INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH, KOLKATA

SEMESTER 2

CH-1201

Class Test -2

ximum mark: 10 Time: 1 Hr. Date: 13.04.2016

wer any two questions, each question carries equal mark.

1. Draw and explain Bernal and Stewart's model of liquid structure. Explain the following: (a) Cybotactic groups (b) Pitch of a liquid crystal. Draw and explain radial distribution function of oxygen in liquid water at three different temperatures.
2. Does the vapour pressure depend on temperature? Explain. Does the vapour pressure depend on external pressure? Explain. How does the magnitude of cohesive force control vapour pressure and heat of vaporisation?
3. How does the internal pressure depend on radius for a cavity? Explain pictorially. Why 'seeding' is necessary for raining at certain atmospheric condition? Explain mathematically.
4. Plot Shear Stress Vs. Strain for Newtonian fluid, non-Newtonian fluid, Ideal fluid, ideal solid, plastic. How does viscosity of liquid and gas depend on temperature? Explain.

terms have their usual meaning.

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH, KOLKATA

SEMESTER 2

CH-1201

Mid-Semester Examination

Maximum mark: 20 Time: 1 Hr. Date: 16.02.2016

Answer any four questions, each question carries equal mark.

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1. Describe the basis of pressure and volume correction in Dieterici equation. Plot Z vs P curve for hydrogen, helium at 30 K. Explain the difference. Convert this plot to P vs. V curve for these gases at the same temperature. (T_B for hydrogen is 110 K, for helium ~22K)
2. Draw van der Waals isotherm for a particular gas at different temperatures. Explain which region would represent supersaturated vapour, supercooled vapour, supersaturated liquid, superheated liquid.
3. What are the units of "a", "b" and virial coefficient w.r.t. real gas equation? Explain how the virial coefficient (B) depends on temperature? Explain pictorially how does the Lennard-Jones potential depend on distance. If $U(r) = 4\varepsilon ((\sigma/r)^{12}-(\sigma/r)^{6})$ obtain an expression for r_{min} and $U(r)_{min}$. Show them pictorially.
4. Explain the terms normal density, limiting density in connection with real gases. How will you experimentally calculate limiting density of hydrogen and nitrogen?
5. Maxwell distribution for translational K.E. (3D) is given by

$$F(\varepsilon_{tr}) = \frac{dn_r}{N} = 2\pi(\frac{1}{\pi kT})^{3/2}(\varepsilon_{tr})^{1/2}\exp(-\varepsilon_{tr}/kT)d\varepsilon_{tr}$$

   Obtain an expression for $\varepsilon_{tr,mp}$, $\langle\varepsilon_{tr}\rangle$, $\varepsilon_{tr,rms}$
6. How does the magnitude of Z_{AA} depend on temperature and pressure? Calculate mean free path of molecules of a gas (d= 4Å) at (a) 1 atm and 300 K (b) 10^{-9} atm and 300 K. Compare the results.

All terms have their usual meaning.

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH, KOLKATA

SEMESTER 2

CH-1201

Class Test -1

Maximum mark: 20 Time: 1 Hr. Date: 28.03.2017

Answer any four questions, each question carries equal mark.

1. Draw and explain radial distribution function of oxygen in liquid water at three different temperatures.
2. Does the vapour pressure depend on temperature? Explain. Does the vapour pressure depend on external pressure? Explain. How does the magnitude of cohesive force control vapour pressure and heat of vaporisation? Calculate increase in vapour pressure of water per atmosphere rise in external pressure at 10^0C (Given, vapour pressure of water at 10^0C = 9.2 mm)
3. How does the internal pressure depend on radius for a cavity? Explain pictorially. Why NaCl is spread at a high altitude for raining at certain atmospheric condition? Explain mathematically.
4. Plot Shear Stress Vs. Strain for Newtonian fluid, non-Newtonian fluid, Ideal fluid, ideal solid, plastic. How does viscosity of liquid and gas depend on temperature? Explain.
5. Explain how will you calculate capillary rise mathematically. If the height of the capillary is less than that length then will you a fountain? Explain mathematically.

All terms have their usual meaning.

$$(\pi r^2)\rho g h = 2\pi r T\cos\theta$$

$$+\frac{1}{3}\pi r^3 \rho g$$

$$\pi r^2 r - \frac{2}{3}\pi r^3$$

$$\frac{1}{3}\pi r^3$$

$$r\left(\pi r^2 \rho g h + \frac{\pi}{3} r^2 g \rho\right) = 2\pi T\cos\theta R$$

$$h = \frac{2RT\cos\theta - r^2 g \rho \times r}{3}$$

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH KOLKATA

SEMESTER 2

CH-1201

Mid-Semester Examination

Maximum mark: 20 Time: 1 Hr. Date: 14.02.2017

Answer all questions, each question carries equal mark.

1. Draw and explain the nature of Maxwell distribution plot for speed (3D). Why do you see a maximum in Maxwell distribution? Explain the difference between Maxwell distribution curve for 1D, 2D and 3D.

or

2. Draw qualitatively Maxwell distribution for speed plot for (a) three different temperatures (b) three different gases. Explain the observation. What is the difference between shape of Maxwell distribution plot of speed and translational kinetic energy?
3. Describe the basis of pressure and volume correction in Dieterici equation. Plot Z vs P curve for hydrogen, helium at 30 K. Explain the difference. Convert this plot to P vs. V curve for these gases at the same temperature. Show ideal gas behaviour in this plot. (T_B for hydrogen is 110 K, for helium ~22K).

or

4. Draw van der Waals isotherm for a particular gas at different temperatures. What is the physical significance of T_c? Explain which region in the plot would represent supersaturated vapour, supercooled vapour, supersaturated liquid, superheated liquid.
5. What are the units of "a", "b" and virial coefficient w.r.t. real gas equation? Explain how the virial coefficient (B) depends on temperature? Explain pictorially how does the Lennard-Jones potential depend on distance. If $U(r) = 4\varepsilon ((\sigma/r)^{12}-(\sigma/r)^{6})$ obtain an expression for r_{min} and $U(r)_{min}$. Show those pictorially.

or

6. Maxwell distribution for translational K.E. (3D) is given by

$$F(\varepsilon_{tr}) = \frac{dn_r}{N} = 2\pi(\frac{1}{\pi kT})^{3/2}(\varepsilon_{tr})^{1/2}\exp(-\varepsilon_{tr}/kT)d\varepsilon_{tr}$$

Obtain an expression for $\varepsilon_{tr,mp}$, $\langle\varepsilon_{tr}\rangle$, $\varepsilon_{tr,rms}$

7. For the dissociation,

$$N_2O_4 \rightleftharpoons 2NO_2$$

The equilibrium constant at 27 ^{0}C is K= 0.115 and is related to the degree of dissociation α and the pressure in atm by $K = 4\alpha^2P/(1-\alpha^2)$. If n is the number of moles of N_2O_4 that would be present if no dissociation occurred. Calculate (V/n) at P = 2 atm, assuming that the equilibrium mixture behaves ideally. Compare the results with (V/n) if dissociation did not occur. Show that as P tends to zero, the compressibility factor , Z tends to 2 instead of the usual value of unity. Why does this happen?

or

8. If the rate of change of root mean square speed of a gas is twice the rate of change of absolute temperature. Calculate the root mean square speed of Neon. Calculate the value of mean square deviation $\langle(C-\langle C\rangle)^2\rangle$ for O_2 at 27 °C.

...s have their usual meaning.

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH KOLKATA

SEMESTER 2

CH-1201

Mid-Semester Examination

Maximum mark: 20 Time: 1 Hr. Date: 20.02.2017

Answer any four questions, each question carries equal mark.

1. Draw and explain the nature of Maxwell distribution plot for speed (3D). Why do you see a maximum in Maxwell distribution? Explain the difference between Maxwell distribution curve for 1D, 2D and 3D.
2. Draw qualitatively Maxwell distribution for speed plot for (a) three different temperatures (b) three different gases. Explain the observation. What is the difference between shape of Maxwell distribution plot of speed and translational kinetic energy?
3. Describe the basis of pressure and volume correction in Dieterici equation. Plot Z vs P curve for hydrogen, helium at 30 K. Explain the difference. Convert this plot to P vs. V curve for these gases at the same temperature. Show ideal gas behaviour in this plot. (T_B for hydrogen is 110 K, for helium ~22K).
4. Draw van der Waals isotherm for a particular gas at different temperatures. What is the physical significance of T_c? Explain which region in the plot would represent supersaturated vapour, supercooled vapour, supersaturated liquid, superheated liquid.
5. What are the units of "a", "b" and virial coefficient w.r.t. real gas equation? Explain how the virial coefficient (B) depends on temperature? Explain pictorially how does the Lennard-Jones potential depend on distance. If $U(r) = 4\varepsilon ((\sigma/r)^{12}-(\sigma/r)^{6})$ obtain an expression for r_{min} and $U(r)_{min}$. Show those pictorially.
6. Maxwell distribution for translational K.E. (3D) is given by

$$F(\varepsilon_{tr}) = \frac{d\dot{n}_r}{N} = 2\pi\left(\frac{1}{\pi kT}\right)^{3/2}(\varepsilon_{tr})^{1/2}\exp(-\varepsilon_{tr}/kT)d\varepsilon_{tr}$$

Obtain an expression for $\varepsilon_{tr,mp}$, $\langle\varepsilon_{tr}\rangle$, $\varepsilon_{tr,rms}$

All terms have their usual meaning.

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH KOLKATA

SEMESTER 2

CH-1201

End Semester Examination

Maximum mark: 50 Time: 3 hr. Date: 05.05.2017

Answer any five questions, each question carries equal mark.

1. How does the concentration of starting material, intermediate and product will vary with time depending on the relative magnitude of rate constants in case of consecutive first order reaction. Explain mathematically and graphically. (6+4)
2. (a) How does the equilibrium constant and rate constant depend on temperature? Explain mathematically and graphically. (b) The rate constant for the decomposition of a certain substance is 1.7×10^{-2} $dm^3mol^{-1}s^{-1}$ at 24^0C and 2.01×10^{-2} $dm^3mol^{-1}s^{-1}$ at 37^0C. Evaluate Arrhenius parameters (activation energy and pre-exponential factor) of the reaction. (4+6).
3. (a) Starting from the concept of 'pre-equilibria' show how to calculate K_M of an enzyme catalyzed reaction. (b) The enzyme catalyzed conversion of a substrate at 25^0C has a Michaelis constant of 0.042 mol dm^{-3}. The rate of the reaction is 2.45×10^{-4} mol dm^{-3} s^{-1} when the substrate concentration is 0.890 mol dm^{-3}. What is the maximum velocity of this enzymolysis?(6+4).
4. (a) Comment on the slope of PV isotherm and PV adiabat of an ideal gas. (b) What is the physical significance of JT inversion temperature? (c) Show that Cv of an ideal gas is independent of volume at a given temperature. (d) Show that Cp of an ideal gas is independent of pressure at a given temperature. (2+2+3+3)

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5. (a) What are the five criteria for spontaneity and equilibrium? Explain mathematically. (b) Comment on the spontaneity and feasibility of a process when (i) ΔH is +ve, ΔS is +ve (ii) ΔH is -ve, ΔS is +ve, (iii) ΔH is -ve, ΔS is -ve (iv) ΔH is +ve, ΔS is -ve. (c) Complete the following expressions using Maxwell relation: (i) $(\delta S/\delta P)_V$ =? , (ii) $(\delta S/\delta P)_T$=?, (iii) $(\delta S/\delta V)_T$ = ?, (iv) $(\delta S/\delta V)_P$=? (6+2+2)
6. (a) Comment on the slope of entropy vs. temperature plot when (i) pressure is constant and (ii) volume is constant. (b) Explain the following (i) Solid is stable below melting point, (ii) Liquid is stable in between melting point and boiling point, (iii) Vapour is stable above boiling point. (c) An ideal monoatomic gas ($C_{v,m}$ = 1.5R) initially at 298 K and 1.013 MPa pressure expands adiabatically and irreversibly until it is in equilibrium with a constant external pressure of 0.1013 MPa. What is the final temperature of the gas? (2+3+5)
7. (a) The enthalpy of formation of ethane, ethylene, and benzene from the gaseous atom are (-) 2839.2, (-)2275.2, (-)5536.0 KJ mol^{-1} respectively. Calculate the resonance energy of benzene compared with one Kekule structure. Given: the bond enthalpy of C-H bond is 410.87 KJ mol^{-1}. (b) Calculate the change in entropy when 4 mol of a monoatomic perfect gas with $C_{p,m}$ = (5/2)R is heated from 250 K to 700 K and simultaneously heated from 20 L to 60 L. (5+5).

(All symbols have their usual meaning.)