NEW / OLD

2015

M.Sc. Part–I Examination

CHEMISTRY

PAPER—IV

(Industrial Chemistry)

The figures in the right-hand margin indicate full marks.

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

Illustrate the answers wherever necessary.

New Syllabus

Answer questions of Group—A and B and C.

Answer *five* questions taking at least *two* from Group—A and B.

Full Marks : 100 *Time* : 4 Hours

Old Syllabus

Answer questions of Group—A and B.

Answer *five* questions taking at least *two* from each group.

Full Marks : 75 *Time* : 3 Hours

Group—A

(*New & Old Syllabus*)

1. (a) Define Ideal fluid and Real fluid.

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

(c) For a steady laminar flow of an incompressible real fluid show that :

$$\frac{u}{u_{max}} = \left(1 - \frac{r^2}{r_0^2}\right)$$

where,

u = liquid velocity at any radius r

r_0 = radius of the tube

u_{max} = maximum velocity at $r = 0$

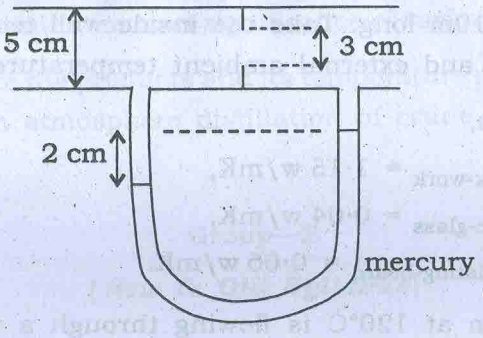
(d) State the Bernoulli's equation and also write the assumptions.

(e) The right limb of a simple U-tube manometer containing mercury (sp. gr. = 13·6) is open to the atmosphere while the left limb is connected to a pipe in which fluid of sp. gr. 0·9 is flowing. The centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the end limbs is 20 cm.

3+2+4+3+3

2. (a) Write the principle of rotameter and draw a neat sketch.

(b) Flow rate of water flowing through a pipe is being measured by using an orificemeter as shown in the figure :



(i) What is the direction of flow in the pipe ?

(ii) Derive an expression for velocity through the orifice. Determine the flow rate for an orifice coefficient of 0·80 . 5+10

3. (a) State and explain the Fourier's law of conduction.

(b) Differentiate between Natural and Forced Convection.

(c) Derive Fourier conduction equation in x, y and z co-ordinate system.

3+3+9

4. (a) A composite wall is made up of an external thickness of brick work 110 mm thick and inside layer of fibre-glass of 75 mm thick. The fibre glass is faced internally by an insulating board 25 mm thick. The surface heat transfer co-efficient of the inside wall is 25 w/m^2K and the outside wall is 3·1 w/m^2K. Determine the heat loss through the wall of 4m high and 10m long. Take the inside wall temperature as 27°C and external ambient temperature as 10°C.

Given,

$K_{Brick\text{-}work}$ = 1·15 w/mK,

$K_{Fibre\text{-}glass}$ = 0·04 w/mK,

$K_{Insulating\text{-}board}$ = 0·06 w/mK.

(b) Steam at 120°C is flowing through a wrought-iron (K = 59 w/mK) tube of ID = 5 cm and OD = 7 cm which is covered with 1 cm thick asbestors (K = 0·1105 w/mk) insulation. If the convection heat transfer co-efficients at the inner and outer surfaces of the tube are 200 w/m^2K and 10 w/m^2K, respectively and the atmospheric air is at 25°C, estimate the rate of heat losses from steam per metre length of the tube. Assume that the steam in the tube is held at constant temperature. 7+8

5. (a) Differentiate between renewable and non-renewable fuels with examples.

(b) Why net calorific value is less than gross calorific value ?

(c) Discuss the origin of Coal.

(d) Discuss proximate analysis of coal with respect to its determination and significance of various parameters.

(e) Write the products and its temperature range obtained from atmosphere distillation of crude oil. 2+2+4+3+4

Group—B

(New & Old Syllabus)

6. (a) Write the condition and catalyst used for the removal of acetylene in the purification of ethylene manufacturing process.

(b) Write the purpose and reactions involved in the dehydrosulfurization process used in refinery.

(c) Write a note on hydrogenation of fats.

(d) With respect to nitration reaction answer the following :

(i) purpose ;

(ii) reagent used ;

(iii) aromatic nitration reactions. 3+4+4+5

7. (a) A gas mixture has the following composition by volume :

SO_2 = 8·5% ; O_2 = 10% ; *and* N_2 = 81·5%

Find (a) density at 200°C and 2 atm g. and (b) Composition by weight.

(b) A close vessel contain a mixture of 40% NO_2 and 60% N_2O_4 at a temperature of 38°C and a pressure of 3990 mm Hg. When the temperature is increased to 60°C, some of N_2O_4 dissociates to NO_2 and a pressure rises to 5100 mm Hg. Calculate the composition of gases at 60°C.

(c) The Orsat analysis of a flue gas is CO_2 = 12·7% ; O_2 = 7·1% ; *and* N_2 = 80·2%. Determine the percent excess air used in combustion. The nitrogen present in the flue gas is contributed by air only.

3+7+5

8. (a) State and explain Fick's law of diffusion.

(b) Show that $D_{AB} = D_{BA}$.

(c) Oxygen is diffusing in a mixture of oxygen-nitrogen at 1 std. atm., 25°C. Concentration of oxygen at planes 2 mm apart are 10 and 20 volume % respectively. Nitrogen is non-diffusing.

(i) Derive the appropriate expression to calculate the flux of oxygen ;

(ii) Calculate the flux of oxygen.
Diffusivity of oxygen in nitrogen = $1.89\times10^{-5}\ m^2/s$.

2+3+10

9. (a) Define ore and mineral.

(b) Write a note on the physical methods used for the concentration of ore.

(c) Discuss the principle of froth flotation process used for ore dressing.

(d) Magnetic separation process is adopted to separate valuable minerals from non-magnetic gangue — discuss.

3+4+4+4

10. (a) Define refractory material.

(b) Write the classification of refractory material.

(c) Write the manufacturing process of ceramics.

(d) Discuss the useful properties of ceramics.

3+3+6+3

Group—C

(Only for New Syllabus)

11. Choose the correct answer : 25×1

(a) For steady state system :

(i) The rate of input is zero ;

(ii) The rate of generation is zero ;

(iii) The rate of consumption is zero ;

(iv) The rate of accumulation is zero.

(b) 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 is :

(i) 20 ; (ii) 12·5 ;

(iii) 0 ; (iv) 10.

(c) 1000 kg of wet solids are to be dried from 60% to 20% moisture (by weight). The mass of moisture removed in kg is :

(i) 520 ; (ii) 200 ;

(iii) 400 ; (iv) 500.

(d) Bernoulli's equation for steady frictionless flow states that along a streamline :

(i) total pressure is constant ;

(ii) total mechanical energy is constant ;

(iii) velocity head is constant ;

(iv) none of the above.

(e) The shear stress – shear rate relationship for a liquid whose apparent viscosity decreases with increasing shear rate is given by :

(i) $\tau_{yz} = -m\left[\frac{dv_x}{dy}\right]^{n-1}\frac{dv_x}{dy}$ for $n < 1$;

(ii) $\tau_{yz} = -m\left[\frac{dv_x}{dy}\right]^{n}$ for $n = 1$;

(iii) $\tau_{yx} = -m\left[\frac{dv_x}{dy}\right]^{n-1}\frac{dv_x}{dy}$ for $n > 1$;

(iv) $\tau_{yx} = -m\frac{dv_x}{dy} + \tau_0$.

(f) Toothpaste is :

(i) Bingham plastic ; (ii) Pseudo plastic ;

(iii) Newtonian fluid ; (iv) Dilatant.

(g) For flow through a horizontal system, the ratio of exit pressure to inlet pressure is found to be greater than one :

(i) The system is a converging pipeline ;

(ii) The system is a diverging pipeline ;

(iii) The system is a pipeline of uniform diameter ;

(iv) The observation is not possible.

(h) Heat transfer occurs by natural convention because change in temperature causes differences is :

(i) Viscosity ; (ii) Density ;

(iii) Thermal conductivity ; (iv) Heat capacity.

(i) The variation of thermal conductivity of a metal with temperature is often correlated using an expression of the form : $k = k_0 + aT$

where k is the thermal conductivity and T is the temperature in K. The unit of 'a' in the SI system will be :

(i) w/mk ; (ii) w/m ;

(iii) w/mk^2 ; (iv) a just a number.

(j) Pr and *tl* number is the ratio of :

(i) mass diffusivity to thermal diffusivity ;

(ii) momentum diffusivity to thermal diffusivity ;

(iii) thermal diffusivity to mas diffusivity ;

(iv) thermal diffusivity to momentum diffusivity.

(k) The units of diffusivity are :

(i) m/s ; (ii) m^2/s ;

(iii) $kmol/(m^2.s)$; (iv) none of these.

(*l*) Sherwood number in mass transfer is analogous to the following dimensionless group in heat transfer :

(i) Greatz number ; (ii) Grashoff number ;

(iii) Nusselt number ; (iv) Pr and t*l* number.

(m) The unit of frequency factor is Arrhenius equation :

(i) is the same as those of the rate constant ;

(ii) depend on the order of the reaction ;

(iii) depend on temperature, pressure etc. of the reaction ;

(iv) is cycles per unit time.

(n) For the following reaction, the rate constant at 373K is 0·5 per min. :

$$05A + B \rightarrow C$$

The overall order of the reaction is :

(i) 0·5 ; (ii) 1·0 ;

(iii) 1·5 ; (iv) 0.

(o) The main product of high temperature carbonisation of coal is :

(i) Coke ; (ii) Ammonia ;

(iii) Tar ; (iv) Phenol.

(p) Low temperature carbonization of coal takes place at :

(i) 300°C ; (ii) 1100°C ;

(iii) 500 – 600°C ; (iv) 150°C.

(q) Main constituent of natural gas is :

(i) CH_4 ; (ii) C_2H_2 ;

(iii) C_2H_4 ; (iv) C_2H_6.

(r) Octane number of gasoline is a measure of its :

(i) knocking tendency ; (ii) ignition delay ;

(iii) ignition temperature ; (iv) smoke point.

(s) Octane number of n-heptane is :

(i) 100 ; (ii) 0 ;

(iii) 70 ; (iv) none of these.

(t) A coal containing high amount of volatile matter will have :

(i) Ion ignition temperature ;

(ii) Very little ash content ;

(iii) high fusion point of its ash ;

(iv) low adiabatic flame temperature.

(u) Reynolds number is the ratio of :

(i) viscous forces to gravity forces ;

(ii) inertia forces to viscous forces ;

(iii) viscous forces to inertia forces ;

(iv) inertia forces to gravity forces.

(v) Filter medium resistance is important during :

(i) the early stages of filtration ;

(ii) all along the process ;

(iii) the final stages of filtration ;

(iv) none of these.

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

(i) 1 ; (ii) 50 ;

(iii) 100 ; (iv) 500.

(x) What is the emissivity of a black body ?

(i) 1 ; (ii) 0 ;

(iii) 0·90 ; (iv) 0·5 .

(y) Mass transfer coefficient is defined as :

(i) Flux = (coefficient) / (concentration difference) ;

(ii) (coefficient) = Flux / (concentration difference) ;

(iii) Flux = (concentration difference) / (coefficient) ;

(iv) None of these.

All Symbols are of usual significance.

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