BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-2   B.Sc. Engineering Examinations 2014-2015
Sub : **CHE 111** (Elements 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 Q. No. 1 and any **TWO**. Question 1 is
UNDERLINE COMPULSORY.

1. COMPULSORY:

(a) Write down the main three rules for determining significant figures in a number.   **(3)**

(b) The waste water from a tannery contains 1 ppm of total chromium. Show that this is
equivalent to 1 mg chromium/litre of waste water, approximately.   **(5)**

(c) Suppose a gas is flowing through a cone-shaped pipe at steady state   **(5)**
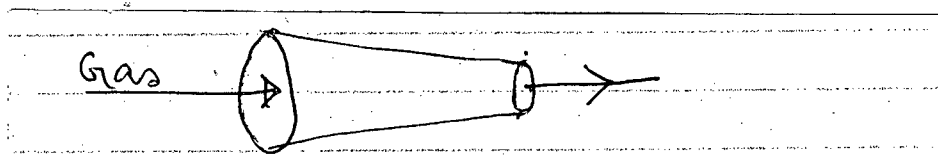
How do the mass flow rates of the gas at the inlet and outlet compare? If the density of
the gas is constant, how do the volumetric flow rates at these two points compare?

(d) What is selectivity? Explain with an example.   **(5)**

(e) Explain and state reasons for using the following: **(6)**

(i) Bypass streams (ii) Recycle (iv) Purge streams

(f) What do you mean by percent excess air? How does it affect the temperature of the
combustion chamber? Explain.   **(5)**

(g) Classify the following process as batch/semibatch/continuous and transient/steady-
state: **(6)**

   (i) A tank is filled with natural gas at a steady rate of 5 g/min.

   (ii) Water is boiled in an open flask.

   (iii) A "Pepsi" can is taken from the refrigerator and left on the table.

2. (a) The Prandtl Number, N_{Pr}, is defined as   **(10)**

$$N_{Pr} = \frac{C_p \mu}{k}$$

where, Cp is the heat capacity of a fluid,
   μ = is the fluid viscosity, and
   k is the thermal conductivity. For a particular fluid,
   Cp = 0.583 J/(g.°C), k = 0.286 W/(m.°C), and
   μ = 2000 lbm/(ft.h).
Determine the value of N_{Pr} with its unit.

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Contd ... Q. No. 6

(b) Apple contains about 20 wt% solids and the rest water. To make apple jam, crushed apple and sugar are mixed in a 50:50 ratio and the mixture is heated to evaporate water until the residue contains one-third water by mass. Draw and label the flow-chart of this process. Calculate how many pounds of apples are needed to make a pound of jam. **(25)**

3. (a) Three different liquids are used in the manometer shown in Fig. Q. 3(a). Derive an expression for $P_1 - P_2$ in terms of ρ_A ρ_B ρ_C h_1 and h_2. Suppose fluid A is methanol, B is water, and C is a manometer fluid with a specific gravity of 1.37; pressure P_2 = 121.0 kPa; h_1 = 30.0 cm and h_2 = 24.0 cm. Calculate P_1 in kPa. SG of methanol is 0.792. **(18)**

(b) An Orset analysis yields the following dry basis composition: **(17)**

N_2 – 60%, CO_2 – 20%, CO – 10%, O_2 -10% A humidity measurement shows that the mole fraction of H_2O in the stack gas is 0.10. Calculate the stack gas composition on a wet-basis. **(17)**

4. (a) Ethylene oxide is produced by the catalytic oxidation of ethylene: **(25)**

$$C_2H_4 + \frac{1}{2}O_2 \rightarrow C_2H_4O$$

An undesired competing reaction is the combustion of ethylene to CO_2. The feed to the reactor contains 3 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 85 moles of ethylene oxide emerges in the reactor products. A multiple unit process is used to separate the products: unreacted ethylene and oxygen are recycled to the reactor, ethylene oxide is sold as a products and carbon dioxide and water are discarded. Draw and label the flow chart. Calculate the molar flow-rates of ethylene and oxygen in the fresh feed needed to produce 1 ton per hour of ethylene oxide.

(b) One hundred kmol/hr of a natural gas containing 94.4 mole% methane, 3.40% ethane, 0.60% propane, 0.50% butane, 0.05% S and the rest inert is the be burned with 20% excess air. Calculate the required molar flow rate of the air. **(10)**

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SECTION – B

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

5. (a) A gas cylinder filled with nitrogen at STP has a mass of 37.289 g. The same container filled with carbon dioxide at STP has a mass of 37.440 g. When filled with an unknown gas at STP, the container mass is 37.062 g. Calculate the molecular weight of the unknown gas, and then state its probable identity. **(15)**

(b) An ideal gas mixture contains 35% helium, 20% Methane and 45% Nitrogen by volume at 2 atm absolute pressure and 90°C. Calculate (i) the partial pressure of each component (ii) the mass fraction of methane (iii) the average molecular weight of the gas, and (iv) the density of the gas in kg/m^3. **(20)**

6. (a) Consider an automobile with a mass of 5500 lbm braking to a stop from a speed of 55 miles/h. **(15)**

   (i) How much energy (Btu) is dissipated as heat by the friction of the braking process?

   (ii) Suppose that in Bangladesh, 300,000,000 such braking processes occur in the course of a given day. Calculate the average rate (MW) at which energy is being dissipated by the resulting friction.

(b) The specific enthalpy of liquid n-Hexane at 1 atm varies linearly with temperature and equals 25.8 kJ/kg at 30°C and 129.8 kJ/kg at 50°C.

   (i) determine the equation that relates H(kJ/kg) to T(°C) and calculate the reference temperature on which the given enthalpies are based. Then derive an equation for U(T) (kJ/kg) at 1 atm.

   (ii) Calculate the average heat transfer rate required to cool 20 kg of liquid n-Hexane from 80°C to 20°C in 5 min.

7. (a) n-Butane is converted to isobutene in a continuous isomerization reactor that operates isothermally at 149°C. The feed to the reactor contains 93 mole% n-butane, 5% isobutene and 2% HCl at 149°C, and a 40% conversion of n-butane is achieved. **(12)**

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

   (ii) Calculate the standard heat of the isomerization reaction (kJ/mol).

(b) Three hundred L/h of a 20 mole% C_3H_8 – 80% n-C_4H_{10} gas mixture at 0°C and 1.1 atm and 200 L/h of a 40 mole% C_3H_8 – 60% n-C_4H_{10} C_4H_{10} mixture at 25°C and 1.1 atm are mixed and heated to 227°C at constant pressure. **(23)**

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Contd ... Q. No. 7(b)

Calculate the heat requirement in kJ/hr. Enthalpies of propane and n-butane are listed below. Assume ideal gas behavior.

T $\hat{H}$ (°C)	Propane $\hat{H}$ (J/mol)	Butane $\hat{H}$ (J/mol)
0	0	0
25	1772	2394
227	20685	27442

8. A gaseous fuel containing methane and ethane is burned with excess air. The fuel enters the furnace at 25°C and 1 atm, and the air enters at 200°C and 1 atm. The stack gas leaves the furnace at 800°C and 1 atm and contains 5.32 mole% CO_2, 1.60% CO, 7.32% O_2, 12.24% H_2O, and the balance N_2.

   (i) Calculate the molar percentage of methane and ethane in the fuel gas and the percentages excess air fed to the reactor.

   (ii) Calculate the heat (kJ) transferred from the reactor per cubic meter of fuel gas fed. **(35)**
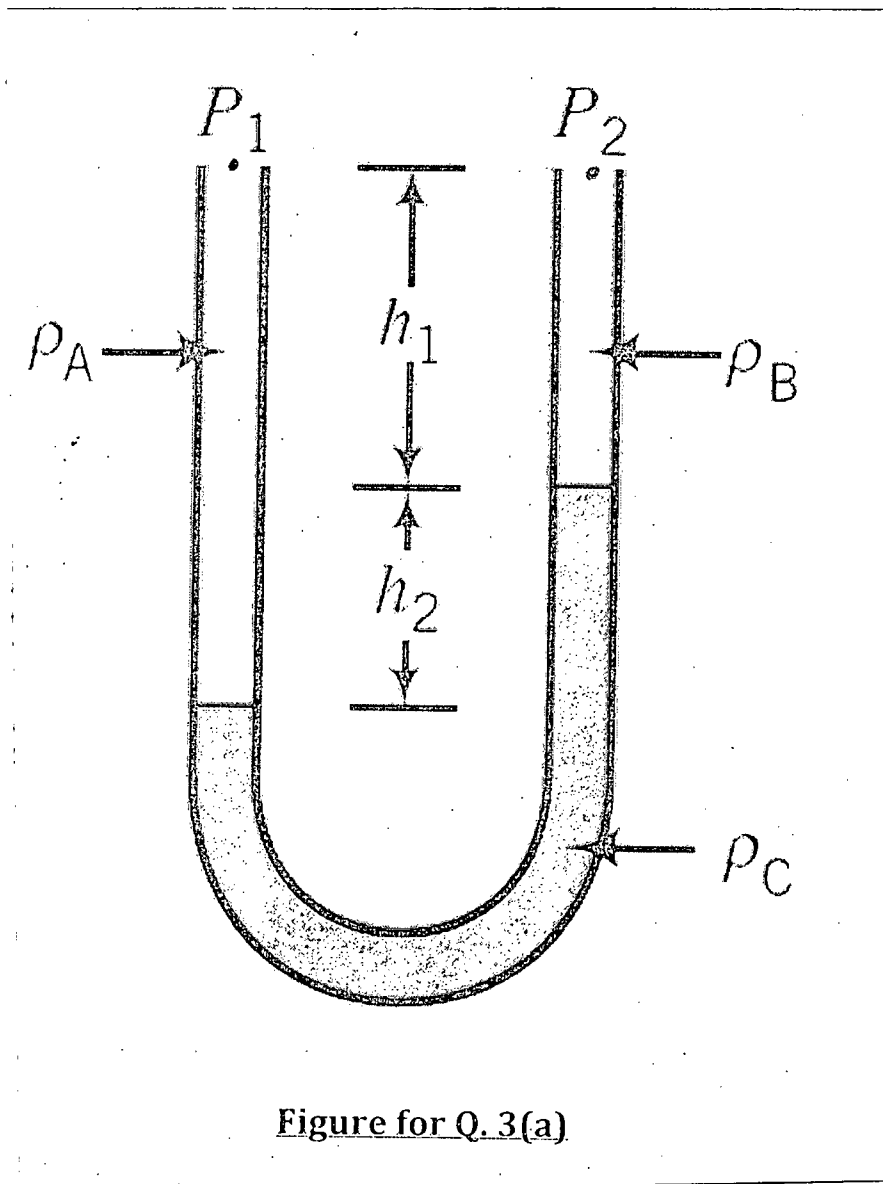

Figure for Q. 3(a)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2014-2015

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) Define "thermodynamic equilibrium constant. What are its physical significance?   **(6)**

   (b) Derive a relation between the standard free energy change and the terhmodynamic equilibrium constant of a reaction.   **(14)**

   (c) What are the factors that can influence chemical equilibrium? Explain the effect of an inert gas on the equilibrium of the following reaction.   **(7)**

   $$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$
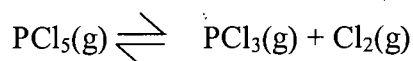
   (d) At 2000 K, the standard free energy change for the reaction $N_2 + O_2 \rightleftharpoons 2NO$ is given by $\Delta G° = 92048 - 10.46 \times T$ J. Calculate the K_p for the reaction.   **(8)**

2. (a) Define heat of solution. State the difference between differential and integral heat of solution.   **(10)**

   (b) Define heat capacity. Establish the relation between the heat capacities of the reactants and the heat of reaction.   **(14)**

   (c) For the reaction $N_2(g) + 3H_2(g) = 2NH_3(g)$, the value of $\Delta H°$ is $- 22.08$ Kcal at 25°C. The molar heat capacities at constant pressure of nitrogen, hydrogen and ammonia can be expressed as functions of absolute temperature in the following manner: **(11)**

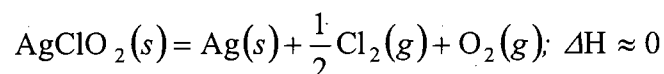 $$C_{N2} = 6.449 + 1.413 \times 10^{-3}\, T - 0.807 \times 10^{-7}\, T^2 \text{caldeg}^{-1}$$
   $$C_{H2} = 6.947 - 0.200 \times 10^{-3}\, T + 4.808 \times 10^{-7}\, T^2 \text{caldeg}^{-1}$$
   $$C_{NH3} = 6.189 + 7.887 \times 10^{-3}\, T - 7.28 \times 10^{-7}\, T^2 \text{caldeg}^{-1}$$

   Calculate the standard heat of reaction at 125°C.

3. (a) Show that all spontaneous processes are accompanied by an increase in entropy.   **(10)**

   (b) $AgClO_2$ on jentle heating decomposes in accordance with the following equation:

   $$AgClO_2(s) = Ag(s) + \frac{1}{2}Cl_2(g) + O_2(g); \quad \Delta H \approx 0$$

   How can you explain the spontaneity of the process?   **(6)**

   (c) Establish the condition under which ΔG can be used to define the spontaneity of a process.   **(11)**

   (d) Calculate the free energy change accompanying the compression of 1 mole of CO_2 at 57°C from 5 atm to 50 atm. Assume that CO_2 behaves like an ideal gas.   **(8)**

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4. (a) What is meant by the term "Chemical potential"? **(4)**

(b) Starting from the ideal gas equation deduce the relation between the chemical potential and the activity of a component in a mixture. **(14)**

(c) Define fugacity. Obtain a relationship between the fugacity and the pressure of a gas. **(11)**

(d) Calculate the fugacity of a gas at 450 atm pressure and 300 K with

$\alpha = -7.5 \times 10^{-4}$ dm^3 mol^{-1} **(6)**

SECTION – B

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

5. (a) The effervescence of soft drinks happens when the cap of the bottle is removed. The phenomenon is related with the solubility of gas in liquid. How this phenomenon can be explained quantitatively? How can you consider the greater solubility of oxygen in blood compared to other solvents? **(5+3=8)**

(b) State the principle which demonstrates the distribution of a solute into two immiscible solvents? How this principle can be applied for the separation of a material by solvent extraction? Show that in the solvent extraction, multistep extraction is much more efficient than single step extraction using the same amount of extracting liquid. **(3+3+6=12)**

(c) Write down the quantitative relation between the temperature and the solubility of solid in liquid. How the relation can be applied for the experimental determination of heat of solution? **(4+4=8)**

(d) (i) Find the concentration on calcium ion (in ppm) in a 3.50 g pill that contains 40.5 mg of Ca^{2+}.

(ii) A sample of rubbing alcohol contains 142 g of isopropyl alcohol (C$_3$H$_7$OH) and 58.0 g of water. What are the mole fraction of alcohol and water? **(3+4=7)**

6. (a) What is the relation between chemical potential and Gibbs free energy? Derive the Gibbs-Duhem equation and write down its significance. **(4+8+3=15)**

(b) What is Azeotropic mixture? Show that an azeotropic mixture cannot be separated by distillation. Discuss the techniques that can be applied for the separation of the components of such mixture? **(4+10+6=20)**

7. (a) Applying Clausius-Clapeyron equation show that freezing point depression is directly proportional to the molality of solute. **(12)**

(b) What are the different mechanisms proposed to explain the osmosis process? **(8)**

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Contd ... Q. No. 7

(c) The Van't Hoff factor was introduced to make the relation between experimental and theoretical values of colligative properties. How Arrhenius theory of electrolytic dissociation made the quantitative relation between Van't Hoff factor and degree of dissociation? **(8)**

(d) A 0.930 g sample of ascorbic acid was dissolved in 95.0 g of water. The concentration of ascorbic acid, as determined by freezing point depression, was 0.0555 m. What is the molecular mass of ascorbic acid? **(7)**

8. (a) Define the terms with suitable examples (i) Foam (ii) Emulsion (iii) Sol (iv) Gel **(8)**

(b) What are the origin of charge formation in colloidal particles. **(12)**

(c) What is dialysis? How the technique is usually applied for the purification of colloids? **(6)**

(d) Show that Brownian motion can be explained with the diffusion laws. **(9)**

L-1/T-2/ChE   **Date : 28/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-2 B. Sc. Engineering Examinations 2014-2015
Sub : **HUM 125** (English)

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 Q. No. 1. and any **TWO** from the rest.

1. (a) Explain with reference to the context any one of the following.   **(8)**

    (i) "I am amazed to see you take my poison and suffer no magic change. I am sure you are Odysseus, the man whom nothing defeats"

    (ii) "All these things which another woman of her station would not have noticed, tortured and angered her."

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

    (i) 'The Bet' is a story about a man's journey to spiritual perfection. –Discuss the statement according to the story you have read.

    (ii) How does 'Circ's Garden" become a story of conflict between good and evil in which evil is defeated?

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

    (i) How did the lawyer spend the last two years of his confinement?

    (ii) Why did Mrs. Loisel throw the invitation spitefully upon the table?

    (iii) What did the Loisel couple decide to do when they found the necklace lost?

    (iv) What do you know about the author of Circe's Garden?

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

    (i) Both the mouse is underfed

    (ii) This is the case what I want.

    (iii) It is the Robinsons whom, I feel certain, are to come.

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

    (v) The priest said that living the upright life was a discipline.

    (vi) He decided to work slow and easy.

    (vii) He could not come to the class due to illness.

    (viii) They can't hardly speak English.

    (ix) We must guard and cast aside any infringement on our rights.

    (x) Chicago is larger than any city in Illinois.

    (xi) He is something better today.

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

HUM 125

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

   Assuage, beckon, chore, deprecate, entice, fluffy, grope, holocaust, munch, protrude, retort, smolder.

   (b) Make sentences with any ten of the following words: **(10)**

   Alleviate, bellow, cogent, detest, equivocal, flounder, hubbub, meddle, pauper, surmise, tumult, wrinkle.

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

   As material civilization advances and the supply of available goods and services increases, man's needs correspondingly multiply. Advertising plays a key role in this never-ending process by stimulating the public desires for certain products and by promoting the sales thereof, until it has, in effect, created new needs, real or supposed, where there were none before. A familiar example is the motor car- once a rare and costly novelty, now an ubiquitous and relatively inexpensive necessity. More recently, the televisions set has undergone the same transformation. While some people would deny that television is a necessity, the fact that sets are found in a majority of western homes shows that it answers, to greater or lesser degree, the need felt by millions of people for entertainment and information. A product, service or commodity that the public needs, tends of course, to 'sell itself'. We might therefore assume that, in such cases, advertising would be of minor importance. To some extent this is true. Meat packers vegetable an fruit growers, and dairy operators spend less on advertising, for instance, than manufacturers of cigarettes, liquors, cosmetics and other items of this type.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** questions including Q. No. 5 as compulsory.

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

   Manners are what separate us from the animals. That and, of course, credit cards. Growing up, my parents made it clear to my siblings and me that we were to treat other people with kindness and civility and that if we didn't; we were going to get it. To this day mother threatens to contact the parents of telemarketers who disturb her during dinner.

   As an adult, I have come to see that there is a right and a wrong way to do everything. Loosely defined, the right way to do things is how I do them myself. For instance, it is just not civilized to hover over someone's table in a busy café, eyeing her half-finished tea until she finally lets you have her seat. The well-bred thing to do is to stand quietly at

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Contd ... Q. No. 5(a)

a discreet distance until the table is vacated and elbow out of your way anyone who tries to get there first.

I realize that knowing the finer points of etiquette is not easy. I recall coming home once from an elegant dinner party with a little dog statue that I'd found placed by my plate as a take-home party favour. A phone call the next day asked If I'd please return my hostess's antique knife rest.

Easy or not, etiquette is important. There's a reason for doing things the way we do them, we just have no idea what it is. I was trying to explain this the other night to my children – Matt, 15, and Becky, 11 – who, I'm ashamed to say, have been allowed to develop less-than- perfect manners, especially at the table. At this particular family dinner, I caught buttering his baked potato with his finger. I had to interrupt my cell phone call to tell him off. It occurred to me that moment that perhaps all of us could use a little brushing up on our manners.

I blame our sorry habits on the busy, stressful world we live in. I find it's hard to insist on using the correct fork when we're eating out of plastic containers. A formal dinner at our house means that we watch the arts channel instead of cartoons when we eat.

I consulted my aged etiquette books to see what we're supposed to be doing. One was written by a woman who taught table etiquette to diplomats, which just goes to prove they don't know how to behave properly either.

One expert told me that if I regularly take my children to the opera, the ballet and art galleries, I will never have to worry about their manners. It's true. They'll go to live with the neighbour.

Time and manners have changed. I decided, though, that the idea of having a formal dinner as a setting for table manners instruction still made sense. I'd show my children that all serviettes do not come from a roll and that "finger food" is not a term synonymous with "Anything on your plate." I would introduce Matt and Becky, to elegant food, properly chosen cutlery and cloth serviettes. Of course this would require some preparatory work on my part.

Questions:

(i) Why should parents teach manners and etiquettes to their children?

(ii) Why does the author consider manners as credit cards?

(iii) Why are the finer points of etiquette so hard to learn?

(iv) What are the expert's opinions on bearing etiquettes?

(v) What is the relationship between time and manners?

(vi) Write down the meaning of the following words as used in the passage:

Hover, discreet, elegant, etiquette, serviettes.

HUM 125

6. (a) Write a complaint letter to the Managing Director of Taifa Fashions Limited informing him about the defective fabrics that they supplied to your company. **(10)**

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

Adjective, colonel, shame, chair, there, blood.

7. (a) Write a dialogue between two conscious citizens of the country about the intrusion of foreign culture into Bangladeshi values. **(10)**

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

(i) Campus violence

(ii) Internet: A Gate way to knowledge

(iii) Environmental Disaster

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

(i) With your permission I will go away. (Complex)

(ii) Father desired that I should go. (Simple)

(iii) Being a cripple, he cannot ride a horse. (Compound)

(iv) As the war ended, the soldiers returned. (Simple)

(v) His answer was not to the point. (Complex)

(vi) She was listening to the news when I returned. (Compound)

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

(i) Diphthongs;

(ii) Qualities of a good paragraph;

(iii) Back Malter of a Report.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **PHY 155** (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 **THREE**.

1. (a) Explain the statement "Charge is quantized". **(8)**

   (b) When can electric dipole is placed in a uniform electric field $\overline{E}$, show that **(20)**

   (i) the torque exerted on the electric dipole by the electric field is given by $\overline{\tau} = \overline{P} \times \overline{E}$ and

   (ii) the work done to charge the orientation of the dipole in the field is given by $W = \overline{P} \cdot \overline{E}$, where $\overline{P}$ is the electric dipole moment.

   (c) An electric dipole consists of two opposite charges of magnitude 2×10^{-6} C separate by a distance 0.01 m. It is placed in an external electric field of 2.0×10^5 N/C. **(7)**

   (i) What is the maximum torque by the external electric field exerted on the electric dipole?

   (ii) How much work must an external agent do to turn the electric dipole from initial position, $\theta = 0°$ to final position, $\theta = 90°$?

2. (a) What is a capacitor? What is a dielectric material? **(8)**

   (b) Derive an expression for Gauss's law as applied to a dielectric. **(20)**

   (c) Compute the energy stored in 60 nF capacitor (i) When charged to a potential difference of 2 kV and (ii) When the charge on each plate is 30 nC. **(7)**

3. (a) Define the magnetic field induction, $\overline{B}$. **(8)**

   (b) Obtain an expression for the torque on a current loop placed in a magnetic field. **(20)**

   (c) A coil of 50 turns bears a current of 0.5A. The radius of cross-section of the coil is 15 mm. It is placed with its plane parallel to magnetic field intensity 0.3T. Determine the torque on the coil. **(7)**

4. (a) Define co-ordination number of a crystal. Why surface co-ordination number differs from bulk co-ordination number is a crystal. **(8)**

   (b) Describe CsCl structure. Considering the ionic radii of Cs^+ and Cl 0.167 nm and 0.181 nm respectively, evaluate the ionic packing factor of CsCl structure. **(15)**

   (c) Write down the characteristic features of covalent bond. Why covalently bonded solids have relating low packing factor? **(12)**

PHY 155

SECTION – B

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

5. (a) What is cohesive energy? Find the expression of cohesive energy of a NaCl crystal. Evaluate the cohesive energy of NaCl crystal considering the equilibrium separation obetween Na^+ and Cl^- - ions as 2.81 Å, Madelung constant (α) = 1.748, n $\approx$ 9, [Ionization energy of Na^+ is –3.61 eV and electron affinity of Cl^- is 1.53 eV]. The symbols have their usual meaning. **(20)**

(b) What does crystal defect mean? Discuss dislocations in crystal. **(15)**

6. (a) Distinguish metal, semiconductor and insulator in terms of band theory of solid. Why does resistance of a metal increase with temperature? **(15)**

(b) What are the properties of X-rays that are useful in crystal structure analysis? Write down the Bragg's law of X-ray diffraction and explain each term. **(10)**

(c) In a tetragonal crystal, (2 1 1) represents a set of parallel planes. The lattice constants of the crystal are a = 3.32 Å and c = 1.74 Å. Find the interplanar spacing between two such parallel planes. Find the Bragg-angle for the 1st order reflection from (2 11) plane when the X-rays of wavelength 1.01 Å are incident on that plane. **(10)**

7. (a) Show that, for low speed (v $\ll$ c) relativistic kinetic of a moving body reduces to the classical one. **(5)**

(b) Derive the Lorentz space time-transformation formulae. **(20)**

(c) A spaceship is moving away from the earth with a speed v = 0.6 c where c is the speed of light. When the ship is at a distance d = 5 $\times$ 10^8 km from the earth, a radio signal is sent to the ship by the observers on earth. How long does the signal take to reach the ship as measured by the scientist on the earth? **(10)**

8. (a) Describe briefly about photo-multiplier tube with schematic diagram. **(10)**

(b) Find the wavelength of the emitted light by an atom for jumping an electron from fourth orbit to third orbit. What type of radiation does it refer to? **(8)**

(c) What are the essential parts of a nuclear reactor? Explain with suitable figure. **(17)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2014-2015

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**.

1. Evaluate the following integrals:

    (a) $\int \dfrac{6 + 6\sin x + 14\cos x}{3 + 4\sin x + 5\cos x}\,dx$ **(14)**

    (b) $\int e^x \dfrac{2 + \sin 2x}{1 + \cos 2x}\,dx$ **(10)**

    (c) $\int (x+2)\sqrt{2x^2 + 2x + 1}\,dx$ **(11)**

2. (a) Derive a reduction formulation for $I_{m,n} = \int \tan^m x \sec^n x\,dx$, and hence evaluate $\int \tan^3 x \sec^4 x\,dx$ **(12)**

    (b) Evaluate: $\displaystyle \lim_{n \to \infty}\left[\left(\dfrac{1^2}{n^3 + 1^3} \right) + \left(\dfrac{2^2}{n^3 + 2^3} \right) + \dots + \left(\dfrac{1}{2n} \right) \right]$ **(11)**

    (c) Evaluate: $\displaystyle \int_0^{\pi/2} \dfrac{\sin^2 x}{1 + \cos x \sin x}\,dx$ **(12)**

3. (a) Prove that $\displaystyle \int_0^{\pi/2} \sin^m x \cos^n x\,dx = \dfrac{\left\lceil \left(\dfrac{m+1}{2} \right) \right\rceil \left\lceil \left(\dfrac{n+1}{2} \right) \right\rceil}{2 \left\lceil \left(\dfrac{m+n+2}{2} \right) \right\rceil}$.   **(11)**

    (b) Show that $\displaystyle \int_0^{\infty} \dfrac{x\,dx}{(1+x)(1+x^2)} = \dfrac{\pi}{4}$ **(12)**

    (c) Show that $\displaystyle \int_0^{\pi/2} \dfrac{dx}{\sqrt{1 - \dfrac{1}{2}\sin^2 x}} = \dfrac{\left(\left\lceil \left(\dfrac{1}{4} \right) \right\rceil \right)^2}{4\sqrt{\pi}}$ **(12)**

4. (a) Find the area inside the circle $r = \sin\theta$ and outside the cardioide $r = 1 - \cos\theta$.   **(15)**

    (b) Find the volume and surface area of the solid generated by revolution of the area $y = 2x - x^2$ about x-axis.   **(20)**

MATH 123

SECTION – B

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

5. (a) Form a differential equation from the relation $\dfrac{x^2}{a^2+\lambda}+\dfrac{y^2}{b^2+\lambda}=1$, with a, b are held fixed. **(10)**

   (b) Solve: $y-x\dfrac{dy}{dx}=a\left(y^2+\dfrac{dy}{dx}\right)$. **(13)**

   (c) Solve: $x^2ydx-\left(x^3+y^3\right)dy=0$. **(12)**

6. (a) Find the integrating factor and solve: $y\left(y^2-2x^2\right)dx+x\left(2y^2-x^2\right)dy=0$. **(10)**

   (b) Solve: $\left(1-x^2\right)\dfrac{dy}{dx}-xy=\left(1-x^2\right)^{3/2}\sin x$. **(12)**

   (c) Reduce the equation to first order linear form and solve for, $\dfrac{dy}{dx}+\dfrac{y}{2x}=\dfrac{x}{y^3}$ at $y(1)=2$. **(13)**

7. (a) Solve: $\left(D^2-2D+1\right)y=xe^x\sin x$ **(11)**

   (b) Solve: $\left(D^2-2D+3\right)y=\cos x+x^2$ **(11)**

   (c) Solve: $x^2\dfrac{d^2y}{dx^2}-x\dfrac{dy}{dx}+4y=\cos(\ln x)+x\sin(\ln x)$. **(13)**

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

   (b) Solve: $\dfrac{d^2y}{dx^2}=1+\left(\dfrac{dy}{dx}\right)^2$. **(11)**

   (c) Solve the differential equation $x\dfrac{d^2y}{dx^2}+(x-2)\dfrac{dy}{dx}-2y=x^3$ by the method of factorization of operator. **(13)**