BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2010-2011

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 – A

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

A BLOOKLET CONTAINING ALL RELAVANT DATA TO BE PROVIDED

1. (a) The rate of nucleation in a crystallizer varies with the seed crystal diameter (D) as:

    r (crystals/min) = $200\,D - 10D^2$ (D in mm)

    (i) What are the units of the constants 200 and 10? (Assume the given equation is valid and therefore dimensionally homogeneous.) **(4)**

    (ii) Calculate the crystal nucleation rate in crystals/s corresponding to a crystal diameter of 0.050 inch. **(9)**

    (iii) Derive a formula for r (crystals/s) in terms of D (inches). **(12)**

    (b) The rate at which a substance passes through a semi-permeable membrane is determined by the diffusivity D (cm^2/s) of the gas. D varies with the membrane temperature T (K) according to the Arrherius equation: **(10)**

    $$D = D_0 \exp(-E/RT)$$

    where D_0 = the pre-exponential factor, E = the activation energy for diffusion, and R = 1.987 cal/(mol.K). A set experimental data, D (cm^2/s) vs T(K) is available. How should the data be plotted to obtain a straight line on reactangular coordinates?

2. (a) A hungry old management is trying to catch fish sitting on a floating boat in a river. On the other hand, a hungry kiddy fish, which is 20 m far from the boat and 10 m below the water surface of the river, is searching for food. What is the difference between the pressures acting on the hungry old man and the hungry kiddy fish? **(11)**

    (b) A mixture is 70.0 mol% ethyl acetate ($C_4H_8O_2$), 15.0 mol% ethyl alcohol, and 15.0 mol% acetic acid. Express this mixture in ppm (parts per million). What is the average molecular weight of the mixture? What is the molar volume of the mixture provided that the specific gravity (SG) of the mixture is 0.98? What would be the mass (kg) of a sample containing 25.0 kmol of ethyl acetate? **(24)**

3. (a) Formaldehyde may be produced in the reaction between methanol and oxygen: **(6)**

    2 CH_3OH(l) + O_2(g) → 2 HCHO(g) + 2 H_2O(l): $\Delta H^\circ_r = -325$ kJ/mol: Calculate the $\Delta \hat{U}^\circ_r$ for this reaction in kJ/mol. Given : Gas constant, R = 8.314 ×10^{-3} kJ/mol K.

    (b) The standard heats of the following reactions have been determined experimentally: **(10)**

    i. $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$: $\Delta \hat{H}^\circ_{r,i} = -286$ kJ/mol

    ii. $3C + 3O_2 \rightarrow 3CO_2$: $\Delta \hat{H}^\circ_{r,ii} = -1179$ kJ/mol

    iii. $2 C_2H_6 + 7O_2 \rightarrow 4 CO_2 + 6H_2O$: $\Delta \hat{H}^\circ_{r,iii} = -3120$ kJ/mol
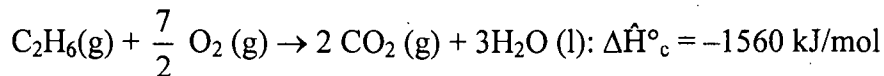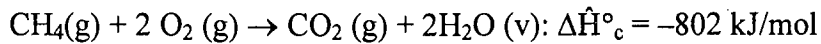
CHE 111
Contd ... Q. No. 3(b)

Use the Hess's law and the given heats of reaction to determine the standard heat of the reaction given below:

$$C + \tfrac{3}{2} H_2 \rightarrow \tfrac{1}{2} C_2H_6 : \Delta\hat{H}°_r = ?$$
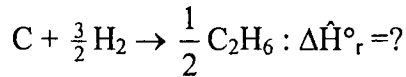
(c) The natural gas supplied by Titas (Bangladesh) contains 76% CH_4 and 24% C_2H_6 by mass. The heats of combustion of CH_4 and C_2H_6 at 25°C and 1 atm are given below. **(14)**

$$CH_4(g) + 2\,O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(v): \Delta\hat{H}°_c = -802\ kJ/mol$$

$$C_2H_6(g) + \frac{7}{2}\,O_2\,(g) \rightarrow 2\,CO_2\,(g) + 3H_2O\,(l): \Delta\hat{H}°_c = -1560\ kJ/mol$$

Calculate the lower heating value (kJ/g) of the natural gas supplied by Titas (Bangladesh). Given ΔH_v (H_2O, 25°C) = 44 kJ/mol.

(d) Why should the adiabatic flame temperature of a fuel be much higher if burnt with pure oxygen than with air? **(5)**

4. (a) Gaseous ammonia is oxidized with air in a packed bed reactor to form nitric oxide in the first step of the production of nitric acid. The main reaction are given below:

$$4\,NH_3 + 5O_2 \rightarrow 4\,NO + 6\,H_2O$$
$$2\,NH_3 + \frac{3}{2}\,O_2 \rightarrow N_2 + 3\,H_2O$$
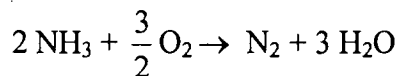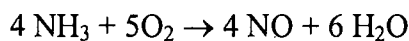
The gaseous ammonia is fed to the reactor at a motor flow rate of 100 mol/min and 25°C & 8 atm. On the other hand, the dry air is fed to the reactor at a moler flow rate of 900 dry air/min and 150° C & 1 atm. Having a molar flow rate of 90 mol NO/min, 150 mol H_2O (v)/min, 716 mol N_2/min, and 69 mol O_2/min the product stream leaves the reactor at 700°C and 15 atm.

(a) Draw and label the flow chart. **(2)**

(b) What methods are available to determine the change in enthalpy ($\Delta\hat{H}$)? **(2)**

(c) Write down the appropriate reference states for enthalpy calculation for each of methods available. **(8)**

(d) Write down the assumption which is required to be made on the behavior of gaseous reactants and products to determine the specific enthalpies at the inlet and outlet conditions. How does this assumption help the determination of specific enthalpies? **(2+3=5)**

(e) Calculate the change in enthalpy ($\Delta\hat{H}$) using the most suitable method. **(13)**

(f) Calculate the required rate of heat transfer to or from the reactor in kW. **(5)**

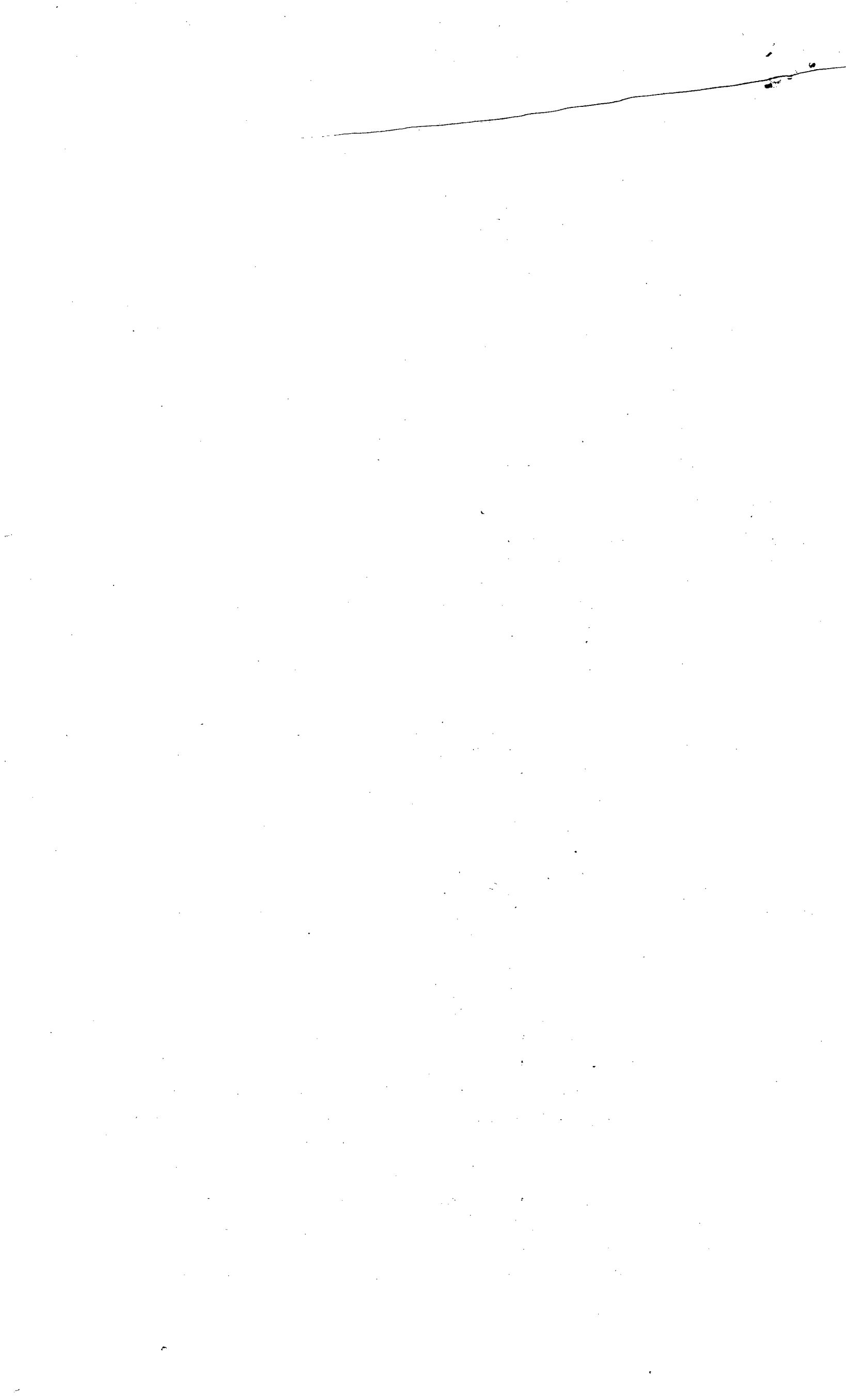## SECTION – B
There are **FOUR** questions in this Section.
Answer Q. No. 5 and any **TWO** from the rest. Q. No. 5 is COMPULSORY.

5. (a) How would you define a chemical engineer? What does a chemical engineer do? Why should you consider chemical engineering a profession? **(8)**

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Contd ... Q. No. 5

(b) List the major raw materials available in Bangladesh for building chemical industries. Name three chemical plants based on these materials now in operation in Bangladesh. **(6)**

(c) List the energy sources of Bangladesh. What are the fuels for power plants in Bangladesh? **(6)**

(d) Production of Zinc Sulfate involves a reaction between Zinc metal and dilute sulfuric acid. The product is $ZnSO_4, 7H_2O$ and is used as a plant micro-nutrient in Bangladesh. Cost of Zinc is \$ 1200/ton (\$ = Tk 80/-) and cost of 98% by weight H_2SO_4 is Tk 16,000/- per ton. The reaction involved is: $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ **(15)**

    [Atomic wts. of Zn = 65.38,   S = 32]
Calculate the cost of raw materials for making one ton (1000 kg) of $ZnSO_4$, $7H_2O$.

6. Carbon Disulfide is burned with air ton form CO_2 and SO_2 as shown below:

$$CS_2 + 2O_2 + N_2 \rightarrow CO_2 + SO_2 + N_2$$

Calculate the followings:

(a) Moles of SO_2 produced per mole of air (molar composition of air: N_2=79%, O_2=21%) **(12)**

(b) The molar flow rate of oxygen corresponding to a feed rate of 5000 kg of CS_2 per hour if the reactants are fed in stoichiometric proportion. **(10)**

(c) Find the molar composition of the products if the reaction proceeds to completion in presence of 10% excess air. **(13)**

7. (a) Explain the following terms with examples (use sketch or chemical reaction as appropriate) **(5×4=20)**

    (i) Semibatch process
    (ii) Steady State Process
    (iii) A balanced process
    (iv) Yield and selectivity for a reacting system
    (v) Theoretical and Excess Air in a combustion process

(b) The following analysis is given for a wet gaseous stream in mole per cent leaving a reactor:

    $N_2 = 20$, $O_2 = 5$, NO = 45 and $H_2O = 30$

Recalculate the analysis on dry basis and express it in weight per cent. **(15)**

8. (a) An acid is extracted from bark containing 4% moisture, 37% acid and 23% soluble non-acid matter. The residue removed from the extraction vats contains 62% moisture, 3% acid and 0.9% non-acid matter. Calculate the percentage of the acid in the original bark remains unextracted in the residue. (All composition are expressed in weight percent). **(20)**

(b) A distillation column handles 84,000 kg of feed per hour containing 45 mol% benzene and 55 mol % toluene at its boiling point. The overhead product from the column must contain 92 mol % benzene while the bottom product must contain 95 mol% toluene at the specified reflux ratio.

Sketch the distillation column system and carry out the material balance around the column to show the stream flow rates. **(15)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2010-2011

Sub : **HUM 125** (English)

Full Marks: 140   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE** questions including question No: 1 as compulsory.

1.   (a) Explain with reference to the context any one of the following.   **(08)**

   (i)   "How singular is life, and how full of changes! How small a thing will ruin or save one!"

   (ii) "The geniuses of all ages and of all lands speak different languages, but the same flame burns in them all."

   (b) Answer any one of the following.   **(10)**

   (i)   Make an appreciation of the changes that came over the life of the lawyer in the story of 'The Bet'.

   (ii) Give a character-sketch of Mrs. Matilda Loisel according to the story of 'The Diamond Necklace'.

   (c) Answer any three of the following questions.   **(12)**

   (i)   What did Odysseus do with the deer that he found on his way back to his ship?

   (ii) How did Circe trap the people of Odysseus?

   (iii) Why did Mrs. Forestier fail to recognize her friend?

   (iv) Briefly describe the terms and conditions of the bet arranged between the banker and the lawyer.

   (v)   Who according to you, actually won the bet?

2.   Recast and correct any ten of the following sentences.   **(20)**

   (i)   We have less students this year than we had last year.

   (ii) Providing that he is not tired, he will address the group.

   (iii) We heard a sound somewheres in the distance woods.

   (iv) The militia is discussing the battle among itself.

   (v)   Jon is the one of the boys who are on time.

   (vi) If I were him, I should not accept the post.

   (vii) Abraham Lincoln was one of the great man in American history.

HUM 125

Contd ... Q. No. 2

(viii)I wish I was as tall as my brother.

(ix) We had a real good time.

(x) He is something better today.

(xi) The man spoke to the lion with a cigar in the corner of his mouth.

(xii) This box is more square than that one.

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

Admonish, Concoct, entice, hilarious, indictment, morrow, rancor, prank, sinuous, tapered, tyro, zealot.

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

Avarice, brawl, clemency, dent, exasperate, flounder, grudge, holocaust, meddle, nadir, sever, wither.

4. Write a precis of the following passage with a suitable title. **(20)**

Men are not made in the same mould, like a lot of bricks. It would have ill-suited the wants of the world if it had been so. Consequently, even in the same country, men differ in disposition and inclination and manners and opinions, more probably than they do in face or form. And between the people of different countries the contrast is even more striking. We have then also, different sentiments, different sympathies, different hopes, different ways together. It will always be so. So long as there are different minds, there will be different views on all matters that admit of opinion. So long as there are different degrees or latitude and longitude as well as differing circumstances there will be different interests, different attachments and different habits. It behaves us, therefore, to cultivate a generous spirit of forbearance towards those, of whatever race, who may think differently and act differently, from ourselves. Even though we may be convinced that they are wrong, if we know them to be sincere, we should still bear with them and give them credit for their sincerity.

SECTION – B

There are **FOUR** questions in this Section. Answer question No. 5 and

any other two from the rest.

5. Read the following passage carefully and answer the questions given below: **(30)**

Education has always had two objects: on the one hand, to give skill; and on the other, to import a vaguer thing which we may call wisdom. The role of skill has become very

HUM 125

Contd ... Q. No. 5

much larger than it used to be and is increasingly threatening to oust the role of wisdom. At the same time it must be admitted that wisdom in our world is useless except for those who realize the great part played by skills, for it is increase of skill that is the distinctive feature of your world.

Although scientific skill is necessary, it is by no means sufficient. A dictatorship of men of science would very soon become horrible. Skill without wisdom may prove to be purely destructive. For this reason, if for no other, it is of great importance that those who receive a scientific education should not be merely scientific, but should have some understanding of that kind of wisdom which, if it can be imparted at all, can only be imparted by the cultural side of education. Science enables us to know the means to any chosen end, but it does not help us to decide upon what ends should be pursued. If we wish to exterminate the human race, it will show you how to do it. If you wish to make the human race so numerous that all are one the very verge of starvation, it will show you how to do that. If you wish to secure adequate prosperity for the whole human race, science will tell you what you must do. But it will not tell you whether one of these ends is more desirable than another. Nor will it give you that instinctive understanding of human beings that is necessary if your measures are not to arouse fierce opposition which only ferocious tyranny can quell. It cannot teach you patience, it cannot teach you sympathy, it cannot teach you a sense of human dignity. These things, insofar as they can be taught in formal education, are most likely to emerge from the learning of history and great literature.

Questions:

    (i)   What should, according to the writer, be the aim of education?

    (ii) Why is increase of skill a distinctive feature of our word?

    (iii) What danger does the writer see in the present emphasis on imparting skill?

    (iv) What is the difference between 'knowledge' and 'wisdom'?

    (v) Why should we study history and great literature?

    (vi) Give the meanings of the following words as used in this passage:

          impart, distinctive, exterminate, tyranny, starvation.

6.   (a) As the Purchase Officer of an organization you had ordered 12 dozen bedsheets after examining the samples sent by the wholesaler. When the consignment arrives you find that neither in texture nor in shades do the sheets conform to the sample you had approved. Write a claim letter requesting their replacement.   **(10)**

HUM 125

Contd ... Q. No. 6

(b) Give phonetic transcriptions of the following words: (Any five)   **(10)**

enrich, extra, mouth, bear, chain, pleasure.

7.   (a) Write a dialogue between two friends about selecting an optional subject from the courses offered by the Department of Humanities.   **(10)**

(b) Write a short essay on any one of the following topics: **(10)**

  (i)   Modern Society and Traditional values

  (ii). Drugs: A Road to Death

  (iii) Technology Today

8.   (a) Transform the following sentences as directed: (Any five)   **(10)**

  (i)   Whatever you do, I will support. (Make it Simple)

  (ii)   In my hurry I forgot the most important letters. (Make it Complex)

  (iii) Your promotion depends on the quality of your work. (Make it Complex)

  (iv) I do not like him on account of his pride and boast·fullness. (Make it Compound)

  (v)   If I am right, you must be wrong. (Make it Compound)

  (vi) He works only for money. (Make it Complex)

(b) Write short notes on any two of the following: **(10)**
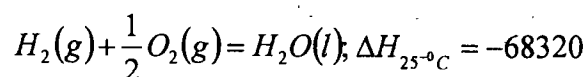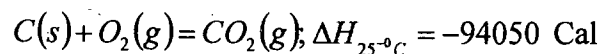
  (i)   Diphthongs

  (ii) Terminator in a paragraph

  (iii) Types of Reports.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2010-2011

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

Full Marks: 210   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What is enthalpy? Show that the change in enthalpy is equal to the heat absorbed when a process is carried out at constant pressure. Deduce a relation between the change in enthalpy and change in internal energy in case of a reaction involving ideal gases at constant temperature. **(10)**

   (b) Justify that the internal energy (E) is a state function but work (W) is not a state function. **(8)**

   (c) Heat neutralization ($\Delta H^o_{25^\circ C}$) of HCl with NaOH is –13,360 cal but heat of neutralization ($\Delta H^o_{25^\circ C}$) of HCN with NaOH is –2460 cal. Comment on the difference between the heats of neutralization. **(7)**

   (d) For the following reaction calculate $\Delta H^o_{25^\circ C}$. **(10)**

   $$2C(s) + 2H_2(g) + O_2(g) = CH_3COOH(L)$$
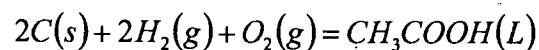
   Given: $CH_3COOH(l) + 2O_2(g) = 2CO_2(g) + 2H_2O(l); \Delta H_{25^\circ C} = -208340$ Cal

   $$C(s) + O_2(g) = CO_2(g); \Delta H_{25^{-0}C} = -94050 \text{ Cal}$$

   $$H_2(g) + \frac{1}{2}O_2(g) = H_2O(l); \Delta H_{25^{-0}C} = -68320$$

2. (a) Discuss with suitable examples, how the heat change in a reaction depends on the physical states of reactants and products. **(10)**

   (b) Deduce kirchhoff's equation showing the influence of temperature on heat of reaction. **(12)**

   (c) Calculate ΔH at 298 K for the following reaction, **(13)**

   $$N_2(g) + 3H_2(g) = 2NH_3(g)$$
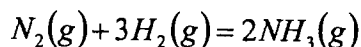
   ΔH_0 for the reaction is –19000 Cal mol^{-1} and the molar heat capacities are:

   $$Cp_{(N_2)} = 6.5 + 10 \times 10^{-4}T \text{ Cal deg}^{-1}$$

   $$Cp_{(H_2)} = 6.5 + 9 \times 10^{-4}T \text{ Cal deg}^{-1}$$

   $$Cp_{(NH_3)} = 8.04 + 7 \times 10^{-4}T + 5.1 \times 10^{-6}T^2 \text{ Cal deg}^{-1}$$

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3. (a) Discuss why the combination Q/T has been chosen to define entropy, S. **(7)**

   (b) What is a Carnot cycle? With the help of a Carnot cycle operating with an ideal gas justify ds is an exact differential and consequently the entropy, S is a thermodynamic property. **(15)**

   (c) Why do you need to have a new thermodynamic function, free energy? Discuss how free energy changes at constant temperature and pressure for reversible and irreversible processes: comment on the suitability of free energy change as a criterion for equilibrium in chemical systems. **(13)**

4. (a) What do you understand by the term 'dynamic equilibrium'? **(6)**

   (b) Establish a relation between the free energy change and equilibrium constant of a reaction. **(12)**

   (c) Derive an expression for the variation of equilibrium constant with temperature. **(10)**

   (d) The equilibrium constant for the reaction $N_2 + 3H_2 = 2NH_3$ is 1.64×10^{-4} at 400°C and 0.144×10^{-4} at 500°C. Calculate the mean heat of formation of 1 mole of ammonia from its elements in this temperature range. **(7)**

SECTION – B

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

5. (a) Explain how dissolution of a non-polar solute occurs in a polar solvent. Sketch the physical views of a solution and a suspension. How these two can be differentiated experimentally? **(4+6=10)**

   (b) What is dynamic equilibrium? Represent the dynamic equilibrium that exists in a saturated solution and discuss the effects of external stresses on the equilibrium based on the Le Chatellier principle. **(2+2+6=10)**

   (c) What is solubility curve (SC)? Classify SC and discuss them all with suitable examples and illustrations. How temperature and solubility are related? Explain the temperature dependence solubility using the Clausius-Clapeyron equation. **(7+8=15)**

6. (a) Explain the ideality of a liquid system based on Raoult's law. Draw and describe the vapour pressure-composition curves for a binary liquid system when deviates from ideality. **(4+6=10)**

   (b) What is 'azeotropic mixture'? Discuss its temperature-composition curves showing boiling points minimum and maximum. **(2+8=10)**

CHEM 131

(c) State clearly the Bunsen absorption co-efficient and Ostwald solubility co-efficient. Deduce mathematically the relationship between solubility of a gas and its mass and mole fraction. Calculate the solubility of N_2 gas in water (1.0 kg) exposed to air at 25°C; partial pressure of N_2 gas is 0.781 atm. ($K_{N_2} = 6.51 \times 10^7$ torr). **(4+6+5=15)**

7. (a) State and explain the Nernst distribution law. **(6)**

    (b) Derive the distribution law from thermodynamic consideration. **(9)**

    (c) How is the distribution law modified when the solute undergoes association in one of the two solvents? How will you determine the extent of association of a solute? **(13)**

    (d) The distribution of benzoic acid between water and benzene is given below: **(7)**

Concentration of acid in water (C_1)	Concentration of acid in benzene (C_2)
0.150	0.242
0.190	0.422
0.289	0.970

From these data, prove that benzoic acid exists in benzene as dimmer.

8. (a) Explain the origin of charge on colloidal particles. **(7)**

    (b) What is electrophoresis? How does this phenomenon provide information regarding the sign of charge on colloidal particles? **(13)**

    (c) State and explain the Hardy-Schulze rule. **(7)**

    (d) A solution containing 0.2 mg/L of a suspended material whose density is 2.2 g/cm^3 is observed under the ultramicroscope in a field view of 0.04 mm in diameter and 0.03 mm in depth. On an average, the field view was found to contain 8.5 particles. Assuming them to be spherical, calculate the diameter of the particles. **(8)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2010-2011

Sub : **MATH 123** (Integral Calculus and Differential Equations)

Full Marks: 210   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Symbols used have their usual meanings.

1. Carryout

    (a) $\int \dfrac{2 + 3\sin x - \cos x}{1 + \cos x + \sin x}\, dx$.   **(13)**

    (b) $\int \dfrac{e^x (1 + \sin x)}{1 + \cos x}\, dx$.   **(11)**

    (c) $\int \sin^{-1} \sqrt{\dfrac{x}{x+1}}\, dx$.   **(11)**

2. Find the value of

    (a) $\displaystyle\int_0^{\pi/2} \log \sin x\, dx$.   **(12)**

    (b) $\displaystyle\int_0^{\pi/2} \dfrac{x\, dx}{\sin x + \cos x}$.   **(12)**

    (c) $\displaystyle\int_0^1 \dfrac{x^3 \sin^{-1} x}{\sqrt{1 - x^2}}\, dx$.   **(11)**

3. (a) Obtain a reduction formula for $\int \cos^m x \sin nx\, dx$ and hence evaluate $\int \cos^2 x \sin 4x\, dx$.   **(20)**

    (b) Prove that $\left|\overline{\dfrac{1}{2}}\right. = \sqrt{\pi}$ and using the result show that $\left|\overline{\left(-\dfrac{3}{2}\right)}\right. = \dfrac{4}{3}\sqrt{\pi}$.   **(15)**

4. (a) Find the common area between the circles $x^2 + y^2 = 4$ and $x^2 + y^2 = 4x$.   **(12)**

    (b) Determine the entire area of the curve $x^{2/3} + y^{2/3} = a^{2/3}$.   **(11)**

    (c) Find the volume of the solid of revolution of the lemniscate $r^2 = a^2 \cos 2\theta$ about the initial line.   **(12)**

MATH 123

SECTION – B

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

5. (a) Find the differential equation of the family of circles with center on the line $y = -x$, and passing through the origin. **(13)**

   (b) Solve $(x+y)^2 \dfrac{dy}{dx} = a^2$. **(10)**

   (c) Solve $\dfrac{dy}{dx} - y\tan x = -y^2 \sec x$. **(12)**

6. Solve the following differential equations:

   (a) $(2x+y+3)\dfrac{dy}{dx} = x + 2y + 3$. **(11)**

   (b) $(1+y^2)dx + (x - \tan^{-1} y)dy = 0$. **(12)**

   (c) $(6x + y^2)dx + y(2x - 3y)dy = 0$. **(12)**

7. (a) The population x of a certain city satisfies the logistic law $\dfrac{dx}{dt} = \dfrac{1}{10^2}x - \dfrac{1}{10^8}x^2$ where time t is measured in years. Given that the population of this city is 10^6 in 2011, determine the population as a function of time for $t > 2011$. In particular answer the following questions: **(20)**

      (i) What will be the population in 2020?

      (ii) In what year will the population of 2011 be doubled?

      (iii) How large will the population ultimately be?

   (b) Solve $x\dfrac{d^2 y}{dx^2} + (x-2)\dfrac{dy}{dx} - 2y = x^3$. **(15)**

8. (a) Solve $(D^4 + 2D^2 + 1)y = x^2 \cos x$. **(12)**

   (b) Solve $x^2 \dfrac{d^2 y}{dx^2} - x\dfrac{dy}{dx} - 3y = x^2 \log x$. **(11)**

   (c) Solve $(1-x^2)\dfrac{d^2 y}{dx^2} - x\dfrac{dy}{dx} = 2$. **(12)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2010-2011

Sub : **PHY 105** (Structure of Matter, Electricity and Magnetism and Modern Physics)

Full Marks : 210   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THEEE**.

1. (a) Distinguish between crystalline and amorphous solids. Of these two states, which state is more favourable and why? **(9)**

(b) Define packing fraction for a crystal system. Calculate packing fraction for sc, bcc and fcc crystal systems. **(18)**

(c) An element is cubic with lattice constant 4.28 Å 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 neighbors does each atom have in this element, and how far away are they? **(8)**

2. (a) Define lattice parameters of a unit cell. Write down the conventional unit cell characteristics of orthorhombic and hexagonal crystal systems. **(12)**

(b) What are Miller indices? How the Miller indices are determined? **(15)**

(c) Determine the Miller indices of a plane that makes an intercept of 3 Å, 4 Å and 5 Å on the coordinate axes of an orthorhombic crystal with $a : b : c = 1 : 2 : 5$. **(8)**

3. (a) Discuss various types of bonds in solids **(17)**

(b) Write short notes on: **(18)**

    (i) Bragg's law

    (ii) Screw dislocation

    (iii) Co-ordination number.

4. (a) State Ampere's law. Apply this law to find the magnetic field at the centre of a toroid. **(13)**

(b) Obtain an expression for the force per unit length between two parallel current carrying conductors. When will the force be attractive and when repulsive. **(16)**

(c) Calculate the flux density at the centre of a coil if there are 2000 turns wound on a solenoid 50 cm long and carrying a current of 16 amperes. **(6)**

PHY 105(CHE)

SECTION – B

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

5. (a) State Gauss' law. Why it is important in electrostatics? How coulomb's law follows from Gauss' law? **(12)**

(b) Show that the electric field at a point between two similarly but oppositely charged plates is constant but zero outside the plates. **(15)**

(c) Two charged concentric spheres have radii of 10 cm and 15 cm. The charge on the inner sphere is 4×10^{-8} C, and on the outer sphere is 2×10^{-8} C. Find the electric field (i) at 12 cm and (ii) at 20 cm from the centre. **(8)**

6. (a) Define resistance and capacitance. **(6)**

(b) Derive the equation $Q = Q_0(1 - e^{-t/RC})$ for charging in a RC circuit, where the terms have their usual meanings. What do you understand by time constant? Does the charging depend on the value of the time constant? **(19)**

(c) A capacitor of capacitance C is discharging through a resistor of resistance R. In term of the time constant $\tau = RC$ (i) when will the charge on the capacitor be half its initial value? (ii) When will the energy stored in the capacitor be half its initial value? **(10)**

7. (a) Write down the postulate of special theory of relativity. What are the basic differences between special theory of relativity and general theory of relativity? **(8)**

(b) What do you understand by time dilation and length contraction? Derive the expression of length of a stick measured by an observer using both Lorentz transformation and inverse Lorentz transformation. **(17)**

(c) Show that the relativistic acceleration transformation equation along x direction is

$$a'_x = \frac{a_x \left(1 - \dfrac{u^2}{c^2}\right)^{3/2}}{\left(1 - \dfrac{u}{c^2} v_x\right)^3}$$ where the terms have there usual meanings. **(10)**

8. (a) What do you mean by half-life and mean life-time of a radioactive substance? Obtain an expression for the mean life-time of a radioactive substance. **(14)**

(b) What is Q-value of nuclear reaction? Derive an expression for the Q-value of a nuclear reaction in a laboratory co-ordinate system. **(15)**

(c) U_{238} and U_{235} occur in nature in an atomic ratio 140 : 1. Calculate the age of the earth, assuming that at the time of the earth's formation the two isotopes were present in equal amounts (half life of U_{235} and U_{238} are 7.13×10^{-8}y and 4.5×10^{-9}y respectively). **(6)**