Sl. No. : 40002121

CHE08

Register Number

2014

CHEMICAL ENGINEERING
(Degree Standard)

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. Prior to attempting to answer the candidates are requested to check whether all the questions are there and ensure there are no blank pages in the question booklet. In case any defect in the Question Paper is noticed it shall be reported to the Invigilator within first 10 minutes.
3. Answer **all** questions. **All** questions carry equal marks.
4. 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.
5. You will also encode your Register Number, Subject Code, Question Booklet Sl. No. 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.
6. 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.
7. In the Answer Sheet there are **four** circles Ⓐ, Ⓑ, Ⓒ and Ⓓ against each question. To answer the questions you are to mark with Ball point pen ONLY ONE circle 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, Ⓑ is the correct answer, you have to mark as follows :

   Ⓐ ● Ⓒ Ⓓ

8. 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.
9. The sheet before the last page of the Question Booklet can be used for Rough Work.
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. Do not tick-mark or mark the answers in the Question booklet.

SEAL

1. If 50 kg of dry solid containing 6% water is obtained by drying 65 kg of wet material, what is the initial moisture content?

(A) 27.7% (B) 77%

(C) 23% (D) 21%

2. The three phase temperature of a system made up of two immiscible liquids

(A) Depends only on the pressure

(B) Depends on the amounts of both liquids constituting the system

(C) Depends on the pressure as well as the amounts of liquid

(D) Is independent of both pressure as well as the amounts present

3. The solubility of gases in liquid at a given partial pressure is

(A) Directly proportional to Henry's law constant

(B) Inversely proportional to Henry's law constant

(C) Increases with increasing temperature

(D) Not related to Henry's law constant

4. Which one of the following is NOT a Maxwell relation?

(A) $\left(\frac{\partial P}{\partial S}\right)_V = -\left(\frac{\partial T}{\partial V}\right)_S$ (B) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial P}{\partial S}\right)_V$

(C) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ (D) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

5. Joule-Thompson coefficient is ———— for an ideal gas.

(A) Zero (B) One

(C) Infinity (D) Dependent on the value of pressure

6. Mollier diagram is a

(A) P – V chart (B) T – S chart

(C) P – H chart (D) H – S chart

7. Antoine equation is an empirical form obtained from ———— equation.

(A) Charle's (B) Van der Waals

(C) Clapeyron (D) Vant-Hoff

8. In compressible fluids flow, the flow is called ————————, when the Mach number is greater than unity.

(A) Subsonic
(B) Supersonic
(C) Sonic
(D) Starsonic

9. Within a thin volume immediately adjacent to the wall, the velocity gradient is essentially constant. This volume is called

(A) Viscous sublayer
(B) Transition sublayer
(C) Turbulent sublayer
(D) Velocity sublayer

10. Friction generated in unseparated boundary layers is called

(A) Form friction
(B) Fanning friction
(C) Skin friction
(D) Boundary friction

11. Turbulence that result from contact between two layers of fluid moving at different velocities is called

(A) forced turbulence
(B) free turbulence
(C) transition turbulence
(D) wall turbulence

12. In shell and tube heat exchangers, baffles are installed in the shell side

(A) To promote turbulence
(B) To promote laminar flow
(C) To prevent agitation
(D) To reduce heat transfer

13. Heat transfer devices used to liquefy vapors by removing their latent heat are called

(A) Air cooled exchangers
(B) Heaters
(C) Coolers
(D) Condensers

14. The total emissive power of a black body is proportional to

(A) T^2
(B) T^3
(C) T^4
(D) T

15. Thermal diffusivity (α) is defined as

(A) $\frac{C_p \mu}{K}$
(B) $\frac{K}{C_p \rho}$
(C) $\frac{\mu}{\rho}$
(D) $\frac{C_p \rho}{K}$

16. Sieder – Tate equation for turbulent flow is

(A) $N_{Nu} = 0.023(N_{Pe})^{0.8}(N_{pe})^{0.33}$

(B) $N_{Nu} = 0.023(N_{Pe})^{0.8}(N_{pr})^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$

(C) $N_{Nu} = 0.02(N_{Pe})^{0.8}(N_{pr})^{1/3}$

(D) $N_{Nu} = 0.023(N_{pr})^{0.8}(N_{Pe})^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$

17. For flow through circular pipe of diameter 'D', length 'L', at a velocity 'v', pressure drop 'ΔP' due to friction is related to the Fanning friction factor (f) as

(A) $\Delta P = \frac{1}{2}\frac{fL\rho v^2}{D}$

(B) $\Delta P = \frac{2fL\rho v^2}{D}$

(C) $\Delta P = \frac{4fL\rho v^2}{D}$

(D) $\Delta P = \frac{2fL\rho v^2}{D^2}$

18. For fluid flow through annulus of concentric pipes of diameters, D_o, D_i $(D_o > D_i)$, the equivalent diameter for fluid flow is given as

(A) $D_o - D_i$

(B) $4(D_o - D_i)$

(C) $D_o + D_i$

(D) $\frac{\pi}{4}(D_o - D_i)$

19. A solid spherical ball of diameter D and density ρ is floating in a fluid of density ρ_f, with half of the ball submerged inside the fluid. The buoyancy force acting over the ball is equal to

(A) $\frac{\pi}{3}D^3\rho_f g$

(B) $\frac{\pi}{6}D^3\rho_f g$

(C) $\frac{\pi}{12}D^3\rho_f g$

(D) $\frac{\pi}{12}D^3\rho g$

20. In a ball mill, the operating speed must be

(A) more than critical speed

(B) less than critical speed

(C) equal to critical speed

(D) independent of critical speed

21. Grizzly screens are recommended for separating particles in the size range of

(A) 5 – 50 mm

(B) 10 – 100 mm

(C) 15 – 200 mm

(D) 20 – 300 mm

22. The equation $E = E_i \sqrt{\frac{100}{L_2}}\left(1 - \frac{1}{q^{1/2}}\right)$, where E is energy required, E_i is work index, L_2 is size of the product and q is the reduction ratio represents

(A) Kicks law
(B) Rittingers law
(C) Bond's law
(D) Fick law

23. For sizing of fine materials, the most suitable equipment is a

(A) Trommel
(B) Grizzly
(C) Shaking screens
(D) Vibrating screens

24. Typical conversion efficiency (chemical to electrical) of thermal power plants is

(A) 35%
(B) 75%
(C) 85%
(D) 90%

25. The power potential (P) of hydropower station is related to the height of water (H) in the dam by

(A) $P \alpha H^{1/2}$
(B) $P \alpha H$
(C) $P \alpha H^2$
(D) $P \alpha H^3$

26. The predominant gaseous constituent of aerobic digestion of biomass is

(A) CH_4
(B) H_2S
(C) CO_2
(D) N_2O

27. Heat of combustion of dry wood is about

(A) 10 kJ/kg
(B) 15 MJ/kg
(C) 100 MJ/kg
(D) 1000 MJ/kg

28. Typical efficiency of commercial solar photovoltaic cell in converting solar energy to electrical energy is

(A) 15%
(B) 40%
(C) 60%
(D) 85%

29. A filter medium resistance can be expressed by the equation where R_m : filter medium resistance, μ : viscosity of filtrate, u : linear velocity of filtrate and ΔP_m = pressure drop

(A) $R_m = \frac{\mu u}{\Delta P_m}$
(B) $R_m = \frac{\Delta P_m}{\mu u}$
(C) $R_m = \frac{\mu \Delta P_m}{u}$
(D) $R_m = \frac{u \Delta P_m}{\mu}$

30. Match the following :

	Technique		Developed by
(a)	HEART	1.	A.D. Swain and HE Guttmann
(b)	THERP	2.	J.C. Williams
(c)	TESEO	3.	G.L. Noble Denton
(d)	Optagon Package	4.	G.C. Bellow and V. Colombari

	(a)	(b)	(c)	(d)
(A)	3	4	1	2
(B)	2	1	4	3
(C)	4	3	2	1
(D)	4	1	2	3

31. The most preferred material for handling dilute sulfuric acid (concentration less than 70%) is

(A) Lead
(B) Mild steel
(C) Cast iron
(D) Stainless steel

32. Suitable material for handling chlorine compounds is

(A) Nickel
(B) Aluminium
(C) Copper
(D) Titanium

33. Pour baix diagrams represent

(A) EMF vs Oxidizing power
(B) EMF vs pH
(C) EMF vs Acidity
(D) EMF vs Electromotive force

[$\because$ EMF = potential]

34. Dezincification is corrosion of a brass alloy containing zinc in which the principal product of corrosion is metallic

(A) Copper
(B) Zinc
(C) Arsenic
(D) Antimony

35. Presence of chlorides does not generally cause cracking of austenitic stainless steels when temperatures are below about

(A) 30° C
(B) 40° C
(C) 50° C
(D) 60° C

36. Selective corrosion in the grain boundaries of a metal or alloy without appreciable attack on the grains or crystals themselves is called ———— corrosion.

(A) Interboundary
(B) Intercrystal
(C) Intergranular
(D) Intergrain

37. The hydrogenation of oils in the presence of nickel catalyst is a/an

(A) endothermic reaction
(B) exothermic reaction
(C) homogeneous reaction
(D) the reaction does not occur

38. Black liquor is concentrated in

(A) multiple effect evaporators
(B) multiple effect evaporator combined with crystallizer
(C) single effect evaporator
(D) single effect evaporator combined with crystallizer

39. Cooking conditions in Kraft pulp process are

(A) time 6 – 12 hrs, temperature 125 – 160° C and pressure 620 – 755 KPa
(B) time 36 – 48 minutes, temperature 160 – 180° C and pressure 660 – 1100 KPa
(C) time 2 – 5 hrs, temperature 170 – 176° C and pressure 660 – 925 KPa
(D) time 4 – 8 hrs, temperature 200 – 215° C and pressure 620 – 825 KPa

40. Which of the following is the characteristics of pulp from sulphate process?

(A) White colour
(B) Easy to bleach
(C) Weak fibres
(D) Brown colour

41. Triple super phosphate is obtained by reacting phosphate rock with

(A) Sulfuric acid
(B) Nitric acid
(C) Hydrochloric acid
(D) Phosphoric acid

42. The undesirable side reaction in urea production is the formation of

(A) thio urea
(B) biuret
(C) uric acid
(D) ammonium carbamate

43. A NPK fertilizer is rated as 15-10-15. This means that, it contains (wt%)

(A) 15% N, 10% P, 15% K
(B) 15% N, 10% P_2O_5, 15% K_2O
(C) 15% N, 10% P_2O_5, 15% KCl
(D) 15% urea, 10% superphosphate, 15% potassium chloride

44. In the contact process for the manufacture of sulfuric acid, absorption of SO_3 is done using

(A) Water
(B) Sulfuric acid of 50% concentration
(C) Sulfuric acid of 15% concentration
(D) Sulfuric acid of 98% concentration

45. Major use of butadiene is
(A) as a plasticiser for unsaturated polyester
(B) in the manufacture of synthetic rubber
(C) as an anti-skinning agent in paint
(D) for the hydrogenation of oils

46. Massecuite is a terminology used in
(A) Paint Industry
(B) Oil Hydrogenation Industry
(C) Soap Industry
(D) Sugar Industry

47. Soda ash is produced by
(A) Chamber's process
(B) Chance process
(C) Contact process
(D) Solvay process

48. Synthetic glycerine is produced from
(A) Toluene
(B) Phenol
(C) Propylene
(D) Napthalene

49. A first – order lag process is
(A) non self–regulating process
(B) self–regulating process
(C) under damped process
(D) over damped process

50. One of the most important advantages of PI control is the elimination of
(A) time delay
(B) measurement lag
(C) offset
(D) temperature delay

51. A proportional controller is described equivalently by its Proportional Band (PB) where,
(A) $PB = 100/K_C$
(B) $PB = 500/K_C$
(C) $PB = 10/K_C$
(D) $PB = 1/K_C$
[$\because K_C$ = proportional gain of the controller]

52. At what temperature, thermometers with °C scale and °F scale show the same number?
(A) – 40°C
(B) 0°C
(C) 100°C
(D) 0 Kelvin

53. Which of the following instruments show significant time delay in their response?
(A) flow sensors
(B) pressure sensors
(C) temperature sensors
(D) composition sensors

54. According to stability analysis, a feed back control system is stable if all the roots of its characteristic equation have

(A) positive real parts
(B) negative real parts
(C) zero real parts
(D) values equal to 1

55. For stability analysis by Routs–Hurwitz criterion, for the system with open loop transfer function G_{OL}, the characteristic equation is written as

(A) $1 + G_{OL} = 1$
(B) $1 + G_{OL} = 0$
(C) $G_{OL} = 0$
(D) $G_{OL} = 1$

56. Identify the wrong statement.
Integral control action

(A) increases the order of dynamics for a closed loop response
(B) eliminates any offset
(C) makes the response of the closed–loop system to more sluggish
(D) produces non – zero offset

57. Transfer function of a first order system with dead time td is given by

(A) $\frac{K_p}{\tau_p S+1} + e^{-tds}$
(B) $\frac{K_p}{\tau_p S+1} e^{-tds}$
(C) $\frac{K_p}{(\tau_p S+1) + e^{-tds}}$
(D) $\frac{K_p}{\tau_p S+1} e^{tds}$

58. A second order system is called over damped if the damping factor (ζ) is

(A) greater than 1
(B) equal to 1
(C) less than 1
(D) zero

59. Time constant of a first order system is equal to the time taken for the step response to reach ———— of the final value.

(A) 50%
(B) 63.2%
(C) 75%
(D) 100%

60. Gain Margin is defined as $\frac{1}{M}$, where M is the amplitude ratio at the cross over frequency. Then for a stable system, Gain Margin is

(A) = 1
(B) < 1
(C) > 1
(D) ≤ 1

61. For which of the following interest rate, interest amount paid per year will be higher?

(A) 10%, compounded annually
(B) 10%, compounded quarterly
(C) 10%, compounded daily
(D) 10%, compounded monthly

62. Symbiotic relationship between bacteria and algae exists in

(A) Ponds
(B) Lagoons
(C) Facultative ponds
(D) Anaerobic lagoons

63. The mixed–liquor suspended solids in the reactor is related to mean cell residence time and

(A) Hydraulic detention time
(B) Influent concentration
(C) Effluent concentration
(D) Food to mass ratio

64. At Break – Even Point (BEP) of production,

(A) Fixed Cost = Variable Cost
(B) Total Cost = Total Revenue
(C) Total Cost = Total Profit
(D) Variable Cost = Sales

65. Rate of return based on discounted – Cash flow is calculated by equating NPV (Net Present Value) to

(A) Zero
(B) One
(C) Hundred
(D) Number of years of service

66. Which of the following investment alternative evaluation methods does not consider time value of money?

(A) Net present value method
(B) Capitalized cost method
(C) Payback period
(D) Payback period with interest

67. The whole process involving separation and bacterial conversion of the organic solid wastes is known as

(A) Land – filling
(B) Incineration
(C) Composting
(D) Deep – well injection

68. Organisms that derive both energy and nutrients from inorganic sources are called

(A) Heterotrophs
(B) Phototrophs
(C) Facultative heterotrophs
(D) Autotrophs

69. Recommended limit of fluoride in drinking water according to EPA/WHO standards are

(A) 0.5 mg/l
(B) 1.5 mg/l
(C) 2.0 mg/l
(D) 3.0 mg/l

70. Supercritical fluid extraction is a process in which the solvent is held at a pressure and temperature above

(A) the triple point temperature
(B) above atmospheric pressure and temperature
(C) at atmospheric temperature and pressure
(D) above critical point

71. What is the major use of carbon molecular sieves?

(A) Separation of lower hydro–carbons
(B) Adsorption of organics from drinking water
(C) Separation of air to produce N_2
(D) Separation of higher mol. wt hydrocarbons

72. In distillation column design, McCabe–Thiele procedure is not suitable and Ponchon–Savarit procedure is needed when

(A) an azeotrope forms
(B) a total condenser is used
(C) saturated feed is not used
(D) the molar latent heats of two components are greatly different

73. In steam distillation of nitrobenzene (normal boiling point 210.6°C) at a total pressure of 1 atm, the boiling point of mixture is

(A) less than 100°C
(B) 100°C
(C) between 100°C and 210.6°C
(D) 210.6°C

74. Absorption towers are operated under the conditions of

(A) low pressure, low temperature
(B) low pressure, high temperature
(C) high pressure, high temperature
(D) high pressure, low temperature

75. The height of a mass transfer equipment can NOT be calculated by

(A) HETP × Number of equivalent stages
(B) HTU × NTU
(C) NTU × distance between redistributors
(D) No. of stages × distance between two stages

76. Which of the following extractor is valuable for the extraction of sensitive products such as vitamins and antibiotics

(A) Centrifugal
(B) Agitated Tower
(C) Baffle Tower
(D) Pulse column

77. In a column tray, the static liquid seal of tray is determined as

(A) $\dfrac{\text{weir height}}{\text{the height of liquid over the weir}}$

(B) weir height + the height of liquid over the weir

(C) weir height – the height of liquid over the weir

(D) $\dfrac{\text{the height of liquid over the weir}}{\text{weir height}}$

78. In a tray column, the turndown ratio is defined as

(A) Design vapour throughput – Minimum operable throughput

(B) $\dfrac{\text{Design vapour throughput}}{\text{Minimum operable throughput}}$

(C) $\dfrac{\text{Minimum operable throughput}}{\text{Design vapour throughput}}$

(D) Minimum operable throughput + design vapour throughput

79. In a binary distillation column, if the feed contains 40 mol% vapor, the q–line will have a slope of

(A) – 1.5 (B) – 0.6

(C) 0.6 (D) 1.5

80. Which of the following property is not desirable in a good adsorbent?

(A) free flowing (B) low pressure drop

(C) friable (D) large specific surface area

81. If the mass transfer resistance is very small the break through line is

(A) a vertical line (B) a horizontal line

(C) a line with unit slope (D) a line with unit negative slope

82. Type of reaction when the rate of a chemical reaction is affected only by temperature, pressure and composition is

(A) Homogeneous reactions (B) Heterogeneous reactions

(C) Only catalytic heterogeneous reactions (D) Non–catalytic gas–solid reactions

83. A balanced chemical equation is in accordance with

(A) law of gaseous volumes (B) law of Avogadro

(C) law of constant proportions (D) law of conservation of mass

84. In the reaction $P + Q \rightarrow R$ if P is taken in excess, then it is an example of

(A) zero order reaction (B) first order reaction

(C) second order reaction (D) pseudo unimolecular reaction

85. The number of tanks in series representing a non-ideal reactor can be obtained using the following relationship where $\bar{t}$ is the mean residence time and σ^2 is the variance

(A) $N = \bar{t}^2/\sigma^2$ (B) $N = \sigma^2/\bar{t}^2$

(C) $N = \sigma^2$ (D) $N = t/\bar{t}^2$

86. For all positive orders, the volume of a plug flow reactor to the volume of a continuous stirred tank reactor, all other parameters remaining constant is

(A) greater than 1 (B) equal to 1

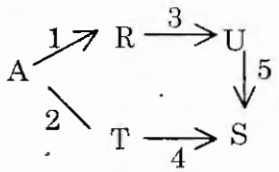
(C) less than 1 (D) insufficient data

87. The mean residence time in an open vessel is given by

(A) $\bar{t} = V/V_0$ (B) $\bar{t} = V/V_0(1 - X_A)$

(C) $\bar{t} = \frac{V}{V_0}\left[1 + 2\frac{D}{uL}\right]$ (D) $\bar{t} = \frac{V}{V_0}\left[1 + 8\frac{D}{uL}\right]$

88. Consider the following scheme of elementary reactions



$E_1 = 79\text{kJ/mol}$, $E_2 = 113\text{kJ/mol}$, $E_3 = 126\text{kJ/mol}$, $E_4 = 151\text{kJ/mol}$, $E_5 = 0$. What temperature progression would you recommend if the desired product is T?

(A) low temperature (B) high temperature

(C) falling temperature profile (D) rising temperature profile

89. The tanks in series model for non–ideal flow is a

(A) Zero parameter model (B) Single parameter model

(C) Two parameter model (D) Multi parameter model

90. In a zero order reaction, the rate of the chemical reaction

(A) increases with increase of concentration of the reactants

(B) decreases with increase in the concentration of the reactants

(C) is independent of the concentration of the reactants

(D) first increases then decreases with concentration of the reactants

91. To fit a curve of the form $y = a + bx + cx^2$ (where a, b, and c are constants) by method of least squares, the number of simultaneous equation to be formed are

(A) 2 (B) 3

(C) 4 (D) 5

92. How many prior values are required to predict the next value in Milne's method?

(A) No prior values (B) 2 prior values

(C) 4 prior values (D) 6 prior values

93. Gregory – Newton forward difference interpolation formula is

(A) $y_n = y_0 + n\Delta y_0 + \frac{n(n-1)}{2!}\Delta^2 y_0 + \frac{n(n-1)(n-2)}{3!}\Delta^3 y_0 + \cdots$

(B) $y_n = y_0 + n\nabla y_0 + \frac{n(n+1)}{2!}\nabla^2 y_0 + \frac{n(n+1)(n+2)}{3!}\nabla^3 y_0 + \cdots$

(C) $y_n = y_0 - n\Delta y_0 + \frac{n(n+1)}{2!}\Delta^2 y_0 - \frac{n(n-1)(n-2)}{3!}\Delta^3 y_0 + \cdots$

(D) $y_n = y_0 - n\nabla y_0 + \frac{n(n-1)}{2!}\nabla^2 y_0 - \frac{n(n-1)(n-2)}{3}\nabla^3 y_0 + \ldots$

94. The Stirlings formula is

(A) Gauss's backward Interpolation formula

(B) Gauss's elimination formula

(C) Gauss's forward interpolation formula

(D) The mean of Gauss's forward and backward interpolation formula

95. What is the disadvantages of using Lagrange interpolation formula?

(A) Complicated

(B) Difficult

(C) Takes a long time

(D) Cannot be used for unequally spaced data

96. Numerical solution of ordinary differential equation of boundary value type is given by

(A) Milne's predictor – corrector method

(B) Runge–Kutta method

(C) Shooting method

(D) Euler's method

97. The condition for convergence for the Newton–Raphson method is

(A) $|f''(x)|^2 < |f'(x).f(x)|$

(B) $|f(x)f''(x)| < |f'(x)|^2$

(C) $|f(x)|^2 < |f'(x).f''(x)|$

(D) $|f(x)f'(x)| < |f''(x)|^2$

98. In the case of fixed point iteration method the convergence is

(A) linear

(B) quadratic

(C) very slow

(D) cubic

99. In what form is the coefficient matrix transformed into when AX = B is solved using Gauss elimination method?

(A) Diagonal matrix

(B) Upper triangular matrix

(C) No transformation

(D) Inverse of the matrix

100. Which does not apply to Gauss – Jordan method for solving a linear system?

(A) Direct method

(B) Indirect method

(C) Coefficient matrix is transformed into diagonal matrix

(D) No need for back substitution

101. Iteration methods are

(A) Self–correcting method

(B) Round off error is large

(C) Direct method

(D) Coefficient of matrix should be upper triangular dominant

102. Purging operation is performed on recycle streams for

(A) Increasing the yield
(B) Reducing the accumulation of inerts
(C) Conserving heat
(D) Improving efficiency

103. Assuming CO_2 obeys the perfect gas law, calculate the density of CO_2 in kilograms per cubic metre at 540 k and 202 kPa.

(A) 1
(B) 2
(C) 3
(D) 4

104. With increase in the molecular weight the vapour pressure of chemically similar liquids at any given temperature

(A) Increases
(B) Decreases
(C) Remains unchanged
(D) May increase or decrease

105. Ideal solution obeys

(A) Boyle's law
(B) Amagats law
(C) Raoults law
(D) Charles law

106. An air-water vapour mixture has a dry bulb temperature of 303 K and wet bulb temperature of 293 K. The mixture is heated at constant pressure to 333 K. The wet bulb temperature will be

(A) constant at 293 K
(B) less than 293 K
(C) greater than 293 K
(D) equal to 333 K

107. At a specified temperature the molal humidity at saturation

(A) Depends on pressure but is independent of the properties of the gas
(B) Independent of pressure and properties of the gas
(C) Depends on the properties of the gas but independent of the pressure
(D) Depends on the properties of the gas and the total pressure

108. The enthalpy of a gas-vapour mixture can be increased by

(A) Increasing the humidity and decreasing the temperature
(B) Increasing the humidity and temperature
(C) Decreasing the humidity and increasing the temperature
(D) Decreasing both temperature and humidity

109. One ton of refrigeration is equal to

(A) 50 kJ/min
(B) 50 kCal/min
(C) 1000 kCal/hr
(D) 4184 kJ/min

110. Clapeyron equation is used to predict the dependence of vapour pressure on

(A) Density
(B) Specific gravity
(C) Temperature
(D) Pressure

111. In a pressure – temperature phase diagram of a pure substance, the fusion and vapourization curve meets at

(A) Sublimation point
(B) Triple point
(C) Vapourization point
(D) Critical point

112. The mean compressibility factor is a function of

(A) Pressure and temperature
(B) Temperature and composition
(C) Pressure and composition
(D) Pressure, temperature and composition

113. The number of moles of a substance can be determined by finding the ratio of

(A) $\frac{\text{Volumes in litres}}{\text{Mass in grams}}$
(B) $\frac{\text{Mass in grams}}{\text{Molecular weight}}$
(C) $\frac{\text{Molecular weight}}{\text{Mass in grams}}$
(D) $\frac{\text{Number of grams}}{\text{Mass in grams}}$

114. The molarity of water in pure water is

(A) 1
(B) 18
(C) 55.55
(D) Infinity

115. The effect of air pollution on rubber is

(A) Cracking
(B) Discoloration
(C) Embrittlement
(D) Tarnishing

116. The dimensionless number especially important in ship design is

(A) Power number
(B) Froude number
(C) Sherwood number
(D) Reynolds number

117. Both the resistance and conductance of steady state conduction depends upon the dimensions of the solid as well as the property of the material. Which of the following property influences the steady state conduction?

(A) Density
(B) Thermal conductivity
(C) Mass
(D) Viscosity

118. For laminar flow through a circular pipe of diameter D, the maximum velocity is observed at which radial position (r) from the centreline of pipe? (For a Newtonian Fluid)

(A) $r = 0$
(B) $r = \frac{D}{2}$
(C) $r = \frac{D}{4}$
(D) $r = \frac{D}{3}$

119. In centrifugal pumps, cavitation occurs when the pressure inside the impeller becomes

(A) Less than atmospheric pressure
(B) More than atmospheric pressure
(C) Less than liquid vapor pressure
(D) Much higher than liquid vapor pressure

120. A solid particle falling in a fluid attains its terminal settling velocity when

(A) Gravity force + drag force = buoyancy force
(B) Gravity – drag force = buoyancy force
(C) Buoyancy – drag force = gravity force
(D) Drag force = buoyancy force

121. The most commonly used pump in chemical industries is

(A) Diaphragm pump
(B) Reciprocating pump
(C) Gear pump
(D) Centrifugal pump

122. Stanton number is defined by

(A) $N_{st} = \frac{C_p G}{h}$
(B) $N_{st} = \frac{h}{C_p G}$
(C) $N_{st} = \frac{C_p}{hG}$
(D) $N_{st} = \frac{G}{hC_p}$

123. For handling toxic and flammable liquid (filtrate), the recommended filter is

(A) Leaf filter
(B) Disc filter
(C) Drum filter
(D) Filter press

124. The Froude number has negligible effect in power calculation, when the Reynolds number value is

(A) less than 100
(B) less than 300
(C) less than 1000
(D) less than 2200

125. Upto what horizontal length can a screw conveyor be used?

(A) 40 m
(B) 60 m
(C) 70 m
(D) 50 m

126. In baffled tanks at Reynolds numbers larger than about 10,000, the power number is ———— of the Reynolds number.

(A) dependent
(B) same as
(C) independent
(D) twice that of

127. Most centrifugal separators for removing particles from gas streams contains ———— moving parts.

(A) two
(B) many
(C) no
(D) required

128. Differential settling methods utilize the difference in ———— velocities that can exist between substances of different density.

(A) fluidization
(B) settling
(C) average
(D) terminal

129. Size reduction equipments which can accept the maximum feed size is

(A) Tube mill
(B) Ball mill
(C) Jaw crusher
(D) Jet pulveriser

130. Maximum size reduction in a fluid energy mill is achieved by

(A) Compression
(B) Interparticle attrition
(C) Culting
(D) Impact

131. Devices that separate particles of differing densities are known as

(A) Thickeners
(B) Sorting classifiers
(C) Clarifiers
(D) Filters

132. Which type of solids has a higher value of internal friction?

(A) Clay
(B) Granular solids
(C) Cohesive solids
(D) Non-cohesive solids

133. Which type of flow is seen in case of flow of wheat grain from a storage bin?

(A) Mass flow
(B) Funnel flow
(C) Frictional flow
(D) Compressible flow

134. Electrical interference due to microphonic effects causes environmental stress to the equipment that leads to

(A) Acoustic noise
(B) Electromagnetic radiation
(C) Thermal shock
(D) Vibration

135. ALARP study means

(A) as low as reasonably practicable
(B) as low as resistive practice
(C) as low as reactive persistance
(D) as low as reasonably persistance

136. Fault tree analysis involves ———— logical possibilities and ———— main symbols.

(A) 1 and 3
(B) 2 and 3
(C) 3 and 2
(D) 3 and 1

137. The amount of moisture in a solid that exerts a vapour pressure less than the normal vapour pressure, of water at the given temperature is called

(A) Bound moisture
(B) Unbound moisture
(C) Equilibrium moisture
(D) Free moisture

138. Galvanic corrosion can be prevented by ———— the metals from each other.
(A) separating (B) insulating
(C) bolting (D) coupling

139. The unit of measure for LD 50 (Lethal dose 50) is
(A) mg/litre (B) mL/m^3
(C) mg/kg (D) mg/m^3

140. Flammability limit of acetone in air is given as 2.6 – 13% (v/v). This indicates that burning of acetone is spontaneous, if
(A) concentration of acetone in air is less than 2.6%
(B) concentration of acetone in air is more than 13%
(C) concentration of acetone in air is between 2.6 and 13%
(D) concentration of acetone in air is not between 2.6 and 13%

141. For preparing dilute sulfuric acid safely, in the laboratory
(A) add Conc. H_2SO_4 slowly to cold water (B) add cold water to the Conc. H_2SO_4
(C) mix SO_3 with water (D) burn sulfur to SO_3 and add water

142. "Likely to occur sometime during life of an item" mishap comes under
(A) Frequent description (B) Occasional description
(C) Probable description (D) Remote description

143. Death or system loss mishap is categorized under
(A) Catastrophic description (B) Critical description
(C) Fatal description (D) Deadly description

144. A categorical description of hazard level based on real or perceived potential for causing horm, injury and/or damage is called
(A) hazard description (B) hazard probability
(C) hazard severity (D) hazard categorization

145. Markov model is a mathematical model used in
(A) reliability analysis (B) dosage analysis
(C) probability analysis (D) numerical analysis

146. Materials that possess oxidizing properties shall be identified by the letter
(A) OP (B) OZ
(C) OD (D) OX

147. 20% oleum is

(A) 20 kg of SO_3 in 100 kg of $H_2SO_4 + SO_3$

(B) 20 kg of H_2SO_4 in 100 kg of $H_2SO_4 + SO_3$

(C) 20 kg of H_2SO_4 in 100 kg of $H_2SO_4 + H_2O$

(D) 20 kg of SO_2 in 100 kg of $H_2SO_4 + SO_2$

148. Ammonia and CO_2 are compressed and reacted at 100 – 200 atms and 170 – 190°C an autoclave to form

(A) Ammonium carbonate

(B) Ammonium carbamate

(C) Ammonium bicarbonate

(D) Biuret

149. Melamine is synthesized by

(A) Condensation of Ammonia

(B) Condensation of Urea

(C) Evaporation of Ammonia

(D) Evaporation of Urea

150. Which component is responsible for the development of the starches of Potatoes, the sugar of fruits and the fibrous material of plants?

(A) Calcium

(B) Potassium

(C) Magnesium

(D) Vanadium

151. Which component is responsible for the early stages of plant growth to promote the development of stems and leaves?

(A) Calcium

(B) Nitrogen

(C) Potassium

(D) Magnesium

152. The promotor used for the production of sulfuric acid is

(A) Acid and metallic compounds in trace

(B) Alkali and/or metallic compounds in trace

(C) Nitric acid with metallic compounds in trace

(D) Hydrochloric acid with metallic compounds in trace

153. Most widely used catalyst for sulfuric acid production is

(A) Hydrogen peroxide

(B) Vanadium pentoxide

(C) Phosphorus pentoxide

(D) Lithium oxide

154. Molecular weight of sulfuric acid is

(A) 98.08

(B) 94.08

(C) 90.28

(D) 98.48

155. Variation of velocity with the radial position of a pipeline can be measured with

(A) orifice meter
(B) venturi meter
(C) pitot tube
(D) rotameter

156. To determine the relative humidity of a gas mixture, the required measurements of temperature is/are :

(A) dry bulb temperature
(B) wet bulb temperature
(C) dew point temperature
(D) both dry and wet bulb temperatures

157. Step response of a second order system will show overshoot if its damping factor (ζ) is

(A) equal to 1
(B) less than 1
(C) greater than 1
(D) equal to infinity

158. Transfer function of a PID controller is given by

(A) $K_C\left(1+\frac{1}{\tau_I S}+\tau_D S\right)$
(B) $K_C(1+\tau_I S+\tau_D S)$
(C) $K_C\left(1+\frac{S}{\tau_I}+\tau_D S\right)$
(D) $K_C\left(S+\frac{S}{\tau_I}+\tau_D S\right)$

159. 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 control action is introduced
(D) Derivative control action is introduced

160. Transfer function of a second order system is given as $\frac{1}{s^2+2s+1}$. The system response

(A) is over damped
(B) is critically damped
(C) is under damped
(D) cannot be predicted

161. According to Bode Stability Criterion, a feed back control system is unstable if the amplitude ratio of the corresponding open loop transfer functions is _____ at the cross over frequency.

(A) larger than 1
(B) equal to zero
(C) less than 1
(D) equal to 1

162. Frequency response of a pure–capacitive process has a phase shift of

(A) 0°
(B) 45°
(C) –90°
(D) ∞

163. Match the following, in the analysis of multi variable equations, where N_V = Number of variables, and N_E = Number of equations

(a)	$N_V = N_E$	1.	under defined
(b)	$N_V > N_E$	2.	exactly defined
(c)	$N_V < N_E$	3.	over defined

	(a)	(b)	(c)
(A)	1	2	3
(B)	2	3	1
(C)	3	1	2
(D)	2	1	3

164. Temperature change due to altitude gain is referred to

(A) Adiabatic lapse rate
(B) Adiabatic gain rate
(C) Ambient lapse rate
(D) Ambient gain rate

165. The length of the cone for cyclone separators according to standard design is

(A) L = 2D
(B) L = D
(C) L = 3D
(D) L = 1/2 D

166. Effective stack height includes stack height physically along with

(A) Stack gas velocity
(B) Stack diameter
(C) Wind speed
(D) Plume rise

167. The dispersion of stack gas takes a horizontal pathway when there is stable air condition, this is called as

(A) looping plume
(B) neutral plume
(C) coning
(D) fanning

168. For which of the following item, depreciation calculation is not done?

(A) computers
(B) land
(C) electrical motors
(D) automobiles

169. By compound interest, calculation of Future Worth (F), for a given Present Worth (P) and interest rate per year of i, for a period of n–years, is done by

(A) $F = P(1 + in)$
(B) $F = P(1 + i)^n$
(C) $F = \dfrac{P}{(1 + i)^n}$
(D) $F = \dfrac{P}{(1 + in)}$

170. Alkalinity imparts ———————— taste in water.

(A) Tangy
(B) Bitter
(C) Sweet
(D) Foul

171. Quantitative assessment of risk (Q) is related to the frequency of incident (F) and loss per incident (L), as

(A) $Q = F + L$
(B) $Q = F/L$
(C) $Q = F \times L$
(D) $Q = F^2 \times L$

172. Which of the following IS code is used in design of pressure vessels is

(A) IS 803
(B) IS 1239
(C) IS 2002
(D) IS 2825

173. Cost of a blower in the year 2000 was Rs. 1,00,000/–. What will be the cost of a blower of the same capacity in 2014? The cost index for the blower in 2000 and 2014 respectively is 200 and 300.

(A) Rs. 2,00,000
(B) Rs. 1,50,000
(C) Rs. 1,40,000
(D) Rs. 2,40,000

174. Distribution coefficient is defined as the ratio of

(A) the concentration of solute in raffinate to that in extract
(B) the concentration of solute in extract to that in raffinate
(C) the concentration of solvent in raffinate to that in extract
(D) the concentration of solvent in extract to that in raffinate

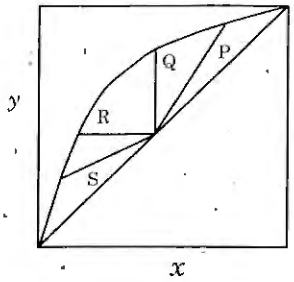
175. Hollow fiber membranes are made by

(A) Solution precipitation technique
(B) Film stretching technique
(C) Track etching technique
(D) Etching technique

176. The overall material balance equation used in absorption column can be given as

(A) $G_S(Y_1 - Y_2) = L_S(X_1 + X_2)$
(B) $G_S(Y_2 - Y_1) = L_S(X_1 - X_2)$
(C) $G_S(Y_1/Y_2) = L_S(X_1/X_2)$
(D) $G_S(Y_2/Y_1) = L_S(X_2/X_1)$

177. Match the feed line as given in the diagram to the type of feed, as below :



Type of feed line	Type of feed
P – slope greater than 1	I. saturated liquid
Q – vertical line	II. saturated vapor
R – horizontal line	III. liquid below bubble point
S – slope less than 1	IV. superheated vapor

(A) P – I, Q – II, R – III, S – IV
(B) P – III, Q – I, R – II, S – IV
(C) P – II, Q – III, R – I, S – IV
(D) P – IV, Q – II, R – I, S – III

178. Entropy change for adsorption is
(A) Negative
(B) Positive
(C) Zero
(D) Uncertain

179. A adsorbent – adsorbate pair exhibits an unfavourable isotherm. When such abed, loaded with the adsorbent is regenerated the depth of the MTZ will
(A) increase with time
(B) decrease with time
(C) increase initially then decrease with time
(D) remain unchanged

180. In a distillation column, the section of the column above the feed tray is called the
(A) Stripping section
(B) Rectifying section
(C) Feed section
(D) Reboiler section

181. The active tray area is determined by
(A) $\frac{\text{allowable liquid velocity}}{\text{allowable gas velocity}}$
(B) $\frac{\text{the gas flow rate}}{\text{allowable gas velocity}}$
(C) $\frac{\text{allowable gas velocity}}{\text{the gas flow rate}}$
(D) $\frac{\text{allowable gas velocity}}{\text{allowable liquid velocity}}$

182. Conversion increases with increase in temperature for

(A) auto catalytic reaction
(B) irreversible reaction
(C) reversible endothermic reaction
(D) reversible exothermic reaction

183. For the irreversible unimolecular reaction of type first order $A \xrightarrow{k}$ products a plot of $-\ln(1-X_A)$ as t gives a straight line passing through the origin whose slope is

(A) $1/K$
(B) –K
(C) K
(D) $-1/K$

184. The half life period of the reaction $A \xrightarrow{k}$ products is independent of the initial concentration of reactant A if order of the reaction is

(A) 0
(B) 1
(C) 2
(D) 1/2

185. For the consecutive unimolecular type first order reaction. $A \xrightarrow{k_1} R \xrightarrow{k_2} S$, the concentration of component A, (C_A) at any time t is equal to

(A) $C_{AO}\, e^{(k_1+k_2)t}$
(B) $C_{AO}\, e^{-(k_1+k_2)t}$
(C) $C_{AO}\, e^{-k_1 t}$
(D) $C_{AO}\, e^{k_1 t}$

186. In a ideal mixed flow reactor at steady state

(A) the rate of the reaction varies with time
(B) composition through the reactor varies with time
(C) the concentration of the reactant inside the reactor and the exit vary
(D) space time and holding time are the same for constant density systems

187. The exit age distribution $E(t)$ for an ideal CSTR is given as

(A) $E(t) = \left(1 - e^{-t/\bar{t}}\right)$
(B) $E(t) = e^{-t/\bar{t}}$
(C) $E(t) = \frac{1}{\bar{t}} e^{-t/\bar{t}}$
(D) $E(t) = k\left(1 - e^{-t/\bar{t}}\right)$

188. The expression C_A/C_{AO} for a zero order reaction of a Newtonian fluid in laminar flow in a tubular reactor is

(A) $C_A/C_{AO} = 1 - e^{-kt}$
(B) $C_A/C_{AO} = e^{-kt}$
(C) $C_A/C_{AO} = \left(1 - \frac{k\bar{t}}{2C_{AO}}\right)^2$
(D) $C_A/C_{AO} = 1 - \frac{k\bar{t}}{C_{AO}}$

189. The most suitable reactor for carrying out an isothermal operation continuously is

(A) Batch reactor
(B) CSTR
(C) Semi–batch reactor
(D) Plug flow reactor

190. In a constant volume system the measure of reaction rate of component i is given by $r_i = \frac{1}{V}\frac{dM_i}{dt} = \frac{dCi}{dt}$. For ideal gases at constant temperature T, r_i is equal to

(A) dp_i/dt
(B) $1/RT.dp_i/dt$
(C) $RT\,dp_i/dt$
(D) $\frac{R}{T}dp_i/dt$

191. Independent variable for a batch reactor with uniform concentration and temperature is

(A) time
(B) volume of the reactor
(C) diameter of the reactor
(D) agitator speed

192. For the unimolecular type elementary reaction $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ the fractional yield of R is always

(A) same in PFR and CSTR for a given conversion of A
(B) lower in PFR than for CSTR for any conversion of A
(C) higher in PFR than in CSTR for any conversion of A
(D) same in batch and CSTR for a given conversion of A

193. The order of convergence for fixed point iteration method is

(A) 0
(B) 1
(C) 2
(D) 3

194. Determinant of the matrix given below is $\begin{bmatrix} 1 & 2 & 1 \\ 1 & 2 & 1 \\ 1 & 0 & 2 \end{bmatrix}$

(A) 0
(B) 4
(C) 5
(D) 11

195. The largest eigen value of the matrix $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ using power method is

(A) 0 (B) 1

(C) 2 (D) 3

196. To fit a curve between y and x, by method of group averages, of the form $y = mx + c$, where m and c are constants, number of groups to be made are :

(A) 1 (B) 2

(C) 3 (D) 4

197. To solve a non-linear equation $f(x) = 0$, by Newton–Raphson method, the iteration formula is written as

(A) $x_{n+2} = x_n - \frac{x_{n+1} - x_n}{f(x_{n+1}) - f(x_n)} f(x_n)$ (B) $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$

(C) $x_{n+1} = x_n - \frac{f'(x_n)}{f(x_n)}$ (D) $x_{n+1} = x_{n-1} - \frac{f(x_n)}{f'(x_n)}$

198. An example of predictor–corrector method of solving ordinary differential equation is

(A) Euler's method (B) Runge–Kutta's method

(C) Picard's method (D) Milne's method

199. A set of simultaneous differential equation is called as a stiff equation, if the rates of changes of different dependent variables are

(A) nearly the same (B) equal to one another

(C) significantly different (D) zero

200. A linear partial differential equation is given as

$$A(x,y)\frac{\partial^2 u}{\partial x^2} + B(x,y)\frac{\partial^2 u}{\partial x \partial y} + C(x,y)\frac{\partial^2 u}{\partial y^2} + F\left(x, y, u, \frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}\right) = 0.$$

The criteria to verify the above equation to be parabolic is

(A) $B^2 - 4AC < 0$ (B) $B^2 - 4AC = 0$

(C) $B^2 - 4AC > 0$ (D) $B^2 - 4AC = 1$