SEAL

Booklet Serial No.

1300277

Booklet Series

A

05/EFC/M-2025-02(A)

Question Booklet

CHEMICAL ENGINEERING

PAPER – II

Candidate's Roll Number

Time Allowed : 2 Hours

Maximum Marks : 300

Read the following instructions carefully before you begin to answer the questions.

IMPORTANT INSTRUCTIONS

1. This Question Booklet contains **100** questions in all.
2. **All** questions carry equal marks.
3. An Answer Sheet has been supplied inside the question booklet to mark the answers. **You must write your Roll Number and encode it and write other particulars in the space provided in the Answer Sheet, failing which your Answer Sheet will not be evaluated.**
4. **Immediately after commencement of the examination, you should check up your Question Booklet and attached answer sheet and ensure that the Question Booklet Series is printed on the top left-hand corner of the Booklet and the series encoded in answer sheet are same. Also please check that the Booklet contains 16 printed pages including two pages (Page Nos. 15 and 16) for Rough Work and no page or question is missing or unprinted or torn or repeated or question booklet and answer sheet have different series. If you find any defect in this Booklet and attached answer sheet, get it replaced immediately by a complete Booklet with OMR sheet of the same series.**
5. You must write your Roll Number in the space provided on the top of this page. Do not write anything else on the Question Booklet.
6. Questions and their responses are printed in English version in this Booklet. Each question comprises of **four** responses – (A), (B), (C) and (D). You are to select ONLY ONE correct response and mark it in your Answer Sheet. In case you feel that there are more than one correct response, mark the response which you consider the best. In any case choose ONLY ONE response for each question.
7. In the Answer Sheet, there are **four** circles – (A), (B), (C) and (D) against each question. To answer the questions, you are to mark with **Black/Blue ink ballpoint pen ONLY ONE circle** of your choice for each question. Select only one response for each question and mark it in your Answer Sheet. If you mark more than one circle for one question, the answer will be treated as wrong. **Use Black/Blue ink ballpoint pen only to mark the answer in the Answer Sheet. Any erasure or change is not allowed.**
8. For each question for which a wrong answer/more than one answer has been given by the candidates, **one third (1/3)** of the marks assigned to that question will be deducted as penalty.
9. You should not remove or tear off any sheet from the Question Booklet. You are not allowed to take this Question Booklet and the Answer Sheet out of the Examination Hall during the examination. **After the examination has concluded, you must hand over your Answer Sheet to the Invigilator.** Thereafter, you are permitted to take away the Question Booklet with you.
10. Failure to comply with any of the above instructions will render you liable to such action or penalty as the Commission may decide at their discretion.
11. Candidates must assure before leaving the Examination Hall that their Answer Sheets will be kept in Self Adhesive LDPE Bag and completely packed/sealed in their presence.

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1. Dead zone is the

(A) Same as time constant

(B) Same as transportation lag

(C) Maximum change in the variable that does not change the reading of the instrument

(D) None of these

2. _____ fluids break down under continued shear and on mixing, give lower shear stress for a given shear rate.

(A) Pseudoplastic

(B) Rheopectic

(C) Thixotropic

(D) Newtonian

3. The viscosity of gases increases with

(A) increase in temperature

(B) decrease in temperature

(C) independent of temperature

(D) first decreases up to 150°C and then increases with temperature

4. Mach, number is the ratio of the speed of the

(A) Fluid of that of the light

(B) Light of that of the fluid

(C) Fluid of that of the sound

(D) Sound of that of the fluid

5. The distance between two parallel plates is 0.00914 m; the lower plate is being pulled at a relative velocity of 0.366 m/s greater than the top plate. The fluid used is soyabean oil with a viscosity of 0.4×10^{-2} Pa.s at 303 K. The shear stress will be nearly:

(A) 0.12 N/m^2

(B) 0.14 N/m^2

(C) 0.16 N/m^2

(D) 0.18 N/m^2

6. A U-tube manometer filled with mercury is connected between two points in a pipeline. If the manometer reading is 20 cm of mercury (difference in mercury column height). Calculate the pressure difference between the points when water is flowing in the pipe.

Density of mercury = 13600 kg/m^3

Density of water = 1000 kg/m^3

g can be taken as 10 m/s^2

(A) 27.2 KN/m^2

(B) 25.2 KN/m^2

(C) 2 KN/m^2

(D) 20.2 KN/m^2

7. The continuity equation is based on

(A) Newton's law of viscosity

(B) Newton's law of cooling

(C) The law of conservation of mass

(D) Newton's law of motion

8. Hydraulic radius is the ratio of

(A) wetted perimeter to flow area

(B) flow area to the wetted perimeter

(C) flow area to the square of the wetted perimeter

(D) the square root of the flow area to the wetted perimeter

9. When the pipes are connected in parallel, the total loss of head

(A) Is equal to the sum of the loss of head in each pipe

(B) Is the same as in each pipe

(C) Is equal to the reciprocal of the sum of the loss of head in each pipe

(D) None of the above

10. A centrifugal pump having an impeller of diameter 120 mm delivers a power of 12 HP. If the diameter of the impeller is halved, what will be the power delivered if other parameters are kept constant?

(A) 6 HP

(B) 2 HP

(C) 4 HP

(D) 3 HP

11. With the increase in pump speed, its NPSH requirement

(A) Decreases

(B) Increases

(C) Remains unaltered

(D) Can either increase or decrease, depending on other factors

12. Water (density = 1000 kg m^{-3}) is pumped at a rate of 36 m^3/h, from a tank 2 m below the pump to an overhead pressurized vessel 10 m above the pump. The pressure values at the point of suction from the bottom tank and the discharge point to the overhead vessel are 120 kPa and 240 kPa, respectively. All pipes in the system have the same diameter. Take acceleration due to gravity, g = 10 ms^{-2}. Neglecting frictional losses, what is the power (in kW) required to deliver the fluid?

(A) 1.2

(B) 2.4

(C) 3.6

(D) 4.8

13. The purpose of providing a check valve in the discharge line of a centrifugal pump is:

(A) To control the flow of fluid when the pump is running

(B) To prevent backflow when the pump is stopped

(C) To control the discharge pressure

(D) To control the discharge temperature

14. Stokes' law is valid when the particle Reynolds number is $N_{Re.p}$ is

(A) Much less than one

(B) Equal to one

(C) Much greater than one

(D) None of the above

15. Terminal velocity of a particle settling in a fluid happens when
(A) Gravity force = Buoyancy force – Drag force
(B) Buoyancy force = Gravity force
(C) Gravity force = Buoyancy force + Drag force
(D) Gravity force = Drag force

16. Chilton-Colburn analogy of momentum, heat and mass transfer is applicable
(A) When there is only skin friction
(B) When there are both skin friction and form drag
(C) When there is only form drag
(D) When heat transfer happens by radiation

17. The dimensionless group in mass transfer that is equivalent to the Prandtl number in heat transfer is
(A) Nusselt number
(B) Sherwood number
(C) Schmidt number
(D) Stanton number

18. Prandtl number is the ratio of
(A) Mass diffusivity to thermal diffusivity
(B) Momentum diffusivity to thermal diffusivity
(C) Thermal diffusivity to mass diffusivity
(D) Thermal diffusivity to momentum diffusivity

19. Sphericity of a cubical particle, when the equivalent diameter is taken as the height of the cube is
(A) 0.5
(B) 1
(C) 2
(D) 3

20. 'Unreacted core model' represents the reaction involving
(A) Combustion of coal particles
(B) Roasting of sulfide ores
(C) Manufacture of carbon disulfide from elements
(D) None of these

21. Shape factor value for sphere
(A) 1
(B) 0.785
(C) 0.524
(D) 0

22. Kick's law relates to
(A) Energy consumption
(B) Final particle size
(C) Feed size
(D) None of these

23. Operating velocity in a packed tower is usually
(A) twice the flooding velocity
(B) half the flooding velocity
(C) equal to the flooding velocity
(D) more than the flooding velocity

24. The equation that is valid for a fluid flow through a packed bed for very large Reynolds numbers is
(A) Fanning equation
(B) Blake-Plummer equation
(C) Kozeney-Carmen equation
(D) Hagen-Poiseuille equation

25. Thermal diffusivity is defined as the ratio of

(A) Thermal conductivity to thermal capacity

(B) Thermal capacity to thermal conductivity

(C) Thermal capacity to diffusivity

(D) Mass diffusivity to thermal capacity

26. Consider a composite wall consisting of three layers of insulation of length L_1, L_2, L_3, and thermal conductivities k_1, k_2 and k_3, respectively. The insulating layers are placed in sequences 1, 2 and 3 and a specific rate of heat transfer results. If the order is now reversed to 3, 2, 1, then the rate of heat transfer through the wall under otherwise uniform conditions

(A) Will decrease

(B) Will increase

(C) Will remain unchanged

(D) Cannot be predicted; more information required

27. Transfer of heat by molecular collision is called

(A) Conduction

(B) Convection

(C) Radiation

(D) All of these

28. The rate constant of a reaction depends on the:

(A) Initial concentration of reactants

(B) Time of reaction

(C) Temperature of the system

(D) Extent of reaction

29. The critical radius(r) of insulation on a pipe is given by:

(A) $r = 2k/h$

(B) $r = k/h$

(C) $r = k/2h$

(D) $r = h/k$

30. It is required to increase the heat dissipation rate over the surface of an electronic device of spherical shape of 5 mm radius exposed to convection with h = 10 W/m^2-K by encasing it in a spherical sheath of conductivity 0.04 W/m-K. For maximum heat flow, the diameter of the sheath should be:

(A) 18 mm

(B) 16 mm

(C) 12 mm

(D) 8 mm

31. Wilson plot is used to determine

(A) Film heat transfer coefficients

(B) Overall heat transfer coefficients

(C) Rate of heat flow

(D) Thermal diffusivity

32. For a current-carrying wire of 20 mm diameter exposed to air (h = 25 W/m^2), maximum heat distribution occurs when the thickness of insulation (k = 0.5 W/m-K) is

(A) 20 mm

(B) 1.5 mm

(C) 10 mm

(D) 0 mm

33. The heat transfer by radiation from mild steel surface is to be reduced by the emissivity of the surface. This can be best achieved by:
(A) Painting the surface black
(B) Painting the surface white
(C) Giving the surface a mirror finish
(D) Roughening the surface

34. The presence of even small amounts of noncondensing gas in a condensing vapor will
(A) increase the rate of condensation
(B) not affect the rate of condensation
(C) reduce the rate of condensation
(D) indirectly affect the rate of condensation

35. To determine Boiling Point Elevation (BPE) for strong solutions which empirical method is used?
(A) Raoult's law
(B) Hagen equation
(C) Graetz number
(D) Duhring's rule

36. Dropwise condensation usually occurs on
(A) Glazed surface
(B) Coated surface
(C) Oily surface
(D) Rough surface

37. Lower BWG means _____ of the tube
(A) Lower thickness
(B) Lower cross-section area
(C) Outer diameter
(D) Inner diameter

38. Multi-pass heat exchangers are used
(A) To minimize pressure drop
(B) To increase the heat transfer rate
(C) To facilitate easy fabrication
(D) None of these

39. Which type of evaporator is preferred for the materials with heat sensitive products and liquids with suspended solids?
(A) Long tube vertical
(B) Horizontal tube
(C) Reboiler
(D) Agitated thin film

40. If the baffle spacing in a shell and tube heat exchanger increases, then the Reynolds number of the shell side fluid
(A) decreases
(B) remain unchanged
(C) increases drastically
(D) increases

41. The size of the plug flow reactor (PFR) for all positive reaction orders and any duty, is _____ that of mixed reactor.
(A) Greater than
(B) Equal to
(C) Smaller than
(D) Unpredictable from the data

42. The absorption factor is defined as
(A) L/(mG)
(B) G/(mL)
(C) mL/G
(D) LG/m

43. If there is no reflux to a fractionating column, then:
(A) Large condenser size is needed
(B) Less reboiler size needed
(C) Minimum number of trays
(D) None of the mentioned

44. The Fenske-Underwood equation is used for determining
(A) Diameter of the column
(B) Efficiency of the tray column
(C) Minimum number of theoretical plates
(D) Efficiency of the packed column

45. The flooding velocity in a plate column operating at 1 atm pressure is 3 m/s. If the column is operated at 2 atm pressure under identical conditions; the flooding velocity will be
(A) 3/2
(B) 2/3
(C) 1
(D) 3/4

46. The distillate flow rate from a distillation column is 100 kmol/hr and the reflux ratio is 2. The flow rate of vapor from the top plate in kmol/h is
(A) 100
(B) 200
(C) 300
(D) 50

47. In distillation operation, q factor is zero for
(A) Cold liquid
(B) Saturated liquid
(C) Saturated vapor feed
(D) Super-heated vapor feed

48. 100 moles of equimolar mixtures of benzene and toluene are fed to a distillation column. The top product contains 95 moles % benzene. The bottom product is 60 moles. What is the % recovery of benzene?
(A) 95%
(B) 5%
(C) 76%
(D) 60%

49. If the relative humidity is 90% and the temperature is 25°C, the water evaporates from the surface of a water body at a rate of 1.0 kg/m^2-h. The relative humidity that will lead to an evaporation rate of 3.0 kg/m^2-h, with other conditions remaining the same, is
(A) 30%
(B) 50%
(C) 60%
(D) 70%

50. The dry bulb temperature of the gas is
(A) Less than the wet bulb temperature
(B) More than the wet bulb temperature
(C) Equal to the wet bulb temperature
(D) None of the above

51. At a climatic station, air pressure is measured as 100 kPa, air temperature as 25°C, and the wet-bulb, or dew-point, temperature as 19°C. Calculate the relative humidity if the saturated vapour pressure at 25°C is given as 2733 Pa and actual vapour pressure is 2126 Pa.
(A) 0.97
(B) 0.77
(C) 0.67
(D) 0.87

52. Lyophilization is a process of drying
(A) of heat-sensitive products
(B) of suspended particles
(C) of non-porous solids
(D) of solids and pastes

53. 1000 kg of wet solids are dried from 60% to 20% moisture (by weight). The mass of moisture removed in kg is.
(A) 520
(B) 200
(C) 400
(D) 500

54. Leaching of coarse solid lumps is also termed as
(A) Liquid-liquid extraction
(B) Dissolution
(C) Percolation
(D) Evaporation

55. The term 'knuckle radius' is associated with
(A) flat heads
(B) tori spherical heads
(C) hemispherical heads
(D) conical heads

56. Which of the following is more suitable for the construction of refractories?
(A) High porosity bricks
(B) Low porosity bricks
(C) Bricks with high thermal expansion
(D) Bricks with low thermal conductivity

57. "The total volume occupied by a gaseous mixture is equal to the sum of the pure component volume." This is
(A) Dalton's law
(B) Amagat's law
(C) Gay-Lussac law
(D) Avogadro's law

58. "Recycle ratio" refers to
(A) Gross feed stream / recycle feed stream
(B) Recycle stream / fresh feed stream
(C) Fresh feed stream / recycle stream
(D) Recycle stream / net product outlet stream

59. It is required to make 100 kg of a solution containing 40% salt by mixing solution A containing 25% salt and solution B containing 50% salt. The mass in kilograms of solution A required is
(A) 40
(B) 60
(C) 75
(D) 25

60. Purging is done to control
(A) Building of impurities in the system
(B) Heat losses
(C) The reaction
(D) Input of the reactants

61. The maximum adiabatic flame temperature is attained when the fuel is burned with:

(A) The theoretically required amount of air

(B) The theoretically required amount of pure oxygen

(C) More than the theoretically required amount of pure oxygen

(D) Less than the theoretically required amount of pure oxygen

62. The number of degrees of freedom for a mixture of ice and water are

(A) 2

(B) 1

(C) 3

(D) 0

63. What is the effect of increasing pressure and molecular weight on the density of a gas?

(A) No effect

(B) Density will decrease

(C) Density will decrease with increasing pressure but will not change with increasing molecular weight

(D) Density will increase

64. The heat required to raise the temperature of one kg of a substance by 1K is defined as

(A) Heat capacity

(B) Heat of mixing

(C) Heat of crystallization

(D) Specific heat

65. An ideal gas is initially at a pressure of 0.1 MPa and a total volume of m^3. It is first compressed to 1 MPa by a reversible adiabatic process and then cooled at constant pressure to a final volume of 0.2 m^3. The total work done (in kJ) on the gas for the entire process ($C_p = 2.5$ R) is

(A) –757.2

(B) 5770

(C) –577.2

(D) 757.2

66. The Joule-Thomson coefficient (μ) for an ideal gas is

(A) Positive

(B) Negative

(C) Infinity

(D) Zero

67. A Carnot cycle consists of the following steps

(A) Two isothermal and two isentropic

(B) Two isobaric and two isothermals

(C) Two isochoric and two isobaric

(D) Two isothermals and two isochoric

68. A compressor sucks the gas at 1 atm gauge pressure and discharges the gas after compression at 9 atm gauge pressure. What is the compression ratio?

(A) 10

(B) 9

(C) 5

(D) 4.5

69. As the entropy of the universe is increasing, day by day, the work-producing capacity of a heat engine is

(A) Not changed

(B) Increasing

(C) Decreasing

(D) Data insufficient, can't be predicted

70. Mollier chart is a

(A) Pressure vs. Enthalpy plot

(B) Pressure vs. volume plot

(C) Enthalpy vs. Entropy chart

(D) Temperature vs. Entropy chart

71. Acentric factor for gas is negative for

(A) CO_2

(B) N_2

(C) O_2

(D) H_2

72. For ideal gases, the fugacity is directly proportional to

(A) Pressure

(B) Temperature

(C) Entropy

(D) Enthalpy

73. Van Laar equation deals with the activity coefficients in

(A) binary solutions

(B) ternary solutions

(C) azeotropic mixture only

(D) none of these

74. The unit of frequency factor in Arrhenius equation

(A) Is same as those of the rate constant

(B) Depend on the order of reaction

(C) Depends on the temperature of the reaction

(D) Depends on the pressure of the reaction

75. A liquid decomposes by irreversible first-order kinetics and the half-life period of this reaction is 8 minutes. The times required for 75% conversion of the liquid will be _____ minutes.

(A) 4

(B) 8

(C) 12

(D) 16

76. Differential method for analyzing the kinetic data is used

(A) When rate expressions are very simple

(B) For testing complicated mechanisms

(C) When the data are scattered

(D) None of these

77. In a steady state CSTR, the composition of the end-stream

(A) is the same as that in the reactor

(B) is different from that in the reactor

(C) depends on the flow rate

(D) insufficient information

78. An ideal plug flow is characterized by

(A) high capacity

(B) presence of axial mixing

(C) presence of lateral mixing

(D) no mixing in axial and lateral

79. For a given duty and for all positive reaction orders, the size of a mixed reactor is

(A) smaller than that of PFR

(B) same as that of PFR

(C) larger than that of PFR

(D) insufficient information

80. When a protective sheath covers a bare thermocouple, the response becomes

(A) Faster and oscillatory

(B) Faster and non-oscillatory

(C) Slower and oscillatory

(D) Slower and non-oscillatory

81. When the density of the reaction mixture is constant in a chemical reaction, the ratio of the mean residence time to space-time is

(A) > 1

(B) < 1

(C) 1

(D) 0

82. The performance equations for constant density systems are identical for

(A) PFR and CSTR

(B) PFR and Batch reactor

(C) PFR, Batch and Back mix reactors

(D) CSTR and Batch reactor

83. The conversion for a first-order liquid phase reaction $A \rightarrow B$ in a CSTR is 50%. If another CSTR of the same volume is connected in series, then the % conversion at the exit of the second reactor will be :

(A) 60

(B) 75

(C) 90

(D) 100

84. A catalyst loses its activity due to

(A) Loss in surface area of the active component

(B) Agglomeration of metal particles caused by thermal sintering of the solid surface

(C) Covering of the catalytic active sites by a foreign substance

(D) All (A), (B) and (C)

85. The unreacted core model represents the reaction involving

(A) Combustion of coal particles

(B) Roasting of sulfide ores

(C) Manufacturing of CS_2 from Clements

(D) None of the above

86. Tracer input signal is used to

(A) Study the reaction mechanism

(B) Study the extent of non-ideal flow in the reactor

(C) Know reaction rate constants

(D) Know Activation energy

87. The Solvay process refers to the manufacture of

(A) Sodium Hydroxide

(B) Sulphuric acid

(C) Nitric acid

(D) Sodium carbonate

88. Vanadium pentoxide is used as a catalyst for the manufacture of

(A) Sulphuric acid

(B) Nitric acid

(C) Hydrochloric acid

(D) Phosphoric acid

89. Contact process

(A) yields acid of higher concentration than the chamber process

(B) yields acid of lower concentration than the chamber process

(C) is obsolete

(D) eliminates absorber

90. 20% oleum means that in 100 kg oleum, there are 20 kg of:

(A) SO_3 and 80 kg of H_2SO_4

(B) H_2SO_4 and 80 kg of SO_3

(C) SO_3 for each 100 kg of H_2SO_4

(D) None of these

91. Triple superphosphate is manufactured by reacting

(A) phosphate rock with phosphoric acid

(B) phosphate rock with sulphuric acid

(C) phosphate rock with nitric acid

(D) ammonium phosphate with phosphoric acid

92. Yeast is used in the manufacture of

(A) Penicillin

(B) Streptomycin

(C) Wine

(D) Lactose

93. Molasses can be converted into ethyl alcohol by

(A) Crystallization

(B) Distillation

(C) Fermentation

(D) Hydrogenation

94. Styrene is produced from ethyl-benzene by

(A) dehydrogenation

(B) alkylation

(C) oxidation

(D) dehydration

95. Buna-N is a polymer of

(A) Butadiene

(B) Butadiene and Styrene

(C) Butadiene and Acrylonitrile

(D) Styrene and Acrylonitrile

96. Petrolatum is:

(A) Same as petroleum ether

(B) Petroleum cake

(C) A mixture of microcrystalline wax in viscous hydrocarbon liquids

(D) None of these

97. 'Sour' crude means the crude oil contains

(A) wax

(B) paraffins and asphalts

(C) nitrogen compounds

(D) sulfur compounds

98. Asphalts are

(A) low molecular weight and low boiling point compounds present in petroleum

(B) desirable in catalytic cracking feed-stock because they produce coke

(C) readily oxidizable and form carbonaceous sludge

(D) all of the above

99. Purpose of adding fluxing agents during ceramic manufacture

(A) To maintain the equilibrium

(B) To raise the temperature

(C) To prevent reversible reaction

(D) To lower the temperature

100. A furnace installed at a cost of Rs. 24 Lakh is expected to serve its useful life of 5 years. Salvage value of the furnace is Rs. 8 Lakh. The interest rate compounded annually is 8%. The estimated capitalized cost (in Lakhs of rupees)

(A) 30

(B) 34.09

(C) 34.9

(D) 58.09