

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. Compute the following integrals:
- (12+10+13)

$$(a) \int \frac{\sin x dx}{\sqrt{1+\sin x}}, \quad (b) \int e^x \frac{1+\sin x}{1+\cos x} dx, \quad (c) \int \frac{dx}{(x-a)\sqrt{(x-a)(b-x)}}$$

2. (a) Find a reduction formula for
- $I_n = \int x^n \sin mx dx$
- .
- (11)

$$(b) \text{ Evaluate: } \int_0^{16} \frac{x^{1/4} dx}{1+x^{1/2}} \quad (11)$$

$$(c) \text{ Evaluate: } \int_0^{\pi} \frac{x \sin x}{1+\cos^2 x} dx \quad (13)$$

3. (a) Evaluate:
- $\int_0^{\infty} \frac{xdx}{(1+x)(1+x^2)}$
- (11)

$$(b) \text{ Prove that } \int_0^{\pi/2} \sin^p x \cos^q x dx = \frac{\left(\frac{p+1}{2}\right) \left(\frac{q+1}{2}\right)}{2 \left(\frac{p+q+2}{2}\right)}. \quad (12)$$

- (c) Find the whole area of the curve
- $a^2 y^2 = a^2 x^2 - x^4$
- .
- (12)

4. (a) Find the larger area enclosed by the circle
- $x^2 + y^2 = 64a^2$
- and the parabola
- $y^2 = 12ax$
- .
- (17)

- (b) Find the volume and surface area of the solid generated by revolving the cardioid
- $r = a(1 - \cos \theta)$
- about the initial line.
- (18)

MATH 123/CHE**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Form the DE of the family of curves $y = Ae^{3x} + Be^{5x}$ for different values of A and B. (10)

(b) Solve: $\left(\frac{x+y-a}{x+y-b}\right)\frac{dy}{dx} = \frac{x+y+a}{x+y+b}$. (12)

(c) Solve: $(2x-3y+4)dx + (3x-2y+1)dy = 0$. (13)

6. (a) Solve: $(1-x^2)\frac{dy}{dx} + xy = xy^2$. (11)

(b) Find the integrating factor and solve:

(i) $(2xy^4e^y + 2xy^3 + y)dx + (x^2y^4e^y - x^2y^2 - 3x)dy = 0$ (12)

(ii) $y(2xy+1)dx + x(1+2xy-x^3y^3)dy = 0$ (12)

7. Solve:

(a) $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = x^2e^{3x} \cos 2x$ (11)

(b) $\frac{d^4y}{dx^4} - y = x \sin x$ (11)

(c) Solve the homogenous linear differential equation (13)

$$x^3 \frac{d^3y}{dx^3} - x^2 \frac{d^2y}{dx^2} + 2x \frac{dy}{dx} - 2y = x^3 + 3x.$$

8. (a) Solve: $x \frac{d^2y}{dx^2} + x \left(\frac{dy}{dx}\right)^2 - \left(\frac{dy}{dx}\right) = 0$ (11)

(b) Solve: $\frac{d^2y}{dx^2} + \frac{dy}{dx} + \left(\frac{dy}{dx}\right)^3 = 0$ (11)

(c) Solve the differential equation (13)

$$[xD^2 + (x^2 + 1)D + x]y = 2x$$

by the method of factorization of operators.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **PHY 155** (Structure of Matter, Electricity & Magnetism and Modern Physics)

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Distinguish between crystalline and amorphous solids. Between these two states, which state is more favourable and why? (7)
- (b) How many atoms are there per unit cell in crystals with simple cubic, body centred cubic and face centred cubic structures? Explain with suitable diagrams. (12)
- (c) Draw a typical unit cell for NaCl. Describe its crystal structure. (10)
- (d) If unit cells have following characteristics (6)
 - (i) $a = 6 \text{ \AA}, b = 6.8 \text{ \AA}, c = 7.2 \text{ \AA}, \alpha = \beta = \gamma = 90^\circ$
 - (ii) $a = 9 \text{ \AA}, b = 9 \text{ \AA}, c = 11.4 \text{ \AA}, \alpha = \beta = 90^\circ$ and $\gamma = 120^\circ$
 - (iii) $a = 8 \text{ \AA}, b = 6.2 \text{ \AA}, c = 5.4 \text{ \AA}, \alpha = 40^\circ, \beta = 81^\circ, \gamma = 95^\circ$
 Identify in which crystal system do these unit cells belong?

2. (a) Distinguish between primitive and non-primitive cells. (9)
- (b) What are Miller indices? Derive a relationship between Miller indices and interplaner distance in terms of unit edge lengths for a typical crystal. (18)
- (c) A crystal structure is cubic with lattice constant 4.28 \AA and with two of its atoms in the unit cube at $(0, 0, 0)$ and $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$. How many nearest neighbours does each atom have in the crystal and how far away are they? (8)

3. (a) Explain Bragg's law in X-ray diffraction. What are the characteristics features of Bragg's law. (15)
- (b) Define crystal defects? Discuss different types of point defects. (12)
- (c) The Bragg angle for reflection from the planes for which $h^2 + k^2 + l^2 = 8$ is 20.2° for an x-ray wavelength of 1.54 \AA . Find the lattice constant of the crystal. (8)

4. (a) Explain electric flux. (5)
- (b) State and explain Gauss's law in electrostatics. Show that the Coulomb's law can be obtained from Gauss's law. (20)
- (c) Find the expression for \vec{E} in case of an infinite line of charge of linear charge density λ using Gauss's law. (10)

PHY 155/CHE

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define the terms: Current, current density, resistance and resistivity. What kinds of parameters are they? (12)
- (b) What is meant by average drift speed of electrons in a conductor? Derive an expression for the average drift speed of electrons in a conductor when an electric field is applied to it. (16)
- (c) The current density in a cylindrical wire of radius $R = 2.0$ mm is uniform across a cross-section of the wire and is given by 2.0×10^5 A/m². What is the current through the outer portion of the wire between radial distances $\frac{R}{2}$ and R of the wire? (7)
6. (a) State and explain Ampere's law. (8)
- (b) What is a solenoid? Derive an expression for the magnetic field induction at the centre of a current carrying solenoid. (20)
- (c) There are 2000 turns in a 500 cm long and 5.0 cm diameter solenoid. The magnetic field induction near the centre of the solenoid is 0.08 T. Determine the current flowing in the solenoid. ($\mu_0 = 4\pi \times 10^{-7}$ wb/A-m). (7)
7. (a) State the basic postulates of special theory of relativity. (7)
- (b) Derive an equation for the relativistic kinetic energy of a body. How does this equation lead to the equivalence of mass and energy? (20)
- (c) A stationary body explodes into two fragments of rest mass 1 kg that move apart at speed of 0.6 c. Find the rest mass of the original body. (8)
8. (a) Define Pair production. Show that pair production can not occur in empty space. (7)
- (b) Derive the expression of Compton shift and hence find the maximum Compton shift. (20)
- (c) The work function for tungsten is 4.52 eV. (i) What is the cutoff wavelength for tungsten? (ii) What is the maximum kinetic energy of the electrons when the radiation of wavelength 198 nm is used? (iii) What is the stopping potential in this case? (8)
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **CHE 111** (Elements of Chemical Engineering)

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION-AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) The density of fluid is given by the empirical equation

$$\rho = 50 e^{8 \times 10^{-7} P}$$

where ρ is density (lb_m/ft^3) and P is pressure (lb_f/in^2).(i) What are the units of 50 and 8×10^{-7} ? (2)(ii) Calculate the density in kg/m^3 for a pressure of $9 \times 10^6 \text{ N}/\text{m}^2$. (6)(iii) Derive a formula for ρ (kg/m^3) as a function of P (N/m^2). (7)

(b) A glass sample composition in mass% is (15+5)

 $\text{Na}_2\text{O} - 7.8\%$, $\text{MgO} - 7\%$, $\text{ZnO} - 9.7\%$, $\text{Al}_2\text{O}_3 - 2\%$, $\text{B}_2\text{O}_3 - 8.5\%$ and the rest SiO_2

Convert the composition in mole %. What is the average molecular weight of the sample?

2. (a) A fluid of unknown density is used in two manometers – one sealed-end, the other across an orifice in a water pipeline (See Figure for Q.2(a)). If the barometric pressure is 756 mm Hg, what is the pressure drop (mm Hg) between point (a) and (b) in the figure? (17)

(b) One thousand kilograms per hour of a mixture containing equal parts of methanol and water by mass is distilled. The flow rate of the bottom stream is measured and found to be 670 kg/h, and the overhead stream is analyzed and found to contain 97 wt% methanol. Draw and level the flow chart. Calculate the mass and mole fractions of methanol and the molar flow rates of methanol and water in the bottom product stream. (18)

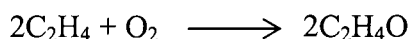
3. (a) An evaporation – crystallization process is used to obtain solid potassium sulfate from an aqueous solution of this salt. The fresh feed to the process containing 20 wt%
- K_2SO_4
- is joined by a recycle stream containing 40 wt%
- K_2SO_4
- , and the combined stream is fed to an evaporator. The concentrated stream leaving the evaporator is fed to a crystallizer and then to a filter. The wet filter cake consists of solid
- K_2SO_4
- crystals and a 40%
- K_2SO_4
- solution, in ratio of 10 kg crystals/kg solution. The filtrate containing 40 wt%
- K_2SO_4
- constitutes the recycle stream. Of the water fed to the evaporator, 45% is evaporated. The evaporator has a maximum capacity of 170 kg water evaporated per second. Draw and label the flow chart. Calculate the maximum production rate of solid
- K_2SO_4
- , the rate at which fresh feed must be supplied to achieve this production rate, and the ratio kg recycle/kg fresh feed. (30)

(b) Write five reasons for using recycle in process industries. (5)

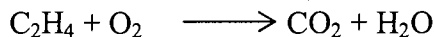
Contd P/2

CHE 111

4. (a) Ethylene oxide is produced by the catalytic oxidation of ethylene:



An undesired competing reaction is the combustion of ethylene:



The feed to the reactor contains three moles of ethylene per mole of oxygen. The single pass conversion of ethylene is 20%, and for every 100 moles of ethylene consumed in the reactor 92 moles of ethylene oxide emerges in the reactor products. A multiple unit process is used to separate the products: ethylene and oxygen are recycled to the reactor, ethylene oxide is sold as a product, and carbon dioxide and water are discarded. Draw and label the flow chart. Calculate all unknown streams and compositions for an ethylene oxide production rate of 1000 kg/hr. (30)

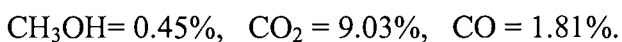
- (b) Explain the concept of limiting reactant and selectivity. (5)

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Five liters of liquid n-hexane and 4 liters of liquid n-heptane are mixed and burned with 4000 gram-moles of air. Not all of the hydrocarbons are burned in the furnace, and both CO and CO₂ are formed. If it is possible to do so without additional information, Calculate the percent excess air supplied to the furnace; if more information is needed, state what it is and outline the calculation of the percent excess air. (17)

(b) Liquid methanol is fed to a space heater at a rate of 12 L/h and burned with excess air. The product gas is analyzed and the following dry basis mole percentages are determined: (18)



- (i) Calculate the fractional conversion of methanol, the percentage excess air fed, and mole fraction of water in the product gas.
 (ii) In case the combustion products are released directly into a room, what potential problems do you see and characteristics remedies can you suggest?

6. (a) An ideal gas mixture contains 35% helium 20% methane, and 45% nitrogen by volume at 2.00 atm absolute and 90°C. Calculate (18)

- (i) the partial pressure of each component,
 (ii) the mass fraction of methane,
 (iii) the average molecular weight of the gas, and
 (v) the density of the gas in kg/m³.

(b) The absolute pressure within a 35 liter gas cylinder should not exceed 51 atm. Suppose the cylinder contains 50.0 mol of a gas. Use the SRK equation of state to calculate the maximum permissible cylinder temperature if the gas is i) argon and ii) carbon dioxide. Finally, calculate the values that would be predicted by the ideal gas equation of state. (17)

CHE 111**Contd ... Q. No. 6 (b)**

The SRK equation of state is.

$$P = \frac{RT}{\hat{V} - b} - \frac{\alpha a}{\hat{V}(\hat{V} + b)}$$

and the following correlations are used:

$$a = 0.42747 (R T_C)^2 P_C$$

$$b = 0.08664 (R T_C) P_C$$

$$m = 0.48508 + 1.55171\omega - 0.1561\omega^2$$

$$\alpha = \left[1 + m(1 - \sqrt{T_r}) \right]^2$$

See attached table to find out values of ω .

7. (a) The heart pumps blood at an average rate of 5L/min. The gauge pressure on the venous (intake) side is 0 mm Hg and that on the arterial (discharge) side is 100 mmHg. Energy is supplied to the heart as heat released by the absorption of oxygen in the cardiac muscles: 5 mL(STP) O₂/min is absorbed, and 20.2 J is released per mL of O₂ absorbed. Part of this absorbed energy is converted to flow work (the work done to pump blood through the circulatory system), and the balance is lost as heat transferred to the tissues surrounding the heart. (20)

(i) Simplify the energy balance equation for this system, assuming (among other things) that there is no change in internal energy from inlet to outlet.

(ii) What percentage of the heat input to the heart (Q_{in}) is converted to flow work?

- (b) Superheated steam at T_1 (°C) and 10.0 bar is combined with saturated steam at T_2 (°C) and 7.0 bar in a ratio (1.96 kg of steam at 10 bar)/(1 kg of steam at 7 bar). The product stream is at 250°C and 7.0 bar. The process operates at steady state. (15)
Calculate T_1 and T_2 , assuming that the blender operates adiabatically.

8. (a) Calculate the standard heat of the acetylene hydrogenation reaction. (17)



Using a) tabulated heats of formation and b) heats of combustion.

- (b) n-Butane is converted to isobutene in a continuous isomerization reactor that operates isothermally at 149°C. The feed to the reactor contains 93 mol% n-butane, 5% isobutene, and 2% HCl at 149°C, and a 40% conversion of n-butane is achieved. (18)

(i) Taking a basis of 1 mol of feed gas, calculate the moles of each component of the feed and product mixtures and the extent of reaction ξ (mol).

(ii) Taking the feed and product species at an appropriate reference state, prepare the inlet-outlet enthalpy table and outline the procedure to calculate the required rate of heat transfer (kJ) to or from the reactor.

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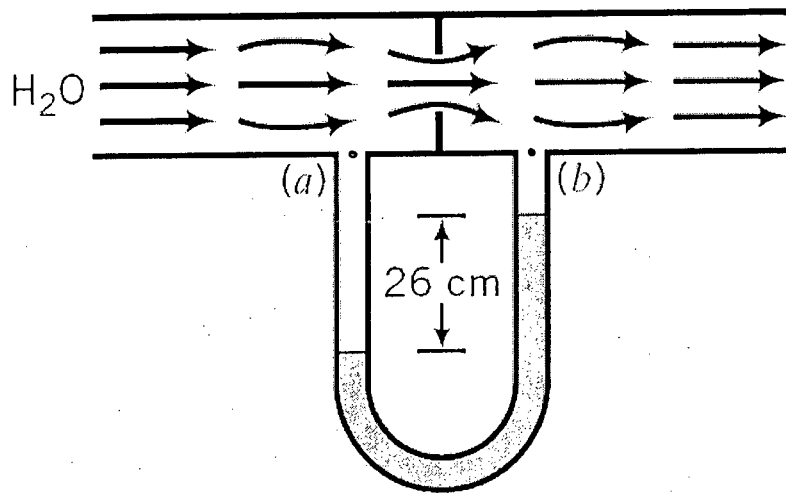
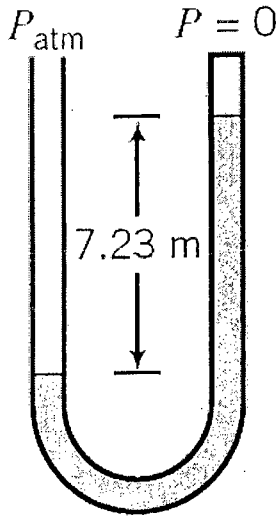


Figure for Q.2(a)

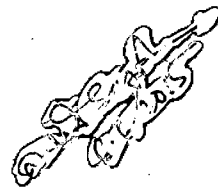
= 5 =

Pitzer Acentric Factors

Compound	Acentric Factor, ω
Ammonia	0.250
Argon	-0.004
Carbon dioxide	0.225
Carbon monoxide	0.049
Chlorine	0.073
Ethane	0.098
Hydrogen sulfide	0.100
Methane	0.008
Methanol	0.559
Nitrogen	0.040
Oxygen	0.021
Propane	0.152
Sulfur dioxide	0.251
Water	0.344

SOURCE: R. C. Reid, J. M. Prausnitz, and B. E. Poling, *The Properties of Gases and Liquids*, 4th Edition, McGraw-Hill, New York, 1986.

Table for Q. 6. (b)



SECTION – A

There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest.

Symbols indicate their usual meaning.

1. (a) Explain with reference to the context any one of the following. (8)
- (i) "Captain punishment kills a man at once, but lifelong imprisonment kills him slowly"
- (ii) "Oh! My poor Matilda! Mine were false. They were not worth over five hundred francs!"
- (b) Answer any one of the following. (10)
- (i) Make an evaluation of the changes that came over the life of the lawyer in The Bet.
- (ii) Do you think that Mrs. Matilda Loisel was responsible for her own sufferings? Why, or why not?
- (c) Answer any three of the following. (12)
- (i) What moral lesson does the story Circe's Garden carry for its readers?
- (ii) What do you know about Odysseus?
- (iii) Describe the night on which the banker proceeded to kill the lawyer.
- (iv) What impression do you get about Mr. Loisel as a husband?
2. Recast and correct any ten of the following sentences. (20)
- (i) We had a large amount of students on hand for the rally.
- (ii) Somewheres, there must be an answer.
- (iii) I was in a dilemma about what to have for dinner.
- (iv) Walt Whitman occupies a most unique place in literature.
- (v) The jury is arguing among itself.
- (vi) Both of the mouse is underfed.
- (vii) Its a long way home.
- (viii) That was me whom you saw yesterday.
- (ix) He played good in every game.
- (x) We were late due to the blowout.
- (xi) Illiteracy is when a man cannot read or write.
- (xii) He had a need and interest in athletics.

HUM 125/CHE

3. (a) Give meanings of any ten of the following words. (10)

Alleviate, congenital, deprecate, eradicate, flounder, hilarious, menace, penetrate, sinuous, traverse, vulnerable, zealot.

- (b) Make sentences with any ten of the following words. (10)

Astound, cataclysm, discern, feud, hamlet, inhabit, lustrous, morsel, retard, smolder, tributary, vestige.

4. Write a précis of the following passage with a suitable title: (20)

Technology now threatens to grow into a system, functioning purely in its own interests without regard for the best interests of mankind. Symptomatic of this is the way in which technology has been driven to evolve a special technique for suggesting to a man what he imagines he needs. We eventually arrive at a stage where man, who should be the beneficiary of modern production, becomes a slave to the productive process. On the one hand, he may buy a car, a television set or a washing machine but he becomes, on the other hand, in the office, at his machine in the factory, at his drawing board, in sales promotion, or even in the manager's office, merely a tiny cog in a gigantic organization. He performs his functions and play his part. The little humanity and individuality he must be bought at the price of living to further the aims of others. Instead of being able to participate in the lively cut-and-thrust of dealing with his fellow beings, instead of handling matters that concern real people, a modern businessman leads a remarkably abstract sort of life. The result is that feeling of 'not-belonging', so often deplored these days in public discussions. It is an inner emotion of modern man who experiences sensations of rootlessness, of belonging nowhere, who feels a stranger in his own backyard. Man's liberation from the vagaries of nature, the basic task we attributed to technology, has now become, by a strange freak of logic, man's alienation from nature. And what in its beginning seemed destined to exert a humanizing influence on man, now turns out to be brutalizing him.

SECTION – B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

5. Read the following passage carefully and answer the questions that follow: (30)

Unquestionably a literary life is for the most part an unhappy life, because if you have genius, you must suffer the penalty of genius; and, if you have only latent, there are so many cares and worries incidental to the circumstances of men of letters, as to make life exceedingly miserable. Besides, the pangs of composition and the continuous

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Contd... Q. No. 5

disappointment which a true artist feels at his inability to reveal himself, there is the difficulty of gaining the public ear. Young writers are buoyed up by the hope and the belief that they have only to throw the poem or novel into print to be acknowledged at once as new light in literature. They are never convinced that the editors of magazines and the publishers of books are practical, who are by no means frantically anxious about placing the best literature before the public. Most of them are mere commercial who conduct their business on the hardest line of profit and loss account. But supposing your book was fairly launched its perils were only beginning. You have to run the gauntlet of the critics. To a young author, again this seems as an ordeal. When you are a little older, you will find that criticism is not much more serious than the play of clowns in a circus. A time comes in the life of every author when he regards critics as comical rather than formidable. But there are sensitive souls that yield under the chastisement and, perhaps after suffering much silent torture, abandon the profession of the pen forever. But the most unwise thing in the world for an author is to take public notice of criticism in the way of defending himself. Silence is the only safe-guard as it is the only dignified protest against insult.

Questions:

- (i) How is a literary life an unhappy life?
 - (ii) What is the difficulty of a young author?
 - (iii) How can an author defend himself?
 - (iv) "criticism is not much more serious than the play of clowns in a circus"—
Explain the idea in brief.
 - (v) What is the main idea of the passage?
 - (vi) Give meanings of the following words as used in the passage:
Pangs, frantically, ordeal, chastisement, safeguard.
6. (a) Draft a suitable reply to a claim made by one of your business clients seeking appropriate steps to be taken in his favour regarding the problems that were identified with the electrical products supplied by you. (10)
- (b) Write the phonetic transcriptions of the following words. (Any five) (10)
Actual, cottage, boat, Spanish, child, leave.
7. (a) Write a dialogue between two friends about their favourite pastimes. (10)
- (b) Write a short essay on any one of the following topics: (10)
- (i) Alarming World Climate
 - (ii) Leisure in Present time
 - (iii) Facebook as a social media

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8. (a) Transform the following sentences as directed. (Any five) **(10)**
- (i) He not only cared the boy but also fined him. (Simple)
 - (ii) The accident took place, because the driver was driving recklessly.
(Compound).
 - (iii) I have no money to lend you. (Complex)
 - (iv) We believe that he is innocent. (Simple)
 - (v) Speak the truth and I shall pardon you (Simple)
 - (vi) He told me that he loved me. (Compound)
- (b) Write short notes on any two of the following: **(10)**
- (i) Vowel sounds
 - (ii) Terminator in a paragraph
 - (iii) Elements of structure of a formal report.
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **CHEM 131** (Physical Chemistry - I)

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Define the term 'solution'. Give a molecular interpretation of solution process. (3+5=8)
- (b) How lattice energy and solvation energy are mutually involved in a solution process of ionic compound in liquid? (6)
- (c) What is 'Thermal pollution'? How such pollution influence the ecosystem? (2+4=6)
- (d) Show that for a binary liquid composition obeying Raoult's law, the vapor is richer in the more volatile component. (8)
- (e) The concentrated sulfuric acid used in laboratory is 98.0 percent H₂SO₄ by mass. Calculate the molality and molarity of the acid solution. The density of the solution is 1.83 g/mL. (7)
2. (a) Draw the water and aniline mutual solubility curve at various temperatures. Mark the critical solution temperature (A), a point anywhere inside the curve (B) and a point anywhere outside the curve (C). Give the significance of point A, B and C. (9)
- (b) What are the origin of positive deviation and negative deviation of Raoult's law from the molecular view point? (8)
- (c) In the following equilibrium, how distribution law can be applied to determine the equilibrium constant experimentally. (9)

$$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$$
- (d) The distribution coefficient of an alkaloid between chloroform and water is 20 in favor of chloroform. Compare the weight of the alkaloid remaining in aqueous solution when 100 mL containing 1g has been shaken with (i) 100 mL of chloroform and (ii) two successive 50 mL portions. Comment on the results about single step and multistep extraction process. (9)
3. (a) Derive an expression which will show the manner how partial molal quantity of one component is dependent on others. (8)
- (b) Consider a liquid-vapor equilibrium and show that free energy is related with pressure in such equilibrium. (9)

CHEM 131/CHE

Contd... Q. No. 3

- (c) Molecular mass can be determined from the laws of colligative properties. Sometimes abnormal molecular mass is resulted from such calculation. How can you account such abnormality? What is your recommendation to avoid such abnormality? (5+4=9)
- (d) A chemist is trying to identify human hormone that controls metabolism by determining its molar mass. A sample weighing 0.546 g was dissolved in 15.0 g benzene and the freezing-point depression was determined to be 0.240°C. Calculate the molar mass of the hormone. (9)
4. (a) What is tyndall effect? What are the conditions required for colloidal particles to show this effect. (2+2=4)
- (b) Describe an instrumental method for the quantitative estimation of Tyndall effect. How can Tyndall effect be used to determine the size of colloidal particle? (6+3=9)
- (c) 10 Particles are counted when a solution containing 0.5 mg/L of a dispersed colloid is observed under the ultra-microscope in a field of view 0.04 mm in radius and 0.02 mm in depth. If the particles are supposed to be spherical and the density of this colloidal solution is 2.7 g/cm³, find out the radius of the particles. (10)
- (d) Why do the colloidal particles acquire electrical charge? Explain the reasons with suitable example. (7)
- (e) Why purification of colloid is necessary after preparation? How it can be purified by electro dialysis method? (1+4=5)

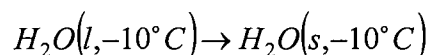
SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Why is it needed to have a thermodynamic function, free energy? What are Helmholtz free energy (A) and Gibb's free energy (G) and how are they related to each other? Prove that both A and G are thermodynamic properties. (10)
- (b) Show that the decrease in free energy ($-\Delta G$) of a system is equal to the work available from the system for useful purpose. (10)
- (c) The standard free energy change of the reaction, $\frac{3}{2}O_2(g) = O_3(g)$ is 39.1 kcal. What is the equilibrium constant of the reaction at 298°K? Comment on the result. (7)
- (d) Calculate the entropy change which results when a hot body at T_h is brought in contact with a cold body at T_c and they reach a final temperature T. Consider the bodies are both composed of 1 mole of the same material. (8)

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6. (a) Calculate the change in entropy when a mole of supercooled water freezes isothermally at -10°C , (10)



Comment on the result.

Given: The crystallization of water at 0°C evolves 80 cal/g and that at -10°C evolves 75 cal/g. The specific heat of water and ice are 1 cal/deg and 0.5 cal/deg respectively.

- (b) Derive an expression for an ideal gas being carried through the reversible Carnot cycle and prove that entropy, S is a thermodynamic property. (15)
- (c) Prove that the entropy of the universe as a result of irreversible expansion is always greater than zero. (10)

7. (a) Show that the change in kinetic energy of a free particle is equal to the work done on the particle by the external force. (6)
- (b) Show that the change in enthalpy is equal to the heat absorbed when a process is carried out at constant pressure. (6)
- (c) 'Internal energy, E of a system is a state function' — justify. (5)
- (d) Draw and explain the different regions of neutralization plot for the titration of a weak acid with strong base. (6)
- (e) What are buffer capacity and buffer range? Mention with reason the condition at which the buffer solution exhibits maximum buffer capacity. (8)
- (f) The pKa value of methanoic acid, HCOOH is 3.75. What will be the pH of the solution when one mole of HCOOH is present in 10 dm^3 solution? (4)

8. (a) What is meant by the term 'dynamic equilibrium' for a chemical reaction? How the dynamic nature of chemical equilibrium can be experimentally determined? (3+3=6)
- (b) What are the thermodynamic criteria of chemical equilibrium? Show that the equilibrium constants k_c and k_x are related by, $k_x = k_c V^{\Delta n}$, symbols have their usual meaning. (2+8)
- (c) Derive an expression that shows the influence of temperature on equilibrium constant. From this expression graphically represent the change of equilibrium constant with the change of temperature for exothermic and endothermic reactions. (8+4=12)
- (d) Calculate the pressure required to obtain 50% dissociation of PCl_5 at 250°C . The equilibrium constant, k_p for the reaction $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$ is 1.8. (7)