CHEMISTRY

BOOKS - G.R. BATHLA & SONS CHEMISTRY (HINGLISH)

Chemical Thermodynamics and Thermochemistry

Example

1. A gas expands by $0.5L$ against a constant pressure of $1atm$. Calculate the work done in joule and calorie.

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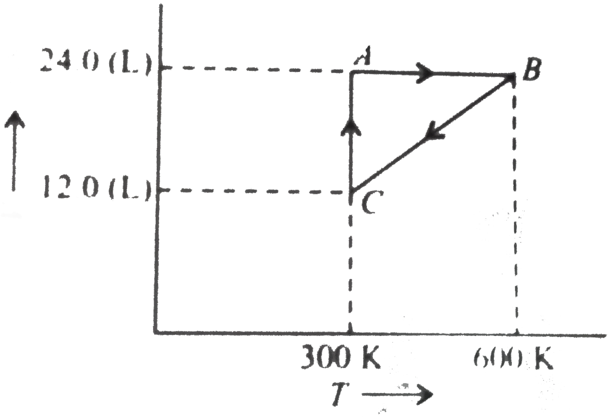
2. One mole of an ideal gas is put through a series of changes as shown in the graph in which $A, B,$ and C, mark the three stages of the system. At each stage the variables are shown in the graph.

a. Calculate the pressure at three stages of system.

b. Name the process during the following chnages:

i. A to B ii. B to C

iii. $C$to$A$ iv. Overall change



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3. The diagram shows a PV graph of a thermodynamic behavious of an ideal gas. Find out from this graph (i) work done in the process $A \rightarrow B, B \rightarrow C, C \rightarrow D$ and $D \rightarrow A$, (ii) work done in the complete cycle $A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$.

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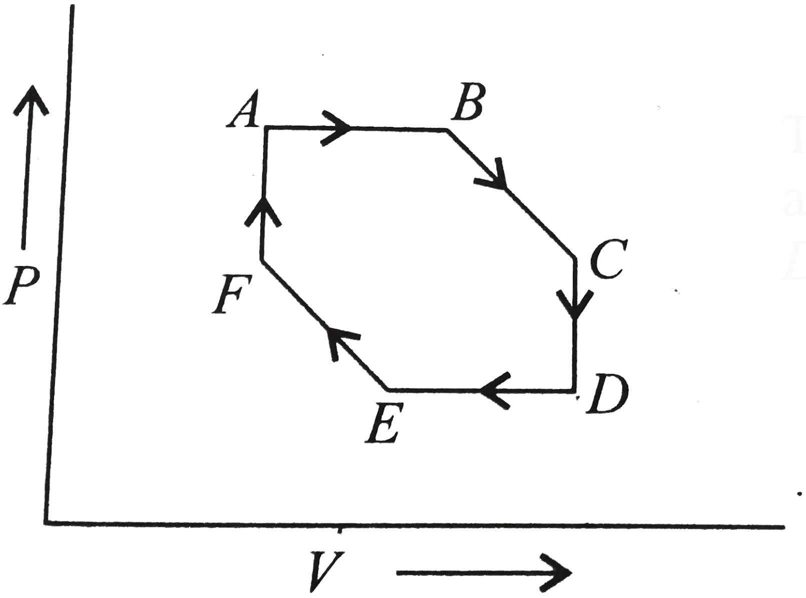
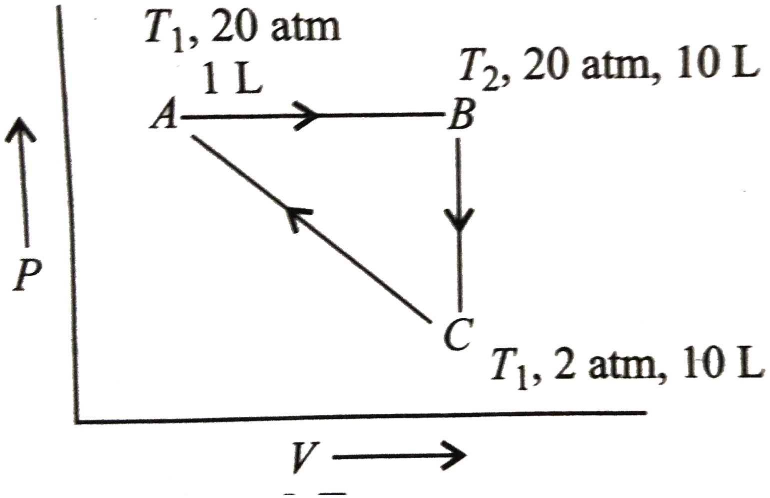
4. Calculate the work done when 1.0 mol of water at $373K$ vaporises against an atmosheric pressure of $1.0 atm$. Assume ideal gas behaviour.

5. Identify different steps in the following cyclic process:



6. $1 mol$ of a mono-atomic gas is subjected to following cyclic process:



a. Calculate T_1 and T_2.

b. Calculate $\Delta U, q,$ and W in calories in each step of cyclic process.

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7. If 500 calorie of heat energy are added to a system and the system does 350 calorie of work on the surroundings, what is the energy change of the system?

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8. If 100 calorie of heat are added to the same system as in example 1 and a work of 50 calorie is done on the system, calculate the energy change of the system.

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9. A gas contained in a cylinder fitted with a frictionless piston expands against a constant pressure 1 atmosphere from a volume of 4 litre to a volume of 14 litre. In doing so, it absorbs 800 J thermal energy from surroundings. Determine ΔU for the process.

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10. Calculate the lattice energy of the reaction

$Li^{\oplus}(g) + CI^{\Theta}(g) \rightarrow LiCI(s)$

from the following data:

$\Delta_{\text{sub}}H^{\Theta}(Li) = 160.67kJmol^{-1}, \frac{1}{2}D\left(CI_2\right) = 122.17kJmol^{-1}, IP(Li) = 520.07kJmol$

$, E_A(CI) = -365.26kJmol^{-1}$ and $\Delta_f H^{\Theta}(LiCI) = -401.66kJmol^{-1}$

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11. When a mole of crystalline sodium chloride is prepared, $410kJ$ of heat is produced. The heat of sublimation of sodium metal is $180.8kJ$. The heat of dissociation fo chloride gas into atoms is $242.7kJ$. The ionisation energy of Na and electron affinity of CI are $493.\,kJ$ and -$368.2kJ$, respectively. calculate the lattice enegry of $NaCI$.

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12. 0.5 g of benzoic acid was subjected to combustion in a bomb calorimeter at $15^\circ C$ when the temperature of the calorimeter system (including water) was found to rise by $0.55^\circ C$. Calculate the heat of combustion of benzoic acid (i) at constant volume and (ii) at constant pressure. the thermal capacity of the calorimeter including water was found to be 23.85 kJ.

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13. A sample of $0.16gCH_4$ was subjected to combustion at $27^{\circ}C$ in a bomb calorimeter. The temperature of the calorimeter system (including water) was found to rise by $0.5^{\circ}C$. Calculate the heat of combustion of methane at (a) constant volume and (b) constant pressure. The thermal capacity of calorimeter system is $17.0kJK^{-1}$ and $R = 8.314JK^{-1}mol^{-1}$.

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14. The heat of combustion of ethane gas is $-368kcalmol^{-1}$. Assuming that 60% of heat is useful, how many m^3 of ethane measured at NTP must be burned to supply heat to convert $50kg$ of water at $10^{\circ}C$ to steam at $100^{\circ}C$?

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15. Will the reaction,

$$I_2(s) + H_2S(g) \rightarrow 2HI(g) + S(s)$$

proceed spontaneously in the forward direction of $298K$

$\Delta_f G^{\Theta} HI(g) = 1.8kJmol^{-1}, \Delta_f G^{\Theta} H_2S(g) = 33.8kJmol^{-1}$?

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16. Compute the standard free enegry of the reaction at $27^{\circ}C$ for the combustion for methane using the give data:

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

$Species$	CH_4	O_2	CO_2	$2H_2O(l)$
$\Delta_f H^{\Theta}\left(kJmol^{-1}\right)$	-74.8	$-$	-393.5	-285.8
$S^{\Theta}\left(JK^{-1}mol^{-1}\right)$	186	205	214	70

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17. The emf of the cell reaction

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aQ) + Cu(s)$

is $1.1V$. Calculate the free enegry change for the reaction. If the enthalpy of the reaction is $-216.7kJmol^{-1}$, calculate the entropy change for the reaction.

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18. Calculate the equilibrium constant for the reaction

$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s), E^{\circ}_{cell} = 0.46V.$

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19. Calculate ΔG^{Θ} for the following reaction:

$CO(g) + \left(\frac{1}{2}\right)O_2(g) \rightarrow CO_2(g), \Delta H^{\Theta} = -282.84kJ$

Given,

$S^{\Theta}_{CO_2} = 213.8JK^{-1}mol^{-1}, S^{\Theta}_{CO(g)} = 197.9JK^{-1}mol^{-1}, S^{\Theta}_{O_2} = 205.0JK^{-1}mol^{-1}$

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20. For the reaction

$A(s) \rightarrow B(s) + C(s)$

Calculate the entropy change at $298K$ and $1atm$ if absolute etropies (in $JK^{-1}mol^{-1}$) are

$A = 130, B = 203, C = 152$

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21. Calculate the maximum efficiency of an engine operating between $100^{\circ}C$ and $25^{\circ}C$

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22. Heat supplied to a Carnot engine is $453.6kcal$. How much useful work can be done by the engine that works between $10^{\circ}C$ and $100^{\circ}C$?

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Solved Example

1. 1 mole of Fe_2O_3 and 2 mole of Al are mixed at temperature $25^\circ C$ and the reaction is completedto give:

$Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Fe(l), \Delta H = -850kJ$

The liberated heat is retained within the products, whose combined specific heat over a wide temperature range is about $0.8Jg^{-1}K^{-1}$. The melting point of iron is $1530^\circ C$. Show that the quantity of heat liberated is sufficient to raise the temperature of the product to the melting point of iron in order to get it welded.

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2. Calculate w and ΔU for the conversion of 0.5 mole of water at $100^\circ C$ to steam at 10 atm pressure. Heat of vaporisation of water at $100^\circ C$ is $40670Jmol^{-1}$

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3. Calculate the work done when 50 g of iron is dissolved in HCl at $25^\circ C$ in (i) a cloed vessel and (ii) an open beaker when the atmospheric pressure is 1atm.

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4. 5 moles of oxygen are heated at constant volume from $10^\circ C$ to $20^\circ C$. The change in internal energy of a gas.

$\left[C_P = 7.03 cal mol^{-1} deg^{-1}$ and $R = 8.3 J mol^{-1} deg^{-1}\right]$

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5. Calculate the amount of work done by 2 mole of an ideal gas at 298 K in reversible isothermal expansion from 10 litre to 20 litre.

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6. 5 moles of an ideal gas expand isothermally and reversible from a pressure of 10 atm to 2 atom at 300K. What is the largest mass which can be lifted through a height of 1 metre in this expansion?

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7. Two moles of an ideal monoatomic gas at NTP are compressed adiabatically and reversibly to occupy a volume of $4.48dm^3$. Calculate the amount of work done, ΔU, final temperature and pressure of the gas. C_V for ideal gas $= 12.45 \text{ J } K^{-1} mol^{-1}$

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8. A certain volume of dry air at NTP is expanded reversible to four times its volume (a) isothermally (b) adiabatically. Calculate the final pressure and temperature in each case, assuming ideal behaviour.

$\left(\frac{C_P}{C_V}\right.$ for air=1.4)

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9. Calculate q,w, ΔU and ΔH for the reversible isothermal expansion of one mole of an ideal gas at $127^{\circ} C$ from a volume of $10 dm^3$ to $20 dm^3$.

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10. A gas expands from $3 dm^3$ to $5 dm^3$ against a constant pressure of 3 atm. The work done during expansion is used to heat 10 mol of water at a temperature of 290 K. Calculate final temperature of water. Specific heat of water $= 4.184 J g^{-1} K^{-1}$

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11. $10 g$ of argon gas is compressed isothermally and reversibly at a temperature of $27^{\circ} C$ from $10 L$ to $5 L$. Calculate $q, w, \Delta U$, and ΔH for this process. $R = 2.0 cal K^{-1} \text{mol}^{-1}, \log_{10} 2 = 0.30$. Atomic weight of $Ar = 40$.

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12. Calculate the maximum work done in expanding $16g$ of oxygen at $300K$ occupying volume of $5dm^3$ and isothermally untill the volume become $25dm^3$?

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13. How much heat is required to change $10g$ ice at $0^\circ C$ to steam at $100^\circ C$? Latent heat of fusion and vaporisation for H_2O are $80clg^{-1}$ and $540calg^{-1}$, respectively. Specific heat of water is $1calg^{-1}$.

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14. A swimmer coming out from a pool is covered with a film of water weighing about $80g$. How much heat must be supplied to evaporate this water ? If latent heat of evaporation for H_2O is $40.79kJmol^{-1}$ at $100^\circ C$.

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15. The heat of combustion of ethylene at $18^{\circ} C$ and at constant volume is -335.8 kcal when water is obtained in liquid state. Calculate the heat of combustion at constant pressure and at $18^{\circ} C$.

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16. The enthalpy of formation of methane at constant pressure and $300K$ is $-75.83kJ$. What will be the heat of formation at constant volume? $\left[R = 8.3JK^{-1}mol^{-1}\right]$

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17. Calculate the enthalpy change for the following reaction:

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

given, enthalpies of formation of CH_4, CO_2 and H_2O are $-74.8kJ \ mol^{-1}$, $-393.5kJ \ mol^{-1}$ and $-286.2kJ \ ml^{-1}$ respectively.

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18. The standard heats of formation at 298K for $CCl_4(g), H_2O(g), CO_2(g)$ and $HCl(g)$ are -25.5, -57.8, -94.1 and -22.1 kcal mol^{-1} respectively. Calculate ΔH°_{298} for the reaction.

$CCl_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4HCl(g)$.

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19. The molar heat of formation of $NH_4NO_3(s)$ is $-367.5kJ$ and those of $N_2O(g)$ and $H_2O(l)$ are $+81.46kJ$ and $-285.78kJ$ respectively at $25^{\circ}C$ and 1 atmospheric pressure. Calculate the ΔH and ΔU for the reaction,

$NH_4NO_3(s) \rightarrow N_2O(g) + 2H_2O(l)$

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20. The heats of combustion of CH_4 and C_4H_{10} are -890.3 and $-2878.7kJmol^{-1}$, respectively. Which of the two has greater efficiency as fuel per gram?

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21. In a gobar gas plant, gobar gas is formed by bacterial fermentation of animal refuse. It mainly contains methane and its heat of combustion is $-809 kJ mol^{-1}$ according to following equation:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O, \Delta H = -809 kJ$

How much gobar gas would have to be produced per day for a small village of 50 families, it it is assumed that each family requires $20000 kJ$ of enegry per day? The methane content in gobar gas is 80% by mass.

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22. The standard molar heats of formation of ethane, carbon dioxide, and liquid water are -21.1, -94.1, and $-68.3 kcal$, respectively. Calculate the standard molar heat of combustion of ethane.

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23. An intimate mixture of ferric oxide and aluminium is used as solid fuel in rockets. Calculate the fuel value per cm^3 of the mixture. Heats of formation and densities are as follows:

$H_f\left(Al_2O_3\right) = -399kcal \quad mol^{-1}, H_f\left(Fe_2O_3\right) = -199kcal \quad mol^{-1}$ ltbr. Density of $Fe_2O_3 = 5.2g/cm^3, \text{ Density of } Al = 2.7g/cm^3$

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24. When 2mole of C_2H_6 are completely burnt $-3129kJ$ of heat is liberated. Calculate the heat of formation of C_2H_6. $\Delta_f H^{\Theta}$ for CO_2 and H_2O are -395 and $-286kJ$, respectively.

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25. Standard heat of formation of CH_4, CO_2 and $H_2O_{(g)}$ are $-76.2, -394.8$ and $-241.6kJmol^{-1}$ respectively. Calculate the amount of heat evolved by burning $1m^3$ of CH_4 measured under normal conditions.

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26. A gas mixture of $3.67L$ of ethylene and methane on complete combustion at $25^\circ C$ produces $6.11L$ of CO_2. Find out the heat evolved on buring $1L$ of the gas mixture. The heats of combustion of ethylene and methane are -1423 and $-891 kJmol^{-1}$, respectively, at $25^\circ C$.

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27. $150mL$ of $0.5N$ nitric acid solution at $25.35^\circ C$ was mixed with $150mL$ of $0.5N$ sodium hydroxide solution at the same temperature. The final temperature was recorded to be $28.77^\circ C$. Calculate the heat of neutralisation of nitric acid with sodium hydroxide.

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28. Whenever an acid is neutralised by a base, the net reaction is

$$H^{\oplus}(aq) + \overset{\ominus}{O}H(aq) \rightarrow H_2O(l), \Delta H = -57.1kJ$$

Calculated the heat evolved for the following experiments?

a. $0.50 mol$ of HCI solution is neutralised by $0.50 mol$ of $NaoH$ solution.

b. $0.50 mol$ of HNO_3 solution is mixed with $0.30 mol$ of KOH solution.

c. $100 mL$ of $0.2 MHCI$ is mixed with $100 mL$ fo $0.3 MNaOH$ solution.

d. $400 mL$ of $0.2 MH_2SO_4$ is mixed with $600 mL$ of $0.1 MKOH$ solution.

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29. $100 cm^3$ of $0.5 NHCI$ solution at $299.95 K$ was mixed with $100 cm^3$ of $0.5 NNaOH$ solution at $299.75 K$ in a thermos flask. The final temperature was found to be $302.65 K$. Calculate the enthalpy of neutralisation of HCI. Water equivalent of thermos flask is $44 g$.

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30. When a student mixed $50 mL$ of $1 MHCI$ and $150 mL$ of $1 MNaOH$ in a coffee cup calorimeter, the temperature of the resultant solution increases from $21 ^\circ C$ to $27.5 ^\circ C$. Assuming that the calorimeter absorbs only a negligible quantity of heat, that the total volume of solution is $100 mL$, its density $1 gm - mL^{-1}$ and that its specific heat is $4.18 Jg^{-1}$.

calculate:

a. The heat change during mixing.

b. The enthalpy change for the reaction

$HCI(aq) + NaOH(aq) \rightarrow NaCI(aq) + H_2O(aq)$

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31. The enthalpies of neutralisation of a string acid HA and a weaker acid HB by $NaOH$ are -13.7 and $-12.7kcalEq^{-1}$, respectively. When one equivalent of $NaOH$ is added to a mixture containing one equivalent of HA and HB, the enthalpy change was $-13.5kcal$. In what ratio is the base distributed between HA and HB?

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32. Calculate the standard heat of formation of carbon disulphide (l). Given that the standard heats of combustion of carbon (s), sulphur (s) and carbon disulphide (l) are -393.3, -293.72 and -1108.76 kJ mol^{-1} respectively.

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33. Calculate the heat of formation of acetic acid form the following date:

a. $CH_3COOH(l) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)\Delta H^{\Theta} = -200.0kcal$

b. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H^{\Theta} = -94.0kcal$

c. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H^{\Theta} = -68.0kcal$

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34. Given the following standard heats of reactions:

(a) heat of formation of water $= -68.3kcal$, (b) heat of combustion of $C_2H_2 = -310.6kcal$, (c) heat of combustion of ethylene $= -337.2kcal$. Calculate the heat of reaction for the hydrogenation of acetylene at constant volume and at $25^{\circ}C$.

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35. For the following reaction,

$C_{\text{diamond}} + O_2 \rightarrow CO_2(g), \Delta H = -94.3 \quad kcal$

$C_{\text{graphite}} + O_2 \rightarrow CO_2(g), \Delta H = -97.6 \quad kcal$

the heat require to change 1 g of

$C_{\text{diamond}} \rightarrow C_{\text{graphite}}$ is:

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36. Methanol can be prepared synthetically by heating carbon monoxide and hydrogen gases under pressure in the presenc eof a catalyst. The reaction is

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

Determine the enthalpy of this reaction by an appropriate combinantion of the following date:

a. $C_{(\text{graphite})} + \frac{1}{2}O_2(g) \rightarrow CO(g), \Delta H^{\ominus} = -110.5 kJmol^{-1}$

b. $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g), \Delta H^{\ominus} = -393.5 kJmol^{-1}$

c. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H^{\ominus} = -285.9 kJmol^{-1}$

d. $CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l), \Delta H^{\ominus} = -726.6 kJmol^{-1}$

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37. How much heat will be required to make $2kg$ of calcium carbide $\left(CaC_2\right)$ according to the following reaction?

$CaO(s) + 3C(s) \rightarrow CaC_2(s) + CO(g)$

The heats of formations of $caO(s), CaC_2(s)$, and $CO(g)$ are $-151.0, -14.0$,and $-26.0kcal$, respectively.

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38. Calculate ΔH of the reaction, $H - \overset{\overset{H}{|}}{C} \,|\, {\scriptstyle CI} - CI(g) \rightarrow C(s) + 2H(g) + 2CI(g)$

Bond enegry for $C - H$ bond and $C - CI$ bond are $400kJ$ and $320kJ$, respectively.

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39. Calculate the enthalpy of the following reaction:

$H_2C = CH_2(g) + H_2(g) \rightarrow CH_3 - CH_3(g)$

The bond enegries of $C - H, C - C, C = C$, and $H - H$ are $99, 83, 147$,and $104 kcal$ respectively.

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40. The bond dissociation energy of gaseous H_2, Cl_2 and HCl are $104, 58$ and $103 kcal mol^{-1}$ respecitvely. Calculate the enthalpy of formation for HCl gas.

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41. Calculate the enthalpy of formation of ammonia from the following bond enegry data:

$(N - H) bond = 389 kJ mol^{-1}, (H - H) bond = 435 kJ mol^{-1}$, and $(N \equiv N) bond = 945.36 kJ mol^{-1}$.

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42. Calculate the resonance enegry of N_2O form the following data

$\Delta_f H^{\Theta} of N_2O = 82kJmol^{-1}$

Bond enegry of $N \equiv N, N = N, O = O,$ and $N = O$ bond is $946, 418, 498,$ and $607kJmol^{-1}$, respectively.

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43. The enthalpies for the following reactions $\left(\Delta H^{\Theta}\right)$ at $25^{\circ} C$ are given below.

a. $\frac{1}{2}H_2(g) + \frac{1}{2}O_2(g) \rightarrow OH(g)$

$\Delta H = 10.06kcal$

b. $H_2(g) \rightarrow 2H(g), \Delta H = 104.18kcal$

c. $O_2(g) \rightarrow 2O(g), \Delta H = 118.32kcal$

Calculate the $O - H$ bond energy in the hydroxyl radical.

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44. The standard molar enthalpies of formation of cyclohexane (l) and benzene (l) at $25^{\circ}C$ are -156 and $+49kJmol^{-1}$, respectively. The standard enthaly of hydrogenation of cyclohenxene (l) at $25^{\circ}C$ is $-119kJmol^{-1}$ Use this data to estimate the magnitude of the resonance enegry of benzene.

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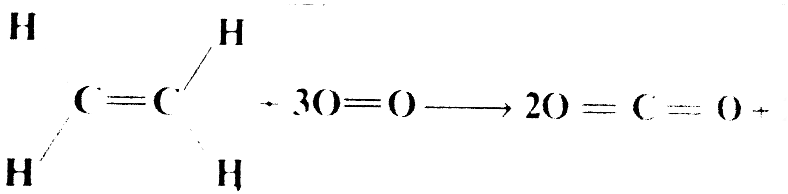
45. Calculate heat of combusion of ethene:



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46. Using the data (all values are in kilocalorie per mole at $25^{\circ}C$) given below, calculate the bond enegry of $C-C$ and $C-H$ bonds.

ΔH^{Θ} combustion of ethane $= -372.0$

ΔH^{Θ} combustion of propane $= -530.0$

ΔH^{Θ} for $C($ garphite$) \rightarrow C(g) = +172.0$

Bond enegry of $H - H$ bond $= +104.0$

$\Delta_f H^{\Theta} of H_2O(l) = -68.0$

$\Delta_f H^{\Theta} of CO_2(g) = -94.0$

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47. Using the bond enthalpy data given below, calculate the enthalpy of formation of acetone (g).

Bond enegry $C - H = 413.4 kJmol^{-1}$,

Bond enegry $C - C = 347.0 kJmol^{-1}$,

Bond enegry $C = O = 728.0 kJmol^{-1}$,

Bond enegry $O = O = 495.0 kJmol^{-1}$,

Bond enegry $H - H = 435.8 kJmol^{-1}$,

$\Delta_{sub} H^{\Theta} C(s) = 718.4 kJmol^{-1}$

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48. The enthalpy change for transition of liquid water to steam is 40.8 kJ mol^{-1} at 373K. Calculate ΔS for the process.

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49. What is entropy change for the conversion of one gram of ice to water at 273 K and one atmospheric pressure?

$$\left(\Delta H_{\text{fusion}} = 6.025kJ \quad mol^{-1}\right)$$

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50. Calculate the enthalpy of vaporisation per mole for ethanol. Given $\Delta S = 109.8JK^{-1}mol^{-1}$ and boiling point of ethanol is 78.5°.

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51. Calculate the entrpoy change for the following reversible process:

$\alpha - T \in \ \Leftrightarrow \beta - T \in$ at

$1mol$ at $1atm$ at $300K$

$\left(\Delta_{trans}H = 2090Jmol^{-1}\right)$

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52. What is the entropy change (in $JK^{-1}mol^{-1}$) when one mole of ice is converted into water at $0\ ^\circ C$?

(The enthalpy change for the conversion of ice to liquid water is $6.0KJmol^{-1}$ at $0\ ^\circ C$)

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53. The enthalpy of vaporisation of liquid diethly ether - $\left(C_2H_5\right)_2O$, is $26.0kJmol(- 1)$ at its boiling point $\left(35.0\ ^\circ C\right)$. Calculate ΔS for conversion of : (a) liquid to vapour, and (b) vapour to liquid at $35\ ^\circ C$.

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54. Calculate entropy change when 10 moles of n ideal gas expands reversibly and isothermally from an initial volume of 10 liter of 100 litre at 300 K.

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55. Oxygen gas weighing 64 g is expanded from 1 atm to 0.25 atm at $30^{\circ} C$ calculate entropy change, assuming the gas to be ideal.

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56. Calculate the change in entropy when 1 mole nitrogen gas expands isothermally and reversibly from an initial volume of 1 litre to a final volume of 10 litre at $27^{\circ} C$

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57. ΔH and ΔS for the reaction:

$Ag_2O(s) \rightarrow 2Ag(s) + (1/2)O_2(g)$

are $30.56kJmol^{-1}$ and $66.0JJK^{-1}mol^{-1}$ respectively. Calculate the temperature at which free energy change for the reaction will be zero. Predict whether the forward reaction will be favoured above or below this temperature.

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58. For the reaction

$2NO(g) + O_2(g) \rightarrow 2NO_2g$

Calculate ΔG at 700K when enthalpy and entropy changes are $-113.0kJ \quad mol^{-1}$ and -145J" "K^(-1)mol^(-1)` respectively.

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59. In the reaction $A^{+} + B \rightarrow A + B^{+}$ there is no entropy change. If enthalpy change is 22 kJ of A^{+}, calculate ΔG for the reaction.

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60. ΔH and ΔS for the reaction $Br_2(l) + Cl_2(g) \rightarrow 2BrCl(g)$ are 29.37 kJ and $104.7J \quad K^{-1}$ respectively. Above what temperature will this reaction become spontaneous?

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61. Calculate the temperature at which liquid water will be in equilibrium with water vapour.

$\Delta H_{vap} = 40.73kJ \quad mol^{-1}$ and $\Delta S_{vap} = 0.109kJ \quad mol^{-1} \quad K^{-1}$

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62. Zinc reacts with dilute hydrochloric acid to give hydrogen at $17\,^{\circ}C$. The enthalpy of the reaction is $-12.55kJ\ mol^{-1}$ of zinc and entropy change equals 5.0 J $k^{-1} \quad mol^{-1}$ for the reaction. Calculate the free energy change and predict whether the reaction is spontaneous or not.

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63. ΔH and ΔS for the system $H_2O(l) \Leftrightarrow H_2O(g)$ at $1atm$ are $40.63kJmol^{-1}$ and $108.8JK^{-1}mol^{-1}$, respectively. Calculate the temperature at which the rates of forward and backward reactions will be the same. Predict the sign of free enegy for this transformation above this temperature.

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64. For the reaction,

$SOCI_2 + H_2O \rightarrow SO_2 + 2HCI$

the enthalpy of reaction is $40.0kJ$ and the entropy of reaction is $336JK^{-1}$. Calculate ΔG at $300K$ and predict the neture of the reaction.

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65. The standard enthalpy and entropy changes for the reaction in equilibrium for the forward direction are given below:

$CO_{(g)} + H_2O_{(g)} \Leftrightarrow CO_{2(g)} + H_{2(g)}$

$\Delta H^{\circ}_{300K} = -41.16 kJmol^{-1}$

$\Delta S^{\circ}_{300K} = -4.24 \times 10^{-2} kJmol^{-1}$

$\Delta H^{\circ}_{1200K} = -32.93 KJmol^{-1}$

$\Delta S^{\circ}_{1200K} = -2.96 \times 10^{-2} kJmol^{-1}$

Calculate K_p at each temperature and predict the direction of reaction at 300K and 1200K, when $P_{CO} = P_{CO_2} = P_{H_2} = P_{H_2O} = 1$ atm at initial state.

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66. The standard Gibbs free energies for the reaction at 1773K are given below:

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta G^{\Theta} = -380 kJmol^{-1}$

$2C(s) + O_2(g) \Leftrightarrow 2CO(g), \Delta G^{\Theta} = -500 kJmol^{-1}$

Discuss the possibility of reducing AI_2O_3 and PbO with carbon at this temperature,

$4AI + 3O_2(g) \rightarrow 2AI_2O_3(s), \Delta G^{\Theta} = -22500 kJmol^{-1}$

$2Pb + O_2(g) \rightarrow 2PbO(s), \Delta G^{\Theta} = -120 kJmol^{-1}$

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67. In a fuel cell, methanol if used as fuel and oxygen gas is used as an oxidiser. The reaction is

$$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

Calculated standard Gibbs free enegry change for the reaction that can be converted into electircal work. If standard enthalpy of combustion for methanol is $-702kJmol^{-1}$, calculate the efficiency of converstion of Gibbs energy into useful work.

$\Delta_f G^{\ominus}$ for CO_2, H_2O, CH_3OH, O_2 is $-394.00, -237.00, -166.00$and $0kJmol^{-1}$ respectively.

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68. What is the equilibrium constant K_c for the following reaction at $400K$?

$$2NOCI(g) \Leftrightarrow 2NO(g) + CI_2(g)$$

$\Delta H^{\ominus} = 77.2kJmol^{-1}$ and $\Delta S^{\ominus} = 122JK^{-1}mol^{-1}at400K.$

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69. For the equilibrium,

$PCI_5(g) \Leftrightarrow PCI_3(g) + CI_2(g) at 25 ^\circ C K_c = 1.8 \times 10^{-7}$

Calculate ΔG^Θ for the reaction $\left(R = 8.314 JK^{-1} mol^{-1}\right)$.

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70. The equilibrium constant at $25 ^\circ C$ for the process:

$CO^{3+}(aq) + 6NH_3(aq) \Leftrightarrow \left[Co\left(NH_3\right)_6\right]^{3+}(aq)$ is 2×10^7.

Calculate the value of ΔG^Θ at $25 ^\circ C at 25 ^\circ C \left[R = 8.314 JK^{-1} mol^{-1}\right]$.

In which direction the reaction is spontaneous when the recatants and proudcts are in standard state?

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71. The equilibrium constant for the reaction

$CO_2(g) + H_2(g) \Leftrightarrow CO(g) + H_2O(g) at 298K$ is 73. Calculate the value of the standard free enegry change $\left(R = 8.314JK^{-1}mol^{-1}\right)$

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72. For the water gas reaction,

$C(s) + H_2O(g) \Leftrightarrow CO(g) + H_2(g)$

the standard Gibbs free energy of reaction (at $1000K$) is $-8.1kJmol^{-1}$.

Calculate its equilibrium constant.

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73. Calculate ΔG^{Θ} for the conversion of oxygen to ozone, $\left(\frac{3}{2}\right)O_2(g) \Leftrightarrow O_3(g)at298K$, of K_p for this conversion is 2.47×10^{-29}.

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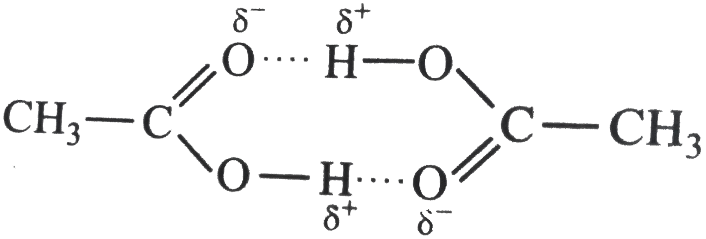
74. Acetic acid CH_3COOH can form a dimer $\left(CH_3COOH\right)_2$ in the gas phase. The dimer is held together by two H - bonds with a total strength of $60.0 kJ per$ mole of dimer



If at $25^\circ C$, the equilibrium constant for the dimerisation is 1.3×10^3, calculate ΔS^Θ for the reaction

$2CH_3COOH(g) \Leftrightarrow \left(CH_3COOH\right)_2(g)$

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Illustrations of Objective Questions

1. $5 mol$ of an ideal gas at $27^\circ C$ expands isothermally and reversibly from a volume of $6L$ to $60L$. The work done in kJ is

A. - 14.7

B. - 28.72

C. $+28.72$

D. -56.72

Answer: B

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2. 10 moles of an ideal gas confined to a volume of 10 L is released into atmosphere at 300 K where the pressure is 1 bar.

The work done by the gas is: ltBrgt $\left(R = 0.083L \text{ bar } K^{-1}mol^{-1}\right)$

A. 249 L bar

B. 259 L bar

C. 239 L bar

D. 220 L bar

Answer: C

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3. One litre-atmosphere is approximately equal to

A. 101.3 J

B. 8.314 J

C. 931 J

D. 19.2 J

Answer: A

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4. A system absorbs $20kJ$ heat and also does $10kJ$ of work. The net internal enegry of the system

A. increases by 10kJ

B. decreases by 10kJ

C. increases by 30kJ

D. decreases by 30 kJ

Answer: A

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5. One mole of a gas is heated at constant pressure to raise its temperature by $1^{\circ} C$. The work done in joules is

A. -4.3

B. -8.314

C. -16.62

D. unpredictable

Answer: B

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6. In open system:

A. there will be exchange of both matter and energy

B. there will be no exchange of matter and energy

C. there wil be exchange of energy only

D. there will be exchange of matter only.

Answer: A

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7. $\Delta H^{\Theta}{}' f298K$ of methanol is given by the chemical equation

A. $CH_4(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(g)$

B. $C(\text{graphite}) + \frac{1}{2}O_2(g) + 2H_2(g) \rightarrow CH_3OH(l)$

C. $C(\text{diamond}) + \frac{1}{2}O_2(g) + 2H_2(g) \rightarrow CH_3OH(l)$

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

Answer: B

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8. The standard molar heats of formation of ethane, carbon dioxide, and liquid water are -21.1, -94.1, and $-68.3 kcal$, respectively. Calculate the standard molar heat of combustion of ethane.

A. -372 kcal

B. $-240 kcal$

C. 162 kcal

D. 182.5 kcal

Answer: A

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9. When ethyne is passed through a red hot tube, then formation of benzene takes place:

$H^{\circ}_{f\left(C_2H_2\right)(g)} = 230kJ \quad mol^{-1}$

$\Delta H^{\circ}_{f\left(C_6H_6\right)(g)} = 85kJ \quad mol^{-1}$

calculate the standard heat of trimerisation of ethyne to benzene.

$3C_2H_2(g) \rightarrow C_6H_6(g)$

A. 205kJ mol^{-1}

B. 605 kJ mol^{-1}

C. $-605kJ \quad mol^{-1}$

D. -205 kJ mol^{-1}

Answer: C

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10. For the reaction $F_2(g) + 2HCL(g) \rightarrow 2HF(g) + C1_2(g)$

ΔH° at $298K$ is $-84.4Kcal$, $\Delta H^{\circ} f(HF) = -64.2Kcal/mol$

$\Delta H^{\circ} f$ for the $HCL(g)$ per gram is

A. $-22.\,kJ \quad mol^{-1}$

B. $88kJ \quad mol^{-1}$

C. $-91.21kJ \quad mol^{-1}$

D. $-183.8kJ \quad mol^{-1}$

Answer: C

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11. Given two processes:

$\frac{1}{2}P_4(s) + 3CI_2(g) \rightarrow 2PCI_3(l), \Delta H = -635kJ$

$PCI_3(l) + CI_2(g) \rightarrow PCI_5(s), \Delta H = -137kJ$ The value of ΔH^{Θ} of PCI_5 is

A. $454.5kJ \quad mol^{-1}$

B. $-454.5kJ$

C. $-772kJ \quad mol^{-1}$

D. $-498kJ \quad mol^{-1}$

Answer: B

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12. The enthalpy of combustion of H_2, cyclohexene $\left(C_6H_{10}\right)$ and cyclohexane $\left(C_6H_{12}\right)$ are -241, -3800 and $-3920KJ$ per mol respectively. Heat of hydrogenation of cyclohexene is

A. $-121kJ/mol$

B. $+121kJ/mol$

C. $-242kJ/mol$

D. $+242kJ/mol$

Answer: A

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13. Given:

i. $2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s), \Delta H^{\Theta} = -193.4kJ$

ii. $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s), \Delta H^{\Theta} = -140.2kJ$

What is ΔH^{Θ} of the reaction?

$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$

A. $-227.2kJ$

B. $-272.3kJ$

C. $227.2kJ$

D. $272.3kJ$

Answer: A

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14. Given that:

i. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -94.05kcal$

ii. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H = -68.32kcal$

iii.$C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l), \Delta H = -310.62 kcal$

The heat of formation fo acetylene is

A. $-1802 kJ$

B. $+1802 kJ$

C. $-800 kJ$

D. $+228 kJ$

Answer: D

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15. The enthalpy changes for two reactions are given by the equations:

$$2Cr(s) + \frac{3}{2}O_2(g) \rightarrow Cr_2O_3(s), \Delta H^{\Theta} = -1130 kJ$$

$$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g), \Delta H^{\Theta} = -110 kJ$$

What is the enthalpy change in kJ for the following reactions?

$$3C(s) + Cr_2O_3(s) \rightarrow 2Cr(s) + 3CO(g)$$

A. $-1460 kJ$

B. $-800kJ$

C. $+800kJ$

D. $+1020kJ$

Answer: C

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16. The enthalpy change ΔH for the neutralisation fo $1MHCI$ by caustic potash in dilute solution at $298K$ is

A. 68kJ

B. 65 kJ

C. 57.3 kJ

D. 50 kJ

Answer: C

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17. Enthalpy of neutralisation of the reaction between $CH_3COOH(aq)$ and $NaOH(aq)$ is $-13.2kcalEq^{-1}$ and that of the reaction between $H_2SO_4(aq)$ and $KOH(aq)$ is $-13.7kcalEq^{-1}$. The enthalpy of dissociation of $CH_3COOH(aq)$ is

A. -0.5 kcal eq^{-1}

B. $+0.5$ kcal eq^{-1}

C. $-26.9kcal\ eq^{-1}$

D. $+13.45kcal\ eq^{-1}$

Answer: B

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18. Calculate the enthalpy change when $50mL$ of $0.01MCa(OH)_2$ reacts with $25mL$ of $0.01MHCI$. Given that ΔH^{Θ} neutralisaiton of strong acid and string base is $140kcalmol^{-1}$

A. 14 kcal

B. 35 cal

C. 10 cal

D. 7.5 cal

Answer: B

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19. Equal volumes of $1MHCI$ and $1MH_2SO_4$ are neutralised by $1MNaOH$ solution and x and $ykJ/$ equivalent of heat are liberated, respectively. Which of the following relations is correct?

A. $x = 2y$

B. $x = 3y$

C. $x = 4y$

D. $x = 1/2y$

Answer: D

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20. Which of the following acid will release maximum amount of heat when completely neutralised by strong base $NaOH$?

A. 1 M HCl

B. 1 M HNO_3

C. $1M\ HClO_4$

D. $1M\ H_2SO_4$

Answer: D

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21. Determine the heat of the following reaction:

$FeO(s) + Fe_2O_3(s) \rightarrow Fe_3O_4(s)$

Given informations:

$2Fe(s) + O_2(g) \rightarrow 2FeO(s), \quad \Delta H^\circ = -544kJ$

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s), \quad \Delta H^\circ = -1648.4kJ$

$Fe_3O_4(s) \rightarrow 3Fe(s) + 2O_2(g), \Delta H^\circ = +1118.4kJ$

A. $-1074kJ$

B. $-22.2kJ$

C. $+249.8kJ$

D. $+2214.6kJ$b

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22. Calculate the enthalpy of formation of $\Delta_f H$ for C_2H_5OH from tabulated data and its heat of combustion as represented by the following equaitons:

i. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g), \Delta H^\Theta = -241.8kJmol^{-1}$

ii. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H^\Theta = -393.5kJmol^{-1}$

iii. $C_2H_5OH(l) + 3O_2(g) \rightarrow 3H_2O(g) + 2CO_2(g), \Delta H^{\Theta} = -1234.7 kJmol^{-1}$

a. $-2747.1 kJmol^{-1}$ b. $-277.7 kJmol^{-1}$

c. $277.7 kJmol^{-1}$ d. $2747.1 kJmol^{-1}$

A. $-2747.1 kJ \quad mol^{-1}$

B. $-277.7 kJ \quad mol^{-1}$

C. $277.7 kJ \quad mol^{-1}$

D. $2747.1 kJ \quad mol^{-1}$

Answer: B

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23. Given that $C + O_2 \rightarrow CO_2, \Delta H^{\circ} = -xKJ$ and $2CO + O_2 \rightarrow 2CO_2, \Delta H^{\circ} = -yKJ$ The enthalpy of formation of carbon monoxide will be

A. $\dfrac{y - 2x}{3}$

B. $\dfrac{y - 2}{2}$

C. $\frac{2x-y}{2}$

D. $\frac{x-y}{y}$

Answer: B

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24. The enthalpies of combustion of diamond and graphite are - 395.4 kJ and - 393.5 kJ respectively calculate the enthalpy of transformation from diamond to graphite.

A. $-0.5kcal$

B. $+0.5kcal$

C. $1kcal$

D. $-1kcal$

Answer: B

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25. For the reaction

$3N_2O(g) + 2NH_3(g) \rightarrow 4N_2(g) + 3H_2O(g), \Delta H^\circ = -879.6kJ$

If $\Delta H_f^\circ\left[NH_3(g)\right] = -45.9kJ \quad mol^{-1}$,

$\Delta H_f^\circ\left[H_2O(g)\right] = -241.8kJ \quad mol^{-1}$

Then $\Delta H_f^\circ\left[N_2O(g)\right]$ will be:

A. $+246$ kJ

B. $+82$ kJ

C. $-82kJ$

D. $-246kJ$

Answer: B

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26. The bond energies of $C = C$ and $C - C$ at $298K$ are 590 and $331kJmol^{-1}$

, respectively. The enthalpy of polymerisation per mole of ethaylene is

A. $-70kJ$

B. $-72kJ$

C. $72kJ$

D. $-68kJ$

Answer: B

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27. For the reaction:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g), \Delta H = -571kJ$

bond enegry of $(H-H) = 435kJ$ and of $(O=O) = 498kJ$. Then, calculate the average bond enegry of $(O-H)$ bond using the above data.

A. 484 kJ

B. $-484kJ$

C. $271kJ$

D. $-271kJ$

Answer: A

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28. Use the bond energies in the table to estimate ΔH for this reaction:

$CH_2 = CH_2 + Cl_2 \rightarrow CICH_2 - CH_2CI$

A. $\Delta H = -684kJ$

B. $\Delta H = -154kJ$

C. $\Delta H = +89kJ$

D. $\Delta H = +177kJ$

Answer: B

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29. Heat of formation of $2mol$ of $NH_3(g)$ is $= -90kJ$, bond energies of $H-H$ and $N-H$ bonds are $435kJ$ and $390kJmol^{-1}$, respectively. The value of the bond enegry of $N \equiv N$ will be

A. $-472.5kJ$

B. $-945kJ$

C. $472.5kJ$

D. $945kJ \quad mol^{-1}$

Answer: D

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30. If ΔH_f° of $Icl(g)$, $Cl(g)$ and $I(g)$ is 17.57, 121.34 and $106.96Jmol^{-1}$ respectively. Then bond dissociation energy of $I-Cl$ bond is

A. 17.57

B. 210.73

C. 35.15

D. 106.96

Answer: B

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31. Calculate the ΔH in joules for

$C(\text{graphite}) \rightarrow C(\text{diamond})$

from the following data:

$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g): \quad \Delta H^\circ = -393.5kJ$

$C(\text{diamond}) + O_2(g) \rightarrow CO_2(g), \quad \Delta H^\circ = -395.4kJ$

A. 1900

B. -788.9×10^3

C. 190000

D. $+788.9 \times 10^3$

Answer: A

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32. The enthalpy change for the following process are listed below:

$(a)\ Cl_{2(g)} \rightarrow 2Cl_{(g)}, \Delta H = 242.3kJmol^{-1}$

$(b)\ I_{2(g)} \rightarrow 2I_{(g)}, \Delta H = 151.0kJmol^{-1}$

$(c)\ ICl_{(g)} \rightarrow I_{(g)} + Cl_{(g)}, \Delta H = 211.3kJmol^{-1}$

$(d)\ I_{2(s)} \rightarrow I_{2(g)}, \Delta H = 62.76kJmol^{-1}$

If standard state of iodine and chloride are $I_{2(s)}$ and $Cl_{2(g)}$, the standard enthalpy of formation for $ICl_{(g)}$ is :

A. $-14.6kJ \quad mol^{-1}$

B. $-16.8kJ \quad mol^{-1}$

C. $+16.8kJ \quad mol^{-1}$

D. $+244.8kJ \quad mol^{-1}$

Answer: C

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33. Given that:

$2C(s) + O_2(g) \rightarrow 2CO_2(g) \quad (\Delta H = -787kJ) \dots$ (i)

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l) \quad (\Delta H = -286kJ) \dots$ (ii)

$C_2H_2 + 2\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l) \quad (\Delta H = -1310kJ) \dots$(iii)

The heat of formation of acetylene is:

A. $-1802kJ \quad mol^{-1}$

B. $+1802kJ \quad mol^{-1}$

C. $+237kJ \quad mol^{-1}$

D. $-800kJ \quad mol^{-1}$

Answer: C

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34. The bond energies of $H - - H$, $Br - - Br$ and $H - - Br$ are $433, , 192$ and $364KJmol^{-1}$ respectively. The ΔH° for the reaction

$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$ is

A. $-261kJ$

B. $+103kJ$

C. $+261kJ$

D. $-103kJ$d

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35. For liquid enthalpy of fusion is $1.435kcalmol^{-1}$ and molar entropy change is $5.26calmol^{-1}K^{-1}$. The melting point of the liquid is

A. $0^{\circ}C$

B. $-273^{\circ}C$

C. $173K$

D. $100^{\circ}C$

Answer: A

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36. Latent heat of vaporisation of water is $540 cal\ g^{-1}$ at $100\ ^{\circ}C$ calculate the entropy change when 1000 g water is converted to steam at $100\ ^{\circ}C$

A. 1447 cal

B. 2447 cal

C. 3447 cal

D. 4447 cal

Answer: A

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37. Enthalpy of fusion of water is 6.01 kJ mol^{-1}. The entropy change of 1 mole of ice at its melting point will be:

A. 22kJ mol^{-1}

B. 109 kJ mol^{-1}

C. 44 kJ mol^{-1}

D. 11 kJ mol^{-1}

Answer: A

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38. For spontaneous process:

A. $\Delta S_{\text{total}} = 0$

B. $\Delta S_{\text{total}} > 0$

C. $\Delta S_{\text{total}} < 0$

D. none of these

Answer: B

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39. Melting point of a solid is x K and its latent heat of fusion is 600 cal mol^{-1}. The entropy change for fusion of 1 mol solid is 2 cal $mol^{-1}K^{-1}$. The value of x will be:

A. 100K

B. 200K

C. 300K

D. 400K

Answer: C

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40. The entropy change involved in the conversion of 1 mole of liquid water at 373 K to vapour at the same temperature will be:

A. 0.119 kJ/g

B. 0.109 kJ/g

C. 0.129 kJ/g

D. 0.120 kJ/g

Answer: B

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41. The free energy for a reaction having $\Delta H = 31400$ cal, $\Delta S = 32 \text{ cal } K^{-1} mol^{-1}$ at $1000\ ^{\circ}C$ is:

A. $-9336 cal$

B. $-7386 cal$

C. $-1936 cal$

D. $+9336 cal$

Answer: A

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42. $F_2C = CF - CF = CF_2 \rightarrow F_2C | FC= - CF_2 | CF$

For this reaction (ring closure), $\Delta H = -49kJmol^{-1}, \Delta S = -40.2JK^{-1}mol^{-1}. Up$ to what temperature is the forward reaction spontaneous?

A. $1492^{\circ} C$

B. $1219^{\circ} C$

C. $946^{\circ} C$

D. $1080^{\circ} C$

Answer: C

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43. For the equilibrium reaction, the value of Gibbs free energy change is:

A. > 0

B. < 0

C. $= 0$

D. $\neq 0$

Answer: C

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44. At $0 ^\circ C$ ice and water are in equilibrium and $\Delta H = 6kJ \quad mol^{-1}$ for this process:

$H_2O \Leftrightarrow H_2O(l)$

The values of ΔS and ΔG for conversion of ice into liquid water at $0 ^\circ C$ are:

A. $-21.9JK^{-1}mol^{-1}$ and 0

B. $0.219JK^{-1}mol^{-1}$ and 0

C. $21.9JK^{-1}mol^{-1}$ and 0

D. $0.0219JK^{-1}mol^{-1}$ and 0

Answer: C

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45. For a reaction,

$Ag_2O(s) \Leftrightarrow 2Ag(s) + \frac{1}{2}O_2(g)$

$\Delta H, \Delta S$ and T are 40.63 kJ mol^{-1}, 108.8 J $K^{-1}mol^{-1}$ and $373.3K$ respectively.

Predict the feasibility of the reaction:

A. feasible

B. non-feasible

C. remains at equilibrium

D. not predicted

Answer: B

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46. For the homogeneous reactions:

$xA + yB \rightarrow lY + mZ$

$\Delta H = -30kJ \quad mol^{-1}, \Delta S = -100JK^{-1} \quad mol^{-1}$

At what temperature the reaction is at equilibrium?

A. $50\,^{\circ}C$

B. $250\,^{\circ}C$

C. $100K$

D. $27\,^{\circ}C$

Answer: D

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47. For the reaction

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$$

ΔH and ΔS are $-283kJ$ and $-87JK^{-1}$, respectively. It was intended to carry out this reaction at 1000,1500,3000, and 3500 K. At which of these temperatures would this reaction be thermodynamically spontaneous?

A. 1500 and 3500 K

B. 3000 and 3500 K

C. 1000, 1500 and 3000K

D. 1500, 3000 and 3500 K

Answer: C

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48. For a reaction

$\Delta H = +29kJ \quad mol^{-1}, \Delta S = -35KJ^{-1} \quad mol^{-1}$

at what temperature, the reaction will be spontaneous?

A. $828.7\,^{\circ}C$

B. $828.7K$

C. Spontaneous at all temperature

D. non possible

Answer: D

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49. What is ΔG° for the reaction?

$$\frac{1}{2}N_2(g)+\frac{3}{2}H_2(g)\rightarrow NH_3(g)\ K_p=4.42\times10^4 at 25^\circ C.$$

A. -26.5 kJ mol^{-1}

B. $-11.5\ \text{kJ}\ mol^{-1}$

C. $-2.2\ \text{kJ}\ mol^{-1}$

D. $-0.97\ \text{kJ}\ mol^{-1}$

Answer: A

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50. What is the sign of ΔG^Θ and the values of K for an electrochemical cell for which $E^\Theta{}_{cell}$ = 0.80volt`?

A. $\begin{matrix}\Delta G^\circ & K \\ - & >1\end{matrix}$

B. $\begin{array}{cc} \Delta G^{\circ} & K \\ + & >1 \end{array}$

C. $\begin{array}{cc} \Delta G^{\circ} & K \\ + & <1 \end{array}$

D. $\begin{array}{cc} \Delta G^{\circ} & K \\ - & <1 \end{array}$

Answer: A

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51. The free energy of formation of NO is $78kJmol^{-1}$ at the temperature of an authomobile engine $(1000K)$. What is the equilibrium constant for this reaction at $1000K$?

$$\frac{1}{2}N_2(g)+\frac{1}{2}O_2(g)\Leftrightarrow NO(g)$$

A. 8.4×10^{-5}

B. 7.1×10^{-9}

C. 4.2×10^{-10}

D. 1.7×10^{-19}

Answer: A

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52. Equilibrium constant for the reaction:

$H_2(g) + I_2(g) \Leftrightarrow 2HI(g) is K_c = 50 at 25^\circ C$

The standard Gibbs free enegry change for the reaction will be:

A. $-6.964kJ$

B. $-9.694kJ$

C. $-4.964kJ$

D. $-6.496kJ$

Answer: B

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53. Standard Gibbs free enegry change ΔG^{Θ} for a reaction is zero. The value of the equilibrium constant will be:

A. 10

B. 1

C. 100

D. ∞

Answer: B

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54. The standard free energy change of a reaction is $\Delta G^{\circ} = -115$ at 298K. Calculate the equilibrium constant K_P in log K_P. $\left(R = 8.314JK^{-1}mol^{-1}\right)$

A. 20.16

B. 2.303

C. 2.016

D. 13.83

Answer: A

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55. For which of the following reactions, the entropy change will be positive?

A. $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

B. $HCl(g) + NH_3(g) \Leftrightarrow NH_4Cl(s)$

C. $NH_4NO_3(s) \Leftrightarrow N_2O + 2H_2O(g)$

D. $MgO(s) + H_2(g) \Leftrightarrow Mg(s) + H_2O(l)$

Answer: C

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56. If an endothermic reaction occurs spontaneously at constant T and P, then which of the following is true

A. $\Delta G > 0$

B. $\Delta G < 0$

C. $\Delta S > 0$

D. $\Delta S < 0$

Answer: C

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57. Which is the correct expression that relates changes of entropy with the change of pressure for an ideal gas at constant temperature, among the following?

A. $\Delta S = nRT \ln \frac{P_2}{P_1}$

B. $\Delta S = T\left(P_2 - P_1\right)$

C. $\Delta S = nR \ln\left(\frac{P_1}{P_2}\right)$

D. $\Delta S = 2.303nRT \ln\left(\frac{P_1}{P_2}\right)$

Answer: C

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58. The correct statement regarding entropy is:

A. At absolute zero temperature, entropy of a perfectly crystalline solid is zero

B. At absolute zero temperature, the entropy of a perfectly crystalline substance is +ve

C. At absolute zero temperature, the entropy of all crystalline substances is zero

D. At $0^\circ C$ the entropy of a perfectly crystalline solid is zero.

Answer: A

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Miscellaneous Numerical Examples

1. Bond dissociation enthalpies of $H_2(g)$ and $N_2(g)$ are $436.0kJmol^{-1}$ and $941.8kJmol^{-1}$, respectively and enthalpy of formation of $NH_3(g)$ is $-46kJmol^{-1}$. What is the enthalpy of atomisation of $NH_3(g)$?. What is the avergae bond ethalpy of $N-H$ bond?

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2. Ethanol was oxidised to acetic acid in a catalyst chamber at $18^{\circ}C$. Calculate the rate of removel of heat to maintain the reaction chamber at $18^{\circ}C$ with the feed rate of $30kgh^{-1}$ ethanol along with excess oxygen to the system at $18^{\circ}C$, given that a $42mol\%$ yield based on ethanol is obtained. Given that

$\Delta_f H^{\Theta}{}' H_2O(l) = -68.0 kcal mol^{-1}$

$\Delta_f H^{\Theta}{}' C_2H_5OH(l) = -66 kcal mol^{-1}$

$\Delta_f H^{\Theta}{}' CH_3COOH(l) = -118 kcal mol^{-1}$

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3. The standard heat of formation listed for gaseous NH_3 is $-11.0 kcal mol^{-1}$ at $298K$. Given that at $298k$, the constant pressure heat capacities of gaseous N_2, H_2, and NH_3 are, respectively, $7.0, 6.0$ and $8.0 cal mol^{-1}$. Determine $\Delta H^{\Theta}{}_{298K}$ and ΔH_{773K} for the reactions:

$$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g)$$

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4. The heat of combusion of glycogen is about $476 kJ mol^{-1}$ of carbon. Assume that average heat loss by an adult male is $150W$. If we were to assume that all the heat comes from oxidation of glycogen, how many units of glycogen ($1mol$ carbon per unit) must be oxidised per day to provide for this heat loss?

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5. At $25^{\circ}C$, the following heat of formations are given:

Compound	$SO_2(g)$	$H_2O(l)$
$\Delta_f H^{\Theta} kJmol^{-1}$	-296.0	-285.0

For the reactions at $25^{\circ}C$,

$$2H_2S(g) + Fe(s) \rightarrow FeS_2(s) + 2H_2(g), \Delta H^{\Theta} = -137kJm\infty l^{-1}$$

$$H_2S(g) + \frac{3}{2}O_2(g) \rightarrow H_2O(l) + So_2(g), \Delta H^{\Theta} = -562kJmol^{-1}$$

Calculate the heat of formation of $H_2S(g)$ and $FeS_2(g)$ at $25^{\circ}C$.

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6. The 'heat of total cracking' of hydrocarbons ΔH_{TC} is defined as ΔH at $298.15K$ and $101.325kPa$ for the process below

$$C_nH_m + \left(2n - \frac{m}{2}\right)H_2(g) \rightarrow nCH_4(g)$$

Given that ΔH_{TC} is $-65.2kJ$ for C_2H_6 and $-87.4kJ$ for C_3H_8, calculate ΔH

for

$CH_4(g) + C_3H_8(g) \rightarrow 2C_2H_6(g)$

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7. A constant pressure calorimeter consists of an insulated beaker of mass $92g$ made up of glass with heat capacity $0.75JK^{-1}g^{-1}$. The beaker contains $100mL$ of $1MHCI$ at $22.6^{\circ}C$ to which $100mL$ of $1MNaOH$ at $23.4^{\circ}C$ is added. The final temperature after the complete reactions is $29.3^{\circ}C$, What is ΔH per mole for this neutralization reaction? Assume that the heat capacities of all solutions are equal that of same volumes of water.

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8. $C_2H_4 + CI_2 \rightarrow C_2H_4CI_2$

$\Delta H = -270.6kJmol^{-1}K^{-1}, \Delta S = -139J$

a. Is the reaction favoured by entropy, enthalpy both or none?

b. Find ΔG if $T = 300K$.

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9. Find bond enthalpy of S-S bond from the following data:

$C_2H_5 - S - C_2H_5, \quad \Delta H_f^{\circ} = -147.2 kJ \quad mol^{-1}$

$C_2H_5 - S - S - C_2H_5, \quad \Delta H_f^{\circ} = -201.9 kJ \quad mol^{-1}$

$S(g), \quad \Delta H_f^{\circ} = 222.8 kJ \quad mol^{-1}$

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10. A natural gas may be assumed to be a mixture of methane and ethane only. On complete combustion of $10L$ of gas at STP the heat evolved was $474.6 kJ$. Assuming $\Delta_{comb} H^{\Theta} CH_4(g) = -894 kJ mol^{-1}$ and $\Delta_{comb} H^{\Theta} C_2H_6(g) = -1500 kJ mol^{-1}$. So, find composition of the mixture by volume.

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11. From the data at $25^\circ C$:

$$Fe_2O_3(s) + 3C_{(\text{graphite})} \rightarrow 2Fe(s) + 3CO(g), \Delta H^{\ominus} = 492.0 kJmol^{-1}$$

$$FeO(s) + C_{(\text{graphite})} \rightarrow Fe(s) + CO(g), \Delta H^{\ominus} = 155.0 kJmol^{-1}$$

$$C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g), \Delta H^{\ominus} = -393.0 kJmol^{-1}$$

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g), \Delta H^{\ominus} = -282.0 kJmol^{-1}$$

Calculate the standard heat of formation of $FeO(s)$ and $Fe_2O_3(s)$.

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12. Calculate ΔH at $85^\circ C$ for the reaction:

$$Fe_2O_3(s) + 3H_2(g) \rightarrow 2Fe(s) + 3H_2O(l)$$

The data: $\Delta H^{\ominus}_{298} = -33.0 kJmol^{-1}$ and

Substance	$Fe_2O_3(s)$	$Fe(s)$	$H_2O(l)$	$H_2(g)$
$C_P^{\circ}\left(JK^{-1}mol\right)$	103.0	25.0	75.0	28.0

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13. The standard heats of formation at 298K for $CCl_4(g), H_2O(g), CO_2(g)$ and $HCl(g)$ are $-25.5, -57.8, -94.1$ and -22.1 kcal mol^{-1} respectively. Calculate ΔH°_{298} for the reaction.

$CCl_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4HCl(g)$.

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14. Calculate$q, W, \Delta U$ and ΔH for the isothermal reversible expansion of one mole of an ideal gas from an initial pressure of 1.0 bar to a final pressure of 0.1 bar at a constant temperature of $273K$.

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15. A sample of argon gas at $1atm$ pressure and $27^{\circ}C$ expands reversibly and adiabatically from $1.25dm^3$ to $2.50dm^3$. Calculate the enthalpy change in this process. C_{vm} for orgon is $12.48JK^{-1}mol^{-1}$.

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16. Show that the reaction

$CO(g) + (1/2)O_2(g) \rightarrow CO_2(g)$

at $300K$ is spontaneous and exothermic, when the standard entropy change is $-0.094 kJmol^{-1}K^{-1}$. The standard Gibbs free energies of formation for CO_2 and CO are -394.4 and $-137.2 kJmol^{-1}$, respectively.

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17. Diborane is a potential rocket fuel which undergoes combustion according to the reaction,

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

from the following data, the enthalpy change for the combustion of diborane will be :

$2B(s) + \frac{3}{2}O_2(g) \rightarrow B_2O_3(s), \quad \Delta H = -1273 \text{ kJ}$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \quad \Delta H = -286 \text{ kJ}$

$H_2O(l) \rightarrow H_2O(g), \quad \Delta H = 44 \text{ kJ}$

$2B(s) + 3H_2(g) \rightarrow B_2H_6(g), \quad \Delta H = 46 \text{ kJ}$

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18. An insulated vessel contains 1mole of a liquid, molar volume $100mL$ at 1bar. When liquid is steeply passed to 100bar, volume decreases to $99mL$. Find ΔH and ΔU for the process.

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19. In the reaction equilibrium

$N_2O_4 \Leftrightarrow 2NO_2(g)$

When 5 mol of each is taken and the temperature is kept at $298K$, the total pressure was found to be 20 bar.

Given : $\Delta_f G^{\ominus}_{n_2O_4} = 100kJ, \Delta_f G^{\ominus}_{NO_2} = 50KJ$

a. Find ΔG of the reaction at $298K$.

b. Find the direction of the reaction.

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20. When 1pentyne (A) is treated with $4N$ alcoholic KOH at $175\,^{\circ}C$, it is slowly converted into an equilibrium mixture of $1.3\,\%$ of 1pentyne (A), $95.2\,\%$ 2-pentyne (B) and $3.5\,\%$ of $1,2$-pentandiene (C). The equilibrium was maintained at $175\,^{\circ}C$. calculate ΔG^{Θ} for the following equilibria:

$B \Leftrightarrow A, \Delta G^{\Theta} = 1?$

$B \Leftrightarrow C, \Delta G^{\Theta} = 2?$

From the calculated value of $\Delta G^{\Theta}1$and $\Delta G^{\Theta}2$, indicate the order of stability of A, B and C.

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21. Two moles of a perfect gas undergo the following processes:

a. A reversible isobaric expansion from $(1.0atm, 20.0L)$ to $(1.0atm, 40.0L)$.

b. A reversible isochroic change of state from $(1.0atm, 40.0L)$ to $(0.5atm, 40.0L)$

c. A reversible isothermal expansion from $(0.5atm, 40.0L) \rightarrow (1.0atm, 20.0L)$.

i. Sketch with lables each of the processes on the same P - V diagram.

ii. Calculate the total work (w) and the total heat change (q) involved in the above process.

iii. What will be the values of ΔH for the overall process?

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22. The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below: $2Cu(s) + H_2O(g) \rightarrow Cu_2O(s) + H_2(g)$ is the minimum partial pressure of H2 (in bar) needed to prevent the oxidation at 1250 K. The value of ln is ____. (Given: total pressure = 1 bar, R (universal gas constant) = $8JK - 1mol^{-1}$, $\ln(10) = 2.3$. $Cu(s)$ and $Cu_2O(s)$ are mutually immiscible. At 1250 K: $2Cu(s) + 1/2O_2(g) \rightarrow Cu_2O(s)$

$\triangle H^{\theta} = -78,000Jmol^{-1}$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g)$, $\triangle G^{\theta} = -1,78,000Jmol^{-1}$, G is the Gibbs energy

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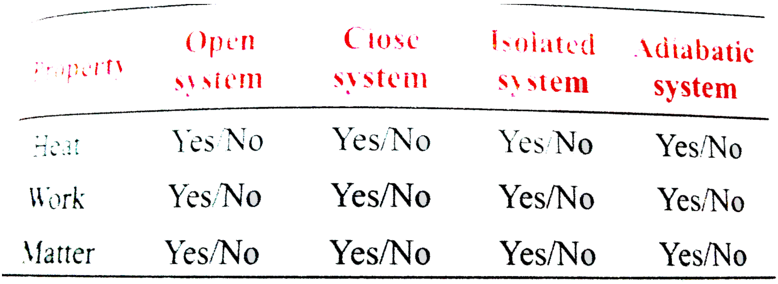
Practice problems

1. Write 'yes' if heat, work or matter are able to cross the boundary of the corresponding system and 'no' if passage is forbidden:



Property	Open system	Close system	Isolated system	Adiabatic system
Heat	Yes/No	Yes/No	Yes/No	Yes/No
Work	Yes/No	Yes/No	Yes/No	Yes/No
Matter	Yes/No	Yes/No	Yes/No	Yes/No

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2. Which of the following are state functions?

(i) Q

(ii) w

(iii). Q+w

(iv) Q-w

(v) Q_v

(vi) Q_{pP}

(vii) $\frac{Q}{w}$

(viii). $\frac{Q}{T}$

(ix) $\frac{\Delta X}{T}$

(x) $U + PV$

(xi) $U - PV$

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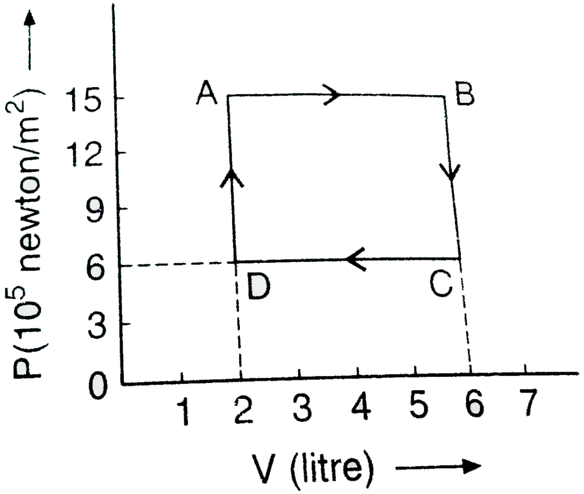

3.

In the adjoining diagram, the p-V graph of an ideal gas is shown. Find out from the graph (i) work done in taking the gas

From the state $A \rightarrow B$ (ii) Work done in taking the gas from $B \rightarrow C$ (iii) Work done in a complete cycle. (1 litre $= 10^{-3} m^3$)

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4. A sample of a gas contracts $200 cm^3$ by an average of .5 atmosphere while 8.5 J heat flows out into the surroundings what is the change in energy of the system?

(1 litre-atm=101.3J)

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5. Calculate the pressure-volume work by the system when the gas expands from 1.0 litre to 2.0 litre against a constant external pressure of 10 atmospheres. Express the answer in calorie and joule.

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6. A sample of a gas in a cyclinder contracts by 7.5 litre at a constant pressure of 5.0 atmosphere. How much work is done on the gas by the surroundings?

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7. A sample of a gas expands from $200 cm^3$ to $500 cm^3$ against an average pressure of 750 torr while 1.5 J heat flows into the system. What is the change in energy of the system?

(1 litre-atm=101.3J)

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8. Calculate the work done when 65.38 g of zinc dissolves in hydrochloric acid in an open beaker at 300K. (At. Mass of Zn=65.38)

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9. 6 moles of an ideal gas expand isothermally and reversible from a volume of $1dm^3$ to a volme of $10dm^3$ at $27^\circ C$. What is the maximum work done? Express your answer in joule.

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10. 1 mole of a ideal gas at $25^\circ C$ is allowed to expand reversibly and isothermally from 5 atm to 1 atm at $25^\circ C$.

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11. 1 mole of a ideal gas at $25^\circ C$ is allowed to expand reversibly and isothermally from 5 atm to 1 atm at $25^\circ C$.

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12. How much energy is absorbed by 10 moles of an ideal gas if it expands from an initial pressure of 8 atmosphere to 4 atmosphere at a constant temperature of $27\,^{\circ}C$?

$\left(R = 8.31J \quad mol^{-1} \quad K^{-1}\right)$

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13. A given mass of a gas at $0\,^{\circ}C$ is compressed reversible and adiabatically to a pressure 20 times the initial value. Calculate the final temperature of the gas. $\left[\frac{C_P}{C_V} = 1.42\right.$

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14. 3 moles of hydrogen are compressed isothermally and reversible from 60 dm^3 to $20dm^3$ and 8.22 kJ of work is done on it. Assuming ideal behaviour, calculate the temperature of the gas.

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15. To what pressure must a certain ideal gas $(\gamma = 1.4)$ at 373 K and 1 atmospheric pressure be compressed adiabatically in order to raise its temperature to 773K?

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16. 1 mole of an ideal gas $\left(C_V = 12.55JK^{-1} \quad mol^{-1}\right)$ at 300K is compressed adiabatically and reversibly to one-fourth of its original volu.e What is the final temperature of the gas?

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17. Calculate the internal energy change for the process in which 1.0 kcal of heat is added to1 .2 litre of O_2 gas in a cyclinder at constant pressure of 1.0 atm and the volume changes to 1.5 litre.

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18. Calculate ΔU and ΔH when $10dm^3$ of helium at NTP is heated in a cylinder to $100^\circ C$, assuming the the gas behaves ideally. $\left(C_V = 3/2R\right)$

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19. For the conversion of 1 mole of $SO_2(g)$ into $SO_3(g)$ the enthalpy of reaction at constant volume. ΔU, at 298 K is $-97.027kJ$. Calculate the enthalpy of reaction, ΔH, at constant pressure.

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20. The heat liberated on complete combustion of $7.8g$ benzene is $327kJ$ .The heat has been measured at constant volume at $27^\circ C$. Calculate the heat of combustion of benzene at constant pressure $\left(R = 8.3Jmol^{-1}K^{-1}\right)$.

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21. 1 mole of naphthalene $\left(C_{10}H_8\right)$ was burnt in oxygen gas at $25^\circ C$ at constant volume. The heat evolved was found to be 5138.8kJ. Calculate the heat of reaction at constant pressure.

$\left(R = 8.3JK^{-1} \quad mol^{-1}\right)$

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22. The enthalpy of formation of methane at constant pressure and $300K$ is $-75.83kJ$. What will be the heat of formation at constant volume? $\left[R = 8.3JK^{-1}mol^{-1}\right]$

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23. The heat change for the reaction,

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

is -92.2kJ. Calculate the heat of formation of ammonia.

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24. $4S(s) + 60_2 \rightarrow 4SO_3(g), \Delta H$ f or this reaction is - 1583.2 kJ . The enthalpy of formation of sulphur trioxide is -

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25. Calculate the heat change in the reaction,

$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(l)$

at 298K given that heats of formation at 298K for $NH_3(g)$ and $H_2O(l)$ are -46.0 and $-286.0kJ \quad mol^{-1}$ respectively.

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26. Calculate the heat of combustion of 1 mole of $C_2H_4(g)$ to form $CO_2(g)$ and $H_2O(g)$ at 398K and 1 atmosphere, given that the heats of formation of $CO_2(g), H_2O(g)$ and $C_2H_4(g)$ are $-94.1, -57.8$ and $+12.5kcal \quad mol^{-1}$ respectively.

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27. The heats of combustion of $CH_4(g)$ and $C_2H_6(g)$ are -890.3 and -150kJ mol^{-1} respectively. Which has higher calorific value?

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28. The heat of combustion of butane is $2880kJ \quad mol^{-1}$. What is the heat liberated by buring 1 kg of butane in excess of oxygen supply?

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29. The heats of formation of $CH_4(g), C_2H_6(g)$ and $C_4H_{10}(g)$ are $-74.8, \ -84.7$ and $-126.1kJ \quad mol^{-1}$ respectively. Arrange them in order of their efficiency as fuel per gram. Heats of formation of $CO_2(g)$ and $H_2O(l)$ are -393.5 and -285.8kJ mol^{-1} respectively.

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30. The heat of combustion of carbon to $CO_2$is-$395.5kJ/mol$.The heat released upon the formation of$35.2g$ of$CO_2$from carbon and oxygen gas is

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31. Calculate ΔH_f° of $C_6(s)$ from the following data:,

ΔH_{comb} of $C_6H_{12}O_6(s) = -2816kJ \quad mol^{-1}, \Delta H_f^\circ$ of $CO_2(g) = -393.5kJ \quad mol^{-1}$ and $\Delta H_{f\left(H_2O\right)}^\circ = -285.9kJ \quad mol^{-1}$.

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32. Calculate the amount of heat released when:

(i) 100 mL of 0.2 M HCl solution is mixed with 50 mL of 0.2 M KOH.

(ii) 200 mL of 0.1 M H_2SO_4 is mixed with 200 mL of 0.2 M KOH solution.

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33. When 100 mL each of HCl and NaOH solutions are mixed, 5.71 kJ of heat was evolved. What is the molarity of two solution? The heat of neutralisation of HCl is 57.1 kJ

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34. Determine enthalpy change for,

$$C_3H_{8(g)} + H_{2(g)} \rightarrow C_2H_{6(g)} + CH_{4(g)}$$

at 25 $^\circ C$ using heat of combustion values under standard condition.

$Compounds$	$H_{2(g)}$	$CH_{4(g)}$	$C_2H_{6(g)}$	$C_{(Graphite)}$
$\Delta H^\circ inkJ/mol$	-285.8	-890.0	-1560.0	-393.5

The standard heat of formation of $C_3H_{8(g)}$ is $-103.8kJmol^{-1}$.

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35. The standard ethelpy of combustion at $25^\circ C$ of hydrogen, cyclohexene $\left(C_6H_{10}\right)$, and cyclohexane $\left(C_6H_{12}\right)$ are -241, -3800, and

$-3920 kJ mol^{-1}$ repectively. Calculate the heat of hydrogenation of cyclohexane.

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36. From the following data of heats of combustion, find the heat of formation of $CH_3OH(l)$

$$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l), \Delta H = -726 kJ$$

$$C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -394 kJ$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H = -286 kJ$$

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37. The heat of combustion of methane is $-880 KJ mol^{-1}$. The quantity of heat liberated in the combustion of 3.2 g methane is

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38. Calculate the standard heat of formation of $C_{10}H_8$ (naphthalene) if standard heat of combustion of nephathalene is $-123.0kcal$ at 298K and standard heats of formation of $CO_2(g)$ and $H_2O(l)$ are -94.0 kcal and -68.4 kcal respectively.

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39. The heat of combustion of liquid ethanol is -327.0 kcal calculate the heat of formation of ethanol. Given that the heats of formation of $CO_2(g)$ and $H_2O(l)$ are -94.0 kcal and -68.4 kcal respectively.

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40. Calculate heeat of formation of cane sugar following data:

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g), \Delta H = -68.4$ kcal

$C(g) + O_2(g) \rightarrow CO_2(g), \Delta H = -94.4kcal$

$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l), \Delta H = -1350.0kcal$

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41. The heats of formation of $C_6H_6(l), H_2O(l)$ and $CO_2(g)$ are 11.70,-68.4 and -94.0 kcal respectively. Calculate the heat of combustion of benzene (l).

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42. Calculate the heat of hydrogenation of C_2H_2 to C_2H_4.

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \quad \Delta H = -68.32kcal$$

$$C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l), \Delta H = -310.61kcal$$

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l), \Delta H = -337.32kcal$$

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43. Calculate the heat of hydrogenation ,

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

Given that, the heats of combustion of ethylene, hydrogen and ethane are -337.0, -68.4 and -373.0 kcal respectively.

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44. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are $-1596KJ$ and $-1134KJ$ respectively. ΔH for the reaction

$2Al + Cr_2O_2 \rightarrow 2Cr + Al_2O_3$ is

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45. Calculate ΔH for the reaction

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g)$

given the bond energies of H-H and O=O bonds and O-H bond are 433 kJ mol^{-1}, 492 kJ mol^{-1} and $464kJ \quad mol^{-1}$.

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46. Using the bond enthalpy data, calculate ΔH of the following reaction:

$2Cl_2(g) + 2H_2O(g) \rightarrow 4HCl(g) + O_2(g)$

given that, bond energies of Cl-Cl,H-Cl,O-H and O=O are 242.8, 431.8,464 and $442kJ \quad mol^{-1}$ respectively.

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47. Calculate the enthalpy of the reaction

$SnO_2(s) + 2H_2(g) \rightarrow Sn(s) + 2H_2O(l)$

given that , bond enthalpies of formation of $SnO_2(s)$ and $H_2O(l)$ are -580.7 kJ and -285.8kJ respectively.

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48. Calculate the enthalpies change for the reaction,

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

Given that, bond energies of H-H,Cl-Cl and H-Cl are 436, 243 and 432 kJ mol^{-1}

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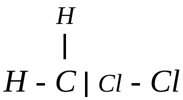
49. use the bond energy data and calculate the enthalpy change for



$$2C(g) + 2H(g) + 2Cl(g) \rightarrow H - \overset{\overset{H}{|}}{C} | Cl - Cl$$

The bond energies of C-H and C-Cl are 413 and 328 kJ mol^{-1} respectively.

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50. Calculate the heat of formation of ammonia from the following data:

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

The bond energies of $N \equiv N, H - H$ and $N - H$ bonds are 226,104 and 92 kcal respectively.

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51. Calculate ΔH_f° for chloride ion from the following data :

$$\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(g)}, \Delta H_f^{\circ} = -92.4kJ$$

$HCl_{(g)} + nH_2O \rightarrow H^+_{(aq.)} + Cl^-_{(aq.)}, \Delta H^\circ = -74.8kJ$

$\Delta H_f^\circ H^+_{(aq.)} = 0.0kJ$

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52. The heat of ionisation of formic acid is 1.5 kJ/ mol. 9.2 g formic acid on reaction with 7 g ammonium hydroxide gives 10.8 kJ of heat. Calculate the heat of ionisation of ammonium hydroxide. (1cal=4.2J)

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53. Assuming that 50% of the heat is useful, how many kg of water at $15^\circ C$ can be heated to $95^\circ C$ by burning 200 litre of methane at STP ? The heat of combustion of methane is $211 kcal/mol$. Specific heat of water is $1.0 kcal kg^{-1}K^{-1}$.

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54. The standard potential for the reaction,

$Ag^{+}(aq.) + Fe^{2+}(aq.) \rightarrow Fe^{3+}(aq.) + Ag(s)$

is 0.028V. What is the standard free energy change for this reaction?

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55. Calculate the theoretical maximum efficiency of a heat engine operating between 373 K and 173K.

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56. The standard free energies of formation in the gaseous state of methanol, dimethyl ether and water are -38.7, -27.3 and -54.6 kcal respectively. Is the transformation of methanol to dimehtyl ether and water in gaseous state possible?

$2CH_3OH \rightarrow CH_3OCH_3 + H_2O$

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57. Ethanol boils at $78.4^{\circ} C$ and the enthalpy of vaporisation of ethanol is $42.4 kJ mol^{-1}$. Calculate the entropy of vaporisation of ethanol.

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58. The following data is known about the melting of KCl:

$\Delta H = 7.25 kJ \quad mol^{1}$ and $\Delta S = +0.007 JK^{-1} \quad mol^{-1}$ Calcualt eits melting point.

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59. ΔH and ΔS for the reaction:

$Ag_2O(s) \rightarrow 2Ag(s) + (1/2)O_2(g)$

are $30.56 kJ mol^{-1}$ and $66.0 JJK^{-1} mol^{-1}$ respectively. Calculate the temperature at which free energy change for the reaction will be zero. Predict whether the forward reaction will be favoured above or below this temperature.

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60. Calculate the boiling point of the liquid if its entropy of vaporization is 110 $JK^{-1} \quad mol^{-1}$ and the enthalpy of vaporization is $11JK^{-1} \quad mol^{-1}$ and the enthalpy of vapporization is $40.85kJ \quad mol^{-1}$.

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61. Using S° values, calculate the entropy of the reaction,

$$SO_2(g) + \frac{1}{2}O_2(g) \rightarrow SO_3(g)$$

The S° values for SO_2, O_2 and SO_3 are 248.5,205.0 and 256.2 J $K^{-1} \quad mol^{-1}$

.

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62. Calculate the entropy change for the following reaction,

	$CaCO_3(s)$	$\rightarrow$	$CaO(s)$	$+$	$CO_2(g)$
S°	92.9		39.7		$213.6JK^{-1} \quad mol^{-1}$

Watch Video Solution

63. Compute the value of ΔS at 298K for the reaction,

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g)$

given that, $\Delta G = -228.6kJ$ and $\Delta H = -241.8kJ$

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64. At 300 K, the standard enthalpies of formation of $C_6H_5COOH(s), CO_2(g)$ and $H_2O(l)$ are -408,-393 and -286kJ mol^{-1} respectively. Calculate the heat of combustion of benzoic acid at (i) constant pressure and (ii) constant volume. $\left(R = 8.31J \quad mol^{-1}K^{-1}\right)$

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65. ΔH and ΔS for

$Br_2(l) + CI_2(g) \rightarrow 2BrCI(g)$

are $29.00 kJ mol^{-1}$ and $100.0 JK^{-1} mol^{-1}$ respectively. Above what temperature will this reaction become spontaneous?

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66. For the sysnthesis of ammonia,

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

Calculate ΔH°, ΔS° and ΔG° at 300 K using the following data:

Species	N_2	H_2	NH_3
$\Delta H_f^\circ(\text{kJ } mol^{-1})$	0	0	-46.2
$S^\circ(JK^{-1} \ mol^{-1})$	191.5	130.6	192.5

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67. How much heat is required to cahgen 15.6 g of benzene from liquid into vapour at its boiling point of $80^\circ C$? Entropy of vaporization of enzene is $87 JK^{-1} \ mol^{-1}$

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68. Calculate the standard free energy change for the combustion of glucose at 298K, using the given data,

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

$\Delta H^\circ = -2820kJ \quad mol^{-1}, \Delta S^\circ = 210JK^{-1} \quad mol^{-1}$

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69. The specific heat at constant volume for a gas is 0.075 cal/g and at constant pressure it is 0.125 cal/g. Calculate,

(i) the molecular weight of gas,

(ii). Atomicity of gas.

Watch Video Solution

70. The polymerisation of ethylene to linear polyethylene is represented by the reaction

$nCH_2 = CH_2 \rightarrow \left(-CH_2-CH_2-\right)_n$

When n has a large integral value. Given theat the average enthalpies of bond dissociation for $C = C$ and $C - C$ at $298K$are $+590$ and $+331kJmol^{-1}$ respectively, calculate the enthalpy of polymerisation per mole of ethylene at $298K$.

Watch Video Solution

71. An athelete is given $100g$ of glucose $\left(C_6H_{12}O_6\right)$ of energy equivalent to $1560kJ$. He utilises 50% of this gained enegry in the event. In order to avoid storage of enegry in the body, calculate the weight of water he would need to perspire. The enthalpy of evaporation of water is $441kJ/mol$.

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72. Calculate the entropy of ideal mixing when 2 m oles of N_2, 3 moles of H_2 and 2 moles of NH_3 are mixed at constant temperature, assuming no chemical reaction is occurring.

Watch Video Solution

73. Calculate free energy change for the reaction,

$H_2(g) + Cl_2(g) \rightarrow 2H - Cl(g)$

By using the bond energy and entropy data.

Bond energies of $H - H, Cl - Cl$ and $H - Cl$ bonds are 435kJ mol^{-1}, $240jK \quad mol^{-1}$ and $430jk \quad mol^{-1}$ respectively standard entropies of H_2, Cl_2 and HCl are 130.59,222.95 and 186.68 $JK^{-1} \quad mol^{-1}$ respectively.

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74. For the reaction,

$4C(s) + 5H_2(g) \rightarrow nC_4H_{10}(g),$

$\Delta H^{\Theta} = -124.73kJmol^{-1}, \Delta S^{\Theta} = -365.8JK^{-1}mol^{-1}$

$4C(s) + 5H_2(g) \rightarrow iso - C_4H_{10}(g)$

$\Delta H^{\Theta} = -131.6kJmol^{-1}, \Delta S^{\Theta} = -381.079JK^{-1}mol^{-1}$

Indicate whether normal butane can be spontaneously converted to iso-butane or not.

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75. The temperature of a bomb calorimeter was found to rise by $1.617K$ when a current of $3.20A$ was passed for $27s$ from a $12V$ source. Calculate the calorimeter constant.

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76. $1mol$ of an ideal gas is allowed to expand isothermally at $27^{\circ}C$ untill its volume is tripled. Calculated $Delya_{sys}S$ and $\Delta_{univ}S$ under the following conditions:

a. The expansion is carried out reversibly.

b. The expansion is a free expansion.

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77. One kilogram water at $0^{\circ}C$ is brought into contact with a heat reservoir at $100^{\circ}C$. Find

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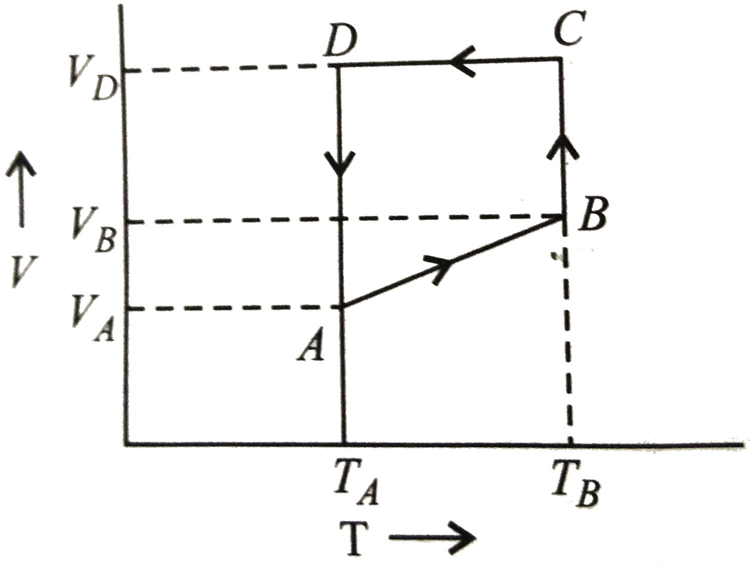
78. A mono-atomic ideal gas of two moles is taken through a cyclic process starting from A as shwon in the figure below.

The volume ratios are $V_B/V_A = 2$ and $V_D/V_A = 4$. If the temperature T_A at A is $27\,^\circ C$. Calculate



a. The temperature of gas at B.

b. Heat absorbed or evolved in each process.

c. Total work done in cyclic process.

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79. The reaction, $SOCl_2 + H_2O \rightarrow SO_2 + 2HCl$, is endothermica by 49.4 kJ and exergonic by 50.8 kJ. What is ht efactor that makes the reaction to be spontaneous? Calculate the entropy change at 298K.

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80. What amount of ice will remains when 52 g ice is added to 100 g of water at $40\,^\circ C$?

Specific heat of water is 1 cal/g and latent heat of fusion of ice is 80 cal/g.

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81. Calculate the ΔH_f° of $C_6H_{12}O_6$(s) from the following data:

$$\Delta H_{comb}\left[C_6H_{12}O_6(s)\right] = -2816.\,kJ/mol$$

ΔH_f° of $CO_2(g) = -393.5kJ/mol$

ΔH_f° of $H_2O(l) = -285.9kJ/mol$

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Objective Question Level-A

1. Thermodynamic is concerned with

A. total energy of a sytem

B. energy chagnes in a system

C. rate of a chemcial change

D. mass changes in nuclear reactions

Answer: B

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2. An isolated system is that system in which

A. there is no exchange of energy with the surroundings

B. there is exchange of mass and energy with the srroundings

C. there is no exchange of energy and mass with the surroundings

D. there is no exchange of mass with the surroundings

Answer: C

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3. Identify intensive property from the following

A. volume

B. mass

C. enthalpy

D. temperature

Answer: D

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4. Which of the following is an extensive property?

A. Enthalpy

B. concentration

C. density

D. viscosity

Answer: A

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5. For an adiabatic process, which of the following relations is correct?

A. $\Delta E = 0$

B. $P\Delta V = 0$

C. $q = 0$

D. $q = \; + w$

Answer: C

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6. Which one is true from the following for isobaric process?

A. $\Delta P = 0$

B. $\Delta q = 0$

C. $\Delta H = 0$

D. $\Delta U = 0$

Answer: A

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7. For an ideal gas, the value of $\left(\frac{dU}{dV}\right)_T$ is:

A. positive

B. zero

C. negative

D. interchangeable

Answer: B

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8. A process in which pressure remians constant is called

A. isochoric process

B. isothermal process

C. adiabatic process

D. isobaric process.

Answer: D

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9. A process in which volume remians constant is called

A. isochoric process

B. isothermal process

C. adiabatic process

D. isobaric process.

Answer: A

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10. For a cyclic process, the condition is

A. $\Delta U = 0$

B. $\Delta H = 0$

C. $\Delta U > 0$ and $\Delta H > 0$

D. both $\Delta U = 0$ and $\Delta H = 0$

Answer: D

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11. Which one of the following is a state property/function?

A. Heat

B. Work

C. Internal energy

D. Potential energy

Answer: C

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12. Internal enegry of a system of molecules is determined by taking into consideration its

A. kinetic energy

B. vibrational energy

C. rotational energy

D. all kinds of energies present in the molecules.

Answer: D

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13. A thermodynamic quantity is that

A. which is used in thermochemistry

B. which obeys all laws of thermodynamics

C. quantity whose value depends only upon the state of the system

D. quantity which is used in mesuring thermal change

Answer: C

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14. The enthalpy change of a reaction does not depend on

A. initial and final starte of the reaction

B. state of the reactants and products

C. nature of the reactants

D. different intermediate states

Answer: D

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15. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter $\Delta U$and$w$ correspond to

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

B. $\Delta U < 0, w < 0$

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

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

Answer: A

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16. A system is provided with 50 Joules of heat and the work done on they system is 10 Joules. What is the change in internal energy of the system in Joules?

A. 60

B. 40

C. 50

D. 10

Answer: A

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17. During isothermal expansion of an ideal gas its

A. internal energy increases

B. enthalpy decreases

C. enthalpy remains unaffected

D. enthalpy reduces to zero

Answer: C

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18. When an ideal gas is compressed adiabatically and reversibly, the final temperature is:

A. higher than the initial temperature

B. lower than the initial temperature

C. the same as initial temperature

D. dependent upon the rate of compression.

Answer: A

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19. Adiabatic reversible expansion of a gas is represented by

A. $\left(\frac{T_1}{T_2}\right)^{\gamma}=\left(\frac{P_2}{P_1}\right)^{1-\gamma}$

B. $\left(\frac{T_1}{T_2}\right)^{\gamma}=\left(\frac{P_1}{P_2}\right)^{1-\gamma}$

C. $\left(\frac{T_1}{T_2}\right)^{\gamma}=\left(\frac{P_2}{P_1}\right)^{\gamma-1}$

D. all are correct

Answer: A

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20. Total energy change for a reversible isothermal cycle is:

A. always positive

B. zero

C. always negative

D. always 100 kJ per degree

Answer: B

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21. Identify the reaction in which the heat liberated corresponds to the heat of formation (ΔH):

A. $C(\text{diamon}) + O_2(g) \rightarrow CO_2(g) + heat$

B. $C(\text{diamond}) + 2H_2(g) \rightarrow CH_4(g) + Heat$

C. $C(\text{diamond}) + 2H_2(g) \rightarrow CH_4(g) + heat$

D. $S(\text{rhombic}) + O_2(g) \rightarrow SO_2(g) + Heat$

Answer: D

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22. For an exothermic reaction, ΔH is positive.

$(True/False)$

A. positive

B. negative

C. zero

D. may be positive or negative

Answer: B

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23. Evaporation of water is

A. a process in which neither heat is evolved nor absorbed

B. a process accompanied by chemical reaction

C. an exothermic change

D. an endothermic change

Answer: D

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24. An endothermic reaction is one in which:

A. heat is converted into electricity

B. heat is absorbed

C. heat is evolved

D. heat changes to mechanical work

Answer: B

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25. If total enthalpy of reactants and products is H_R and H_P respectively, then for exothermic reaction:

A. $H_R = H_P$

B. $H_R < H_P$

C. $H_R > H_P$

D. $H_R - H_P = 0$

Answer: C

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26. Calculate the work invoved when 1 mol of an ideal gas is compressed reversibly from 1.00 bar to 5.00 bar at a constant temperature of $300K$.

A. 4.01 K

B. $-8.02kJ$

C. $18.02kJ$

D. $-14.01kJ$

Answer: A

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27. Under which of the following condition is the relation $\Delta H = \Delta U + P\Delta V$ valid for a closed system at

A. constant pressure

B. constant pressure

C. constant temperature and pressure

D. constant temperature, pressure and composition

Answer: C

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28. Which of the following is an endothermic reaction?

A. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

B. $N_2(g) + O_2(g) \rightarrow 2NO(g)$

C. $NaOH(aq.) + HCl(aq.) \rightarrow NaCl(aq.) + H_2O(l)$

D. $C_2H_5OH(aq.) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

Answer: B

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29. The formation of water from $H_2(g)$ and $O_2(g)$ is an exothermic process because :

A. the chemical energy of $H_2(g)$ and $O_2(g)$ is more than that of water

B. the chemical energy of $H_2(g)$ and $O_2(g)$ is less than that of wa ter

C. the temperature of $H_2(g)$ and $O_2(g)$ is higher than that of water

D. the temperature of $H_2(g)$ and O_2g is lower than that of water.

Answer: A

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30. Which of the following are applicable for a thermochemical equation ?

It tells :

A. It tells about physical state of reactants and products.

B. It tells whether the reaction is spontaneous

C. it tells whether the reaction in exothermic or endothermic

D. it tells about the allotropic form (if any) of the reactants.

Answer: B

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31. The enthalpies of all elements in their standard state at $25^{\circ} C$ and one atmospheric pressure are:

A. Same

B. Always positive

C. Always negative

D. zero

Answer: D

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32. Since the enthalpy of elements in their natural state is taken to be zero, the heat of formation $\left(\Delta_f H\right)$ of compounds

A. is always negative

B. is always positive

C. is zero

D. may be positive or negative

Answer: D

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33. The difference between the heats of reaction at constant pressure and a constant volume for the reaction $2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$ at $25\,^\circ C$ in kJ is

A. $+7.43$

B. $+3.72$

C. -7.43

D. -3.72

Answer: C

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34. For a gaseous reaction, $A(g) + 3B(g) \rightarrow 3C(g) + 3D(g)$, ΔD is 17 kcal at $27\,^\circ C$. Assuming $R = 2cal \quad K^{-1}mol^{-1}$, the value of ΔH for the above reaction is:

A. 15.8 kcal

B. 18.2 kcal

C. 20.0 kcal

D. 16.4 kcal

Answer: B

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35. At constant $T and P$,Which of the following statements is correct for the reaction,

$$CO(G) + \frac{1}{2}O_2(g) \rightarrow CO_2(g),$$

A. $\Delta H = \Delta U$

B. $\Delta H < \Delta U$

C. $\Delta H > \Delta U$

D. none of these

Answer: B

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36. For the reaction, $Ag_2O(s) \rightarrow 2Ag(s) + \frac{1}{2}O_2(g)$ which one of the following is true?

A. $\Delta H = \Delta U$

B. $\Delta < \Delta U$

C. $\Delta H > \Delta U$

D. $\Delta H = \frac{1}{2}\Delta U$

Answer: C

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37. Which one of the following is applicable for an adiabatic expansion of ideal gas?

A. $\Delta U = 0$

B. $W = \Delta U$

C. $W = -\Delta U$

D. $W = 0$

Answer: C

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38. Assume each reaction is carried out in an open container.

For which reaction will $\Delta H = \Delta U$?

A. $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$

B. $C(s) + 2H_2O(g) \rightarrow 2H_2(g) + CO_2(g)$

C. $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

D. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

Answer: A

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39. Reaction, $H_2(g) + I_2(g) \rightarrow 2HI, \Delta H = 12.40kcal$ ltbr. According to this, heat of formation of HI will be:

A. $12.40kcal$

B. - $12.4kcal$

C. - $6.20kcal$

D. $6.20kcal$

Answer: D

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40. For the reaction

(i) $H_2(g) + Cl_2(g) = 2HCl(g) + xkJ$

(ii). $H_2(g) + Cl_2(g) = 2HCl(l) + ykJ$

which one of the following statements is correct?

A. $x > y$

B. $x < y$

C. $x - y = 0$

D. $x = y$

Answer: B

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41. For the reactions,

(i) $H_2(g) + Cl_2(g) = 2HCl(g) + xkJ$

(ii) $2HCl(g) = H_2(g) + Cl_2(g) - ykJ$

Which one of the following statements is correct?

A. $x - y > 0$

B. $x - y < 0$

C. $x - y = 0$

D. none of these

Answer: C

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42. According to equation, $C_6H_6(l) + 15/2O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l), \Delta H = -3264.4\text{KJ mol}^{-1}$ the energy evolved when 7.8 g benzene is burnt in air will be -

A. 163.22 kJ

B. 32.64 kJ

C. 3.264 kJ

D. 326.4 kJ

Answer: D

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43. If $\Delta H_f(X)$, $\Delta H_f(Y)$, $\Delta H_f(R)$ and $\Delta H_f(S)$ denote the enthalpies of formation of X, Y, R and S respectively, the enthalpy of the reaction $X + Y \rightarrow R + S$ is given by

A. $\Delta H_{f(x)} + \Delta H_{f(y)}$

B. $\Delta H_{f(R)} + \Delta H_{f(S)}$

C. $\Delta H_{f(x)} + \Delta H_{f(y)}$ - $\Delta H_{f(R)}$ - $\Delta H_{f(S)}$

D. $\Delta H_{f(R)} + \Delta H_{f(S)}$ - $\Delta H_{f(x)}$ - $\Delta H_{f(y)}$

Answer: D

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44. The enthalpy change for the reaction,

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2(g)$ is called:

A. enthalpy of formation

B. enthalpy of combustion

C. enthalpy of vaporisation

D. enthalpy of sublimation

Answer: B

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45. The enthalpy change for the reaction $2C(\text{graphite}) + 3H_2(g) \rightarrow C_2H_6(g)$ is called

A. enthalpy of formation

B. enthalpy of combustion

C. enthalpy of hydroenation

D. enthalpy of vaporisation

Answer: A

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46. The enthalpy of formation of organic compounds are conveniently determined from their:

A. -286.0

B. -143.0

C. 286.0

D. 143.0

Answer: C

View Text Solution

47. The enthalpies of formation of organic substances are conveniently determined from

A. boiling points

B. melting points

C. enthalpies of neutralization

D. enthalpies of combustion

Answer: D

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48. The heat of neutralization of any strong acid and strong base is always constant and $\Delta H = -57.3kJ$. This because.

A. both the acid and base undergo complete ionization

B. during neutralization, salt and waer are formed.

C. 1 mole of water is formed from H^{+} and OH^{-} ions

D. the reaction is exothermic.

Answer: A

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49. The enthalpy of neutralization of oxalic acid by strong acid is $-25.4 kcal mol^{-1}$. The enthalpy of neutralization of strong acid and strong base is $-13.7 kcal equil^{-1}$. The enthalpy of dissociation of $H_2C_2O_4 \Leftrightarrow 2H^+ + C_2O_4^{2-}$ is

A. 1 kcal mol^{-1}

B. 2 kcal mol^{-1}

C. 18.55 kcal mol^{-1}

D. 11.7 kcal mol^{-1}

Answer: B

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50. The amount of heat liberated when one mole of NH_4OH reacts with one mole of HCl is

A. 13.7 kcal

B. more than 13.7 kcal

C. less than 13.67 kcal

D. cannot e predicted.

Answer: C

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51. Heat of neutralisation for the reaction:

$NaOH + HCl \rightarrow NaCl + H_2O$

is 57.1 kJ mol^{-1}. The heat released when 0.25 mole of NaOH is titrated against 0.25 mole of HCl will be:

A. 22.5 kJ

B. 57.1 kJ

C. 28.6 kJ

D. 14.3 kJ

Answer: D

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52. If $H^+ + OH^- \rightarrow H_2O + 13.7 Kcal$, the heat of neutralisation for complete neutralisation of 1 mole of H_2SO_4 by base will be

A. 13.7 kcal

B. 27.4 kcal

C. 6.85 kcal

D. 3.425 kcal

Answer: B

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53. In which of the following neutralization reaction, the heat of neutralization will be highest?

A. HCl and NaOH

B. CH_3COOH and $NaOH$

C. CH_3COOH and NH_3OH

D. HCl and NH_4OH

Answer: A

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54. "The enthalpy of formation of a compound is equal in magnitude but of opposite sign to the enthalpy of decomposition of that compound under the same conditions". This law was presented by:

A. Hess

B. Le Chatelier

C. Kirchhoff

D. Lavoisier annd Laplace

Answer: D

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55. "The change of enthalpy of a chemical reaction is the same whether the reaction takes place in one step or in several steps". This law was presented by:

A. Hess

B. Le chatelier

C. Van't Hoff

D. Kirchhoff

Answer: A

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56. From the thermochemical reactions,

$$C_{(\text{graphite})} + \frac{1}{2}O_2 \rightarrow CO, \Delta H = -110.5kJ$$

$$CO + \frac{1}{2}O_2 \rightarrow CO_2, \Delta H = -283.2kJ$$

the heat of reaction of $C_{(\text{graphite})} + O_2 \rightarrow CO_2$ is:

A. $+393.7kJ$

B. $-393.7kJ$

C. $-172.7kJ$

D. $+172.7kJ$

Answer: B

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57. Calculate heat of formation of $KOH(s)$ using the following equations

$$K(s) + H_2O(l) + aq \rightarrow KOH(aq) + 1/2H_2(g), \Delta H = -48.0kcal\ldots(i)$$

$$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l), \Delta H = -68.4kcal\ldots(ii)$$

$$KOH(s) + (aq) \rightarrow KOH(aq), \Delta H = -14.0kcal.... (iii)$$

A. $-68.39 + 48 - 14.0$

B. $-68.39 - 48.0 + 14.0$

C. $+68.39 - 48.0 + 14.0$

D. $+68.39 + 48.0 - 14.0$

Answer: B

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58. The enthalpies of combustion of $C_{(\text{graphite})}$ and $C_{(\text{diamond})}$ are -393.5 and $-395.4 kJ/mol$ respectively. The enthalpy of conversion of $C_{(\text{graphite})}$ to $C_{(\text{diamond})}$ in kJ/mol is:

A. -1.9

B. -788.9

C. 1.9

D. 788.9

Answer: C

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59. The heat of combustion of yellow phoshphorus and red phosphorus are $-9.91 KJmol^{-1}$ and -8.78 KJ/mol respectivaly. The heat of transition from yellow phosphrous to red phosphorus is

A. $-18.69kJ$

B. $+1.13kJ$

C. $+18.69kJ$

D. $-1.13kJ$

Answer: D

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60. What will be the heat of formation of methane, if the heat of combustion of carbon is '-x' kJ, heat of formation of water is '-y' kJ heat of combustion of methane is '-z' kJ?

A. $(-x-y+z)kJ$

B. $(-z-x+2y)kJ$

C. $(-x-2y-z)kJ$

D. $(-x-2y+z)kJ$

Answer: D

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61. Given $C_s + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94.2Kcal$

$H_{2(g)} + ½O_{2(g)} \rightarrow H_2O_{(g)}, \Delta = -68.3Kcal$

$CH_{4(g)} + 2O_{2(g)} \rightarrow 2H_2O + CO_2 = -210.8Kcal$

what will be heat of formation of CH_4 in (Kcal) ?

A. 45.9

B. 47.8

C. 20

D. 47.3

Answer: C

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62. On combustion carbon forms two oxides CO and CO_2, heat of formation of CO_2 is $-94.3 kcal$ and that of CO is -26. kcal. Heat of combustion of carbon is:

A. $-26.0 kcal$

B. $-68.3 kcal$

C. $-94.3 kcal$

D. $-120.3 kcal$

Answer: C

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63. The heat of combustion of ethanol was determined in a bomb calorimeter and was found to be $-670.48 kcal mol^{-1}$ at $25^{\circ} C$. What will be ΔU for the same reaction at $298K$?

A. $-760 kcal \quad mol^{-1}$

B. $-670.48 kcal \quad mol^{-1}$

C. $+760 kcal \quad mol^{-1}$

D. $+670.48 kcal \quad mol^{-1}$

Answer: B

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64. For an endothermic reaction where ΔH represent the enthalpy of reaction in kj/mol, the minimum value for the energy of activation will be:

A. less than ΔH

B. zero

C. equal to ΔH

D. more than ΔH

Answer: C

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65. If $S + O_2 \rightarrow SO_2, \Delta H = -298.2 \text{ kJ mole}^{-1}$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3 \Delta H = -98.7 \text{ kJ mole}^{-1}$

$SO_3 + H_2O \rightarrow H_2SO_4, \Delta H = -130.2 \text{ kJ mole}^{-1}$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2SO_4, \Delta H = -287.3 \text{ kJ mole}^{-1}$

the enthlapy of formation of H_2SO_4 at 298 K will be

A. $-754.4kJ$

B. $+320.5kJ$

C. $-650.3kJ$

D. $-433.7kJ$

Answer: A

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66. Which of the following units represent the largest amount of energy?

A. Electron-volt

B. Erg

C. Joule

D. Calorie

Answer: D

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67. If ΔH_f° for $H_2O_2(l)$ and $H_2O(l)$ are -188kJ and mol^{-1} and -286 kJ mol^{-1}, what will be the enthalpy change of the reaction $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$?

A. $146kJ \quad mol^{-1}$

B. $-196kJ \quad mol^{-1}$

C. $-494kJ \quad mol^{-1}$

D. $-98kJ \quad mol^{-1}$

Answer: B

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68. The bond dissociation energies for Cl_2, I_2 and ICl are 242.3, 151.0 and $211.3kJ/\text{mole}$ respectively. The enthalpy of sublimation of iodine is $62.8kJ/\text{mole}$. What is the standard enthalpy of formation of $ICI(g)$ nearly equal to

A. $-211.3kJ/mol$

B. $-14.6kJ/mol$

C. $16.8kJ/mol$

D. $33.5kJ/mol$

Answer: C

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69. The standard heats of formation at 298K for $CCl_4(g), H_2O(g), CO_2(g)$ and $HCl(g)$ are $-25.5, -57.8, -94.1$ and -22.1 kcal mol^{-1} respectively. Calculate ΔH°_{298} for the reaction.

$CCl_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4HCl(g)$.

A. 36.4kJ

B. 20.7kJ

C. $-20.7kJ$

D. $-41.4kJ$

Answer: D

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70. Heats of combustion of CH_4, C_2H_6, C_2H_4 and C_2H_2 are -212.8,-373.0,-337.0 and -310.5 kcal respectively at the same temperature. The best fuel among these gases is:

A. CH_4

B. C_2H_6

C. C_2H_4

D. C_2H_2

Answer: A

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71. Given

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -395kJ$

$S(s) + O_2(g) \rightarrow SO_2(g), \Delta H = -295kJ$

$CS_2(l) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g), \Delta H = -1110kJ$

The heat of formation of $CS_2(l)$ is

A. 250 kJ

B. 62.5 kJ

C. 31.25 kJ

D. 125 kJ

Answer: D

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72. The heats evolved in combustion of rhombic and monoclinic sulphur are, respectively, 70960 and $71030 calmol^{-1}$. What will be the heat of conversion of rhomic sulphur to monoclinic?

A. $-70960cal$

B. $-71030cal$

C. 70cal

D. $-70cal$

Answer: C

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73. The bond dissociation energy of C-H in CH_4 from the equation

$C(g)+4H(g) \rightarrow CH_4(g), \quad \Delta H = -397.8kcal$

is:

A. $+99.45kcal$

B. $-99.45kcal$

C. $+397.8kcal$

D. $+198.9kcal$

Answer: A

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74. The dissociation energy of CH_{40} and C_2H_6 are respectively 360 and $620 kcal/mol$. The bond energy of C - C bond is :

A. 270 kcal

B. 70 kcal

C. 200 kcal

D. 240 kcal

Answer: B

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75. When 10 mL of a strong acid is added to 10 mL of an alkali, the temperature rises by $5^{\circ} C$. If 100 mL of the same acid si mixed with 100 mL of the same base, the temperature rise would be:

A. $5^\circ C$

B. $50^\circ C$

C. $20^\circ C$

D. cannot be predicted.

Answer: A

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76. Energy required to dissociate $4g$ of gaseous hydrogen into free gaseous atoms is $208Kcal$ at $25^\circ C$

The bond energy of $H-H$ bond will be

A. 1.04 cal

B. 10.4 kcal

C. 104 kcal

D. 1040 kcal

Answer: C

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77. The enthalpy of combustion of H_2 , cyclohexene $\left(C_6H_{10}\right)$ and cyclohexane $\left(C_6H_{12}\right)$ are -241 , -3800 and $-3920KJ$ per mol respectively. Heat of hydrogenation of cyclohexene is

A. $-121kJ \quad mol^{-1}$

B. $121kJ \quad mol^{-1}$

C. $-242kJ \quad mol^{-1}$

D. $242kJ \quad mol^{-1}$

Answer: A

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78. Given that, heat of neutralisation of strong acid and strong base is 57.1 kJ. Calculate the heat produced when 0.25 mole of HCl is neutralised with 0.25 mole of NaO in aqueous solution:

A. 22.5 kJ

B. 57 kJ

C. 14.275 kJ

D. 28.55 kJ

Answer: C

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

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

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

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

D. $+64.8kcal \quad mol^{-1}$

Answer: D

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80. The value of ΔH_{O-H} is $109kcalmol^{-1}$. Then formation of one mole of water in gaseous state from $H_2(g)$ and $O_2(g)$ is acccompained by

A. 218 kcal

B. $-109kcal$

C. $-218kcal$

D. unpredictable

Answer: C

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81. Heat of neutralisation of a strong dibasic acid in dilute solution by NaOH is nearly :

A. $-27.4 kcal / eq$

B. $-13.7 kcal / eq$

C. $+13.7 kcal / eq$

D. $-13.7 kcal / mol$

Answer: B

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82. The enthalpy changes at 298 K in successive breaking of $O-H$ bonds of water, are

$H_2O(g) \rightarrow H(g) + OH(g), \Delta H = 498 kJmol^{-1}$

$OH(g) \rightarrow H(g) + O(g), \Delta H = 428 kJmol^{-1}$

The bond energy of the O-H bond is

A. 498 kJ mol^{-1}

B. 428 kJ mol^{-1}

C. 70 kJ mol^{-1}

D. 463 kJ mol^{-1}

Answer: D

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83. The combustion of methane is written as

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

The difference between enthalpy change and energy change is equal to:

A. $-2RT$

B. 0

C. RT

D. $\frac{RT}{2}$

Answer: A

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84. A spontaneous change is one in which a system under goes

A. an increase in internal energy

B. lowering in entropy

C. lowering in free energy

D. no energy change

Answer: C

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85. In which of the following change entropy decreases?

A. Crystallisation of sucrose from solution

B. Dissolving sucrose in water

C. Meltin of ice

D. Vaporisation of campor

Answer: A

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86. For the percipitation reaction of $Ag^{\oplus}$ ions with $NaCI$, which of the following statements is true?

A. ΔH is zero for the reaction

B. ΔG is zero for the reaction

C. ΔG is negative for the negative

D. ΔG should be equal to ΔH

Answer: C

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87. If the enthalpy of vaporisation of water is $186.5 J mol^{-1}$, then entropy of its vaporisation will be

A. 0.5

B. 1

C. 1.5

D. 2

Answer: A

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88. A reaction is non-spontaneous when:

A. ΔH is $+ve$, ΔS is -ve

B. both ΔH and ΔS are -ve

C. ΔH is -ve and ΔS is +ve

D. none of these

Answer: A

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89. Standard entropy of X_2 , Y_2 and XY_3 are $60, 40$ and $50JK^{-1}mol^{-1}$, respectively. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3, \Delta H = -30KJ$, to be at equilibrium, the temperature will be:

A. 750 K

B. 1000 K

C. 1250 K

D. 500 K

Answer: A

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90. The unit of entropy is

A. $JK^{-1} \quad mol^{-1}$

B. $J \quad mol^{-1}$

C. $J^{-1}K^{-1} \quad mol^{-1}$

D. $JK \quad mol^{-1}$

Answer: A

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91. Given that $\Delta h_f(H) = 218 kJ/mol$. Express the $H - H$ bond energy in $Kcal/mol$

A. 52.15

B. 911

C. 109

D. 5.2153

Answer: C

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92. For which reaction from the following, ΔS will be maximum?

A. $Ca(s) + \frac{1}{2}O_2(g) \rightarrow CaO(s)$

B. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

C. $C(s) + O_2(g) \rightarrow CO_2(g)$

D. $N_2(g) + O_2(g) \rightarrow 2NO(g)$

Answer: B

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93. A particular reaction at $27^\circ C$ for which $\Delta H > 0$ and $\Delta S > 0$ is found to be non-spontaneous. The reaction may proceed spontaneously if

A. the temperature is decreased

B. the temperature is kept constant

C. the temperature is increased.

D. it is carried in open vessel at $27^\circ C$

Answer: C

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94. Althought he dissolution of ammonium chloride in water is an endothermic reaction, even then it is spontaneous because:

A. ΔH is positive, ΔS is -ve

B. ΔH is +ve, Δ is zero

C. ΔH is positive, $T\Delta S < \Delta H$

D. ΔH is +ve ΔS is positive and $\Delta H < T\Delta S$

Answer: D

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95. In general, for exothermic reactions to be spontaneous

A. temperature must be high

B. temperature must be zero

C. temperature may have any magnitude

D. temperature must be low

Answer: D

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96. For the reversible process, the value of ΔS is given by the expression:

A. $\frac{q_{rev}}{T}$

B. T - q_{rev}

C. $q_{rev} \times T$

D. q_{rev} - T

Answer: A

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97. In an electrochemical cell, if E° is the e.m.f. of the cell involving $'n'$ mole of electrons, then ΔG° is

A. $\Delta G^{\circ} = nFE^{\circ}$

B. $\Delta G^{\circ} = -nFE^{\circ}$

C. $E^{\circ} = nF\Delta G^{\circ}$

D. $\Delta G^{\circ} = nF/E^{\circ}$

Answer: B

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98. The standard Gibb's free energy change, ΔG° is related to equilibrium constant, kp as

A. $\Delta G^{\circ} = RT \ln K$

B. $K = e^{-\Delta G^{\circ}/2.303RT}$

C. $\Delta G^{\circ} = -RT \log K$

D. $K = 10^{-\Delta G^{\circ}/2.303RT}$

Answer: D

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99. The value of entropy in the universe is

A. constant pressure

B. decreasing

C. increasing

D. zero

Answer: C

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100. Which of the following thermodynamic relation is correct?

A. $dG = VdP - SdT$

B. $dU = PdV + TdS$

C. $dH = -VdP + TdS$

D. $dG = VdP + SdT$

Answer: A

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101. The enthalpy of formation for $C_2H_4(g)$, $CO_2(g)$ and $H_2O(l)$ at $25^\circ C$ and 1 atm. Pressure be 52, -394 and $-286 kJmol^{-1}$ respectively. The enthalpy of combustion of $C_2H_4(g)$ will be

A. $+141.2kJ \quad mol^{-1}$

B. $+1412kJ \quad mol^{-1}$

C. $-141.2kJ \quad mol^{-1}$

D. $-1412kJ \quad mol^{-1}$

Answer: D

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102. Identify the correct statement regarding entropy

A. at absolute zero, the entropy of a perfectly crystalline substance is +ve.

B. at absolute zero, the entropy of a perfectly crystalline substance is zero.

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

D. at absolute zero of temperature the entropy of all crystalline substances is taken to be zero.

Answer: B

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103. When enthalpy and entropy change for a chemical reaction are -2.5×10^3 cals and 7.4 cals deg^{-1} respectively. Predict that reaction at 298 K is

A. spontaneous

B. reversible

C. irreversible

D. non-spontaneous

Answer: A

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104. One mole of an ideal gas at $300K$ is expanded isothermally from an inital volume of 1 litre to 10 litres. The ΔE for this process is $\left(R = 2calmol^{-1}K^{-1}\right)$

A. 163.7 cal

B. 1381.1 cal

C. 8 litre-atm

D. zero

Answer: D

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105. Latent heat of vaporisation of a liquid at $500K$ and 1 atm pressure is $10.0kcal/mol$. What will be the change in internal energy (ΔE) of 3 mol of liquid at same temperature?

A. 13.0 kcal

B. - 13.0 kcal

C. 27.0 kcal

D. - 27.0 kcal

Answer: C

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106. The enthalpy change of a reaction does not depend on

A. state of reactants and products

B. nature of reactants and products

C. different intermediates reaction

D. initial and final enthalpy change of reaction.

Answer: C

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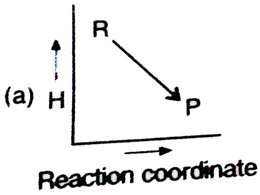
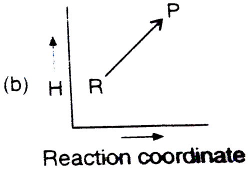
107. Which plot represents for an exothermic reaction ?

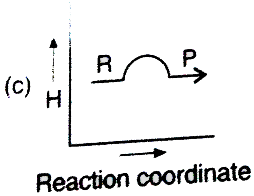
A.



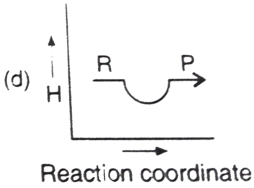
B.



C.



D.



Answer: A

108. Given : $S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)} + 2XKcal$

$SO_{2(s)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)} + YKcal$

The heat of formation of SO_2 is : -

A. y - $2x$

B. $2x + y$

C. $x + y$

D. $2x/y$

Answer: A

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109. $NH_3(g) + 3Cl_2 \rightarrow NCl_3(g) + 3HCl(g), \Delta H_1$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g), \Delta H_2$

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g), \Delta H_3$

The heat of formation of NCl_3(g) in the terms of

$\Delta H_1, \Delta H_2, \Delta H_3$ is :

A. $\Delta H_f = -\Delta H_1 + \frac{1}{2}\Delta H_2 - \frac{3}{2}\Delta H_3$

B. $\Delta H_f = \Delta H_1 + \frac{1}{2}\Delta H_2 - \frac{3}{2}\Delta H_3$

C. $\Delta H_f = \Delta H_1 - \frac{1}{2}\Delta H_2 - \frac{3}{2}\Delta H_3$

D. none of the above

Answer: A

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110. The word 'standard' in standard molar enthalpy change implies

A. temperature 298K

B. pressure 1 atm

C. temperature 298 K and pressure 1 atm

D. all temperature and all pressure

Answer: B

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111. The heat of formation $\left(\Delta H_f^\circ\right)$ of $H_2O(l)$ is equal to :

A. zero

B. molar heat of combustion of $H_2(l)$

C. Molar heat of combustion of $H_2(g)$

D. sum of heat of formation of $H_2O(g)$ and $O_2(g)$

Answer: C

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112. The value of ΔH and ΔS for a reaction are respectively 30 kJ mol^{-1} and $100 JK^{-1} mol^{-1}$. Then temperature above which the reaction will become spontaneous is:

A. 300 K

B. 30 K

C. 100 K

D. $300^{\circ} C$

Answer: A

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113. The value of ΔH° for the reaction $Cu^{+}(g) + I^{-}(g) \rightarrow CuI(g)$ is -446kJ mol^{-1}. If the ionisation energy of $Cu(g)$ is 745 kJ mol^{-1} and the electron affinity of I(g) is -295 kJ mol^{-1}, then the value of ΔH° for the formation of one mole of CuI(g) from Cu(g) and I(g) is:

A. $-446kJ$

B. 450 kJ

C. 594 kJ

D. 4 kJ

Answer: D

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114. If the enthalpy change for the reaction,

$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g), \Delta H = $ - 25kcal,

bond energy of C-H is 20 kcal mol^{-1} greater than the bond energy of C-Cl and bond energies of H-H and H-Cl are same in magnitude, then for the reaction $H_2(g) + Cl_2(g) \rightarrow 2HCl(g), \Delta H = $?

A. $-22.5kcal/mol$

B. $-20.5kcal/mol$

C. $-32.5kcal/mol$

D. $-12.5kcal/mol$

Answer: A

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115. The standard heat of formation of sodium ions in aqueous solution from the following data:

heat of foramtion of $NaOH(aq.)$ at $25\,^\circ C = -470.7kJ$

heat of formation of OH^-(aq.) at $25\,^\circ C = -228.8kJ$ is:

A. $-251.9kJ$

B. $241.9kJ$

C. $-241.9kJ$

D. $251.9kJ$

Answer: C

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116. AB, A_2 and B_2 are diatomic molecules. If the bond enthalpies of A_2, AB and B_2 are in the ratio $1:1:0.5$ and the enthalpy of formation of AB from A_2 and B_2 is $-100kJmol^{-1}$, what is the bond enthalpy of A_2 ?

A. 400 kJ mol^{-1}

B. 200 kJ mol^{-1}

C. 100 kJ mol^{-1}

D. 300 kJ mol^{-1}

Answer: A

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117. The lattice energy of solid $NaCI$ is $180 kcalmol^{-1}$. The dissolution of the solid in H_2O is endothermic to the extent of $1.0 kcalmol^{-1}$. If the hydration energies of $Na^{\oplus}$ and $CI^{\ominus}$ ions are in the ratio of $6:5$ what is the enthalpy of hydration of sodium ion?

A. $-85.6 kcal/mol$

B. $-97.5 kcal/mol$

C. $82.6 kcal/mol$

D. $+100 kcal/mol$

Answer: B

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118. Which one of the following statement is false?

A. Work is a state function

B. Temperature is a state function

C. Work appears at the boundary of the system

D. Change in the state is completely when the initial and final state are specified

Answer: A

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119. $\Delta G^{\ominus}$ for the reaction $X + Y \Leftrightarrow C$ is $-4.606kcalat1000$ K`. The equilibrium constant for the reverse mode of the reaction will be:

A. 100

B. 10

C. 2

D. 0.01

Answer: A

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120. The enthalpy of dissolution of $BaCl_2(s)$ and $BaCl_2.2H_2O$ are -20.6 and 8.8 KJ mol^{-1} respectively . Calculate enthalpy of hydration forgiven reaction:

$BaCl_2(s) + 2H_2O \rightarrow BaCl_2.2H_2O(s)$

A. 29.8 kJ

B. $-11.8kJ$

C. $-20.6kJ$

D. $-29.4kJ$

Answer: A

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121. For the reaction

$A(g) + 2B(g) \rightarrow 2C(g) + 3D(g)$,

the value of ΔH at $27^{\circ}C$ is $19.0 kcal$. The value of ΔE for the reaction would be

$\left(R = 2.0 cal H^{-1} mol^{-1}\right)$

A. 20.8 kcal

B. 19.8 kcal

C. 18.8 kcal

D. 17.8 kcal

Answer: D

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122. In thermodynamics, a process is called reversible when

A. surroundings and system change into each other

B. there is no boundary between system and surroundings

C. the sorroundings are always in equilibrium with the system

D. the system changes into the surroundings spontaneously

Answer: C

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123. The heat liberated when $1.89g$ of benzoic acid is burnt in a bomb calorimeter at $25\,^{\circ}C$ increases the temperture of $18.94kg$ of water by $0.632\,^{\circ}C$. If the specific heat of water at $25\,^{\circ}C$ is $0.998cal/g\deg$, the value of the heat of combustion of benzoic acid is

A. 88.1 kcal

B. 771. 4 kcal

C. 981.1 kcal

D. 871.2 kcal

Answer: B

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124. One mole of a non-ideal gas undergoes a change of state $(2.0 atm, 3.0 L, 95 K) \rightarrow (4.0 atm, 5.0 L, 245 K)$ With a change in internal energy $\Delta E = 30 L$ atm. The change in enthalpy (ΔH) in the process in L-atm is

A. 40

B. 42.4

C. 44

D. not defined, because pressure is not constant.

Answer: C

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125. Which of the reaction defines molar ΔH_f° ?

A. $C_{(\text{diamond})} + O_2(g) \rightarrow CO_2(g)$

B. $\frac{1}{2}H_2(g) + \frac{1}{2}F_2(g) \rightarrow HF(g)$

C. $N_{2(g)} + 3H_2(g) \rightarrow 2NH_3(g)$

D. $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

Answer: B

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126. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are $-1596KJ$ and $-1134KJ$ respectively. ΔH for the reaction

$2Al + Cr_2O_2 \rightarrow 2Cr + Al_2O_3$ is

A. $-462kJ$

B. $-1365kJ$

C. $-2530kJ$

D. $+2530kJ$

Answer: A

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127. Which of the following is true for spontaneous process?

A. $\Delta G > 0$

B. $\Delta G < 0$

C. $\Delta G = 0$

D. $\Delta G = T\Delta S$

Answer: B

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128. Considering entropy (S) as a thermodynamics parameter, the criterion for the spontaneity of any process is

A. $\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} > 0$

B. ΔS_{system} - $\Delta S_{\text{surroundings}} > 0$

C. $\Delta S_{\text{system}} > 0$ only

D. $\Delta S_{\text{surroudings}} > 0$ only

Answer: A

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129. An ideal gas expands from $1 \times 10^{-3} m^3$ to $1 \times 10^{-2} m^3$ at $300K$ againts a constant pressure of $1 \times 10^5 Nm^{-2}$. The work done is :

A. $-900J$

B. $-900kJ$

C. $270kJ$

D. $+900kJ$

Answer: A

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130. What is the value of internal energy change (ΔU) at $27^{\circ}C$ a gaseous reaction $2A_2(g) + 5B_2(g) \rightarrow 2A_2B_5(g)$ (whose heat chhange at constant pressure is -50700J)? $\left(R = 8.314JK^{-1} \quad mol^{-1}\right)$

A. $-50700J$

B. $-63171J$

C. $-38229J$

D. $+38299J$

Answer: C

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131. Two moles of an ideal gas is expanded isothermally and reversibly from 1 liter to 10 liter at $300K$. The enthalpy change (in kJ) for the process

A. 11.4 kJ

B. $-11.4kJ$

C. $0kJ$

D. $4.8kJ$

Answer: B

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132. The enthalpy of vaporisation of a liquid is $30kJmol^{-1}$ and entropy of vaporisation is $75Jmol^{-1}K^{-1}$. The boiling point of the liquid at $1atm$ is :

A. 250 K

B. 400 K

C. 450 K

D. 600 K

Answer: B

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133. The sublimation energy of I_2 (solid) is 57.3 KJ/mole and enthalpy of fusion is 15.5 KJ/mole. The enthalpy of vapourisation of I_2 is

A. 41.8 kJ/mol

B. $-41.8kJ/mol$

C. $72.8kJ/mol$

D. $-72.8kcal/mol$

Answer: A

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134. ΔH and ΔS for a reaction are $+30.558 kJmol^{-1}$ and $0.066 kJmol^{-1}$ at 1 atm pressure. The temperature at which free energy is equal to zero and the nature of the reaction below this temperature are

A. 483K, spontaneous

B. 443K, non-spontaneous

C. 443K, spontaneous

D. 463 K, non-spontaneous

Answer: D

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135. What would be the heat released when an aqueous solution containing $0.5 mol$ if HNO_3 is mixed with 0.3 mol of OH^{-1} (enthalpy of neutralisation is $-57.1 kJ$)

A. 28.5 kJ

B. 17.1 kJ

C. 45.7 kJ

D. 1.7 kJ

Answer: B

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136. A process in which the system does not exchange heat with the surroundings is known as

A. isothermal

B. isobaric

C. isochoric

D. adiabatic

Answer: D

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137. The entropy of a crystalline substance a absolute zero on the basis of the third law of thermodynamics should be taken as

A. 100

B. 50

C. zero

D. different for difference substances

Answer: C

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138. Which of the following expressions is correct?

A. $\Delta G^{\circ} = nFE^{\circ}$

B. $\Delta G^{\circ} = -nFE^{\circ}$

C. $\Delta G^{\circ} = 2.303RTnFE^{\circ}_{cell}$

D. $\Delta G^{\circ} = nF\log K_c$

Answer: A

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139. Consider the reaction: $N_2 + 3H_2 \Leftrightarrow 2NH_3$ carried out at constant pressure and temperature. If ΔH and ΔU are change in enthalpy and change in internal energy respectively, then:

A. $\Delta H = 0$

B. $\Delta H = \Delta U$

C. $\Delta H < \Delta U$

D. $\Delta H > \Delta U$

Answer: C

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140. The absolute enthalpy of neutralization of the reaction,

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

A. -57.33 kJ mol^{-1}

B. greater than -57.33 kJ mol^{-1}

C. less than -57.33 kJ mol^{-1}

D. 57.33 kJ mol^{-1}

Answer: C

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141. Given the following entropy values (in $JK^{-1}\text{mol}^{-1}\big)$ at 298 K atm : $H_2(g): 130.6$. $Cl_2(g): 223.0$ and $HCl(g): 186.7$. The entropy change (in $JK^{-1}\text{mol}^{-1}\big)$ for the reaction

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$is

A. $+540.3$

B. $+727.3$

C. -166.9

D. $+19.8$

Answer: D

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142. A mixture of 2 mole CO and 1 mole O_2 in a closed vessel is ignited to convert CO into CO_2. Then

A. $\Delta H > \Delta U$

B. $\Delta H < \Delta U$

C. $\Delta H = \Delta U$

D. the relationship depends on the capacity of the vessel

Answer: B

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143. Consider the following reaction at $1000\ ^\circ C$

$(A)Zn_{(s)} + \frac{1}{2}O_{2(s)} + ZnO_s, \Delta G^0 = -360kJmole^{-1}$

(B) $(B)Cn_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_s, \Delta G^0 = -460kJmole^{-1}$

choose the correct statement at 1000^0C

A. zinc can be oxidised by carbon monoxide

B. ZnO can be reduced by graphite.

C. both a and b are true.

D. both a and b are false.

Answer: B

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144. Which of the following equations does not correctly represent the first law of thermodynamcis?

A. Isothermal process : q=-w

B. Cyclic process : q=-w

C. Isochoric process : $\Delta U = q$

D. Adiabatic process : $\Delta U = -w$

Answer: D

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145. Assuming ΔH° and S° do not change with temperature. Calculate, the boiling point of liquid A uing the thermodynamic data given below:

$$\text{Thermodynamic data}\,\Delta H^\circ\,(kJ/mol)\,S^\circ\left(JK^{-1}mol^{-1}\right)\left|, A(l)-130100,\right| A-100200(g)$$

A. 300K

B. 130 K

C. 150 K

D. 50 K

Answer: A

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146. $(\Delta H - \Delta U)$ for the formation of carbon monoxide (CO) from its elements at $298K$ is

$\left(R = 8.314K^{-1}mol^{-1}\right)$

A. $-1238.78J \quad mol^{-1}$

B. $1238.78J \quad mol^{-1}$

C. $-2477.57J \quad mol^{-1}$

D. $2477.57J \quad mol^{-1}$

Answer: B

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147. For a phase change:

$H_2O(l) \Leftrightarrow H_2O(s)$

$0\,^{\circ}C$, 1 bar

A. $\Delta G = 0$

B. $\Delta S = 0$

C. $\Delta H = 0$

D. $\Delta U = 0$

Answer: A

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148. We can drive any thermodynamically forbidden reaction in the desired direction by coupling with:

A. highly exothermic reaction

B. highly enodthermic carbon

C. highly exergonic reaction

D. highly endergonic reaction

Answer: C

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149. The amount of heat released when $20ml, 0.5M\ NaOH$ is mixed with $100ml, 0.1M\ H_2SO_4$ is xKJ. The heat of neutralization will be : -

A. $-100x$

B. $-50x$

C. $+100x$

D. $+50x$

Answer: A

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150. In conversation of lime-stone ti lime, $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)7$ the value of ΔH° and ΔS° are $+179.1KJmol^{-1}$and $160.2J/K$ respectively at 298K and 1 bar. Assuming that ΔH and ΔS do not change with temperature, temperature above which coversation of lime-stone to lime will be just spontaneous is:

A. 1118 K

B. 1008 K

C. 1200 K

D. 845 K

Answer: A

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151. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and

$100^{\circ}C$, (Given : Molar enthalpy of vapourisation of water at 1 abr and 373 K = 41 kJ mol^{-1} and $R = 8.3 J mol^{-1} K^{-1}$ will be) :-

A. $41.00 kJ \quad mol^{-1}$

B. $4.100 kJ \quad mol^{-1}$

C. $3.7904 kJ \quad mol^{-1}$

D. $37.904 kJ \quad mol^{-1}$

Answer: D

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152. For the process $H_2O(l)(1\text{bar}, 373K) \rightarrow H_2O(g)(1\text{bar}, 373K)$ the correct set of thermodynamic parameters is

A. $\Delta G = 0, \Delta S = +ve$

B. $\Delta G = 0, \Delta S = -ve$

C. $\Delta G = +ve, \Delta S = 0$

D. $\Delta G = -ve, \Delta S = +ve$

Answer: A

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153. In a closed insulated container, a liquid is stirred with a paddle to increase the temperature, which of the following is true?

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

B. $\Delta U = w = 0, q \neq 0$

C. $\Delta U = 0, w = q \neq 0$

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

Answer: A

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154. Which of the following is correct?

A. $C_V = \left(\frac{\partial U}{\partial T}\right)_P$

B. $C_P = \left(\frac{\partial H}{\partial T}\right)_V$

C. $C_P - C_V = R$

D. $\left(\frac{\partial U}{\partial V}\right)_t = \frac{-a}{V^2}$

Answer: C

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155. Which of the following represents total kinetic energy of one mole of gas?

A. $\frac{1}{2}RT$

B. $\frac{3}{2}RT$

C. $\left(C_P - C_V\right)RT$

D. $\frac{2}{3}RT$

Answer: B

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156. Standard entropy of X_2 , Y_2 and XY_3 are $60, 40$ and $50JK^{-1}mol^{-1}$, respectively. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3, \Delta H = -30KJ$, to be at equilibrium, the temperature will be:

A. 1000K

B. 1250 K

C. 500 K

D. 750 K

Answer: D

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157. $4.48L$ of an ideal gas at STP requires 12 cal to raise its temperature by $15\,^{\circ}C$ at constant volume. The C_P of the gas is

A. 3 cal

B. 4 cal

C. 7 cal

D. 6 cal

Answer: D

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158. On the basis of the following thermochemical data :

$$\left(\Delta_f G^{\circ} H^{+}_{(aq.)} = 0\right)$$

$$H_2O_{(l)} \rightarrow H^{+}_{(aq.)} + OH^{-}_{(aq.)}, \Delta H = 57.32kJ$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286.20kJ$$

The value of enthalpy of formation of OH^{-} ion at $25\,^{\circ}C$ is :

A. $-22.88kJ$

B. $-228.88kJ$

C. $-228.88kJ$

D. $-343.53kJ$

Answer: B

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159. The Habar's process of production of ammonia involves the equilibrium:

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_2(g)$

Assuming ΔH° and ΔS° for the reaction do not change with temperature, which of the statements is true?

$\left(\Delta H^\circ = -95kJ \text{ and } \Delta S^\circ = -198JK^{-1}\right)$

A. Ammonia dissociates spontaneously below 500 K

B. Ammonia dissociates spontaneously above 500K

C. Ammonia dissociates at all temperature.

D. Ammonia does not dissociate at any temperature.

Answer: A

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160. In which reaction there will be increase in entropy ?

A. $Na(s) + H_2O(l) \rightarrow NaOH(aq) + \frac{1}{2}H_2(g) \uparrow$

B. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

C. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

D. $Cu^{2+}(aq) + 4NH_3(g) \rightarrow \left[Cu\left(NH_3\right)_4\right]^{2+}_{(aq)}$

Answer: A

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161. The species which by definition has zero standard molar enthalpy of formation at $298K$ is

A. $Br_2(g)$

B. $Cl_2(g)$

C. $H_2O(g)$

D. $CH_4(g)$

Answer: B

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162. The standard enthalpy of formation of NH_3 is $-46.0KJmol^{-1}$. If the enthalpy of formation of H_2 from its atoms is $-436KJmol^{-1}$ and that of N_2 is $-712KJmol^{-1}$, the average bond enthalpy of $N-H$ bond in NH_3 is

A. $+1056kJ \quad mol^{-1}$

B. $-1102kJ \quad mol^{-1}$

C. $-964kJ \quad mol^{-1}$

D. $+352kJ \quad mol^{-1}$

Answer: D

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163. A $1.0g$ sample of substance A at $100^\circ C$ is added to $100mL$ of H_2O at $25^\circ C$. Using separate $100mL$ portions of H_2O, the procedure is repeated with substance B and then with substance C. How will the final temperatures of the water compare ?

Substance	Specific heat
A	$0.60Jg^{-1}$^(@)C^(-1)),(B,0.40 J g^(-1) $^\circ C^{-1}$
C	$0.20Jg^{-1}{}^\circ C^{-1}$

A. $T_C > T_B > T_A$

B. $T_B > T_A > T_C$

C. $T_A > T_B > T_C$

D. $T_A = T_B = T_C$

Answer: C

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164. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of $10dm^3$ to a volume of $100dm^3$ at $27\,^{\circ}C$ is

A. $42.3J \quad mol^{-1}K^{-1}$

B. $38.3J \quad mol^{-1}K^{-1}$

C. $35.8J \quad mol^{-1}K^{-1}$

D. $32.3J \quad mol^{-1}K^{-1}$

Answer: B

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165. The incorrect expression among the following is

A. $\frac{\Delta G_{\text{system}}}{\Delta S_{\text{total}}} = -T$

B. In isothermal process

$$w_{(\text{reversible})} = -nRT\left(\frac{V_f}{V_i}\right)$$

C. ln $K = \frac{\Delta H^\circ - T\Delta S^\circ}{RT}$

D. $K = e^{-\Delta G^\circ/RT}$

Answer: C

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166. Using the data provided, calculate the multiple bond energy $\left(kJmol^{-1}\right)$ of a $C \equiv C$ bond in C_2H_2. That energy is (take the bond energy of a $C - H$ bond as $350kJmol^{-1}\right)$.

$2C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)}, \Delta = 225kJmol^{-1}$

$2C_{(s)} \rightarrow 2C_g\big), \Delta H = 1410kJmol^{-1}$

$H_{2(g)} \rightarrow 2H_{(g)}, \Delta H = 330kJmol^{-1}$

A. 1165

B. 837

C. 865

D. 815

Answer: D

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167. The approxiamte standard enthalpies of formation of methanol and octane are determiend to be -1.5 kJ/mol and -10.9 kJ/mol respectively. The standard enthalpies of combustion of octane is denoted as $\Delta H(\text{octane})$ and that fo methanol as ΔH (methanol). the correct statement is:

A. ΔH (octane) is more negative than ΔH (methanol)

B. ΔH(octane) is less negative than ΔH (methanol)

C. ΔH (octane) is equal to ΔH (methanol)

D. ΔH (octane)$+\Delta H$(methanol)=0

Answer: A

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168. The sysmbols F,H,S,V_m and E° denote Helmholtz free energy, enthalpy, entropy, molar volume and standard electrode potential, respectively. The correct classification of the properties is:

A. F,H,S ar intensive, V_m and E° are extensive

B. F,H,S are extensive, V_m and E° are intensive

C. F,H,S and V_m are intensive , E° is extensive

D. F,H,S and E° are extensive, V_m is intensive

Answer: B

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169. A piston filled with 0.04 mole of an ideal gas expands reversible from $50.0mL$ at a constant temperature of $37.0\,^\circ C$. As it does so, it absorbs $208J$ of heat. The value of q and W for the process will be $(R = 8.314J/molK, 1n7.5 = 2.01)$

A. $q = -208J, w = +208J$

B. $q = +208J, w = +208J$

C. $q = +208J, w = -208J$

D. $q = -208J, w = -208J$

Answer: C

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170. For the complete combustion of ethanol, $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ the amount of heat produced as measured in bomb calorimeter is $1364.47KJmol^{-1}$ at $25\,^\circ C$. Assuming ideality, the enthalpy of combustion, ΔH_C, for the reaction will be

$\left[R = 8.314JK^{-1}mol^{-1}\right]$

A. $-1460.50kJ \quad mol^{-1}$

B. $-1350.50kJ \quad mol^{-1}$

C. $-1366.95kJ \quad mol^{-1}$

D. $-1361.95kJ \quad mol^{-1}$

Answer: C

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171. The standed free energy of fromation of NO(g) is 86.6 kj/ mol at 298 K what is the standed free energy of fromation of NO_2g at 298 k? $K_p = 1.6 \times 10^{12}$

A. $0.5\left[2 \times 86.600 - R(298)\ln\left(1.6 \times 10^{12}\right)\right.$

B. $R(298)\ln\left(1.6 \times 10^{12}\right) - 86.600$

C. $86.600 + r(298)\ln\left(1.6 \times 10^{12}\right)$

D. $86.600 - \frac{\ln\left(1.6 \times 10^{12}\right)}{R(298)}$

Answer: A

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172. The enthalpies of combustion of carbon and carbon monoxide are -393.5 and -283 kJ mol^{-1} respectively. The enthaly of formation of carbon monoxide per mole is :

A. 110.5

B. 676.5

C. -676.5

D. -110.5

Answer: D

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173. δU is equal to

A. Isochoric work

B. Isobaric work

C. Adiabatic work

D. isothermal work

Answer: C

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174. Given $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g)$,

$\Delta_r H^0 = -393.5 kJ \quad mol^{-1}$

$H_2(g) = +\frac{1}{2}O_2(g) \rightarrow H_2O(1)$,

$\Delta_r H^0 = -285.8 \text{ kJ } mol^{-1}$

$CO_2(g) + 2H_2O(1) \rightarrow CH_4(g) + 2O_2(g)$,

$\Delta_r H^0 = +890.3 kJ \quad mol^{-1}$

Based on the above thermochemical equations, the value of $\Delta_r H^0$ at at

298 K for the reaction

$C_{(\text{graphite})} + 2H_2(g) \rightarrow CH_4(g)$ will be:

A. $+74.8kJ \quad mol^{-1}$

B. $+144.0kJ \quad mol^{-1}$

C. $-74.8kJ \quad mol^{-1}$

D. $-144.8kJ: \quad mol^{-1}$

Answer: C

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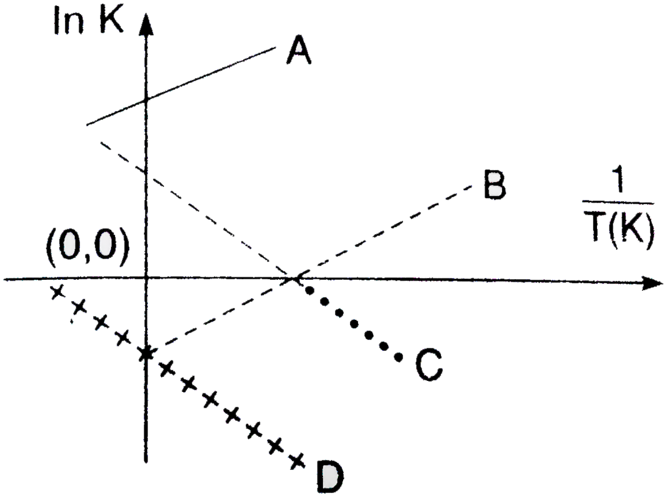
175. Which of the following lines correctly show the temperatrue dependence equilibrium constant,K, for an exotehrmic reaction?



A. B and C

B. C and D

C. A and D

D. A and B

Answer: D

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176. The combustion of benzene (l) gives $CO_2(g)$ and $H_2O(l)$. Given that heat of combustion of benzene at constant volume is $-3263.9 kJmol^{-1}$ at $25^\circ C$, heat of combustion (in kJmol^{-1}) of benzene at constant pressure will be

(R = 8.314 JK–1 mol–1)

A. -452.46

B. 3260

C. -3267.6

D. 4152.6

Answer: C

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177. If 1.5 L of an ideal gas at a apressure of 20 atm expands isothermally and reversibly to a final volume of 15 L, the work done by the gas in L atm is:

A. 69.09

B. 34.55

C. -34.55

D. -69.09

Answer: D

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Set 2

1. Which is intensive property ?

A. mass

B. Mass/volume

C. Volume

D. volume/mass

Answer: B::D

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2. Which is an irreversible process?

A. Mixing of two gases by diffusion

B. Evaporation of water at 373 K and 1 atm pressure

C. Dissolution of NaCl in water

D. All of the above

Answer: A::C

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3. One mole of anahydrous $MgCl_2$ dissolves in water and liberates 25 cal/ mol. Heat of dissolution of $MgCl_2.H_2O$ is :

A. $+5cal/mol$

B. $-5cal/mol$

C. $55cal/mol$

D. $-55cal/mol$

Answer: A

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4. Following enthalpy changes are given:

$\alpha\text{ - }Dglucose(s) \rightarrow \alpha\text{ - }Dglucoes(aq), \Delta H = 10.72kJ$

$\beta\text{ - }Dglucose(s) \rightarrow \beta\text{ - }Dglucose(aq), \Delta H = 4.68kJ$

$\alpha\text{ - }Dglucose(aq) \rightarrow \beta\text{ - }Dglucose(aq), \Delta H = 1.16kJ$

Calculate enthalpy change in

$\alpha\text{ - }Dglucose(s) \rightarrow \beta\text{ - }Dglucose(s)$

A. $14.24kJ$

B. $16.56kJ$

C. $-7.2kJ$

D. $4.88kJ$

Answer: D

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5. If x and y are arbitrary extensive variables, then

A. $(x+y)$ is an extensive variable

B. x/y is an intensive variable

C. dx/dy is ann intensive variable

D. both b and c

Answer: A::B::C

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6. If x and y are arbitrary intensive variables, then

A. xy is an intensive variable

B. x/y is an intesive variable

C. (x+y) is an extensive property

D. dx/dy is an intensive property.

Answer: A::B::D

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7. $H_2O(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g), \quad \Delta H = x$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \quad \Delta H = y$

heat of vaporization of water is:

A. x+y

B. x-y

C. y-x

D. $-(x+y)$

Answer: B

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8. Which is correct about ΔG?

A. $\Delta G = \Delta H - T\Delta S$

$= 49.4 - \left(300 \times 336 \times 10^{-3}\right)$

$= -51.4kJ$

Since, the free energy change is negative, the given reaction is spontaneous.

B. At equilibrium $\Delta G^{\circ} = 0$

C. At eq. $\Delta G = -RT\log K$

D. $\Delta G = \Delta G^{\circ} + RT \log K$

Answer: A::D

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9. Dissociation of sodium azide is given below:

$NaN_3 \rightarrow Na + 3/2N_2,$

ΔH for this is:

A. $3/2\Delta H^{\circ}_{f(N_2)} - \Delta H^{\circ}_{f(NaN_3)}$

B. $\Delta H^{\circ}_{f(NaN_3)}$

C. $\Delta H^{\circ}_{f(NaN_3)} - \left[\Delta H^{\circ}_{f(Na)} + 3/2\Delta H^{\circ}_{f(N_2)}\right]$

D. $\Delta H^{\circ}_{f(Na)} + 3/2\Delta H^{\circ}_{f(N_2)} - \Delta H^{\circ}_{f(NaN_3)}$

Answer: B

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10. The lattice energy of KCl is 202 kcal/mo. When KCl is dissolved in water 2 kcal/mol is absorbed. If the sol energies of K^+ and Cl^- are in the ratio 2:3 then $\Delta H_{\text{hydration}}$ of K^+ is:

A. $-80kJ/mol$

B. $-120kJ/mol$

C. $-150kJ/mol$

D. $133.3kJ/mol$

Answer: A

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11. Which is a correct relationship?

A. $\left[\frac{dH}{dT}\right]_p - \left[\frac{dU}{dT}\right]_v = (+ve)$

B. $\left[\frac{dU}{dT}\right]_T = 0$ (for ideal gas)

C. $\left[\frac{dV}{dT}\right]_p = \frac{nR}{P}$ (for ideal gas)

D. All of the above

Answer: D

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12. The standard Gibb's free energy change, ΔG° is related to equilibrium constant, kp as

A. $K_P = -RT\log\Delta G^{\circ}$

B. $K_P = [e/RT]^{\Delta G^{\circ}}$

C. $K_P = -\Delta G^{\circ}/RT$

D. $K_P = e^{-\Delta G^{\circ}/RT}$

Answer: D

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13. For the two equations given below:

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l) + x_1kJ$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g) + x_2kJ$

Select the correct answer:

A. $x_1 > x_2$

B. $x_2 > x_1$

C. $x_1 = x_2$

D. $x_1 + x_2 = 0$

Answer: A

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14. $\Delta E = 0$, for which process :-

A. Cyclic process

B. Isothermal expansion

C. Isochoric process : $\Delta U = q$

D. Adiabatic process

Answer: A::B

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15. For a reaction to be spontaneous in neither direction, which of the following is/are correct regarding the closed system?

(1). $(\Delta G)_{T,P} = 0$

(2) $(\Delta G)_{T,P} < 0$

(3) $(\Delta S)_{U,V} = 0$

(4). $(\Delta S)_{U,V} > 0$

A. 1,2 and 3 are correct

B. 1 and 2 are correct

C. 2 and 4 are correct

D. 1 and 3 are correct

Answer: D

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16. Enthalpy of neutralization of a strong acid by strong base:

(1) has a contant value of -57.32 kJ

(2) is independent of the nature of strong acid and strong base

(3) result in heat change accompanied by the reaction

$H^+(aq) + OH^-(aq) \rightarrow H_2O$

A. 1 and 2

B. 1 and 3

C. 1 only

D. 1,2 and 3

Answer: D

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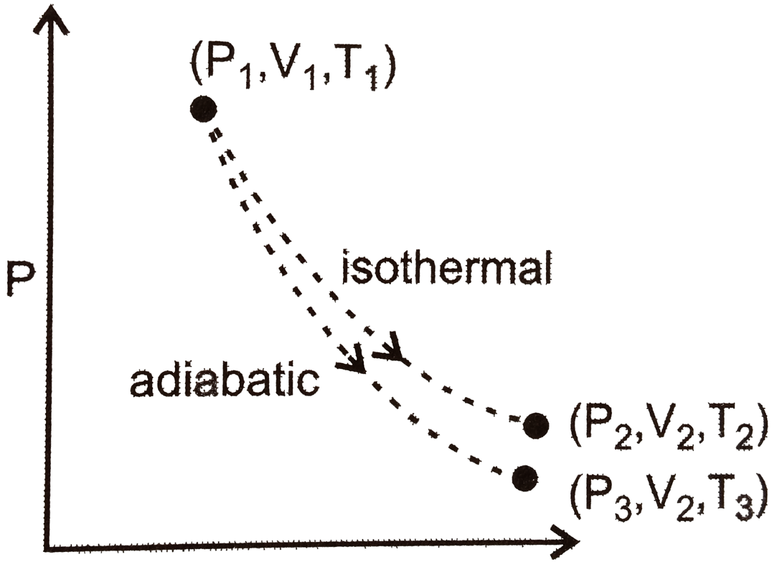
17. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following statement(s) is (are) correct?



A. $T_1 = T_2$

B. $T_3 > T_1$

C. $w_{\text{isothermal}} > w_{\text{adiabatic}}$

D. $\Delta U_{\text{isothermal}} > \Delta U_{\text{Adibatic}}$

Answer: A::C::D

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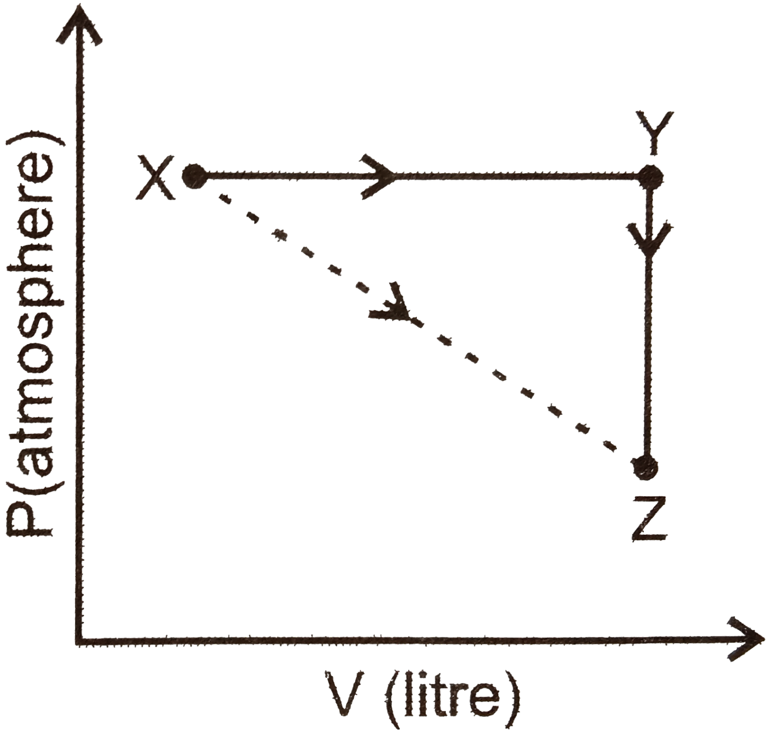
18. For an ideal gas, consider only P - V work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is (are) correct? [Take ΔS as change in entropy and w as work done]



A. $\Delta S_{x \to z} = \Delta S_{x \to y} + \Delta_{y \to z}$

B. $w_{x \to z} = w_{x \to y} + w_{y \to z}$

C. $w_{x \to y \to z} = w_{x \to y}$

D. $\Delta S_{x \to y \to z} = \Delta S(x \to y)$

Answer: A::C

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Objective Question Level B

1. In which of the following pairs, both proeperties are intensive?

A. pressure, temperature

B. Density, Volume

C. Temperature, density

D. Pressure, volume

Answer: C

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2. Although the dissociation of ammonium chloride $\left(CH_4Cl\right)$ in water is an endothermic reaction, even then it is spontaneous because:

A. $\Delta S = -ve$

B. $\Delta S =$ zero

C. $T\Delta S < \Delta H$

D. $\Delta S = +ve$ and $\Delta H < T\Delta S$

Answer: D

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3. The S-S bond energy is if $\Delta H_f^{\circ}\left(E_t - S - E_t\right) = -147kJ/mol, \Delta H_f^{\circ}\left(E_t - S - S - E_t\right) = -202kJ/mol$ and ΔH_f

A. 168kJ

B. 126 kJ

C. 278 kJ

D. 572 kJ

Answer: C

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4. Standard enthalpies of formation of O_3, CO_3, NH_3 and HI are 142.2,-383.2,-46.2 and +25.9kJ mol^{-1} respectively. The order of their increasing stabilities will be:

A. O_3, CO_2, NH_3, HI

B. CO_2, NH_3, HI, O_3

C. O_3, HI, NH_3, CO_2

D. NH_2, HI, CO_2, O_3

Answer: C

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5. Consider the following reaction.

$$C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(g)$$

signs of ΔH, ΔS and ΔG for the above reaction will be

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

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

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

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

Answer: B

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6. Which among the following represents the reaction of formation of the product?

A. $C_{(\text{diamond})} + O_2(g) \rightarrow CO_2(g)$

B. $S_{(\text{monoclinic})} + O_2(g) \rightarrow SO_2(g)$

C. $2N_2(g) + O_2(g) \rightarrow 2N_2O(g)$

D. None of these

Answer: D

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7. How much energy must be supplied to change 36 g of ice at $0^\circ C$ to water at room temperature $25^\circ C$?

Data for water	
$\Delta H^\circ_{\text{fusion}}$	$6.01 kJ/mol$
$C_{P\ \text{liquid}}$	$4.18 JK^{-1} g^{-1}$

A. 12 kJ

B. 16 kJ

C. 19 kJ

D. 22 kJ

Answer: B

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8. A large positive value of $\Delta G^{\ominus}$ corresponds to which of these?

A. Small positive K

B. Small negative K

C. Large positive K

D. Large negative K

Answer: A

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9. Consider the values of $\Delta H\left(\text{in}kJmol^{-}\right)$ and for $\Delta S\left(\text{in}mol^{-}K^{-1}\right)$ given for four different reactions. For which reaction will ΔG increases the most (becoming more positive) when the temperature is increased form $0^{\circ}C\text{to}25^{\circ}C$?

A. $\Delta H^{\circ} = 50, \Delta S^{\circ} = 50$

B. $\Delta H^{\circ} = 90, \Delta S^{\circ} = 20$

C. $\Delta H^{\circ} = -20, \Delta S^{\circ} = -50$

D. $\Delta H^{\circ} = -90, \Delta S^{\circ} = -20$

Answer: C

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10. $Fe_2O_2(s) + \frac{3}{2}C(s) \rightarrow \frac{3}{2}CO_2(g) + 2Fe(s)$

$\Delta H^{\circ} = +234.12KJ$

$C(s) + O_2(g) \rightarrow CO_2(g)\Delta H^{\circ} = -393.5KJ$

Use these equations and ΔH° value to calculate ΔH° for this reaction :

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

A. $-1648.7kJ$

B. $-1255.3kJ$

C. $-1021.2kJ$

D. $-129.4kJ$

Answer: A

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11. Consider this equation and the associated value for ΔH°.

$2H_2(g) + 2Cl_2(g) \rightarrow 4HCl(g), \Delta H = -92.3Kj$

which statement abount this information is incorrect?

A. If the equation is reversed, the ΔH° value equals +92.3kJ

B. The four HCl bonds are stronger than four bonds in H_2 and Cl_2

C. The ΔH° value will be -92.3 kJ if HCl is produced as a liquid.

D. 23.1 kJ of heat will be evolved when 1 mole of HCl(g) is produced.

Answer: C

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12. The internal energy (U) of an ideal gas decreases by the same amount as the work done by the system:

A. cyclic

B. isothermal

C. adiabatic

D. isolated.

Answer: C

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13. The enthalpy of neutralisation of a strong acid by a string base is $-57.32 kJ mol^{-1}$. The enthalpy of formation of water is $-285.84 kJ mol^{-1}$. The enthalpy of formation of hydroxyl ion is

A. $+228.52 \text{ kJ } mol^{-1}$

B. $-114.26 \text{ kJ } mol^{-1}$

C. $-228.52 \text{ kJ } mol^{-1}$

D. $+114.2 \text{ kJ } mol^{-1}$

Answer: C

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14. For which process will ΔH and ΔG° be expected to be most similar?

A. $2Al(s) + Fe_2O_3 \rightarrow 2Fe(s) + Al_2O_3(s)$

B. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq.) + H_2(g)$

C. $2NO_2(g) \rightarrow N_2O_4(g)$

D. $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

Answer: A

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15. For a particular reaction, $\Delta H = -38.3kJ$ and $\Delta S^{\circ} = -113J \times K^{-1}$. This reaction is:

A. spontaneous at all temperature

B. non-spontaneous at all temperature

C. spontaneous at temperature below $66^{\circ}C$

D. spontaneous at temperature above $66^{\circ}C$

Answer: D

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16. Which halogen in its standard state has the greatest absolute entropy per mole?

A. $F_2(g)$

B. $Cl_2(g)$

C. $Br_2(l)$

D. $I_2(s)$

Answer: B

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17. For which of these processes is the value of ΔS negative?

i. Sugar is dissolved in water.

ii. Steam condenses on a surface.

iii. $CaCO_3$ is decomposed into CaO and CO_2.

A. I only

B. II only

C. I and III only

D. II and III only

Answer: B

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18. When solid NH_4NO_3 is dissolved in water at $25\,^{\circ}C$, the temperature of the solution decreases. What is true about the signs of ΔH and ΔS for this process?

A. $\begin{array}{cc} \Delta H & \Delta S \\ - & + \end{array}$

B. $\begin{array}{cc} \Delta H & \Delta S \\ - & - \end{array}$

C. $\begin{array}{cc} \Delta H & \Delta S \\ + & + \end{array}$

D. $\begin{array}{cc} \Delta H & \Delta S \\ + & - \end{array}$

Answer: C

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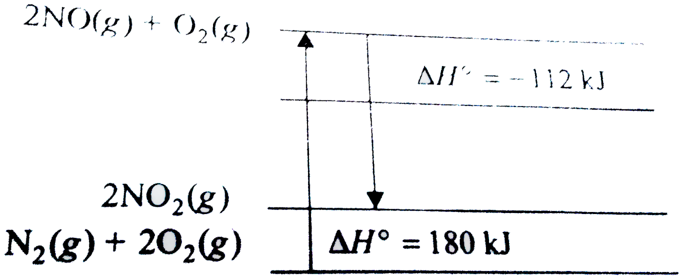
19. The diagram below shows the heat of reaction between N_2, O_2NO and NO_2:



Which of the following statements pertaining to the formation of NO and NO_2 are correct?

1. The standard heat of formation of NO_2 is 68 kJ mol^{-1}

2. NO_2 is formed faster than NO at higher temperature.

3. The oxidation reaction of nitrogen to NO_2 is endothermic.

4. These two reactions often take place in troposphere and causes green house effect.

5. These two reactions often take place and are responsible for city smog.

A. 1 and 2

B. 1 and 3

C. 1 and 4

D. 3 and 5

Answer: D

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20. The enthalpy changes for two reactions are given by the equations:

$$2Cr(s) + \frac{3}{2}O_2(g) \rightarrow Cr_2O_3(s), \Delta H^{\Theta} = -1130kJ$$

$$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g), \Delta H^{\Theta} = -110kJ$$

What is the enthalpy change in kJ for the following reactions?

$$3C(s) + Cr_2O_3(s) \rightarrow 2Cr(s) + 3CO(g)$$

A. $-1460kJ$

B. $-800kJ$

C. $+800kJ$

D. $+1020kJ$

Answer: C

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21. The enthalpy changes at 298 K in successive breaking of $O - H$ bonds of water, are

$H_2O(g) \rightarrow H(g) + OH(g), \Delta H = 498 kJmol^{-1}$

$OH(g) \rightarrow H(g) + O(g), \Delta H = 428 kJmol^{-1}$

The bond energy of the O-H bond is

A. 498 kJ mol^{-1}

B. 463 kJ mol^{-1}

C. 428 kJ mol^{-1}

D. 70 kJ mol^{-1}

Answer: B

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22. Consider the following two reactions:

i. Propene $+H_2 \rightarrow$ Propane, ΔH_1

ii. Cyclopropane $+H_2 \rightarrow$ Propane, ΔH_2 Then, $\Delta H_2 - \Delta H_1$ will be:

A. 0

B. $2BE_{C-C} - BE_{C=C}$

C. $BE_{C=C}$

D. $2BE_{C=C} - BE_{C-C}$

Answer: B

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23. Under which circumstances would the free energy change for a reaction be relatively temperature independent?

A. ΔH° is negative.

B. ΔH° is positive

C. ΔS° has a large positive value

D. ΔS° has a small magnitude.

Answer: D

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24. Using the Gibbs energy change, $\Delta G^\circ = +63.3 kJ$, for the following reaction,

$Ag_2CO_3 \Leftrightarrow 2Ag^+(aq) + CO_3^{2-}$

the K_{sp} of $Ag_2CO_3(s)$ in water at $25^\circ C$ is

$\left(R = 8.314 JK^{-1} mol^{-1}\right)$

A. 3.2×10^{-26}

B. 8×10^{-12}

C. 2.9×10^{-3}

D. 7.9×10^{-2}

Answer: B

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25. Which statement (s) is/are true?

1. S^{Θ} values for all elements in their states are positive.

2. S^{Θ} values for all aqueous ions are positive.

3. ΔS^{Θ} values for all spontaneous reactions are positive.

A. 1 only

B. 1 and 2 only

C. 2 and 3 only

D. all of these

Answer: A

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26. The enthalpy of reaction does not depend upon:

A. the intermediate reaction steps

B. the temperature of initial and final states of the reaction

C. the physical states of reactants and products.

D. use of different reactants for the formation of the same products.

Answer: A

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27. A solution of $200mL$ of $1MKOH$ is added to $200mL$ of $1MHCl$ and the mixture is well shaken. The rise in temperature T_1 is noted. The experiment is repeated by using $100mL$ of each solution and increase in temperature T_2 is again noted. Which of the following is correct?

A. $T_1 = T_2$

B. $T_1 = 2T_2$

C. $T_2 = 2T_1$

D. $T_1 = 4T_2$

Answer: A

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28. The heat of combustion of solid benzoic acid at constant volume is $-321.30kJ$ at $27^{\circ}C$. The heat of combustion at constant pressure is

A. $-321.30-300R$

B. $-321.30+300R$

C. $-321.30-150R$

D. $-321.30+900R$

Answer: C

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29. $A \rightarrow B, \quad \Delta U=40kJ \quad mol^{-1}$

If the system goes from A to B by a reversible path and returns to state A by an irreversible path, what would be the net change in internal energy?

A. More than 40 kJ

B. zero

C. Less than 40 kJ

D. 40 kJ

Answer: B

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30. For the process

$NH_3(g) + HCI(g) \rightarrow NH_4CI(s)$

A. $\Delta H = +ve, \Delta S = +ve$

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

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

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

Answer: D

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31. A gas is allowed to expand reversibly under adiabatic conditions. What is zero for such a process ?

A. ΔT

B. ΔS

C. ΔG is negative for the negative

D. none of these

Answer: D

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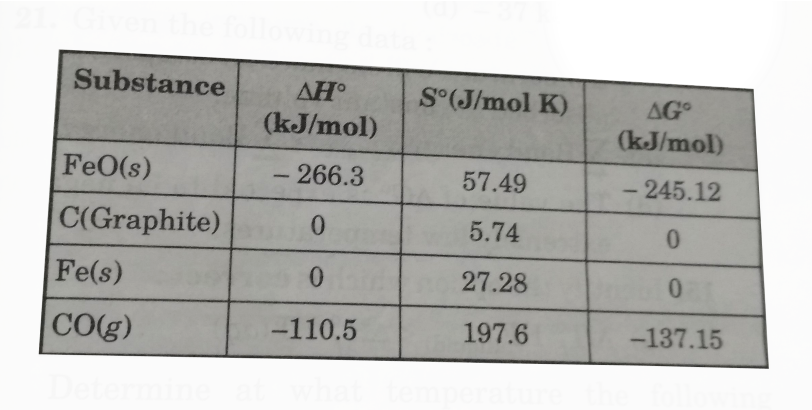
32. Given the following data :



Substance	ΔH° (kJ/mol)	S°(J/mol K)	ΔG° (kJ/mol)
FeO(s)	– 266.3	57.49	– 245.12
C(Graphite)	0	5.74	0
Fe(s)	0	27.28	0
CO(g)	–110.5	197.6	–137.15

Determine at what temperature the following reaction is spontanous?

$$FeO(s) + C_{\text{graphite}} \rightarrow Fe(s) + CO(g)$$

A. 298 K

B. 668 K

C. 966K

D. ΔG° is +ve, hence the reaction will never be spontaneous.

Answer: C

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33. Which of the following equations has/have enthalpy changes equal to $\Delta H_{comb} C$?

I. $C(s) + O_2(g) \rightarrow CO_2(g)$

II. $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$

III. $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

A. I and II

B. I,II and III

C. I and III

D. I only

Answer: D

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34. The enthalpy change of which reaction corresponds to $\Delta H_f^\circ \text{ for} Na_2CO_3(s) 298K$?

A. $2Na(s) + C(s) + \frac{3}{2}O_2(g) \rightarrow Na_2O_3(s)$

B. $Na_2O(s) + CO_2(g) \rightarrow Na_2CO_3(s)$

C. $2Na^+(aq.) + CO_3^{2-}(aq.) \rightarrow Na_2CO_3(s)$

D. $2Na^+(aq.) + 2OH^-(aq.) + CO_2(aq.) \rightarrow Na_2CO_3(s) + H_2O$

Answer: A

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35. Enthalpy is equal to

A. $T^\circ \left[\frac{\partial(G/T)}{\partial T}\right]_P$

B. $-T^2\left[\frac{\partial(G/T)}{\partial T}\right]_P$

C. $T^2\left[\frac{\partial(G/T)}{\partial T}\right]_V$

D. $-T^2\left[\frac{\partial(G/T)}{\partial T}\right]_V$

Answer: B

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36. When a bomb calorimeter is sued to determine the heat of reaction, which proper

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37. For the reaction shown , which which is closest to the value o fΔH?

$\Delta H_f^\circ \qquad \left(KJ.\,mol^{-1}\right)$

$Cr^{3+}(aq) \quad -143$

$Ni^{2+}(aq) \quad -54$

$2Cr^{3+}(aq) + 3Ni(s) \rightarrow 2Cr(s) + 3Ni^{2+}(aq)$

A. 124 kJ

B. 89 kJ

C. $-89kJ$

D. $-124kJ$

Answer: A

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38. An ice cube at $0.00\,^\circ C$ is placed is 200g of distilled water at $25\,^\circ C$. The final temperature after ithe ice is completely metled is $5.00\,^\circ C$. What is the mass of the ice cube?

$\delta H_{fus} = 340J.\,g^{-1}, C_p = 4.18J.\,g^{-1}..\,^\circ C^{-1}$

A. 23.6 g

B. 46.3 g

C. 50.0 g

D. 800 g

Answer: B

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39. Which reaction occurs with the greatest increase in entropy?

A. $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

B. $2NO\left(g0 \rightarrow N_2(g) + O_2(g)\right.$

C. $C(s) + O_2(g) \rightarrow CO_2(g)$

D. $Br_2(g) + Cl_2(g) \rightarrow 2BrCl(g)$.

Answer: A

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

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

Which of the atoms has smallest size ?

A. A

B. B

C. C

D. E

Answer: D

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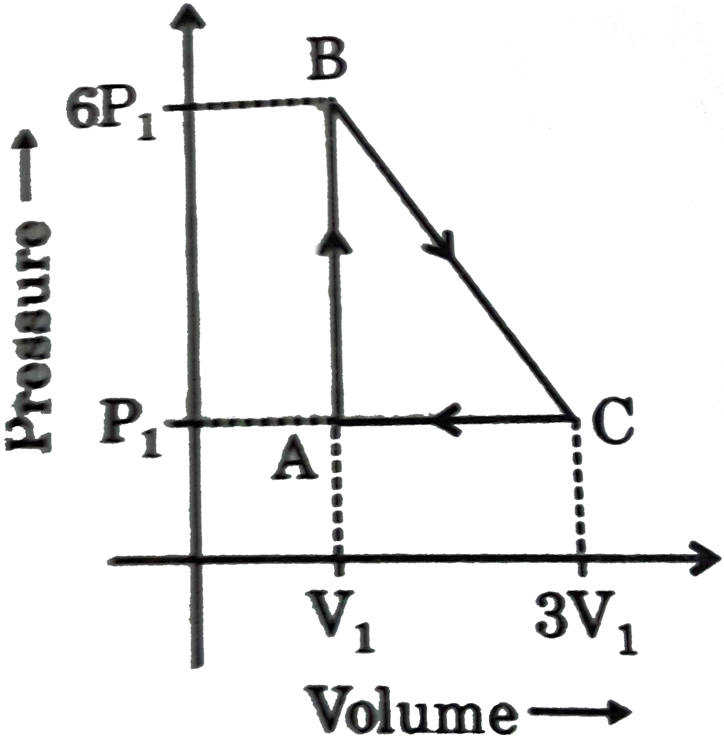
41. An ideal gas is taken around the cycle ABCA as shown in P-V diagram.

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



A. $12P_1V_1$

B. $6P_1V_1$

C. $3P_1V_1$

D. P_1V_1

Answer: C

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42. One gram mole of graphite and diamond were burnt to form CO_2 gas:

$$C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g), \quad \Delta H^\circ = -399.5kJ$$

$$C_{(\text{diamond})} + O_2(g) \rightarrow CO_2(g), \quad \Delta H^\circ = -395.4kJ$$

A. graphite is more stable than diamond

B. diamond is more stable than graphite

C. graphite has greater affinity with oxygen

D. diamond has greater affinity with oxygen.

Answer: A

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43. Which among the following is not an exact differential?

A. Q(dQ=heat abosorbed)

B. U (dU=change in internal energy)

C. S (dS=entropy change)

D. G (dG=Gibbs free energy change)

Answer: A

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44. A gas expands adiabatically at constant pressure such that:

$$T \propto \frac{1}{\sqrt{V}}$$

The value of γ i.e., $\left(C_P/C_V\right)$ of the gas will be:

A. 1.3

B. 1.5

C. 1.7

D. 2

Answer: B

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45. $2Zn + O_2 \rightarrow 2ZnO, \quad \Delta G^\circ = -606J \ldots$ (i)

$2Zn + 2S \rightarrow 2ZnS, \quad \Delta G^\circ = -293J \ldots$(ii)

$2S + 2O_2 \rightarrow 2SO_2(g), \quad \Delta G^\circ = -408J \ldots$ (iii)

ΔG° for the following reaction

$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

would be:

A. $-731J$

B. $-1317J$

C. $+731J$

D. $+1317J$

Answer: A

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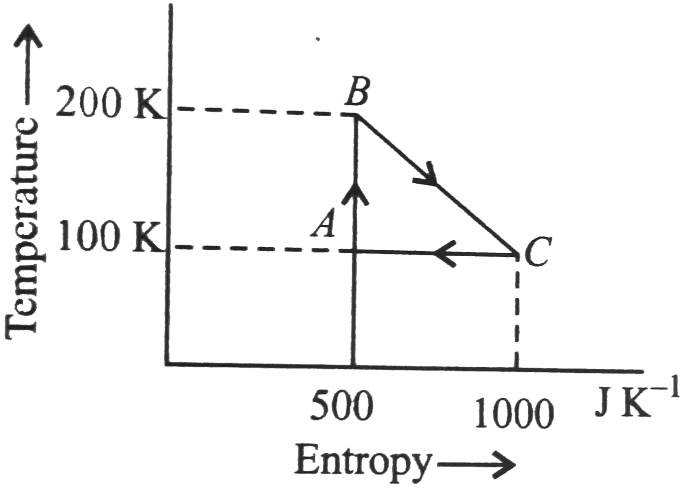
46. The efficiency of the reversible cycle shown in the given figure is



A. 0.3333

B. 0.56

C. 0.66

D. 0.25

Answer: B

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47. IN Haber's process of manufacturing of ammonia :

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g), H^{\circ}_{25\,^{\circ}C} = -92.2kJ$

Molecule $N_2(g)$ $H_2(g)$ $NH_3(g)$

C_pJK^{-1} 29.1 28.8 35.1

If C_p is independent of temperature, then reaction at $100\,^{\circ}$ C as compared to that of $25\,^{\circ}$ C will be :

A. More endothermic

B. less endothermic

C. more exothermic

D. less exothermic

Answer: C

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48. Consider the following statements:

I. Change in enthalpy is always smaller than change in internal energy.

II. The variation in enthalpy of a reaction with temperature is given by Kirchhoff's equation.

III. The entropy change in reversible adiabatic process is equal to zero.

Select the correct answer.

A. I and III

B. II and III

C. III and I

D. all are correct

Answer: A

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49. In C_2H_4 energies of formation of $(C = C)$ and $(C - C)$ are -145 kJ/mol and -80kJ/mol respectively. What is the enthalpy change w hen ethylene polymerises to form polythene?

A. $+650kJ/mol$

B. $+65kJ/mol$

C. $-650kJ \quad mol^{-1}$

D. $-65kJ \quad mol^{-1}$

Answer: B

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50. If $150kJ$ of energy is needed for muscular work to walk a distance of one km, than how much of gulcose one has to consume to walk a distance of five km, provided only 30% energy is available for muscular work.The enthalpy of combustion of glucose is $3000kJmol^{-1}$

A. 75 g

B. 30 g

C. 180 g

D. 150 g

Answer: D

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51. The value of $1og_{10}$ K for a reaction $A \Leftrightarrow B$ is:

(Given,

$\Delta_r H^\circ_{298K} = -54.07kJ \quad mol^{-1}, \Delta_r S^\circ_{298K} = 10JK^{-1} \quad mol^{-1}$ and $R = 8.314JK^{-1} \quad m$

)

A. 5

B. 10

C. 95

D. 100

Answer: B

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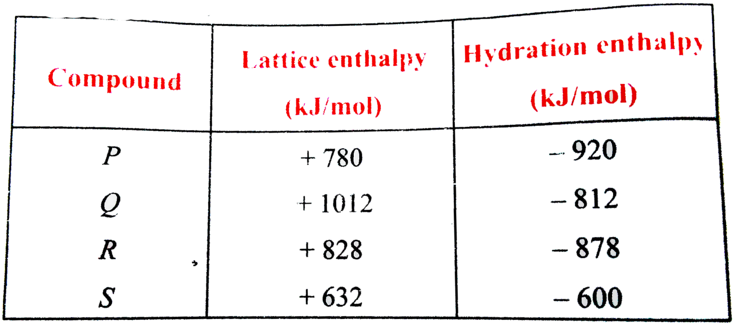
52. The lattice enthalpy and hydration enthalpy of four compounds are given below:



Compound	Lattice enthalpy (kJ/mol)	Hydration enthalpy (kJ/mol)
P	$+780$	-920
Q	$+1012$	-812
R	$+828$	-878
S	$+632$	-600

the pair of compounds which is soluble in water is:

A. P and Q

B. Q and R

C. R and S

D. P and R

Answer: D

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53. The standard enthalpies fo formation of $CO_2(g), H_2O(1)$, and glucose (s) at $25^\circ C$ are $-400kJmol^{-1}$, $-300kJmol^{-}$, and $-1300kJmol^{-1}$, respectively. The standard enthalpy of combustion per gram of glucose at $25^\circ C$ is

A. $+2900kJ$

B. $-2900kJ$

C. $-16.11kJ$

D. $+16.11kJ$

Answer: C

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54. For the process $H_2O(l) \rightarrow H_2O(g)$ at $t = 100^\circ C$ and 1 atmosphere pressure, the correct choice is:

A. $\Delta S_{\text{system}} > 0, \Delta S_{\text{surroundings}} > 0$

B. $\Delta S_{\text{system}} > 0, \Delta S_{\text{surroundings}} < 0$

C. $\Delta S_{\text{system}} < 0 \text{ and } \Delta S_{\text{surroundings}} > 0$

D. $\Delta S_{\text{System}} < 0 \text{ and } \Delta S_{\text{surroundings}} < 0$

Answer: B

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55. one mole of an ideal gas at 300k in thermal contact with surroundings expands isothermally from 1.0 L to 2.0 L against a constant presses of 3.0 atm. In this process. The change in entropy of surrroundings (ΔS) in J^{-1} is (1 L atm = 101.3 J)

A. 5.763

B. 1.013

C. -1.013

D. -5.763

Answer: C

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56. The standard state Gibbs free energies of formation of) C(graphite and C(diamond) at T = 298 K are

$\Delta_f G^\circ [\text{C(graphite)}\Big] = 0kJmol^{-1}$

$\Delta_f G^\circ [\text{C(diamond)}\Big] = 2.9kJmol^{-1}$

The standard state means that the pressure should be 1 bar, and substance should be pure at a given temperature. The conversion of graphite [ ) C(graphite] to diamond [C(diamond)] reduces its volume by $2 \times 10^{-6} m^3 mol^{-1}$. If) C(graphite is converted to C(diamond) isothermally at T = 298 K, the pressure at which) C(graphite is in equilibrium with C(diamond), is

$\Big[\text{Useful information:}1J = 1kgm^2 s^{-2}, 1Pa = 1kgm^{-1}s^{-2}, 1\text{bar} = 10^5 Pa\Big]$

A. 14501 bar

B. 29001 bar

C. 58001 bar

D. 1405 bar

Answer: A

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Objective Question Level B Set II

1. Which of the following are correct about irreversible isothermal expansion of ideal gas?

A. $w = -q$

B. $\Delta U = 0$

C. $\Delta T = 0$

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

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

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

A. $nC_V\Delta T$

B. $\frac{nR}{(\gamma - 1)}\left(T_2 - T_1\right)$

C. $-nR \quad P_{ext}\left[\frac{T_2P_1 - T_1P_2}{P_1P_2}\right]$

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

Answer: A::B::C

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

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

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

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

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

Answer: B

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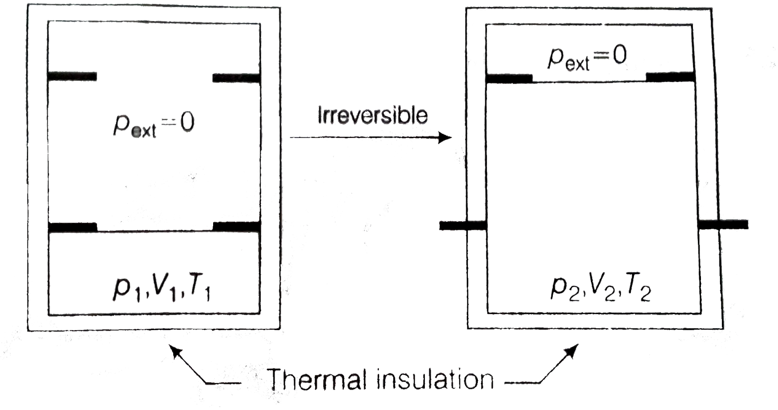
4. An ideal gas in thermally insulated vessel at internal $(pressure) = P_1, (volume) = V_1$ and absolute $temperature = T_1$ expands irreversiby against zero external, pressure , as shown in the diagram, The final internal pressure, volume and absolute temperature of the gas are p_2, V_2 and T_2, respectively . For this expansion



A. $q = 0$

B. $T_2 = T_1$

C. $P_2V_2 = P_1V_1$

D. $P_1V_2^{\gamma} = P_1V_1^{\gamma}$

Answer: A::B::C

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5. For a reaction taking place in a container in equilibrium with its surroundings, the effect of temperature on its equilibrium constant Kin terms of change in entropy is described by

A. With increase in temperature, the value of K for exothermic reaction decreases because the entropy change of the system is positive.

B. With increase in temperature, the value of K for endothemic reaction increases because unfavourable change in entropy of the surrounding decreases

C. With increases in temperature, the value of K for exothermic reaction decreases because because favourable change in entropy of the surroundings decreases

D. With increases in temperature, the value of K for endothemic reaction increases because the entropy change of the system negative.

Answer: B::C

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6. An ideal gas is expanded from $\left(p_1, V_1, T_1\right)$ to $\left(p_2, V_2, T_2\right)$ under different conditions. The correct statement(s) among the following is (are).

A. The work done on the gas is maximum when it is compressed irreversibly from $\left(p_2 V_2\right)$ to $\left(p_1, V_1\right)$ against constant pressure p_1

B. The work done on the gs is less when it is expanded reversibly from V_1 to V_2 under isothermal conditions.

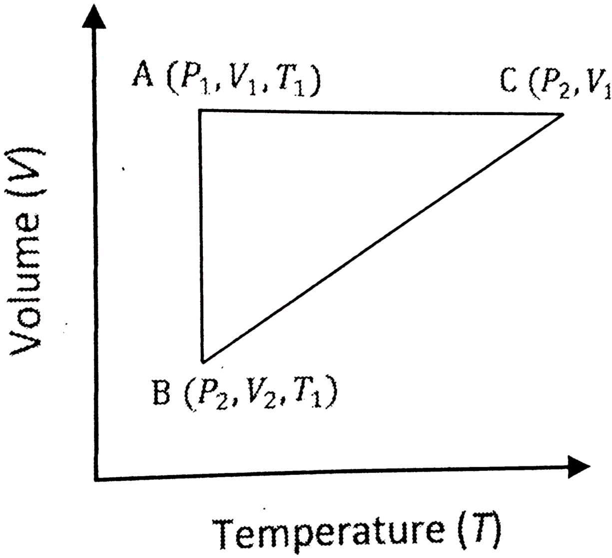
C. The change in internal energy of the gas (i) zero, if it is expanded reversibly with $T_1 = T_2$, and (ii) positive, if it is expanded reversible under adiabatic conditions with $T_1 \neq T_2$

D. If the expansion is carried out freely, it is simultaneously both isothermal as well as adiabatic.

Answer: A::B::D

View Text Solution

7. A reversible cyclic process for an ideal gas is shown below. Here, P, V, and T are pressure, volume and temperature, respectively. The thermodynamic parameters q, w, H and U are heat, work, enthalpy and internal energy, respectively.



The correct option (s) is (are)

A. $q_{AC} = \Delta U_{BC}$ and $w_{AB} = P_2(V_2 - V_1)$

B. $w_{BC} = P_2(V_2 - V_1)$ and $q_{BC} = \Delta H_{AC}$

C. $\Delta H_{CA} < \Delta U_{CA}$ and $q_{AC} = \Delta U_{BC}$

D. $q_{BC} = \Delta H_{AC}$ and $\Delta H_{CA} > \Delta U_{CA}$.

Answer: B::C

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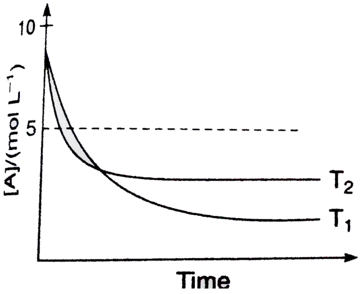
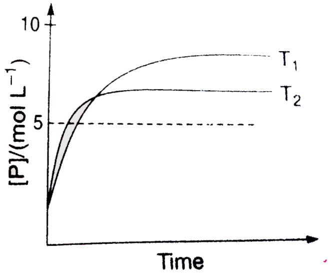
8. For a reaction, $A \Leftrightarrow P$, the plots of [A[and [P] with time at temperature T_1 and T_2 are given ahead:





If $T_1 > T_1$, the correct statement(s) is (are):

(Assume ΔH° and ΔS° are independent of temperature and ratio of ln K at T_1 to ln K at T_2 as greater than $\frac{T_2}{T_1}$. Here, H,S,G and K are enthalpy, entropy, Gibbs energy and equilibrium constant, respectively.

A. $\Delta H^\circ < 0, \Delta S^\circ < 0$

B. $\Delta G^{\circ} < 0, \Delta H^{\circ} > 0$

C. $\Delta G^{\circ} < 0, \Delta S^{\circ} < 0$

D. $\Delta G^{\circ} < 0, \Delta S^{\circ} > 0$

Answer: A::C

View Text Solution

Assertion Reason Type Question

1. Assertion (A): The endothermic reactions are favoured at lower temperature and the exothermic reactions are favoured at higher temperature.

Reason (R) : when a system in equilibrium is disturbed by changing the temperature, it will tend to adjust itself so as to overcome the effect of the change.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: D

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2. Assertion: C_P - $C_V = R$ for an ideal gas.

Reason: $\left(\frac{\partial E}{\partial V}\right)_T = 0$ for an ideal gas.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: B

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3. Assertion (A): When hydrogen gas at high pressure and room temperature expands adiabatically into a region of low pressure, there is a decrease in temperature.

Reason (R) : Hydrogen gas at room temperature is above its inversion temperature.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: D

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4. Statement: The thermodynamics functions which determines the spontaneity of a process is the free energy. For a process to be spontaneous, the change in free energy must be negative.

Explanation:The change in free energy is related to the change in enthalpy and change in entropy. the change in entropy for a process must be always positive if it is spontaneous.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: C

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5. Assertion (A): The Joules -Thomon coefficient for an ideal gas is zero.

Reason (R) : There are no intermlecular attactive forces in an ideal gas.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: A

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6. (A) As temperature increases, heat of reaction also increases for exothermic as well as endothermic reactions. ltBrgt (R) $\Delta H_{\text{reaction}}$ varies according to the relation:

$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P.$$

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: D

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7. (A) All exothermic reactions are spontaneous at room temperature. ltBrgt (R) $\Delta G = -ve$ for above reactions and for spontaneous reactions $\Delta G = -ve$.

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: A

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8. Assertion (A): Enthalpy of graphite is lower than that of diamond.

Reason (R) : Entropy of graphite is lower than that of diamond.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

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9. Assertion: The enthalpy of formation of gaseous oxygen molecules at $298K$ and under1 atm is zero.

Reason: The entropy of formation of gaseous oxygen molecules under the same condition is zero.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: C

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10. Assertion (A): Heat of neutralisation for both HNO_3 and HCI with $NaOH$ is $53.7 kJ per mol^{-1}$.

Reason (R) : $NaOH$ is a strong electrolyte/base.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

Watch Video Solution

11. Assertion (A): Decrease in free energy causes spontaneous reaction

Reason (R) : Spontaneous reactions are invariably exothermic.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: C

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

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

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

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13. 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 (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: A

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14. Assertion (A): For a particular reaction, heat of combustion at constant pressure $\left(q_P\right)$ is always greater than that at constant volume $\left(q_V\right)$.

Reason (R) : Combustion reactions are invariably accomplished by increase in number of moles.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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15. Assertion (A): The enthalpy of both graphite and diamond is taken to be zero, being elementary substances

Reason (R) : The enthalpy of formation of an elementary substance in any state is taken as zero.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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16. Statement -1: heat of neutralistion of perchoric acid , $HClO_4$ with NaOH is same as that of Hcl with NaOH .

Statement -2: Both HCl and $HClO_4$ are strong acid

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: A

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17. Assertion (A): The Heat of ionisation of water is equal to the heat of neutralistion of a strong acid with a strong base.

Reason (R) : Water ionises to a very small extent while $H^{\oplus}$ ions from from an acid combine very rapidly with $\overset{\Theta}{OH}$ from a base to form H_2O.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

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18. Assertion (A): The enthalpy of formation of HCI is equal to the bond energy of HCI.

Reason (R) : The enthalpy of formation and the bond enegry both involve formation of one mole of HCI from the elements.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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19. Assertion (A): Pressure, volume, and temperature are all extensive properties.

Reason (R) : Extensive properties depend upon the amount and nature of the substance.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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20. Assertion (A): When a gas at high pressure expands against vacuum, the work done is maximum.

Reason (R) : Work done in expansion depends upon the pressure inside the gas and increase in volume.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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21. Assertion: When a real gas is allowed to expand adiabatically through a fine hole from a region of high presssure to a region of low pressure, the temperature of gas falls in a completely insulated container.

Reason: Work is done at the cost of internal energy of the gas.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: A

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22. Assertion (A): Internal energy change in a cyclic process is zero.

Reason (R) : Internal energy is a state funciton.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: A

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23. Assertion (A): An exothermic process, non-spontaneous at high temperature, may become spontaneous at low temperature.

Reason (R) : With decrease in temperature, randomness (entropy) decreases.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

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24. Assertion (A): There is no reaction known for which ΔG is positive, yet it is spontaneous.

Reason (R) : For photochemical reaction, ΔG is negative.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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25. Assertion (A): A reaction which is spontaneous and accompained by decreases of randomness must be exothermic.

Reason (R) : All exothermic reactions are accompained by decrease of randomness.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: C

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26. Assertion: Molar entropy of vaporization of water is different from ethanol.

Reason: Water is more polar than ethanol.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: B

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27. Assertion (A): Heat of neutralisation for both HNO_3 and HCI with $NaOH$ is $53.7kJpermol^{-1}$.

Reason (R) : $NaOH$ is a strong electrolyte/base.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: A

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28. Statement -1 in the following reaction :

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = \Delta U - RT$

Statement -2: ΔH Is related to ΔU by the equation ,

$\Delta H = \Delta + \Delta n_g RT$

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: D

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29. (A) For reaction ltBrgt $2NH_3(g) \rightarrow N_2(g) + 3H_2(g), \quad \Delta H > \Delta E$

(R) Enthalpy change is always greater than internal energy change.

A. If both (A) and (R) are correct and (R) is the correct reason for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is true but (R) is false

D. If both (A) and (R) are false.

Answer: C

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Assertion Reason Type Question Set-2

1. (A) Efficiency of a reversible ingine is 100% (maximum) when the temperature of sink is $-273\,^{\circ}C$.

(R) Efficiency of engine $\eta = \dfrac{T_2 - T_1}{T_2}$

A. If both (A) and (R) are correct and (R) is the correct explanation for (A).

B. If both (A) and (R) are correct but (R) is not the correct explanation for (A).

C. If (A) is correct but (R) is incorrect

D. If (A) is incorrect but (R) is correct.

Answer: A

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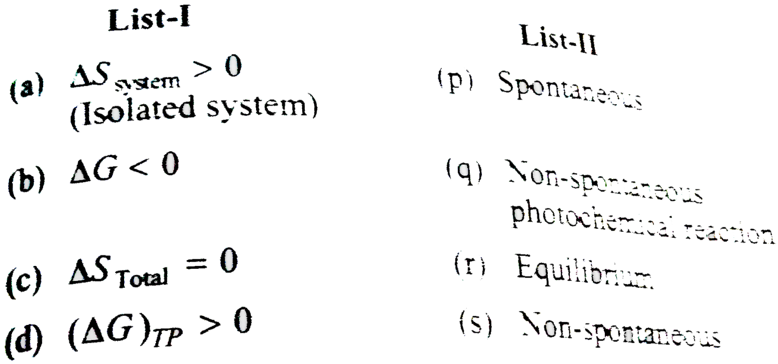
Matric Matching Type Questions

1. Matrix-Matching problems:

[A] Match the List-I with List-II:



List-I	List-II
(a) $\Delta S_{\text{system}} > 0$ (Isolated system)	(p) Spontaneous
(b) $\Delta G < 0$	(q) Non-spontaneous photochemical reaction
(c) $\Delta S_{\text{Total}} = 0$	(r) Equilibrium
(d) $(\Delta G)_{TP} > 0$	(s) Non-spontaneous

Column-I	Column-II
(a) Isothermal process (reversible)	(p) $W = 2.303nRT \log\left(\frac{P_1}{P_2}\right)$
(b) Adiabatic process	(q) $PV^{\gamma} = \text{constant}$
(c) $W = \frac{nR}{r-1}(T_2 - T_1)$	(r) $W = 2.303nRT \log\left(\frac{V_2}{V_1}\right)$
(d) Irreversible isothermal process	(s) $W = -P_{\text{ext}}(V_2 - V_1)$

List-I (Quantity)	List-II (Relation)
(a) ΔG	(p) $-nFE$ or $-nFE^{\circ}$
(b) ΔG°	(q) $\Delta H - T\Delta S$
(c) W or $W_{\max}$	(r) $-RT \log_e K$
(d) ΔS°	(s) $2.303nR \log_{10}\left(\frac{V_2}{V_1}\right)$

Column-I (Gas)	Column-II (Thermodynamic property)
(a) O_2	(p) $\gamma = 1.4$
(b) N_2	(q) $C_P = \frac{7}{2}R$
(c) CO_2, CH_4	(r) $\frac{23}{6}R$
(d) 1 mol O_2 + 2 mol O_3	(s) $\gamma = 1.33$

Column-I (Reaction)	Column-II (Relation)
(a) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$	(p) $\Delta H = \Delta U + RT$
(b) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$	(q) $\Delta H = \Delta U$
(c) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	(r) $\Delta H = \Delta U - 2RT$
(d) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	(s) Forward shift by increasing pressure

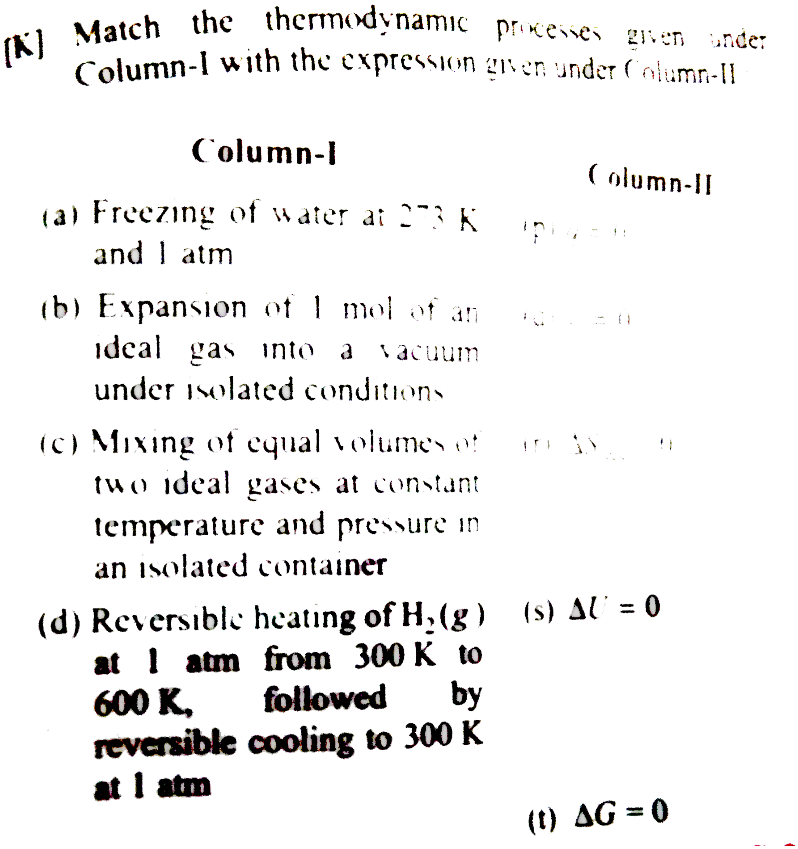
Column-I	Column-II
(a) $N_2(g) + O_2(g) \rightarrow 2NO(g)$	(p) ΔS [illegible] 0
(b) $2KI(aq.) + HgI_2(aq.) \rightarrow K_2[HgI_4](aq.)$	(q) ΔS [illegible] 0
(c) $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$	(r) $\Delta H > 0$
(d) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$	(s) $\Delta H < 0$

List-I (Reaction)	List-II (Process)
(a) $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$	(p) Combustion
(b) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$	(q) Neutralization
(c) $NaOH(aq.) + HCl(aq.) \rightarrow NaCl(aq.) + H_2O$	(r) Process of formation
(d) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	(s) Reaction of apollo fuel cell

Column-I	Column-II
(a) $\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P$	(p) Trouton equation
(b) $\frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V$	(q) Effect of temperature on the heat of reaction
(c) $\frac{\Delta H_{\text{fusion}}}{T_{\text{mp}}} = \Delta S_{\text{fusion}}$	(r) Kirchhoff's equation
(d) $\lim_{T \rightarrow 0\,K} S \rightarrow 0$	(s) Third law of thermodynamics

Column-I	Column-II
(a) Amount of heat required to raise the temperature of 1 mol substance by 1°C	(p) Specific heat × molar mass
(b) $\frac{\Delta H}{\Delta T}$ or $\frac{\Delta U}{\Delta T}$	(q) Heat capacity = C, C_p or C_V
(c) Heat evolved in the combustion of 1 g of a substance	(r) Electron gain enthalpy
(d) Heat evolved when an extra electron is added to valence shell of an isolated gaseous atom	(s) Calorific value

Column-I	Column-II
(a) $\Delta H = +$ ve, $\Delta S = +$ ve	(p) Spontaneous at all temperature
(b) $\Delta H = -$ ve, $\Delta S = +$ ve	(q) Non-spontaneous at all temperature
(c) $\Delta H = +$ ve, $\Delta S = -$ ve	(r) Non-spontaneous at high temperature
(d) $\Delta H = -$ ve, $\Delta S = -$ ve	(s) Spontaneous at high temperature



[K] Match the thermodynamic processes given under Column-I with the expression given under Column-II

Column-I	Column-II
(a) Freezing of water at 273 K and 1 atm	(p) $q = 0$
(b) Expansion of 1 mol of an ideal gas into a vacuum under isolated conditions	(q) $w = 0$
(c) Mixing of equal volumes of two ideal gases at constant temperature and pressure in an isolated container	(r) $\Delta S_{sys} < 0$
(d) Reversible heating of $H_2(g)$ at 1 atm from 300 K to 600 K, followed by reversible cooling to 300 K at 1 atm	(s) $\Delta U = 0$
	(t) $\Delta G = 0$

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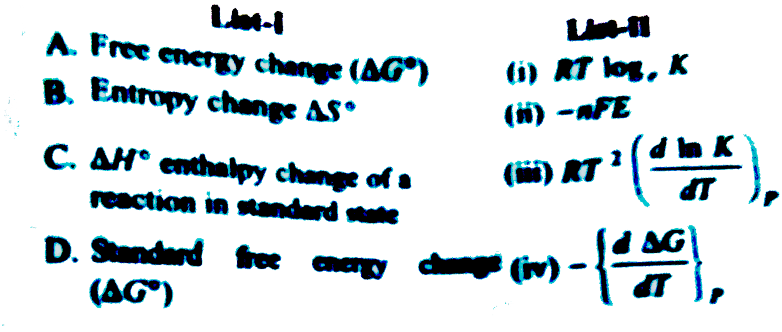
2. Match the thermodynamic properties (List-I) with their relation (List-II):



List-I	List-II
A. Free energy change (ΔG°)	(i) $RT \log_e K$
B. Entropy change ΔS°	(ii) $-nFE$
C. ΔH° enthalpy change of a reaction in standard state	(iii) $RT^2\left(\frac{d \ln K}{dT}\right)_P$
D. Standard free energy change (ΔG°)	(iv) $-\left\{\frac{d\,\Delta G}{dT}\right\}_P$

Select the correct answer.

A.

A	B	C	D
i	ii	iii	iv

B.

A	B	C	D
iv	iv	iii	i

C.

A	B	C	D
iv	ii	iii	i

D.

A	B	C	D
i	ii	iv	iii

Answer: B

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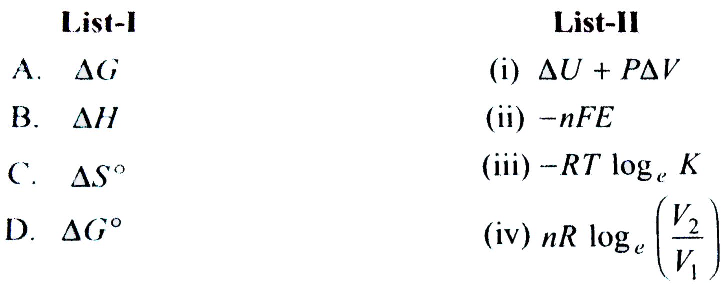

List-I	List-II
A. ΔG	(i) $\Delta U + P\Delta V$
B. ΔH	(ii) $-nFE$
C. ΔS°	(iii) $-RT \log_e K$
D. ΔG°	(iv) $nR \log_e \left(\frac{V_2}{V_1}\right)$

3. ltBrgt

Match the physical changes in List-I with their relations given in List-II:

A. $\begin{array}{cccc} A & B & C & D \\ \text{ii} & \text{i} & \text{iv} & \text{iii} \end{array}$

B. $\begin{array}{cccc} A & B & C & D \\ \text{i} & \text{ii} & \text{iii} & \text{iv} \end{array}$

C. $\begin{array}{cccc} A & B & C & D \\ \text{iv} & \text{iii} & \text{ii} & \text{i} \end{array}$

D. $\begin{array}{cccc} A & B & C & D \\ \text{i} & \text{ii} & \text{iv} & \text{iii} \end{array}$

Answer: A

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Integer Type

1. A bubble of 8 moles of helium is submerged at certain depth n water. The temperature of water increases by $30^{\circ} C$. How much heat is added approximately to helium (in kJ) during expansion?

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2. For liquid enthalpy of fusion is $1.435 kcal mol^{-1}$ and molar entropy change is $5.26 cal mol^{-1} K^{-1}$. The melting point of the liquid is

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3. For the reaction, $Ag_2O(s) \Leftrightarrow 2Ag(s) + \frac{1}{2}O_2(g)$

$\Delta H, \Delta S$ and T are 40.63 kJ mol^{-1}, 108.8 $JK^{-1} mol^{-1}$ and $373.4 K respectively. Freee \ne rgychan \ge$ DeltaG` of the reaction will be:

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4. Standard Gibbs free enegry change ΔG^{Θ} for a reaction is zero. The value of the equilibrium constant will be:

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5. ΔG^{Θ} for the reaction $X + Y \Leftrightarrow C$ is -$4.606 kcalat$1000 K`. The equilibrium constant for the reverse mode of the reaction will be:

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6. $4.48L$ of an ideal gas at STP requires 12 cal to raise its temperature by $15^{\circ} C$ at constant volume. The C_P of the gas is

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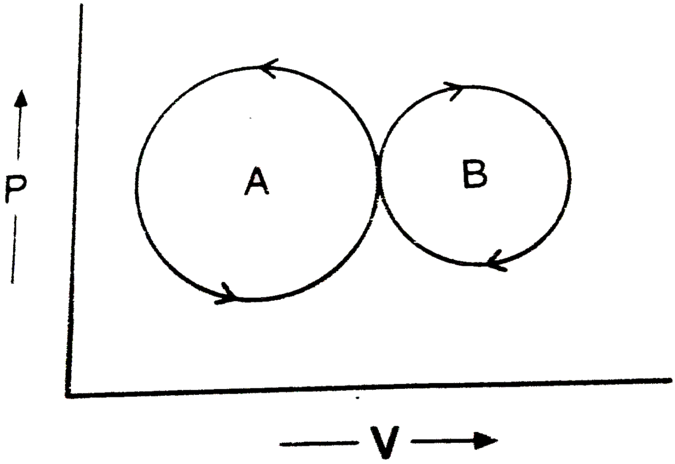

7.

In the present graph, the areas of circles A and B are 25 unit and 20 unit respectively. Work done will be . . .unit.

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8. For the reaction,

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

Heat of reaction at constant volume exceeds the heat reaction at constant pressure by the value of xRT. The va lue x is:

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9. Gas (A_x) has the ratio of cpecific heat, equal to 1.66. The value of x will be:

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10. For a liquid the vapour pressure is given by:

$$\log_{10}P = \frac{-400}{T} + 10$$

Vapour pressure of the lqiuid is 10^x mm Hg. The value of x will be:

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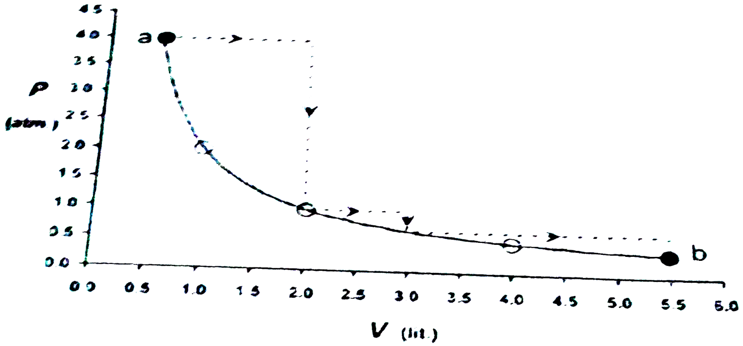
11. One mole of an ideal gas is taken from a to b along two paths denoted by the solid and the dashed lines as shown In the graph below. If the work done along the solid line path is W_s and that along the the dotted line path is w_d, then the integer closest to the ratio w_d / w_s is



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Linked Comprehension Type Questions

1. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

q - $ms\Delta T, \quad s =$ specific heat

$= c\Delta T, \quad c =$ Heat capacity.

Heat of reaction at constant pressure is measured using bomb calorimeter.

$q_V = \Delta U =$ Internal energy change

heat of reaction at constant pressure is measrued using simple or water calorimeter.

$q_P = \Delta H$

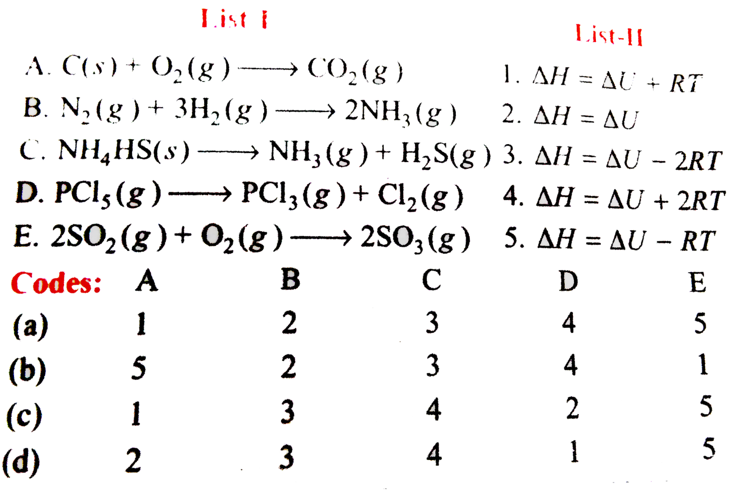
$q_P = q_V + P\Delta V$

$\Delta H = \Delta U + \Delta nRT$

The amount of energy released during a chemical change depends on the physical state of reactants and products, te conditions of pressure, temperatrue and volume at which the reaction is carried out. the variation of heat of reaction with temperature and pressure is given by kirchhoff's equation:

$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P, \quad \frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V.$$

Q. Matht eh List-I and List-II and select the answer from the given codes:



List I

List-II

A. $C(s) + O_2(g) \longrightarrow CO_2(g)$ 1. $\Delta H = \Delta U + RT$

B. $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$ 2. $\Delta H = \Delta U$

C. $NH_4HS(s) \longrightarrow NH_3(g) + H_2S(g)$ 3. $\Delta H = \Delta U - 2RT$

D. $PCl_5(g) \longrightarrow PCl_3(g) + Cl_2(g)$ 4. $\Delta H = \Delta U + 2RT$

E. $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$ 5. $\Delta H = \Delta U - RT$

Codes:	A	B	C	D	E
(a)	1	2	3	4	5
(b)	5	2	3	4	1
(c)	1	3	4	2	5
(d)	2	3	4	1	5

A. $\begin{array}{ccccc} A & B & C & D & E \\ 1 & 2 & 3 & 4 & 5 \end{array}$

B. $\begin{array}{ccccc} A & B & C & D & E \\ 5 & 2 & 3 & 4 & 1 \end{array}$

C. $\begin{array}{ccccc} A & B & C & D & E \\ 1 & 3 & 4 & 2 & 5 \end{array}$

D. $\begin{array}{ccccc} A & B & C & D & E \\ 2 & 3 & 4 & 1 & 5 \end{array}$

Answer: D

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2. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

$q - ms\Delta T,\quad s =$ specific heat

$= c\Delta T,\quad c =$ Heat capacity.

Heat of reaction at constant pressure is measured using bomb calorimeter.

$q_V = \Delta U =$ Internal energy change

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$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P, \quad \frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V.$$

Q. The heat capacity of a bomb calorimeter is 500 J/K. When 0.1g of methane was burnt in this calorimeter, the temperature rose by $2\,^{\circ}C$. the value of ΔU per mole will be:

A. $+1kJ$

B. $-1kJ$

C. $+160kJ$

D. $-160kJ$

Answer: D

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3. Chemical reactions are invariably associated with the transfter of energy either in the form of heat or light. In the laboratory, heat changes in physical and chemical processes are measured with an instrument called calorimeter. Heat change in the process is calculated as

$q = ms\Delta T$ $\quad s$ = Specific heat

$= c\Delta T$ $\quad c$ = Heat capacity

Heat of reaction at constant volume is measured using bomb calorimeter.

$q_V = \Delta U =$ Internal energy change

Heat of reaction at constant pressure is measured using simple or water calorimeter.

$q_p = \Delta H$

$q_p = q_V + P\Delta V$

$\Delta H = \Delta U + \Delta nRT$

. For which reaction will ΔH=ΔU? Assume each reaction is carried out in an open container.

A. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

B. $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$

C. $C(s) + 2H_2O(g) \rightarrow 2H_2(g) + CO_2(g)$

D. $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

Answer: B

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4. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

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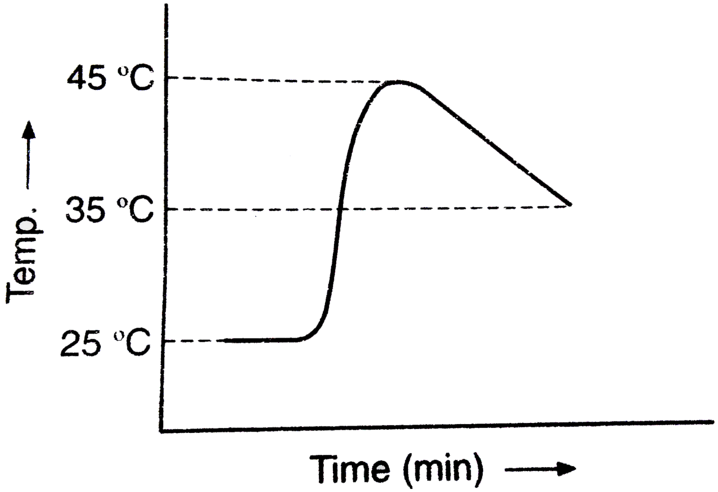

Q.

What value of ΔT should be used for the calorimetry experiment that gives the following graphical result?

A. $10\,^\circ C$

B. $25\,^\circ C$

C. $20\,^\circ C$

D. $35\,^\circ C$

Answer: C

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5. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

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$q_P = q_V + P\Delta V$

$\Delta H = \Delta U + \Delta nRT$

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$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P, \quad \frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V.$$

Q. The enthalpy of fusion of ice is 6.02 kJ mol^{-1}. The heat capacity of water is $4.18 Jg^{-1}.^{\circ} C^{-1}$. What is the smallest number of ice cubes at $0^{\circ} C$, each containing one mole of water, that are needed to cool 500 g of liquid water from 20^{C} to $0^{\circ} C$?

A. 1

B. 7

C. 14

D. 125

Answer: B

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6. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

$q - ms\Delta T, \quad s =$ specific heat

$= c\Delta T, \quad c =$ Heat capacity.

Heat of reaction at constant pressure is measured using bomb calorimeter.

$q_V = \Delta U =$ Internal energy change

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$q_P = \Delta H$

$q_P = q_V + P\Delta V$

$\Delta H = \Delta U + \Delta nRT$

The amount of energy released during a chemical change depends on the physical state of reactants and products, te conditions of pressure, temperatrue and volume at which the reaction is carried out. the variation of heat of reaction with temperature and pressure is given by kirchhoff's equation:

$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P, \quad \frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V.$$

Q. The enthalpy change (ΔH) for the reaction,

$N_2(g) + 3H_2(g) \rightarrow 2NH_2(g)$

is -91.38 kJ at 298 K. The nternal energy change ΔU at 298K is:

A. $-92.38kJ$

B. $-87.42kJ$

C. $-97.34kJ$

D. $-89.9kJ$

Answer: B

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7. Chemical reactions are invariable associated with the transfer of enery either in the form of heat or light. In the laboratory, heat energy I physical and chemical processes are measured with an instrument called caloriemter. Heat change in the process is calcualted as:

q - $ms\Delta T, \quad s =$ specific heat

$= c\Delta T, \quad c =$ Heat capacity.

Heat of reaction at constant pressure is measured using bomb calorimeter.

$q_V = \Delta U =$ Internal energy change

heat of reaction at constant pressure is measrued using simple or water calorimeter.

$q_P = \Delta H$

$q_P = q_V + P\Delta V$

$\Delta H = \Delta U + \Delta nRT$

The amount of energy released during a chemical change depends on the physical state of reactants and products, te conditions of pressure, temperatrue and volume at which the reaction is carried out. the variation of heat of reaction with temperature and pressure is given by kirchhoff's equation:

$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_P, \quad \frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_V.$$

Q. The specific heats of I_2 in vapour and solid states are 0.031 and 0.055

cal/g respectively. The heat of sublimation of iodine at $200\,^{\circ}C$ is 6.096 kcal mol^{-1}. the heat of sublimation of iodine at $250\,^{\circ}C$ will be:

A. 3.8 kcal mol^{-1}

B. 4.8 kcal mol^{-1}

C. 2.28 kcal mol^{-1}

D. 5.8 kcal mol^{-1}

Answer: D

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8. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegry depends on three factors:

a. Greater is the bond length, lesser is the bond enegry.

b. Bond energy increases with the bond multiplicity.

c. Bond enegry increases with electronegativity difference between the bonding atoms.

Arrange $N - H, O - H$, and $F - H$ bonds in teh decreasing order of bond enegry.

A. $F - H > O - H > N - H$

B. $O - H > N - H > F - H$

C. $N - H > O - H > F - H$

D. $F - H > N - H > O - H$

Answer: A

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9. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegry depends on three factors:

a. Greater is the bond length, lesser is the bond enegry.

b. Bond energy increases with the bond multiplicity.

c. Bond enegy increases with electronegativity difference between the bonding atoms.

Bond enegy of differene halogen molecules will lie in the sequences

A. $F_2 > Cl_2 > Br_2 > I_2$

B. $Cl_2 > Br_2F_2 > I_2$

C. $I_2 > Cl_2 > Br_2 > F_2$

D. $Br_2 > F_2 > I_2 > Cl_2$.

Answer: B

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10. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegy depends on three factors:

a. Greater is the bond length, lesser is the bond enegy.

b. Bond energy increases with the bond multiplicity.

c. Bond enegry increases with electronegativity difference between the bonding atoms.

Which among the following sequences is correct about the bond energy of $C - C, C = C$ and $C \equiv C$ bonds?

A. $C \equiv C > C = C > C - C$

B. $C \equiv C < C = C < C - C$

C. $C = C > C \equiv C > C - C$

D. $C \equiv C > C - C > C = C$

Answer: A

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11. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegry depends on three factors:

a. Greater is the bond length, lesser is the bond enegry.

b. Bond energy increases with the bond multiplicity.

c. Bond enegry increases with electronegativity difference between the bonding atoms.

In CH_4 molecule, which of the following statement is correct about the C - H bond enegry?

A. All C-H bonds of methane have same energy

B. Average of all C-H bond energies is considered

C. Fourth C-H bond requires highest energy to break

D. none of the above

Answer: B

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12. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegry depends on three factors:

a. Greater is the bond length, lesser is the bond energy.

b. Bond energy increases with the bond multiplicity.

c. Bond enegry increases with electronegativity difference between the bonding atoms.

Use the bond enegries to estimate ΔH for this reaction:

$H_2(g) + O_2(g) \rightarrow H_2O_2(g)$

Bond	Bond energy
$H - H$	$436 kJmol^{-1}$
$O - O$	$142 kJmol^{-1}$
$O = O$	$499 kJmol^{-1}$
$H - O$	$460 kJmol^{-1}$

A. $-127 kJ$

B. $-209 kJ$

C. $-487 kJ$

D. $-841 kJ$

Answer: A

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13. Bond energies can be obtained by using the following relation: $\Delta H(reaction) = \sum$ Bond energy of bonds, broken in the reactants - $\sum$ Bond energy fo bonds, formed in the products

Bond enegry depends on three factors:

a. Greater is the bond length, lesser is the bond enegry.

b. Bond energy increases with the bond multiplicity.

c. Bond enegry increases with electronegativity difference between the bonding atoms.

The heat of formation of NO from its elements is $+90kJmol^{-1}$, What is the approximate bond dissociation enegry of the bond in NO?

$BE_{N=N} = 941kJmol^{-1}BE_{O=O} = 499kJmol^{-1}$

A. 630 kJ mol^{-1}

B. 720 kJ mol^{-1}

C. 760 kJ mol^{-1}

D. 810 kJ mol^{-1}

Answer: A

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14. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta_{sys}G = \Delta_{sys}H - T\Delta_{sys}S$

At constant temperature and pressure

$\Delta_{sys}G < 0$ (spontaneous)

$\Delta_{sys}G = 0$ (equilibrium)

$\Delta_{sys}G > 0$ (non-spontaneous)

The free enegry for a reaction having $\Delta H = 31400 cal, \Delta S = 32 cal K^{-1} mol^{-1} at 1000 ^\circ C$ is

A. $-9336 cal$

B. $-7386 cal$

C. $-1936 cal$

D. $+9336 cal$

Answer: A

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15. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta_{sys}G = \Delta_{sys}H - T\Delta_{sys}S$

At constant temperature and pressure

$\Delta_{sys}G < 0$ (spontaneous)

$\Delta_{sys}G = 0$ (equilibrium)

$\Delta_{sys}G > 0$ (non-spontaneous)

For a spontaneous reaction ΔG, equilibrium K and E^{Θ}_{cell} will be, respectively

A. $-ve, \ > 1, \ +ve$

B. $+ve, \ > 1, \ -ve$

C. $-ve, \ < 1, \ -ve$

D. $-ve, \ > 1, \ -ve$

Answer: A

Watch Video Solution

16. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta_{sys}G = \Delta_{sys}H - T\Delta_{sys}S$

At constant temperature and pressure

$\Delta_{sys}G < 0$ (spontaneous)

$\Delta_{sys}G = 0$ (equilibrium)

$\Delta_{sys}G > 0$ (non-spontaneous)

For a system in equilibrium, $\Delta G = 0$, under conditions of constant

A. Temperature and pressure

B. temperature and volume

C. pressure and volume

D. energy and volume.

Answer: A

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17. The change in Gibbs free energy (ΔG) of the system along provides a criterion for the spontaneity of a process at constant temperature and pressure. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta G_{\text{system}} = \Delta H_{\text{system}} - T\Delta S_{\text{system}}$

At constant temperature and pressure:

$\Delta G_{\text{system}} < 0$ (Spontaneous)

$\Delta G_{\text{system}} = 0$ (equilibrium)

$\Delta G_{\text{system}} > 0$ (non-spontaneous)

Free energy is related to the equilibrium constant as:

$\Delta G^{\circ} = 2.303RT\log_{10}K_e.$

Q. If b oth ΔH and ΔS are negative, the reaction will be spontaneous:

A. at high temperature

B. at low temperature

C. at all temperature

D. at absolute zero

Answer: C

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18. The change in Gibbs free energy (ΔG) of the system along provides a criterion for the spontaneity of a process at constant temperature and pressure. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta G_{\text{system}} = \Delta H_{\text{system}} - T\Delta S_{\text{system}}$

At constant temperature and pressure:

$\Delta G_{\text{system}} < 0$ (Spontaneous)

$\Delta G_{\text{system}} = 0$ (equilibrium)

$\Delta G_{\text{system}} > 0$ (non-spontaneous)

Free energy is related to the equilibrium constant as:

$\Delta G^{\circ} = 2.303RT\log_{10}K_e$.

Q. A reaction has positive values of ΔH and ΔS. From this you can deduce that the reaction:

A. must be spontaneous at any temperature.

B. cannot be spontaneous at any temperature.

C. Will be spontaneous only at low temperature

D. will be spontaneous only at high temperature.

Answer: D

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19. The change in Gibbs free energy (ΔG) of the system along provides a criterion for the spontaneity of a process at constant temperature and pressure. A change in the free energy of a system at constant temperature and pressure will be:

$\Delta G_{\text{system}} = \Delta H_{\text{system}}$ - $T\Delta S_{\text{system}}$

At constant temperature and pressure:

$\Delta G_{\text{system}} < 0$ (Spontaneous)

$\Delta G_{\text{system}} = 0$ (equilibrium)

$\Delta G_{\text{system}} > 0$ (non-spontaneous)

Free energy is related to the equilibrium constant as:

$\Delta G^\circ = 2.303RT\log_{10}K_e$.

Q. For a reaction to be spontaneous at all temperature.

A. ΔG - ve, $\Delta H + ve$ and $\Delta S + ve$

B. $\Delta G + ve$, ΔH - ve and $\Delta S + ve$

C. ΔG - ve, ΔH - ve and ΔS - ve

D. ΔG - ve, ΔH - ve and $\Delta S + ve$.

Answer: D

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20. 3 moles of CO_2 gas expands isothermally against external pressure of 1 bar. Volume increases from 10 L to 30 L respectively. The system is in thermal contact of surroundings at temperature $15^\circ C$. Entropy change in isotehrmal process is:

$$\Delta S = 2.303nR \log\left(\frac{V_2}{V_1}\right).$$

Q. If CO_2 behaves like an ideal gas, then entropy change of system $\left(\Delta S_{\text{system}}\right)$ will be:

A. $+27.4JK^{-1}$

B. $9.1JK^{-1}$

C. $-27.4JK^{-1}$

D. $-9.1JK^{-1}$

Answer: A

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21. 3 moles of CO_2 gas expands isothermally against external pressure of 1 bar. Volume increases from 10 L to 30 L respectively. The system is in thermal contact of surroundings at temperature $15\,^{\circ}C$. Entropy change in isotehrmal process is:

$$\Delta S = 2.303nR\ \log\left(\frac{V_2}{V_1}\right).$$

Q. Select the correct relation:

A. $\Delta S_{\text{system}} > 0, \Delta S_{surr.} = 0$

B. $\Delta S_{surr} < 0, \Delta S_{\text{system}} > 0$

C. $\Delta S_{\text{system}} = 0, \Delta S_{surr.} = 0$

D. $\Delta S_{surr} > 0, \Delta S_{\text{system}} < 0$

Answer: B

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22. When $100mL$ of $1.0MHCl$ was mixed with $100mL$ of $1.0MNaOH$ in an insulated beaker at constant pressure, a temperature increase of $5.7\,^{\circ}C$ was measured for the beaker and its contents (Expt.1). Because the enthalpy of neutralisation of a strong acid with a strong base is constant $\left(-57.0kJmol^{-1}\right)$ this experiment couldbe used to measure the calorimeter constant. In a second experiment (Expt.2), $100mL$ of $2.0M$ acetic acid $K_a = 2.0 \times 10^{-5}\big)$ was mixed with $100mL$ of $1.0MNaOH$ (under identical conditions to Expt. 1) where a temperature rise of $5.6\,^{\circ}C$ was measured.

Enthalpy of dissociation (in $kJmol^{-1}$) of acetic acid obtained from the Expt. 2 is

A. 1

B. 10

C. 24.5

D. 51.4

Answer: A

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23. When $100mL$ of $1.0MHCl$ was mixed with $100mL$ of $1.0MNaOH$ in an insulated beaker at constant pressure, a temperature increase of $5.7^{\circ}C$ was measured for the beaker and its contents (Expt.1). Because the enthalpy of neutralisation of a strong acid with a strong base is constant $\left(-57.0kJmol^{-1}\right)$ this experiment couldbe used to measure the calorimeter constant. In a second experiment (Expt.2), $100mL$ of $2.0M$ acetic acid $K_a = 2.0 \times 10^{-5}\big)$ was mixed with $100mL$ of $1.0MNaOH$ (under identical conditions to Expt. 1) where a temperature rise of $5.6^\circ C$ was measured.

The pH of the solution after Expt. 2 ils

A. 2.8

B. 4.7

C. 5

D. 7

Answer: B

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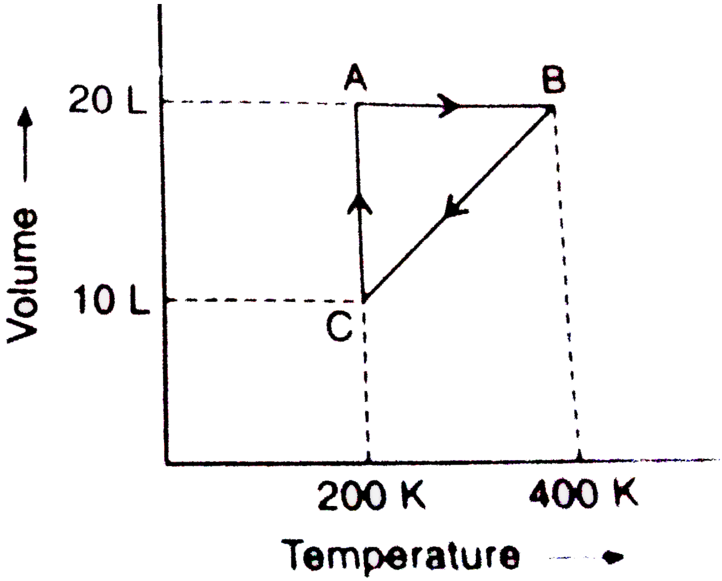

Graph for one mole gas

24.

Process, $A \rightarrow B$ represent:

A. isobaric

B. isochoric

C. isothermal

D. adiabatic

Answer: B

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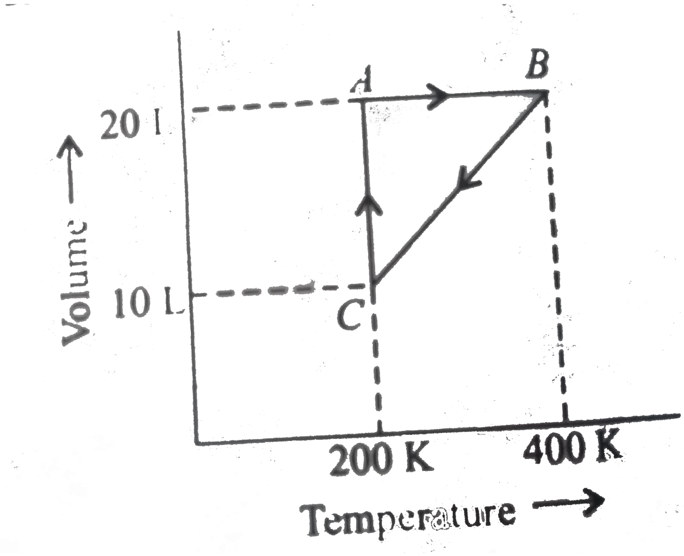

25.

The pressure at C is

A. 3.284 atm

B. 1.642 atm

C. 0.0821 atm

D. 0.821 atm

Answer: B

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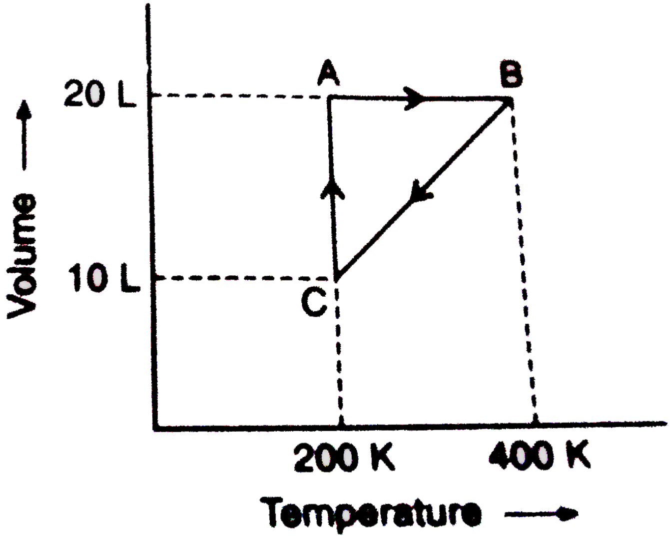

Graph for one mole gas

26.

Q. Work doen in the process $C \rightarrow A$ is:

A. zero

B. 8.21 L atm

C. 16.2 L atm

D. unpredictable

Answer: B

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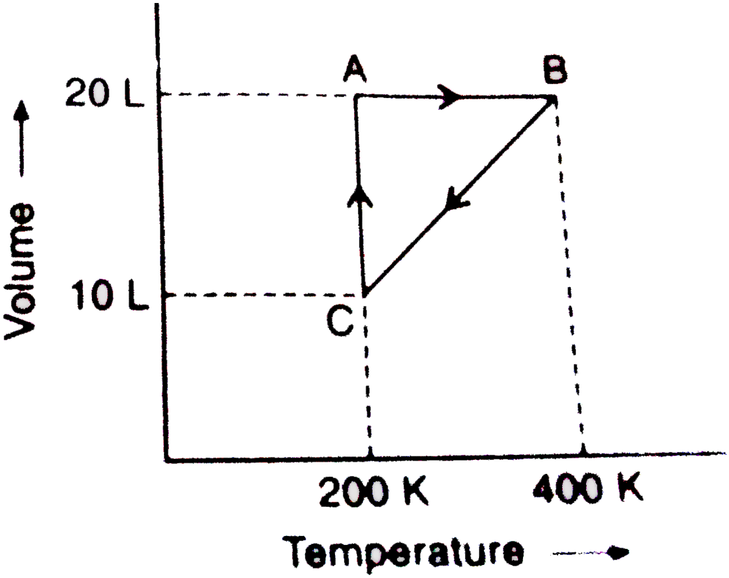

Graph for one mole gas

27.

Q. The process which occurs in going from $B \rightarrow C$ is:

A. isothermal

B. adiabatic

C. isobaric

D. isochoric

Answer: C

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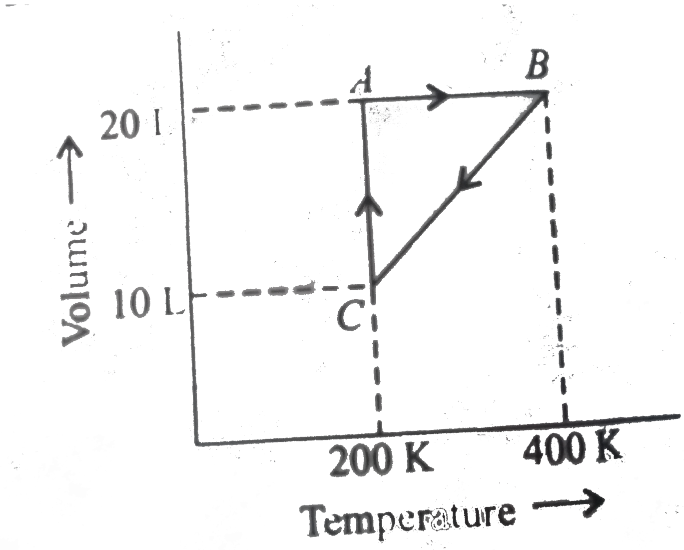
28.



The pressures at A and B in the atmosphere are, respectively,

A. 0.821 and 1.642

B. 1.642 and 0.821

C. 1 and 2

D. 0.082 and 0.164

Answer: A

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29. The thermodynamic property that measures the extent of molecular disorder is called entropy. Entropy change of phase transformation can be calculated using Trouton's formula ($\Delta S = \Delta H / T$). In the reversible adiabatic process, however, ΔS will be zero. the rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system.

$$\Delta S = 2.303 C \log \left(T_1 / T_2 \right)$$

The entropy change in an adiabatic process is

A. zero

B. Always positive

C. Always negative

D. sometimes postive and sometimes negative

Answer: A

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30. The thermodynamic property that measuers the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's furmula $\left(\Delta S = \frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system.

Q. $\Delta S = 2.303C \log \left(T_1/T_2\right)$

$C = C_P$ or C_V.

Q. If water in an insulated vessel at $-10\,^\circ C$, suddenly freezes, the entropy change of the system will be:

A. $+10JK^{-1}mol^{-1}$

B. $-10JK^{-1}mol^{-1}$

C. zero

D. equal to that of surroundings.

Answer: C

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31. The thermodynamic property that measuers the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's furmula $\left(\Delta S = \frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system.

Q. $\Delta S = 2.303C\ \log\ \left(T_1/T_2\right)$

$C = C_P$ or C_V.

Q. The melting point of a solid is 300 K and its latent heat of fusion is 600 cal mol^{-1}. the entropy change for the fusion of 1 mole of the solid (in cal K^{-1}) at the same temperature would be

A. 200

B. 2

C. 0.2

D. 20

Answer: B

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32. The thermodynamic property that measures the extent of molecular disorder is called entropy. Entropy change of phase transformation can be calculated using Trouton's formula ($\Delta S = \Delta H / T$). In the reversible adiabatic process, however, ΔS will be zero. the rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system.

$\Delta S = 2.303 C \log \left(T_1 / T_2 \right)$

For which of the following cases, $\Delta S = \dfrac{\Delta H}{T}$?

A. A process for which $\Delta C_P = 0$ but $\Delta C_V = 0$

B. An adiabatic process

C. An siobaric or isothermal process

D. An isothermal reversible phase transition process.

Answer: D

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33. The thermodynamic property that measures the extent of molecular disorder is called entropy. Entropy change of phase transformation can be calculated using Trouton's formula $(\Delta S = \Delta H / T)$. In the reversible adiabatic process, however, ΔS will be zero. the rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system.

$\Delta S = 2.303 C \log \left(T_1 / T_2\right)$

When 1 mol of an ideal gas is compressed to half of its volume, its temperature becomes half. Then the change in entropy (ΔS) would be

A. C_V ln 2

B. C_P ln 2

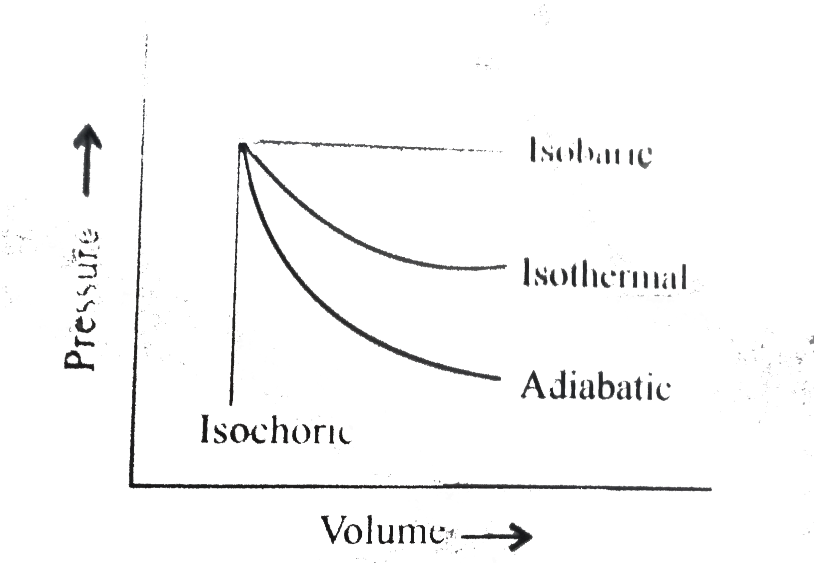
C. $C_V R$ ln 2

D. $\left(C_V - R\right)$ ln 2 × C_P

Answer: B

Watch Video Solution

34. The pressure-volume of various thermodynamic process is shown in graphs:



Work is the mole of transference of energy. It has been observed that reversible work done by the system is the maximum obtainable work.

$w_{rev} > w_{irr}$

The works of isothermal and adiabatic processes are different from each other.

$$w_{\text{isothermal reversible}} = 2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$= 2.303nRT\log_{10}\left(\frac{P_2}{P_1}\right)$$

$$w_{\text{adiabatic reversible}} = C_V\left(T_1 - T_2\right)$$

If w_1, w_2, w_3 and w_4 are work done in isothermal, adiabatic, isobaric, and isochoric reversible processes, respectively 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. $w_3 > w_2 > w_2 > w_4$.

Answer: D

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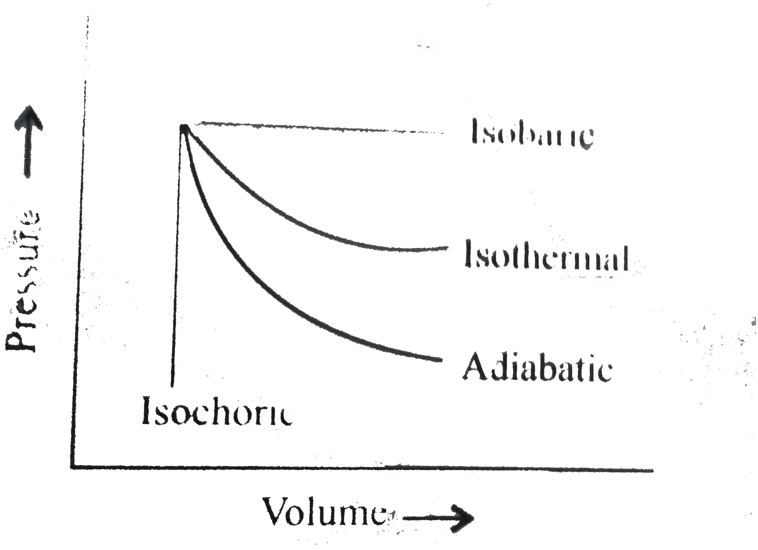
35. The pressure-volume of various thermodynamic process is shown in graphs:



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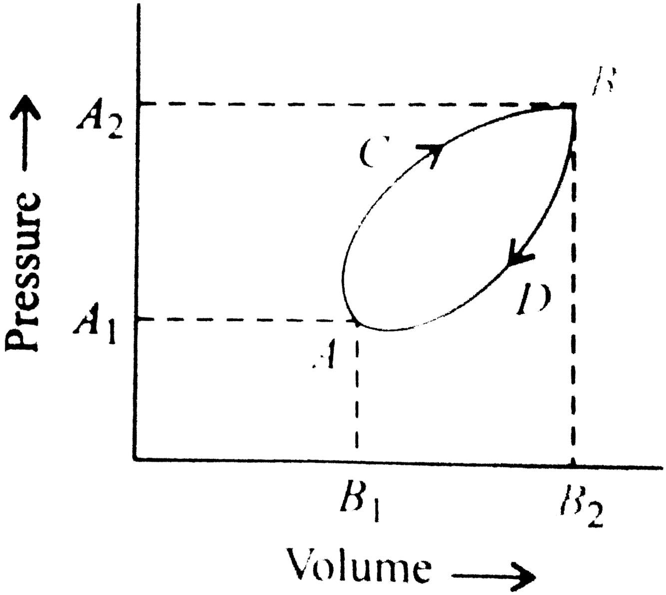
$$= 2.303nRT\log_{10}\left(\frac{P_2}{P_1}\right)$$

$$w_{\text{adiabatic reversible}} = C_V\left(T_1 - T_2\right)$$

A thermodynamic system goes in a cyclic process as represented in the following P - V diagram:



The net work done during the complete cycle is given by the area

A. cycle ACBDA

B. AA_1, B_1BDA

C.

D. AA_2B_2B

Answer: A

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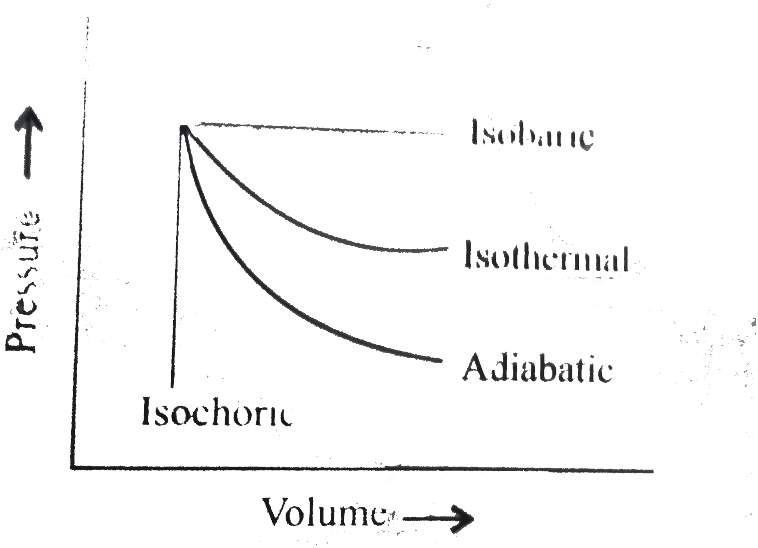
36. The pressure-volume of various thermodynamic process is shown in graphs:



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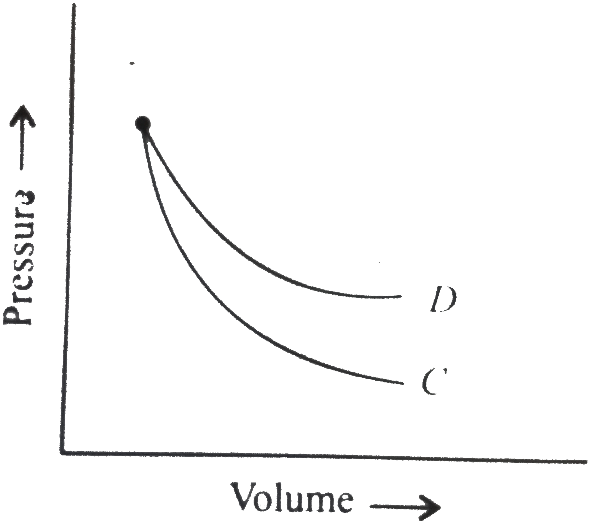
The works of isothermal and adiabatic processes are different from each other.

$$w_{\text{isothermal reversible}} = 2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$= 2.303nRT\log_{10}\left(\frac{P_2}{P_1}\right)$$

$$w_{\text{adiabatic reversible}} = C_V\left(T_1 - T_2\right)$$

P - V plots for two gases during adiabatic processes are given in the given figure:



Plot D and Plot C should correspond to

A. He and O_2

B. He and Ar

C. O_2 and He

D. O_2 and F_2

Answer: C

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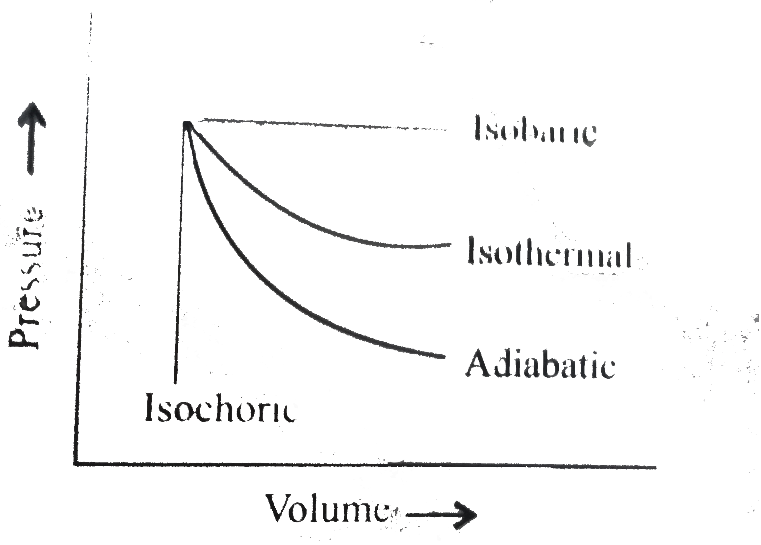
37. The pressure-volume of varies thermodynamic process is shown in graphs:



Work is the mole of transference of energy. It has been observed that reversible work done by the system is the maximum obtainable work.

$w_{rev} > w_{irr}$

The works of isothermal and adiabatic processes are different from each other.

$$w_{\text{isothermal reversible}} = 2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$= 2.303nRT\log_{10}\left(\frac{P_2}{P_1}\right)$$

$$w_{\text{adiabatic reversible}} = C_V\left(T_1 - T_2\right)$$

The q value and work done in isothermal reversible expansion of one mole of an ideal gas from initial pressure of 1 bar to final pressure of 0.1 bar at constant temperature $273K$ are:

A. 5.22 kJ, -5.22 kJ

B. $-5.22kJ, 5.22kJ$

C. $5.22kJ, 5.22kJ$

D. $-5.22kJ, \ -5.22kJ$

Answer: A

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38. Work is the mode of transference of energy. If the system involves gaseous substance and there is difference of pressure between system and surroundings, such a work is referred to as pressure - volume work $\left(W_{PV} = -P_{ext}\Delta V\right)$. It has been observed that reversible work done by the system is the maximum obtainable work. $w_{rev} > w_{irr}$

The works of isothermal and adiabatic processes are different from each other. for isothermal reversible proces,

$$W_{\text{isothermal reversible}} = 2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$W_{\text{adiabatic reversible}} = C_V\left(T_1 - T_2\right)$$

Calculate work done when 1 mole of an ideal gas is expanded reversibly from 20 L to 40 L at a constant temperature of 300 K.

A. 7.78kJ

B. $-1.73kJ$

C. $11.73kJ$

D. $-4.78kJ$

Answer: B

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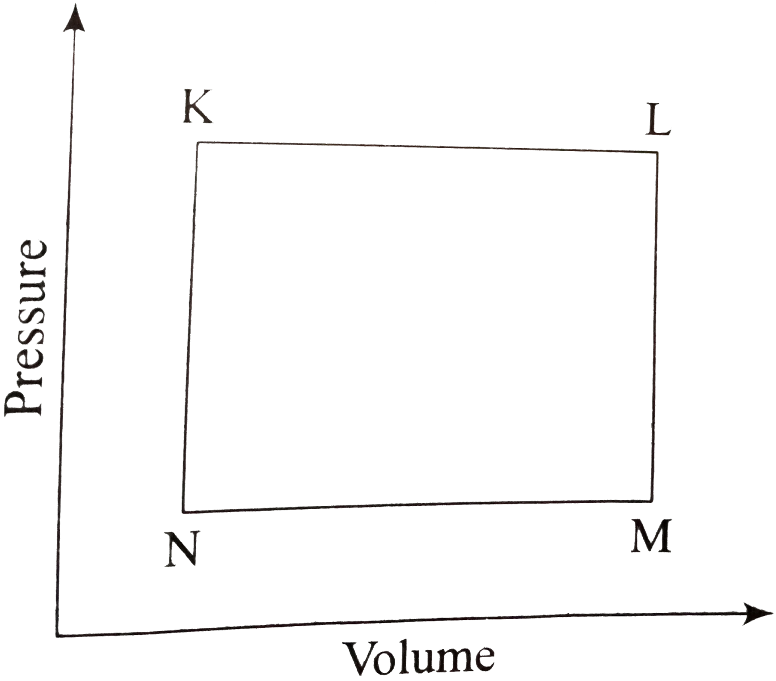
39. A fixed mass m of a gas is subjected to transformation of state: K to L to M and back to K as shown in the figure.

The succeeding operations that enabel this transformation of state are



A. hating,cooling,heating,coolong

B. cooling,heating,cooling,heating

C. heating,cooling,cooling,heating

D. cooling,heating,heating,cooling

Answer: C

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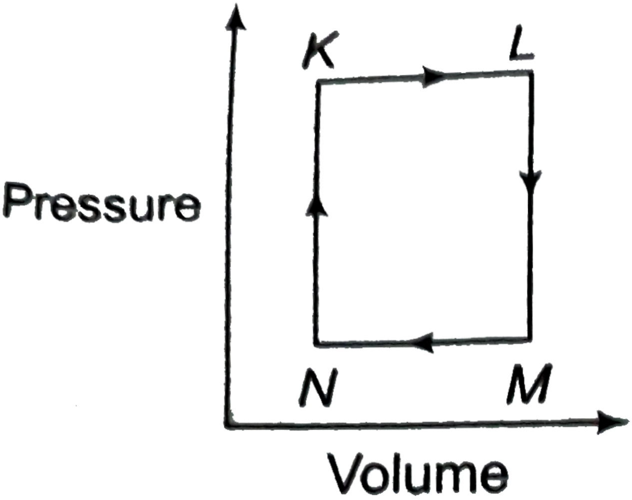
40. A fixed mass m of a gas is subjected to transfromation of states from K to L to M and back to K as shown in the figure.



The pair of isochoric processes among the transfromation of states is

A. K to L and L to M

B. L to M and N to K

C. L to M and M to N

D. M to N and N to K

Answer: B

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Self Assessment

1. For the given reactions

$$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O, \Delta H = -10.17 kcal$$

$$SiO_2 + 4HCI \rightarrow SiCI_4 + 2H_2O, \Delta H = 36.7 kcal$$

It may be concluded that

A. HF and HCl both will react with silica

B. Only Hf will react with silica

C. Only HCl will react with silica

D. Neither HF nor HCl will react with silica

Answer: B

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2. In Mayer's relation:

$C_P - C_V = R$

'R' stands for:

A. translational kinetic energy of 1 mol gas

B. rotational kinetic energy of 1 mol gas

C. vibrational kinetic energy of 1 mol gas

D. work done to increase the temperature of 1 mol gas by one degree

Answer: D

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3. For an ideal gas Joule-Thomon coefficient is:

A. zero

B. positive

C. negative

D. depends on atomicity of gas

Answer: A

Watch Video Solution

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4. Entropy change in reversible adiabatic process is:

A. infinite

B. zero

C. equal to $C_V \Delta T$

D. equal to nR ln $\left(\frac{V_2}{V_1}\right)$

Answer: B

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5. For a process to be in equilibrium it is necessary that:

A. $\Delta S_{\text{system}} = \Delta S_{\text{surr}}$

B. $\Delta S_{\text{system}} = -\Delta S_{\text{surr}}$

C. $\Delta S_{\text{system}} = 0$

D. $\Delta S_{\text{surr}} = 0.$

Answer: B

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6. Predict the sign of ΔS for each of the following processes, which occur at constant temperature.

I. The volume of 2 mol of $O_2(g)$ increases from 44L to 54L

II. The pressure of 2 mol of $O_2(g)$ increases from 1 atm to 1.2 atm.

A. $\begin{array}{ll} \text{I} & \text{II} \\ \Delta S = \text{ - } ve & \Delta S = \text{ - } ve \end{array}$

B. $\begin{array}{ll} \text{I} & \text{II} \\ \Delta S = \text{ - } ve & \Delta S = +ve \end{array}$

C. $\begin{array}{ll} \text{I} & \text{II} \\ \Delta S = +ve & \Delta S = \text{ - } ve \end{array}$

D. $\begin{array}{ll} \text{I} & \text{II} \\ \Delta S = +ve & \Delta S = +ve \end{array}$

Answer: C

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7. Which of the following statements must be true for the entropy o a pure solid to be zero?

I. The temperature must be zero kelvin.

II. The solid must be perfectly crystalline.

III. The solid must be an element

IV. The solid must be ionic.

A. I

B. I and II

C. I, II and III

D. All are correct

Answer: B

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8. Which of the following statements is correct?

A. Slope of adiabatic P-V curve will be same as that in isothermal one

B. Slope of adiabatic P-V curve will be same as that in isothermal one

C. Slope of adiabatic P-V curve will be larger than in isothermal one

D. Slope of adiabatic P-V curve will be zero.

Answer: C

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9. $\left(\frac{\partial H}{\partial P}\right)_T$ for an ideal gas is equal to:

A. zero

B. $\frac{\Delta VRT}{P}$

C. $\frac{P\Delta V}{T}$

D. $nR\Delta T$

Answer: A

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10. A refrigerator is used to remove heat from enclosure at $0^{\circ}C$ at the rate of 600 watt. If the surroundings temperature is $30^{\circ}C$, calculate the power needed:

A. 303 watt

B. 11000 watt

C. 65.9 watt

D. 110 watt

Answer: C

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Self Assessment (Multiple Choice)

1. For which process does $\Delta U = 0$ holds true?

A. Cyclic process

B. Isothermal expansion

C. Isochoric process

D. Adibatic process.

Answer: A::B

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2. If x and y are arbitrary intensive variables, then

A. xy is an intensive variable

B. $\frac{x}{y}$ is an intensive variable.

C. $(x+y)$ is an intensive variable

D. $\frac{dx}{dy}$ is an extensive property.

Answer: A::B::D

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3. Which of the following expression is/are correct for a adiabatic process?

A. $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma - 1}$

B. $\frac{P_2}{P_1} = \left(\frac{T_1}{T_2}\right)^{\gamma - 1/\gamma}$

C. $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

D. $P_1V_1^{\gamma - 1} = P_2V_2^{\gamma - 1}$.

Answer: A::C

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4. Select the state functions amont the following:

A. temperature

B. entropy

C. work

D. enthalpy

Answer: A::B::D

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5. Select the correct expressions among the following:

A. $\frac{\Delta G - \Delta H}{T} = \left(\frac{\partial G}{\partial T}\right)_P$

B. $\frac{\Delta G - \Delta H}{T} = \left[\frac{\partial(\Delta G)}{\partial T}\right]_V$

C. $\frac{\Delta S}{nF} = \left(\frac{\partial E_{\text{Cell}}}{\partial T}\right)_P$

D. $\left(\frac{\partial T}{\partial P}\right)_H = -\left(\frac{\partial H}{\partial P}\right)_{T/C_P}.$

Answer: A::C::D

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6. Which of the following are correct for an idealg as?

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

B. $\left(\frac{\partial H}{\partial P}\right)_T = 0$

C. $\left(\frac{\partial T}{\partial P}\right)_H = 0$

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

Answer: A::B::C

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7. The Clausius-Clapeyron equation may be given as:

A. $\log_{10}\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

B. $\frac{dP}{dT} = \frac{q}{T\Delta V}$

C. $\frac{dP}{dT} = \frac{q}{T\Delta V}$

D. $\frac{dP}{dT} = \frac{\Delta V}{\Delta S}$

Answer: A::B::C

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8. Which of the following is/are not state fuction?

A. q

B. q-w

C. $\frac{q}{w}$

D. $q + w$

Answer: A::B::C

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Self Assessment (Assertion Reason)

1. Statement-1: Most of the combustion reacton are exothermic.

Because Statement-2: Products are more stable than reactants in exothermic process.

A. Statement-1 is true, statement-2 is true, statement-2 is a correct explanation for statement-1

B. Statement-1 is true, statement-2 is true, statement-2 is not a correct explnation for statement-1

C. Statement-1 is true, statement-2 is false.

D. Statement-1 is false, statement-2 is true.

Answer: A

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2. Statement-1: There is no exchange in internal energy in a cyclic process. Statement-2: In a cyclic process, the system returns to original state in a number of steps.

A. Statement-1 is true, statement-2 is true, statement-2 is a correct explanation for statement-1

B. Statement-1 is true, statement-2 is true, statement-2 is not a correct explnation for statement-1

C. Statement-1 is true, statement-2 is false.

D. Statement-1 is false, statement-2 is true.

Answer: A

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3. Assertion(A) : The value of enthalpy of neutralization of a weak acid by strong base is numerically less than $57.1kJ$.

Reason(R) : All OH^{-} ions of strong base are not completely neutralized by H^{+} ions obtained from acid.

A. Statement-1 is true, statement-2 is true, statement-2 is a correct explanation for statement-1

B. Statement-1 is true, statement-2 is true, statement-2 is not a correct explnation for statement-1

C. Statement-1 is true, statement-2 is false.

D. Statement-1 is false, statement-2 is true.

Answer: C

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4. Statement-1: Heat of solution is positive when $Na_2SO_4 \cdot 10H_2O$ is dissolved in water bu it is negative when anhydrous $CuSO_4$ is dissolved in water.

Statement-2: Molar masses of $Na_2SO_4 \cdot 10H_2O$ and $CuSO_4$ are different.

A. Statement-1 is true, statement-2 is true, statement-2 is a correct explanation for statement-1

B. Statement-1 is true, statement-2 is true, statement-2 is not a correct explnation for statement-1

C. Statement-1 is true, statement-2 is false.

D. Statement-1 is false, statement-2 is true.

Answer: C

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5. Statement-1: Mass, volume and pressure are extensive properties.

Statement-2: Extensive properties depent upon the amount of the substance.

A. Statement-1 is true, statement-2 is true, statement-2 is a correct explanation for statement-1

B. Statement-1 is true, statement-2 is true, statement-2 is not a correct explnation for statement-1

C. Statement-1 is true, statement-2 is false.

D. Statement-1 is false, statement-2 is true.

Answer: A

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Self Assessment (Matrix Type)

1. Match the List-I with List-II :

List-I	List-II
(a) $\left(\frac{\partial T}{\partial P}\right)_H$	(p) V
(b) $\left(\frac{\partial G}{\partial P}\right)_T$	(q) T
(c) $\left(\frac{\partial H}{\partial S}\right)_P$	(r) $-S$
(d) $\left(\frac{\partial G}{\partial T}\right)_P$	(s) μ_{jT}

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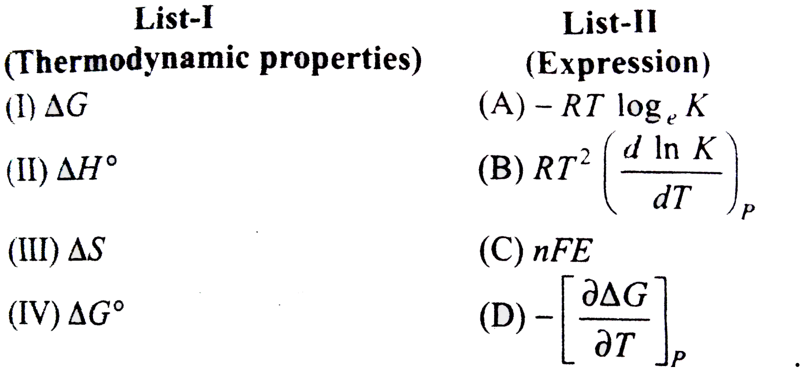
2. Match the list-I with list-II and select the correct answer from the given codes:



List-I (Thermodynamic properties)	**List-II (Expression)**
(I) ΔG	(A) $-RT\log_e K$
(II) ΔH°	(B) $RT^2\left(\frac{d\ln K}{dT}\right)_P$
(III) ΔS	(C) nFE
(IV) ΔG°	(D) $-\left[\frac{\partial \Delta G}{\partial T}\right]_P$

A. I-C,II-B,III-D,IV-A

B. I-B,II-CltIII-D,IV-A

C. I-A,II-B,III-C,IV-D

D. I-D,II-A,III-B,IV-C

Answer: A

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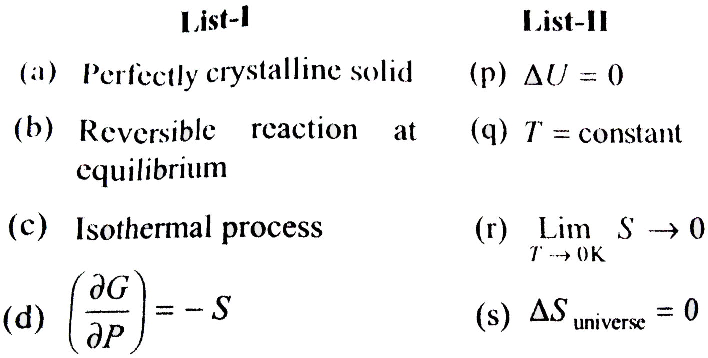
3. Matcht he List-I with List-II :



List-I	List-II
(a) Perfectly crystalline solid	(p) $\Delta U = 0$
(b) Reversible reaction at equilibrium	(q) T = constant
(c) Isothermal process	(r) $\lim\limits_{T \to 0K} S \to 0$
(d) $\left(\frac{\partial G}{\partial P}\right) = -S$	(s) $\Delta S_{\text{universe}} = 0$

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Self Assessment (Integer type).

1. heat of neutralisation of HCl against NaOH is 13.7 kcal eq^{-1} what will be the ionisation energy of CH_3COOH in kcal mol^{-1} if its heat of neutralisation is 11.7 kcal eq^{-1}.

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2. Free energy change for the process $A(s) \Leftrightarrow A(l)$ will be:

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3. A gas X_n has the value of γ equal to 1.40 : what will be the value of $'n'$?

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