance energy of  $CO_2$  is  $-z$  KJ/mol and

$\Delta H_{\text{vaporization}}[H_2O(l)]$  is  $y$  KJ/mol]

A.  $8x_1 + 2x_5 + 5x_2 - 6x_3 - 8x_4 - 4y - 3z$

B.  $6x_1 + x_5 + 5x_2 - 3x_3 - 4x_4 - 4y - 3z$

C.  $8x_1 + 2x_5 + 5x_2 - 6x_3 - 8x_4 - y - z$

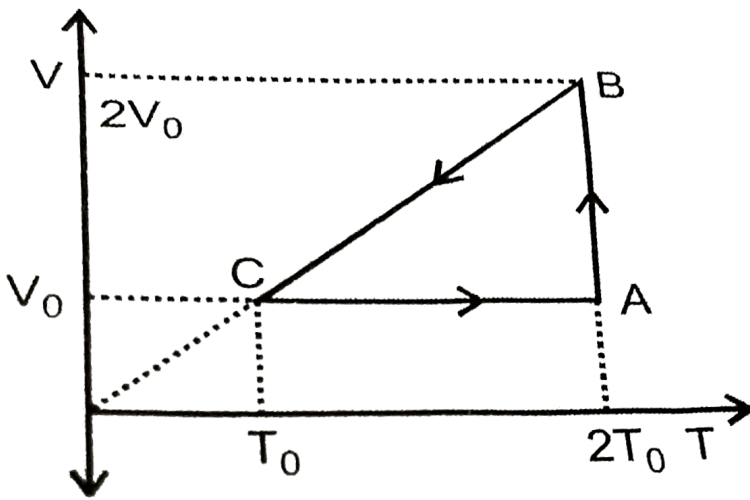
D.  $8x_1 + x_5 + 5x_2 - 6x_3 - 8x_4 - 4y + 3z$

Answer: A



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174. The efficiency of an ideal gas with adiabatic exponent ' $\gamma$ ' for the shown cyclic process would be



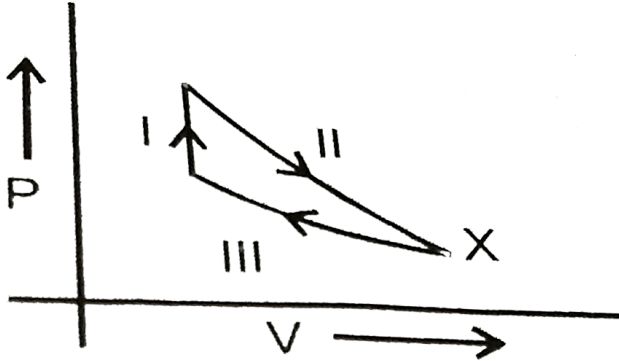
- A.  $\frac{(\gamma - 1)(2 \ln 2 - 1)}{1 + (\gamma - 1)2 \ln 2}$
- B.  $\frac{(\gamma - 1)(1 - 2 \ln 2)}{(\gamma - 1)2 \ln 2 - 1}$
- C.  $\frac{(2 \ln 2 + 1)(\gamma - 1)}{(\gamma - 1)2 \ln 2 + 1}$
- D.  $\frac{(2 \ln 2 - 1)}{\gamma / (\gamma - 1)}$

**Answer: A**



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175. Initially one mole of ideal gas ( $C_v = \frac{5}{2}R$ ) at 0.1 atm and 300 K is put through the following cycle:



Step-I : Heating to twice its initial pressure at constant volume.

Step-II : Adiabatic expansion to its initial temperature.

Step-III : Isothermal compression back to 1.00 atm.

what is the volume at state X?

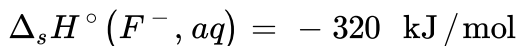
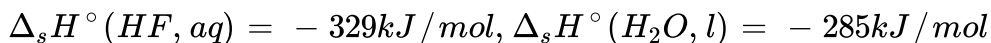
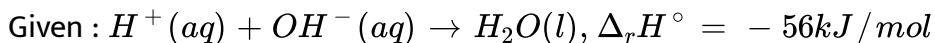
- A. 40.4 L
- B. 65.0 L
- C. 139 L
- D. 4.35 L

**Answer: C**



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176. What is the enthalpy of neutralization of HF against a strong base?



A.  $-17 \text{ kJ/mol}$

B.  $-38 \text{ kJ/mol}$

C.  $-47 \text{ kJ/mol}$

D.  $-43 \text{ kJ/mol}$

Answer: C



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177. The molar heat capacities of Iodine vapour and solid are 7.8 and 14 cal/mol respectively. If enthalpy of iodine is 6096 cal/mol at  $200^\circ C$ , then



what is  $\Delta U$  (internal energy change) at  $250^\circ C$  in cal/mol

A. 5360

B. 4740

C. 6406

D. None of these

**Answer: B**



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**178.** For the reaction taking place at certain temperature  $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$  if equilibrium pressure is  $3X$  bar then  $\Delta_r G^\circ$  would be

A.  $-RT \ln 9 - 3RT \ln X$

B.  $RT \ln 4 - 3RT \ln X$

C.  $-3RT \ln X$

D. None of these

**Answer: D**

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**179.** The first law of thermodynamics for a closed system is  $dU = dq + dw$ , where  $dw = dw_{pv} + dw_{\text{non-pv}}$ . The most common type of  $w_{\text{non-pv}}$  is electrical work. As per IUPAC convention work done on the system is positive.

A system generates 50 J electrical energy, has 150 J of pressure-volume work done on it by the surroundings while releasing 300 J of heat energy.

What is the change in the internal energy of the system?

A. – 500

B. – 100

C. – 300

D. – 200

**Answer: D**

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**180.** The first law of thermodynamics for a closed system is  $dU = dq + dw$ , where  $dw = dw_{pv} + dw_{\text{non-pv}}$ . The most common type of  $w_{\text{non-pv}}$  is electrical work. As per IUPAC convention work done on the system is positive.

A system generates 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while releasing 300 J of heat energy. What is the change in the internal energy of the system?

- A. – 100
- B. – 400
- C. – 300
- D. – 500

**Answer: D**





**181.** If the boundary of system moves by an infinitesimal amount, the work involved is given by  $dw = -P_{\text{ext}}dV$

for irreversible process  $w = -P_{\text{ext}}\Delta V$  (where  $\Delta V = V_f - V_i$ )

for reversible process  $P_{\text{ext}} = P_{\text{int}} \pm dP \cong P_{\text{int}}$

so for reversible isothermal process  $w = -nRT \ln. \frac{V_f}{V_i}$

2mole of an ideal gas undergoes isothermal compression along three different paths :

(i) reversible compression from  $P_i = 2$  bar and  $V_i = 8L$  to  $P_f = 20$  bar

(ii) a single stage compression against a constant external pressure of 20 bar, and

(iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until  $P_{\text{gas}} = P_{\text{ext}}$ , followed by compression against a constant pressure of 20 bar until  $P_{\text{gas}} = P_{\text{ext}}$

Work done (in bar-L) on the gas in reversible isothermal compression is :

A. 9.212

B. 36.848

C. 18.424

D. None of these

**Answer: B**

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**182.** If the boundary of system moves by an infinitesimal amount, the work involved is given by  $dw = -P_{\text{ext}}dV$

for irreversible process  $w = -P_{\text{ext}}\Delta V$  (where  $\Delta V = V_f - V_i$ )

for reversible process  $P_{\text{ext}} = P_{\text{int}} \pm dP \cong P_{\text{int}}$

so for reversible isothermal process  $w = -nRT \ln. \frac{V_f}{V_i}$

2mole of an ideal gas undergoes isothermal compression along three different paths :

(i) reversible compression from  $P_i = 2$  bar and  $V_i = 8L$  to  $P_f = 20$  bar

(ii) a single stage compression against a constant external pressure of 20 bar, and

(iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until  $P_{\text{gas}} = P_{\text{ext}}$ , followed by

compression against a constant pressure of 20 bar until  $P_{\text{gas}} = P_{\text{ext}}$

Work done on the gas in single stage compression is :

A. 36

B. 72

C. 144

D. None of these

**Answer: C**



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**183.** If the boundary of system moves by an infinitesimal amount, the work

involved is given by  $dw = -P_{\text{ext}}dV$

for irreversible process  $w = -P_{\text{ext}}\Delta V$  (where  $\Delta V = V_f - V_i$ )

for reversible process  $P_{\text{ext}} = P_{\text{int}} \pm dP \cong P_{\text{int}}$

so for reversible isothermal process  $w = -nRT \ln. \frac{V_f}{V_i}$

2mole of an ideal gas undergoes isothermal compression along three different plaths :

- (i) reversible compression from  $P_i = 2$  bar and  $V_i = 8L$  to  $P_f = 20$  bar
- (ii) a single stage compression against a constant external pressure of 20 bar, and
- (iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until  $P_{\text{gas}} = P_{\text{ext}}$ , followed by compression against a constant pressure of 20 bar until  $P_{\text{gas}} = P_{\text{ext}}$

Total work done on the gas in two stage compression is :

- A. 40
- B. 80
- C. 160
- D. None of these

**Answer: B**



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**184.** If the boundary of system moves by an infinitesimal amount, the work involved is given by  $dw = - P_{\text{ext}} dV$

for irreversible process  $w = -P_{\text{ext}}\Delta V$  (where  $\Delta V = V_f - V_i$ )

for reversible process  $P_{\text{ext}} = P_{\text{int}} \pm dP \cong P_{\text{int}}$

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- (ii) a single stage compression against a constant external pressure of 20 bar, and
- (iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until  $P_{\text{gas}} = P_{\text{ext}}$ , followed by compression against a constant pressure of 20 bar until  $P_{\text{gas}} = P_{\text{ext}}$

Order of magnitude of work is :

A.  $w_1 > w_2 > w_3$

B.  $w_3 > w_2 > w_1$

C.  $w_2 > w_3 > w_1$

D.  $w_1 = w_2 = w_3$

**Answer: C**





**185.** Standard Gibb's energy of reaction ( $\Delta_r G^\circ$ ) at a certain temperature can be computed  $\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$  and the change in the value of  $\Delta_r H^\circ$  and  $\Delta_r S^\circ$  for a reaction with temperature can be computed as follows :

$$\Delta_r H_{T_2}^\circ - \Delta_r H_{T_1}^\circ = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S_{T_2}^\circ - \Delta_r S_{T_1}^\circ = \Delta_r C_p^\circ \ln \left( \frac{T_2}{T_1} \right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$$

and by  $\Delta_r G^\circ = -RT \ln K_{eq}$ .

Consider the following reaction :  $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

Given

$$\Delta_f H^\circ(CH_3OH, g) = -201 \text{ kJ/mol}, \quad \Delta_f H^\circ(CO, g) = -114 \text{ kJ/mol}$$

$$S^\circ(CH_3OH, g) = 240 \text{ J/K-mol}, \quad S^\circ(H_2, g) = 29 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$S^\circ(CO, g) = 198 \text{ J/mol-K}, \quad C_{p,m}^\circ(H_2) = 28.8 \text{ J/mol-K}$$

$$C_{p,m}^\circ(CO) = 29.4 \text{ J/mol-K}, \quad C_{p,m}^\circ(CH_3OH) = 44 \text{ J/mol-K}$$

and  $\ln \left( \frac{320}{300} \right) = 0.06$ , all data at 300 K

$\Delta_r S^\circ$  at 300 K for the reaction is :

A. 152.6 J/K-mol

B. 181.6 J/K-mol

C. - 16 J/K-mol

D. None of these

**Answer: C**

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**186.** Standard Gibb's energy of reaction ( $\Delta_r G^\circ$ ) at a certain temperature can be computed  $\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$  and the change in the value of  $\Delta_r H^\circ$  and  $\Delta_r S^\circ$  for a reaction with temperature can be computed as follows :

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$$\Delta_r S_{T_2}^\circ - \Delta_r S_{T_1}^\circ = \Delta_r C_p^\circ \ln. \left( \frac{T_2}{T_1} \right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$$

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Given

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$$S^\circ(\text{CH}_3\text{OH}, g) = 240 \text{ J/K-mol}, \quad S^\circ(\text{H}_2, g) = 29 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$S^\circ(\text{CO}, g) = 198 \text{ J/mol-K}, \quad C_{p,m}^\circ(\text{H}_2) = 28.8 \text{ J/mol-K}$$

$$C_{p,m}^\circ(\text{CO}) = 29.4 \text{ J/mol-K}, \quad C_{p,m}^\circ(\text{CH}_3\text{OH}) = 44 \text{ J/mol-K}$$

and  $\ln\left(\frac{320}{300}\right) = 0.06$ , all data at 300 K

$\Delta_r H^\circ$  at 300 K for the reaction is :

- A.  $-87 \text{ kJ/mol}$
- B.  $87 \text{ kJ/mol}$
- C.  $-315 \text{ kJ/mol}$
- D.  $-288 \text{ kJ/mol}$

**Answer: A**



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**187.** Standard Gibb's energy of reaction ( $\Delta_r G^\circ$ ) at a certain temperature can be computed  $\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$  and the change in the

value of  $\Delta_r H^\circ$  and  $\Delta_r S^\circ$  for a reaction with temperature can be computed as follows :

$$\Delta_r H_{T_2}^\circ - \Delta_r H_{T_1}^\circ = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S_{T_2}^\circ - \Delta_r S_{T_1}^\circ = \Delta_r C_p^\circ \ln \left( \frac{T_2}{T_1} \right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$$

and by  $\Delta_r G^\circ = -RT \ln K_{eq}$ .

Consider the following reaction :  $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

Given :

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$$S^\circ (CH_3OH, g) = 240 \text{ J/K-mol}, \quad S^\circ (H_2, g) = 29 \text{ JK}^{-1} \text{ mol}^{-1}$$

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$$C_{p,m}^\circ (CO) = 29.4 \text{ J/mol-K}, \quad C_{p,m}^\circ (CH_3OH) = 44 \text{ J/mol-K}$$

and  $\ln \left( \frac{320}{300} \right) = 0.06$ , all data at 300 K

$\Delta_r S^\circ$  at 320 K is :

A. 155.18 J/mol-K

B. 150.02 J/mol-K

C. 172 J/mol-K

D. None of these

Answer: D



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**188.** Standard Gibb's energy of reaction ( $\Delta_r G^\circ$ ) at a certain temperature can be computed  $\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$  and the change in the value of  $\Delta_r H^\circ$  and  $\Delta_r S^\circ$  for a reaction with temperature can be computed as follows :

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$$C_{p,m}^\circ (CO) = 29.4 \text{ J/mol-K}, \quad C_{p,m}^\circ (CH_3OH) = 44 \text{ J/mol-K}$$

and  $\ln\left(\frac{320}{300}\right) = 0.06$ , all data at 300 K

$\Delta_r H^\circ$  at 320 K is :

A.  $-288.86$  kJ/mol

B.  $-289.1$  kJ/mol

C.  $-87.86$  kJ/mol

D. None of these

**Answer: C**

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**189.** Standard Gibb's energy of reaction ( $\Delta_r G^\circ$ ) at a certain temperature can be computed  $\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$  and the change in the value of  $\Delta_r H^\circ$  and  $\Delta_r S^\circ$  for a reaction with temperature can be computed as follows :

$$\Delta_r H_{T_2}^\circ - \Delta_r H_{T_1}^\circ = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S_{T_2}^\circ - \Delta_r S_{T_1}^\circ = \Delta_r C_p^\circ \ln. \left( \frac{T_2}{T_1} \right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ$$

and by  $\Delta_r G^\circ = -RT \ln K_{eq}$ .

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$$C_{p,m}^\circ(CO) = 29.4 \text{ J/mol-K}, \quad C_{p,m}^\circ(CH_3OH) = 44 \text{ J/mol-K}$$

and  $\ln\left(\frac{320}{300}\right) = 0.06$ , all data at 300 K

$\Delta_r G^\circ$  at 320 K is :

A.  $-48295.2 \text{ kJ/mol}$

B.  $240.85 \text{ kJ/mol}$

C.  $240.85 \text{ kJ/mol}$

D.  $-81.91 \text{ kJ/mol}$

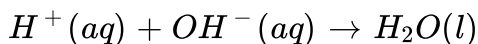
**Answer: D**



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**190.** Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid / base is completely neutralized by base / acid in dilute solution .

For Strong acid and strong base neutralization net chemical change is



$$\Delta_r H^\circ = -55.84 \text{ kJ/mol}$$

$\Delta H_{\text{ionization}}^\circ$  of aqueous solution of strong acid and strong base is zero .

when a dilute solution of weak acid or base is neutralized, the enthalpy of neutralization is somewhat less because of the absorption of heat in the ionization of the because of the absorption of heat in the ionization of the weak acid or base ,for weak acid /base

$$\Delta H_{\text{neutrlzation}}^\circ = \Delta H_{\text{ionization}}^\circ + \Delta_r H^\circ (H^+ + OH^- \rightarrow H_2O)$$

If enthalpy of neutralization of  $CH_3COOH$  by NaOH is  $-49.86 \text{ kJ/mol}$  then enthalpy of ionization of  $CH_3COOH$  is:

A.  $5.98 \text{ kJ/mol}$

B.  $-5.98 \text{ kJ/mol}$

C.  $105.7 \text{ kJ/mol}$



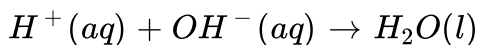
D. None of these

Answer: A

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**191.** Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid /base is completely neutralized by base /acid in dilute solution .

For Strong acid and strong base neutralization net chemical change is



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$$\Delta H_{\text{neutrlzation}}^\circ = \Delta H_{\text{ionization}}^\circ + \Delta_r H^\circ (H^+ + OH^- \rightarrow H_2O)$$

What is  $\Delta H^\circ$  for complete neutralization of strong diacidic base

$A(OH)_2$  by  $HNO_3$ ?

A.  $-55.84 \text{ kJ/mol}$

B.  $111.68 \text{ kJ/mol}$

C.  $55.84 \text{ kJ/mol}$

D. None of these

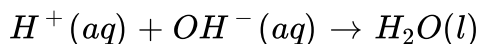
**Answer: B**



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**192.** Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid /base is completely neutralized by base /acid in dilute solution .

For Strong acid and strong base neutralization net chemical change is



$$\Delta_r H^\circ = -55.84 \text{ kJ/mol}$$

$\Delta H_{\text{ionization}}^\circ$  of aqueous solution of strong acid and strong base is zero .

when a dilute solution of weak acid or base is neutralized, the enthalpy of neutralization is somewhat less because of the absorption of heat in the ionization of the because of the absorption of heat in the ionization of the weak acid or base ,for weak acid /base

$$\Delta H_{\text{neutrlzation}}^{\circ} = \Delta H_{\text{ionization}}^{\circ} + \Delta_r H^{\circ} (H^{+} + OH^{-} \rightarrow H_2O)$$

under same conditions ,how many mL of 0.1 m NaOH and 0.05 M  $H_2A$  (strong diprotic acid ) solution should be mixed for a total volume of 100mL to producce the hight rise in temperature ?

A. 25: 75

B. 50: 50

C. 75: 25

D. 66.66: 33.33

**Answer: B**



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**193.** Gibbs Helmholtz equation relates the enthalpy, entropy and free energy change of the process at constant pressure and temperature as

$$\Delta G = \Delta H - T\Delta S \quad (\text{at constant } P, T)$$

In General the magnitude of  $\Delta H$  does not change much with the change in temperature but the terms  $T\Delta S$  changes appreciably. Hence in some process spontaneity is very much dependent on temperature and such processes are generally known as entropy driven process.

Fro the reaction at 298 K,  $A_2B_4 \rightarrow 2AB_2$

$\Delta H = 2 \text{ kJ}$  and  $\Delta S = 20 \text{ J/K}$  at constant P and T, the reaction will be

- A. spontaneous and entropy driven
- B. spontaneous and enthalpy driven
- C. non-spontaneous
- D. at equilibrium

**Answer: A**



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194. Gibbs Helmholtz equation relates the enthalpy, entropy and free energy change of the process at constant pressure and temperature as

$$\Delta G = \Delta H - T\Delta S \quad (\text{at constant } P, T)$$

In General the magnitude of  $\Delta H$  does not change much with the change in temperature but the terms  $T\Delta S$  changes appreciably. Hence in some process spontaneity is very much dependent on temperature and such processes are generally known as entropy driven process.

When  $CaCO_3$  is heated to a high temperature it decomposes into  $CaO$  and  $CO_2$ , however it is quite stable at room temperature. It can be explained by the fact that

- A.  $\Delta_r H$  dominates the term  $T\Delta S$  at high temperature
- B. the term  $T\Delta S$  dominates the  $\Delta_r H$  at high temperature
- C. at high temperature both  $\Delta_r S$  and  $\Delta_r H$  becomes negative
- D. thermodynamics can not say anything about spontaneity

**Answer: B**



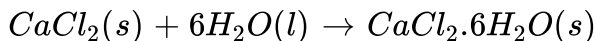
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**195.** Gibbs Helmholtz equation relates the enthalpy, entropy and free energy change of the process at constant pressure and temperature as

$$\Delta G = \Delta H - T\Delta S \quad (\text{at constant } P, T)$$

In General the magnitude of  $\Delta H$  does not change much with the change in temperature but the terms  $T\Delta S$  changes appreciably. Hence in some process spontaneity is very much dependent on temperature and such processes are generally known as entropy driven process.

The Dissolution of  $CaCl_2 \cdot 6H_2O$  in a large volume of water is endothermic to the extent of  $3.5 \text{ kcal mol}^{-1}$  and  $\Delta H$  for the reaction is  $-23.2 \text{ kcal mol}^{-1}$ .



Select the correct statement :

- A.  $\Delta H_{\text{solution}}$  for anhydrous  $CaCl_2$  is  $-19.7 \text{ kcal/mol}$  and the process is enthalpy driven
- B.  $\Delta H_{\text{solution}}$  for anhydrous  $CaCl_2$  is  $-19.7 \text{ kcal/mol}$  and the process is entropy driven
- C. Dissolution of  $CaCl_2 \cdot 6H_2O$  in water is enthalpy driven process

D. The  $\Delta_r S$  the reaction  $CaCl_2(s) + 6H_2O(l) \rightarrow CaCl_2 \cdot 6H_2O(s)$  is negative

**Answer: A**



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**196.** Identify the intensive quantities from the following :

- A. Enthalpy
- B. Temperature
- C. Pressure
- D. Mass

**Answer: B::C**



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**197.** Identify the extensive quantities from the following :

A. Gibb's energy

B. Entropy

C. Refractive index

D. Specific heat

**Answer: A::B**



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**198.** Identify the state functions from the following :

A. Heat

B. Work

C. Enthalpy

D. Enthalpy change



**Answer: C**

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**199.** Which of the following statements is/are correct as per IUPAC sign convention?

- A. The work done by the system on the surrounding is negative
- B. The work done by the surrounding on the system is positive
- C. The heat absorbed by the system from the surrounding is positive
- D. The heat absorbed by the surrounding from the system is positive

**Answer: A::B::C**

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**200.** In an isothermal irreversible expansion of an ideal gas as per IUPAC sign convention :

A.  $\Delta U = 0$

B.  $\Delta H = 0$

C.  $w = -nRT \ln. \frac{P_1}{P_2}$

D.  $w = -q$

**Answer: A::B::D**

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**201.** In reversible isothermal expansion of an ideal gas :

A.  $w = 0$

B.  $U_1 = U_2$

C.  $H_1 = H_2$

D.  $q = nRT \ln. \frac{V_2}{V_1}$

**Answer: B::C::D**

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202. An adiabatic process is that process in which :

- A. energy is transferred as heat
- B. no energy is transferred as heat
- C.  $\Delta U = w$
- D. the temp. of gas increases in a reversible compression

Answer: B::C::D



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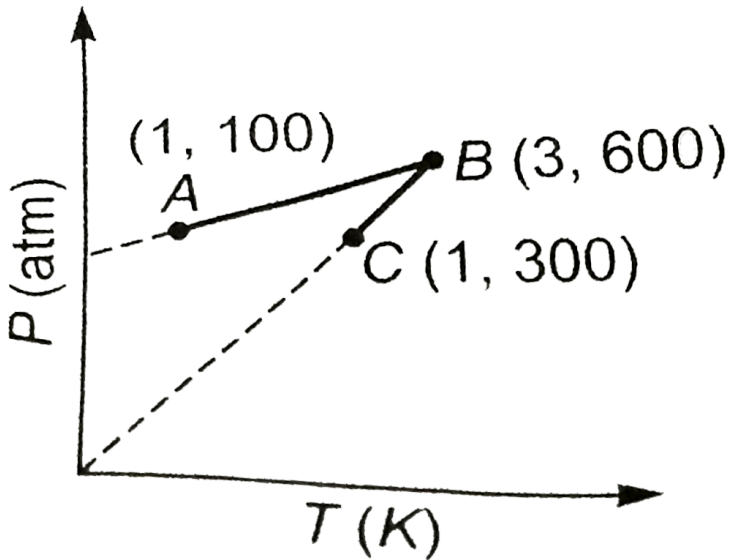
203. In adiabatic process, the work involved during expansion or compression of an ideal gas is given by :

- A.  $nC_v \Delta T$
- B.  $\frac{nR}{\gamma - 1} (T_2 - T_1)$
- C.  $-nRP_{\text{ext}} \left[ \frac{T_2 P_1 - T_1 P_2}{P_1 P_2} \right]$

$$D. -2.303 RT \log \frac{V_2}{V_1}$$

Answer: A::B::C

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204.

One mole of an ideal gas is subjected to a two step reversible process (A-B and B-C). The pressure at A and C is same. Mark the correct statement(s)

:

A. Work involved in the path AB is zero

B. In the path AB work will be done on the gas by the surrounding

C. Volume of gas at C = 3 × volume of gas at A

D. Volume of gas at B is 16.42 litres

**Answer: C::D**

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**205.** Which of the following is/are correct?

A.  $\Delta H = \Delta U + \Delta(PV)$  when P and V both changes

B.  $\Delta H = \Delta U + P\Delta V$  when pressure is constant

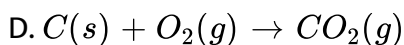
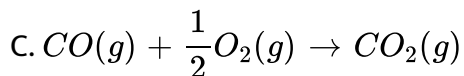
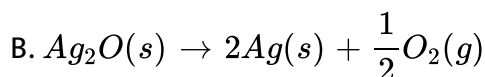
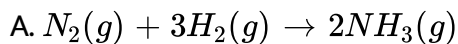
C.  $\Delta H = \Delta U + V\Delta P$  when volume is constant

D.  $\Delta H = \Delta U + P\Delta V + V\Delta P$  when P and V both changes

**Answer: A::B::C**

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206.  $\Delta H < \Delta U$  for the reaction(s) :

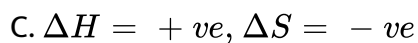
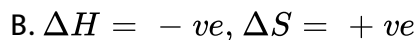


Answer: A::C



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207. Which of the following conditions may lead to a non-spontaneous change?



$$D. \Delta H = -ve, \Delta S = -ve$$

**Answer: A::C::D**

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**208.** For a process to be spontaneous :

A.  $(\Delta G_{\text{system}})_{T,P} = 0$

B.  $\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} > 0$

C.  $\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} < 0$

D.  $(\Delta G_{\text{system}})_{T,P} < 0$

**Answer: B::D**

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209. The normal boiling point of a liquid X is 400 K. Which of the following statement is true about the process  $X(l) \rightarrow X(g)$  ?

- A. at 400 K and 1 atm pressure  $\Delta G = 0$
- B. at 400 K and 2 atm pressure  $\Delta G = +ve$
- C. at 400 K and 0.1 atm pressure  $\Delta G = -ve$
- D. at 410 K and 1 atm pressure  $\Delta G = +ve$

Answer: A::B::C



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210. When ice melts at  $1^\circ C$  :

- A. an increase in entropy
- B. a decrease in enthalpy
- C. a decrease in free energy
- D. process is spontaneous



**Answer: A::C::D**

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**211.** The value of  $\Delta H_{\text{transition}}$  of C (graphite)  $\rightarrow$  C (diamond) is 1.9 kJ/mol at  $25^\circ\text{C}$ . Entropy of graphite is higher than entropy of diamond. This implies that :

- A. C (diamond) is more thermodynamically stable than C (graphite) at  $25^\circ\text{C}$
- B. C (graphite) is more thermodynamically stable than C (diamond) at  $25^\circ\text{C}$
- C. diamond will provide more heat on complete combustion at  $25^\circ\text{C}$
- D.  $\Delta G_{\text{transition}}$  of C (diamond)  $\rightarrow$  C (graphite) is -ve

**Answer: B::C::D**

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212. Which of the following statement(s) is/are false?

A. All adiabatic process are isentropic (or isentropic) processes

B. When  $(\Delta G_{\text{system}})_{T,P} < 0$ , the reaction must be exothermic

C.  $dG = VdP - SdT$  is applicable for closed system, both PV and non-PV work

D. The heat of vaporisation of water at  $100^\circ C$  is 40.6 kJ/mol. When 9 gm of water vapour condenses to liquid at  $100^\circ C$  and 1 atm, then

$$\Delta S_{\text{system}} = 54.42 \text{ J/K}$$

Answer: A::B::C::D

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213. Which of the following statement(s) is/are true?

A.  $\Delta U = 0$  for combustion of  $C_2H_6(g)$  in a sealed rigid adiabatic container

B.  $\Delta_f H^\circ$  (S, monoclinic)  $\neq 0$

C. If dissociation energy of  $CH_4(g)$  is  $1656 \text{ kJ/mol}$  and  $C_2H_6(g)$  is  $2812 \text{ kJ/mol}$ , then value of C-C bond energy will be  $328 \text{ kJ/mol}$

D. If

$$\Delta H_f(H_2O, g) = -242 \text{ kJ/mol}, \Delta H_{\text{vap}}(H_2O, l) = 44 \text{ kJ/mol}$$

then,  $\Delta_f H^\circ(OH^-, aq.)$  will be  $-142 \text{ kJ/mol}$

**Answer: A:C**

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**214.** From the following data, mark the option(s) where  $\Delta H$  is correctly written for the given reaction.



$$\Delta H = -57.3 \text{ kJ}$$

$$\Delta H_{\text{solution}} HA(g) = -70.7 \text{ kJ/mole}$$

$$\Delta H_{\text{solution}} BOH(g) = -20 \text{ kJ/mole}$$

$\Delta H_{\text{ionization}}$  of  $HA = 15 \text{ kJ/mole}$  and  $BOH$  is a strong base.

|     | Reaction   | $\Delta H_r$ (kJ/mol) |
|-----|--|-----------------------|
| (a) | $HA(aq) + BOH(aq) \longrightarrow BA(aq) + H_2O$ | -42.3                 |
| (b) | $HA(g) + BOH(g) \longrightarrow BA(aq) + H_2O$   | -93                   |
| (c) | $HA(g) \longrightarrow H^+(aq) + A^-(aq)$        | -55.7                 |
| (d) | $B^+(aq) + OH^-(aq) \longrightarrow BOH(aq)$     | -20                   |

23. Select the correct statement(s).

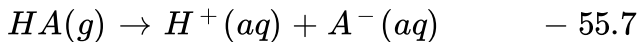
A. Reaction  $\Delta_r H$  (kJ/mol)



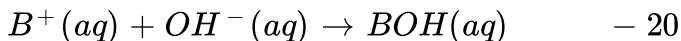
B. Reaction  $\Delta_r H$  (kJ/mol)



C. Reaction  $\Delta_r H$  (kJ/mol)



D. Reaction  $\Delta_r H$  (kJ/mol)



**Answer: A::B::C**



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**215.** Select correct statement(s)

- A. An adiabatic system can exchange energy with its surroundings.
- B. A thermodynamic property which is intensive is additive.
- C. Work done may be zero in a cyclic process.
- D. For a simple compressible substance, the relation  $dq - P \cdot Dv = 0$  is true for any cycle involving mechanical work only.

**Answer: A::C::D**



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**216.** For an isolated system, the entropy :

- A. either increases or remains constant
- B. either decreases or remains constant
- C. can never decrease
- D. can never increase

**Answer: A::C**

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**217.** The normal boiling point of a liquid X is 400 K.  $\Delta H_{\text{vap}}$  at normal boiling point is 40 kJ/mol. Select correct statement(s) :

- A.  $\Delta S_{\text{vaporisation}} < 100 \text{ J/mol.K}$  at 400 K and 2 atm
- B.  $\Delta S_{\text{vaporisation}} < 10 \text{ J/mol.K}$  at 400 K and 1 atm
- C.  $\Delta G_{\text{vaporisation}} < 0$  at 410 K and 1 atm
- D.  $\Delta U = 43.32 \text{ kJ/mol.K}$  at 400 K and 1 atm

**Answer: A::C**

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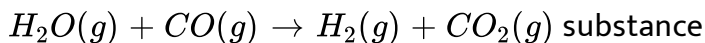
218. Select incorrect statement(s)

- A. A closed system with all adiabatic boundaries must be an isolated system
- B. Total heat exchange in a cyclic process may be zero
- C. Entropy of a closed system is maximum at equilibrium
- D. Molar Gibb's Energy is an extensive property

Answer: A::C::D

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219. Select correct statement(s) for the reaction



|  |     |     |     |    |
|--|-----|-----|-----|----|
| $\Delta_f H_{400}^\circ$ (kcal mol <sup>-1</sup> )       | -25 | -95 | -55 | 0  |
| $S_{400}^\circ$ (cal mol <sup>-1</sup> K <sup>-1</sup> ) | 45  | 50  | 40  | 30 |

- A. Reaction is enthalpy driven
- B. Reaction is entropy driven
- C. Reaction is spontaneous at 400 K
- D. Reaction is non-spontaneous at 400 K

**Answer: A:C**

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**220.** Match the following columns

| Column-I  | Column-II                        |
|---|----------------------------------|
| (A) Reversible cooling of an ideal gas at constant volume | (P) $w = 0; q < 0; \Delta U < 0$ |
| (B) Reversible isothermal expansion of an ideal gas       | (Q) $w < 0; q > 0; \Delta U > 0$ |
| (C) Adiabatic expansion of non-ideal gas into vacuum      | (R) $w = 0; q = 0; \Delta U = 0$ |
| (D) Reversible melting of sulphur at normal melting point | (S) $w < 0; q > 0; \Delta U = 0$ |

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221. Match the following columns

| Column-I                 | Column-II          |
|--------------------------|--------------------|
| (A) Adiabatic process    | (P) $q = 0$        |
| (B) Isothermal process   | (Q) $\Delta H = 0$ |
| (C) Isoenthalpic process | (R) $\Delta T = 0$ |
| (D) Isoentropic process  | (S) $\Delta S = 0$ |

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222. Match the following columns

| Column-I  | Column-II  |
|---|--|
| (A) Reversible isothermal expansion of an ideal gas     | (P) $w = -2.303 nRT \log \left( \frac{V_2}{V_1} \right)$ |
| (B) Reversible adiabatic compression of an ideal gas    | (Q) $PV^\gamma = \text{constant}$                        |
| (C) Irreversible adiabatic expansion of an ideal gas    | (R) $w = \frac{nR}{(\gamma - 1)} (T_2 - T_1)$            |
| (D) Irreversible isothermal compression of an ideal gas | (S) $\Delta H = 0$                                       |

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223. Match the following columns

**Column-I**

(A)  $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$   
in a closed system

(B)  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$   
in a closed system

(C)  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$   
in a closed system

(D)  $\text{CO}(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{CO}_2(\text{g})$   
in an isolated system

**Column-II**

(P)  $\Delta H < \Delta U$

(Q)  $\Delta H = \Delta U \neq 0$

(R)  $\Delta H > \Delta U$

(S)  $\Delta U = 0$

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224. Match the following columns

**Column-I (Process)**

(A) Reversible isothermal compression of an ideal gas

(B) Isothermal free expansion ( $P_{\text{ext}} = 0$ ) of an ideal gas

(C) Reversible adiabatic expansion of an ideal gas

(D) Reversible ideal gas expansion

**Column-II (Entropy Change)**

(P)  $\Delta S_{\text{system}} > 0$

(Q)  $\Delta S_{\text{system}} < 0$

(R)  $\Delta S_{\text{system}} = 0$

(S) Information insufficient

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225. Match the following columns

| Column-I (Process)  | Column-II (Entropy change)              |
|---|---|
| (A) Reversible isothermal ideal gas expansion                         | (P) $\Delta S_{\text{surrounding}} = 0$ |
| (B) Reversible adiabatic ideal gas compression                        | (Q) $\Delta S_{\text{surrounding}} < 0$ |
| (C) Adiabatic free expansion ( $P_{\text{ext}} = 0$ ) of an ideal gas | (R) $\Delta S_{\text{surrounding}} > 0$ |
| (D) Irreversible isothermal ideal gas compression                     | (S) $\Delta S_{\text{system}} = 0$      |

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226. Match the following columns

| Column-I   | Column-II                              |
|--|--|
| (A) $(\Delta G_{\text{system}})_{T, P} = 0$                        | (P) Process is in equilibrium          |
| (B) $\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} > 0$ | (Q) Process is nonspontaneous          |
| (C) $\Delta S_{\text{system}} + \Delta S_{\text{surrounding}} < 0$ | (R) Process is spontaneous             |
| (D) $(\Delta G_{\text{system}})_{T, P} > 0$                        | (S) System is unable to do useful work |

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227. Match the following columns

| Column-I   | Column-II                                    |
|--|--|
| (A) $(\Delta G_{\text{system}})_{T, P}$                              | (P) $nR \ln \left( \frac{V_2}{V_1} \right)$  |
| (B) Work done in reversible isothermal ideal gas expansion           | (Q) $nRT \ln \left( \frac{P_2}{P_1} \right)$ |
| (C) $\Delta G$ for reversible isothermal expansion of an ideal gas   | (R) $-nFE$                                   |
| (D) $\Delta S_{\text{gas}}$ for isothermal expansion of an ideal gas | (S) $nR \ln \left( \frac{P_1}{P_2} \right)$  |

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228. Match the following columns

| Column-I  | Column-II   |
|---|---|
| (A) Heating of an ideal gas at constant pressure                | (P) $\Delta H = nC_{p, m} \Delta T \neq 0$              |
| (B) Compression of liquid at constant temperature               | (Q) $\Delta U = 0$                                      |
| (C) Reversible process for an ideal gas at constant temperature | (R) $\Delta G = V \Delta P$                             |
| (D) Adiabatic free expansion of an ideal gas                    | (S) $\Delta G = nRT \ln \left( \frac{P_2}{P_1} \right)$ |

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229. Match the following columns

| Column-I   |
|--|
| (Sign of $\Delta H$ and $\Delta S$ respectively) |
| (A) - & -  |
| (B) - & +  |
| (C) + & +  |
| (D) + & -  |

| Column-II                                |
|--|
| (Nature of reaction)                     |
| (P) Spontaneous only at low temperature  |
| (Q) Spontaneous only at high temperature |
| (R) Spontaneous at all temperature       |
| (S) Non-spontaneous at all temperature   |

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230. Match the following columns

| Column-I  |
|---|
| (A) Reversible adiabatic compression                  |
| (B) Reversible vaporisation of liquid                 |
| (C) $2N(g) \rightarrow N_2(g)$                        |
| (D) $MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)$ |

| Column-II                               |
|---|
| (P) $\Delta S_{\text{system}} > 0$      |
| (Q) $\Delta S_{\text{system}} < 0$      |
| (R) $\Delta S_{\text{surrounding}} < 0$ |
| (S) $\Delta S_{\text{surrounding}} = 0$ |

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231. Match the following columns

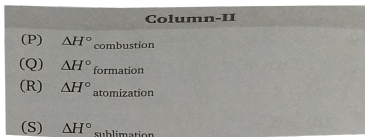
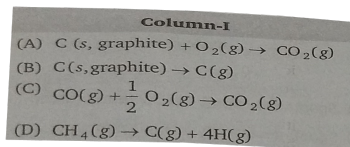
| Column-I                   |
|----------------------------|
| (A) $H^+(aq)$              |
| (B) $H(g)$                 |
| (C) $H_2(g)$               |
| (D) $C(s, \text{diamond})$ |

| Column-II                     |
|-------------------------------|
| (P) $\Delta_f H^\circ = 0$    |
| (Q) $\Delta_f H^\circ \neq 0$ |
| (R) $\Delta_f G^\circ = 0$    |
| (S) $\Delta_f S^\circ < 0$    |



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232. Match the following columns



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233. Heat and work are "definite quantities".

Heat and work are not properties of a system. Their values depend on the path of the process and vary accordingly.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: D**



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**234.** There is no change in internal energy for an ideal gas at constant temperature.

Internal energy of an ideal gas is a function of temperature only.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-2
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-2
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**



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**235.** Assertion: The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero.

Reason: The volume occupied by the molecules of an ideal gas is zero.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-3
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-3
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: B**



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236.  $\Delta H$  and  $\Delta U$  are the same of the reaction,  
 $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ ,

All reactants and products are gases where all gases are ideal.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: B**



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237. Statement -1: The magnitude of the work involved in an isothermal expansion is greater than that involved in an adiabatic expansion.

Statement -2: P-v curve (P on y-axis and V on X-axis) decrease more rapidly for reversible adiabatic expansion compared to reversible isothermal expansion starting from same initial state.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**



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**238.** Statement -1: Entropy change in reversible adiabatic expansion of an ideal gas is zero.

Statement-2: The increase in entropy due to volume increase just compensates the decrease in entropy due to fall in temperature.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-6
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-6
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**



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**239.** There cannot be chemical equilibrium in an open system.

There is no fixed mass in an open system.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-7
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-7
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**



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**240.** Statement -1: The Standard free energy changes of all spontaneously occurring reactions are negative .

Statement-2: The standard free energies of the elements in their standard states at 1 bar and 2985K aare taken as zero.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-8

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-8

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: B**

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**241.** Statement -1: Enthalpy and entropy of any elements substance in the standard states are taken as zero .

Statement-2: At absolute zero , partiles of the perfectly crystalline substance become completely motioness.

A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-9

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-9

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: D**

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**242.** Statement-1: A reaction which is spontaneous and accompanied by decrease of randomness must be exothermic.

Statement -2: All exothermic reaction that are accompanied by decrease of randomness.

A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: C**

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**243.** Assertion (A): May endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.

Reason (R ) : Entropy of the system increases with increase in temperature.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-11
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-11
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: B**

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**244.** Statement-1: Decrease of free energy during the process under constant temperature and pressure provides a measure of its spontaneity.

Statement -2: A spontaneous change must have +ve sign of  $\Delta S_{\text{system}}$ .

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-12
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-12
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: C**



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245.  $|\Delta_f H|$  of  $(H_2O, l) > |\Delta_f H|$  of  $(H_2O, g)$

$\Delta H_{\text{condensation}}$  is negative.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-13
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-13
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**

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246. All combustion reactions are exothermic.

Enthalpies of products are greater than enthalpies of reactants

$$(\sum v_p \Delta_f H(P) > \sum v_R \Delta_f H(R))$$

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-14
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-14
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: C**

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**247.** Enthalpy of neutralization of  $CH_3COOH$  by NaOH is less than that of HCl by NaOH.

Enthalpy of neutralization of  $CH_3COOH$  is less because of the absorption of heat in the ionization process.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-15

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-15

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**

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**248.** Assertion: – Internal energy of a real gas may change during expansion at const. temperature.

Reason: – Internal energy of a real gas is a function of  $T$  &  $P$ .

A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-16

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-16

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: A**

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**249.** Work is a state function which is expressed in joule.

work appears only at the boundary of the system.

A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1

C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: D**

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**250.** The expansion of a gas into an evacuated space takes place non-spontaneously.

A process in which all steps cannot be retraced by themselves is called a spontaneous process.

- A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-18
- B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-18
- C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE
- D. If STATEMENT-1 is FALSE and STATEMENT-2 is TRUE

**Answer: D**



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251. A perfect gas undergoes a reversible adiabatic expansion from (300 K, 200 atm) to (90 K, 10 atm). Find the atomicity of gas.

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252. 5 mole of an ideal gas at temp.  $T$  are compressed isothermally from 12 atm. To 24 atm. Where,

$$r = \frac{\text{Work done along reversible process}}{\text{Work done along single step irreversible process}} \quad (\text{Given : } \ln 2 = 0.7)$$

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253. A diatomic ideal gas is expanded according to  $PV^3 = \text{constant}$ , under very high temperature (Assume vibration mode active). Calculate the molar heat capacity of gas (in cal / mol K) in this process.

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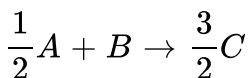
**254.** A heat engine is operating between 500 K to 300 K and it absorbs 10 kcal of heat from 500 K reservoir reversibly per cycle. Calculate the work done (in kcal) per cycle.

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**255.** In a carnot cycle involving ideal non-linear triatomic gas, if during adiabatic expansion volume increases from 2L to 16L and heat absorbed during isothermal expansion is 8 kcal, then calculate magnitude of work done by carnot engine (in kcal).

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**256.** Molar heat capacities at constant pressure for A, B and C are 3, 1.5 and 2 J/K mol. The enthalpy of reaction and entropy of reaction,  $A + B \rightarrow 3C$  are 20 kJ/mol and 20 J/K mol at 300 K. Calculate  $\Delta G$  (in kJ / mol) for the reaction,





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**257.** Standard molar enthalpy of combustion of glucose is  $-2880$  kJ. If only 25% of energy is available for muscular work and 1.0 km walk consumes 90 kJ of energy, what maximum distance (in km) a person can walk after eating 90 g of glucose.



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**258.** Given  $C_2H_2(g) + H_2(g) \rightarrow C_2H_4(g): \Delta H^\circ = -175 \text{ kJ mol}^{-1}$

$\Delta H_{f(C_2H_4, g)}^\circ = 50 \text{ kJ mol}^{-1}$ ,  $\Delta H_{f(H_2O, l)}^\circ = -280 \text{ kJ mol}^{-1}$ ,  $\Delta H_{f(CO_2, g)}^\circ = -393 \text{ kJ mol}^{-1}$

If  $\Delta H^\circ$  is enthalpy of combustion (in  $\text{kJ mol}^{-1}$ ) of  $C_2H_2(g)$ , then

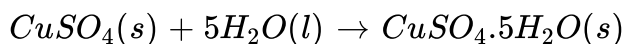
calculate the value of  $\left| \frac{\Delta H^\circ}{257} \right|$



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**259.** The integral enthalpies of solution of anhydrous  $CuSO_4(s)$  and hydrated  $CuSO_4 \cdot 5H_2O(s)$  are  $-70$  kJ per mol and  $10$  kJ per mol respectively. Determine the magnitude of enthalpy of hydration of  $0.1$  mole anhydrous  $CuSO_4(s)$  as



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**260.** Enthalpy of neutralization of  $HCl$  by  $NaOH$  is  $-57.1J/mol$  and by  $NH_4OH$  is  $-51.1KJ/mol$ . Calculate the enthalpy of dissociation of  $NH_4OH$ .

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**261.** Lattice energy of  $NaCl(s)$  is  $-790$  kJ  $mol^{-1}$  and enthalpy of hydration is  $-785$  kJ  $mol^{-1}$ . Calculate enthalpy of solution of  $NaCl(s)$ .

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**262.**  $x$  g sample of  $NH_4NO_3$  is decomposed in a Bomb calorimeter. The temperature of calorimeter increase by  $4^\circ C$ . The heat capacity of the system is  $1.25 \text{ kJ}/^\circ C$ . Calculate the value of  $x$ . Given molar heat of decomposition of  $NH_4NO_3$  at constant volume is  $400 \text{ kJ mol}^{-1}$ .

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**263.** A heat engine operating between  $227^\circ C$  and  $77^\circ C$  absorbs 10 kcal of heat from the  $227^\circ C$  reservoir reversibly per cycle. Calculate total work done (in kcal) in two cycles.

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**264.** Calculate work done in chemical reaction (in kcal)

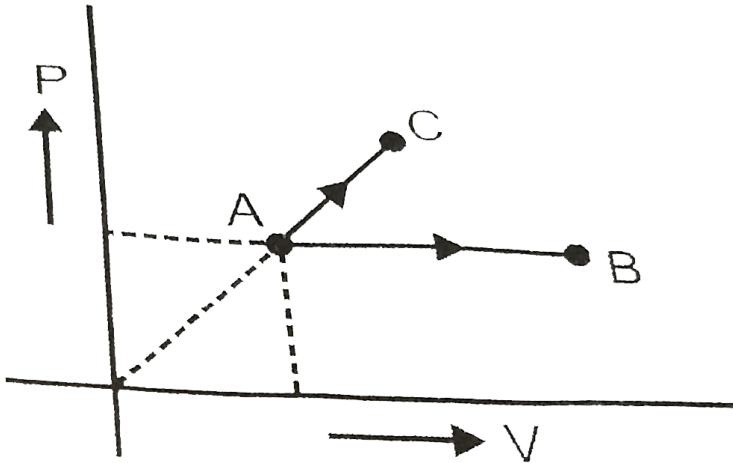
$A(s) + 3B(g) \rightarrow C(l)$  at  $227^\circ C$  at 1 atm in closed vessel.

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265. One mole ideal monoatomic gas is heated according to path AB and AC.

If temperature of state B and state C are equal.

Calculate  $\frac{q_{AC}}{q_{AB}} \times 10$ .



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### Level 1 (Q.1 To Q.30)

1. A system undergoes a process in which  $\Delta U = +300J$  while absorbing 400 J of heat energy and undergoing an expansion against 0.5 bar. What is the change in the volume (in L)?

A. 4

B. 5

C. 2

D. 3

**Answer: C**

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2. One mole of an ideal gas at  $25^\circ\text{C}$  expands in volume from 1.0 L to 4.0 L at constant temperature. What work (in J) is done if the gas expands against vacuum ( $P_{\text{external}} = 0$ )?

A.  $-4.0 \times 10^2$

B.  $-3.0 \times 10^2$

C.  $-1.0 \times 10^2$

D. Zero

**Answer: D**



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3. At  $25^\circ\text{C}$ , a 0.01 mole sample of a gas is compressed from 4.0 L to 1.0 L at constant temperature. What is the work done for this process if the external pressure is 4.0 bar?

A.  $1.6 \times 10^3\text{ J}$

B.  $8.0 \times 10^2\text{ J}$

C.  $4.0 \times 10^2\text{ J}$

D.  $1.2 \times 10^3\text{ J}$

**Answer: D**



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4. Calculate the work done (in J) when 4.5 g of  $H_2O_2$  reacts against a pressure of 1.0 atm at  $25^\circ C$   $2H_2O_2(l) \rightarrow O_2(g) + 2H_2O(l)$

A.  $-1.63 \times 10^2$

B.  $4.5 \times 10^2$

C.  $3.2 \times 10^2$

D.  $-6.1 \times 10^2$

**Answer: A**



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5. Temperature of 1 mole of a gas is increased by  $2^\circ C$  at constant pressure. Work done is :

A.  $R$

B.  $2R$

C.  $R/2$

D. 3R

**Answer: B**



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6. If  $w_1$ ,  $w_2$ ,  $w_3$  and  $w_4$  for an ideal gas are magnitude of work done in isothermal, adiabatic, isobaric and isochoric reversible expansion processes, the correct order will be :

A.  $w_1 > w_2 > w_3 > w_4$

B.  $w_3 > w_2 > w_1 > w_4$

C.  $w_3 > w_2 > w_4 > w_1$

D.  $w_3 > w_1 > w_2 > w_4$

**Answer: D**



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1. A gas expands against a variable pressure given by  $P = \frac{20}{V}$  (where P in atm and V in L). During expansion from volume of 1 litre to 10 litre, the gas undergoes a change in internal energy of 400 J. How much heat is absorbed by the gas during expansion?

A. 46 J

B. 4660 J

C. 5065.8 J

D. 4260 J

**Answer: C**



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2. 2 mole of an ideal gas at  $27^\circ C$  expands isothermally and reversibly from a volume of 4 litre to 40 litre. The work done (in kJ) by the gas is :



A.  $w = -28.72\text{kJ}$

B.  $w = -11.488\text{kJ}$

C.  $w = -5.736\text{kJ}$

D.  $w = -4.988\text{kJ}$

**Answer: B**

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### Level 1 (Q.91 To Q.120)

1. At  $25^\circ\text{C}$ ,  $\Delta G^\circ$  for the process  $\text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}(g)$  is 8.6 kJ. The vapour pressure of water at this temperature, is nearly :

A. 24 torr

B. 285 torr

C. 32.17 torr

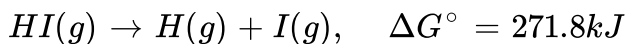
D. 100 torr

**Answer: A**



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2. The molar entropies of  $\text{HI}(g)$ ,  $\text{H}(g)$  and  $\text{I}(g)$  at 298 K are 206.5, 114.6, and  $180.7 \text{ J mol}^{-1} \text{ K}^{-1}$  respectively. Using the  $\Delta G^\circ$  given below, calculate the bond energy of HI.



A.  $282.4 \text{ kJ mol}^{-1}$

B.  $298.3 \text{ kJ mol}^{-1}$

C.  $290.1 \text{ kJ mol}^{-1}$

D.  $315.4 \text{ kJ mol}^{-1}$

**Answer: B**



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1. Gasoline has an enthalpy of combustion 24000 kJ/mol gallon. When gasoline burns in an automobile engine, approximately 30% of the energy released is used to produce mechanical work. The remainder is lost as heat transfer to the engine's cooling system. As a start on estimating how much heat transfer is required, calculate what mass of water could be heated from  $25^{\circ}\text{C}$  to  $75^{\circ}\text{C}$  by the combustion of 1.0 gallon of gasoline in an automobile? (Given :  $C(\text{H}_2\text{O}) = 4.18\text{J}/\text{g}^{\circ}\text{C}$ )

- A. 34.45 kg
- B. 80.383 kg
- C. 22 kg
- D. 224 kg

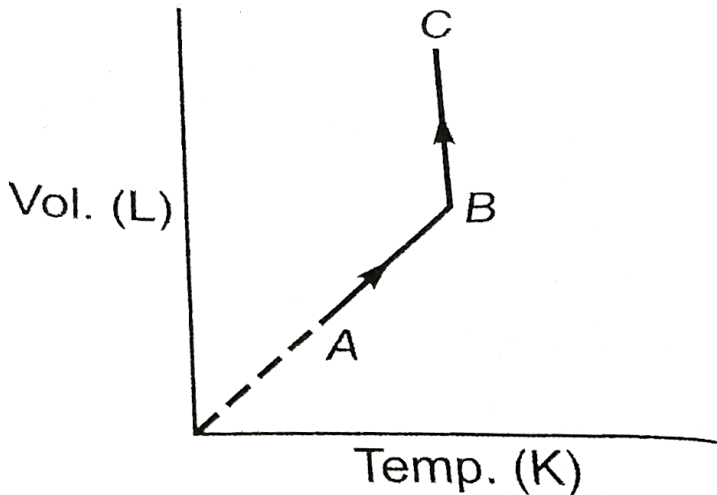
**Answer: B**



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1. Two moles of a triatomic linear gas (neglect vibration degree of freedom) are taken through a reversible process ideal starting from A as shown in figure.

The volume ratio  $\frac{V_B}{V_A} = 4$ . If the temperature at A is  $-73^\circ\text{C}$ , then :



Work done by the gas in AB process is :

6.16 kJ

308.3 kJ

9.97 kJ

0 J

(ii) Total enthalpy change in both steps is :

A. 3000 R

B. 4200 R

C. 2100 R

D. 0

**Answer: B::C**



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**Level 3 - One Or More Answers Are Correct**

1. Assume ideal gas behaviour for all the gases considered and neglect vibrational degrees of freedom. Separate equimolar sample. Separate equimolar samples of Ne,  $O_2$ ,  $CO_2$  and  $SO_2$  were subjected to a two process as mentioned. Initially all are at same state of temperature and pressure.

Step I  $\rightarrow$  All undergo reversible adiabatic expansion to attain same final volume, which is double the original volume thereby causing the decreases in their temperature.

Step  $\rightarrow$  After step I all are given appropriate amount of heat isochorically to restore the original temperature.

Mark the correct option(s) :

- A. Due to step I only, the decrease in temperature will be maximum for Ne
- B. During step II, heat given will be minimum for  $SO_2$
- C. There will be no change in internal energy for any of the gas after both the steps of process are completed
- D. The P-V graph of  $O_2$  and  $CO_2$  will be same

**Answer: A::C::D**



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1.

| Column-I<br>(Partial derivative)                   | Column-II<br>(Thermodynamic variable) |
|--|---------------------------------------|
| (A) $\left(\frac{\partial U}{\partial T}\right)_V$ | (P) $C_P$                             |
| (B) $\left(\frac{\partial H}{\partial T}\right)_P$ | (Q) $C_V$                             |
| (C) $\left(\frac{\partial G}{\partial T}\right)_P$ | (R) $-S$                              |
| (D) $\left(\frac{\partial G}{\partial P}\right)_T$ | (S) $V$                               |


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2.

| Column-I      | Column-II   |
|---------------|---|
| (A) $O_2(g)$  | (P) $\Delta_f H^\circ = +ve$ ; $\Delta_f S^\circ = +ve$ |
| (B) $O_3(g)$  | (Q) $\Delta_f H^\circ = -ve$ ; $\Delta_f S^\circ = -ve$ |
| (C) $Br_2(g)$ | (R) $\Delta_f H^\circ = +ve$ ; $\Delta_f S^\circ = -ve$ |
| (D) $H_2O(l)$ | (S) $\Delta_f H^\circ = 0$ ; $\Delta_f S^\circ = 0$     |


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