Combined Engineering Services

MICA

Booklet Series **A**

Register Number

2007

CHEMICAL ENGINEERING

Time Allowed : 3 Hours] **[Maximum Marks : 300**

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

IMPORTANT INSTRUCTIONS

1. This Booklet has a cover (this page) which should not be opened till the invigilator gives signal to open it at the commencement of the examination. As soon as the signal is received you should tear the right side of the booklet cover carefully to open the booklet. Then proceed to answer the questions.
2. This Question Booklet contains **200** questions.
3. Answer **all** questions. **All** questions carry equal marks.
4. The Test Booklet is printed in *four* series *e.g.* [A] [B] [C] or [D] (See Top left side of this page). The candidate has to indicate in the space provided in the Answer Sheet the series of the booklet. For example, if the candidate gets [A] series booklet, he/she has to indicate in the side 2 of the Answer Sheet with Blue or Black Ink Ball point pen as follows :

   [A] ■ [B] [C] [D]

5. You must write your Register Number in the space provided on the top right side of this page. Do not write anything else on the Question Booklet.
6. An Answer Sheet will be supplied to you separately by the invigilator to mark the answers. You must write your Name, Register No. and other particulars on side 1 of the Answer Sheet provided, failing which your Answer Sheet will not be evaluated.
7. You will also encode your Register Number, Subject Code etc., with Blue or Black Ink Ball point pen in the space provided on the side 2 of the Answer Sheet. If you do not encode properly or fail to encode the above information, your Answer Sheet will not be evaluated.
8. Each question comprises *four* responses (A), (B), (C) and (D). You are to select ONLY ONE correct response and mark 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. Your total marks will depend on the number of correct responses marked by you in the Answer Sheet.
9. In the Answer Sheet there are **four** brackets [A] [B] [C] and [D] against each question. To answer the questions you are to mark with Ball point pen ONLY ONE bracket of your choice for each question. Select one response for each question in the Question Booklet and mark in the Answer Sheet. If you mark more than one answer for one question, the answer will be treated as wrong. *e.g.* If for any item, (B) is the correct answer, you have to mark as follows :

   [A] ■ [C] [D]

10. You should not remove or tear off any sheet from this 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 is concluded, you must hand over your Answer Sheet to the Invigilator. You are allowed to take the Question Booklet with you only after the Examination is over.
11. 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.
12. Do not tick-mark or mark the answers in the Question Booklet.

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1. Standard free energy change ΔG° of a chemical reaction is given by the relation

A) $\Delta G^\circ = -R \ln K$ B) $\Delta G^\circ = -RT \ln K$

C) $\Delta G^\circ = RT \ln K$ D) $\Delta G^\circ = -R \log_{10} K$.

2. The second law of thermodynamics states that

A) the energy change of a system undergoing any reversible process is zero

B) it is not possible to transfer heat from a lower temperature to a higher temperature

C) the total energy of the system and surroundings remains constant

D) none of these.

3. For isobaric process

A) $\Delta H = Q = \int C_p \, dT$ (for a finite change)

B) $C_P = \left(\frac{\partial H}{\partial T} \right)_P$

C) $C_P = C_v + R$

D) All of these.

4. Which one of the following is true ?

A) $G = H - TS$ B) $G = H + TS$

C) $G = H + T/S$ D) None of these.

5. Helmholtz free energy A^t is defined as

A) $A^t = U^t - TS^t$ B) $A^t = U^t + TS^t$

C) $A^t = H^t - TS^t$ D) $A^t = H^t + TS^t$

where superscript t signifies for the entire mass of the system.

6. The fugacity of a component i in an ideal solution $\hat{f}_i^{id}$ is given by $\hat{f}_i^{id} = x_i f_i$

where x_i = mole fraction of component i

f_i = fugacity of pure component i at the same temperature and pressure.

This is known as

A) Henry's law B) Raoult's law

C) Lewis Randall law D) None of these.

7. In a mixture of ideal gases, the fugacity of component is equal to the

A) pressure of gas mixture

B) partial pressure of component *i* in the gas mixture

C) zero

D) none of these.

8. A Carnot cycle consists which of the following steps ?

A) Two isothermals and two isentropics

B) Two isobarics and two isothermals

C) Two isochorics and two isobarics

D) Two isothermals and two isochorics.

9. Which of the following is derived to bring about a certain change in the state of a system by performing work on the system under adiabatic conditions ?

A) The amount of work needed is path dependent

B) Work alone cannot bring about such a change of state

C) The amount of work needed is independent of path

D) More information is needed to conclude anything about the path dependence or otherwise of the work needed.

10. Pressure is an example for

A) intensive property

B) extensive property

C) both intensive and extensive properties

D) none of these.

11. Air initially at 101·3 k Pa and 40°C and with a relative humidity of 50% is cooled at constant pressure to 30°C. The cooled air has

A) a higher dew point

B) a higher absolute specific humidity

C) a higher relative humidity

D) a higher wet bulb temperature.

12. Maxwell's relation corresponding to the identity $dH = dS + VdP + \Sigma \mu_i dn_i$ is

A) $\left(\frac{\partial T}{\partial V}\right)_{S, ni} = -\left(\frac{\partial P}{\partial S}\right)_{V,ni}$ B) $\left(\frac{\partial S}{\partial P}\right)_{T, ni} = \left(\frac{\partial V}{\partial T}\right)_{P,ni}$

C) $\left(\frac{\partial S}{\partial V}\right)_{T, ni} = \left(\frac{\partial P}{\partial T}\right)_{V,ni}$ D) $\left(\frac{\partial T}{\partial P}\right)_{S, ni} = \left(\frac{\partial V}{\partial S}\right)_{P,ni}$.

13. 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 per cent of H_2 in the gas on a dry basis will be

A) 10% B) 5%

C) 18·18% D) 20%.

14. At triple point of water system, the system is

A) invariant B) univariant

C) bivariant D) trivariant.

15. Stochiometric quantity of air is the quantity of air required for complete combustion of fuel with

A) some excess oxygen B) no oxygen left unused

C) 50% excess air D) 100% excess air.

16. A binary system consisting of two substances which are miscible in all proportion in the liquid phase, but do not react chemically is known as

A) Univariant system B) Eutectic system

C) Metastable system D) Congruent melting system.

17. The value of universal gas constant is

A) 8·3144 kJ/mole K B) 1·983 cal/g mole K

C) 1·983 Btu/lb mole K D) all of these.

18. Heat pump is a device operating by taking up

A) heat at high temperature and discharges at low temperature

B) heat at high temperature and discharges at same temperature

C) heat at low temperature and discharges at high temperature

D) none of these.

19. Gibbs phase rule finds application when heat transfer occurs by

A) conduction B) convection

C) radiation D) condensation.

20. High pressure steam is expanded adiabatically and reversibly through a well insulated turbine which produces some shaft work. If the enthalpy change and entropy change across the turbine are represented by ΔH and ΔS respectively, for this process

A) $\Delta H = 0$ and $\Delta S = 0$ B) $\Delta H \neq 0$ and $\Delta S = 0$

C) $\Delta H \neq 0$ and $\Delta S \neq 0$ D) $\Delta H = 0$ and $\Delta S \neq 0$.

21. Bomb calorimeter is used for determining the calorific value of

A) solid fuel B) liquid fuel

C) gaseous fuel D) both (A) and (B).

22. In the friction factor chart the slope of the line for the laminar flow region is

A) + 1 B) – 1

C) 0 D) none of these.

23. If the Prandtl number is greater than the Schmidt number,

A) the thermal boundary layer lies inside the concentration boundary layer

B) the concentration boundary layer lies inside the thermal boundary layer

C) the thermal and concentration boundary layer are of equal thickness

D) the hydrodynamic (momentum) boundary layer is thicker than the other two.

24. Molecular diffusivity of a liquid

A) increases with temperature

B) decreases with temperature

C) may increase or decrease with temperature

D) is independent of temperature.

25. How many times the tube side coefficient of the four pass heat exchanger is greater than that for the single pass heat exchanger ?

A) 4 B) $4^{0.2}$

C) $4^{0.8}$ D) None of these.

26. In shell and tube Heat Exchangers the LMTD correction factor is used to account for the

A) parallel flow B) cross flow

C) counter flow D) none of these.

27. Plate type heat exchangers are preferred when

A) the fluids are at high pressures between 20 and 40 atm

B) the fluids are at low or moderate pressures below 20 atm

C) both (A) & (B)

D) none of these.

28. Due to which of the following properties liquid metals offer a greater advantage in heat transfer ?

A) Good specific heat B) Low viscosities

C) High thermal conductivity D) All of these.

29. Select the correct equation

where, NR_e – Reynolds number

NP_e – Peclet number

NP_r – Prandtl number

A) $NP_r = NP_e - NR_e$ B) $NP_e = NP_r / NR_e$

C) $NP_e = NP_r \cdot NR_e$ D) None of these.

30. For momentum transfer the ratio of wall-transfer flux to the convective flux is

A) $2f$ B) $f/2$

C) f^2 D) none of these.

31. The magnitude of the Prandtl number at 70°C for water is

A) 2·5 B) 0·7

C) 0·01 D) none of these.

32. Example for dropwise condensation is the condensation of

A) steam B) liquid metals

C) ethylene glycol D) all of these.

33. The average heat transfer coefficient for dropwise condensation is

A) greater than film type condensation coefficient

B) less than film type condensation coefficient

C) equal to film type condensation coefficient

D) none of these.

34. Volume surface mean diameter of the bubbles is defined as

A) $\frac{6 \times \text{Total volume}}{\text{Total surface area}}$ B) $\frac{\text{Total volume}}{6 \times \text{Total surface area}}$

C) $\frac{6 \times \text{Total surface area}}{\text{Total volume}}$ D) none of these.

35. In area meters

A) velocity head is constant B) pressure drop is constant

C) both (A) and (B) D) none of these.

36. Drag coefficient (C_D) is defined as

A) $C_D = \frac{F_D/A_p}{\rho u_0^2/2g_e}$ B) $C_D = \frac{A_p/F_D}{\rho u_0^2/2g_e}$

C) $C_D = \frac{F_D/A_p}{2g_e/\rho u_0^2}$ D) none of these.

37. Friction factor is defined as the ratio of

A) shear stress to the product of velocity head and density

B) shear stress to the product of velocity head and viscosity

C) the product of velocity head and density to the shear stress

D) none of these.

38. The Kozeny-Carman equation is applicable for flow through beds at particle Reynolds numbers up to about

A) 2·5 B) 1·0

C) 1·5 D) none of these.

39. The emissivity of the black body is

A) 0 B) 1

C) 2 D) none of these.

40. The equation $W_b = \sigma T^4$,

where, W_b = Total emissive power of the black body

T = Absolute temperature

represents the following

A) Stefan-Boltzmann law B) Planck's law

C) Kirchhoff's law D) None of these.

41. The micro-organism used for the biogas production by anaerobic digestion is

A) Algae B) Fungi

C) Yeast D) Methanogenic bacteria.

42. Which of the following in coal decreases its calorific value ?

A) Carbon B) Hydrogen

C) Oxygen D) Sulphur.

43. Filtrate flows at constant rate means

A) linear velocity constant B) pressure drop constant

C) both (A) and (B) D) none of these.

44. The filter medium resistance may vary with

A) pressure drop

B) age and cleanliness of the filter medium

C) both (A) and (B)

D) none of these.

45. The energy absorbed by unit mass of the material (W_n) is

A) $W_n = \frac{e_s (A_{wb} - A_{wa})}{\eta_c}$ B) $W_n = \frac{\eta_c (A_{wb} - A_{wa})}{e_s}$

C) $W_n = \eta_c \rho_s (A_{wb} - A_{wa})$ D) none of these.

46. Solids may be broken by

A) compression B) impact

C) attrition D) all of these.

47. The mixing index at zero mixing is

A) $\sqrt{n}$ B) $\frac{1}{\sqrt{n}}$

C) n D) none of these.

48. Sauter mean diameter is defined as

A) $\overline{D}_s = \frac{6 \times \text{Total volume of bubbles}}{\text{Total surface area of bubbles}}$

B) $\overline{D}_s = \frac{6 \times \text{Total surface area of bubbles}}{\text{Total volume of bubbles}}$

C) $\overline{D}_s = \frac{1}{6} \times \frac{\text{Total volume of bubbles}}{\text{Total surface area of bubbles}}$

D) none of these.

49. Reynolds number calculated from the diameter and peripheral speed of the impeller is

A) $NR_e = \frac{nD_a^2 \cdot \rho^2}{\mu}$ B) $NR_e = \frac{nD_a^2 \cdot \rho}{\mu}$

C) $NR_e = \frac{n^2 D_a \cdot \rho}{\mu}$ D) none of these.

50. Flow number is defined as the

A) $N_Q = \frac{q}{n^2 D_a^2}$ B) $N_Q = \frac{nD_a^3}{q}$

C) $N_Q = \frac{q}{n D_a^3}$ D) none of these.

51. Circulatory flow and swirling can be prevented by

A) mounting the impeller off centre

B) installing baffles

C) both (A) and (B)

D) none of these.

52. Critical speed (N_c) of a ball mill is equal to

A) $\frac{1}{4\pi}\sqrt{\frac{g}{R-r}}$ B) $\frac{1}{2\pi}\sqrt{\frac{g}{R-r}}$

C) $\frac{1}{\pi}\sqrt{\frac{g}{R-r}}$ D) $\frac{1}{2\pi}\sqrt{\frac{R-r}{g}}$

53. Effectiveness of a screen is equal to

A) $\frac{x_F}{x_P} \cdot \frac{F}{P}\left[1 - \frac{(1 - x_P)P}{(1 - x_F)F}\right]$ B) $\frac{x_P}{x_F} \cdot \frac{P}{F}\left[1 - \frac{(1 - x_P)P}{(1 - x_F)F}\right]$

C) $x_F \cdot \frac{P}{F}\left[1 - \frac{(1 - x_F)F}{(1 - x_P)P}\right]$ D) $\frac{x_P}{x_F} \cdot \frac{P}{F}\left[1 - \frac{(1 - x_F)F}{(1 - x_F)P}\right]$.

54. Alcohol-blended petrol possesses

A) better calorific value B) better anti-knock properties

C) poorer anti-knock properties D) none of these.

55. The feed stock for thermal power station is

A) coal B) lignite

C) both (A) and (B) D) none of these.

56. A cell capable of generating an electric current by converting chemical energy to electrical energy is known as

A) MHD generator B) Biogas digester

C) Fuel cells D) none of these.

57. An equipment which is used to absorb sensible heat from one stream and transfers to another stream is

A) Heat recuperator B) Condenser

C) Reboiler D) none of these.

58. The transition (critical) temperature of the superconducting material is one at which the resistance falls to

A) 1 B) zero

C) 1·1 D) 1·2.

59. Axial flow impellers are those that generate currents

A) in a tangential or radial direction to the axis of the impeller

B) parallel with axis of the impeller

C) both (A) and (B)

D) none of these.

60. Specific heat of water at 20°C and atmospheric pressure in kJ/kgK is

A) 4·19 B) 8·314

C) 4·91 D) 3·19.

61. Volumetric strain is the ratio of

A) change in volume to the original volume

B) original volume to the change in volume

C) change in length to the original volume

D) none of these.

62. Good thermal conductivity of a refractory material is desirable, if it is to be used in the construction of walls of a

A) blast furnace B) muffle furnace

C) reverberatory furnace D) all of these.

63. Nitriding is the process of getting

A) hard weiring surface B) super hard surface

C) both (A) and (B) D) none of these.

64. Nichrome is used at the temperature range

A) 500° – 600°C B) 800° – 900°C

C) 1000° – 1100°C D) none of these.

65. Constantan is

A) 60% Cu and 40% Ni B) 40% Cu and 60% Ni

C) 50% Cu and 50% Ni D) none of these.

66. Drainage pipes are usually made of

A) Whitewares B) Stonewares

C) Porcelain D) China wares.

67. The main constituent of safety glass is

A) $CaCO_3$ B) PbO

C) Vinyl plastic D) Boron.

68. In water line corrosion, the maximum amount of corrosion takes place

A) along line just above the level of water meniscus

B) along a line at the level of the water meniscus

C) along a line just below the level of the water meniscus

D) at the bottom of the pipe.

69. A good refractory material must

A) be chemically inactive in use

B) possess low softening temperature

C) undergo spalling

D) possess high thermal expansion.

70. Metal at the top of electromotive series is

A) most stable B) least active

C) most noble D) most active.

71. During wet corrosion

A) the anodic part undergoes oxidation

B) the cathodic part undergoes oxidation

C) the anodic part undergoes reduction

D) neither anodic nor cathodic parts undergo any changes.

72. The rate of corrosion of iron in atmosphere depends on

A) the humidity of the atmosphere

B) the degree of pollution to the atmosphere

C) the frequency of rainfall

D) all of these.

73. Corrosion due to biological materials is called as

A) Chemisorption B) Biosorption

C) Biocorrosion D) None of these.

74. A suitable material of construction to use fuming sulphuric acid is

A) Carbon steel B) Stainless steel type 304

C) Nickel D) Monel.

75. In distillation columns, the number of bubble caps per tray primarily depends on the

A) allowable liquid velocity B) allowable gas velocity

C) allowable gas and liquid velocity D) feed composition.

76. The advantage of using 1-2 shell and the tube heat exchanger over a 1-1 shell and tube heat exchanger is

A) lower tube side pressure drop

B) lower shell side pressure drop

C) higher tube side heat transfer coefficient

D) higher shell side heat transfer coefficient.

77. For a sphere falling in the constant drag coefficient regime, its terminal velocity depends on its diameter (d) as

A) d B) $\sqrt{d}$

C) d^2 D) $\frac{1}{d}$.

78. The baffle pitch or baffle spacing in a shell and tube heat exchanger

A) should not be less than one-fifth the diameter of the shell

B) should not be more than the inside diameter of the shell

C) both (A) and (B)

D) none of these.

79. During galvanic corrosion the more noble metal acts as

A) anode B) cathode

C) corroding metal D) anode as well as cathode.

80. Photovoltaic cells which are used to generate electricity are made up of

A) superconductors B) semiconductors

C) non-conductors D) none of these.

81. Starch can be converted to glucose by

A) hydrogenation B) hydrolysis

C) hydration D) none of these.

82. The purity of absolute alcohol is represented as

A) 100 proof B) 200 proof

C) 100 Brix D) all of these.

83. Silver catalyst is used for the manufacture of

A) Formaldehyde B) Methanol

C) Propylene D) Acetylene.

84. Bagasse can be used as a

A) fuel for generation of steam B) raw material for furfural

C) feed stock for making paper D) all of these.

85. The steps involved in the manufacture of detergents are

A) causticization, hydrolysis, electrolytic addition of chlorine

B) alkylation, sulphonation, neutralisation

C) oxidation, hydration, chlorination

D) none of these.

86. Ethyl alcohol from molasses is produced by

A) chemical oxidation B) reduction

C) fermentation D) hydrolysis.

87. Which of the following impurities in the Sulphur feed causes poisoning of the Vanadium pentoxide catalyst in H_2SO_4 manufacture ?

A) Nickel B) Antimony

C) Arsenic D) All of these.

88. Main constituent of natural gas is

A) carbon monoxide B) methane

C) hydrogen D) ethane.

89. Methanol is produced using

A) Synthesis gas ($N_2 + H_2$) B) Synthesis gas ($CO + H_2$)

C) Producer gas D) Water gas.

90. The conversion of SO_2 to SO_3 using V_2O_5 as catalyst is an

A) endothermic process B) exothermic process

C) alkylation process D) both (A) and (B).

91. Urea is manufactured by

A) once through process
B) partial recycle process
C) total recycle process
D) oxidation of ammonia.

92. The quality of Urea fertilizer is judged by the presence of

A) ammonia
B) ammonium bicarbonate
C) biuret
D) all of these.

93. Titanium dioxide is associated with which of the following industries ?

A) Detergent
B) Paints and pigments
C) Soaps
D) None of these.

94. N_2 required for ammonia synthesis can be obtained from

A) fractional distillation of atmospheric air
B) Ammonia
C) Ammonium nitrate
D) Ammonium sulphate.

95. Terylene is the polyester of

A) hexamethylene diamine and adipic acid
B) vinyl chloride and formaldehyde
C) melamine and formaldehyde
D) ethylene glycol and terephthalic acid.

96. The major raw materials for manufacture of styrene are

A) Benzene and toluene
B) Benzene and ethylene
C) Toluene and ethylene
D) Ethylene and propylene.

97. Solvay process is used for the manufacture of

A) Caustic soda B) Soda ash

C) Caustic potash D) Sodalime.

98. Phthalic anhydride is produced by the oxidation of

A) Naphthalene B) Benzene

C) Toluene D) Aniline.

99. Refining of Sugar involves

A) Decolourization and Filtration B) Concentration and Crystallisation

C) Drying D) All of these.

100. Kraft process is a popular process of making

A) Sugar B) Pulp

C) Ethanol D) Beer.

101. Energy requirement (per unit mass of material crushed/ground) is highest for

A) Jaw crusher B) Rod mill

C) Ball mill D) Fluid energy mill.

102. The velocity gradients around each particle are affected by the presence of nearby particles in settling. It is known as

A) aggregate settling B) hindered settling

C) fluidization D) all of these.

103. The velocity profile for a Bingham plastic fluid flowing (under laminar conditions) in a pipe is

A) parabolic

B) flat

C) flat near the wall and parabolic in the middle

D) parabolic near the wall and flat in the middle.

104. The drag co-efficient for laminar flow varies as (where R_e = Reynolds number)

A) R_e B) $\frac{1}{R_e}$

C) $\sqrt{R_e}$ D) $\frac{1}{\sqrt{R_e}}$.

105. Inclined manometers are used to measure small pressure differences. When the angle of inclination of the manometer is increased

A) the pressure difference can be measured accurately

B) the pressure difference cannot be measured accurately

C) the temperature compensation is necessary

D) none of these.

106. The S.I. unit of viscosity is

A) $N.s/m^2$ B) poise

C) centipoise D) none of these.

107. Mercury manometer is a

A) first order system

B) second order system

C) may be first order or second order

D) none of these.

108. A typical example of a physical system with underdamped characteristics is

A) U-tube manometer

B) Spring loaded diaphragm valve

C) CSTR with first order reaction

D) Thermocouple kept immersed in a liquid filled thermowell.

109. The Laplace transform of the function e^{-at} has the term

A) $\frac{1}{s+a}$ B) $\frac{1}{s(s+a)}$

C) $\frac{a}{s}$ D) $s+a$.

110. The static error of an instrument

A) is a constant for the entire range

B) is not a constant in the measured range

C) will vary with time

D) both (B) and (C).

111. The root locus plot of the characteristic equation of a closed loop system having the open loop transfer function $\frac{k(s+1)}{s(2s+1)(3s+1)}$ will have a definite number of loci for variation of K from 0 to ∞. The number of loci is

A) 1 B) 2

C) 3 D) 4.

112. The transfer function of a PID controller is

A) $K_c\left(1+\tau_i s+\tau_D s\right)$ B) $K_c\left(1+\frac{1}{\tau_i s}+\tau_D s\right)$

C) $K_c\left(1+\tau_i s+\frac{1}{\tau_D s}\right)$ D) $K_c\left(1+\frac{1}{\tau_i s}+\frac{1}{\tau_D s}\right)$.

113. A proportional controller with a gain of K_c is used to control a first order process. The offset will increase if

A) K_c is reduced B) K_c is increased

C) integral action is introduced D) derivative action is introduced.

114. The second order system with the transfer function $\frac{4}{s^2 + 2s + 4}$ has a damping ratio of

A) 2·0 B) 0·5

C) 1·0 D) 4·0.

115. An ideal PID controller has the transfer function $\left[1 + \frac{1}{(0{\cdot}5_S)} + 0{\cdot}2S\right]$. The frequency at which the magnitude ratio of the controller is 1, is

A) $\frac{0{\cdot}5}{0{\cdot}2}$ B) $\frac{0{\cdot}2}{0{\cdot}5}$

C) $0{\cdot}2 \times 0{\cdot}5$ D) $\frac{1}{\sqrt{0{\cdot}2 \times 0{\cdot}5}}$.

116. A first order system with a time constant of 1 min is subjected to frequency response analysis. At an input frequency of 1 radian/min, the phase shift is

A) 45° B) – 90°

C) – 180° D) – 45°.

117. The unit step response of the transfer function $\frac{1}{s^2 + 2s + 3}$

A) has a non-zero slope at the origin

B) has a damped oscillator characteristics

C) is overdamped

D) is unstable.

118. A second order system can be obtained by connecting two first order systems $\frac{1}{(\tau_1 S + 1)}$ and $\frac{1}{(\tau_2 S + 1)}$ in series. The damping ratio of the resultant second order system for the case $\tau_1 \neq \tau_2$ will be

A) > 1 B) = 1

C) < 1 D) $= \tau_2 / \tau_1$.

119. Presence of functional groups in a compound can be established by using

A) IR spectroscopy B) UV spectroscopy

C) chromatography D) none of these.

120. Bubble-cap plate column is

A) a finite stage contactor

B) used only for distillation not for absorption

C) a differential stage contactor

D) none of these.

121. Heating waste materials at very high temperature in absence of air to recover heat and useful chemicals is known as

A) combustion B) incineration

C) pyrolysis D) none of these.

122. Activated sludge process in effluent treatment is a/an

A) attached growth process B) suspended growth process

C) chemical oxidation process D) none of these.

123. Payout period has relation with

A) comparing alternative investment choices

B) profitability evaluation

C) cost accounting

D) working capital.

124. For a particle settling in water at its terminal settling velocity which of the following is true ?

A) Buoyancy = Weight + Drag B) Weight = Buoyancy + Drag

C) Drag = Buoyancy + Weight D) Drag = Weight.

125. Future worth (S) of an investment (P) at an interest rate (i) for n years is

A) $S = P(1 + i)^n$ B) $S = \frac{P}{(1 + i)^n}$

C) $S = \frac{P^n}{(1 + i)}$ D) none of these.

126. Most poisonous pollutant in water is

A) Zinc B) Phosphate

C) Arsenic D) Carbon dioxide.

127. Aerobic oxidation is caused by

A) Aerobic bacteria in presence of excess oxygen

B) Anaerobic bacteria in presence of insufficient oxygen

C) Aerobic bacteria in absence of oxygen

D) Both anaerobic and aerobic bacteria in any condition.

128. Use of leaded gasoline internal combustion engines causes

A) no pollution B) more pollution

C) less pollution D) more smoke emission.

129. Growing more trees helps to

A) reduce oxygen in the environment

B) increase of carbon dioxide in the environment

C) reduce the carbon dioxide only in the environment

D) reduce CO_2 and increase O_2 in the environment.

130. The presence of which of the following gases in air checks the ultraviolet light from sunlight ?

A) SO_2 B) CO_2

C) NO D) O_3.

131. P is the investment made on an equipment. S is its salvage value and n is the life of the equipment in years. The depreciation for the m th year by the sum of years-digits method will be

A) $\frac{P-S}{n}$ B) $1-\left(\frac{P}{S}\right)^{\frac{1}{m}}$

C) $\frac{m}{n}(P-S)$ D) $\frac{2(n-m+1)}{n(n+1)}(P-S)$.

132. An investment of Rs. 1,000 is carrying an interest of 10% compounded quarterly. The value of the investment at the end of five years will be

A) $1000\left(1+\frac{0{\cdot}1}{4}\right)^{20}$ B) $1000(1+0{\cdot}10)^{20}$

C) $1000\left(1+\frac{0{\cdot}1}{4}\right)^{5}$ D) $1000\left(1+\frac{0{\cdot}1}{2}\right)^{5}$.

133. Algae help in the waste water treatment by giving O_2 required for biological oxidation and taking up CO_2 for preparation of starch. This activity of the micro-organism is called as

A) Symbiotic B) Inhibitive

C) Poisoning D) Both (A) and (B).

134. The overall collection efficiency of the cyclone separator is

A) $\frac{\text{Amount of particulates fed}}{\text{Amount of particulates in the exit gas stream}}$

B) $\frac{\text{Amount of particulates collected}}{\text{Amount of particulates in the feed}}$

C) 100%

D) None of these.

135. CO_2 gas in the atmosphere absorbs the infrared rays reradiated from the earth causing

A) global warming B) greenhouse effect

C) both (A) and (B) D) none of these.

136. Venturi scrubber is used to remove

A) solid dust present in air or gas
B) liquid particulates
C) both (A) and (B)
D) none of these.

137. Optimum reflux ratio is

A) the point of most economical operation
B) maximum operating cost
C) maximum fixed cost
D) none of these.

138. The controlled and complete oxidation of wastes using air is called as

A) Incineration
B) Combustion
C) Pyrolysis
D) None of these.

139. SO_x emission from thermal power plants is mainly due to the combustion of which of the following components in the feed stock ?

A) Sulphur
B) Arsenic
C) Phosphorous
D) None of these.

140. For the reversible reaction A + B $\rightleftharpoons$ C + D the expression for the equilibrium constant is

A) $\frac{C_A \cdot C_D}{C_B \cdot C_C}$
B) $\frac{C_A \cdot C_B}{C_C \cdot C_D}$
C) $\frac{C_C \cdot C_D}{C_A \cdot C_B}$
D) all of these.

141. For the liquid phase zero order irreversible reaction $A \rightarrow B$, the conversion of A in a CSTR is found to be 0·3 at a space velocity of 0·1 m^{-1}. What will be the conversion for a PFR with a space velocity of 0·2 min^{-1} ? All other conditions are same for both.

A) 0·15 B) 0·3

C) 0·6 D) 0·9.

142. Find the expansion factor for the reaction $4A \rightarrow R$ if the feed is sent with 25% inerts.

A) – 0·56 B) – 3/5

C) 4 D) none of these.

143. The non-ideality in real reactors may be due to

A) channelling B) by-passing

C) shortcircuiting D) all of these.

144. The rate of reaction is decreased due to which one of the following ?

A) Increase in temperature B) Increase in pressure

C) Both (A) and (B) D) Catalyst deactivation.

145. For the gaseous reaction $3A \rightarrow B$ where the feed consists of 50 mol% A and 50 mol% Inerts, the expansion factor is

A) 1 B) – 0·33

C) – 0·25 D) – 0·5.

146. The Arrhenius plot for most of the reactions gives a straight line with a

A) negative slope B) positive slope

C) slope = + 1 D) none of these.

147. The integrated form of first order irreversible reaction rate equation is

A) $-\ln (1 - X_A) = Kt$ B) $\ln (1 - X_A) = Kt$

C) $\ln X_A = Kt$ D) None of these.

148. For the reversible reaction $A \rightleftharpoons 2B$, if the equilibrium constant K is 0·05 mol/lit. Starting from initially 2 moles of A and zero moles of B, how many moles of B will be formed at equilibrium ?

A) 0·253 B) 0·338

C) 0·152 D) 0·637.

149. In multiple reactions if the order of the desired reaction is equal to the order of the unwanted reaction, then to obtain a maximum product distribution

A) use high C_A B) use suitable catalyst

C) select the appropriate temperature D) both (B) and (C).

150. The experimentally determined overall order for the reaction $A + B \rightarrow C + D$ is 2. Then the

A) reaction is elementary with a molecularity of 2

B) molecularity of the reaction is 2, but it may not be elementary

C) molecularity is less than 2

D) molecularity is greater than 2.

151. The reaction $A \rightarrow B$ is conducted in an isothermal batch reactor. If the conversion of A increases linearly with holding time, then the order of the reaction is

A) 0 B) 1

C) 1·5 D) 2.

152. The first order, gas phase reaction $A \xrightarrow{K_1} 2B$ is conducted isothermally in batch mode. The rate of change of conversion with time is given by

A) $\frac{dx_A}{dt} = K_1 (1 - x_A)^2 (1 + 2x_A)$

B) $\frac{dx_A}{dt} = K_1 (1 - x_A) (1 + 0{\cdot}5x_A)$

C) $\frac{dx_A}{dt} = K_1 (1 - x_A)$

D) $\frac{dx_A}{dt} = K_1 \frac{(1 - x_A)}{(1 + x_A)}$.

153. A pulse tracer is introduced in an ideal CSTR (with a mean residence time τ) at time = 0. The time taken for the exit concentration of the tracer to reach half of its initial value will be

A) 2τ B) $0{\cdot}5\tau$

C) $\tau/0{\cdot}693$ D) $0{\cdot}693\ \tau$.

154. For a reversible reaction the equilibrium conversion value is

A) 1 B) > 1

C) 100% D) <1.

155. How do you arrange the combination of two reactors namely CSTR and PFR in series for second order reaction ?

A) PFR first and then CSTR

B) CSTR first and then PFR

C) The conversion remains same for both (A) and (B)

D) None of these.

156. The vessel dispersion number in non-ideal flow reactors is defined as

A) L/UD B) D/UL

C) U/DL D) None of these.

157. Recycle reactors are mainly used for

A) Multiple reactions B) Increasing the intensity of mixing

C) Autocatalytic reactions D) Both (B) & (C).

158. Multiple Steady State conditions are obtained in case of

A) Exothermic reactions in plug flow reactors

B) Endothermic reactions in mixed flow reactors

C) Exothermic reactions in mixed flow reactors

D) None of these.

159. The equilibrium constant of a reversible chemical reacion K >> 1 indicates that

A) the reaction attains equilibrium very soon

B) the rate of reaction approaches a steady state

C) the reaction is far away from the equilibrium

D) all of these.

160. Two mixed reactors of unequal size are available for producing a specified product, formed by a homogeneous second order reaction. To achieve maximum production rate

A) the smaller reactor should be placed in series before the larger reactor

B) the larger reactor should be placed in series before the smaller reactor

C) both should be arranged in parallel

D) none of these.

161. The elementary liquid phase decomposition reaction $A \xrightarrow{K} 2B$ is to be carried out in a CSTR. The design equation is

A) $K\tau = \frac{x_A}{1 - x_A}$ B) $K\tau = \frac{x_A(1 + x_A)}{(1 + x_A)}$

C) $K\tau = \frac{x_A}{(1 - x_A)^2}$ D) $K\tau\, C_{Ao} = \frac{x_A}{(1 + x_A)^2}$

162. In a plug flow reactor the conversion

A) increases along the length of the reactor

B) decreases along the length of the reactor

C) remains same throughout the reactor

D) none of these.

163. The space velocity of continuous flow reactors is equal to

A) volumetric feed rate/volume of reactor

B) $\frac{1}{\text{space time}}$

C) no. of reactor volumes which can be processed in time

D) all of these.

164. Industrial application of gas-separation membrane is

A) separation of carbon dioxide from natural gas

B) separation of helium from natural gas

C) separation of hydrogen from purge streams in ammonia plants

D) all of these.

165. The flux through a dense polymer film is

A) directly proportional to thickness

B) inversely proportional to thickness

C) there is no linear relationship

D) none of these.

166. The transport of gases through dense (non-porous) polymer membranes occur by a

A) solution diffusion mechanism B) solvent diffusion mechanism

C) both (A) and (B) D) none of these.

167. For an ideal breakthrough curve

A) initial solute concentration remains unchanged

B) all the solute fed is adsorbed

C) the concentration on the solid has increased from initial value to equilibrium value

D) both (B) and (C).

168. The Langmuir isotherm is given by $W = W_{max}\left[\frac{KC}{KC + 1}\right]$. For linear relationship

A) $KC < 1$ B) $KC > 1$

C) $KC = 0$ D) none of these.

169. In absorption with chemical reaction

A) mass transfer coefficient increases

B) less number of transfer unit required

C) both (A) and (B)

D) none of these.

170. When the gas-film resistance is controlling absorption efficiencies are generally in the range of

A) 60% – 80%
B) 30% – 40%
C) 80% – 90%
D) > 90%.

171. Number of transfer unit is defined as

A) $N_{oy} = \frac{y_b - y_a}{y_b + y_a}$
B) $N_{oy} = \frac{(y_b - y_a)^2}{y_b + y_a}$
C) $N_{oy} = \frac{y_b - y_a}{\overline{\Delta y}_L}$
D) none of these.

172. The flooding velocity strongly depends on

A) Liquid mass velocity
B) Size of packing
C) Both (A) and (B)
D) None of these.

173. Rayleigh equation is defined by

A) $\ln \frac{n_1}{n_0} = \int_{x_0}^{x_1} \frac{dy}{y - x}$
B) $\ln \frac{n_0}{n_1} = \int_{x_0}^{x_1} \frac{dy}{x - y}$
C) $\ln \frac{n_1}{n_0} = \int_{x_0}^{x_1} \frac{dx}{y - x}$
D) none of these.

174. Plate efficiency is a function of

A) rate of mass transfer between liquid and vapour
B) rate of heat transfer in the reboiler
C) rate of cooling in the condenser
D) none of these.

175. In distillation process at pinch point there will be

A) infinite set of plates

B) no change in concentration of either liquid or vapour from plate to plate

C) both (A) and (B)

D) none of these.

176. At total reflux

A) the number of plates is infinite

B) the rate of feed and products are zero

C) the number of plates is minimum

D) both (B) and (C).

177. The distribution coefficient is defined by

A) $K_i \equiv \frac{x_{ie}}{y_{ie}}$ B) $K_i = \frac{y_{ie}}{x_{ie}}$

C) $K_i = y_{ie} \times x_{ie}$ D) none of these.

178. For a fixed number of ideal stages in a distillation column, as the reflux ratio is increased, the difference in composition between the top and bottom product streams

A) increases B) decreases

C) remain unaffected D) passes through a maximum.

179. For the nth tray (counted from the bottom of the distillation column) the Murphree tray efficiency is given by

A) $\frac{y_{n+1} - y_n}{y_n^x - y_{n-1}}$ B) $\frac{y_{n-1} - y_n}{y_{n+1} - y_n}$

C) $\frac{y_n - y_{n-1}}{y_n^x - y_{n-1}}$ D) $\frac{y_n^x - y_{n-1}}{y_n^x - y_{n+1}}$

180. Solvent used in extractive distillation

A) is of low volatility

B) forms a low boiling azeotrope

C) forms a high boiling azeotrope

D) does not alter the relative volatility of the original components.

181. The absorption factor is defined as

A) $\frac{L}{mG}$ B) $\frac{mL}{G}$

C) $\frac{G}{mL}$ D) $\frac{LG}{m}$.

182. For a partially vaporized feed to the distillation line the value of q is

A) $q < 0$ B) $q > 0$

C) $q = 1$ D) $0 < q < 1$.

183. For an unicomponent absorption process the degree of freedom is

A) 1 B) 2

C) 3 D) none of these.

184. The S. I. unit of mass velocity is

A) kg/s B) m^3/s

C) $kg/m^2 s$ D) none of these.

185. In a manufacturing industry break-even point occurs when

A) the total annual rate of production equals the assigned value

B) the total annual product cost equals the total annual sales

C) the annual profit equals the expected value

D) the annual sales equals the fixed cost.

186. The power number for a stirred tank becomes constant at high Reynolds number. In this limit the variation of power input with impeller rotational speed (N) is to

A) N^0 B) N^1

C) N^2 D) N^3.

187. A first order system with unity gain and time constant τ is subjected to a sinusoidal input of frequency $\omega = \frac{1}{\tau}$. The amplitude ratio for this system is

A) 1 B) 0·5

C) $\frac{1}{\sqrt{2}}$ D) 0·25.

188. V-notch is used to measure

A) flow rate in open channels B) flow rate in closed ducts

C) viscosity D) none of these.

189. The differential equation $\left(\frac{dy}{dx}\right)^2 + y \cdot \frac{d^2y}{dx^2} = 0$ can be reduced to

(where α is a constant)

A) $\left(\frac{dy}{dx}\right)^3 = \alpha - \frac{3y^2}{2}$ B) $\left(\frac{dy}{dx}\right)^2 = \alpha - 2y$

C) $\frac{dy}{dx} = \frac{a}{y^2}$. D) $\frac{dy}{dx} = \frac{\alpha}{y}$.

190. The differential equation $\frac{d^2y}{dx^2} + \sin x \frac{dy}{dx} + ye^x = \sinh x$ is a

A) first order and linear B) first order and non-linear

C) second order and linear D) second order and non-linear.

191. The range of values for a constant 'K' to yield a stable system in the following set of time dependent differential equations is

$\frac{dy_1}{dt} = -5y_1 + (4 - K)\, y_2$

$\frac{dy_2}{dt} = y_1 - 2y_2$

A) $0 < K < 7$ B) $6{\cdot}25 < K < 10$

C) $-6 < K \leq 6{\cdot}25$ D) $0 \leq K \leq 7$.

192. What is the value of y as $t \to \infty$ for the following differential equation, if for an initial value of $y(1) = 0$ is $(4t^2 + 1)\frac{dy}{dt} + 8yt - t = 0$?

A) 1 B) $\frac{1}{2}$

C) $\frac{1}{4}$ D) $\frac{1}{8}$.

193. The differential equation $\frac{d^2x}{dt^2} + 10\frac{dx}{dt} + 25x = 0$ will have a solution of the form

A) $(C_1 + C_2 t)\, e^{-5t}$ B) $C_1 e^{-2t}$

C) $C_1 e^{-5t} + C_2 e^{5t}$ D) $C_1 e^{-5t} + C_2 e^{2t}$

where C_1 and C_2 are constants.

194. The solution for the differential equation $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 6y = 0$ is

A) $C_1 e^{-2t} + C_2 e^{3t}$ B) $C_1 \sin 2t + C_2 \cos 2t$

C) $C_1 e^{2t} + C_2 e^{-3t}$ D) $C_1 e^{-2t} + C_2 e^{-3t}$.

195. The integral $\int_0^1 \frac{dx}{x^P}$ is convergent for

A) no value of P B) $P > 1$

C) $P < 1$ D) all values of P.

196. The cubic equation $x^3 - x + 10 = 0$ has a root in the interval

A) $(-1, 0)$ B) $(0, 1)$

C) $(-3, -1)$ D) $(3, 4)$.

197. Given $f(x, y) = x^2 + y^2$, $\nabla^2 f$ is

A) 4 B) 2

C) 0 D) $4(x + y)^2$.

198. The series $1 + x + x^2 + x^3 + \ldots\ldots\ldots$ is a divergent for

A) $x < 1$ B) $x > 1$

C) for all values of x D) none of these.

199. How many times the terminal velocity is greater than the minimum fluidization velocity ?

A) 25 B) 50

C) 75 D) 100.

200. Depletion of ozone layer is due to which of the following pollutants causing chain reaction

A) H_2S emissions B) Chlorofluorocarbons

C) SO_x emission D) none of these.

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