NEW & OLD

2017

M.Sc. Part–I Examination

CHEMISTRY

PAPER—IV

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(Industrial)

For New Syllabus

Full Marks : 100

Time : 4 Hours

Answer questions for Group–A, Group–B and Group–C.

Answer *five* questions taking at least *two* from Group–A and Group–B ; Answer Group–C.

For Old Syllabus

Full Marks : 75

Time : 3 Hours

Answer questions for Group–A and Group–B.

Answer *five* questions taking at least *two* from Group–A & B.

(Turn Over)

Group–A

1. (a) Define Ideal and Real fluid.

   (b) Explain why pseudoplastic liquid is known as shear thinning liquid.

   (c) State and explain the Bernoulli's equation.

   (d) Define guage pressure and absolute pressure.

   (e) For the flow of an incompressible fluid through a pipe under laminar condition, derive an expression for the pressure drop per unit length, $-\Delta P/L$, in terms of the pipe diameter d, the average velocity u, the density ρ, and the viscosity μ of the fluid. 2+2+3+2+6

2. (a) Write the principle of rotameter.

   (b) A standard 1 cm orifice is installed in a 60.325 mm steel pipe. Dry air at upstream condition of 21°C and 1.045×10^5 N/m^2 guage flows such that a U-tube manometer reads 35 cm. The density of the manometric liquid is 760 kg/m^3. Calculate (i) the mass flow rate of air, (ii) the permanent pressure loss. Assume the air to be incompressible.
   Given, $C_0 = 0.61$ 7+8

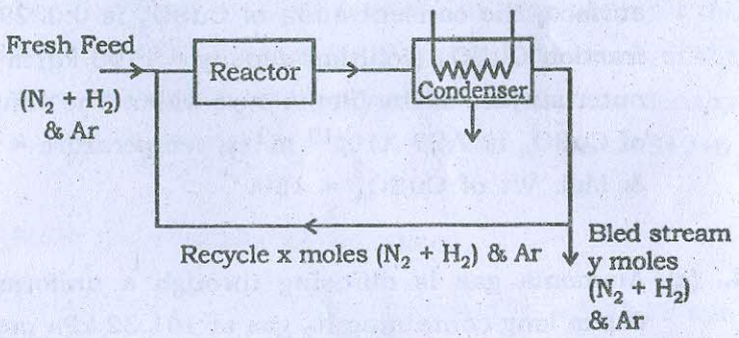
3. (a) Derive an expression for steady state counter current diffusion of gas A and B.

   (b) A crystal of copper sulphate $CuSO_4.5H_2O$ falls through a large tank of pure water at 20°C. Estimate the rate at which the crystal dissolves by calculating the flux of $CuSO_4$ from the crystal surface to the bulk solution. Molecular diffusion occurs through a film of water uniformly 0.0305 mm surrounding the crystal. At the inner side of the film, adjacent to the crystal surface, the concentration of $CuSO_4$ is 0.0229 mole fraction $CuSO_4$ (solution density = 1193 kg/m^3), the outer surface of the film is pure water. The diffusivity of $CuSO_4$ is 7.29×10^{-10} m^2/s, temperature = 293 K & Mol. Wt of $CuSO_4$ = 160. 5+10

4. (a) Ammonia gas is diffusing through a uniform tube 0.1 m long containing N_2 gas at 101.32 kPa pressure and 298 K. At point 1, p_{A1} = 10.13 kPa and at point 2, p_{A2} = 5.07 kPa. The diffusivity $D_{AB} = 2.3 \times 10^{-5}$ m^2/s. Calculate, the flux J_A at steady state, and the flux J_B. (A = Ammonia, B = Nitrogen)

   (b) In the operation of a synthetic ammonia plant, shown diagrammatically in figure below, a 1 : 3 nitrogen-hydrogen mixture is fed to the converter resulting in a 25% conversion to ammonia. The ammonia formed

is separated by condensation, and the unconverted gases are recycled to the reactor. The initial nitrogen-hydrogen mixture contains 0.20 parts of Argon to 100 parts of $N_2 - H_2$ mixture. The toleration limit of Argon entering the reactor is assumed to be 5 parts to 100 parts of N_2 and H_2 by volume. Estimate the recycle ratio, yield of NH_3 and the fraction of recycle that must be continually purged. 5+10



5. (a) State and explain (i) Fourier's law of conduction, (ii) Stefan-Boltzman law.

(b) A furnace wall is composed of 220 mm of fire brick, 150 mm of common brick, 50 mm of magnesia and

3 mm of steel plate on the outside. If the inside surface temperature is 1500°C and outside surface temperature is 90°C, estimate the heat loss.

Given,

k (for fire brick) = 4 kJ/m.hr.°C ; k (for common brick) = 2.8 kJ/m.hr.°C ; k (for 85% magnesia) = 0.24 kJ/m.hr.°C, and k (steel) = 240kJ/m.hr.°C. 6+9

Group–B

6. (a) Define unit operation and unit process.

(b) Write the names of the nitrating agents used in the industrial nitrating process.

(c) Write the evidence to support the formation of nitryl ion in the mixed acid.

(d) Define D.V.S and nitric ratio and state its significance.

(e) Write the reactions involved in the hydrogenation of fat. 5×3

7. (a) Define and classify refractory.

(b) Define refractoriness and describe Pyrometric cone test in detail.

(c) What is Thermal spalling? Write its effects and the procedure to reduce it.

(d) What is refractoriness under load (RUL) and how to determine it.

(e) Describe the manufacturing process of high alumina refractory bricks. 2+3+3+2+5

8. (a) Draw the general flow diagram to show the steps involve ore to final metal preparation.

(b) Write the principle of gravity separator or magnetic separator used in ore dressing.

(c) Explain why calamine is calcined and zinc blend is roasted.

(d) Describe liquation process. 5+5+3+2

9. (a) A single effect evaporator is fed with 10,000 kg/hr of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic. Calculate (i) kg/hr water evaporated; (ii) kg/hr of thick liquor.

(b) The waste acid from a nitrating process contains 30% H_2SO_4; 35% HNO_3 and 35% H_2O by weight. The acid is to be concentrated to contain 39% H_2SO_4 and 42% HNO_3 by addition of concentrated sulphuric acid containing 98% H_2SO_4 and concentrated nitric acid containing 72% HNO_3 by weight. Calculate the quantities of three acids to be mixed to get 1000 kg of desired acid. 5+10

10. (a) Define (i) conventional and synthetic fuel, (ii) gross and net calorific values.

(b) Write a note on origin of coal.

(c) Explain and write the significance of proximate analysis of coal.

(d) Write the raw materials and reaction involved in the catalytic cracking process used in the refinery.

(e) What is the significance of Octane number? 4+3+4+2+2

Group–C

(For New Syllabus)

Answer *all* questions.

11. A. Choose the correct answer (any *fifteen*) : 15×1

(a) The speed of a rotary drum vacuum filter (in rpm) may be

(i) 1 (ii) 50 (iii) 100 (iv) 500

(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) Rotameter is a

(i) variable area flow measuring device

(ii) constant area flow measuring device

(iii) temperature measuring device

(iv) pH measuring device

(d) Main constituent of LPG

(i) mixture of methane and ethane

(ii) mixture of ethane and propane

(iii) mixture of propane and butane

(iv) mixture of butane and pentane

(e) The unit of momentum or thermal diffusivity is

(i) m/s (ii) m^2/s (iii) $N.s/m^2$ (iv) $kmol/(m^2.s)$

(f) Filter medium resistance is important during

(i) the early stage of filtration

(ii) the final stage of filtration

(iii) all along the process

(iv) none of these

(g) Toothpaste is an example of

(i) Newtonian fluid

(ii) Pseudoplastic fluid

(iii) Bingham plastic

(iv) Dilatant fluid

(h) Gross and net calorific value of a fuel is same for

(i) if its hygrogen/hydrogen compound content is zero

(ii) if its carbon content is very low

(iii) if its ash content is zero

(iv) under no circumstances

(i) Which is not basic refractory ?

(i) Silicon carbide

(ii) Magnesite

(iii) Chrome magnesite

(iv) Dolomite

(j) Laminar flow of a Newtonian fluid ceases to exist, when the Reynolds number exceeds

(i) 2100 (ii) 4000 (iii) 1500 (iv) 3000

(k) A chemical process is said to occur under unsteady state, if the

(i) ratio of streams entering/leaving are independent of time

(ii) inventory changes do not take place

(iii) flow rates & composition both are time dependent

(iv) none of these

(l) A bypass stream in a chemical process is useful, because it

(i) facilitates better control of the process

(ii) increase the yield of products

(iii) improves the conversion

(iv) none of these

(m) Which has the lowest Prandtl number ?

(i) Aqueous solution

(ii) Liquid metal

(iii) Water

(iv) Lube oil

(n) The molar composition of a gas is 10% H_2, 10% O_2, 30% CO_2 and balance H_2O. If 50% H_2O condenses, the final mole percent of H_2 in the dry gas will be

(i) 10%

(ii) 5%

(iii) 18.8%

(iv) 20%

(o) Pure carbon is completely burnt in oxygen. The flue gas analysis is 70% CO_2, 20% CO and 10% O_2. The percent excess oxygen used is

(i) 20

(ii) 12.5

(iii) 0

(iv) 10

(p) The value of R is SI system is

(i) 1.987 cal/(mol.K)

(ii) 0.08206 L.atm/(mol.K)

(iii) 8.314 m3.Pa/(mol.K)

(iv) 62.36 L.mm Hg/(mol.K)

(q) Pure A in gas phase enters a reactor. 50% of this A is converted to B through the reaction A → 3B. Mole fraction of A in the exit stream is

(i) $\frac{1}{2}$ (ii) $\frac{1}{3}$ (iii) $\frac{1}{4}$ (iv) $\frac{1}{5}$

B. Differentiate between (any *five*) : 5×2

(i) Adsorption and absorption ;

(ii) Extraction and leaching ;

(iii) Ore and mineral ;

(iv) Calcination and roasting ;

(v) Newtonian and non-Newtonian fluid ;

(vi) Gray and black body ;

(vii) Natural and forced convection.

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