

M.E.(Chemical with specialization in Environmental Engg.)

- For which reaction order, the half-life of the reactant is half of the full-life time (time for 100% conversion) of the reactant?
A) Zero order B) Half order C) First order D) Second order
- A spherical naphthalene ball of 2 mm diameter is subliming very slowly in stagnant air at 25 °C. The change in the size of the ball during the sublimation can be neglected. The diffusivity of naphthalene in air at 25 °C is $1.1 \times 10^{-6} \text{ m}^2/\text{s}$. The value of mass transfer coefficient is $B \times 10^{-3} \text{ m/s}$, where B (up to one decimal place) is _____.
A) 2.1 B) 1.1 C) 3.1 D) 4.1
- Which of the following can change if only the catalyst is changed for a reaction system?
A) Enthalpy of a reaction B) Activation energy
C) Free energy of the reaction D) Equilibrium constant
- Adsorption on activated carbon is to be used for reducing phenol concentration in waste water from 0.04 mol/L to 0.008 mol/L. The adsorption isotherm at the operating temperature can be expressed as $q = 0.025 C^{1/3}$, where q is the phenol concentration in solid (mol/g solid) and C is the phenol concentration in water (mol/L). The minimum amount of solid (in g) required per litre of waste water (up to one decimal place) is _____.
A) 5.8 B) 6.0 C) 6.2 D) 6.4
- For fanning friction factor f (for flow in pipes) and drag coefficient C_D (for flow over immersed bodies), which of the following statement is correct?
P: f accounts only for the skin friction
Q: C_D accounts only for the form friction
R: C_D accounts for both skin friction and form friction
S: Both f and C_D depends upon Reynolds number
T: For laminar flow through a pipe, f doubles on doubling the volumetric flow rate
A) R, S, T B) P, Q, S C) P, R, S D) P, Q, S, T
- For the time domain function $f(t) = t^2$, which one of the following is the Laplace transform of $\int_0^t f(t) dt$?
A) $3/s^4$ B) $1/4s^2$ C) $2/s^3$ D) $2/s^4$
- If $f^*(x)$ is the complex conjugate of $f(x) = \cos x + i \sin x$, then for real a and b,
 $\int_a^b f * f(x) dx$ is always:
A) Positive B) Negative C) Real D) Imaginary
- The unit of fugacity of is the same as that of the
A) Temperature B) Pressure C) Volume D) Molar concentration

9. From the following list, identify the properties which are equal in both vapor and liquid phases at equilibrium

P: density

Q: temperature

R: chemical potential

S: enthalpy

A) P and Q

B) Q and R

C) R and S

D) P and S

10. In order to achieve same conversion under identical reaction conditions and feed flow rate for a non autocatalytic reaction of positive order, the volume of an ideal CSTR is

A) Always greater than that of an ideal PFR

B) Always smaller than that of an ideal PFR

C) Same as that of an ideal PFR

D) Smaller than that of an ideal PFR only for first order reaction

11. The local velocity of a fluid along a streamline can be measured by

A) Venturi meter

B) Orifice meter

C) Rotameter

D) Pitot tube

12. A unit impulse response of a first order system with time constant τ and steady state gain K is given by

A) $\frac{1}{(K\tau)} e^{\frac{t}{\tau}}$

B) $Ke^{-\frac{t}{\tau}}$

C) $\tau Ke^{-t/\tau}$

D) $\frac{K}{\tau} e^{-t/\tau}$

13. In case of a pressure driven laminar flow of a Newtonian fluid of viscosity (μ) through a horizontal circular pipe, the velocity of the fluid is proportional to

A) μ

B) μ^{-1}

C) $\mu^{0.5}$

D) $\mu^{-0.5}$

14. In Blake Jaw crusher the angle between the jaws is usually

A) 5°

B) 15°

C) 30°

D) 90°

15. In order to produce fine solid particles between 5 and 10 μm , the appropriate size reducing equipment is

A) Hammer mill

B) Fluid energy mill

C) Jaw crusher

D) Gyratory crusher

16. Slurries are most conveniently pumped by a

A) Syringe pump

B) Gear pump

C) Diaphragm pump

D) Vacuum pump

17. Assuming the mass transfer coefficients in the gas and the liquid phase comparable, the absorption of CO_2 from reformer gas ($\text{CO}_2 + \text{H}_2$) into an aqueous solution of diethanolamine is controlled by

A) Gas phase resistance

B) Liquid phase resistance

C) Both gas phase and liquid phase resistance

D) Composition of the reformer gas

18. Which one of the following statements is correct for the surface renewal theory?

A) Mass transfer takes place at steady state

B) Mass transfer takes place at unsteady state

- C) Contact time is same for all the liquid elements
- D) Mass transfer depends only on the film resistance

19. In rolling of two math dice, the outcome of an experiment is considered to be the sum of the numbers appearing on the dice. The probability is highest for the outcome of _____.
 A) 1/6 B) 2/6 C) 3/6 D) 5/6

20. A step change of magnitude 2 is introduced into a system having the following transfer function

$$G(s) = \frac{2}{s^2 + 2s + 4}. \text{The percent overshoot is } \underline{\hspace{2cm}}.$$

- A) 15.5 B) 15.3 C) 16.5 D) 16.3

21. For estimation of heat capacity of a solid compound, one can use

- A) Clapeyron equation B) Gibb's equation
- C) Kopp's rule D) Trouton's rule

22. The molar density of water vapor at normal boiling point of water is 33 mol/m³. The Compressibility factor under these conditions is close to which one of the following?
 R= 8.314 J/mol-K

- A) 0.75 B) 1 C) 1.25 D) 1.5

23. In a pool boiling experiment, the following phenomenon were observed.

- P. Natural convection
- Q. Film boiling
- R. Transition boiling
- S. Nucleate boiling

What was the correct sequence of their occurrence?

- A) P, Q, R, S B) S, R, Q, P C) Q, R, P, S D) P, S, R, Q

24. A wet solid is dried over a long period of time by unsaturated air of non-zero constant relative humidity. The moisture content eventually attained by the solid is termed as the

- A) Unbound moisture content B) Bound moisture content
- C) Free moisture content D) Equilibrium moisture content

25. For a Newtonian fluid flowing in a circular pipe under steady state conditions in fully developed laminar flow, the Fanning friction factor is

- A) $0.046 \text{ Re}^{-0.2}$ B) $0.0014 + 0.125/(\text{Re}^{0.32})$
- C) $16/\text{Re}$ D) $24/\text{Re}$

26. Carbon black is produced by decomposition of methane as:



The single pass conversion of methane is 60%. If fresh feed is pure methane and 25% of the methane exiting the reactor is recycled, then molar ratio of fresh feed stream to recycle stream is

- A) 0.7 B) 1.5 C) 6.7 D) 9.0

27. The units of isothermal compressibility are

- A) m^{-3} B) Pa^{-1} C) $\text{m}^3 \text{Pa}^{-1}$ D) $\text{m}^{-3} \text{Pa}^{-1}$

28. The product of combustion of methane in atmospheric air (21% O_2 and 79% N_2) have the following composition on a dry basis:

Product	Mol%
CO_2	10.00
O_2	2.37
CO	0.53
N_2	87.10

The ratio of moles of CH_4 to the moles of O_2 in the feed stream is

- A) 1.05 B) 0.60 C) 0.51 D) 0.45

29. The diameter of a drop of liquid fuel changes with time due to combustion according to the relationship; $D = D_0 (1 - t/t_b)$, while burning, the drop falls at its terminal velocity under Stokes law regime. The distance it will travel before complete combustion is given by

- A) $\frac{D_0^2 \Delta \rho t_b g}{18\mu}$ B) $\frac{D_0^2 \Delta \rho t_b g}{36\mu}$ C) $\frac{D_0^2 \Delta \rho t_b g}{54\mu}$ D) $\frac{D_0^2 \Delta \rho t_b g}{108\mu}$

30. In a fully turbulent flow ($\text{Re} > 10^5$) in a pipe of diameter d for a constant pressure gradient, the dependence of volumetric flow rate of an incompressible fluid is

- A) d^2 B) d C) $d^{2.5}$ D) d^4

31. The critical speed of ball mill of radius R , which contains balls of radius r is proportional to

- A) $(R - r)^{-0.5}$ B) $(R - r)^{-1}$ C) $(R - r)$ D) $(R - r)^2$

32. In constant pressure filtration, the rate of filtration follows the relation (V = filtrate volume, t = time, $k = C$ = constants)

- A) $\frac{dV}{dt} = kV + C$ B) $\frac{dV}{dt} = \frac{1}{kV + C}$
 C) $\frac{dV}{dt} = kV$ D) $\frac{dV}{dt} = kV^2$

33. A sand mixture was screened through a standard 10 mesh screen. The mass fraction of the oversize material in feed, overflow and underflow were found to be 0.38, 0.79 and 0.22 respectively. The screen effectiveness based on the oversize is:

- A) 0.50 B) 0.58 C) 0.68 D) 0.62

34. A gas (density = 1.5 kg/m^3 , viscosity = $2 \times 10^{-5} \text{ kg/m-s}$) flowing through a packed bed (particle size = 0.5 cm. porosity 0.5) at superficial velocity of 2 m/s causes a pressure drop of 8400 Pa/m. The pressure drop for another gas with density of 1.5 kg/m^3 , viscosity of $3 \times 10^{-5} \text{ kg/m-s}$, flowing at 3 m/s will be

- A) 8400 Pa/m B) 18900 Pa/m C) 12600 Pa/m D) 16800 Pa/m

35. For the reaction $2R + S \rightarrow T$, the rates of formation of r_R, r_S and r_T of substances R, S and T are related by

- A) $2r_R = r_S = r_T$ B) $2r_R = r_S = -r_T$ C) $r_R = 2r_S = 2r_T$ D) $r_R = 2r_S = -2r_T$

36. A centrifugal pump is used to pump water through a horizontal distance of 150 m and then raised to an overhead tank 10 m above. The pipe is smooth with an ID of 50 mm. What head (of water) must the pump generate at its exit to deliver water at a flow rate of $0.001 \text{ m}^3/\text{s}$? The fanning friction factor f is 0.0062.

- A) 10 B) 11 C) 12 D) 20

37. The experimental data for the reaction, $2A + B_2 \rightarrow 2AB$ is

Expt. No.	[A]	[B]	Rate (mol s^{-1})
1.	0.50	0.50	1.6×10^{-4}
2.	0.50	1.00	3.2×10^{-4}
3.	1.0	1.00	3.2×10^{-4}

The rate equation for above data is

- A) $\text{rate} = k[B_2]^2$ B) $\text{rate} = k[B_2]$ C) $\text{rate} = k[A]^2 [B]^2$ D) $\text{rate} = k[A]^2 [B]$

38. V_{mf} is the minimum fluidization velocity for a bed of particles. An increase in the superficial gas velocity from $2V_{mf}$ to $2.5 V_{mf}$ results in (all velocities are smaller than the entrainment velocities of the particles) no change in

- A) Drag on the particles B) Drag on the column walls
C) The bed height D) The bed voidage

39. The range of standard current signal in process instruments is 4 to 20 Ma. The reason to choose 4 mA instead of 0 mA as minimum signal is (p-611)

- A) To minimize resistive heating in instruments
B) To distinguish between signal failure and minimum signal condition
C) To ensure a smaller difference between maximum and minimum signals
D) To ensure compatibility with other instruments

40. Among the following, choose one that is an endothermic process.

- A) Methanol synthesis B) Catalytic cracking
C) Ammonia synthesis D) Oxidation of Sulphur

41. Styrene is produced from ethylbenzene by the process of

- A) Dehydrogenation B) Oxidation C) Alkylation D) Dehydration

42. The amplitude ratio for sinusoidal response is always equal to 1 for (597-24)

- A) First order system B) Second order system
C) Transportation lag D) Proportional controller

43. For a proportional controller with gain K_c , the value of amplitude ratio (AR) and phase angle at all frequencies are respectively (597-36)

A) K_c and 0^0 B) K_c and 90^0 C) $1/K_c$ and 0^0 D) $K_c/2$ and 0^0

44. If the control loop is to operate at a gain margin of 2.0, the gain of the proportional controller must equal (616-49)

A) 0.85 B) 2.87 C) 3.39 D) 11.50

45. Platinum-10%, rhodium-platinum thermocouple can be used from (598-38)

A) 0^0C to 63.074^0C B) 0^0C to 1064.43^0C
C) 630.74^0C to 1263.74^0C D) 630.74^0C to 1064.43^0C

46. Given the characteristic equation below, select the number of roots which will be located to the right of the imaginary axis, $s^4 + 5s^3 - s^2 - 17s + 12$ (619-66)

A) One B) Two C) Three D) Zero

47. In a shell and tube heat exchanger, clearance of the tube is generally (666-134)

A) Not less than one-fourth of the tube diameter or 3/16 inch
B) More than the tube diameter
C) Equal to the tube diameter
D) More in case of triangular pitch as compared to the square pitch tube layout

48. A reactor has been installed at a cost of ₹ 50000 and is expected to have a working life of 10 Years with a scrap value of ₹ 10000. The capitalized cost (in ₹) of the reactor based on annual compound interest rate of 5% is

A) 113600 B) 42000 C) 52500 D) 10500

49. A sale contract signed by chemical manufacturer is expected to generate a net cash flow of ₹ 250000 per year at the end of each year for a period of 3 years. The applicable discount rate (interest rate) is 10%. The net present worth of the total cash flow, is ₹

A) ₹ 750000 B) ₹ 683750 C) ₹ 621500 D) ₹ 332750

50. Commercially ethylene is produced from naphtha by

A) Catalytic cracking B) Catalytic dehydrogenation
C) Pyrolysis D) Hydrocracking

51. In a fluid catalytic cracking unit, the nature of the reactions occurring in the reactor and the regenerator is

A) Reactor-exothermic, Regenerator-exothermic
B) Reactor-exothermic, Regenerator-endothermic
C) Reactor-endothermic, Regenerator-exothermic
D) Reactor-endothermic, Regenerator-endothermic

52. Which one is desirable in gasoline but undesirable in kerosene?

A) Aromatics B) Mercaptans C) Naphthenes D) Paraffins

53. The characteristic equation for the system is:

$$s^3 + 9s^2 + 26s + 12 (2 + K_c) = 0$$

A) 20.9 B) 18.4 C) 17.5 D) 15.3

- A) Ultrafiltration
C) Activated carbon
- B) Pressure sand filter
D) Nano filter

65. Which of these is the strongest disinfectant?
 A) Ozone B) Chlorine C) Chlorine dioxide D) UV rays
66. Fresh water carrying pipelines in chemical industries are coloured with_____ color
 A) Brown B) Sea green C) Yellow D) Red
67. In a shell and tube heat exchanger the “tube pitch” is defined as
 A) O.D. of the tube for square pitch
 B) Shortest distance between two adjacent tube holes
 C) Longest distance between two adjacent tube holes
 D) Shortest centre to centre distance between adjacent tubes
68. Pour point and freezing point is equal for
 A) Petrol B) Crude petroleum C) Water D) Diesel
69. Which of the following is a detergent?
 A) Benzene hexachloride B) Cellulose nitrate
 C) Polyvinyl chloride D) Alkyl benzene sulphonate
70. 25per cent cut segmental baffle means that the baffle
 A) Height is 75% of the I.D. of the shell B) Width is 25% of its height
 C) Height is 25% of the I.D. of the shell D) Spacing is 75% of its height
71. Solvent used in deasphalting process is?
 A) Furfural B) Phenol C) Propane D) Hexane
72. What is the specific humidity, if the mass of water is 10 g and mass of bone dry air is 20 g?
 A) 10% B) 30% C) 50% D) 80%
73. How are the traces of organic compounds removed from the soil?
 A) Denitrification B) Soil filtration C) Precipitation D) Sorption
74. Ethene is burnt with 50% of excess air, what is the percentage of CO₂ in the products?
 A) 11.11% B) 36.36% C) 66.66% D) 72.72%
75. 80 kg of Na₂SO₄ (mol wt 142) is present in 330 kg of an aqueous solution. The solution is cooled such that 80 kg of Na₂SO₄.10 H₂O crystals separate out. The weight fraction of Na₂SO₄ in the remaining solution is
 A) 0.06 B) 0.18 C) 0.24 D) 1.00