RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.SC. FOURTH SEMESTER EXAMINATION, MAY-JUNE 2013

SECOND YEAR

Date : 20/05/2013 **Industrial Chemistry (Honours)**

Time : 11am – 3pm Paper : IV Full Marks : 75

(Use separate answer book for each group)

Group-A

1. Choose the correct alternatives for any **four** of the following questions: 1½×4

   a) Dimension of absolute viscosity is
      i) $ML^{-1}T^{-1}$
      ii) MLT^{-1}
      iii) $ML^{-1}T$
      iv) MLT

   b) Reynolds Number is the ratio of
      i) Viscous force to gravity force
      ii) Inertia force to viscous force
      iii) Viscous force to inertia force
      iv) Inertia force to gravity force

   c) $f = 16 / N_{Re}$ is valid for
      i) Turbulent flow
      ii) Laminar flow through a circular pipe
      iii) Laminar flow through a open channel
      iv) None of these

   d) For the same flow rate of a fluid the pressure drop is the least for
      i) Venturimeter
      ii) Orifice meter
      iii) Flow-nozzle
      iv) ΔP is same for all

   e) Prandtl number is given
      i) $C_p\mu / D$
      ii) hD / k
      iii) $C_p\mu / k$
      v) μ / hC_p

   f) Maximum heat transfer rate is achieved in _____ flow
      i) Co-current
      ii) Counter-current
      iii) Turbulent
      iv) laminar

   g) Which of the following crushing laws is most accurately applicable to the fine grinding of materials
      i) Bond's crushing law
      ii) Kick's law
      iii) Rittinger's law
      iv) None of these

h) Which are used in case of heat flow by conduction through a cylinder
   i) Logarithmic mean area
   ii) Arithmetic mean area
   iii) Geometric mean area
   iv) None of these

i) The unit of heat transfer coefficient is
   i) $W/m^2\ ^oK$
   ii) $W/m\ ^oK$
   iii) $Btu/m\ ^oF$
   iv) $Btu/ft^2\ ^oF$

2. Answer any **five** questions from the following: 5×2
   a) Check the dimensional homogeneity of the following equation: $H_f = 4flV^2 / 2gd$ where the terms bear their usual meanings.
   b) What will be the % Na_2O content of lye containing 73% caustic soda?
   c) With the help of Bernoulli's theorem explain the principle for lifting of aircrafts.
   d) The mass flow rate of a fluid through a 5 sq. cm pipe area is 5.5 Kg/h. Express the fluid velocity through volumetric flow rate.
   e) The available nitrogen in an area sample is found to be 45% by weight. Find the actual urea content in the sample.
   f) What is vena contracta?
   g) Explain the significance of using log mean area in heat transfer problems.
   h) Calculate the dimension of Fick's diffusivity.
   i) What is black body? How it is different from a grey body?
   j) What do you mean by critical fluid velocity?

Answer any **three** questions from Q. No. 3 to Q. No. 8: 13×3

3. a) State and derive Bernoulli's equation for a perfect incompressible liquid flowing in a continuous steam. 2+6
   b) A venturimeter with 150mm diameter at inlet and 100 mm at throat is laid with its axis horizontal and is used for measuring the flow of oil Sp. Gravity 0.9. The oil mercury differential manometer shows a gauge difference of 200mm. Assume co-efficient of the meter is 0.98. Calculate the discharge per minute. 5

4. a) Define Fick's first law of diffusion explaining the terms.
   b) Explain the Principle of Interphase Mass Transfer with sketch.
   Methane diffuses at steady state through a tube containing helium. At point 1 the partial pressure of methane is PA1 = 55 kpa and point 2, 0.03 m apart, PA2= 15 kpa. The total pressure is 101.32 kpa and the temperature is 298 K. At this pressure and temperature, the value of diffusivity is $6.75 \times 10^{-5}\ m^2/s$. Calculate the flux of methane at steady state for equimolar counter-diffusion. 2+4+7

5. a) What is meant by Overall heat transfer coefficient? Write the design equation and Unit of overall heat transfer coefficient? 3
   b) Write the Dittus-Bolter equation. 2
   c) The wall of drying chamber are built up of a layer of red brick (k = 0.7 w/mk) of thickness 250mm and a layer of felt (k = 0.046 w/mk) of thickness 20mm the temperature of the outside surface of the red brick layer is 110ºC and that of felt layer is 25ºC. Calculate the heat loss from 1 m^2 of the wall. 8

6. a) State Fourier's law. Derive the equation for heat flow through a cylinder. 2+3

   b) Crude oil flows at the rate of 2000 Kg/hr through the inside pipe of a double pipe heat exchangers and is heated from 30ºC to 90ºC. The heat is supplied by kerosene initially at 200ºC flowing through annular space. If the temperature of approach (minimum temperature difference) is 10ºC, determine the heat transfer area for co-current flow and kerosene flow rate.

   C_p for crude oil = 0.5 kcal / kg ºC

   C_p for kerosene = 0.6 kcal / kg ºC

   U_0 = 400 kcal / hr.m^2 ºC 8

7. a) State the following

      i. Rittinger's law

      ii. Kick's law

      iiii. Bond's law 2×3

   b) Calculate the energy required to crush 100 tons per hour of limestone if 80% of the feed passes through a screen 3.75 cm aperture and 80% of the product passes through a screen with 0.03 cm aperture. The Work index for limestone is 12.74, when the capacity is expressed in tones per minute, energy required in H_p and size of feed and product in feet. 7

8. a) A centrifugal pump with an efficiency of 60% is driven by an electric motor with an efficiency of 90%. The pump delivers 250 kg of water per minute against a total head of 25 m. What is the power required by the motor? 5

   b) Dry methane is burned with dry air and both are initially at 25 degree centigrade. The flame temperature is 1297 degree centigrade. If complete combustion is assumed, how much excess air is to be used? 8

   Data:

   Heat for reaction, $\Delta H_R = -0.2 \times 106$ cal

   Specific heat for carbon dioxide = 12.37 cal/gm mol degree centigrade

   Specific heat for water = 9.60 cal/gm mol degree centigrade

   Specific heat for nitrogen = 7.68 cal/gm mol degree centigrade

   Specific heat for air = 7.74 cal/mol degree centigrade

OR

   c) What is Biochemical Reactor? Name the different types Bio-Reactors used in Industry. Bring their salient features. Describe an immobilized cell bioreactor. 2+4+7

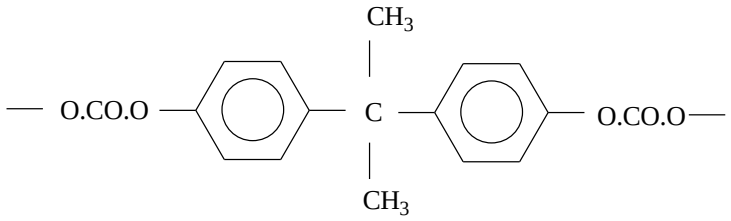
Group-B

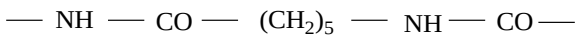
Answer any **four** questions: 4×5

9. Deduce Carother's equation in the context of Polycondensation reactions.

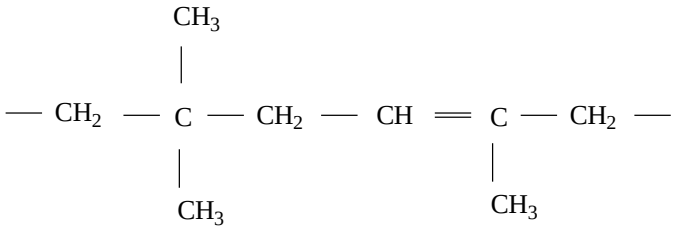
   A glyptal (glycering + Phthalic Anhydride) resin is to be prepared using stoichiometric ratio of the reactants. Calculate the extent of reaction at gel point. 3+2

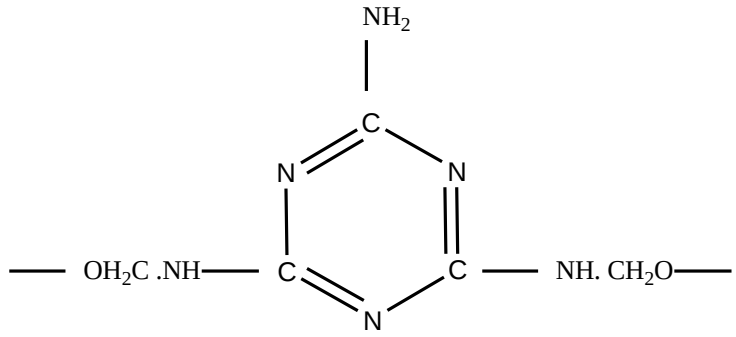
10. Recognize the polymers from their repeat units shown below. Mention one major usage of each: 5×1

i) 

ii) 

iii) 

iv) 

v) 

11. Write short notes on synthesis, properties and use of the following macromoles (**any two**): 2½+2½
(i) Phenolic resin (ii) Epoxy Resin (iii) PVC (iv) HDPE (v) Nylon 66.

12. Elucidate (**any two**): 2½+2½
(i) Cationic and Anionic polymerisation
(ii) Co-Polymerisation and its benefit
(iii) Vulcanization of Natural Rubber
(iv) Comparison between chain-growth and step-growth polymers.

13. Discuss synthesis, properties and application of (i) Nitrile Rubber (NBR) (ii) Butyl Rubber (BR). 2½+2½

14. Narrate briefly the process of Recovery of Polyisoprene (NR) from Haevia Brasilensis; crepe and smoked sheet; mastication and compounding operations. 5