CHEMISTRY

BOOKS - FULL MARKS CHEMISTRY (TAMIL ENGLISH)

THERMODYNAMICS

In Text Example Problems

1. A gas contained in a cylinder fitted with a frictionless piston expands against a constant external pressure or 1 atm from a volume of 5 litres to a volume of 10 litres. In doing so it absorbs 400 J of thermal energy from its surroundings. Determine the change in internal energy of system.

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2. The standard enthalpies of formation of $C_2H_5OH_{(l)}$, $CO_{2(g)}$ and $H_2O_{(l)}$ are -277 , -393.5 and $-285.5 \text{kJ mol}^{-1}$ respectively .

Calculate the standard enthalpy change for the reaction

$$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$$

The enthalpy of formation of $O_{2(g)}$ in the standard state is zero , by definition.

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3. Calculate the value of ΔU and ΔH on heating 128.0 g of oxygen from $0^\circ C$ to $100^\circ C$. CV and C_p on an average are 21 and 29 J $\text{mol}^{-1}K^{-1}$ (The difference is $8J\text{mol}^{-1}K^{-1}$ which is approximately equal to R)

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4. Calculate the enthalpy of combustion of ethylene at 300K at constant pressure if its enthalpy of combustion at constant volume is $-1406 \text{ kJ mol}^{-1}$.

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5. Calculate the enthalpy of combustion of ethylene at 300K at constant pressure if its enthalpy of combustion at constant volume is $-1406\ \text{kJ mol}^{-1}$.

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6. Enthalpy for the oxidation of graphite to CO_2 and CO to CO_2 can easily be measured. For these conversions, the heat of combustion values are -393.5 kJ and - 283.5 kJ respectively.find the enthalpy of combustion of graphite to CO

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7. Calculate the lattice energy of $NaCl$ using Born-Haber cycle.

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8. If an automobile engine burns petrol at a temperature of $816^{\circ}C$ and if surrounding temperature is $21^{\circ}C$,what is its maximum percentage ?

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9. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

Calculate the standard entropy change for the above reaction, given the standard entropies of $CO_{2(g)}, C_{(S)}, O_{2(g)}$ are 213.6, 5.740 and 205 JK^{-1} respectively.

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10. Calculate the entropy change during the melting of one mole of ice into water at $0^{\circ}C$ and 1 atm pressure. Enthalpy of fusion of ice is 6008J mol^{-1} .

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11. Show that the reaction $CO + 1/2O_2 \rightarrow CO_2$ at 300 K is spontaneous. The standard Gibbs free energies of formation of CO_2 and CO are -394.4 and -137.2 kJ mole^{-1} respectively.

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12. Calculate ΔG^0 for conversion of oxygen to ozone $3/2O_2 \Leftrightarrow O_{3(g)}$ at 298 K, if K_p for the conversion is 2.47×10^{-29} in standard pressure units.

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In Text Example Problems Additional

1. Calculate the maximum % efficiency of thermal engine operating between 110° and 25° .

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2. Calculate the entropy change in the system, and in the surroundings and the total entropy change in the universe when during a process 75 J of heat flow out of the system at $55^{\circ} C$ to the surrounding at $20^{\circ} C$.

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3. 1 mole of an ideal gas, maintained at 4.1 atm and at a certain temperature , absorbs heat 3710 J and expands to 2 litres . Calculate the entropy changes in expansion process.

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4. Calculate the entropy change of process $H_2O_{(l)} \rightarrow H_2O_{(g)}$ at 373K. Enthalpy of vaporization of water is $40850 \mathrm{J\ Mole}^{-1}$

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5. 30.4 KJ is required to melt one mole of sodium chloride . The entropy change during melting is $28.4JK^{-1}mol^{-1}$ .Calculate the melting point of sodium chloride .

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6. For the reaction $N_2O_5(g) \rightarrow 2NO_2(g) + \frac{1}{2}O_2(g)$, the value of rate of disappearance of N_2O_5 is given as $6.5 \times 10^{-2}\text{mol L}^{-1}s^{-1}$. The rate of formation of NO_2 and O_2 is given respectively as

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7. The boiling point of water at a pressure of 50 atm is 538 K.Compare the theoretical efficiencies of a stem engine operating between the boiling point of water at

50 atm pressure , assuming the temperature of the sink to be $35^\circ C$ in each case.

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8. The standard enthalpies of formation of SO_2 and SO_3 are -297 kJ mol^{-1} 396 kJ mol^{-1} respectively. Calculate the standard enthalpy of reaction for the reaction: $SO_2 + 1/2O_2 \rightarrow SO_3$

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9. For the reaction at 298 K : 2A +B $\rightarrow$ C

$\Delta H = 400\ \text{KJ mol}^{-1}$, $\Delta S = 0.2\ \text{JK}^{-1}\text{mol}^{-1}$

Determine the temperature at which the reaction would be spontaneous .

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10. Calculate the heat of glucose and its calorific value from following data :

(i)$C_{(\text{graphite})} + O_{2(g)} \rightarrow CO_{2(g)}$, ΔH=-395 KJ

(ii)$H_{2(g)} + 1/2O_2 \rightarrow H_2O_{(l)}$, ΔH=-269.4 KJ

(iii)$6C + 6H_{2(g)} + 3O_{2(g)} \rightarrow C_6H_{12}O_{6(s)}$, ΔH=-1169.8 KJ

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11. Calculate the entropy change when 1 mole of ethanol is evaporated at 351 K. The molar heat of vaporization of ethanol is 39.84 kJ mol^{-1}

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12. Calculate the entropy change of a process possessing $\Delta H_t = 2090 Jmol^{-1}$.

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13. Calculate the standard enthalpy of formation of $CH_3OH_{(l)}$ from the following data :

(i)

$CH_3OH_{(l)} + 3/2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}, \Delta_r H^{\ominus} = -726 \text{kJ mol}^{-1}$

(ii)$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta_c H^{\ominus} = -393 \text{kJ mol}^{-1}$

(iii) $H_{2(g)} + 1/2O_{2(g)} \rightarrow H_2O_{(l)}, \Delta_f H^{\ominus} = -286 \text{kJ mol}^{-1}$

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14. The equilibrium constant of the reaction is 10 . Calculate the value of $\Delta G^{\ominus}$, Given $R = 8.314 JK^{-1}\text{mol}^{-1}$, T=300 K

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15. Calculate the entropy change in surroundings when 1 mol of $H_2O_{(l)}$ is formed under standard conditions. Given $\Delta H^{\ominus} = -286 \text{kJ mol}^{-1}$

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16. The enthalpy of formation of methane at constant pressure and 300 K is-78.84 kJ. What will be the enthalpy of formation at constant volume?

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17. Calculate $\Delta_r G^{\Theta}$ for conversion of oxygen to ozone , $3/2O_{2(g)} \rightarrow O_{3(g)}$ at 298 K . If K_P for this conversion is 2.47×10^{-29} .

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18. Under what condition, the heat evolved or absorbed in a reaction is equal to its free energy change ?.

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Textual Question Solved Mcqs

1. The amount of heat exchanged with the surrounding at constant quantity _____

A. ΔE

B. ΔH

C. ΔS

D. ΔG

Answer: B

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2. All the naturally occurring processus proceed spontaneously in a direction which leads to _____

A. decrease in entropy

B. increase in entropy

C. increase in free energy

D. decrease in free energy

Answer: D

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3. In an adiabatic process, which of the following is true ?

A. q=w

B. q=0

C. $\Delta E = q$

D. $P\Delta V = 0$

Answer: B

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4. In a reversible process, the change in entropy of the universe is ___

A. > 0

B. ≥ 0

C. < 0

D. $= 0$

Answer: D

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5. In an adiabatic expansion of an ideal gas

A. $w = -\Delta u$

B. $w = \Delta u + \Delta H$

C. $\Delta u = 0$

D. $w = 0$

Answer: A

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6. .....is an intensive property .

A. mass

B. volume

C. enthalpy

D. mass/volume

Answer: D

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

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A. -900 J

B. 900 J

C. 270 kJ

D. -900 kJ

Answer: A

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8. Heat of combustion is always ____

A. positive

B. negative

C. zero

D. either positive or negative

Answer: B

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9. The heat of formation of CO and CO_2 are $-26.4kCal$ and $-94kCal$, respectively. Heat of combustion of carbon monoxide will be

A. $+26.4$ kcal

B. -67.6 kcal

C. -120.6 kcal

D. $+52.8$ kcal

Answer: B

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10. C(Diamond) $\rightarrow$ C(Graphite), ΔH=-ve, this indicates that _____

A. graphite is more stable than diamond

B. graphite has more energy than diamond

C. both are equally stable

D. stability cannot be predicted

Answer: A

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11. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are -1596 kJ and -1134 KJ, respectively . ΔH for reaction $2Al + Cr_2O_3 \rightarrow 2Cr + Al_2O_3$ is _____

A. -1365 kJ

B. 2730 kJ

C. -2730 kJ

D. -462 kJ

Answer: D

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12. Which of the following is not a thermodynamic function?

A. internal energy

B. enthalpy

C. entropy

D. frictional energy

Answer: D

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13. If one mole of ammonia and one mole of hydrogen chloride are mixed in a closed container to form ammonium chloride gas, then ____

A. $\Delta H > \Delta U$

B. $\Delta H - \Delta U = 0$

C. $\Delta H + \Delta U = 0$

D. $\Delta H < \Delta U$

Answer: D

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14. Change in internal energy, when 4 kJ of work is done on the system and 1 kJ of heat is given out by the system is ____

A. $+1$ kJ

B. -5 kJ

C. $+3$ kJ

D. -3 kJ

Answer: C

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15. The work done by the liberated gas when 55.85 g of iron (molar mass 55.85 g mol^{-1}) reacts with hydrochloric acid in an open beaker at $25^{\circ} C$

A. -2.48 kJ

B. -2.22 kJ

C. $+2.22$ kJ

D. $+2.48$ kJ

Answer: A

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16. The value of ΔH for cooling 2 moles of an ideal monoatomic gas from $125^\circ C$ to $25^\circ C$ at constant pressure will be [given $C_P = \frac{5}{2}R$] ____

A. -250R

B. -500 R

C. 500 R

D. $+250$ R

Answer: B

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17. Given that $C_{(g)} + O_{2(g)} \rightarrow CO_{2(g)}\, \Delta H^\circ = -akJ, 2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$,

=-b kJ , Calculate the ΔH° for the reaction $C_{(g)} + 1/2O_{2(g)} \rightarrow CO_{(g)}$

A. $\frac{b+2a}{2}$

B. $2a-b$

C. $\frac{2a-b}{2}$

D. $\frac{b-2a}{2}$

Answer: D

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18. When 15.68 litres of a gas mixture of methane and propane are fully combusted at $0^{\circ}C$ and 1 atmosphere, 32 litres of oxygen at the same temperature and pressure are consumed. The amount of heat released from this combustion in kJ is ($\Delta H_C(CH_4)$=-890 kJ mol^{-1} and $\Delta H_C(C_3H_8) = -2220kJ\text{mol}^{-1}$)

A. $-889kJ$

B. -1390 kJ

C. -3180 kJ

D. 653.66 kJ

Answer: D

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19. The bond dissociation energy of methane and ethane are 360 kJ mol^{-1} and 620 kJ mol^{-1} respectively. Then, the bond dissociation energy of C-C bond is _____

A. $170\ \mathrm{kJ\ mol}^{-1}$

B. $50\ \mathrm{kJ\ mol}^{-1}$

C. $80\ \mathrm{kJ\ mol}^{-1}$

D. $220\ \mathrm{kJ\ mol}^{-1}$

Answer: C

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20. The correct thermodynamic conditions for the spontaneous reaction at all temperature is ___

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

B. $\Delta H < 0$ and $\Delta S < 0$

C. $\Delta H > 0$ and $\Delta S = 0$

D. $\Delta H > 0$ and $\Delta S > 0$

Answer: A

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21. The temperature of the system, decreases in an_____.

A. isothermal expansion

B. isothermal compression

C. adiabatic expansion

D. adiabatic compression

Answer: C

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22. In an isothermal reversible compression of an ideal gas the sign of q, ΔS and w are respectively

A. $+, -, -$

B. $-, +, -$

C. $+, -, +$

D. $-, -, +$

Answer: D

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23. Molar heat of vapourisation of a liquid is $4.8kJ\text{mol}^{-1}$. If the entropy change is $16Jmol^{-1}K^{-1}$, the boiling point of the liquid is

A. 323 K

B. $27^{\circ} C$

C. $164 K$

D. 0.3 K

Answer: B

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24. ΔS is expected to be maximum for the reaction _____

A. $Ca_{(s)} + 1/2O_{2(g)} \rightarrow CaO_{(s)}$

B. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

C. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

D. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

Answer: D

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25. The values of ΔH and ΔS for a reaction are respectively $30\ \mathrm{kJ\ mol^{-1}}$ and $100 KJ^{-1} mol^{-1}$. Then the temperature above which the reaction will become spontaneous is ___

A. 300 K

B. 30 K

C. 100 K

D. $20^{\circ} C$

Answer: A

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Textual Question Solved

1. Define first law of thermodynamics.

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2. Define Hess's law of constant heat summation.

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3. Explain intensive properties with two examples .

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4. Define the following terms: (a) Isothermal process (b) adiabatic process (c) isobaric proces (d) isochoric process.

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5. what is the usual definition of entropy ? What is the unit of entropy ?

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6. Predict the feasibility of a reaction when (i) both ΔH and ΔS positive (ii) both ΔH and ΔS negative (iii) ΔH decreases but ΔS increases

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7. Define Gibb's free energy .

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8. Define enthalpy of combustion.

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9. Define latent heat capacity . Give its unit

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10. Define the calorific value of food. What is the unit of calorific value?

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11. Define enthalpy of neutralization.

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12. What is lattice energy?

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13. What are state and path functions? Give two examples.

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14. Give Kelvin statement of second law of thermodynamics.

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15. The equilibrium constant of a reaction is 10, what will be the sign of ΔG ? Will this reaction be the sign of ΔG ? Will this reaction be spontaneous ?

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16. Enthalpy of neutralization is always a constant when a strong acid is neutralized by a strong base: account for the statement.

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17. State the third law of thermodynamics.

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18. Write down the Born-Haber cycle for the formation of $CaCl_2$

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19. Identify the state and path functions out of the following: (a) Enthalpy (b)Entropy (c) Heat (d) Temperature (e) Work (f) Free energy.

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20. State the various statements of second law of thermodynamics.

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21. What are spontaneous reactions? What are the conditions for the spontaneity of a process?

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22. List the characteristics of internal energy.

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23. Explain how heat absorbed at constant volume is measured using bomb calorimeter with neat diagram.

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24. Calculate the work done by the torque.

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25. Give the relation between ΔU and ΔH.

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26. Suggest and explain an indirect method to calculate lattice enthalpy of sodium chloride crystal.

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27. Define Gibb's free energy .

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28. Calculate the work done when 2 moles of an ideal gas expands reversibly and isothermally from a volume of 500 ml to a volume of 2 L at $25^{\circ} C$ and normal pressure.

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29. In a constant volume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in ress oxygen at 298 K. The temperature of the calorimeter

was found to Increase from 298 K to 298.45 K due to the combustion process. Given that the calorimeter constant is $2.5 KJK^{-1}$ .Calculate the enthalpy of combustion of the gas in $\mathrm{kJ\ mol^{-1}}$.

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30. Calculate the entropy change in the system and surroundings, and the total entropy change in the universe during a process in which 245 J of heat flow out of the system at $77^{\circ} C$ to the surrounding at $33^{\circ} C$.

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31. 1 mole of an ideal gas, maintained at 4.1 atm and at a certain temperature, absorbs heat 3710 J and expands to 2 litres. Calculate the entropy change in expansion process.

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32. 30.4 kJ is required to melt one mole of sodium chloride. The entropy change during melting is $28.4JK^{-1}mol^{-1}$. Calculate the melting point of sodium chloride.

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33. Calculate the standard heat of formation of propane, if its heat of combustion is-2220.2 kJ mol^{-1} , the heats of formation of $CO_{2(g)}$ and $H_2O_{(l)}$ are - 393.5 and -285.8 kJ mol^{-1} respectively.

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34. You are given normal boiling points and standard enthalpies of vaporization, Calendly. the entropy of vaporization of liquids listed below.

S.No.	Liquid	Boiling points (°C)	ΔH (kJ mol^{-1})
1.	Ethanol	78.4	+ 42.4
2.	Toluene	110.6	+ 35.2

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35. ΔH and ΔS for the reaction

$Ag_2O_{(s)} \rightarrow 2Ag_{(s)} + \frac{1}{2}O_{2(g)}$ are $30.56kJmol^{-1}$

and $66.0Jk^{-1}mol^{-1}$ respectively. Calculate the temperature at which the free energy for this reaction will be zero. What will be the direction of reaction at this temperature and at temperature below this and why ?

Given: $\Delta H = 30.56kJmol^{-1} = 30560Jmol^{-1}$

$\Delta S = 66.0JK^{-1}mol^{-1}$

$\Delta G = 0$

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36. What is the equilibrium constant K_{eq} for the following reaction at 400 K.

$2NOCl_{(g)} \Leftrightarrow 2NO_{(g)} + Cl_{2(g)}$, given that $\Delta H^0 = 77.2\text{kJ mol}^{-1}$ and $\Delta S^0 = 122\text{JK}^{-1}\text{mol}^{-1}$.

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37. Cyanamide (NH_2CN) is completely burnt in excess oxygen in a bomb calorimeter, ΔU was found to be -742.7 kJ mol^{-1}, calculate the enthalpy change of the reaction at 298K.

$NH_2CN_{(s)} + 3/2O_{2(g)} \rightarrow N_{2(g)} + CO_{2(g)} + H_2O_{(l)}\, \Delta H$ =?

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38. Calculate the enthalpy of hydrogenation of ethylene from the following data. Bond energies of C-H , C-C , C=C and H-H are 414,347,618 and 435 kJ mol^{-1} .

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39. Calculate the lattice energy of $CaCl_2$ from the given data.

$Ca_{(s)} + Cl_{2(g)} \rightarrow CaCl_{2(s)}\, \Delta H_f^0 = -795\text{kJ mol}^{-1}$

Sublimation : $Ca_{(s)} \rightarrow Ca_{(g)} \quad \Delta H_1^0 = +121\text{kJ mol}^{-1}$

Ionisation : $Ca_{(g)} \rightarrow Ca_{(g)}^{2+} + 2e^- \quad \Delta H_2^0 = +2422\text{kJ mol}^{-1}$

Dissociation : $Cl_{2(g)} \rightarrow 2Cl_{(g)} \quad \Delta H_3^0 = +242.8\text{kJ mol}^{-1}$

Electron affinity : $Cl_{(g)} + e^- \rightarrow Cl_{(g)}^- \quad \Delta H_4^0 = -355\text{kJ mol}^{-1}$

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40. Calculate the enthalpy change for the reaction $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ from the following data.

$2Fe + \frac{3}{2}O_2 \rightarrow Fe_2O_3$, ΔH=-741 kJ

$C + \frac{1}{2}O_2 \rightarrow CO$, ΔH=-137 kJ

$C + O_2 \rightarrow CO_2$, ΔH=-394.5 kJ

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41. When 1-pentyne (A) is treated with 4N alcoholic KOH at $175^\circ C$, it is converted slowly into an equilibrium mixture of 1.3% 1-pentyne(A), 95.2% 2-pentyne(B) and 3.5% of 1,2 pentadiene (C) the equilibrium was maintained at $175^\circ C$, calculate ΔG^0 for the following equilibria.

$B \Leftrightarrow A \quad \Delta G_1^0$=?

$B \Leftrightarrow C \quad \Delta G_2^0$= ?

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42. At 33K , N_2O_4 is fifty percent dissociated Calculate the standard free energy change at this temperature and at one atmosphere.

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43. The standard enthalpies of formation of SO_2 and SO_3 are -297 kJ mol^{-1} 396 kJ mol^{-1} respectively. Calculate the standard enthalpy of reaction for the reaction: $SO_2 + 1/2O_2 \rightarrow SO_3$

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44. For the reaction at 298 K : 2A +B $\rightarrow$ C

$\Delta H = 400\ \text{KJ mol}^{-1}, \Delta S = 0.2\ \text{JK}^{-1}\text{mol}^{-1}$

Determine the temperature at which the reaction would be spontaneous .

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45. Find out the value of equilibrium constant for the following reaction at 298K,

$2NH_{3(g)} + CO_{2(g)} \Leftrightarrow NH_2CONH_{2(aq)} + H_2O_{(l)}$

Standard Gibbs energy change, ΔG_r^0 at the given temperature is -13.6 kJ mol^{-1}.

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46. A gas mixture of 3.67 lit of ethylene and methane on complete combustion at $25^\circ C$ and at 1 atm pressure produce 6.11 lit of carbon dioxide. Find out the amount of heat evolved in kJ, during this combustion. $\left(\Delta H_C(CH_4) = -890\text{kJ mol}^{-1}\right)$ and $\left(\Delta H_C(C_2H_4) = -1423\text{kJ mol}^{-1}\right)$.

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In Text Questions Evaluate Yourself

1. Calculate ΔH_f° for the reaction $CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$ given that ΔH_f^0 for $CO_2(g), CO(g)$ and $H_2O(g)$ are -393.5 , -111.31 and -242kJ mol^{-1} respectively.

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2. Calculate the amount of heat necessary to raise 180 g of water from $25^\circ C$ to $100^\circ C$. Molar heat capacity of water is $75.3 \text{J mol}^{-1} K^{-1}$

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3. From the following data at constant volume for combustion of benzene, calculate the heat of this reaction at constant pressure condition.

$C_6H_{6(l)} + 7\frac{1}{2}O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O_{(l)}$

ΔU at $25^\circ C$ =-3268.12 kJ

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4. When a mole of magnesium bromide is prepared from 1 mole of magnesium and 1 mole of liquid bromine, 524 kJ of energy is released. The heat of sublimation of Mg metal is 148kJ mol^{-1}. The heat of dissociation of bromine gas into atoms is 193kJ mol^{-1}. The heat of vaporization of liquid bromine is 31 kJ mol^{-1}. The ionisation energy of magnesium is 2187 kJ mol^{-1} and the electron affinity of bromine is -662kJ mol^{-1}. Calculate the lattice energy of magnesium bromide.

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5. An engine operating between $127^{\circ}C$ and $47^{\circ}C$ takes some specified amount of heat from a high temperature reservoir. Assuming that there are no frictional losses, calculate the percentage efficiency of an engine.

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6. Urea on hydrolysis produces ammonia and carbon dioxide. The standard entropies of urea, H_2O, CO_2, NH_3 are 173.8,70,213.5 and 192.5 $\text{J mole}^{-1}K^{-1}$ respectively. Calculate the entropy change for this reaction.

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7. Calculate the entropy change when 1 mole of ethanol is evaporated at 351 K. The molar heat of vapourisation of ethanol is 39.84kJ mol^{-1}

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8. For a chemical reaction the values of ΔH and ΔS at 300 K are - 10 kJ mol^{-1} and -20 J $\text{deg}^{-1}\text{mol}^{-1}$ respectively. What is the value of ΔG of the reaction? Calculate the ΔG of a reaction at 600K assuming ΔH and ΔS values are constant. Predict the nature of the reaction.

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Additional Questions Solved I

1. In which of the following process, the process is always non-feasible?

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

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

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

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

Answer: C

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2. Which of the following process is feasible at all temperatures?

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

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

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

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

Answer: C

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3. Calculate the entropy change during the melting of one mole of ice into water at $0^{\circ} C$ and 1 atm pressure. Enthalpy of fusion of ice is 6008 J Mole^{-1}

A. $22.007 \text{J K}^{-1} \text{Mole}^{-1}$

B. 22.007 J K Mole

C. $220.07 \text{J K}^{-1} \text{Mole}^{-1}$

D. 2.2007J K^{-1} Mole

Answer: A

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4. Calculate the entropy change of a process $H_2O_{(l)} \rightarrow H_2O_{(g)}$ at 373K. Enthalpy of vaporization of water is 40850 J Mole^{-1}

A. $120 JK^{-1}\text{mol}^{-1}$

B. $9.1 \times 10^{-3} JK^{-1}\text{mol}^{-1}$

C. $9.1 \times 10^{-4} JK^{-1}\text{mol}^{-1}$

D. $109.52 JK^{-1}\text{mol}^{-1}$

Answer: D

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5. The final temperature of an engine whose initial temperature 400 K and having efficiency 25% .

A. 200 K

B. 400 K

C. 300 K

D. 450 K

Answer: C

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6. In which of the following entropy decreases?

A. Condensation of water vapour

B. Liquid freezes to solid

C. Sublimation

D. Gas freezes to a solid

Answer: C

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7. Which of the following is a state function?

A. q

B. Δq

C. w

D. ΔS

Answer: D

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8. Which of the following will have highest ΔH_{vap} value?

A. Acetone

B. Ethanol

C. Carbon tetrachloride

D. Chloroform

Answer: B

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9. Which of the following is not a state function?

A. S

B. H

C. G

D. q

Answer: D

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10. Which of the following does not result in an increase in the entropy ?

A. Crystallisation of sucrose from solution

B. Rusting of Iron

C. Conversion of ice to water

D. Vapourisation of camphor

Answer: A

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

A. calories

B. Joule

C. erg

D. eV

Answer: A

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12. Which of the following is not an intensive property?

A. Pressure

B. Density

C. Volume

D. Surface tension

Answer: C

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13. Identify the state quantity among the following

A. 1) q

B. 2) q-w

C. 3) q+w

D. 4) w

Answer: B

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14. Which of the following properties is not a function of state?

A. Concentration

B. Internal energy

C. Enthalpy

D. Entropy

Answer: A

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15. Which of the following relation is true?

A. $C_p > C_v$

B. $C_v > C_p$

C. $C_p = C_v$

D. $C_p = C_v = 0$

Answer: A

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16. Which one of the following always be negative?

A. 1) heat of reaction

B. 2) heat of solution

C. 3) heat of combustion

D. 4) heat of formation

Answer: C

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17. The bond energy depends upon _____

A. 1) size of the atom

B. 2) electronegativity

C. 3) bond length

D. 4) all of the above

Answer: D

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18. Which one is the correct unit for entropy?

A. KJ mol

B. JK^{-1} mol

C. $JK^{-1}\text{mol}^{-1}$

D. KJ mol^{-1}

Answer: C

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19. Which one of the following is an example for closed system?

A. Hot water contained in a thermos flask

B. A gas contained in a cylinder fitted with a piston

C. All living things

D. Hot water contained in a open beaker

Answer: B

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20. Statement-I: All living things are open systems.

Statement-II: Because they continuously exchange matter and energy with the surroundings

A. Statement-I and II are correct and Statement-II is the correct explanation of Statement-I

B. Statement-I and II are correct but Statement-II is not the correct explanation of Statement-I

C. Statement-I is correct and Statement-II is wrong

D. Statement-I is wrong but Statement-II is correct

Answer: A

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21. Which of the following is an extensive property?

A. Molar volume

B. Density

C. Molarity

D. Entropy

Answer: D

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22. Which one of the following is an intensive property?

A. Specific heat capacity

B. Mass

C. Enthalpy

D. Heat capacity

Answer: A

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23. Which one of the following is not an extensive property ?

A. Mole

B. Energy

C. Molar mass

D. Free energy

Answer: C

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24. Which of the following is not an intensive property?

A. Density

B. Molarity

C. Molality

D. Mole

Answer: D

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25. Which one of the following is independent to the mass of the system?

A. Density

B. Mole fraction

C. Mass

D. Molar mass

Answer: C

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26. Which one of the following is true?

A. Volume

B. Enthalpy

C. Entropy

D. Density

Answer: D

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27. Which one of the following is not a path function

A. Work

B. Heat

C. Pressure

D. Either (a) or (b)

Answer: C

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28. Which one of the following is a path function?

A. Pressure

B. Volume

C. Temperature

D. Heat

Answer: D

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29. Which one of the following is a state function?

A. Internal energy

B. Enthalpy

C. Free energy

D. All the above

Answer: D

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30. Statement-I: Internal energy of a system is an extensive property.

Statement-II: Internal energy depends on the amount of the substances present in the system.

A. Statement-I and II are correct and Statement-II is the correct explanation of Statement-I

B. Statement-I and II are correct but Statement-II is not the correct explanation of Statement-I

C. Statement-I is correct and Statement-II is wrong

D. Statement-I is wrong but Statement-II is correct

Answer: A

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31. Which one of the following is equal to 1 Joule?

A. Nm^{-1}

B. $\frac{N}{m^2}$

C. Nm

D. $Kgms^{-2}$

Answer: C

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32. Which of the following represents the gravitational work?

A. Q_V

B. F.x

C. mgh

D. $-P\Delta V$

Answer: C

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33. Enthalpy is defined as ____

A. q+w

B. $q - P\Delta V$

C. U+PV

D. w

Answer: C

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34. Which one of the following is true?

A. Enthalpy of combustion

B. Enthalpy of fusion

C. Enthalpy of vaporization

D. Enthalpy of sublimation

Answer: A

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35. For an ideal gas ____

A. $C_P - C_V = 0$

B. $C_P - C_V = R$

C. $C_V - C_P = R$

D. $C_R - C_P > R$

Answer: B

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36. Which of the following is not a spontaneous process?

A. All water fall runs downhill

B. A lump of sugar dissolves in cup of coffee.

C. Heat flow from hotter object to colder one.

D. A water flow from a well to upper reservoir

Answer: D

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37. Which one of the following is an endothermic process ?

A. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

B. $H^+ + OH^- \rightarrow H_2O$

C. $NH_4NO_3 \xrightarrow{H_2O} NH_4^+ + NO_3^-$

D. $C + O_2 \rightarrow CO_2$

Answer: C

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38. In which of the following entropy decreases?

A. melting of ice

B. evaporation of water

C. crystallization of sugar

D. dissolution of salt

Answer: C

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39. Gibbs free energy is defined as ____

A. G=H+TS

B. G = H x TS

C. G=H-TS

D. G=H/TS

Answer: C

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Additional Questions Solved Ii

1. Match the following

	List-I	List-II
A.	Gravitational work	1. QV
B.	Mechanical work	2. PV
C.	Electrical work	3. $F.x$
D.	Expansion work	4. mgh

A. A-4,B-3,C-1,D-2

B. A-3,B-4,C-2,D-1

C. A-1,B-2,C-4,D-3

D. A-2,B-4,C-3,D-1

Answer: A

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2. Match the following

List-I		List-II	
A.	Cyclic process	1.	$\Delta U = q - P\Delta V$
B.	Adiabatic process	2.	$\Delta U = q_V$
C.	Isobaric process	3.	$q = -w$
D.	Isochoric process	4.	$\Delta U = w$

A. 1) A-4,B-2,C-3,D-1

B. 2) A-3,B-4,C-1,D-2

C. 3) A-2,B-1,C-4,D-3

D. 4) A-1,B-3,C-2,D-4

Answer: B

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3. Match the following

List-I	List-II
A. $2O_{3(g)} \rightarrow 3O_{2(g)}$	1. Spontaneous of high temperature
B. $2H_2O_{(g)} + O_{2(g)} \rightarrow 2H_2O_{2(l)}$	2. Spontaneous at all temperature
C. Solid $\rightarrow$ liquid	3. Non-spontaneous of high temperature
D. Adsorption of gases	4. Non-spontaneous at all temperature

A. A-4,B-2,C-1,D-3

B. A-2,B-4,C-1,D-3

C. A-1,B-3,C-2,D-4

D. A-3,B-1,C-4,D-2

Answer: B

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Additional Questions Solved Iii Fill In The Blanks

1. When a liquid boils , there is ___ in entropy.

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2. If ΔG for a reaction is negative , the change is ____

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3. Change in Gibbs free energy is given by _____

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4. When solid melts there is an ___ in entropy

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5. The unit of entropy is ____

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6. If $\Delta G = 0$, then the process is ___

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7. The standard conditions for G^0 are ____

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8. The efficiency of engine working between 100 to 400 K ____

Watch Video Solution

9. Entropy is a _____ function

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10. An efficiency of an engine is always ____

Watch Video Solution

11. If system moves from ordered state to disordered state, its entropy ____

Watch Video Solution

12. In a reversible process, the change in entropy of the universe is

Watch Video Solution

13. We consider a thermodynamic system. If ΔU represent the increase in the its energy and W the work done by the system, which of the following statements is true?

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14. The net work done by the system ____

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15. The enthalpy of vaporization of a liquid is $30kJ\text{mol}^{-1}$ and the entropy of vapourisation $75JK^{-1}mol^{-1}$ .The boiling point of the liquid at 1 atm is ____

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16. In a reversible process $\Delta S_{\text{sys}} + \Delta S_{\text{surr}}$ is ____

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17. The standard free energy change $\left(\Delta G^0\right)$ is related to equilibrium constant (K) as ____

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18. Entropy change involved in the conversion of 1 mole of liquid water at 373 K to vapour at the same temperature will be ____ ($\Delta H_{\text{vap}} = 2.257 kJg^{-1}$)

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19. The intensive property among the quantities is _____

Watch Video Solution

20. System in which there is no exchange of matter , work or energy from surrounding is ____

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21. A gas can expand from 100 ml to 250 ml under a constant pressure of 2 atm. The work done by the gas is _____

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

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23. In general , for an exothermic reaction to be spontaneous temperature should be _____

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24. Heat of neutralization of a strong acid by a strong base is a constant value because ____

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25. The heat absorbed at constant volume is equal to the system's change in ___

Watch Video Solution

26. Heat of neutralization is always _____

Watch Video Solution

27. The heat of formation of CO and CO_2 are $-26.4kCal$ and $-94kCal$, respectively. Heat of combustion of carbon monoxide will be

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28. For the reaction $H_2 + I_2 \Leftrightarrow 2HI$, ΔH=12.40 Kcal the heat of formation of HI is _____

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29. The specific heat capacity of ___ is maximum.

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30. The relation between C_P and C_V is .....

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31. The heat required to raise the temperature of a body by 1 K is called ____

Watch Video Solution

Watch Video Solution

32. Heat liberated when 100 ml of 1N NaOH is neutralized by 300 ml of 1N HCl ____

Watch Video Solution

33. In order to decompose 9 g of water, 142.5 kJ of heat is required. Hence enthalpy formation of water is _____

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34. Thermodynamics is applicable to ____ system only

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35. In an Isochoric process _____ is constant

Watch Video Solution

Watch Video Solution

36. For a cyclic process, the change in internal energy of the system is ____

Watch Video Solution

37. For an endothermic reaction ΔH is ____

Watch Video Solution

38. The process depicted by the below equation is _____

$H_2O_{(s)} \rightarrow H_2O_{(l)}$ ΔH=+1.43 kcal represents

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39. A thermodynamic state function is a quantity whose value is ____

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40. For the process to occur under adiabatic conditions, the correct condition is ____

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41. The enthalpies of all elements in their standard states are _____

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42. $\Delta U^{\ominus}$ of combustion of methane is $-X\text{kJ mol}^{-1}$. The value of $\Delta H^{\ominus}$ is _____

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43. The enthalpy of combustion of methane, graphite and dihydrogen at 298K are -890.3 kJ mol^{-1} ,- 393.5 kJ mol^{-1} and - 285.8 kJ mol^{-1} respectively. Enthalpy of formation of $CH_{4(g)}$ will be ____

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44. A reaction , $A + B \rightarrow C + D + q$ is found to have a positive entropy change . The reaction will be

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45. A fundamental goal of thermodynamics is the ___of the reaction

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46. The first law of thermodynamics states that ΔU= ___

Watch Video Solution

47. Anything which separates the system from its surroundings is called ____

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48. Hot water in a thermos flask is an example of ____ system

Watch Video Solution

49. In which process there is no exchange of heat between the system and surrounding during the process ?

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50. For an adiabatic process q = _____

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51. In an isothermal process

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52. The process in which the volume of the system remains constant is called _____

Watch Video Solution

53. For an isochoric process , dv= ____

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54. Combustion of fuel in a bomb calorimeter is an example of _____

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55. The unit of heat is

Watch Video Solution

56. The quantity of heat required to raise the temperature of 1 gm of water by $1^{\circ} C$ is ____

Watch Video Solution

57. The standard substances used in the enthalpy of combustion of a substance in bomb calorimeter is ____

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58. The standard value of enthalpy of combustion of benzoic acid is ____

Watch Video Solution

59. The heat of neutralization of a strong acid and strong base is around _____

Watch Video Solution

60. The SI unit of entropy is .....

Watch Video Solution

61. Write a short note , Van't Hoff equation.

Watch Video Solution

62. Mathematically , the third law of thermodynamics is expressed as _____

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Additional Questions Solved Iv Choose The Odd One Out

1. Choose the odd one out

A. Volume

B. Number of moles

C. Internal energy

D. Refractive index

Answer: D

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2. Choose the odd one out

A. Surface tension

B. Density

C. Internal energy

D. Boiling point

Answer: C

Watch Video Solution

3. Choose the odd one out.

A. Boiling point

B. Number of moles

C. Freezing point

D. Temperature

Answer: D

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4. Choose the odd one out.

A. 1) Entropy

B. 2) Enthalpy

C. 3) Free energy

D. 4) Molality

Answer: D

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5. Choose the odd one out.

A. 1) Mole fraction

B. 2) Molarity

C. 3) Specific heat capacity

D. 4) Free energy

Answer: D

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Additional Questions Solved V Choose The Correct Pair

1. Choose the correct pair

A. Isochoric process : dp=0

B. Isobaric process : dv=0

C. Adiabatic process : q=0

D. Cyclic process : p=q

Answer: C

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2. Choose the correct pair

A. 1) Isothermal process : dp=0

B. 2) Adiabatic process : q=0

C. 3) Cyclic process : q=0

D. 4) Isochoric process : p=q

Answer: D

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3. Choose the correct pair

A. H:U+PV

B. $\Delta U : q - w$

C. $\Delta U : \Delta U - \Delta ngRT$

D. $H : U - nRT$

Answer: A

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Additional Questions Solved Vi Choose The Incorrect Pair

1. Choose the incorrect pair.

A. For an perfectly ordered crystalline state : $\lim_{x \to 0} S = 0$

B. Isochoric process in which volume remains constant : dV=0

C. Isobaric process in which temperature remains constant : dT=0

D. Adiabatic process in which no heat transfer take place : q=0

Answer: C

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2. Choose the incorrect pair.

A. 1) Work is defined as force multiplied by the displacement : -w=F. x

B. 2) Enthalpy change : $\Delta H = \Delta U - \Delta ngRT$

C. 3) Gibbs free energy : $\Delta G = \Delta H - T\Delta S$

D. 4) The entropy of a perfectly crystalline material at absolute zero :Zero

Answer: B

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Additional Questions Solved Vii Assertion Reason

1. Statement I : Combustion of all organic compounds is exothermic in nature.

Statement II : The enthalpies of all elements in their standard states are zero.

A. both Assertion and Reason are true and Reason is the correct explanation of Assertion

B. both Assertion and Reason are true and Reason is not correct explanation of Assertion

C. both Assertion and Reason are false

D. Assertion is false but Reason is true

Answer: B

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2. Assertion (A): Spontaneous process is an irreversible process and may be reversed by external agency

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

A. 1) both Assertion and Reason are true and Reason is the correct explanation of Assertion

B. 2) both Assertion and Reason are true and Reason is not correct explanation of Assertion

C. 3) both Assertion and Reason are false

D. 4) Assertion is false but Reason is true

Answer: B

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3. Assertion (A): A liquid crystallizes into a solid and accompanied by decrease in entropy

Reason (R): In crystals molecules are organised in an ordered manner.

A. both Assertion and Reason are true and Reason is the correct explanation of Assertion

B. both Assertion and Reason are true and Reason is not correct explanation of Assertion

C. both Assertion and Reason are false

D. Assertion is false but Reason is true

Answer: A

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Additional Questions Solved Viii Choose The Correct Statement

1. Choose the correct statement .

A. Enthalpy H is defined as sum of internal energy and pressure volume.

B. The entropy of a perfectly crystalline material at absolute zero is unity

C. Isobaric process in which volume remains constant.

D. Isochoric process in which pressure remains constant.

Answer: A

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2. Choose the correct statement .

A. Adiabatic process in which heat is transferred form 0 to 100 K.

B. Isothermal process in which temperature remains constant.

C. Isochoric process in which no heat transfer take place.

D. Isobaric process in which volume remains constant

Answer: B

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Additional Questions Solved Ii Answer Briefly

1. What is the aim of the study of chemical thermodynamics?

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2. What are the scope of thermodynamics?

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3. What are the limitations of the thermodynamics?

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4. Define (i) System (ii) Surroundings.

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5. What is meant by isolated system? Give example.

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6. Explain a closed system with an example.

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7. What is meant by open system? Give example.

Watch Video Solution

8. What are extensive properties?

Watch Video Solution

9. What is reversible process? Give an example.

Watch Video Solution

10. What is reversible process? Give an example.

Watch Video Solution

11. Define cyclic process. Give example.

Watch Video Solution

12. What is meant by internal energy?

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13. Define Heat. Give its unit.

Watch Video Solution

14. Write a note about the sign convention of heat.

Watch Video Solution

15. What is meant by work ? Give its unit.

Watch Video Solution

16. Explain about gravitational work. Give its unit.

Watch Video Solution

17. Define electrical work. Give its unit.

Watch Video Solution

18. Write a note about mechanical work. Give its unit.

Watch Video Solution

19. State Zeroth law of thermodynamic .

Watch Video Solution

20. Define Heat. Give its unit.

Watch Video Solution

21. Define standard entropy of formation.

Watch Video Solution

22. Specific heat capacity

Watch Video Solution

23. Molar heat capacity at constant volume is .....

Watch Video Solution

24. Define specific heat capacity at constant prossure .

Watch Video Solution

25. For an ideal gas ____

Watch Video Solution

26. What are the applications of Bomb Calorimeter?

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27. Define heat of solution.

Watch Video Solution

28. Define molar heat of fusion.

Watch Video Solution

29. What is meant by molar heat of vaporization?

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30. (i) What is sublimation? (ii) Define molar heat of sublimation.

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31. Define heat of transition?

Watch Video Solution

32. How do you measure the enthalpy of formation of carbon monoxide?

Watch Video Solution

33. What are the Important features of lattice enthalpy?

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34. Why there is need for second law of thermodynamics? Give its importance.

Watch Video Solution

35. Write the entropy statement of second law of thermodynamics.

Watch Video Solution

36. State Clausius form of the second law of thermodynamics.

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37. What are spontaneous reaction? Give three examples for spontaneous reaction.

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38. Calculate the standard entropy of formation ΔS_f° of $CO_{2_{(g)}}$. Given the standard entropies of $CO_{2_{(g)}}, C_{(s)}, O_{2_{(g)}}$ as $218.8, 8.740$ and $205.60 Jk^{-1}$ respectively.

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39. What is entropy of fusion?

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40. What is entropy of Vaporization?

Watch Video Solution

41. Define entropy of transition.

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42. Explain the following:

(i)Out of diamond and graphite, which has greater entropy? Why?

(ii) From thermodynamic point of view, in which system the animals and plants belong?

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43. What is the condition spontaneity in terms of free energy change?

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44. Why standard entropy of an elementary substance is not zero whereas standard enthalpy of formation is taken as zero?

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45. The equilibrium constant for a reaction is one or more if $\Delta G^{\ominus}$ for it is less than zero.Explain .

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46. Many thermodynamically feasible reactions do not occur under ordinary conditions. Why ?

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47. Predict in which of the following , entropy increases or decreases .

(i) A liquid crystallizes into a solid

(ii)Temperature of a crystallized solid is raised from 0 K to 115 K

(iii)$2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$

(iv)$H_{2(g)} \rightarrow 2H_{(g)}$

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Additional Questions Solved 5 Mark Questions

1. Explain how heat absorbed at constant pressure is measured using coffee calorimeter with neat diagram.

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2. List the characteristics of entropy.

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3. Explain about the characteristics of work.

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4. Write the relationship between Permutation and Combination?

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5. Write the various definition of first law of thermodynamics.

Watch Video Solution

6. Derive the various mathematical statements of the first law.

Watch Video Solution

7. What are the characteristics of enthalpy?

Watch Video Solution

8. What are thermochemical equation? What are the conventions adopted in writing thermochemical equation?

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9. Calculate the values of ΔU and ΔH for an ideal gas in terms of C_P and C_V.

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10. Suggest and explain an indirect method to calculate lattice enthalpy of magnesium bromide.

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11. The standard free energy change $\left(\Delta G^{0}\right)$ is related to equilibrium constant (K) as ____

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