1. Definition of pressure is
   a. force per unit area  b. momentum per unit time  c. mass per volume  d. temperature per unit time

2. SI unit of pressure is
   a. bar  b. atmosphere  c. Pascal  d. Torr

3. Pressure exerted by a person weighing "m" kilograms when wearing skates of total area of crosssection 5 cm² is, (g is the acceleration due to gravity)
   a. \( \frac{mg}{5 \times 10^{-4}} \text{Pa} \)  b. \( \frac{mg}{5} \text{Pa} \)  c. \( \frac{mg}{5 \times 10^{-2}} \text{Pa} \)  d. \( \frac{mg}{5} \text{Pa} \)

4. The pressure exerted by a column of fluid of density \( \rho \) and height \( h \) on the surface of the moon, with acceleration due to gravity on the moon \( \frac{g}{5} \) is
   a. \( \rho gh \)  b. \( \rho gh/5 \)  c. \( 5\rho gh \)  d. \( \rho gh^2 \)

5. Celsius scale \( (t/°C) \) can be converted to the corresponding value in the absolute scale of temperature \( \text{(Kelvin) (T/K)} \) by adding
   a. 200  b. 273.15  c. 273  d. 1/273.15

6. According to Boyle's Law, the pressure \( 'p' \), temp \( 'T' \), and volume \( 'V' \) are related as
   a. \( pV = \text{const} \)  b. \( \frac{p}{V} = T \)  c. \( p\frac{V}{n} = RT \)  d. \( p\frac{V}{n} = RT \)

7. Real gases may obey Boyle's Law at
   a. low pressure  b. high pressure  c. low temperatures  d. never

8. If the pressure and volume of an ideal gas are 1 atm, and 25 liters at 25 °C, the volume at 25 °C and 10 atm is
   a. 2.0 liters  b. 250 liters  c. 2.5 liters  d. 4 liters

9. If a particle of mass \( 'm' \) is moving with a velocity \( 'v' \) hits a wall the change in the momentum of the particle is
   a. \( 2mv \)  b. \(-2mv \)  c. 0  d. \( mv \)  e. \(-mv \)

10. The RMS speed of gas molecules increases with
    a. increase in temperature  b. decrease in temperature  c. high mol. mass

11. Charles' law states that for a gas at constant pressure, volume \( 'V' \) and temperature \( 'T' \) are related as
    a. \( V \propto T \)  b. \( V \propto 1/T \)  c. \( V \propto T^2 \)  d. \( TV = \text{constant} \)

12. The statement that equal volumes of gases at the same temperature and pressure contain equal number of particles is

13. The pressure \( 'p' \), volume \( 'V' \), temperature \( 'T' \) and the number of moles of a gas \( 'n' \) are related as
    a. \( p\frac{V}{n}T = \text{constant} \)  b. \( npV = T \)  c. \( p\frac{V}{n} = T \)  d. \( p\frac{V}{n} = T \)

14. A gas sample occupies a constant volume of 25 liters at 300 K and 500 kPa. The pressure exerted by the gas when temperature is raised to 500 K is
    a. \( 8.33 \times 105 \text{ Pa} \)  b. 600Pa  c. 8330 kPa  d. 500 kPa
15. If an ideal gas occupies 24.93553 liters of volume at 100 kPa and 300 K, the number of moles of the gas are
   a. 2.2        b. 9.6        c. 1.0        d. 0.1

16. If a mixture of ideal gases contains n1 moles of component '1' n2 moles of component 2 at temperature T and occupies a volume 'V', the total pressure exerted by the mixture is
   a. n1n2RT/V     b. (n1+n2)RT/V   c. (n1 - n2)RT/V   d. n1/n2RT/V

17. A gas mixture contains 10% by weight component A and the remaining component B, with a total pressure of 1 atm. The ratio of partial pressures of A and B is, when molecular weight of A equals that of B
   a. 1/10        b. 1/90        c. 1/9        d. 9

18. A mixture of two gases A and B exerts a total pressure of 1 atm. If the mole fraction of A is 0.2 the partial pressure exerted by B is
   a. 0.2 atm     b. 0.8 atm     c. 0.4 atm     d. 0.6 atm

Chapters 3-4

Self-Tests

1. Certain gas mixture consisting of 1 mol of oxygen and 3 mol of nitrogen exerts a total pressure of 1 atm. The partial pressure of oxygen, in the mixture is
   a. 0.5 atm   b. 0.33 atm   c. 0.25 atm   d. 1 atm   e. None of these

2. Differential of ln(T) is (i.e. d ln(T) = )
   a. 1/T   b. -(1/T)   c. (1/T)dT   d. -(1/T)dT   e. None of these

3. For an ideal gas, the coefficient of volume expansion \( \frac{1}{V} \frac{\partial V}{\partial T} \) is
   a. nR/T   b. pV/nR   c. 1/T   d. T/V   e. None of these

4. Three gases occupy equal volumes separated by movable walls. The initial pressures are \( P_1 \); \( P_2 \); and \( P_3 \). Then, the walls between these three compartments were removed and the gases have been mixed, so that they occupied all the volume. What will be the total pressure of the gas mixture?
   a. 3(P1+P2+P3);   b. (P1+P2+P3);   c. 1/3(P1+P2+P3);   d. largest of P1, P2 and P3.

5. What is the ratio of the root mean square velocity \( C_{\text{rms}} \), and most probable velocity \( C_{\text{mp}} \) of a gas molecule?
   a. \( \sqrt{3} \);   b. 1.5   c. \( \sqrt{2/3} \)   d. \( \sqrt{3/2} \)

6. If gas has density \( \rho \), and pressure \( p \), its average velocity \( C_{\text{rms}} \) in term of density and pressure is:
   a. \( \sqrt{3 \rho / p} \)   b. \( \sqrt{3 \rho p} \)   c. \( \sqrt{2 \rho / p} \)   d. \( \sqrt{3 \rho p} \)

7. Units of compressibility factor \( \kappa \) ("kappa") for liquids is
   a. kg/cm\(^2\)   b. N/m\(^2\)   c. kg/m s\(^2\)   d. atm\(^{-1}\)

8. The average time required for a perfume molecule (vapor) of \( M = 0.1 \) kg/mol to travel a distance of 5 m at room temperature \( (T = 300 \text{ K}) \) is about
   a. 0.002 s   b. 0.02 s   c. 0.2 s   d. 2 s   e. 20 s.

9. The time needed for the above perfume molecule to reach a sensitive nose at 5 m away is
   a. same time as above   b. in shorter time   c) in longer time   d) never

10. Temperature at which the distinction between gas and liquid vanishes
11. At high altitudes the air is richest in
   a. heavier gases   b. nitrogen   c. CO₂ d. None of these

12. If a and b are the molecular weights of two gases in a mixture and a>b, then the average
    velocities Ca, Cb of these molecules, respectively, are related as
   a. Ca = Cb   b. Ca/Cb = 1c. Ca > Cb   d. Ca < Cb

13. If two gas samples A, and B are at temperatures Ta, Tb and Ta>Tb then the velocities Ca,
    Cb of the gas samples, respectively, are related as
   a. Ca = Cb   b. Ca/Cb = 1c. Ca > Cb   d. Ca < Cb

14. At higher temperatures the width of Maxwell distribution becomes
   a. broader   b. sharper   c. no change   d. taller and shaper

15. The width of Maxwell distribution for heavier gases, when compared to lighter ones, is
   a. broader   b. sharper   c. no change   d. taller and sharper

Chapters 5-7 Self-Tests

16. The heat transferred across the boundary of an isolated system, during a process is
   a. >0   b. =0   c. <0   d. unknown   e. none of these

17. Melting of a solid in equilibrium with its liquid is a reversible process
   a. false   b. true   c. may be   d. none of these

18. The process of gasoline combustion in an automobile engine is
   a. reversible   b. isothermal   c. irreversible   d. adiabatic

19. The work done during the one-step isothermal expansion of a gas against constant external
    pressure (P_{ex}) is
   a. - P_{ex} \times \text{Change in Volume}   b. P_{ex} \times \text{Change in Volume} c. =0   d. unknown

20. The work done during a reversible isothermal expansion of an ideal gas (W_{rev}) is related to the
    corresponding change during an irreversible expansion (W_{irr}) as
   a. W_{rev} > W_{irr} b. W_{rev} = W_{irr} c. W_{rev} < W_{irr} d. W_{irr} = 0

21. The work done by an ideal gas (1 mol) during an isothermal expansion into vacuum with a
    change in volume equal to 25 lit. is
   a. 25 lit atm b. >25 lit atm c. =0   d. <0   e. None of these

22. The temperature of 100g of water in the surroundings of a system increased by 2 K during a
    process. If S is the specific heat of water, the heat appeared at the boundary is
   a. 200 kCal b. - 200 S k Cal c. 200 S Cal d. -200g K S

Chapters 5-7 cont. Self-Tests

1. During the adiabatic process, work done is equal to
   a. ΔU b. =0 c. ΔH d. - ΔU

2. Enthalpy of a closed system was found to be independent of temperature, at constant
   pressure, C_p for the system, in this temperature range is
3. During an isothermal process, the enthalpy of a system under constant pressure was found to increase. $C_p$ of the system is
  a. 0  b. > 1  c. < 0  d. infinity  e. None of these

4. According to the first law of thermodynamics, the work done during an isothermal process is
  a. 0  b. -(q)  c. q  d. unknown  e. none of these

5. Internal energy of a closed system was found to increase with temperature, at constant volume. $C_v$ of the system in this temperature range is
  a. 0  b. < 0  c. > 0  d. infinity  e. none of these

6. An ideal gas was allowed to expand into vacuum at constant temperature, the heat that enters the system is
  a. 0  b. >0  c. <0  d. infinity

7. The volume change that occurs (in liters) when 3 liters of xenon is heated through 100 K from 300 K at constant pressure is (alpha=0.001)
  a. 3.31  b. 0.3 1  c. -0.3 1  d. 0  e. 0.51

8. Temperature of a gas sample increases with pressure, in an isoenthalpic compression. The Joule-Thompson coefficient of the gas is
  a. 0  b. > 0  c. < 0  d. None of these

9. Volume of a liquid decreases with increase in pressure, at constant temperature. The isothermal compressibility of the liquid is
  a. 0  b. < 0  c. > 0  d. None of these

10. An ideal gas (1 mol) expands reversibly under adiabatic conditions, from a volume of 1 l to 2 l, while temperature changes from 295 K to 290 K. Heat capacity at constant volume is
    a. $\ln 0.5/\ln(290/295)$  b. $\ln(290/295)/\ln 0.5$  c. 0  d. None of these

11. Change in enthalpy of the system due to a process at constant pressure is
    a. dq  b. -dq  c. 0  d. dU + pdV

12. Change in molar enthalpy of nitrogen when it is heated from 298 K to 373 K is ($C_p = a + bT; a = 28.6 \text{ J K}^{-1} \text{ mol}^{-1}; b = 3.8 \times 10^{-3} \text{ J K}^{-2} \text{ mol}^{-1}$)
    a. 2.24 J mol$^{-1}$  b. 2.24 kJ mol$^{-1}$  c. 0  d. 224 kJ mol$^{-1}$

13. The result in the above question when $C_p$ is independent of T is
    a. 2.14 J mol$^{-1}$  b. 2.14 kJ mol$^{-1}$  c. 0  d. none of these  e. 21.4 kJ mol$^{-1}$

14. Change in the internal energy of an ideal gas due to adiabatic reversible expansion is
    a. -pdV  b. dV/p  c. $(nRT/V)dV$  d. 0

15. Which one of the following equations describes an adiabatic reversible process for an ideal gas?
    a. $pV=\text{const}$  b. $V/T=\text{const}$  c. $pV^{\gamma}=\text{const}$  d. $(pV)^{\gamma}=\text{const}$

16. Change in enthalpy when a gas expands adiabatically across a porous plug is
    a. > 0  b. < 0  c. 0  d. none of these
17. For an ideal gas, the difference in molar heat capacities at constant pressure and constant volume is
   a. nR   b. R   c. RT   d. ΔU   e. None of these

18. Change in internal energy when an ideal gas is heated through dT at constant volume is given as
   a. Cv dT   b. -CvdT   c. Cv   d. Cv dT / Cv   e. dT / Cv

19. One of the following is not a state function
   a. U   b. q
   c. q_v   d. q   e. H

20. The coefficient of Joule - Thompson expansion is
   a. \( \frac{\partial H}{\partial T} \) / p   b. \( \frac{\partial U}{\partial T} \) / p   c. \( \frac{\partial T}{\partial p} \) / H   d. \( \frac{\partial H}{\partial p} \) / T   e. \( \frac{\partial T}{\partial p} \) / U

21. For an ideal gas, the following is zero
   a. \( \frac{\partial U}{\partial V} \) T   b. \( \frac{\partial H}{\partial p} \) T   c. \( \frac{\partial U}{\partial T} \) V   d. \( \frac{\partial H}{\partial T} \) V

Chapters 8-9 Self-Tests

1. Total entropy change \( \Delta S_{tot} \), (system + surroundings) when an irreversible change occurs in the system is
   a. <0   b. >0   c. = 0   d. None of these   e. 0.5R

2. The entropy change accompanying an isothermal expansion of 1 mol of ideal gas when the volume doubles is
   a. R ln 2   b. 1/12 x R   c. -ln 2   d. R ln 1/2   e. None of these

3. The efficiency of a cyclic engine operating between 200 K and 300 K is
   a. 0.277   b. -0.3   c. 1/3   d. -1/3   e. 1/2

4. The efficiencies of a steam engine (high T= 100° C) in summer time (when the lower T is at 20° C) and in winter time (when the lower T is at -20° C) are
   a. 0.5 and 0.4   b. 0.33 and 0.67   c. 0.41 and 0.54   d. 0.22 and 0.32

5. The entropy change when 1 mol of ice melts to water at 273 K, 1 atm is 22 J K\(^{-1}\) mol\(^{-1}\). The molar enthalpy change of water is
   a. 22 x 273 J/mol   b. -22 x 273 J/mol   c. 22/273 J/mol   d. -22/273 J/mol

7. \( \Delta S \) for the melting of 5.0 g of ice (fusion enthalpy is 79.7 cal/g) at 0 °C and 1 atm is
   a. 2.56 cal/K   b. 1.2 cal/K   c. 1.46 cal/K   d. 6.17 J/K

8. The entropy change when an ideal gas (1 mol) undergoes free expansion at 300 K is
   a. >0   b. <0   c. =0   d. \( \infty \)   e. None of these

9. \( \Delta S \) when 24 mg of N\(_2\)(g) at 89 torr and 22 °C expands adiabatically into vacuum to a final pressure of 34 torr, \( \Delta S \) is (assume perfect gas behavior).
   a. 8.7 J/K   b. 27 mJ/K   c. 1.2 J/K   d. 6.9 mJ/K

10. According to 3rd law of thermodynamics, for perfectly crystalline substances, entropy approaches zero as temperature approaches
    a. infinity   b. zero K   c. 273K   d. None of these
Chapter 10

Self-Tests

1. Gibbs energy of a liquid decreases with temperature, at constant pressure, \((\partial G/\partial T)_p\) is
   a. >0  b. <0  c. =0  d. None of these

2. Rate of change in Gibbs energy with pressure, at constant temperature, for a liquid is
   a. greater than that of the vapor  b. less than that of the vapor  c. about the same as the vapor  d. None of these

3. Standard state of a real gas is a
   a. hypothetical state  b. state when p→0  c. non-equilibrium state  d. None of the above

4. Chemical potential of a solid, at constant pressure,
   a. increases with temperature  b. decreases with temperature  c. independent of temperature  d. None of the above

5. Gibbs energy of a liquid, at constant temperature, increases with pressure. This statement is
   a. True  b. false  c. Can’t say

6. Given \((\partial G/\partial T)_p=G-H/T\), \((\partial (G/T)/\partial T)_p\) is

7. Change in chemical potential as a liquid boils at its boiling point is,
   a. <0  b. >0  c. =0  d. Can’t say  e. None of these

8. The difference in the chemical potential between two locations of a column of fluid separated by height “h”, and density “ρ” is ,
   a. ρgh  b. Vρgh  c. Vρgh  d. V/ρgh

9. Change in chemical potential when 1mol of H₂O evaporates at 1 bar and 25°C is \((\Delta G_{vap} = 8.56\text{ kJ/mol at }25°C)\)
   a. 8.56 kJ/mol + ln2  b. 8.56 kJ/mol  c. -8.56 kJ/mol  d. None of these

10. As pressure of a real gas approaches zero, its fugacity coefficient approaches \((f = \text{fugacity coefficient } x p)\)
    a. zero  b. 1  c. infinity  d. None of the above

Chapter 11

Self-Tests

1. A given chemical reaction will be spontaneous if the change in the Gibbs energy accompanying the reaction is
   a. =0  b. >0  c. <0  d. none of the above

2. If \(df\) is the progress of the reaction, then the change in mole numbers of A in the following chemical reaction
   \(n_1 A + n_2 B \rightarrow n_3 C + n_4 D\)
   a. n_1 df  b. -n_1 df  c. n_2 df  d. -df  e. none of the above

3. For the reaction \(A \rightarrow B\), chemical potentials of pure substances A and B are \(μ_a\) and \(μ_b\), respectively. The Gibbs free energy change of the reaction is
   a. \(μ_a - μb\)  b. \(μb - μa\)  c. <0  d. \(μb + μa\)  e. none of the above

4. Consider the reaction \(A \rightarrow B\). The partial molar Gibbs energies of A and B are \(μ_a\) and \(μ_b\), respectively. The Gibbs free energy of the reaction when it proceeds by \(df\), is
   a. \(μa - μb\)  b. \(μb - μa\)  c. <0  d. \(μb + μa\)  e. none of the above
5. For the reaction \[ A \rightarrow B \], chemical potentials of pure substances A and B are \( \mu_a \) and \( \mu_b \), respectively. The reaction is spontaneous if
   a. \( \mu_a = \mu_b \)  
   b. \( \mu_b > \mu_a \)  
   c. \( \mu_a > \mu_b \)  
   d. \( \mu_b + \mu_a = 0 \)  
   e. none of the above

6. A chemical reaction was allowed to equilibrate at 1 atm and 273K. The free energy change at equilibrium is
   a. \( = 0 \)  
   b. \( > 0 \)  
   c. \( < 0 \)  
   d. none of the above

7. Consider the reaction \[ 2A \rightarrow B \]. Let A and B be perfect gases in equilibrium at 1 atm and 300K. If \( K \) is the equilibrium constant, the standard free energy change for the reaction is
   a. \( RT \ln(K) \)  
   b. \( -RT \ln(K) \)  
   c. \( -\ln(K) \)  
   d. \( \ln(K)/RT \)  
   e. none of the above

8. For the chemical equilibrium \[ 2A(g) + B(g) \rightarrow 2C(g) + 3D(g) \], the equilibrium constant expressed in partial pressures \( p_A, p_B, p_C, \) and \( p_D \) is (assume ideal behavior for all constituents)
   a. \( (p_A p_B)/(p_C p_D) \)  
   b. \( p_A^2 p_B/p_C p_D \)  
   c. \( p_A^2 p_B/p_C^2 p_D \)  
   d. \( p_A^2 p_B/p_C^2 p_D^3 \)  
   e. none of the above

9. Change in pressure was found to change the equilibrium composition of a certain chemical reaction. The change in the equilibrium constant with respect to change in pressure is
   a. \( = 0 \)  
   b. \( > 0 \)  
   c. \( < 0 \)  
   d. none of these

10. The standard free energy of a reaction is estimated to be 596.1 kCal/mol at 300K. The equilibrium constant for the reaction is
     a. \( e^{1000} \)  
     b. \( \exp \text{kCal}/RT \)  
     c. \( \exp(-55/33) \text{RT} \)  
     d. \( \exp(-299.7) \)  
     e. 1.0

11. The chemical potential of a solute in an ideal solution is given by
    a. \( \mu_a^*(\text{solute}) + \ln(x_a) \)  
    b. \( \mu_a^*(\text{solvent}) + \ln(x_a) \)  
    c. \( \mu_a^*(\text{solution}) + \ln(x_a) \)  
    d. \( \mu_a^*(\text{solute}) + RT \ln(x_a) \)  
    e. none of these

12. When one gram of a solute is dissolved in 180g of water, the vapor pressure of water decreased from 23.76 Torr to 22.41 Torr at room temperature. Assuming ideal behavior, the mole fraction of the solute is
    a. 22.41/13.5  
    b. 22.41/1.35  
    c. 23.76/13.5  
    d. 23.76/1.35  
    e. None of these

13. In problem 12, the molecular weight of the solute is
    a. 22.41/13.5 g/mol  
    b. 22.41/1.35 g/mol  
    c. 23.76/13.5 g/mol  
    d. 23.76/1.35 g/mol  
    e. None of these

14. The standard free energy of formation of ozone from molecular oxygen is 166.2 kJ/mol at 297K. The standard free energy of the reaction 3O2 (g) -----> 2 O3 (g) is
     a. 83.1 kJ/mol  
     b. 166.2kJ/mol  
     c. -166.2kJ/mol  
     d. 0  
     e. None of these

15. For the reaction PCl5 (g) -----> PCl3 (g) + Cl2 (g), lnKp at 25°C is -14.93. If the standard enthalpy of the reaction is 88kJ/mol, the equilibrium constant at 600°C is
    a. 2.93  
    b. 18.8  
    c. 3.93  
    d. 3.28x1027  
    e. None of these

Chapter 11-12

Self-Tests

1. When 1 mol of ethanol was added to a tank of water of 250 gallons, the volume changes by 14 cm³.
   Partial molar volume of ethanol at this composition is
   a. 14 cm³  
   b. 14/25 cm³/gal  
   c. 14 cm³/mol  
   d. 250 gal/14cm³  
   e. none of these

2. Partial molar volumes of liquids A and B in a mixture of 25% of B in A (by mole numbers) are V1 & V2. Total volume of the mixture of 4 mols at this composition is
   a. V1+V2  
   b. 3V1+V2  
   c. 1/3 V1 + V2d. V1+3V2  
   e. none of these

3. A plot of total volume of a mixture of 2 liquids as a function of mole fraction of component ‘1’ was determined. The slope of the tangent drawn on the curve at any composition corresponds to
a. total volume  b. partial molar volume of 1  c. partial molar volume of 2  d. volume of 1 
  e. volume of 2

4. The chemical potentials of A and B in a binary mixture of composition 1 mol of A and 2 mols of B are 5 kJ/mol and 7 kJ/mol, respectively. The total free energy of the mixture is 
  a. 19 kJ    b. 5/14 kJ    c. -19 kJ    d. 9 kJ    e. None of these

5. If \( \mu_A \) and \( \mu_B \) are the chemical potentials of pure A and pure B, the Gibbs free energy of an equimolar mixture of A and pure B is 
  a. \( \mu_A - \mu_B \)   b. \( \mu_A \times \mu_B \)   c. \( -\mu_A + \mu_B \)   d. \( \mu_A \div \mu_B \)    e. \( \mu_A + \mu_B \)

6. The change in the chemical potential of component '1' in a binary mixture (of molar composition, 1:1) was 5 kJ/mol when the composition was changed by adding an infinitesimal amount of '1'. The change in the partial molar free energy of the second component is 
  a. infinity    b. 5 kJ    c. 5 kJ/mol    d. -5 kJ/mol    e. None of these

7. The Gibbs free energy of mixing was found to be -30 kJ at 300 K for a mixture of perfect gases. The entropy of mixing for this system is 
  a. 19 kJ/K    b. 0.1 kJ/K    c. -0.1 kJ/K    d. 10 kJ/K    e. -10 kJ/K

8. The enthalpy of mixing of two ideal gases of 1 mol of A and 3 mol of B is 
  a. 4 kJ    b. zero    c. -4 kJ/mol    d. -4 kJ    e. None of these

9. For an ideal solution of a non-volatile solute dissolved in a solvent, the mole fraction of the solute was found to be 0.25. If the pure liquid has a vapor pressure of 0.5 atm, vapor pressure of the solution is 
  a. 1.5/4 atm    b. 0.5x.25 atm    c. 0.5/0.25 atm    d. 1.5/3 atm    e. None of these

10. Chemical potential of water changes by 5 kJ/mol when certain amount of sodium chloride was dissolved. Mole fraction of sodium chloride in the solution is 
  a. 1+ e -(5 kJ/mol.RT)    b. 1+ e (5 kJ/mol.RT)    c. 1- e -(5 kJ/mol.RT)    d. 1    e. None

11. Henry's law constant for oxygen in water is 3.3x107 Torr at 300K. Mole fraction of oxygen dissolved in water when partial pressure of oxygen is 0.1 atm 
  a. (7.6/3.3)x10-5    b. (3.3/7.6)x10-5    c. 1    d. 0    e. (7.6/3.3)x10-6

12. When two liquids are not miscible, the enthalpy of mixing is 
  a. <TΔmixS    b. >TΔmixS    c. =0    d. free energy of mixing    e. None of these

13. When a solute was dissolved in a solvent, the chemical potential of the solution is less than the chemical potential of the pure solvent. This is 
  a. true for ideal solutions    b. not true    c. none of these    d. false for ideal solutions

14. When a non-volatile solute was dissolved in water the chemical potential of pure water \( \mu(l)* \) and that of the solution \( \mu(l) \) are related as 
  a. \( \mu(l)*\equiv\mu(l) \)    b. \( \mu(l) = \mu(g) \)    c. \( \mu(l) <\mu(l)* \)    d. Can't say    e. none of these

15. Osmotic pressure exerted by a solution of salt in water was measured to be 62.36 Torr at 300K. If the volume of the solution is 10 cm3, the concentration of salt is, 
  a. 1 mol/L    b. 7.5 mol/L    c. 1 mol    d. 10 mol/L    e. none of these

Chapter 12

Self-Tests

1. When two phases are in equilibrium, the chemical potentials of the two phases \( \mu(\alpha) \) and \( \mu(\beta) \) are related as
   a. \( \mu(\alpha)\neq\mu(\beta) \)    b. \( \mu(\alpha)\geq\mu(\beta) \)    c. \( \mu(\alpha)\leq\mu(\beta) \)    d. \( \mu(\alpha)=\mu(\beta) \)
2. The melting temperature of ice changes with pressure. When pressure is increased from 1 to 2 bar the change in melting temperature is
\[ 1 < 0 \quad 2 > 0 \quad 3 = 0 \quad 4 \text{ None of these} \]

3. If \( \Delta S/\Delta V \) for melting of a solid is 2.3 \( \text{J/km}^3 \), the rate of change of melting temperature with pressure is
\[ 1 \text{ 2.3 J/km}^3 \quad 2 > 1/2.3 \text{ km}/J \quad 3 -2.3 \text{ J/km}^3 \quad 4 -1/2.3 \text{ km}/J \]

4. If the molar volume of a solid is greater than molar volume of the corresponding liquid, (dp/dT) for Solid->Liquid transformation is,
\[ 1 > 0 \quad 2 < 0 \quad 3 = 0 \quad 4 \text{ None of these} \]

5. Change in chemical potential of a solid with molar volume 2 liters, when pressure is changed from 1 bar to 2 bar (Const. T) is
\[ 1 -2 \times 10^{-3} \text{m}^3/\text{bar/mol} \quad 2 2 \times 10^{-3} \text{m}^3/\text{bar/mol} \quad 3 1/2 \times 10^{-3} \text{m}^3/\text{bar/mol} \quad 4 1/2 \times 10^3 \text{m}^3/\text{bar/mol} \]

6. What is the melting temperature, if \( \Delta H_{\text{fus}}, \Delta V_{\text{fus}} \) per mol of the substance at its melting point “\( T_i \)”, and pressure “\( p_i \)”, are known, when the pressure is changed to “\( p_f \)”
\[ 1 p_f = p_i + (\Delta H_{\text{fus}}/\Delta V_{\text{fus}}) \ln(T_f/T_i) \quad 2 p_f = p_i(\Delta H_{\text{fus}}/\Delta V_{\text{fus}}) \ln(T_f/T_i) \quad 3 p_f = p_i(\Delta H_{\text{fus}}/\Delta V_{\text{fus}}) \ln(T_f/T_i) \quad 4 \text{ None of these} \]

7. If the molar volume of a liquid is 0.03 liters, at temperature “T” and 1 bar, the change in its vapor pressure when inert gas of partial pressure 1 bar was added to the vapor is
\[ 1 (e^{-3 \times 10^{-5}/8.31 T} - 1) \text{ bar} \quad 2 e^{3 \times 10^{-5}/8.31} \text{ bar} \quad 3 e^{10+5/8.31} \text{ bar} \quad 4 \text{ None of these} \]
9. A binary mixture of liquids obeys Raoult's law and the ratio of the vapor pressure of one of the pure components to its partial pressure in the mixture is 2. Mole fraction of this component in the liquid phase is  
a. 0.3  
b. 2  
c. 0.5  
d. 1  
e. None of these

10. For a binary mixture of liquids at 1 atm, the partial vapor pressure of a component is 0.2 atm, the mole fraction of this component in the vapor phase is  
a. 0.3  
b. 2  
c. 0.2  
d. 1  
e. None of these

11. In a binary equimolar mixture of A & B, A is more volatile than B. If the mixture is ideal, the boiling point (Tm) of the mixture is related to the boiling points of A and B (Ta, Tb respectively) as  
a. >Ta  
b. < Ta  
c. >Tb  
d. =Tb  
e. None of these

12. If the mixture in problem 11 is not ideal, the boiling point of the mixture is  
a. >Ta b. < Ta c. >Tb d. =Tb e. None of these

13. At one atm, the partial pressure of a volatile component in a binary liquid mixture was found to be 0.1 atm. Its mole fraction in the vapor phase is  
a. 0.3  
b. 0.1  
c. 0.2  
d. 1  
e. None of these

14. The normal boiling point of a mixture of two immiscible liquids is Tm. If Ta and Tb are the normal boiling points of the two components,  
a. Tm< Ta or Tb  
b. Tm> Ta or Tb  
c. Tm> Ta  
d. Tm > Tb  
e. None of these

15. In a plot of the boiling point vs composition of a binary liquid mixture, a maximum was encountered at a composition of 20% of the less volatile component. When the mixture containing 30% of more volatile component was subjected to fractional distillation, the liquid remaining in the boiling flask will be rich in the component that is  
a. more volatile  
b. less volatile  
c. equal mix.  
d. None of these

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**Key to the self-tests**

Chapter 2: 1a, 2c, 3a, 4b, 5b, 6a, 7a, 8c, 9b, 10a, 11a, 12c, 13a, 14a, 15c, 16b, 17c, 18b.

Chapters 3-4, 5-7: 1c, 2c, 3c, 4c, 5d, 6d, 7d, 8b, 9c, 10b, 11b, 12d, 13c, 14a, 15b, d, 16b, 17b, 18c, 19b, 20a, 21c, 22d

Chapters 5-7 cont. 1d, 2a, 3d, 4c, 5c, 6a, 7b, 8b, 9c, 10d, 11d, 12b, 13b, 14a, 15c, 16c, 17b, 18a, 19d, 20c, 21b

Chapters 8-9 1b, 2a, 3c, 4d, 5a, 7c, 9a

Chapter 10 1b, 2b, 3d, 4b, 5a, 6c, 7c, 8a, 9b, 10b

Chapter 11 1c, 2b, 3b, 4b, 5c, 6a, 7b, 8e, 9a, 10a, 11.d, 12.c, 13.a, 14.b, 15.b

Chapter 11-12 1c, 2b, 3b, 4a, 5.e, 6.d, 7.b, 8.b, 9.a, 10.c, 11.e, 12.b, 13.a, 14.c, 15.e

Chapter 12 1/4, 2/1, 3/2, 4/2, 5/2, 6/17/3

Chapter 13 1.a, 2.b, 3.b, 4.c, 5.b, 6.d, 7.a, 8.d, 9.c, 10.c, 11.a, 12.e, 13.b, 14.a, 15.a

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