Sl. No. 025204

CHUG

Register Number

2012
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.
4. **All** questions carry equal marks.
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., Question Booklet Sl. 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, 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.
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.
13. The last sheet of the Question Booklet can be used for Rough Work.

Tear here ✂ DO NOT TEAR THIS COVER OF THE QUESTION BOOKLET UNTIL YOU ARE ASKED TO DO SO ✂ Tear here

1. Enthalpy H is defined as

A) $H = E - PV$ B) $H = F - TS$

C) $H - E = PV$ D) none of these.

2. In a closed system, there is

A) No exchange of energy of the system

B) Exchange of mass with the surroundings

C) Exchange of mass and energy with the surroundings

D) Exchange of energy with the surroundings and not the mass.

3. The internal energy of a system depends upon

A) The quantity of substance B) Its chemical nature

C) Temperature, pressure and volume D) all of these.

4. According of first law of thermodynamics the change in internal energy (ΔE) accompanying a process, performing a work (W) and involving absorption of heat (Q) on the surroundings is given by the relation

A) $\Delta E = Q - W$ B) $\Delta E = \frac{Q}{W}$

C) $\Delta E = \frac{W}{Q}$ D) $\Delta E = WQ$.

5. Specific heat at a constant pressure (C_p) is defined by

A) $(\partial E/\partial T)_p$ B) $(\partial H/\partial T)_p$

C) $(\partial S/\partial T)_p$ D) none of these.

6. Thermochemistry is the study of the relationship between Chemical energy and

A) Heat energy B) Potential energy

C) Activation energy D) Threshold energy.

7. Efficiency of a Carnot engine working between hot reservoir at temperature T_1 and sink reservoir at temperature T_2 is

A) $[T_1 - T_2] / T_1$ B) $T_1/[T_1 - T_2]$

C) $[T_1 - T_2] / T_2$ D) $T_2/[T_1 - T_2]$.

8. The change in entropy (∂S) for reversible process is

A) (∂S) = Change of heat transfer/absolute temperature

B) (∂S) = Absolute temperature / change of heat transfer

C) (∂S) = Change of heat transfer/change of mass transfer

D) none of these.

9. For gases, isothermal compressibility (k) is equal to

A) $(\partial V/\partial T)_T$ B) $(1/V)\ (\partial V/\partial T)_T$

C) $-(1/V)\ (\partial V/\partial T)_T$ D) $V\ (\partial V/\partial T)_T$

10. Work and heat are examples of

A) Point functions B) Path functions

C) State functions D) Transfer functions.

11. A polytropic process is described by

A) PV = Constant B) PV^{γ} = Constant

C) PV^{n+1} = Constant D) $P\gamma^{n}$ = Constant.

12. Isobaric process means a constant ..... process.

A) temperature B) pressure

C) volume D) entropy.

13. The point at which all three (solid, liquid and gas) phases co-exist is known as

A) freezing point B) triple point

C) boiling point D) none of these.

14. Gibbs Free energy (G) is defined as

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

C) $G = U + TS$ D) $G = H + TS$.

15. 1°Brix is equivalent to a sugar solution containing

A) 10% sugar B) 1% sugar

C) 0.1% sugar D) 0.01% sugar.

16. Charles law for a given mass of an ideal gas is

A) ratio of the volume to temperature is constant

B) ratio of the temperature to volume is constant

C) ratio of the pressure to volume is constant

D) product of pressure and volume is constant.

17. Molality is defined as

A) The number of moles of solute dissolved in 1 litre of solution

B) The number of gram equivalent dissolved in 1 litre of solution

C) The number of mole of solute dissolved in 1 kilogram of solvent

D) The number of gram of solute dissolved in 1 kg of solvent.

18. For an ideal gas mixture

A) volume % = weight % = pressure %

B) volume % = mole % = pressure %

C) mole % = molecular weight % = pressure %

D) none of these.

19. In a textile mill, a double effect evaporator system concentrates weak liquor containing 4% (by weight) caustic soda to produce a lye containing 25% solids (by weight). What is the evaporation of water per 100 kg of feed in the evaporator ?

A) 80 kg B) 82 kg

C) 84 kg D) 86 kg.

20. Equation $C_p - C_v = R$ is true for

A) an ideal gas only
B) any real gas
C) ideal as well as real gases
D) non-ideal gas only.

21. All oxidation reactions are

A) Endothermic with irreversible
B) Endothermic with reversible
C) Exothermic with reversible
D) Exothermic with irreversible.

22. The equivalent weight of an element or a compound is equal to

A) Molecular weight divided by valency
B) Weight divided by valency
C) Valency divided by weight
D) Molal volume divided by molecular weight.

23. An ideal solution obeys

A) Charles law
B) Boyle's law
C) Raoult's law
D) Dühring law.

24. A chemical reaction will occur spontaneously at constant pressure and temperature, if the free energy is

A) zero
B) positive
C) negative
D) none of these.

25. Air has 21 % oxygen and 79 % nitrogen by volume. What is the average molecular weight ? (Atomic weight of O = 16, N = 14)

A) 29
B) 28.84
C) 29.3
D) 27.5.

26. The ratio of the actual mesh dimension of Taylor series to that of the next smaller screen is

A) 2 B) $\sqrt{2}$

C) 1.5 D) none of these.

27. The opening of 200 mesh screen (Taylor series) is

A) 0.0074 cm B) 0.0074 mm

C) 0.0047 cm D) none of these.

28. For coarse reduction of hard solids, use

A) impact B) attrition

C) compression D) cutting.

29. Crushing efficiency is the ratio of

A) surface energy created by the crushing to the energy absorbed by the solid

B) the energy absorbed by the solid to that fed to the machine

C) the energy fed to the machine to the surface energy created by the crushing

D) the energy absorbed by the solid to the surface energy created by the crushing.

30. Rittinger's crushing law states that

A) work required to form a particle of any size is proportional to the square of the surface to volume ratio of the product.

B) work required to form a particle of a particular size is proportional to the square root of the surface to volume ratio of the product.

C) work required in crushing is proportional to the new surface created

D) for a given machine and feed, crushing efficiency is dependent on the size of feed and product.

31. Work index is defined as the

A) gross energy (kWh/ton of feed) needed to reduce very large feed to such a size that 80% of the product passes a 100 micron screen.

B) energy needed to crush one ton of feed to 200 microns

C) energy (kWh/ton of feed) needed to crush small feed to such a size that 80% of the product passes a 200 mesh screen.

D) energy needed to crush one ton of feed to 100 microns.

32. The operating speed of a ball mill should be ..... the critical speed.

A) less than B) much more than

C) at least equal to D) none of these.

33. A fluid energy mill is used for

A) cutting B) grinding

C) ultragrinding D) crushing.

34. For the preliminary breaking of hard rock, we use

A) gyratory crusher B) ball mill

C) tube mill D) squirrel-cage disintegrator.

35. With increase in the capacity of screens the effectiveness

A) Remains unchanged B) Increases

C) Decreases D) Increases exponentially.

36. A classifier is a device that

A) Separates solids into two fractions

B) Virtually removes all the particles from a liquid

C) Settles the particles from a liquid by sedimentation

D) Helps to suspend the particle in the liquid.

37. Filter medium resistance is that offered by the

A) filter cloth

B) embedded particles in the septum

C) filter cloth and the embedded particle collectively

D) none of these.

38. The porosity of a compressible cake is

A) minimum at the filter medium

B) minimum at the upstream face

C) maximum at the filter medium

D) same throughout the thickness of cake.

39. The unit of specific cake resistance is

A) gm/cm^2 B) cm/gm

C) cm/gm^2 D) gm/gm.

40. The most common filter aid is

A) diatomaceous earth B) calcium silicate

C) sodium carbonate D) silica gel.

41. Catalyst used in manufacture of sulphuric acid by chamber and contact processes are respectively

A) V_2O_5 and Cr_2O_5

B) oxides of nitrogen and Cr_2O_5

C) V_2O_5 on a porous carrier and oxides of nitrogen

D) oxides of nitrogen and V_2O_5 on a porous carrier.

42. Contact process

A) yields acid of higher concentration than chamber process

B) yields acids of lower concentration than chamber process

C) is obsolete

D) eliminates absorber.

43. Which of the following glasses is optically important for their high index of refraction and dispersion ?

A) Sodalime glass B) Borosilicate glass

C) Float glass D) Lead glass.

44. Cement mainly contains

A) CaO, SiO_2, Al_2O_3 B) MgO, SiO_2, K_2O

C) Al_2O_3, MgO, Fe_2O_3 D) CaO, MgO, K_2O.

45. Gypsum is

A) calcium chloride B) potassium sulphate

C) sodium sulphate D) calcium sulphate.

46. Oil is

A) a mixture of glycerides

B) a mixture of glycerides of fatty acids

C) solid at normal temperature

D) ester of alcohols other than glycerin.

47. Unsaturated oils compared to saturated oils have

A) lower melting point and higher reactivity to oxygen

B) higher melting point and higher reactivity to oxygen

C) lower melting point and lower reactivity to oxygen

D) higher melting point and lower reactivity to oxygen.

48. Solvent used for extraction of oil is

A) hexane B) methyl ethyl ketone

C) furfurol D) none of these.

49. Detergents are manufactured from

A) Fatty acids B) Glycerin

C) Fats D) Fatty alcohols.

50. Catalyst used in hydrogenation of oil is

A) nickel B) platinum

C) iron D) alumina.

51. Which of the following is a detergent ?

A) Fatty alcohol B) Alkyl benzene sulphonate

C) Fatty acids D) Methylene chloride

52. The octane number of gasoline is increased by the addition of

A) Tetraethyl Lead (TEL) B) Organophosphates

C) Sulphur D) Greases.

53. The ideal pulp for the manufacture of paper should have high

A) cellulose content B) lignin content

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

54. Bleaching of paper pulp is done with

A) activated clay B) bromine

C) chlorine or chlorine dioxide D) magnesium sulphite.

55. Which of the following is super-efractory ?

A) Silicon carbide B) Insulating brick

C) Magnesia D) High alumina refractory.

56. Which of the following is not an antibiotic ?

A) Penicillin B) Streptomycin

C) Tetracyclin D) Quinine.

57. Penicillin is separated from fermented broth by

A) extraction with amyl or butyl acetate

B) ternary azeotropic distillation

C) evaporation in calendria

D) extractive distillation.

58. Carborundum consists mainly of

A) bauxite B) silicon carbide

C) boron carbide D) calcium carbide.

59. Fire clay is

A) a basic refractory B) an acidic refractory

C) a neutral refractory D) not a refractory material.

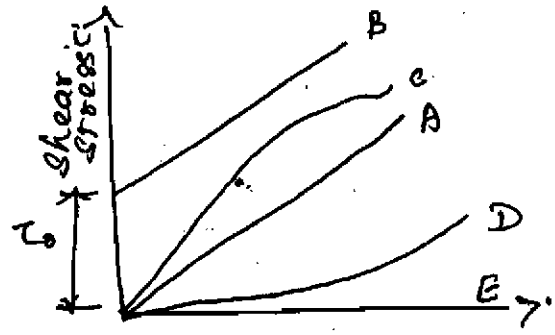
60. Calcination of limestone is not done in a..... kiln for producing lime.

A) vertical shaft
B) rotary
C) fluidized bed
D) fixed bed.

61. A Newtonian fluid is one which,

A) is frictionless and incompressible
B) has a linear relationship between the magnitude of applied shear stress and the resulting rate of deformation.
C) has a non-linear relationship between the magnitude of applied shear stress and the resulting rate of deformation
D) has a vapour pressure of $1N/m^2$ at 25°C.

62. Which curve in the given figure represents Newtonian fluid ?



Velocity Gradient, $\frac{du}{dy}$

A) A
B) B
C) C
D) E.

63. Which of the following has the form of a Mach number (NMa) ?

A) $\frac{v}{\sqrt{gl}}$
B) $\frac{v}{c}$
C) $\frac{P}{\rho v^2}$
D) $\frac{v^2 L \rho}{\sigma}$

64. Friction factor $f = \frac{16}{N_{Re}}$ is valid for

A) laminar flow only
B) both laminar and turbulent flows
C) turbulent flow only
D) transition region only.

65. The momentum correction factor (β) is used in fluid flow problems to account for

A) change in pressure
B) change in total energy
C) change in direction of flow
D) non-uniform direction of velocities at inlet and outlet sections.

66. Cavitation in fluid flow occurs when

A) the pressure of flow reaches to a value close to its vapour pressure
B) the total energy increases suddenly
C) the total energy decreases suddenly
D) the fluid velocity decreases to zero.

67. Select the correct relation for centrifugal pumps at equal efficiencies.

A) $\frac{D_2}{D_1} = \left(\frac{Q_2}{Q_1}\right)^{\frac{1}{2}} = \left(\frac{H_2}{H_1}\right)^{\frac{1}{3}} = \left[\frac{(BHP)_2}{(BHP)_1}\right]^{\frac{1}{2}}$

B) $\frac{D_2}{D_1} = \frac{Q_2}{Q_1} = \left(\frac{H_2}{H_1}\right)^{\frac{1}{2}} = \left[\frac{(BHP)_2}{(BHP)_1}\right]^{\frac{1}{3}}$

C) $\left(\frac{D_2}{D_1}\right)^{\frac{1}{2}} = \left(\frac{Q_2}{Q_1}\right)^{\frac{1}{3}} = \frac{H_2}{H_1} = \frac{(BHP)_2}{(BHP)_1}$

D) $\left(\frac{D_2}{D_1}\right)^{\frac{1}{3}} = \left(\frac{Q_2}{Q_1}\right)^{\frac{1}{2}} = \frac{H_2}{H_1} = \frac{(BHP)_2}{(BHP)_1}$

68. For a specific impeller diameter, fixed impeller speed of a centrifugal pump, and constant density,

A) NPSH required decreases with increase in the capacity

B) NPSH required increases with increase in the capacity

C) NPSH required increases with increase in the capacity

D) NPSH required and NPSH available both increase with increase in the capacity.

69. Cavitation in centrifugal pumps is caused by

A) high fluid velocity at the suction B) low barometric pressure

C) low suction pressure D) high suction pressure.

70. When heat is transferred by a chain of molecules from the hot area of an object to a colder area, the process of heat transfer is called

A) natural convection B) forced convection

C) conduction D) radiation.

71. The thermal diffusivity of a material is defined as

A) $k/(\rho C_p)$ B) $(\rho C_p)/k$

C) $(k\,C_p)/\rho$ D) $(k\rho)/C_p$.

72. The Fourier number (N_{F_o}) is defined as

A) tL^2/α B) $\frac{\alpha t}{r^2}$

C) $\frac{hL}{k}$ D) $\frac{hk}{L}$.

73. In forced convection the heat transfer depends on

A) N_{Re} only B) N_{Pr} only

C) N_{Re} and N_{Pr} D) none of these.

74. Dittus–Boelter equation, $N_{Nu} = 0{\cdot}023\ (N_{Re})^{0.8}\ (N_{Pr})^{n}$, where $n = 0{\cdot}4$ for hot fluid and $n = 0{\cdot}3$ for cold fluid, is applicable for

A) $10000 < N_{Re} < 1{\cdot}2 \times 10^5$ B) $0{\cdot}7 < N_{Pr} < 120$

C) $L/D > 60$ D) all of these.

75. Two very large gray planes are at the constant temperatures of T_1 and T_2. If the two gray planes have emissivities of ε_1 and ε_2, respectively, what is the net heat exchange rate per unit area ?

A) $\sigma\ (\varepsilon_1\ T_1^4 - \varepsilon_2\ T_2^4)$ B) $\varepsilon_1\ \varepsilon_2\ \sigma\ (\ T_1^4 - T_2^4\ )$

C) $\sigma\left(\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1\right)\left(T_1^4 - T_2^4\right)$ D) $\dfrac{\sigma\ (T_1^4 - T_2^4\ )}{\left(\dfrac{1}{\varepsilon_1} + \dfrac{1}{\varepsilon_2} - 1\right)}$.

76. In a finned tube heat exchanger

A) only heat transfer area is augmented

B) only film coefficient is augmented

C) both heat transfer area & film coefficient are augmented

D) none of these.

77. 25 per cent cut segmental baffle means

A) a baffle plate whose height is 25% of the inside diameter of the shell

B) a baffle plate whose height is 75% of the inside diameter of the shell

C) a baffle plate whose height is 25% of the inside diameter of the tube

D) a baffle plate whose height is 25% of the length of tube.

78. Capacity of an evaporator is defined as

A) the number of kilograms of solvent vapourized per hour

B) the number of kilograms of solvent vapourized per kilogram of steam fed to the evaporator

C) the number of kilograms of steam consumed per hour

D) the number of kilograms of steam consumed per kilogram of solvent vapourized.

79. Economy of an evaporator is defined as

A) the number of kilograms of steam consumed per hour

B) the number of kilograms of steam consumed per kilogram of solvent vaporized

C) the number of kilograms of solvent vaporized per hour

D) the number of kilograms of solvent vaporized per kilogram of steam fed to the evaporator.

80. Match **List I** correctly with **List II** and select your answer using the codes given below :

List I		**List II**
a)	$I_\lambda = \frac{c_1 \lambda^{-5}}{e^{c_2/\lambda T} - 1}$	1. Wien's Law
b)	λT = constant	2. Planck's Law
c)	$E_b = \sigma T^4$	3. Nusselt equation
d)	$h = 0 \cdot 943 \left(\frac{k^3_f \rho^2_f \lambda_g}{\mu_l L \Delta T_f} \right)^{\frac{1}{4}}$	4. Stefan-Boltzmann's Law.

Codes :

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

D) none of these.

81. If n is the order of reaction, then unit of rate constant is

A) 1 / (time) (concentration)$^{n-1}$ B) (time)$^{-1}$ (concentration)$^{n-1}$

C) (time)$^{n-1}$ (concentration) D) (time^{-1}) (concentration)$^{1-n}$

82. The rate of reaction doubles for each 10°C rise in temperature. What activation energy would this suggest at a temperature 25°C ?

A) 11810 cal/mol
B) 11820 cal/mol
C) 11825 cal/mol
D) 11830 cal/mol.

83. Sum of the powers of the concentration term in the rate equation is called the

A) order of reaction
B) molecularity
C) elementary reaction
D) none of these.

84. Transition state theory predicts the temperature dependency of reaction rate as

A) $K \alpha T$
B) $K \alpha e^{-E/RT}$
C) $K \alpha T e^{-E/RT}$
D) $K \alpha T e^{E/RT}$

85. The reaction $Cl_2 + H_2 \rightarrow 2HCl$ is carried out in the presence of sunlight. What is the order of reaction ?

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

86. Integral method is used for analysis of kinetic data

A) for testing complicated mechanism
B) when the data are scattered
C) when rate expressions are simple
D) none of these.

87. A batch reactor is characterized by

A) Constant residence time
B) Variation in extent of reaction and proportion of the reaction mixture with time
C) Variation in reactor volume
D) Very low conversion.

88. What is the partial pressure of a gas mixture containing 50 mol % *A* and 50 mol% inert in a closed vessel at pressure of 10 atm and temperature of 150°C ?

A) 10 atm
B) 4 atm
C) 5 atm
D) 6 atm.

89. The half-life time $t_{1/2} = 0.693/k$. Then the reaction is of

A) Zero order
B) First order
C) Second order
D) Third order.

90. Oil is hydrogenated using nickel catalyst in a

A) Batch reactor
B) Fluidized bed reactor
C) Slurry reactor
D) Fixed bed reactor.

91. Space velocity of 5 hr^{-1} means that

A) Five reactor volume of feed (at specified conditions) are being fed into the reactor per hour

B) After every 5 hours, the reactor is being filled with the feed

C) Cent per cent conversion can be achieved in at least 5 hours

D) A fixed conversion of a given batch of feed takes 5 hours.

92. For a recycle reactor the recycle ratio is given by

A) $R = \dfrac{\text{Volume of fluid returned to the reactor inlet}}{\text{Volume of fluid leaving the system}}$

B) $R = \dfrac{\text{Volume of fluid leaving the system}}{\text{Volume of fluid returned to the reactor outlet}}$

C) $R = \dfrac{\text{Volume of fluid leaving the system}}{\text{Volume of fluid retained in the reactor}}$

D) $R = \dfrac{\text{Volume of fluid retained in the reactor}}{\text{Volume of fluid leaving the system}}$

93. Fluidised bed reactor is characterized by

A) uniformity of temperature

B) comparatively smaller equipment

C) very small pressure drop

D) absence of continuous catalyst regeneration facility

94. In an ideal P.F.R at steady state conditions

A) the composition of reactants remains constant along a flow path

B) the conversion of the reactant varies from point to point along a flow path

C) there is no lateral mixing of fluid

D) all of these.

95. Arrhenius equation shows the variation of ..... with temperature.

A) Reaction rate B) Rate constant

C) Energy of activation D) Frequency factor.

96. When a catalyst alters rate of a chemical reaction, the value of rate constant

A) increases

B) decreases

C) constant

D) remains increasing or decreasing depending upon the type of reaction.

97. For a batch system, the selectivity (S) is

A) $S = \frac{\text{Moles of desired product formed}}{\text{Moles of undesired product formed}}$

B) $S = \frac{\text{Moles of desired product formed}}{\text{Moles of feed admitted to the system}}$

C) $S = \frac{\text{Moles of undesired product formed}}{\text{Moles of desired product formed}}$

D) $S = \frac{\text{Moles of desired product formed}}{\text{Volume of fluid leaving the system}}$

98. For a reaction of zero order, the rate of reaction is

A) independent of the concentration

B) dependent on concentration

C) dependent on temperature

D) independent of temperature.

99. Inversion of cane sugar is a

A) Bimolecular reaction with second order

B) Bimolecular reaction with first order

C) Unimolecular reaction with second order

D) Pseudo-unimolecular reaction with first order.

100. A photochemical reaction is

A) Catalyzed by light

B) Accompanied with emission of light

C) Initiated by light

D) Used to convert heat energy to light.

101. Transfer function of a second order system is

A) $\frac{1}{\tau^2 S^2 + 2\xi\tau S + 1}$ B) $\frac{1}{\tau^2 S^2 + 2\tau S + 1}$

C) $\frac{1}{\tau^2 S^2 + 2\xi\tau + 1}$ D) None of these.

102. Response of a system to a sinusoidal input is called

A) impulse response B) unit step response

C) frequency response D) none of these.

103. Which one of the following is a first order system ?

A) Damped vibrator

B) Mercury in glass thermometer kept in boiling water

C) Interacting system of two tanks in series

D) Non-interacting system of two tanks in series.

104. The time required for the response to come within ± 5% of its ultimate value & remain there is known as

A) Rise time
B) Response time
C) Period of oscillation
D) Decay ratio.

105. Overshoot and decay ratio are related as

A) Overshoot = Decay Ratio
B) Overshoot = $(\text{Decay Ratio})^2$
C) Overshoot = $(\text{Decay Ratio})^{\frac{1}{2}}$
D) Overshoot = $(\text{Decay Ratio})^{-\frac{1}{2}}$.

106. The difference between the new steady state value & the original value is called as

A) offset
B) error
C) deviation
D) none of these.

107. Tracking of missiles & aircrafts are the well known examples of

A) Servo-type problem
B) Regulator problem
C) Response problem
D) Set point problem.

108. Transfer function of a transportation lag is

A) $e^{\tau s}$
B) $\frac{1}{\tau s + 1}$
C) $\frac{e^{\tau s}}{\tau s + 1}$
D) $e^{-\tau s}$.

109. The transfer function of a process is $\frac{1}{16s^2 + 8s + 4}$. If a step change is introduced into the system, then the response will be

A) overdamped
B) underdamped
C) critically damped
D) none of these.

110. Dead-time compensation is also referred as

A) Smith predictor
B) Single loop control system
C) Ratio controller
D) Adaptive controller.

111. Hot wire anemometer is used to measure

A) Temperature
B) Thermal conductivity
C) Specific heat
D) Flow rate of fluids.

112. The general condition for stability of a continuous system is

A) the roots of the characteristic equation fall in the right half of the complex plane.
B) the roots of the characteristic equation fall in the left half of the complex plane
C) the roots of the characteristic equation fall in the centre of the complex plane
D) none of these.

113. Controlling of more than one feedback loop is known as

A) cascade control
B) ratio control
C) feed forward control
D) feed backward control.

114. The error required to move the value from fully closed to fully open is termed as

A) offset
B) set point
C) differential gap
D) proportional band.

115. Gain margin is equal to the

A) Amplitude ratio
B) Gain in *P* controller
C) Gain in *PI* controller
D) Reciprocal of Amplitude ratio.

116. A sinusoidal variation in the input passing through a linear first order system

A) becomes more oscillatory (frequency increases)
B) becomes less oscillatory (frequency decreases)
C) gets amplified (magnitude increases)
D) gets attenuated (magnitude decreases).

117. The time constant of a first order process with resistance R & capacitance C is

A) $R + C$ B) $R - C$

C) RC D) $\frac{1}{RC}$.

118. The basic principle involved in the measurement of temperature by thermocouple is

A) Raman effect B) Seebeck effect

C) Peltier & Seebeck effect D) Thomson & Peltier effect.

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

A) KC is reduced

B) KC is increased

C) Integral control action is introduced

D) Derivative control action is introduced.

120. The primary task of a microprocessor based controller is

A) implementation of control algorithm

B) provide static & dynamic display on the monitor

C) provide data acquisition & storage

D) all of these.

121. For a differential function $f(x)$ to have maximum, $\frac{df}{dx}$ & $\frac{d^2f}{dx^2}$ should be

A) zero & negative B) negative & zero

C) zero & positive D) positive & zero.

122. If p & q are roots of $x^2 + px + q = 0$ then

A) $p = 1$ B) $p = 2$

C) $p = 0$ D) $p = -2$.

123. Integrating factor of differential equation $\cos x \frac{dy}{dx} + y \sin x = 1$ is

A) $\cos x$ B) $\tan x$

C) $\sec x$ D) $\sin x$.

124. Differential equation for $y = A \cos \alpha x + B \sin \alpha x$, where A & B are arbitrary constants, is

A) $\frac{d^2y}{dx^2} - \alpha^2 y = 0$ B) $\frac{d^2y}{dx^2} + \alpha^2 y = 0$

C) $\frac{d^2y}{dx^2} + \alpha y = 0$ D) $\frac{d^2y}{dx^2} - \alpha y = 0$.

125. The first differentiation of a constant is equal to.

A) 1 B) > 1

C) < 1 D) 0.

126. The PDE $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x, y)$ is called as

A) Heat equation B) Wave equation

C) Laplace equation D) Poisson's equation.

127. The auxiliary equation of $(aD^2 + bD + c) = 0$ is having two real & distinct roots m_1 & m_2 then the general solution is

A) $y = Ae^{m_1 y} + Be^{m_2 y}$ B) $y = Ae^{m_1 x} + Be^{m_2 x}$

C) $y = (Ax + B)e^{m_1 x}$ D) $y = (Ax + B)e^{m_2 x}$.

128. Solution of differential equation $xdy - ydx = 0$ represents

A) Rectangular hyperbola

B) Straight line passing through origin

C) Parabola whose vertex is at origin

D) Circle whose centre is at origin.

129. Order & degree of differential equation $\frac{d^2y}{dx^2} = \left\{ y + \left(\frac{dy}{dx} \right)^2 \right\}^{\frac{1}{4}}$ are

A) 4 & 2 B) 1 & 2

C) 1 & 4 D) 2 & 4.

130. The number of real roots of the equation

$(x-1)^2 + (x-2)^2 + (x-3)^2 = 0$ is

A) 2 B) 1

C) 0 D) 3.

131. The solution for $L(t^2 e^{2t})$ is

A) $\frac{2}{s^3}$ B) $\frac{2}{(s-2)^3}$

C) $\frac{2}{(s+2)^3}$ D) $\frac{4}{(s+2)^3}$

132. The line $y = mx + 1$ is a tangent to $y^2 = 4x$ if m equals

A) 4 B) 2

C) 1 D) -1.

133. The sum of the infinite series $3 + 1 + \frac{1}{3} + \left(\frac{1}{3}\right)^2 + \ldots\ldots \left(\frac{1}{3}\right)^n + \ldots\ldots$ is

A) 9 B) $\frac{9}{2}$

C) $\frac{15}{2}$ D) ∞.

134. What type of graph sheet is used to get a straight line by plotting (x, y) for the equation $y = ax^n$?

A) Semi-log graph B) Log-Log graph

C) Polar graph D) None of these.

135. Which one of the following is a method of curve fitting ?

A) Method of group averages
B) Least square method
C) Method of moments
D) all of these.

136. The normal equation for fitting a straight line $y = ax + b$ is

A) $\Sigma x = a\Sigma x + nb$

$\Sigma x^2 y = a\Sigma x^2 + b\Sigma x$

B) $\Sigma y = a\Sigma x + nb$

$\Sigma xy = a\Sigma x^2 + b\Sigma x$

C) $\Sigma x^2 y = a\Sigma x + nb$

$\Sigma y = a\Sigma x^2 + b\Sigma x$

D) $\Sigma y = a\Sigma x^2 + nb$

$\Sigma xy = a\Sigma x + b\Sigma x^2$.

137. If a chemical substance disintegrates at a rate inversely proportional to the square of the amount present at any instant, what is the differential equation governing this law ?

A) $\frac{dN}{dx} \propto \frac{1}{N^2}$
B) $\frac{dN}{dt} \propto \frac{1}{N}$
C) $\frac{dN}{dt} \propto \frac{1}{N^2}$
D) $\frac{dN^2}{dt^2} \propto \frac{1}{N}$.

138. How many arbitrary constants will be there in the solution of second order differential equation ?

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

139. The solution for the equation $ax^2 + bx + c = 0$ is given by

A) $\frac{-b \pm \sqrt{b^2 + 4ac}}{2a}$
B) $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
C) $\frac{-b \pm \sqrt{b^2 - 4ac}}{2c}$
D) $\frac{-b \pm \sqrt{b^2 - 4bc}}{2a}$.

140. The equation to find the roots by Regula falsi method is

A) $x = \frac{b f(b) - a f(a)}{f(b) - f(a)}$ B) $x = \frac{f(b) - f(a)}{b f(b) - a f(a)}$

C) $x = \frac{a f(b) - b f(a)}{f(b) - f(a)}$ D) $x = \frac{a f(b) - b f(a)}{f(a) - f(b)}$

141. In a distillation operation, the heat removed in condenser

A) remains unaffected with change in reflux ratio

B) increases with increase in reflux ratio

C) decreases with increase in reflux ratio

D) and the heat required in reboiler decrease with increase in reflux ratio.

142. Relative humidity is the ratio of

A) partial pressure of the vapour to the vapour pressure of the liquid at room temperature

B) partial pressure of the vapour to the vapour pressure of the liquid at gas temperature

C) actual humidity to saturation humidity

D) none of these.

143. In concurrent liquid-liquid extraction, the solvent *B* is used to separate solute *C* from a given solution *A* and *C*. The liquids *A* and *B* are insoluble. The slope of the operating line for each state will be

A) zero B) positive

C) infinity D) negative.

144. At plait point of a ternary system

A) the selectivity of solvent will be unity

B) the distribution coefficient for solute will be unity

C) the density difference between the two equilibrium phases becomes zero

D) all of these.

145. in counter-current liquid-liquid extraction, the maximum concentration of solute in extract layer

A) is that corresponding to equilibrium with the incoming feed

B) is less than the concentration corresponding to equilibrium with the incoming feed

C) can be increased than that obtained in (A) above by using raffinate reflux

D) none of these.

146. Absorption factor is defined as

A) $\frac{S_2}{S_1}$ B) $S_1 \times S_2$

C) $S_2 - S_1$ D) $\frac{S_1}{S_2}$,

where

S_1 = slope of the operating line

S_2 = slope of the equilibrium line.

147. Desorption of the adsorbed solute by solvent is called

A) reverse osmosis B) dialysis

C) sublimation D) elution.

148. Higher hold up of the solid in the rotary drier results in

A) increased drying action

B) poor exposure of the solid to the gas

C) an increase in power required for operating the drier

D) all of these.

149. Minimum number of ideal stages are required in a fractionating column when the reflux ratio is equal to

A) minimum reflux ratio B) optimum reflux ratio

C) zero D) infinity.

150. Constant rate period is that drying period during which

A) the rate of vaporization per units of drying surface area is constant

B) the rate of vaporization continually decreases with time

C) the rate of vaporization continually increases with time

D) the moisture content of the substance remains constant.

151. Match **List I** correctly with **List II** and select your answer using the codes given below :

	List I		**List II**
a)	Distillation	1.	Solvent
b)	Absorption	2.	Heat
c)	Adsorption	3.	Adsorbent
d)	Ion exchange	4.	Resin.

Codes :

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

152. HETP is numerically equal to HTU only when operating line

A) lies below the equilibrium line

B) lies above the equilibrium line

C) is parallel to equilibrium lines

D) is far from the equilibrium lines.

153. Absorption accompanied by heat evolution results in

A) increased capacity of the absorber

B) increase in equilibrium solubility

C) decrease in equilibrium solubility

D) none of these.

154. Humidification involves mass transfer between a pure liquid phase and a fixed gas which is

A) insoluble in the liquid B) soluble in the liquid

C) non-ideal in nature D) at a fixed temperature.

155. The equipment frequently used for adiabatic humidification operation with recirculating liquid is

A) natural draft cooling tower B) induced draft cooling tower

C) spray chamber D) none of these.

156. Flooding in a column results due to

A) high pressure drop B) low pressure drop

C) low velocity of the liquid D) high velocity of the liquid.

157. If the selectivity of the solvent used in liquid-liquid extraction is unity

A) any degree of separation of solute is possible

B) only little amount of solute may be separated

C) no separation is possible

D) none of these.

158. The most economical range of absorption factor is

A) 0 to 0·5 B) 0 to 3

C) 1·25 to 2 D) 5 to 15.

159. Match **List I** correctly with **List II** and select your answer using the codes given below :

	List I		**List II**
a)	Underwood's equation	1.	Number of real trays
b)	Fenske's equation	2.	Column diameter
c)	Gilliland's equation	3.	Minimum number of ideal trays
d)	Vapour velocity at flooding	4.	Actual number of ideal trays
		5.	Minimum reflux ratio
		6.	Tray efficiency

Codes :

	a	***b***	***c***	***d***
A)	1	3	4	6
B)	2	5	1	3
C)	5	3	6	2
D)	5	3	4	2

160. The rate of drying during constant-rate period

A) is unaffected by the air humidity

B) increases with increased air humidity

C) decreases with increased air humidity

D) increases linearly with increase in air humidity.

161. The expansion of term "HAZOP" is

A) Hazard operation

B) Hazard operability studies

C) Hazard zone

D) None of these.

162. Which is not a chemical coagulant ?

A) Aluminium sulphate
B) Ferrous sulphate
C) Hydrated lime
D) None of these.

163. Match **List I** relating health hazards correctly with **List II** and select your answer using the codes given below :

	List I		**List II**
a)	Irritant	1.	CO_2
b)	Asphyxiant	2.	Chlorine
c)	Lung damage	3.	Lead
d)	Systemic poison	4.	Dust

Codes :

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

D) none of these.

164. Radioactive substances present in the polluted water stream can be removed by

A) biological treatment
B) coagulation & filtration
C) adsorption in ion-exchange materials
D) all of these.

165. Fault free analysis is an effective tool to identify

A) the system failure which results in loss
B) the potential of malfunction of the equipment
C) the areas of concentration of loss producing events
D) none of these.

166. Correct use of 'factor of safety' is very important in equipment design. It is defined as the ratio of the

A) ultimate stress to breaking stress

B) ultimate stress to working stress

C) working stress to ultimate stress

D) none of these.

167. Chemical foam extinguishers are applicable only for

A) solid fire B) liquid fire

C) gaseous fire D) all of these.

168. Factor of safety or overdesign factor in heat transfer equipment is about ..... per cent more than the actual theoretical design factor.

A) 15 - 20 B) 10 - 15

C) 5 - 10 D) 20 – 25.

169. Both liquid fire and gaseous fire can be extinguished by

A) water gas extinguishers B) mechanical foam extinguishers

C) carbon dioxide extinguishers D) all of these.

170. In water chemical treatment plant, use of chloramines ensures

A) disinfection B) taste and odour control

C) weed control in reservoirs D) removal of permanent hardness.

171. Which of the following is the most lethal water pollutant ?

A) Phenol and cyanide. B) Chlorine

C) Alkalis D) Suspended solids.

172. Freshwater carrying pipelines in chemical industries are coloured with ..... colour.

A) green B) brown

C) yellow D) red.

173. Which of the following processes is involved in the biochemical treatment of sewage effluents ?

A) Oxidation B) Reduction

C) Dehydration D) Hydrogenation.

174. Accidents in chemical plants are mostly due to

A) faulty operating procedures

B) improper layout of the equipment

C) failure of equipment

D) inadequate equipment design.

175. Which one of the following is not a main industrial heat source ?

A) Electricity B) Smoking

C) Chemical action D) None of these.

176. Which of the following is not a natural source of air pollution ?

A) Volcanic eruption and lightning discharges

B) Biological decay of vegetable matter

C) Photochemical oxidation of organic matter

D) None of these.

177. Radioactive solid nuclear wastes are disposed off by

A) high temperature incineration

B) pathological incineration

C) pyrolysis

D) underground burial in concrete containers.

178. Carbon monoxide is a pollutant, which causes

A) respiratory disease

B) asphyxiation leading to death

C) retardation in crop growth

D) damage to building materials.

179. Four major constituents of atmospheric air are

(I) N_2 (II) Ar (III) O_2 (IV) CO_2

Arrange them in ascending order of their % in air :

A) IV, II, III, I B) I, IV, II, III

C) III, IV, II, I D) I, III, IV, II.

180. The total capital investment for a chemical process plant comprises the fixed capital investment and the

A) coverhead cost

B) working capital

C) indirect production cost

D) direct production cost.

181. 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.

182. Match **List I** correctly with **List II** and select your answer using the codes given below :

List I		**List II**	
a)	Capitalized cost	1.	Comparing alternative investment choices
b)	Unamortized value	2.	Updating cost data of equipment
c)	Pay-out period	3.	Profitability evaluation
d)	Cost index	4.	Cost accounting
		5.	Replacement decisions
		6.	Working capital.

Codes :

	a	*b*	*c*	*d*
A)	3	6	1	2
B)	6	5	2	1
C)	4	1	5	6

D) none of these.

183. 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) $1000\left(1+\frac{0\cdot1}{4}\right)^{20}$ B) $1000\,(1+0\cdot10)^{20}$

C) $1000\left(1+\frac{0\cdot1}{4}\right)^{5}$ D) $1000\left(1+\frac{0\cdot1}{2}\right)^{5}$.

184. 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-year-digit method will be

A) $\frac{P-S}{n}$

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

C) $\frac{m}{n}(P-S)$

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

185. Match **List I** (Terminology used in plant economics) correctly with **List II** (Factor) and select your answer using the codes given below :

	List I		**List II**
a)	Lang factor for a chemical plant	1.	Ratio of gross annual sales to the fixed capital investment.
b)	Depreciation	2.	Ratio of capital investment to the delivered cost of major equipment.
c)	Break-even point	3.	It figures in the calculation of income tax liability on cash flows from an investment.
d)	Turnover ratio	4.	It is the point of intersection of total cost and sales revenue.

Codes :

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

186. Pick out the wrong statement :

A) Net worth means paid up share capital and reserve & surplus (i.e. share-holder's equity)

B) Return on equity = profit after tax/net worth

C) Working capital turnover ratio = sales/net working capital

D) Total cost of production is more than net sales realization (NSR) at break-even point.

187. Utilities cost in the operation of chemical process plant comes under the

A) plant overhead cost B) fixed charges

C) direct production cost D) general expenses.

188. 'Six tenth factor' rule is used for estimating the

A) equipment installation cost B) equipment cost by scaling

C) cost of piping D) utilities cost.

189. Direct costs component of the fixed capital consists of

A) contingency B) on-site and off-site costs

C) labour costs D) raw material costs.

190. A series of equal payments (e.g., deposit or cost) made at equal intervals of time is known as

A) perpetuity B) capital charge factor

C) annuity D) future worth.

191. Payback method for measurement of return on investment

A) gives a correct picture of profitability

B) underemphasizes liquidity

C) does not measure the discounted rate of return

D) takes into account the cash inflows after the recovery of investments.

192. A balance sheet for an industrial concern shows

A) the financial condition at any given time

B) only current assets

C) only fixed assets

D) current and fixed assets.

193. Chemical engineering plant cost index is used for finding the present cost of a particular chemical plant, if the cost of similar plant at some time in the past is known. The present cost of the plant =

$$\text{original cost} \times \left[\frac{\text{index value at present}}{\text{index value at the time of original cost was obtained}} \right]$$

The most major component of this cost index is

A) fabricated equipment and machinery

B) process instruments and control

C) pumps and compressor

D) electrical equipment and material.

194. Pick out the wrong statement :

A) Gross margin = Net income – Net expenditure

B) Net sales realization (NSR) = Gross sales – Selling expenses

C) At break-even point, NSR is more than the total production cost

D) Net profit = Gross margin – Depreciation – Interest.

195. Gantt chart or Bar chart is helpful in

A) efficient utilization of man power and machines

B) preparing production schedule

C) efficient despatching of products

D) inventory control.

196. Which of the following is not a principle of Pinch Technology ?

A) Do not use a hot utility below the pinch point

B) Do not use a cold utility above the pinch point

C) Avoid loops in the heat integration system

D) none of these.

197. If an amount R is paid at the end of every year for n years then the net present value of the annuity at an interest rate of i is

A) $R\left[\frac{(1+i)^n - 1}{i}\right]$

B) $R\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$

C) $R(1+i)^n$

D) $\frac{R}{(1+i)^n}$.

198. Optimum economic pipe diameter for fluid is determined by the

A) viscosity of the fluid

B) density of the fluid

C) total cost consideration (pumping cost plus fixed cost of the pipe)

D) none of these.

199. Operating profit of a chemical plant is equal to

A) profit before interest & tax

B) profit after tax plus depreciation

C) net profit + tax

D) profit after tax.

200. Which of the following is not related to the flow diagram in the chemical process industries ?

A) Qualitative flow diagram

B) Quantitative flow diagram

C) Combined detail flow diagram

D) None of these.

(SPACE FOR ROUGH WORK)

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