

2018

M.Sc.

Part-I Examination

**CHEMISTRY**

PAPER—IV

Full Marks : 100

Time : 4 Hours

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

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

*Illustrate the answers wherever necessary.*

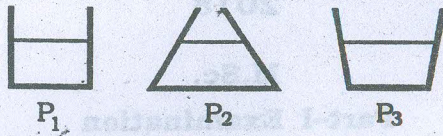
**(Industrial)**

**Group-A**

1. Choose the correct answer (any ten) : 10×1

- (i) Three containers are filled with water up to the same height as shown. The pressure at the bottom of the containers are denoted as  $P_1$ ,  $P_2$  and  $P_3$ . Which one of the following relationship is true ?

(Turn Over)



- (a)  $P_3 > P_1 > P_2$       (b)  $P_2 > P_1 > P_3$   
 (c)  $P_1 > P_2 = P_3$       (d)  $P_1 = P_2 = P_3$
- (ii) Losses for flow through valves and fittings are expressed in terms of
- drag coefficient
  - equivalent length of a straight pipe.
  - Shape factor.
  - roughness factor.
- (iii) Pressure is a
- vector
  - Scalar
  - tensor
  - None of these.
- (iv) What is the emissivity of a black body?
- 1
  - 0
  - 0.90
  - 0.5

- (v) Assumption made in the Fourier's law is that the heat flow
- is in steady state
  - through a solid is one dimensional
  - Both (a) and (b)
  - None of these.
- (vi) Molecular diffusivity of a liquid
- increases with temperature
  - decreases with temperature
  - may increase or decrease with temperature
  - is independent of temperature.
- (vii) The most important outlet for ethylene is the manufacture of
- ethylene oxide
  - styrene
  - vinyl chloride
  - polyethylene.

(viii) Fuel required by most modern car engines should have an octane number in the range between

- (a) 50 and 60                      (b) 65 and 75  
(c) 80 and 85                      (d) 90 and 98

(ix) Dry natural gas contains mainly

- (a) methane (plus small amount other components)  
(b) ethane                              (c) propane  
(d) butane.

(x) Polyethylene is

- (a) an addition polymerization polymer  
(b) a condensation polymerization polymer  
(c) a thermosetting polymer  
(d) very low molecular weight polymer.

(xi) A sample of natural gas is 82% methane and 18% ethane by volume. The density of mixture at 18°C and 750 mm Hg pressure is

- (a) 0.765 g/L                      (b) 0.805 g/L  
(c) 0.92 g/L                        (d) None of these.

2. Differentiate between (any five) :

5×2

- (a) Molecular diffusion and Eddy diffusion  
(b) Gross calorific value and Net calorific value  
(c) White body and Black body  
(d) Laminar flow and Turbulent flow  
(e) Humidification and Dehumidification  
(f) Gauge pressure and Absolute pressure  
(g) Fluid kinematics and Fluid dynamics.

### Group-B

Answer any *eight* questions

3. (a) Define Ideal fluid and Real fluid.  
(b) Explain why dilatant fluid is known as shear thickening fluid.

- (c) Write example of Newtonian Pseudoplastic and Bingham fluid.
- (d) Show that the Reynolds number is the ratio of inertia force to viscous force.
- (e) Write the Bernoulli's equation for an ideal fluid and explain the terms. 3×4
4. (a) For a steady laminar flow of an incompressible real fluid show that

$$\frac{U}{U_{\max}} = \left(1 - \frac{r^2}{r_o^2}\right)$$

Where,

$U$  = liquid velocity at any radius  $r$

$r_o$  = radius of the tube

$U_{\max}$  = maximum velocity at  $r = 0$

- (b) A horizontal venturi meter of throat diameter 75 mm is connected to a water pipeline of 125 mm diameter. If the mercury manometer attached to this system shows a reading of 375 mm. calculate the rate of discharge of water through the pipe. The venture coefficient can be taken as 0.98. 4+6
5. (a) State Fourier's law of conduction and Stefan-Boltzman law.
- (b) Derive the generalized heat conduction equation in  $x, y, z$  co-ordinate system. 3+7
6. Liquid nitrogen is at 77 K is stored in an insulated spherical container that is vented to the atmosphere. The container is made of a thin-walled material with an outside diameter of 0.5 m. 25 mm insulation ( $k = 0.002 \text{ W/mK}$ ) covers its outside surface. The latent heat of nitrogen is 200 kJ/kg, its density in the liquid phase is 804 kg/m<sup>3</sup>. For surroundings at 25°C and with a convection coefficient is 18 W/m<sup>2</sup>K at the outside surface of the insulation. What will be the rate of liquid nitrogen boil-off? 10

7. (a) A waste acid from nitrating process contain 23%  $\text{HNO}_3$ , 57%  $\text{H}_2\text{SO}_4$  and 20% water by weight. This acid is to be concentrated to contain 27%  $\text{HNO}_3$ , 60%  $\text{H}_2\text{SO}_4$  by the addition of Conc.  $\text{H}_2\text{SO}_4$  (93%) and Conc.  $\text{HNO}_3$  (90%). Calculate the weight of waste and Conc. acids that must be combined to obtain 1000 kg of the desired mixture.

(b) Methanol is produced by the reaction of CO with  $\text{H}_2$  as  $\text{CO} + 2\text{H}_2 \rightarrow \text{CH}_3\text{OH}$

Only 15% CO entering the reactor is converted to methanol. The methanol formed is condensed and removed completely. The unconverted CO and  $\text{H}_2$  are recycle back to the reactor. The fresh feed will contained  $\text{H}_2$  and CO in the molar ratio of 2 : 1. The 3200 kg/hr of methanol produced, calculate the amount of (i) kmol/hr of fresh feed and (ii) kmol/hr of recycled feed required. 5+5

8. The producer gas made from the coke has the following composition by volume

CO - 28%;  $\text{CO}_2$  - 3.5%;  $\text{O}_2$  - 0.5% and  $\text{N}_2$  - 68.0%

The gas is burned with such a quantity of air that oxygen from air is 20% in excess of the net oxygen required for

combustion. If the combustion is 98% complete, calculate the weight of the gaseous product formed per 100 kg of the gas burned. 10

9. (a) Write a note on the nitrating agent used in industrial nitration process.

(b) Write the nitrating product obtained from isopentane.

(c) Discuss the thermodynamic and engineering aspects of nitration process.

(d) Describe Schmid nitrator in detail. 2+2+3+3

10. (a) How acetylene is converted into ethylene?

(b) What are the catalyst used in hydro treating operation used in refinery?

(c) What are the undesirable characteristics of the refinery feed eliminated in hydro treating process?

(d) Write a note on the hydrogenation of fats. 2+2+3+3

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

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

(c) Ammonia diffuses through nitrogen gas under equimolar counter diffusion at a total pressure of  $1.013 \times 10^5$  Pa and at a temperature of 298 K. The diffusion path is 0.15 m. The partial pressure of ammonia at one point is  $1.5 \times 10^4$  Pa and at the other point is  $5 \times 10^3$  Pa. Diffusivity under the given condition is  $2.3 \times 10^{-5}$  m<sup>2</sup>/s. Calculate the flux of ammonia. 2+3+5

12. (a) Discuss the origin of coal.

(b) Discuss the significance of various parameters measured in the Proximate analysis of coal.

(c) Discuss the principle of the Fischer-Tropsch synthesis. 3+4+3

13. (a) Discuss the calcination and roasting of the ore.

(b) Which method of concentration is applied in the following cases?

(i) Magnetic ores;

(ii) Sulphide ores

(iii) Bauxite ores.

(c) Explain why K, Na, Ca areas are extracted only by electrolysis process?

(d) Write the principle of gravity separation for concentration of ores. 2+3+2+3

14. (a) Define refractory materials.

(b) Discuss the classification of refractory materials based on the chemical nature.

(c) Write the drawback of the pyrometric cone equivalent measurement test.

(d) Write the refractoriness under load test methodology.

- (e) Discuss the effects of thermal conductivity and porosity for a refractory brick. 1+1+2+3+3
15. (a) What is thermal spalling? What are the effects of thermal spalling? How the thermal spalling can be reduced?
- (b) Draw the flow diagram for the general method of manufacture of refractory brick.
- (c) Discuss the properties and application of
- (i) High alumina brick
  - (ii) Zirconia brick. 3+4+3
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