CHEMISTRY

BOOKS - NARENDRA AWASTHI

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

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

3. Thermodynamic equilibrium involves

A. chemicla 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 $(C = 0.45J/g°C)$ at $100°C$ is dropped into $25g$ of water $(C = 4.2J/g°C)$ at $27°C$. Find temperature of the rion and water system at thermal equilibrium .

    A. $30°C$

    B. $33°C$

    C. $40°C$

    D. None of these

Answer: A

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

    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
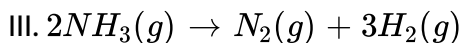
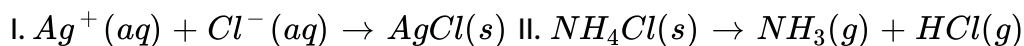B. liquid-liquid

C. solid-solid

D. amalgam

Answer: A

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8. Determine which of the following reactions at constant pressure represent systems that do work on the surrounding environment
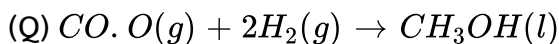
I. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ II. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$

III. $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$
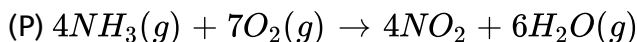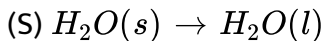
A. I

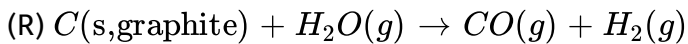B. III

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 :

(P) $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2 + 6H_2O(g)$

(Q) $CO.O(g) + 2H_2(g) \rightarrow CH_3OH(l)$

(R) $C(\text{s,graphite}) + H_2O(g) \rightarrow CO(g) + H_2(g)$

(S) $H_2O(s) \rightarrow H_2O(l)$

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 container (a calorimetre) is strirred for 2 hr. by a mechancal linkage to motor in the surrounding ,for this procees :

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 $25°$ C. The work done in open vessel is :

    A. $-2.477 kJ$

    B. $-4.955 kJ$

    C. $0.0489 kJ$

    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
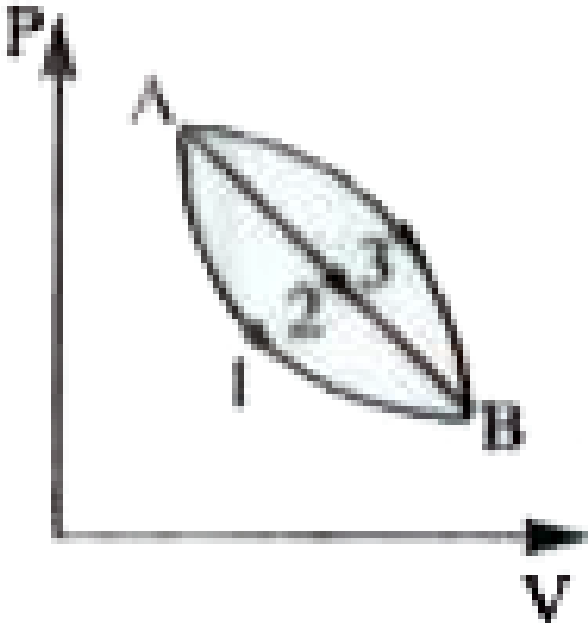
C. 52 kJ

D. 5267 .6 kJ

Answer: A

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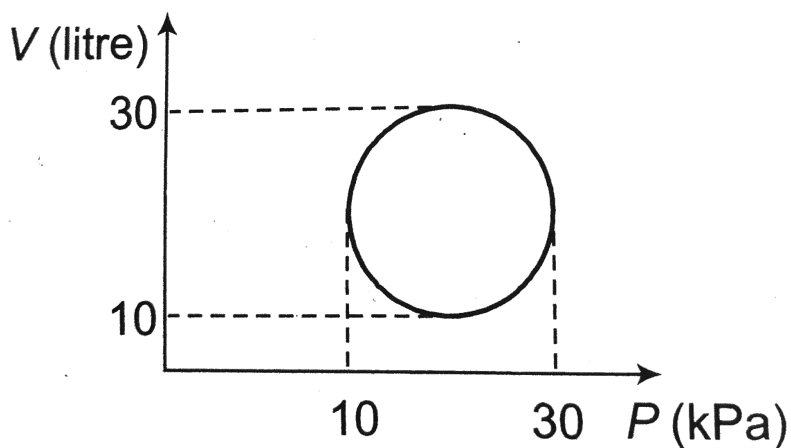
A. $w_1 > w_2 > w_3$

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 abosrbed by a system in going through a cyclic process shown in figure is
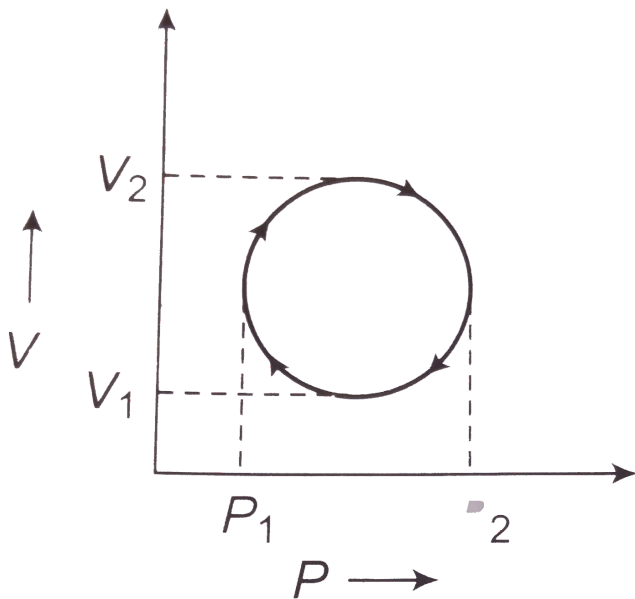
A. $10^7 \pi J$

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

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

C. $\dfrac{\pi}{4}(P_2 - P_1)(V_2 - V_1)$
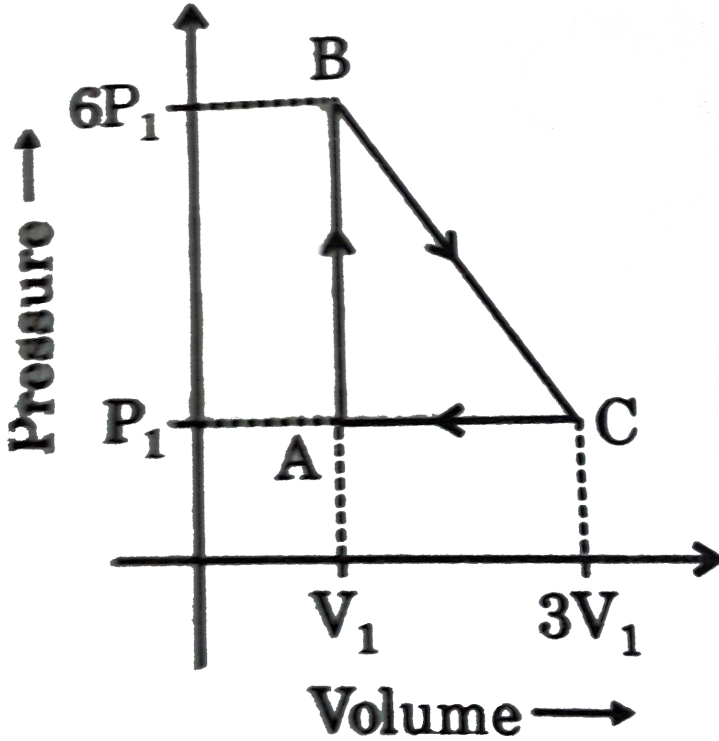
D. $\pi(V_2 - V_1)^2$

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 temerature T in a box, which is kept in vaccum 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 $ABCDA$. The change in internal energy of the tgas will be:
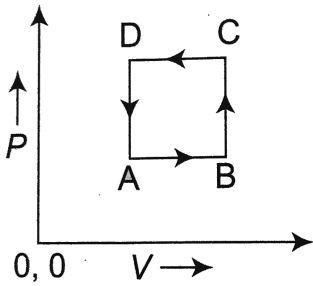
(1)
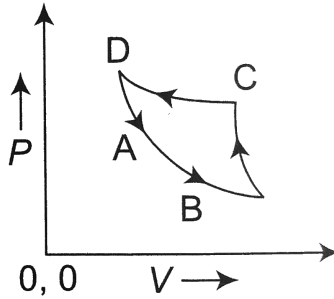
(2)
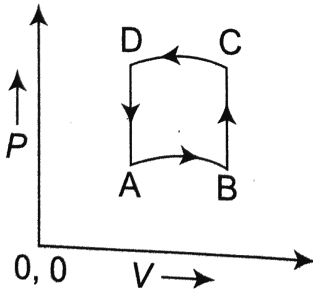
(3)
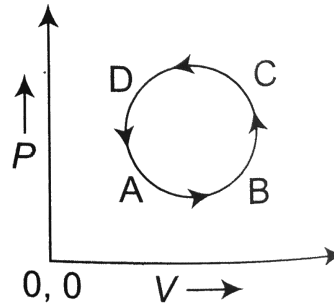
(4)

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. neigther 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. Temperature of an ideal gas increases in:

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

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

C. $\left(\dfrac{\partial U}{\partial P} \right)_T = 0$

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

Answer: C

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24. If 10 gm of a gas at atmospheric pressure is cooled from 273°C to 0°C keeping the volume constant, its pressure would become

(a)

A.

(b)

B.

(c)

C.

(d)
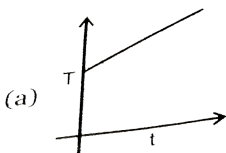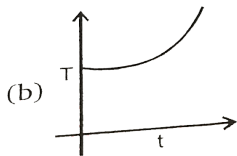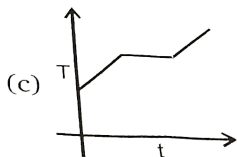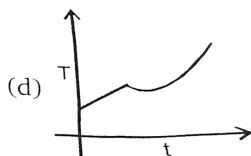
D.

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 repsents correct variation of log $V v/s$ log T where V is in litre and T is in Kelvin ? $\left(R = 0.0821\dfrac{atmL}{molK}\right)$

(a) ![log V vs log T graph with 45° angle]

A.

(b) ![log V vs log T graph with 30° angle]

B.

(c) ![log V vs log T graph with 45° angle]

C.

(d) ![log T vs log V graph]

D.
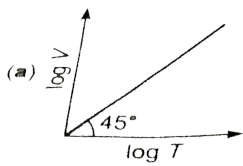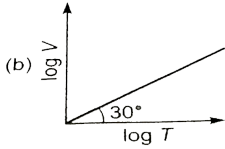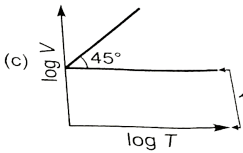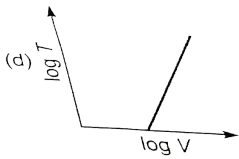
Answer: A

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26. 10 mole of ideal gas expand isothermally and reversibly from a pressure of $10atm$ to $1atm$ at $300K$. What is the largest mass which can 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 :
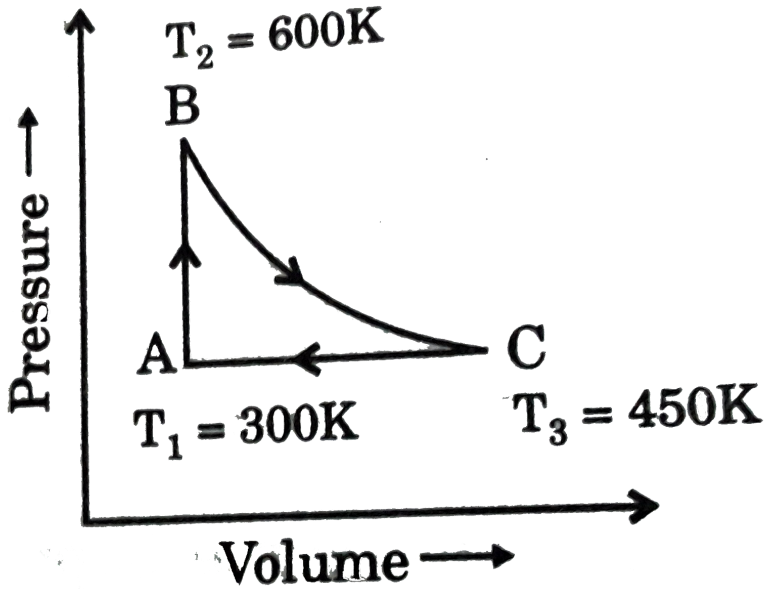
A. $q_{AB} = 450R$ and $q_{CA} = -450R$

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

28. What is the final temperature of 0.10 mole monoatomic ideal gas that performs $75cal$ of work adiabatically.if the initial temperature is $227°C$ (use $R = 2calKmol$)

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. $\dfrac{P_2V_2 - P_1V_1}{\gamma - 1}$

B. $\dfrac{nR(T_1 - T_2)}{\gamma - 1}$

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

D. None of these

Answer: A

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30. For 1 mole of an ideal gas, during an adiabatic process, the square of the pressure of a gas is found to be proportional to the cube of its absolute temperature. The specific heat of the gas at constant volume is (R - universal gas constant)

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

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

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

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

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

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

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

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

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

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

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:
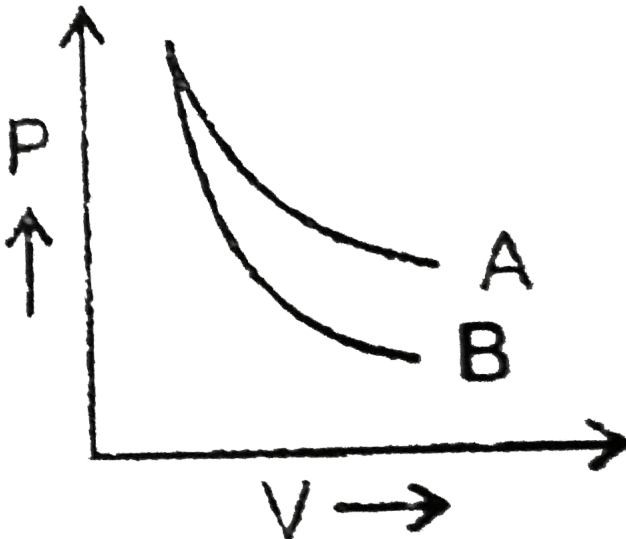
A. He and H_2

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 idal 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

35. 5 mole of an ideal gas expands isothermally and irreversibly from a pressure of 10 atm to 1 atm against a contant external pressure of 1 atm. W_{irr} at 300K is:

A. $-15.921kJ$

B. $-11.224kJ$

C. $-110.83kJ$

D. None of these

Answer: B

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 $2atm$ starting from initial pressure of $1atm$ and initial temperature of $300K(R = 2cal/\text{mol-degree})$

A. 360 cal

B. 720 cal

C. 800 cal

D. 1000 cal

Answer: B

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38. 1 mole of an ideal gas A ($C_{v,m} = 3R$) and 2 mole of an ideal gas B are $\left(C_{v.m} = \dfrac{3}{2}R\right)$ taken in a constainer and expanded reversible and adiabatically from 1 litre of 4 litre starting from initial temperature of 320K. ΔE or ΔU for the process is (in Cal) (Give your answer after divide with 240)

A. 270 K

B. 273 K

C. 248.5 K

D. 200 K

Answer: C

39. 10 litre of a non linear polyatomic ideal gas at $127°C$ 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

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

A. R

B. 2R

C. 3R

D. 8R

Answer: B

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41. 0.5 mole each of two ideal gases $A\left(C_{v.m} = \dfrac{5}{2}R\right)$ and $B(C_{v.m} = 3R)$ are taken in a container and expanded reversibly and adiabtically, during this process temperature of gaseous mixture decreases from 350K and 250K. Find DH (in cal/mol) for the process

A. $- 100R$

B. $- 137.5R$

C. $- 375R$

D. None of these

Answer: C

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

(a)

A.

(b)

B.

(c)

C.

(d) V

D.
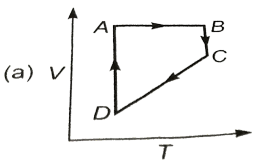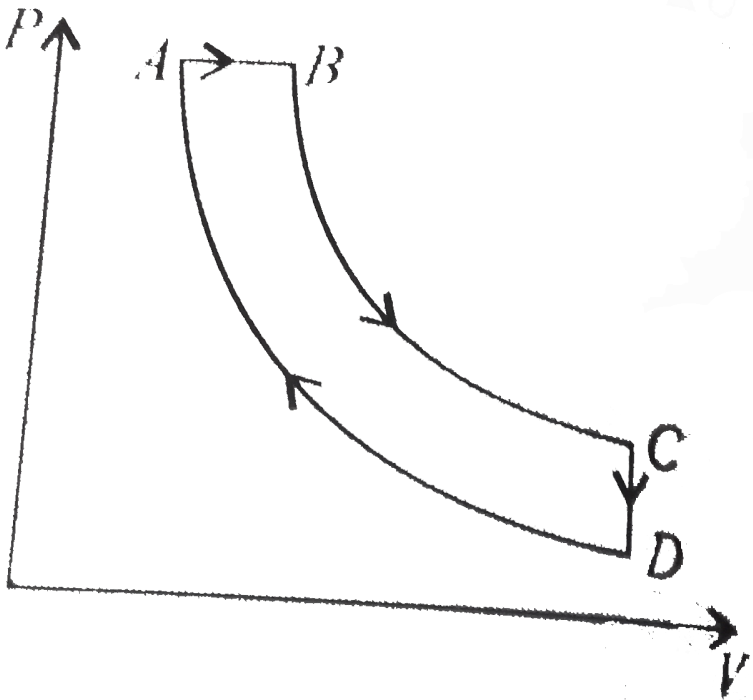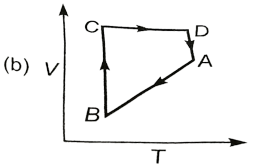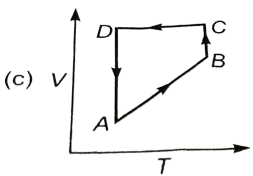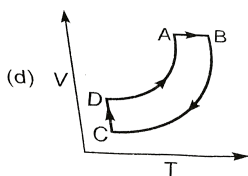
Answer: A

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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. $40.3 kJ/mol$

B. $43.2 kJ/mol$

C. $4.03 kJ/mol$

D. None of these

Answer: A

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44. For the reaction : $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$:

A. $\Delta H = \Delta U$

B. $\Delta H > \Delta U$

C. $\Delta H < \Delta U$

D. None of the above

Answer: B

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45. Consider the reaction at 300 K

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g), \Delta H^\circ = -185kJ$

If 2 mole of H_2 compeletely react with 2 mole of Cl_2 to form HCl. What

is ΔU° for this reaction ?

A. 0

B. $-185 kJ$

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?

$$CO_{(g)} + 3H_{2(g)} \rightarrow CH_{4(g)} + H_2O_{(g)}$$
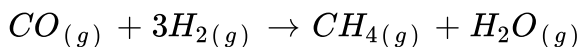
A. $\Delta U = \Delta H$

B. $\Delta U > \Delta H$

C. $w < 0$

D. $q > 0$

Answer: B

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 (ΔH) of the process in L-atm :

A. 22

B. 38

C. 25

D. None of these

Answer: B

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. $-84J$

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 a 10L rigid vessel at 500K, the initial pressure is 70 bar and after 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

51. Consider the reacting at $300K$

$$C_6H_6(l) + \frac{15}{2}O_2(l) \rightarrow 6CO_2(g) + 3H_2O(l), \Delta H = -3271kJ$$
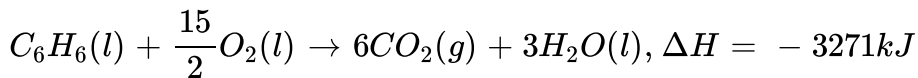
What is ΔU for the combustion of 1.5 mole of benzene at $27°C$?

A. $-3267.25kJ$

B. $-4900.88kJ$

C. $-4906.5kJ$

D. $-3274.75kJ$

Answer: B

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52. For the reaction , $FeCO_3(s) \rightarrow FeO(s) + CO_2(g), \Delta H = 82.8kJ$

at $25°C$, what is $(\Delta E$ or $\Delta U)$ at $25°C$?

A. 82.8 kJ

B. 80.32 kJ

C. $-2394.77kJ$

D. $-3274.75kJ$

Answer: B

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53. At 5×10^5 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. $100kJ/mol$

B. $50kJ/mol$

C. $-100kJ/mol$

D. None of these

Answer: A

54. Determine which of the following reactions at constant pressure represent systems that do work on the surrounding environment

I. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ II. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$ III. $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$
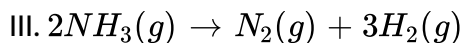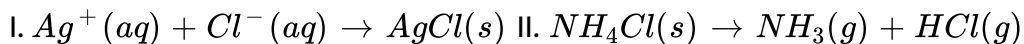
A. I and II

B. III

C. II and III

D. II

Answer: c

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

I. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

II. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

III. $2KClO_4(s) \rightarrow 2KClO_3(s) + O_2(g)$
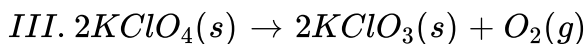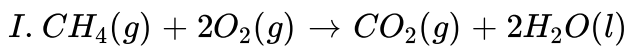
A. III

B. II

C. I and II

D. I

Answer: C

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

A. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

B. $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

C. $C(s, \text{graphite}) + O_2(g) \rightarrow CO_2(g)$

D. $3C_2H_2(g) \rightarrow C_6H_6(l)$
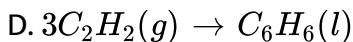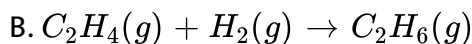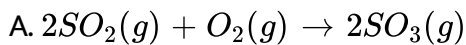
Answer: D

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57. When two moles of an ideal gas $\left(C_{p.m.} = \dfrac{5}{2}R\right)$ heated form 300K to 600K at constant pressure, the change in entropy of gas (ΔS) is:

A. $\dfrac{3}{2}R\ln 2$

B. $-\dfrac{3}{2}R\ln 2$

C. $5R\ln 2$

D. $\dfrac{5}{2}R\ln 2$

Answer: C

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

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

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

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

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

Answer: A

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

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

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

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

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

Answer: A

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

    A. $5R \ln 2$

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

    C. $3R \ln 2$

    D. $-3R \ln 2$

Answer: C

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

A. zero

B. infinity

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

D. $R\ln 3$

Answer: D

62. If one mole of an ideal gas $C_p = \dfrac{5}{2}R$ is expanded isothermally at 300 k until it's 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

---

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 (ΔS) 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

64. What is the change in entropy when 2.5 mole of water is heated from

$27°C$ to $87°C$?

Assume   that   the   heat   capacity   is   constant

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

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

$Fe_2O_{3(s)} + 3H_{2(g)} \rightarrow 2Fe_{(s)} + 3H_2O_{(l)}$
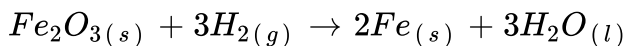
Given:

$S_m^0(Fe_2O_3, s) = 87.4 S_m^0(Fe, s) = 27.3, S_m^0(H_2g) = 130.7, S_m^0(H_2O, 1) =$ (

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

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

$2PbS(s)[19.2] + 3O_2(g)[205.1]$

$\rightarrow 2PbO(s)[66.5] + 2O_2(g)[248.2]$
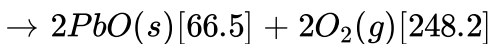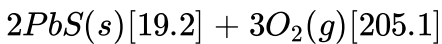
A. $- 113.5$

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° for $Fe_3O_4(s)$:

$$4Fe_3O_4(s)[...] + O_2(g)[205] \rightarrow 6Fe_2O_3(s)[87]$$
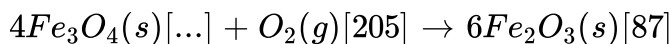
A. 248.25

B. $+111.1$

C. $+122.4$

D. 145.75

Answer: C

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68. How does entropy changes with the transformation at different temperature?

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

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

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

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

Answer: C

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69. What is the melting point of benzene if $\Delta H_{\text{fusion}} = 9.95 kJ/mol$ and $\Delta S_{\text{fusion}} = 35.7 J/K - mol$?

A. $278.7°C$

B. $278.7°K$

C. 300 K

D. 298 K

Answer: B

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70. ΔS for freezing of 10 g of $H_2O(l)$ (enthalpy of fusion is 80 cal/g) at $0°C$ and 1 atm is :

A. $12.25 J/K$

B. $-0.244 J/K$

C. $-2.93 J/K$

D. $-12.25 J/K$

Answer: D

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

What is the value of $\Delta S_{\text{vaporization}}$ for chloroform ?

A. $87.3 J/\text{molk}$

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

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

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

Answer: A

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

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

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

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

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 $0°C$ 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

---

74. Calculate ΔS for following process :

$$X(s) \rightarrow X(l)$$
$$\text{at} 100K \quad \text{at} 200K$$
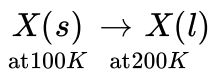
Given : Melting point of

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

A. $26.93J/K$

B. $206.93J/K$

C. $203J/K$

D. $206.93kJ/K$

Answer: B

75. For a perfectly crystalline solid $C_{p.m} = aT^3$, where a is constant. If $C_{p.m}$ is 0.42 J/K $-$ mol at 10K, molar entropy at 10K is

A. 0.42 J/k mol

B. 0.14 J/K mol

C. 1.12 J/K 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 ΔG for the reaction ?

A. $+ve, \ +ve, \ +ve$

B. $+ve, \ -ve, \ -ve$

C. $-ve, \ +ve, \ -ve$

D. $-ve,\ -ve,\ -ve$

Answer: D

---

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

A. $+,\ -$

B. $+,\ +$

C. $-,\ +$

D. $-,\ -$

Answer: D

78. Consider the following reaction.

$$C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(g)$$
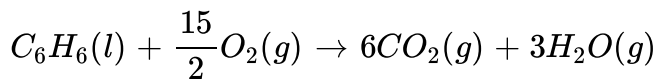
signs of $\Delta H, \Delta S$ and ΔG for the above reaction will be

A. $+, -, +$

B. $-, +, -$

C. $-, +, -$

D. $+, +, -$

Answer: B

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79. Consider the following reaction at temperature T :

$$CH_2 = CH_2(g) + Cl_2(g) \rightarrow ClCH_2CH_2Cl(g)$$
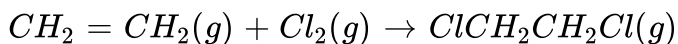
$$\Delta_r H° = -217.5kJ/mol, \quad \Delta_r S° = -233.9J/K - mol$$

Reaction is supported by :

A. entropy

B. enthalpy

C. both (a) & (b)

D. neither

Answer: B

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80. For a process to be spontaneous, ΔG must be............ .

A. $(\Delta G)_{system}$ must be negative

B. $(\Delta G)_{system}$ must be positive

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

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

Answer: A

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81. For a reaction to occur spontaneously

A. ΔS must be negative

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

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

D. ΔH must be negative

Answer: B

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

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 is the condition for a non spontaneous reaction at high temperature but spontaneous at low temperature ?

A. ΔH and ΔS both $+ve$

B. ΔH is $-ve$ and ΔS is $+ve$

C. ΔH and ΔS both $-ve$

D. ΔH is $+ve$ and ΔS is $-ve$

Answer: D

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85. Suppose that a reaction has $\Delta H = -400kJ$ 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. In the isothermal expansion of an ideal gas

A. $\Delta G = \Delta S$

B. $\Delta G = \Delta H$

C. $\Delta G = -T.\Delta S$

D. None of these

Answer: C

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87. What is the normal boiling point of mercury?

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

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

A. 624.8 K

B. 626.8 K

C. 636.8 K

D. None of these

Answer: B

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88. One mole of ice is converted into water at 273 K. The entropies of

$H_2O_{(s)}$ and $H_2O_{(l)}$ are 38.20 and $60.01 Jmol^{-1}K^{-1}$ respectively.

The enthalpy change for the conversion is

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

B. $595.14 J / mol$

C. $-5951.4 J / mol$

D. None of these

Answer: A

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89. Using the listed [ΔG_f° values] calculate ΔG° for the reaction :

$$3H_2S(g)[-33.6] + 2HNO_3(l)[-80.6] \rightarrow 2NO(g)[+86.6] + 4H_2O(l)[-$$
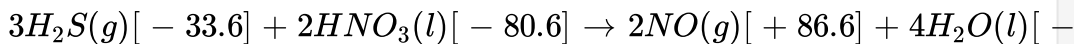
A. -513.2

B. -1037.0

C. $+433.4$

D. $+225.0$

Answer: A

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90. From the following $\Delta H°$ and $\Delta S°$ values, predict which of reactions

I, II and III would be spontaneous at $25°C$.

	$\Delta H°(kJ)$	$\Delta S°(J/K)$
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 $\Delta H_f°$ for Ubr_4 from the $\Delta G°$ of reaction and the $S°$ values

at 298 K.

$U(s) + 2Br_2(l) \rightarrow UBr_4(s), \Delta G° = -788.6kJ. \quad S°(J/K - \text{mol})50.3,$
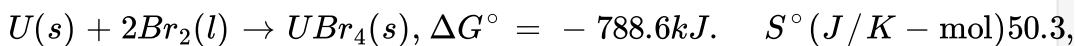
A. $-822.1kJ/mol$

B. $-841.2kJ/mol$

C. $-775.6kJ/mol$

D. $-804.3kJ/mol$

Answer: A

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

$$H_2(g) \rightarrow 2H(g), \Delta G^\circ = 406.6kJ$$
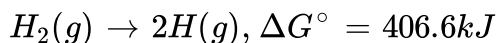
A. 377.2

B. 436

C. 425.5

D. 430.5

Answer: B

93. Consider the ΔG_f^0 and ΔH_f^0 (kJ/mol) for the following oxides. Which oxide can be most easily decomposed to form the metal and oxygen gas?

A. $ZnO(\Delta G° = -318.4, \Delta H° = -348.3)$

B. $Cu_2O(\Delta G° = -146.0, \Delta H° = -168.8)$

C. $HgO(\Delta G° = -58.5, \Delta H° = -90.8)$

D. $PbO(\Delta G° = -187.9, \Delta H° = -217.3)$

Answer: C

94. Which of the following option is correct ?

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

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

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

D. All of these

Answer: D

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95. Calculate ΔG° (kJ/mol) at $127^{\circ}C$ for a reaction with $K_{equilibrium} = 10^5$:

A. -38.294

B. -16.628

C. -9.16

D. None of these

Answer: A

96. At equilibrium state

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

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

C. equilibrium constant K=0

D. equilibrium constant K=1

Answer: D

97. For the auto-ionization of water at $25^\circ C$, $H_2O(l) \Leftrightarrow H^+(aq) + OH^-$ (aq) equilibrium constant is 10^{-14}. What is ΔG° 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

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 comound 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 $X \to Y$ takes place in three steps

$$X \to A, \Delta H = -q_1, \qquad B \to A, \Delta H = -q_2, \qquad B \to Y, \Delta H = -q_3$$

If Hess's law is applicable, then the heat of the reaction $(X \to Y)$ 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 ΔH° at 373 K given the following values of the molar heat capacities at constant pressure :

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

Assume that the heat capacities are independent of temperature :

A. $-242.6 kJ/mol$

B. $-485.2 kJ/mol$

C. $-121.3 kJ/mol$

D. $-286.4 kJ/mol$

Answer: A

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102. Which of the following value of ΔH_f° represent that the product is least stable ?

A. $-94.0 kcalmol^{-1}$

B. $-231.6 kcalmol^{-1}$

C. $+21.4 kcalmol^{-1}$

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

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

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

$3Co(s) + 2O_2(g) \rightarrow Co_3O_4(s)$

$2Co(s) + O_2(g) \rightarrow 2CoO(s), \quad \Delta H_1^{\circ} = -475.8kJ$

$6CoO(s) + O_2(g) \rightarrow 2Co_3O_4(s), \Delta H_2^{\circ} = -355.0kJ$
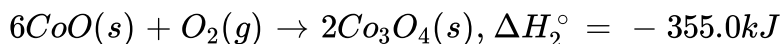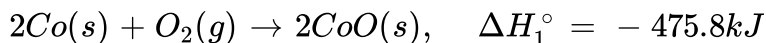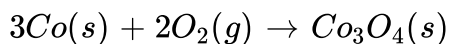
A. $-891.2kJ$

B. $-120.8kJ$

C. $+891.2kJ$

D. $-830.8kJ$

Answer: A

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105. Given the following equations and ΔH° values, determine the enthalpy of reaction at 298 K for the reaction :

$C_2H_4(g) + 6F_2(g) \rightarrow 2HF_4(g) + 4HF(g)$

$H_2(g) + F_2(g) \rightarrow 2HF(g) + 2HF(g),$ $\quad \Delta H_1^\circ = -537$ kJ

$C(s) + 2F_2(g) \rightarrow CF_4(g),$ $\quad \Delta H_2^\circ = -680$ kJ

$2C(s) + 2H_2(g) \rightarrow C_2H_4(g),$ $\quad \Delta H_3^\circ = 52$ kJ
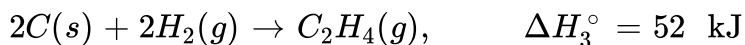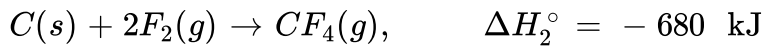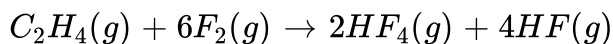
A. -1165

B. -2486

C. $+1165$

D. $+2486$

Answer: B

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106. Given :

$C(\text{diamond}) + O_2 \rightarrow CO_2, \Delta H = -395kJ$

$C(\text{graphite}) + O_2 \rightarrow CO_2, \Delta H = -393kJ$
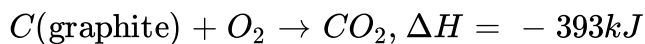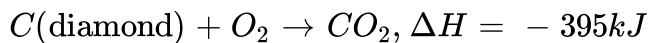
The enthalpy of formation of diamond from graphite is

A. $+2.0kJ$

B. $-1.5kJ$

C. $-788kJ$

D. 788 kJ

Answer: A

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107. Which of the following equations represents a reaction that provides the enthalpy of formation of CH_3Cl?

A. $C(s) + HCl(g) + H_2(g) \rightarrow CH_3Cl(g)$

B. $C(s) + 3H(g) + Cl(g) \rightarrow CH_3Cl(g)$

C. $C(s) + 3/2H_2(g) + 1/2Cl_2(g) \rightarrow CH_3Cl(g)$

D. $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$
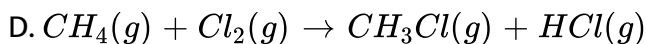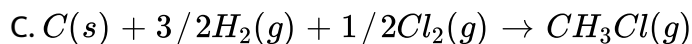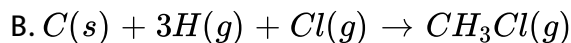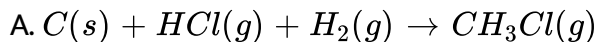
Answer: C

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

$NH_3(g) + 3F_2(g) \rightarrow NF_3 + 3HF(g)$
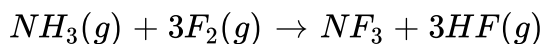
$\Delta H_f^\circ (NH_3, g) = -46.2, \quad \Delta H_f^\circ (NF_3, g) = -113.0, \quad \Delta H_f^\circ (HF, g) =$

A. $-335.8kJ/mol$

B. $-873.8kJ/mol$

C. $-697.2kJ/mol$

D. $-890.4kJ/mol$

Answer: B

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109. The standard enthalpy of formation of octane (C_8H_{18}) is $-250kJ/mol$. 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 kJ/mol

B. -5726 kJ/mol

C. -5476 kJ/mol

D. -5310 kJ/mol

Answer: C

110. Determine the enthalpy of formation of $B_2H_6(g)$ in kJ/mol of the following reaction :

$$B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(g),$$
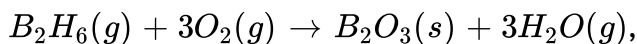
Given :

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

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

A. -75.6

B. $+75.6$

C. -57.4

D. -28.4

Answer: C

111. Consider the following reactions:

$$C(s) + O_2(g) \rightarrow CO_2(g) + x \ \text{kJ}$$

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g) + y \ \text{kJ}$$
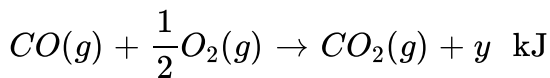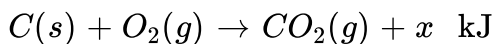
The heat formation of CO(g) is :

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. $2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l), \Delta H = -5757.2kJ$

b. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -405.4kJ$

c. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l), \Delta H = -572.4kJ$
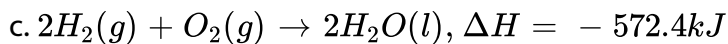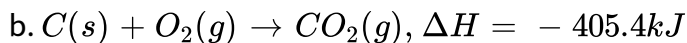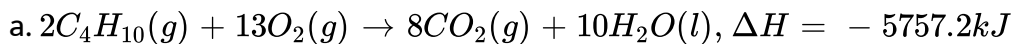
A. 575.6

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 releated in formation of 22.3 g PbO(s)?

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

$$2Pb(s) + O_2(g) \rightarrow 2PbO(s)$$
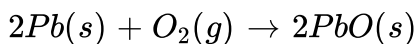
A. 21.9

B. 28.7

C. 14.6

D. 34.2

Answer: A

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.

$$C_{57}H_{104}O_6(s) + 80O_2(g) \rightarrow 57CO_2(g) = -52H_2O(l)$$
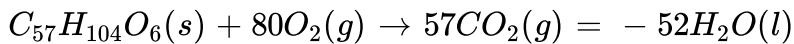
$$\Delta_f H^\circ (C_{57}H_{104}O_6, s) = -70870 \ \text{kJ/mol}, \ \Delta_f H^\circ (H_2O, l) = -285.8 \ $$

,

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

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 kJ mol^{-1}. The ΔH (in 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:

$H_2O(l) \rightarrow H_2O(g) \qquad \Delta H_1 = 44kJ$

$2CH_3OH(l) + 3O_2 \rightarrow 4H_2O(l) + 2CO_2(g) \qquad \Delta H_2 = -1453kJ$
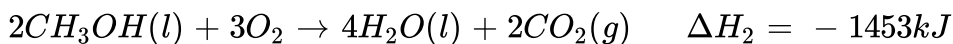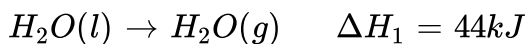
What is the value of ΔH for second reaction if water vapour instead of liquid water is formed as product?

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 :

$$H_2(g) \rightarrow H(g) + H(g)$$
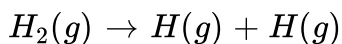
What is the $\Delta_f H°$ of atomic hydrogen (H)?

A. 872.8 kJ/mol

B. 218.2 kJ/mol

C. -218.2 kJ/mol

D. -436.9 kJ/mol

Answer: B

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

$N_2H_4(l) + 2H_2O_2(l) \rightarrow N_2(g) + 4H_2O(l),$

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

$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(l)$
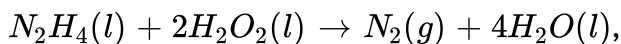
$$\Delta_r H_2^\circ = -622kJ/mol$$
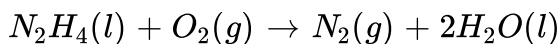
$H_2(g) + \dfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta_r H_3^\circ = -285kJ/mol$
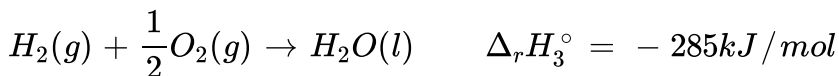
A. -383 kJ/mol

B. -187 kJ/mol

C. -498 kJ/mol

D. None of these

Answer: B

120. Heat of combustion of ethanol at constant pressure and at temperature TK is found to be $-qJ \ mol^{-1}$. Hence, heat of combustion (in $J \ mol^{-1}$) 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

121. Stearic acid $\left[CH_3(CH_2)_{16}CO_2H\right]$ 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 :

$HCl(aq.) + NH_3(aq.) \rightarrow NH_4Cl(aq.)$
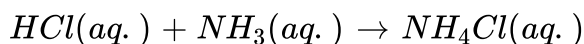
A. − 52.32

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 $24.2°C$,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 $CaCl_2. 6H_2O$ 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,

$CaCl_2(s) + 6H_2O(l) \rightarrow CaCl_2.6H_2O(s)$
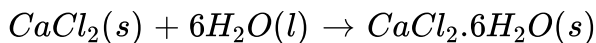
then heat of solution of $CaCl_2$ (anhydrous) in a large volume of water is - 19.7 kcal/mol

(II) For the reaction $2Cl(g) \rightarrow Cl_2(g)$, the sign of ΔH and ΔS 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-92.3kj /mol and -75.14kJ/mol respectively then find the enthalpy of Cl^- (aq):

A. $- 17.16$ kJ/mol

B. $- 167.44$ kJ/mol

C. 17.16 kJ/mol

D. None of these

Answer: B

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126. At $25°C$, when 1 mole of $MgSO_4$ was dissolved in water, the heat evolved was found to be 91.2 kJ. One mole of $MgSO_4 \cdot 7H_2O$ on dissolution gives a solution of the same composition accompanied by an absorption of 13.8 kJ. The enthalpy of hydration, i.e., ΔH_h for the reaction $MgSO_4(s) + 7H_2O(l) \rightarrow MgSO_4 \cdot 7H_2O(s):$

A. $-105kJ/mol$

B. $-77.4kJ/mol$

C. 105 kJ/mol

D. None of these

Answer: A

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127. The enthalpy of neutraliztion of weak base A OH and a strong base BOH by HCl are -12250 cal/mol and -13000 cal/mol respectively . When one mole of HCl is added to a solution containting 1 mole of A OH and 1 mole

of BOH , the enthalpy change was -12500 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,

$MgO(s) + 2HCl(aq.) \rightarrow MgCl_2(aq) + H_2O(l)$ will be

A. less that 57 kJ mol^{-1}

B. -57 kJ mol^{-1}

C. greater than 57 kJ mol^{-1}

D. 57 kJ mol^{-1}

Answer: C

---

129. Enthalpy of neutralization of HCl by NaOH is -55.84 kJ/mol and by NH_4OH is 51.34 kJ/mol. The enthalpy of ionization of NH_4OH is :

A. 107.18 kJ/mol

B. 4.5 kJ/mol

C. -4.5 kJ/mol

D. None of these

Answer: B

130. Which of the following reaction is endothermic?

A. $CaCO_3 \rightarrow CaO + CO_2$

B. $Fe + S \rightarrow FeS$

C. $NaOH + HCl \rightarrow NaCl + H_2O$

D. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
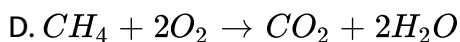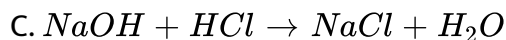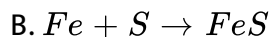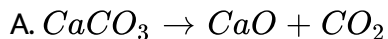
Answer: A

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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 δU

Answer: C

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

$$A_2B(g) \begin{cases} \longrightarrow A_2(g) + B(g); & \Delta H° = 40 \text{ kJ/mol} \\ \longrightarrow A(g) + AB(g); & \Delta H° = 50 \text{ kJ/mol} \end{cases}$$
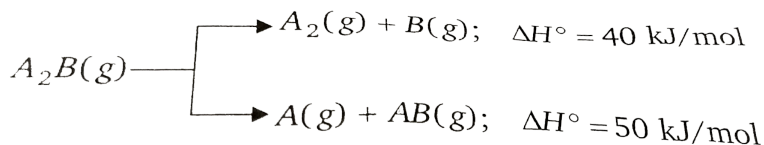
If the molar ratio of $A_2(g)$ to A(g) is $5:3$ in a set of product gases, then the energy involved in the decomposition of 1 mole of $A_2B(g)$ is :

A. 48.75 kJ/mol

B. 43.73 kJ/mol

C. 46.25 kJ/mol

D. None of these

Answer: B

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

$$2B(s) + \frac{3}{2}O_2(g) \rightarrow B_2O_3(s), \quad \Delta H = -1260 \ kJ$$

$$2B(s) + 3H_2(g) \rightarrow B_2H_6(g), \quad \Delta H = 30 \ kJ$$
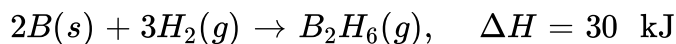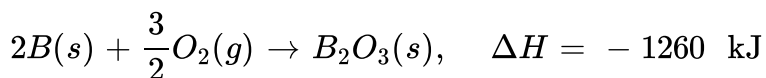
Assume no other reactions are occuring.

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. $15:2$

B. $42:1$

C. $1:42$

D. $1:84$

Answer: D

134. The enthalpy change for the following reaction is 368kJ. Calculate the average O-F bond energy. $OF_{2(g)} \rightarrow O_{(g)} + 2F_{(g)}$

A. 184 kJ/mol

B. 368 kJ/mol

C. 536 kJ/mol

D. 736 kJ/mol

Answer: A

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. $\dfrac{X}{2}$

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

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

D. data insufficient

Answer: D

136. The table shown lists the bond dissociation energies (E_{diss}) for single covalent bonds formed between carbon and atoms of elements A,B,C and D. Which element is the smallest atom ?

A) C –A   240
B) C – B   328
C) C – C   276
D) C – D   485

A. D

B. E

C. A

D. D

Answer: B

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137. Calculate $P - Cl$ bond enthalpy

$P(s) + \dfrac{3}{2}Cl_2(g) \rightarrow PCl_3(g)$ Given : $\Delta_f H(PCl_3, g) = 306kJ/mol$

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

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

A. 123.66 kJ/mol

B. 371 kJ/mol

C. 19 kJ/mol

D. None of these

Answer: A

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

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

$CH_3 - OH(g) + HCl \rightarrow CH_3 - Cl(g) + H_2O(g)$
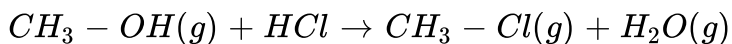
A. $- 23$ kJ/mol

B. $- 42$ kJ/mol

C. $- 59$ kJ/mol

D. $- 511$ kJ/mol

Answer: A

139. Based on the values of B.E. given, $\Delta_f H^0$ of $N_2H_{4(g)}$ is : Given BE of : $N - N$ is 159 kJ mol^{-1}, H-H is 436 kJ mol^{-1}, $N = -N$ is 941 kJ mol^{-1}, $N - H$ is 398 kJ mol^{-1}

A. 711 kJ mol^{-1}

B. 62 kJ mol^{-1}

C. -98 kJ mol^{-1}

D. -711 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 $100°$ 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 kg/m^3 and

0.60 kg/m^3 respectively . Magnitude of the work done forthe process is :

(Take : 1L-atm= 100J)`

A. 4997J

B. 4970J

C. 9994 J

D. None of these

Answer: C

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141. A rigid and insulated tank of $3m^3$ volume is divided into two compartments. One second compartment of volume of $2m^3$ contains an ideal gas at 0.8314 Mpa and 400K and while the second compartment of volume $1m^3$ contains the same gas at 8.314 MPa and 500K. If the partition between the two compartments isruptured. 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?

$$H_2O(l, 323K) \rightarrow H_2O(g, 423K)$$
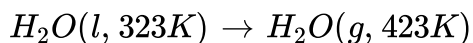
Given

:

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

$$\Delta H_{vap}\text{ar } 373 \text{ K} = 40.7KJ/mol$$

A. $42.91kJ/mol$

B. $43086kJ/mol$

C. $42.6 kJ/mol$

D. $49.6 kJ/mol$

Answer: C

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

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

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

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

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

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 $\left(C_{v.m} = \dfrac{3}{2}R\right)$ taken in a constainer and expanded reversible and adiabatically from 1 litre of 4 litre starting from initial temperature of 320K. ΔE or ΔU for the process is (in Cal) (Give your answer after divide with 240)

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 (sing step) adiabatic expansion of 2 mole of a polyatomic gas ($\gamma = 4/3$) from 300K

and pressure 10atm to 1 atm: (in KJ) (Give your answer after multiplying with 2.08).

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

duing the cycle
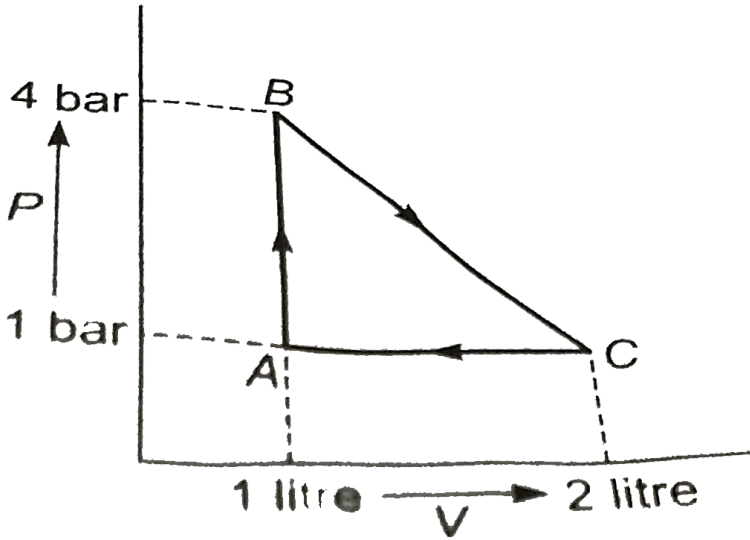
A. $\dfrac{7}{6R}$

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

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

D. None of these

Answer: C

147. A gas $\left(C_{v.m} = \dfrac{5}{2}R \right)$ behaving ideally is allowed to expand reversibly and adiabatically from 1 litre to 32 litre. Its initial temperature is $327°\,C$. 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 $27°\,C$ to $127°\,C$. If $C_{v,m} = 20 + 10^{-2}TJK^{-1}mol^{-1}$, then q and ΔU 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 $27°C$ to $127°C$. If $C_{v,m} = 21.686 + 10^{-3}T$, then ΔH for the process is $x \times 10^5 J1$. Then x is

A. 3000 J

B. 3350 J

C. 3700 J

D. $3181.4J, 2350J$

Answer: D

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

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

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

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

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

Answer: B

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

A. − 600 R

B. − 1000 R

C. − 3000 R

D. None of these

Answer: B

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152. Calculate ΔS for 3 moles of a diatomic ideal gas which is heated and compressed from 298K and 1bar to 596K and 4 bar

A. $- 14.7\text{cal K}^{-1}$

B. $+ 14.7 calK^{-1}$

C. $- 4.9 calK^{-1}$

D. 6.3 cal K^{-1}

Answer: D

153. One mole of an ideal monoatomic gas at $27°C$ is subjected to a reversible isoentropic compression until final temperature reaches $327°C$. If the initial pressure was 1.0 atm then find the value of ln P_2:

A. 1.75 atm

B. 0.176 atm

C. 1.0395 atm

D. 2.0 atm

Answer: A

154. Two mole of an ideal gas is expanded irreversibly and isothermally at $37°C$ until its volume is doubled and 3.41 kJ heat is absorbed from surroundings. ΔS_{total} (system + surroundings) 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 cyrstalline solid $C_{p,m} = aT^3 + bT$, where a and b are constants. If $C_{p,m}$ is 0.40 J/K mol at 10K and 0.92 J/K mol at 20K, then molar entropy at 20K is $0.2x \times R$ joules. Then the value of x is

A. 0.92 J/K mol

B. 8.66 J/K mol

C. 0.813 J/K mol

D. None of these

Answer: C

---

156. Which one of the following statement is correct for d^4 ions [P = pairing energy]

    A. Statement i, ii, iii

    B. Statement ii, iv

    C. Statement I, ii, iii

    D. None of these

Answer: D

---

157. Combustion of sucrose is used by aerobic organisms for providing energy for the life substaining process. If all the capturing 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

gm of sucrose Given :

$\Delta H_{sucrose} = -6000 kJmol^{-1}$, $\Delta S_{combustion} = 180 J/Kmol$ 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

$A_{2(g)} + B_{2(g)} \Leftrightarrow 2AB_{(g)}$ $\Delta_r G^\circ$ and $\Delta_r S^\circ$ are 20 kJ/mol and

$-20 JK^{-1} mol^{-1}$ respectively at 200K. If $\Delta_r C_P$ is $20 JK^{-1} mol^{-1}$ then

$\Delta_r H^\circ$ at 400K is

A. 20 kJ/mol

B. 7.98 kJ/mos

C. 28 kJ/mol

D. None of these

Answer: A

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159. Calculate $\Delta_r G^0$ for (NH_4Cl, s) at 310K. Given: $D \leq ta_f H^0$ for

$(NH_4Cl, s) = -314.5$ KJ/mol,

$\Delta_r C_P = 0 S^0_{N_2(g)} = 192 JK^{-1}mol^{-1}, S^0_{H_2(g)} = 130.5 JK^{-1}mol^{-1}, S^0_{Cl_2(g)}$

. All given data at 300K

A. $-198.56 kJ/mol$

B. $-426.7 kJ/mol$

C. $-202.3 kJ/mol$

D. None of these

Answer: A

---

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

$$Co_3O_4(s) + 4CO(g) \rightarrow 3Co(s) + 4CO_2(g)$$
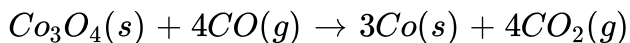
Given : At 300 K $\Delta H_f^\circ (kJ/mol) - 891, \; -110.5, 0.0, \; -393.5$

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

A. -214.8

B. -195.0

C. -200.3

D. -256.45

Answer: D

161. Fixed mass of an ideal gas collected in a 24.64 litre sealed rigid vessel at 10 atm is heated from $-73°C$ to $27°C$ calculate change in gibbs free energy if entropy of gas is a function of temperature as $S = 2 + 10^{-2}T(J/K)(1latm = 0.1kJ)$

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 enthyalpy change for the exothermic reaction $A + 2B \rightarrow 3c$ at 300k and 310 K is ΔH_{300} and ΔH_{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 $\Delta H_{310} < \Delta$

Answer: C

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163. Determine ΔU° at 300K for the following reaction using the listed enthalpies of reaction :

$4CO(g) + 8H_2(g) \rightarrow 3CH_4(g) + CO_2(g) + 2H_2O(l)$

$C(\text{graphite}) + \frac{1}{2}O_2(g) \rightarrow CO(g), \Delta H_1^\circ = -110.5KJ$

$CO(g)\frac{1}{2}O_2(g) \rightarrow CO_2(g), \Delta H_2^\circ = -282.9KJ$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H_3^\circ = -285.8KJ$

$C(\text{graphite}) + 2H_2(g) \rightarrow CH_4(g), \Delta H_4^\circ = -74.8KJ$
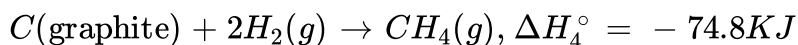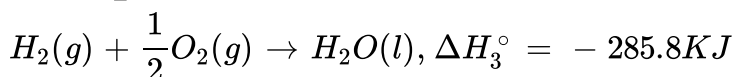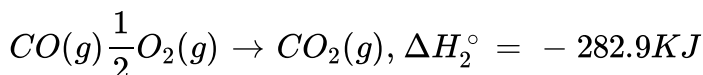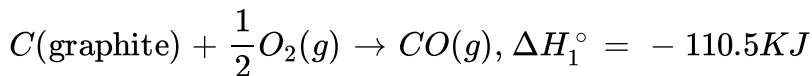
A. − 653.5 kJ

B. − 686.2 kJ

C. − 767.35 kJ

D. None of these

Answer: D

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

values provided at 27°

$4Cr(s) + 3O_2(g) \rightarrow 2Cr_2O_3(s)$, $\Delta_r G^\circ = -2093.4 kJ/mol$
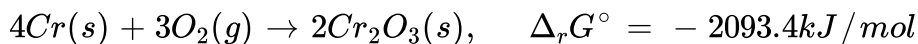
S° (J//K mol): $S^\circ(Cr, s) = 24$, $S^\circ(O_2, g) = 205$, $S^\circ(Cr_2O_3, s) =$

A. − 2258.1kJ/mol

B. − 1129.05kJ/mol

C. − 964.35kJ/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 $27°$ in a container of fixed volume.

Given

$$\Delta H_f^\circ (CaCO_3, s) = -1207kJ/mol, \quad \Delta H_f^\circ (CaO, s) = -635kJ/mol$$

$$\Delta H_f^\circ (CO_2, g) = -394kJ/mol, \left[\text{Use R} = 8.3JK^{-1}mol^{-1}\right]$$

A. 702.04 kJ

B. 721.96 kJ

C. 712 kJ

D. 721 kJ

Answer: A

166. When 1.0g of oxalic acid $(H_2C_2O_4)$ is burned in a bomb calorimeter whose heat capacity is 8.75kJ/K, the temperature increases by 0.312K. The enthalpy of combustion of oxalic acid at $27°C$

A. $-245.7kJ/mol$

B. $-244.452kJ/mol$

C. $-241.5kJ/mol$

D. None of these

Answer: D

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167. Enthalpy of neutralisation of H_3PO_3 acid is $-106.68kJ/mol$ using NaOH. If enthaly of neutralisation of HCl by NaOH is -55.84 kJ/mol. Calculate $\Delta H_{\text{ionization}}$ of H_3PO_3 into its ions

A. $50.84kJ/mol$

B. $5kJ/mol$

C. $2.5kJ/mol$

D. None of these

Answer: B

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168. The enthalpy of neutralization of weak monoprotic acid, HA in 1M solution with a strong base is -55.95 KJ/mol if the unionised acid requires 1.4 KJ/mol heat for its complete ionization and enthalpy of neutralisation of the strong monobasic acid with a strong monoacidic base is $= -57.3$ KJ/mol. What will be % ionization of weak acid in molar solution is

A. 1 %

B. 3.57 %

C. 35.7 %

D. 0.1

Answer: B

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169. The bond dissociation energy depends upon the nature of the bond and nature of the molecule. If any molecule more than 1 bonds of similar nature are present then the bond energy reported is the average bond energy.

Determine $C - C$ and $C - H$ bond enthalpy (in kJ/mol). Given: $\Delta_f H^0(C_2H_6, g) = -85kJ/mol$, $\Delta_f H^0(C_3H_8, g) = -104kJ/mo \leq , \Delta_s$, B.E. (H-H)= 436 kJ/mol,

A. 414345

B. 345414

C. 287404.5

D. None of these

Answer: B

170. Consider the following data:

$\Delta_f H^2(N_2H_4, l) = 50kJ/mol,$, $\Delta_f H°(NH_3, g) = -46kJ/mol,$ B.E.

$(N-H) = 393kJ/mol$ and $B.E.(H-H) = $ 436 kJ/mol, also

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

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

$$XeF_4(g) \rightarrow Xe^+(g) + F^-(g) + F_2(g), \quad \Delta_r H = 292\text{kcal/mol}$$

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

$B.\ E.\ (F - F) = 30\text{kcal/mol}$, Electron affinity of F = 85 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 enthaopy of hydrogenation of $C_6H_6(l)$ into $C_6H_{12}(l)$ is $-205kJ/mol$ and resonance energy of $C_6H_6(l)$ is $-152kJ/mol$ then enthaopy of hydrogenation of
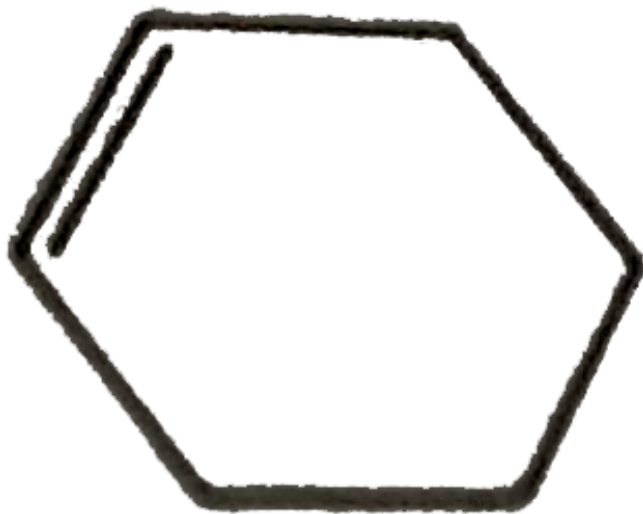
Assume ΔH_{vap} of $C_6H_6(l)$, $C_6H_8(l)$ all equal :

A. $-535.5 kJ/mol$

B. $-238 kJ/mol$

C. $-357 kJ/mol$

D. -119 kJ/mol

Answer: D

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173. The enthalpy of combustion of propance (C_3H_8) gas in temes of given of geven data is , Bond energy (kJ/mol)

$$\overset{\varepsilon}{\underset{+x_1}{.\,C}} - \overset{\varepsilon}{H.} \overset{\varepsilon}{\underset{+x_2}{O}} - \overset{\varepsilon}{\underset{+x_3}{O.\,C}} - \overset{\varepsilon}{\underset{+x_4}{O.\,O}} - \overset{\varepsilon}{H.} \overset{\varepsilon}{\underset{+x_5}{C} - C}$$
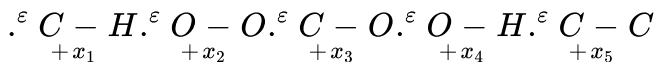
[Resonance energy of CO_2 is -z KJ/mol and

$\Delta H_{\text{vaporization}}[H_2O(l)$ 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
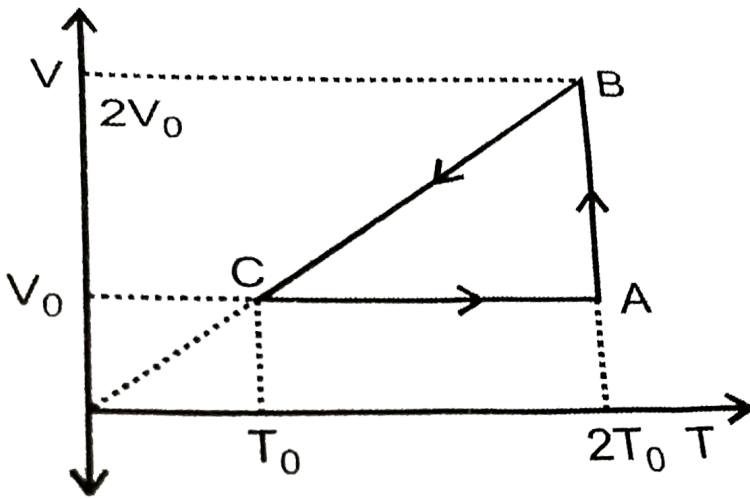
A. $\dfrac{(\gamma - 1)(2 \ln 2 - 1)}{1 + (\gamma - 1)2 \ln 2}$

B. $\dfrac{(\gamma - 1)(1 - 2 \ln 2)}{(\gamma - 1)2 \ln 2 - 1}$

C. $\dfrac{(2 \ln 2 + 1)(\gamma - 1)}{(\gamma - 1)2 \ln 2 + 1}$

D. $\dfrac{(2 \ln 2 - 1)}{\gamma / (\gamma - 1)}$

Answer: A

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175. Initially one mole of ideal gas $\left(C_v = \dfrac{5}{2}R\right)$ at 0.1 atm and 300 K is put through the following cycle:
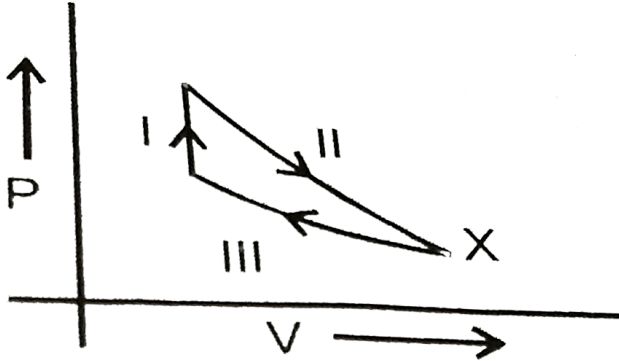
Step-I : Heating to twice its initial pressure at constant volume.

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

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

Given : $H^+(aq) + OH^-(aq) \rightarrow H_2O(l), \Delta_r H^\circ = -56kJ/mol$

$\Delta_s H^\circ(HF, aq) = -329kJ/mol, \Delta_s H^\circ(H_2O, l) = -285kJ/mol$

$\Delta_s H^\circ(F^-, aq) = -320 \; kJ/mol$
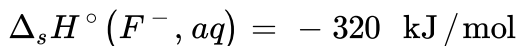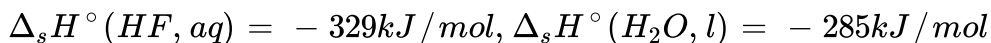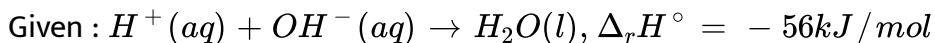
  A. -17 kJ/mol

  B. -38 kJ/mol

  C. -47 kJ/mol

  D. -43 kJ/mol

Answer: C

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 $200°C$, then

what is ΔU (internal energy change) at $250°C$ 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 3 X bar then $\Delta_rG°$ 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 = $dw_{pv} + dw_{non\text{-}pv}$. The most common type of $w_{non\text{-}pv}$ 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. -500

B. -100

C. -300

D. -200

Answer: D

---

180. The first law of thermodynamics for a closed system is dU = dq + dw, where dw = $dw_{pv} + dw_{non\text{-}pv}$. The most common type of $w_{non\text{-}pv}$ 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 $dw = - P_{ext} dV$, for irreversible process $W = - P_{ext} \Delta V$ (where $\Delta V = V_f - V_i$). For reversible process. $P_{ext} = P_{int} \pm dP \cong P_{int}$, so for reversible isothermal process

$$W = - nRT \ln \frac{V_f}{V_i}$$

2 mole 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

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

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 $dw = -P_{ext}dV$

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

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

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

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 $P_{gas} = P_{ext}$, 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 infinitiesimal 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 $P_{\text{ext}} = P_{\text{int}} \pm dP \approx P_{\text{int}}$, so for reversible isothermal process $W = -nRT\ln\dfrac{V_f}{V_i}$. 2 mole of an ideal gas undergoes isothermal compression along three different paths:

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

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

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

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 $dw = -P_{ext}dV$, for irreversible process $W = -P_{ext}\Delta V$ (where $\Delta V = V_f - V_i$). For reversible process.

$$P_{ext} = P_{int} \pm dP \cong P_{int}, \quad \text{so} \quad \text{for} \quad \text{reversible} \quad \text{isothermal} \quad \text{process}$$

$$W = -nRT\ln\frac{V_f}{V_i}$$

2 mole 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

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

Order of magnitude 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

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185. Standard Gibb's energy of reaction $(\Delta_r G^\circ)$ at a certain temperature can be computed $\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$ 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 :

$$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C^\circ_p (T_2 - T_1)$$

$$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C^\circ_p \ln.\left(\frac{T_2}{T_1}\right)$$

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

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

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

Given :

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

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

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

$C^\circ_{p,m}(CO) = 29.4 \ \text{J}/\text{mol-K}, \qquad C^\circ_{p,m}(CH_3OH) = 44 \ \text{J}/\text{mol-K}$

and $\ln\left(\dfrac{320}{300}\right) = 0.06$, 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. Consider the following reaction :

$$CO_{(g)} + 2H_{2(g)} \Leftrightarrow CH_3OH_{(g)}$$
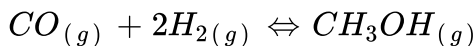
Given

$\Delta_r H°(CH_3OOH, g) = -201k\dfrac{J}{m}ol, \Delta_r H°(CO, g) = -114k\dfrac{J}{m}ol$

$S°(CH_3OOH, g) = 240\dfrac{J}{K} - mol, S°(H_2, g) = 29JK^{-1}mol^{-1}$

$S°(CO, g) = 198\dfrac{J}{m}ol - K, C°_{-}(p, m)(H_2) = 28.8\dfrac{J}{m}ol - K$

$C°_{-}(p, m)(CO) = 29.4\dfrac{J}{m}ol - K, C°_{-}(p, m)(CH_3OH) = 44\dfrac{J}{m}ol - F$

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

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

A. − 87 kJ/mol

B. 87 kJ/mol

C. – 315 kJ/mol

D. – 288 kJ/mol

Answer: A

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187. Consider the following reaction :

$$CO_{(g)} + 2H_{2(g)} \Leftrightarrow CH_3OH_{(g)}$$
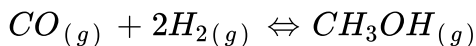
Given   ⋮

$$\Delta_r H^\circ (CH_3OH, g) = -201k\frac{J}{m}ol, \Delta_r H^\circ (CO, g) = -114k\frac{J}{m}ol$$

$$S^\circ (CH_3OOH, g) = 240\frac{J}{K} - mol, S^\circ (H_2, g) = 29 JK^{-1}mol^{-1}$$

$$S^\circ (CO, g) = 198\frac{J}{m}ol - K, C^\circ{}_-(p, m)(H_2) = 28.8\frac{J}{m}ol - K$$

$$C^\circ{}_-(p, m)(CO) = 29.4\frac{J}{m}ol - K, C^\circ{}_-(p, m)(CH_3OH) = 44\frac{J}{m}ol - K$$

and $\ln\left(\dfrac{320}{300}\right) = 0.06$, 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

---

188. Standard Gibb's energy of reaction $(\Delta_r G^\circ)$ at a certain temperature can be computed $\Delta_r G^\circ = \Delta_r H^\circ - T. \Delta_r S^\circ$ 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 :

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

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

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

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

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

Given

:

$\Delta_f H°(CH_3OH, g) = -201$ kJ/mol, $\Delta_f H°(CO, g) = -114$ kJ/m

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

$S°(CO, g) = 198$ J/mol-K, $C_{p,m}°(H_2) = 28.8$ J/mol-K

$C_{p,m}°(CO) = 29.4$ J/mol-K, $C_{p,m}°(CH_3OH) = 44$ J/mol-K

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

$\Delta_r H°$ 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 $(\Delta_r G°)$ at a certain temperature can be computed $\Delta_r G° = \Delta_r H° - T.\Delta_r S°$ and the change in the value of $\Delta_r H°$ and $\Delta_r S°$ for a reaction with temperature can be

computed as follows :

$$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C^\circ_p \left(T_2 - T_1\right)$$

$$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C^\circ_p \ln. \left(\frac{T_2}{T_1}\right)$$

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

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

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

Given   :

$\Delta_f H^\circ (CH_3OH, g) = - 201$ kJ / mol, $\Delta_f H^\circ (CO, g) = - 114$ kJ/m

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

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

$C_{p,m}(CO) = 29.4$ J / mol-K, $C_{p,m}(CH_3OH) = 44$ J / mol-K

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

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

A. $- 48295.2$ kJ/mol

B. 240.85 kJ/mol

C. 240.85 kJ/mol

D. $- 81.91$ kJ/mol

Answer: D

---

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 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$, $\Delta H^0_r \equiv -55.84 kJ/mol$

If enthalpy of neutralization of CH_3COOH by NaoH is -49.86 kJ/mol then enthalpy of ionisation of CH_3COOH is

A. 5.98 kJ/mol

B. -5.98 kJ/mol

C. 105.7 kJ/mol

D. None of these

Answer: A

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 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H^0_r \equiv -55.84 kJ/mol$

What is ΔH^0 for complete neutralisation of strong diacidic base $A(OH)_2$ by HNO_3?

    A. -55.84 kJ/mol

    B. 111.68 kJ/mol

    C. 55.84 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 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H^0_r \equiv -55.84 kJ/mol$

Under the same conditions how many mL of 0.1M NaOH and 0.05 M H_2A (strong diprotic acid) should be mixed for a total volume of 100mL to produce the highest 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

$\Delta G = \Delta H - T\Delta S \qquad$ (at constant P, T)

In General the magnitude of ΔH 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, $A_2 B_4 \rightarrow 2AB_2$

$\Delta H = 2$ kJ and ΔS = 20 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

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

In General the magnitude of ΔH 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

$\Delta G = \Delta H - T\Delta S \qquad$ (at constant P, T)

In General the magnitude of ΔH 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 $CaCl_2.6H_2O$ in a large volume of water is endothermic to the extent of 3.5 kcal mol^{-1} and ΔH for the reaction is -23.2 kcal mol^{-1}.

$CaCl_2(s) + 6H_2O(l) \rightarrow CaCl_2.6H_2O(s)$
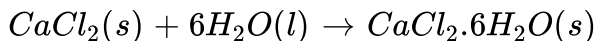
Select the correct statement :

   A. $\Delta H_{solution}$ for anhydrous $CaCl_2$ is - 19.7 kcal/mol and the process is

      enthalpy driven

   B. $\Delta H_{solution}$ for anhydrous $CaCl_2$ is - 19.7 kcal/mol and the process is

      entropy driven

   C. Dissolution of $CaCl_2.6H_2O$ in water is enthalpy driven process

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

---

199. Which of the following statementl 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

---

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

A. $\Delta U = 0$

B. $\Delta H = 0$

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

D. $w = -q$

Answer: A::B::D

201. In reversible isothermal expansion of an ideal gas :

A. w = 0

B. $U_1 = U_2$

C. $H_1 = H_2$

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

Answer: B::C::D

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. $\dfrac{nR}{\gamma - 1}(T_2 - T_1)$

C. $-nRP_{\text{ext}}\left[\dfrac{T_2P_1 - T_1P_2}{P_1P_2}\right]$

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

Answer: A::B::C
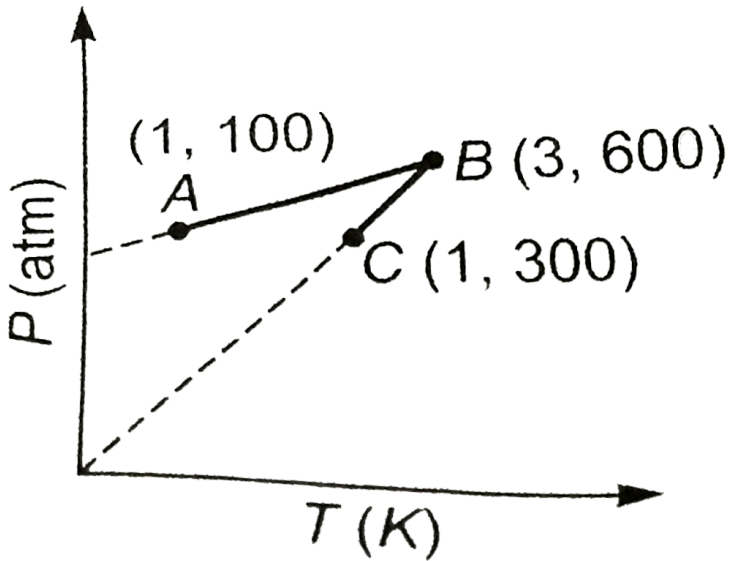
204.

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) :

A. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

B. $Ag_2O(s) \rightarrow 2Ag(s) + \dfrac{1}{2}O_2(g)$

C. $CO(g) + \dfrac{1}{2}O_2(g) \rightarrow CO_2(g)$

D. $C(s) + O_2(g) \rightarrow CO_2(g)$
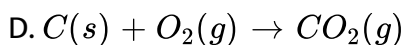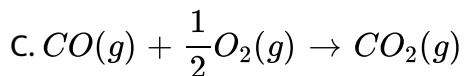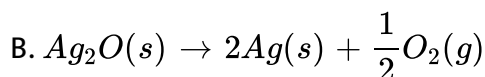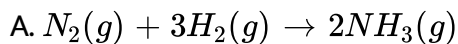
Answer: A::C

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

A. ΔH and ΔS both $+ve$
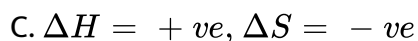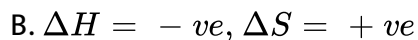
B. $\Delta H = -ve, \Delta S = +ve$

C. $\Delta H = +ve, \Delta S = -ve$

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

Answer: A::C::D

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208. For a process to be spontaneous :

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

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

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

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

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 $1°C$:

A. an increase in entropy

B. a decrease in enthalpy

C. a decrease in free energy

D. process is spontaneous

Answer: A::C::D

---

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

A. C (diamond) is more thermodynamically stable than C (graphite) at $25°C$

B. C (graphite) is more thermodynamically stable than C (diamond) at $25°C$

C. diamond will provide more heat on complete combustion at $25°C$

D. $\Delta G_{\text{transition}}$ of C (diamond) $\rightarrow$ C (graphite) is - ve

Answer: B::C::D

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

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

B. When $(\Delta G_{system})_{T,P} < 0,$ 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 $100°C$ is 40.6 kJ/mol. When 9 gm of water vapour condenses to liquid at $100°C$ and 1 atm, then ΔS_{system} = 54.42 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. $\Delta_f H°$ (S, monoclinic) $\neq 0$

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

D. If

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

then, $\Delta_f H° (OH^-, aq.)$ will be -142 kJ/mol

Answer: A:C

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214. From the following date , mark the opation(s) where ΔH is correctly written for the given reaction .

Given: $H + (aq) + OH - (aq) \rightarrow H_2O(l)$, $\Delta H = -57.3 kJ$
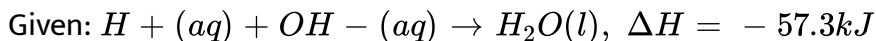
$\Delta H_{solution} HA(g) = -70.7 kJ$mole

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

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

Reaction	ΔH_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

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

$\quad HA(aq) + BOH(aq) \rightarrow BA(aq) + H_2O \qquad -42.3$

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

$\quad HA(g) + BOH(g) \rightarrow BA(aq) + H_2O \qquad -93$

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

$\quad HA(g) \rightarrow H^+(aq) + A^-(aq) \qquad\qquad -55.7$
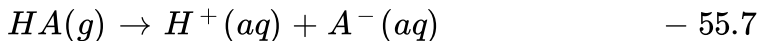
D. Reaction $\qquad\qquad\qquad\qquad\qquad\qquad$ $\Delta_r H$(kJ/mol)

$\quad B^+(aq) + OH^-(aq) \rightarrow BOH(aq) \qquad\qquad -20$
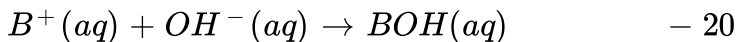
Answer: A::B::C

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 . Dv = 0 is

  true for any cycle involving mechanical work only.

Answer: A::C::D

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. ΔH_{vap} at normal boiling point is 40 kJ/mol. Select correct statement(s) :

A. $\Delta S_{\text{vaporisation}} < 100$ J/mol.K at 400 K and 2 atm

B. $\Delta S_{\text{vaporisation}} < 10$ J/mol.K at 400 K and 1 atm

C. $\Delta G_{\text{vaporisation}} < 0$ at 410 K and 1 atm

D. $\Delta U = 43.32$ kJ/mol.K at 400 K and 1 atm

Answer: A::C

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218. Gases tend to behave non-ideally at low temperatures and high pressures. The deviation from ideal behaviour can be explained by considering two types of corrections. They are volume correction and pressure correction.

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. The enthalpy of the reaction

$$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(g)}$$

    is ΔH_1 and   that   of

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$ is ΔH_2. Then

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

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223. Match the following columns

Column-I	Column-II
(A) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ in a closed system	(P) $\Delta H < \Delta U$
(B) $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ in a closed system	(Q) $\Delta H = \Delta U \neq 0$
(C) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ in a closed system	(R) $\Delta H > \Delta U$
(D) $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$ in an isolated system	(S) $\Delta U = 0$

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224. Match the following columns

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

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226. Match the following columns

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

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227. Match the following columns

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

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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) $\Delta G = nRT \ln\left(\dfrac{P_2}{P_1}\right)$

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229. Match the following columns

Column-I	Column-II
(Sign of ΔH and ΔS respectively)	(Nature of reaction)
(A) $-$ & $-$	(P) Spontaneous only at low temperature
(B) $-$ & $+$	(Q) Spontaneous only at high temperature
(C) $+$ & $+$	(R) Spontaneous at all temperature
(D) $+$ & $-$	(S) Non-spontaneous at all temperature

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230. Match the following columns

Column-I	Column-II
(A) Reversible adiabatic compression	(P) $\Delta S_{system} > 0$
(B) Reversible vaporisation of liquid	(Q) $\Delta S_{system} < 0$
(C) $2N(g) \rightarrow N_2(g)$	(R) $\Delta S_{surrounding} < 0$
(D) $MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)$	(S) $\Delta S_{surrounding} = 0$

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231. Match the following columns

Column-I	Column-II
(A) $H^+(aq)$	(P) $\Delta_f H° = 0$
(B) $H(g)$	(Q) $\Delta_f H° \neq 0$
(C) $H_2(g)$	(R) $\Delta_f G° = 0$
(D) $C(s, diamond)$	(S) $\Delta_f S° < 0$

232. Match the following columns

Column-I
(A) C (s, graphite) + $O_2(g) \rightarrow$ $CO_2(g)$
(B) C(s,graphite) $\rightarrow$ C(g)
(C) $CO(g) + \dfrac{1}{2} O_2(g) \rightarrow CO_2(g)$
(D) $CH_4(g) \rightarrow$ C(g) + 4H(g)
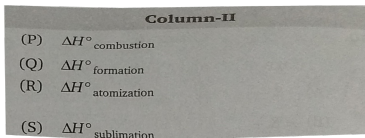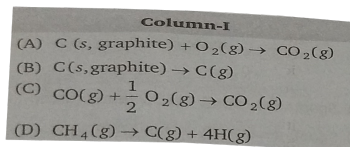
Column-II
(P) $\Delta H°_{combustion}$
(Q) $\Delta H°_{formation}$
(R) $\Delta H°_{atomization}$
(S) $\Delta H°_{sublimation}$

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. Statement -I : There is no change in enthalpy of an ideal gas during compression at constant temperature.

Statement-II: Enthalpy of an ideal gas is a function of temperature and pressure.

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. (A): The heat absorbed during isothermal expansion of an ideal gas against vacuum is zero.

(R): The volume occupied by the molecules 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

236. STATEMENT -1ΔH and ΔU are the same of the reaction, $N_2(g) + O_2(g) \Leftrightarrow 2NO(g),$

STATEMENT-2 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-I : The amount of work done in the isothermal expansion is greater than work done in the adiabatic system for same final volume.

Statement-II: In the adiabatic expansion of a gas temperature and pressure both decrease due to decrease in internal energy of the system.

A. If both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-5

B. If both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-5

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

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-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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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 aszero.

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. Assertion(A): The enthalpies of elements in their standard states are taken as zero

Reason (R): It is impossible to determine the absolute enthalpy of any substance

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 accompained by

decrease of randomness must be exothermic.

Statement -2: All exothermic reaction that are accomained by decrease of

randomness.

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

   explanation of STATEMENT-10

B. If both the statements are TRUE but STATEMENT-2 is NOT the

correct explanation of STATEMENT-10

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. STATEMENT -1: Many endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.

STATEMENT -2: 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 ΔS_{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. Assertion (A): The enthalpy of formation of $H_2O_{(l)}$ is greater than that of $H_2O_{(g)}$

Reason (R): Enthalpy change is negative for the condensation reaction $H_2O_{(g)} \rightarrow H_2O_{(l)}$

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

246. STATEMENT -1: All combustion reactions are exothermic.

STATEMENT -2: Enthalpies of products are greater than enthalpies of reactants $\left(\Sigma v_p \Delta_f H(P) > \Sigma v_R \Delta_f H(R)\right)$

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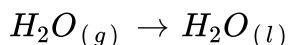
C. If STATEMENT-1 is TRUE and STATEMENT-2 is FALSE

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

Answer: C

247. STATEMENT -1: Enthalpy of neutralization of CH_3COOH by NaOH is less than that of HCl by NaOH.

STATEMENT -2: 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. STATEMENT -1: — Internal energy of a real gas may change during expansion at const. temperature.

STATEMENT -2: — Internal energy of a real gas ia 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. STATEMENT -1: Work is a state function which is expressed in joule.

STATEMENT -2: 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. STATEMENT -1: The expansion of a gas into an evacuated space takes place non-spontaneously.

STATEMENT -2: 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 calculate the value of 10r

.   Where,

$$r = \frac{\text{Work done along reversible process}}{\text{Work done along single step irreversible process}}$$ (Given : ln 2 = 0.

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

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.

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

256. 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.

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

$\Delta H^\circ_{f(C_2H_4,g)} = 50 \ \text{kJ mol}^{-1}, \Delta H^\circ_{f(H_2O,l)} = -280 \ \text{kJ mol}^{-1}, \Delta H^\circ_{f(CO_2}$
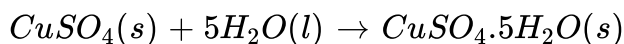
If ΔH° is enthalpy of combustion (in kJ mol^{-1}) of $C_2H_2(g)$, then calculate the value of $\left| \dfrac{\Delta H^\circ}{257} \right|$

258. The integral enthalpies of solution of anhydrous $CuSO_4$ (s) and hydrated $CuSO_4.5H_2O(s)$ 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

$$CuSO_4(s) + 5H_2O(l) \rightarrow CuSO_4.5H_2O(s)$$

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259. If enthalpy of neutralisation of HCl by NaOH is -57 kJ mol^{-1} and with NH_4OH is -50 kJ mol^{-1}. Calculate enthalpy of ionisation of NH_4OH (aq).

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

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

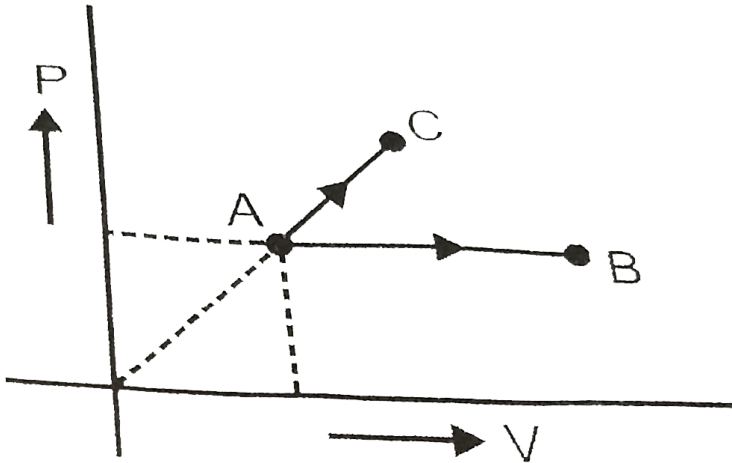**263.** Calculate work done in chemical reaction (in kcal)

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

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

If temperature of state B and state C are equal.

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

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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 $25°C$ 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. -4.0×10^2

B. -3.0×10^2

C. -1.0×10^2

D. Zero

Answer: D

3. At $25^\circ C$, 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. $1.6 \times 10^3 J$

B. $8.0 \times 10^2 J$

C. $4.0 \times 10^2 J$

D. $1.2 \times 10^3 J$

Answer: D

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

A. -1.63×10^2

B. 4.5×10^2

C. 3.2×10^2

D. -6.1×10^2

Answer: A

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

A. R

B. 2R

C. $R/2$

D. 3R

Answer: B

6. If w_1, w_2, w_3, and we are work done in isothermal adiabatic, isobaric and isochoric reversible processes, then the correct sequence (for expansion) would 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

1. A gas expands against a variable pressure given by $P = \dfrac{20}{V}$ (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 $27°C$ expands isothermally and reversibly from a volume of 4 litre to 40 litre. The work done (in kJ) by the gas is

A. $w = -28.72kJ$

B. $w = -11.488kJ$

C. $w = -5.736kJ$

D. $w = -4.988kJ$

Answer: B

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Level 1 Q 91 To Q 120

1. At $25^\circ C$, ΔG^0 for the process $H_2O_{(l)} \Leftrightarrow H_2O_{(g)}$ is 8.6kJ. 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

2. The molar entropies of $HI_{(g)}$, $H_{(g)}$ and $I_{(g)}$ at 298K are 206.5, 114.6, and $180.7 Jmol^{-1}K^{-1}$ respectively. Using the $\Delta G°$ given below, calculate the bond energy of HI.

$HI_{(g)} \rightarrow H_{(g)} + I_{(g)}$, $\Delta G° = 271.8kJ$ (Give your answer after divide with 49.7)

A. $282.4kJmol^{-1}$

B. $298.3kJmol^{-1}$

C. $290.1kJmol^{-1}$

D. $315.4kJmol^{-1}$

Answer: B

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 $25°C$ to $75°C$ by the combustion of 1.0 gallon of gasoline in an automobile? (Given : $C(H_2O) = 4.18 J/g°C$)

A. 34.45 kg

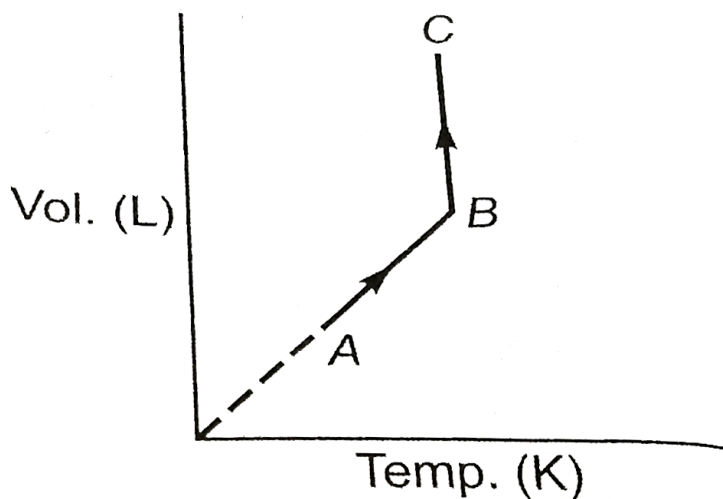B. 80.383 kg

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 $\dfrac{V_B}{V_A} = 4$. If the temperature at A is $-73°\,C$, then :

(ii) Total enthalpy change in both steps is :

    A. 3000 R

    B. 4200 R

    C. 2100 R

D. 0

Answer: B::C

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 pressue.

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 competed

D. The P-V graph of O_2 and CO_2 will be same

Answer: A::C::D

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Level 3 Match The Column

1. Match the following columns

Column-I
(Partial derivative)

(A)	$\left(\dfrac{\partial U}{\partial T}\right)_V$
(B)	$\left(\dfrac{\partial H}{\partial T}\right)_P$
(C)	$\left(\dfrac{\partial G}{\partial T}\right)_P$
(D)	$\left(\dfrac{\partial G}{\partial P}\right)_T$

Column-II
(Thermodynamic variable)

(P)	C_P
(Q)	C_V
(R)	$-S$
(S)	V

2. Match the following columns

Column-I
(A) $O_2(g)$
(B) $O_3(g)$
(C) $Br_2(g)$
(D) $H_2O(l)$

Column-II
(P) $\Delta_f H° = +$ ve; $\Delta_f S° = +$ ve
(Q) $\Delta_f H° = -$ ve; $\Delta_f S° = -$ ve
(R) $\Delta_f H° = +$ ve; $\Delta_f S° = -$ ve
(S) $\Delta_f H° = 0$; $\Delta_f S° = 0$