PRAADIS EDUCATION

CHEMISTRY XI

THERMODYNAMICS

OBJECTIVE QUESTIONS

Thermodynamic Terms

1. Which of the following property cannot be used to describe the state of a system?
a) pressure
b) volume
c) temperature
d) universal gas constant

Answer: d
Explanation: State functions are used to specify the state of a thermodynamic system. The state is described by measurable macroscopic particles like pressure, temperature, volume, amount, etc and the is P, V and T are called state variables.

2. When work is done on system or by a system there is a change in _____
a) external energy
b) internal energy
c) adiabatic energy
d) isothermal energy

Answer: b
Explanation: When a work is done or by the system, heat passes into out of the system and matter enters or leaves the system, there is a change in internal energy of the system. It is represented by the symbol “U”.

3. The system that does not allow the heat to pass through its boundary between the system and surroundings is called as _____ system.
a) adiabatic
b) open
c) isothermal
d) close

Answer: a
Explanation: An adiabatic system does not allow the exchange of heat between system and surroundings. Energy is transferred to the surrounding only through work Done. In the adiabatic process, the total energy is given as zero.

4. In an adiabatic process the work done is 50 KJ, what is its internal energy?
a) 50 KJ
b) 25 KJ
c) -50 KJ
d) -25 KJ

Answer: c
Explanation: The total energy in an adiabatic process is zero, so internal energy is equal to the negative of the work done. Here work done is given by 50 kilojoules, so the internal energy is -50 kilojoules as the sum of internal energy and the work done should be zero.

5. An adiabatic process pressure is related to volume as _____
a) PV = constant
b) PV^{γ} constant
c) PV^3 constant
d) PV^2 constant

Answer: b
Explanation: Let P is pressure and V is volume whereas Gamma is the ratio of specific heat capacity at constant pressure and volume. The

relation between pressure and volume in an adiabatic process is given by PV^{γ} constant.

6. The first law of thermodynamics states that the energy of an isolated system is constant.
a) true
b) false

Answer: a
Explanation: The first law of thermodynamics is commonly stated as the law of conservation of energy that is energy can neither be created nor be destroyed, in other terms we can also say that the energy of an isolated system is constant.

7. An open system allows the transfer of _____
a) only mass
b) only energy
c) both mass and energy
d) neither mass nor energy

Answer: c
Explanation: An open system allows the transfer of both mass and energy into the system from the surroundings. An example of an open system is the human body, we consume food, energy and excrete waste.

8. Both isolated and closed systems are the same.
a) True
b) False

Answer: b
Explanation: An open system allows only energy transfer whereas an isolated system neither allows energy nor mass transfer through the system from the surroundings. Isolated and closed systems are not the same. So the above statement is false.
9. If the work is done on an adiabatic wall, then which of the following is true?

a) $\Delta U = -W$
b) $\Delta U = W$
c) $\Delta U + W = 0$
d) $\Delta U = -W$

Answer: b
Explanation: In an adiabatic process, the total energy is always zero. We have that $\Delta H = \Delta U + W$, as ΔH is zero, we get $\Delta U + W = 0$; $\Delta U = -W$. But as work is done on the system by observing no heat W becomes negative, so $\Delta U = -(-)W = W$. Hence $\Delta U = W$.

10. The temperature of an object increases slowly, then the energy of that object _____
a) increases slowly
b) decreases quickly
c) increases quickly
d) decreases slowly

Answer: a
Explanation: Energy of a substance is directly proportional to its temperature. As we know that heat energy of a substance is $q = mc\Delta T$. If the temperature increases slowly then the energy also increases slowly.

Thermodynamics Applications

1. When an ideal gas is compressed in a piston using 5 atm of pressure through a 50-metre cube of volume, what is the amount of work done?
a) 10 Newton metre
b) 0.1 Newton metre
c) 250 Newton metre
d) 55 Newton metre
View Answer
Answer: c
Explanation: When a pressure P is exerted through a volume V the work done is given by $P \Delta V$, so here pressure is 5 atm and volume is a 50-

metre cube. The work that is done is 5 atm X 50-metre cube = 250 Newton metre.

2. When the pressure of 3 atm is exerted over a surface area of a 10-metre square, what is a force that is applied?
a) 30 Newton
b) 3.33 Newton
c) 0.33 Newton
d) 0.3 Newton
View Answer
Answer: a
Explanation: Force is defined as the product of pressure and the surface area so here as pressure is 3 atm and surface area is 10-metre square. The force that is applied equals 3 atm x 10-metre square = 30 Newton.

3. Expansion of gas under zero pressure is free expansion.
a) True
b) False
View Answer
Answer: a
Explanation: The expansion of a gas in a vacuum without pressure is called free expansion. During the free expansion of gas, the work is not done whether the process is reversible or Irreversible. So the above statement is considered to be true.

4. 6 litres of an ideal gas expands isothermally at a temperature of 300 Kelvin up to 10 litres at a pressure of 5 atm, what is the work done?
a) 30 Newton metre
b) 80 Newton metre
c) 50 Newton metres
d) 20 Newton metre
View Answer

Answer: d
Explanation: The expression for work done is given by pressure x volume difference, here an ideal gas has a volume difference of 4 litres at 5 ATM pressure. So the work done = 10 – 6 liters x 5atm = 20 Newton metre.

5. Which of the following is an intensive property?
a) Volume
b) Colour
c) Enthalpy
d) Internal energy
View Answer
Answer: b
Explanation: An intensive property does not depend on the quantity or size of the object, whereas extensive property depends on the quantity and size of the object. Here volume, enthalpy and internal energy are extensive properties, while colour is an intensive property.

6. The value of the product of a universal gas constant and the temperature difference is given by 10 kJ/mol at 1 mole and the internal energy is given by 20 KJ, what is the enthalpy of this system in KJ?
a) 30
b) 10
c) 20
d) 200
View Answer
Answer: a
Explanation: We know that $\Delta H = \Delta U + nR\Delta T$; where ΔH is the enthalpy, ΔU is the internal energy, n is the number of moles, R is the universal gas constant and ΔT is the temperature difference. So enthalpy is 10 KJ + 20KJ = 30 KJ.

7. What is the difference in heat capacities at constant volume and pressure?
a) Universal volume constant

b) Universal gas constant
c) Universal pressure constant
d) Universal temperature constant
View Answer
Answer: b
Explanation: We all know that $\Delta H = \Delta U + nR\Delta T$; $\Delta H = nC_P\Delta T$ and $\Delta U = nC_v\Delta T$; $\Delta H - \Delta U = nC_P\Delta T - nC_v\Delta T = n(C_P - C_V)\ \Delta T$. By equating L.H.S. and R.H.S., we get $n(C_P - C_V)\ \Delta T = nR\Delta T$; $C_P - C_V = R$. Hence it's proven that difference of heat capacities at constant volume and pressure is the universal gas constant.

8. Write temperature difference in terms of heat capacity and heat energy?
a) $\Delta T = q/C$
b) $\Delta T = qC$
c) $\Delta T = C/q$
d) $\Delta T = qm/C$
View Answer
Answer: a
Explanation: As we know that $q = C\Delta T$, where q is the heat energy, C is the specific heat and ΔT is the temperature difference, When the temperature difference is expressed in terms of the heat capacity and heat energy, it is given as $\Delta T = q/C$.

9. If gas is expanded freely from 1 litre to 5 litres at a temperature of 60-degree centigrade what is the work done?
a) Positive
b) Negative
c) 0
d) Infinity
View Answer
Answer: c
Explanation: When gas is expanded freely in a vacuum there is zero pressure exerted. The formula for work done is given by pressure X change in volume = 0 x 4. So the work done is zero in the process of free expansion.

10. The specific heat at constant pressure is given by the expression _____

a) $C_V = dq/dT$
b) $C_P = dq/dT$
c) $C_V = dqdt$
d) $C_P = dq/dt$

View Answer

Answer: b

Explanation: As we know that dq = CdT; where q is the heat energy, C is the specific heat and T is the temperature. At constant pressure, specific heat is given as C_P. The specific heat at constant pressure is given by the expression $C_P = dq/dt$.

Measurement of ΔU and ΔH: Calorimetry

1. Bomb calorimeter is _____ in nature.

a) isothermal
b) isochoric
c) isobaric
d) absolute

Answer: b

Explanation: ABomb calorimeter works at constant volume, so it is isochoric in nature. Here, the heat energy that's measured is only the internal energy. The work done is zero because of no change in volume.

2. If an exothermic reaction occurs in a Bomb calorimeter then the temperature of the water bath _____

a) increases
b) decreases
c) remains constant
d) cannot predict

Answer: a
Explanation: In a Bomb calorimeter, the reaction occurs in a vessel and that is surrounded by the water bath. If it is an exothermic reaction the temperature rises and if it is an endothermic reaction the temperature decreases. Temperature can be measured using a thermometer.

3. Heat capacity of a Bomb calorimeter is given by _____
a) C_V
b) C_P
c) C_M
d) C_B

Answer: a
Explanation: A bomb calorimeter operates at a constant volume i.e. it is an isochoric process. So the heat capacity is C_V which represents heat capacity at constant volume. While C_P represents heat capacity at constant pressure.

4. Bomb calorimeter is used to determine _____
a) molar heat capacity
b) heat of combustion
c) rate kinetics
d) affinity

Answer: b
Explanation: A bomb calorimeter is used to measure the heat of combustion of a reaction. It has to withstand a large amount of pressure, in order to determine the heat of combustion. It is an isochoric process and the heat energy is equal to the internal energy.

5. “c” the specific heat capacity of a substance is given by temperature difference is given by ΔT and the heat energy is given by Q then what is the mass of the substance?
a) $Q/c\Delta T$
b) $c\Delta T /Q$
c) $Qc\Delta T$

d) QΔT

Answer: a
Explanation: Heat energy of a substance is denoted by Q and is given by the expression mcΔT, where m is a mass of the substance, c is a specific heat capacity and ΔT is temperature difference, so the mass of the substance is Q/cΔT.

6. During the process of conversion of ice into the water, the specific heat capacity is given by _____
a) 0
b) positive
c) infinity
d) negative

Answer: c
Explanation: During the phase change of a substance the temperature change is zero. As we know that specific heat capacity = Q/cΔT which is zero; specific heat capacity becomes infinity, so during the process of conversion of ice into the water, the specific heat capacity is infinity.

7. What is the value of specific heat capacity in the adiabatic process?
a) 0
b) infinity
c) positive
d) negative

Answer: a
Explanation: During an adiabatic process the change in total energy is zero, As we know that the specific heat capacity is given by the total heat required by mass X change in temperature, heat energy is zero the specific heat capacity becomes zero.

8. When 1 kg of water at 373 k, is converted into steam how much amount of heat energy is required?
a) 22600 KJ

b) 226 KJ
c) 2260 KJ
d) 22.6 KJ

Answer: c
Explanation: The latent heat of vaporization of water is 2260 KJ/Kg. The heat that is required to convert water at 373 k to steam is given by Q = mL, where m = mass of the water and L = latent heat vaporization of water; heat energy required = 1 kg x 2260 KJ/Kg = 2260 KJ.

9. The total heat energy utilized for increasing the temperature by 4 degrees Kelvin in a 3 kgs substance is 100 KJ what is the specific heat capacity of that substance?
a) 8.34 KJ/g-k
b) 8.34 KJ/Kg-k
c) 8.34 KJKg-k
d) 8.34 KJ/Kg

Answer: b
Explanation: The formula of heat energy is given by the expression: $Q = mc\Delta T$, m is the mass of the substance, c is the specific heat capacity and ΔT is the temperature difference. $c = Q/m\Delta T$; $c = 100KJ/3kg(4k) = 8.34$ KJ/Kg-k.

10. The enthalpy, internal energy during a process and change in volume are 500 units, 400 units, and 2 units. What is the pressure that is exerted on the gas during this process?
a) 20 units
b) 80 units
c) 100 units
d) 50 units

Answer: d
Explanation: We know that $\Delta H = \Delta U + P\Delta V$; ΔH is the enthalpy, ΔU is the internal energy, ΔV is the change in volume and P is the pressure. So by substituting the enthalpy, internal energy during a process and change

in volume as 500 units, 400 units and 2 units, we get pressure as 50 units.

Enthalpy Change, ΔrH of a Reaction – Reaction Enthalpy

1. The standard state of a substance is considered when the temperature is 298 k and the pressure is _____
a) 1 ATM
b) 1 bar
c) 1 Pascal
d) 760 mm HG

Answer: b
Explanation: All the standard states of a substance are considered when the temperature is 298 Kelvin and the pressure is 1 bar. 1 bar = 0.987 atmospheric pressure = 10000 Pascal = 750.0617 mm of Mercury.

2. All the enthalpies of fusion are positive.
a) true
b) false

Answer: a
Explanation: Fusion is a process of conversion of liquid to solid the enthalpy is energy that is required for a process. As the melting of a solid is endothermic, the enthalpies of fusion are positive so the above statement is true.

3. Consider that, a ball is immersed in water at room temperature and then taken out having 18 grams of water on it, how much amount of energy is required to dry that water at room temperature?
a) 41.43 KJ/mol
b) 49.53 KJ/mol
c) 41.3 KJ/mol
d) 41.53 KJ/mol

Answer: d
Explanation: Heat required to eliminate water : n x $\Delta_{vap}H^{-}$ = (1 mol) × (44.01 kJ mol^{-1}) = 44.01 kJ mol^{-1}. Δ_{vap}or = $\Delta_{vap}H$ – ΔnRT = 44.01 kJ mol^{-1} – 1×8.314 J/K-mol x 298 k x 10^{-3} = 41.53 KJ/mol. So the amount of energy needed is 41.53 KJ/mol.

4. Calculate the internal energy change when 2 moles of water at 0 degrees converts into ice at 0-degree centigrade?
a) 12 KJ per mole
b) 6 KJ per mole
c) 1 KJ per mole
d) 102 KJ per mole

Answer: a
Explanation: Energy change when 1 mol of water at 0-degree centigrade changes into ice at 0 degrees in centigrade is 6 kJ/mol, So the internal energy change when 2 moles of water at 0 degrees converts into ice at 0 degrees is 12 kJ/mole.

5. What is a change in energy if 18 grams of water is heated from room temperature to 20 degrees above it?
a) 1.50 KJ
b) 0.506 KJ
c) 1.06 KJ
d) 1.506 KJ

Answer: d
Explanation: We know that Q = msΔT, where Q is the energy,m is the mass of water, s is the specific heat of water and T is the temperature. So the change in energy required here = 18 g x 4.184 J/g-K x 20K = 1.506KJ.

6. When a chemical reaction is reversed the value of enthalpy is reversed in sign.
a) true

b) false

Answer: a
Explanation: For example, the formation of ammonia has an enthalpy of -91.8 KJ per mole and the decomposition of ammonia has an enthalpy of + 91.8 KJ per Mol. So the above statement that when a chemical reaction is reversed the value of enthalpy is reversed in the sign is true.

7. Consider the equation $2\ H_2 + O_2 \rightarrow 2\ H_2O$, what does the 2 in the coefficient of H_2O molecule represent?
a) number of particles
b) the number of molecules
c) number of moles
d) number of atoms

Answer: c
Explanation: In a balanced thermochemical equation, the coefficients always refer to the number of the moles (but never molecules) of reactants and products involved in a reaction so 2 in the coefficient of H_2O refers to the number of the moles of water.

8. What is the unit of standard enthalpy of fusion or molar enthalpy of fusion?
a) KJ Mol
b) KJ per Mol
c) Mol per KJ
d) 1/KJ Mol

Answer: b
Explanation: The enthalpy change that occurs during melting of one mole of a solid substance in the standard state is called standard enthalpy of fusion or molar enthalpy of fusion, it is represented by the symbol $\Delta_{fus}H^{-}$, the units of this are KJ per Mol.

9. Which of the following is not an application of Hess's law?
a) determination of heat of formation

b) determination of heat of transition
c) determination of Gibb's energy
d) determination of heat of hydration

Answer: c
Explanation: The following are the applications of Hess's law; determination of heat of formation, determination of heat of transition and determination of heat of hydration, also to calculate bond energies.

10. $\Delta H_r = \Sigma \Delta H_f[\text{products}] - \Sigma \Delta H_f[\text{reactants}]$.
a) true
b) false

Answer: a
Explanation: The equation $\Delta H_r = \Sigma \Delta H_f[\text{products}] - \Sigma \Delta H_f[\text{reactants}]$ says that the enthalpy of a reaction is the difference between the enthalpy of products and enthalpy of reactants. The above statement regarding enthalpy is true.

Enthalpies for Different Types of Reactions

1. Enthalpy of combustion as always _____
a) positive
b) negative
c) 0
d) infinity

Answer: b
Explanation: Enthalpy of combustion is the enthalpy change that takes place when one mole of a compound undergoes complete combustion in the presence of oxygen. It is represented by ΔHc, it is always negative because the process of combustion is exothermic.

2. Calculate the heat of combustion of ethane, in the reaction $C_2H_{6(g)} + 3\ 1/2O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ where the heats of formation of ethane gas, carbon dioxide gas and water liquid are –84.7 kJ mol^{-1}, -393.5 kJ mol^{-1} and –285.8 kJ mol^{-1} respectively.
a) -1559.7 kJ mol^{-1}
b) -155.7 kJ mol^{-1}
c) -159.7 kJ mol^{-1}
d) -559.7 kJ mol^{-1}

Answer: a
Explanation: Given that $C_2H_6(g) + 3\ 1/2\ O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ As we know that, $\Delta Hr = \Sigma\ \Delta H_f[products] – \Sigma\ \Delta H_f[reactants]$; $\Delta H_c(C_2H_6)$ = 2 X (-393.5 kJ mol^{-1}) + 3 X (-285.8 kJ mol^{-1}) – (- 84.7 kJ mol^{-1}) – 2 X (0 kJ mol^{-1}) = $\Delta H_c(C_2H_6)$ = – 1559.7 kJ mol^{-1}.

3. The enthalpy of 435 KJ per Mol is obtained from the conversion of hydrogen molecule into two hydrogen atoms.
a) True
b) False

Answer: a
Explanation: The enthalpy change that occurs when one mole of a molecule breaks into its atoms is known as enthalpy of atomization. The energy released during the conversion of a hydrogen molecule into two hydrogen atoms is enthalpy of atomization.

4. In which of the following reactions the energy released is not an enthalpy of atomization?
a) decomposition of a hydrogen molecule into two hydrogen atoms
b) decomposition of an oxygen molecule into 2 oxygen atoms
c) formation of a water molecule
d) decomposition of chlorine molecule

Answer: c
Explanation: The enthalpy of atomization is an enthalpy change that occurs when one molecule of a molecule breaks into its atoms, but here

the of a water molecule formation does not satisfy the definition of the enthalpy of atomization.

5. In case of the decomposition of hydrogen molecule into two hydrogen atoms, the enthalpy of atomization is same as the _____
a) bond dissociation enthalpy
b) enthalpy of formation
c) enthalpy of combustion
d) enthalpy of sublimation

Answer: a
Explanation: In case of the decomposition of hydrogen molecule the enthalpy is the same as enthalpy of atomization as well as bond dissociation enthalpy because the bond association enthalpy refers to the breakage of H-H Bond. So that two hydrogen atoms are formed whereas enthalpy of atomization is the breakage of hydrogen molecules in order to form two atoms.

6. Calculate the carbon carbon double bond energy in ethane from the following reaction, $H_2C{=}CH_2(g) + H_2(g) \rightarrow H_3C{-}CH_3(g)$ $\Delta H = -138$ kJ/mol. If Bond enthalpies are: C−C = 348; H−H = 436; C−H = 412 in KJ/mol.
a) 498 KJ/mol
b) 593 KJ/mol
c) 508 KJ/mol
d) 598 KJ/mol

Answer: d
Explanation: By following the rule $\Delta H_r = \Sigma\, \Delta H_f[\text{products}] - \sum \Delta H_f[\text{reactants}]$, we get $-(x + 4(412) + 432) + (348 + 6(412)) = -138$ KJ/mol; x = 598 KJ/mol. So the carbon carbon double bond energy in Ethane is given as 598 KJ per Mol.

7. Decomposition of sodium chloride into a sodium ion and chloride ion releases energy of 788 KJ per Mol, what is the energy called?
a) lattice energy

b) translation energy
c) dilution energy
d) neutralization energy

Answer: a
Explanation: Lattice enthalpy is the enthalpy change when one molecule of an ionic compound dissociates into its ions and gaseous state. Here sodium chloride is an ionic compound and it decomposes into sodium and chloride ions, so the energy released is lattice energy.

8. Which of the following cycle allows has to analyze reaction energies?
a) carbon cycle
b) born Haber cycle
c) nitrogen cycle
d) chemical cycle

Answer: b
Explanation: An indirect method, in which we can construct an enthalpy diagram is called a Born-Haber cycle as it is nearly impossible to determine lattice enthalpies directly by experiment. It is an approach to analyze reaction energies.

9. Enthalpy of solution can either be positive or _____
a) negative
b) does not exist
c) 0
d) infinity

Answer: a
Explanation: Enthalpy change when 1 mole of a substance is dissolved in a large excess of solvent so that on further delusion no appreciable heat change occurs, is known as enthalpy of solution. It can either be positive or negative depending on the reaction, whether it is exothermic or endothermic.

10. The enthalpy of dilution of a solution is _____ on the original concentration of the solution and the amount of solvent added.
a) dependent
b) independent
c) may be dependent
d) may be independent

Answer: a
Explanation: Enthalpy of dilution is the enthalpy change when 1 mole of a substance is diluted from one concentration to another. So it is dependent on your original concentration of the solution and the amount of solvent added

Spontaneity

1. Which of the following is not a spontaneous process?
a) sugar dissolves in water
b) melting of iron
c) rusting of iron
d) evaporation of water

Answer: b
Explanation: A physical or chemical process which occurs by its on in a particular direction under a particular set of conditions without any force is known as a spontaneous process and it cannot be reversed. Here melting of iron is only possible when we supply a large amount of heat so it is not a spontaneous process.

2. Spontaneous reactions that occur or mostly _____in nature.
a) endothermic
b) exothermic
c) both endothermic and exothermic
d) neither exothermic nor endothermic

Answer: b
Explanation: All the processes which occur with a decrease of energy are exothermic in nature, those with change of enthalpy as negative occurs spontaneously. It is not true in case of some endothermic reactions, when they occur spontaneously.

3. Entropy increases for a spontaneous reaction.
a) true
b) false

Answer: a
Explanation: A process is spontaneous if and only if the entropy of Universe increases for a process to be spontaneous $\Delta S(universe) > 0$. At equilibrium, $\Delta S = 0$. Saudi about the statement that the Entropy increase for a spontaneous reaction is true.

4. Entropy is an _____ property.
a) intensive
b) extensive
c) neither intensive or extensive
d) both intensive and extensive

Answer: b
Explanation: Entropy is a measurement of randomness or disorder of molecules it is a state function as well as an extensive property. Its units are J/K-mole. Extensive property depends on the size and quantity of the mass.

5. Which of the following relation is true between Gibbs energy, enthalpy, temperature, and entropy?
a) G = H -TS
b) G = H -T
c) G = H -S
d) G = -TS

Answer: a
Explanation: The energy that is available for a system at some conditions and by which useful work can be done is Gibbs free energy. The relation between Gibbs free energy, enthalpy, temperature and entropy is given by Gibbs Helmholtz equation; G = H -TS.

6. Reaction is spontaneous if Gibbs free energy is _____
a) greater than zero
b) equal to zero
c) less than zero
d) infinity

Answer: c
Explanation: A reaction is spontaneous if Gibbs free energy is less than zero and the reaction is nonspontaneous if the Gibbs free energy is greater than zero. The reaction is at equilibrium state if gives free energy is equal to zero.

7. If the enthalpy is positive and entropy is negative, what do you understand about Gibbs free energy?
a) it is positive
b) negative
c) may be negative
d) may be positive

Answer: a
Explanation: According to the Helmholtz equation; G = H -TS, when enthalpy H is positive and entropy S is negative, the Gibbs free energy is always positive and the reaction is not spontaneous at all temperatures.

8. The entropy of the universe is always increasing is _____
a) zeroth law of thermodynamics
b) first law of thermodynamics
c) second law of thermodynamics
d) third law of thermodynamics

Answer: b
Explanation: The second law of thermodynamics is given as the entropy of the universe is always increasing in the course of every spontaneous or natural change also can be said as the heat cannot flow itself from a colder to a hotter body.

9. Third law of thermodynamics is only applicable for perfectly crystalline substances.
a) true
b) false

Answer: a
Explanation: We can define the third law of thermodynamics entropy of a perfectly crystalline substance at zero kelvin or absolute zero is taken to be zero, but this is not applicable if there is any Imperfection at 0 k, the entropy will be larger than 0.

10. $\Delta S(universe) > 0$ can also be written as _____
a) $\Delta S(system) + \Delta S(surroundings) > 0$
b) $\Delta S(surroundings) > 0$
c) $\Delta S(system)$
d) $\Delta S(system) - \Delta S(surroundings) > 0$

Answer: a
Explanation: $\Delta S(universe) > 0$ can also be written as $\Delta S(system) + \Delta S(surroundings) > 0$, as the universe is nothing but the system and surroundings. The above mentioned condition is used when a reaction is at equilibrium.

Gibbs Energy Change and Equilibrium

1. Find out whether the following reaction is spontaneous or not at 127 degrees centigrade? $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$; $\Delta H = 92.22$ kJ/mol and $\Delta S = -198.75$ J/K-mol.
a) it is spontaneous
b) it is not spontaneous

c) it may be spontaneous
d) cannot predict

Answer: b
Explanation: We have $\Delta G = \Delta H - T\Delta S$; by substituting ΔH = 92.22 kJ/mol and ΔS = -198.75 J/K-mol, we get ΔG = 92.22 kJ/mol – 400k(-198.75 J/K-mol) = 92.22 kJ/mol + 79.5 kJ/mole = 171.72 KJ/mol. As Gibbs free energy is positive the reaction is non spontaneous.

2. Calculate the Gibbs free energy for the reaction of conversion of ATP into ADP at 293 Kelvin the change in enthalpy is 19.07 Kcal and the change in entropy is 90 cal per Kelvin.
a) 7.3 cal
b) -5.3 Kcal
c) 7.3 Kcal
d) -7.3 Kcal

Answer: d
Explanation: We have $\Delta G = \Delta H - T\Delta S$; by substituting ΔH = 19.07 kcal and ΔS = 90 cal/K, we get ΔG = 19.07 Kcal – 293(90 cal/K) = 19.07 Kcal – 26.37 Kcal = -7300 cal = -7.3 Kcal. The Gibbs free energy change is -7.3 Kcal.

3. In a reaction, the change in entropy is given as 2.4 cal/K and the change in Gibbs free energy is given as 3.4 kcal, calculate the change in heat at the temperature of 20-degree centigrade?
a) 3.4 kcal
b) 3.4 cal
c) 3.4 kJ
d) 3.4 J

Answer: a
Explanation: Using the equation $\Delta G = \Delta H - T\Delta S$, where G is represented by the Gibbs free energy, H is represented by the change in enthalpy, T is represented by the temperature and S is represented by the entropy. $\Delta H = \Delta G + T\Delta S$ = 3.4 kcal – 293 x 2.4 cal/K = 3.4 kcal.

4. The melting of ice into liquid water is an example of tube _____ reaction.
a) endergonic
b) exergonic
c) exothermic
d) endothermic

Answer: a
Explanation: An unfavorable reaction or a nonspontaneous reaction that requires more energy than we get from that reaction is called endergonic reaction. It observes heat from surroundings and the change in entropy decreases it is also a type of endothermic reaction.

5. Which of the following is not a type of exergonic reaction?
a) formation of table salt from Sodium and chlorine
b) combustion reaction
c) chemiluminescence
d) photosynthesis

Answer: d
Explanation: A reaction that is spontaneous and favorable is known as an exergonic reaction, it releases energy into the surroundings. The system's free energy decreases here. The Gibbs free energy of an exergonic reaction is negative.

6. The Gibbs free energy is positive when a change in enthalpy and change in entropy are positive at _____
a) high temperatures
b) low temperature
c) all temperatures
d) only at 0 Kelvin

Answer: b
Explanation: When a change in entropy and the change in enthalpy are positive the Gibbs free energy is positive at low temperatures and

negative at high temperatures. We can obtain this through the equation $\Delta G = \Delta H - T\Delta S$.

7. Calculate the Gibbs free energy for the conversion of oxygen to Ozone at room temperature if KP is given as 2.47×10^{-29}.
a) 163 kJ/mol
b) 163 J/mol
c) 163 kJ
d) 163 k/mol

Answer: a
Explanation: The chemical equation for the conversion of oxygen to Ozone is $3/2O_2 \rightarrow O_3$. We have the equation, $\Delta G = -2.303\ RT \log Kp$. So by substituting we get $\Delta G = -2.303 \times 8.314$ J/K-mol x 293K x $2.47 \times 10^{-29} = 163000$ J/mol = 163 kJ/mol.

8. In the equation, $\Delta G = -2.303\ RT \log K$, what is K?
a) change in temperature
b) kelvin
c) equilibrium constant
d) change in enthalpy

Answer: c
Explanation: In the above equation $\Delta G = -2.303\ RT \log K$, G is the change in standard Gibbs free energy, R is the universal gas constant, T is temperature, K is the equilibrium constant while log stands for the logarithm of base 10.

9. What is the relation between Gibbs free energy and the EMF of the cell?
a) $\Delta G = -nFE_{cell}$
b) $G = -nFE_{cell}$
c) $\Delta G = -nE_{cell}$
d) $\Delta G = -nF_{cell}$

10. Write 1 Faraday in terms of coulombs.
a) 96500 C
b) 95600 C
c) 9560 C
d) 9650 C

Answer: a
Explanation: Faraday is a unit which has no dimensions and it represents electric charge quantity. In the International System of units, it’s coulombs. 1 Faraday is equal to 96500 coulombs. F represents Faraday constant.