Graduate Aptitude Test in Engineering 2017

Question Paper Name: Chemical Engineering 12th Feb 2017
Subject Name: Chemical Engineering
Duration: 180
Total Marks: 100

Organizing Institute:

Indian Institute of Technology Roorkee

Question Number : 1 **Correct : 1 Wrong : 0**

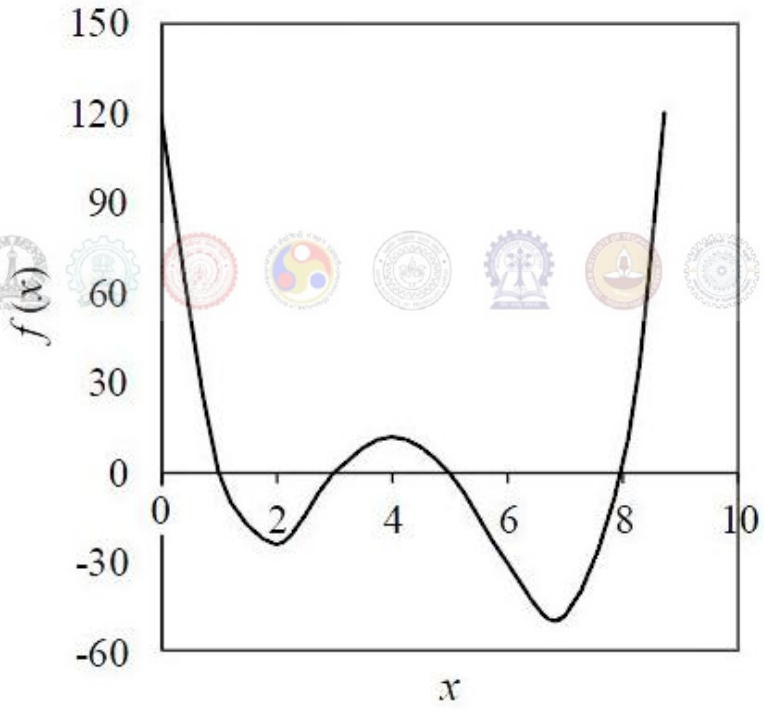
The value of $\lim_{x \to 0} \frac{\tan(x)}{x}$ is _____.

Question Number : 2 **Correct : 1 Wrong : 0**

The real part of $6e^{i\pi/3}$ is _____.

Question Number : 3 **Correct : 1 Wrong : 0**

The number of positive roots of the function $f(x)$ shown below in the range $0 < x < 6$ is ____.



Question Number : 4 **Correct : 1 Wrong : -0.33**

Let **i** and **j** be the unit vectors in the x and y directions, respectively. For the function

$$F(x, y) = x^3 + y^2$$

the gradient of the function, i.e., ∇F is given by

(A) $3x^2\mathbf{i} - 2y\mathbf{j}$

(B) $6x^2y$

(C) $3x^2\mathbf{i} + 2y\mathbf{j}$

(D) $2y\mathbf{i} - 3x^2\mathbf{j}$

Question Number : 5 **Correct : 1 Wrong : -0.33**

The marks obtained by a set of students are: 38, 84, 45, 70, 75, 60, 48.

The mean and median marks, respectively, are

(A) 45 and 75 (B) 55 and 48 (C) 60 and 60 (D) 60 and 70

Question Number : 6 **Correct : 1 Wrong : -0.33**

The volumetric properties of two gases M and N are described by the generalized compressibility chart which expresses the compressibility factor (Z) as a function of reduced pressure and reduced temperature only. The operating pressure (P) and temperature (T) of two gases M and N along with their critical properties (P_C, T_C) are given in the table below.

Gas	P (bar)	T (K)	P_C (bar)	T_C (K)
M	25	300	75	150
N	75	1000	225	500

Z_M and Z_N are the compressibility factor of the gases M and N under the given operating conditions, respectively.

The relation between Z_M and Z_N is

(A) $Z_M = 8Z_N$ (B) $Z_M = 3Z_N$ (C) $Z_M = Z_N$ (D) $Z_M = 0.333Z_N$

Question Number : 7 **Correct : 1 Wrong : -0.33**

Water is heated at atmospheric pressure from 40°C to 80°C using two different processes. In process I, the heating is done by a source at 80°C. In process II, the water is first heated from 40°C to 60°C by a source at 60°C, and then from 60°C to 80°C by another source at 80°C.

Identify the correct statement.

(A) Enthalpy change of water in process I is greater than enthalpy change in process II
(B) Enthalpy change of water in process II is greater than enthalpy change in process I
(C) Process I is closer to reversibility
(D) Process II is closer to reversibility

Question Number : 8 **Correct : 1 Wrong : -0.33**

In a venturi meter, ΔP_1 and ΔP_2 are the pressure drops corresponding to volumetric flowrates Q_1 and Q_2. If $Q_2/Q_1 = 2$, then $\Delta P_2/\Delta P_1$ equals

(A) 2 (B) 4 (C) 0.5 (D) 0.25

Question Number : 9 **Correct : 1 Wrong : -0.33**

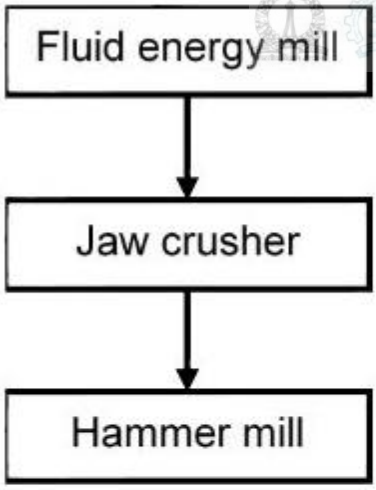
The thickness of laminar boundary layer over a flat plate varies along the distance from the leading edge of the plate. As the distance increases, the boundary layer thickness

(A) increases
(B) decreases
(C) initially increases and then decreases
(D) initially decreases and then increases

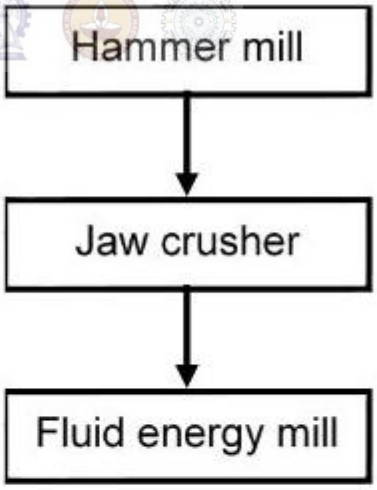
Question Number : 10 **Correct : 1 Wrong : -0.33**

Which of the following is the correct sequence of equipment for size reduction of solids?

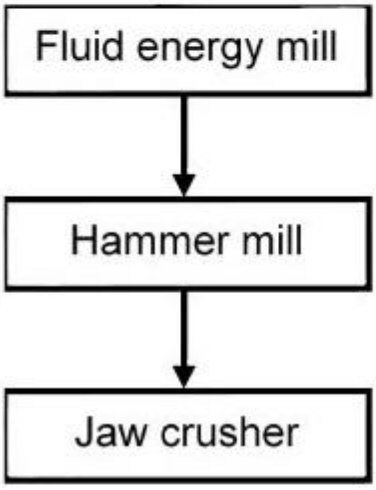
(A)



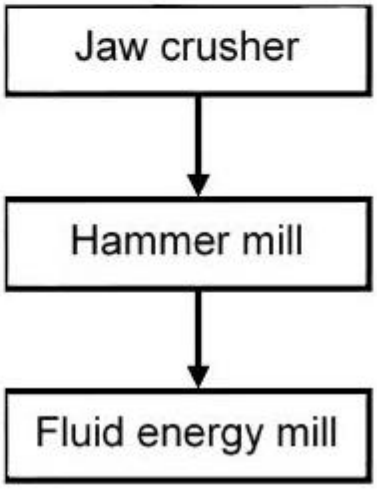
(B)



(C)



(D)



Question Number : 11 **Correct : 1 Wrong : 0**

A gas bubble (gas density $\rho_g = 2$ kg/m^3; bubble diameter $D = 10^{-4}$ m) is rising vertically through water (density $\rho = 1000$ kg/m^3; viscosity $\mu = 0.001$ Pa.s). Force balance on the bubble leads to the following equation,

$$\frac{dv}{dt} = -g\frac{\rho_g - \rho}{\rho_g} - \frac{18\mu}{\rho_g D^2}v$$

where v is the velocity of the bubble at any given time t. Assume that the volume of the rising bubble does not change. The value of $g = 9.81$ m/s^2.

The terminal rising velocity of the bubble (in cm/s), rounded to 2 decimal places, is _____ cm/s.

Question Number : 12 **Correct : 1 Wrong : -0.33**

The one-dimensional unsteady heat conduction equation is

$$\rho C_p \frac{\partial T}{\partial t} = \frac{1}{r^n}\frac{\partial}{\partial r}\left(r^n k \frac{\partial T}{\partial r}\right)$$

where T – temperature, t – time, r – radial position, k – thermal conductivity, ρ – density, and C_p – specific heat.

For the cylindrical coordinate system, the value of n in the above equation is

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

Question Number : 13 **Correct : 1 Wrong : 0**

In a heat exchanger, the inner diameter of a tube is 25 mm and its outer diameter is 30 mm. The overall heat transfer coefficient based on the inner area is 360 W/m^2.°C. Then, the overall heat transfer coefficient based on the outer area, rounded to the nearest integer, is _____ W/m^2.°C.

Question Number : 14 **Correct : 1 Wrong : -0.33**

Which of the following conditions are valid at the plait point?

P) Density difference between the extract and raffinate phases is zero

Q) Interfacial tension between the extract and raffinate phases is zero

R) Composition difference between the extract and raffinate phases is zero

(A) P and Q only (B) Q and R only (C) P and R only (D) P, Q and R

Question Number : 15 **Correct : 1 Wrong : 0**

The composition of vapour entering a tray in a distillation column is 0.47. The average composition of the vapour leaving the tray is 0.53. The equilibrium composition of the vapour corresponding to the liquid leaving this tray is 0.52. All the compositions are expressed in mole fraction of the more volatile component.

The Murphree efficiency based on the vapour phase, rounded to the nearest integer, is _____ %.

Question Number : 16 **Correct : 1 Wrong : -0.33**

Consider steady state mass transfer of a solute A from a gas phase to a liquid phase. The gas phase bulk and interface mole fractions are $y_{A,G}$ and $y_{A,i}$, respectively. The liquid phase bulk and interface mole fractions are $x_{A,L}$ and $x_{A,i}$, respectively. The ratio $\frac{(x_{A,i} - x_{A,L})}{(y_{A,G} - y_{A,i})}$ is very close to zero.

This implies that mass transfer resistance is

(A) negligible in the gas phase only

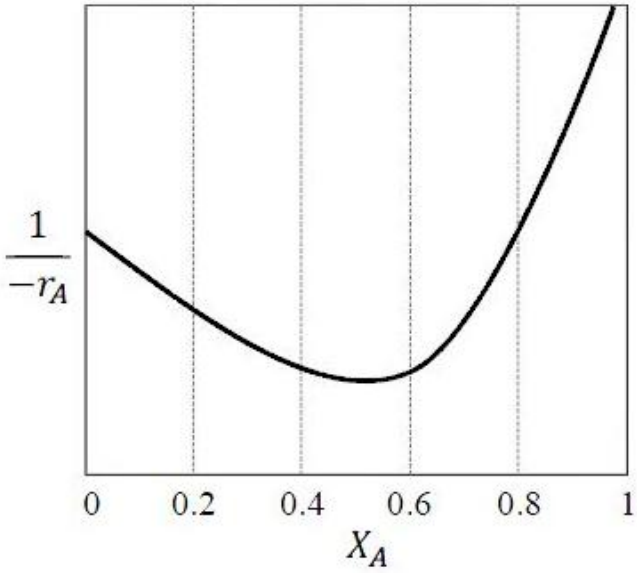
(B) negligible in the liquid phase only

(C) negligible in both the phases

(D) considerable in both the phases

Question Number : 17 Correct : 1 Wrong : -0.33

The following reaction rate curve is shown for a reaction A → P. Here, $(-r_A)$ and X_A represent reaction rate and conversion, respectively. The feed is pure A and 90% conversion is desired.



Which amongst the following reactor configurations gives the lowest total volume of the reactor(s)?

(A) CSTR followed by PFR
(B) Two CSTRs in series
(C) PFR followed by CSTR
(D) A single PFR

Question Number : 18 Correct : 1 Wrong : -0.33

Consider a first order catalytic reaction in a porous catalyst pellet.
Given R – characteristic length of the pellet; $\mathcal{D}_e$ – effective diffusivity; k_C – mass transfer coefficient; k_1 – rate constant based on volume of the catalyst pellet; C_s – concentration of reactant on the pellet surface.

The expression for Thiele modulus is

(A) $\dfrac{k_C R}{\mathcal{D}_e}$

(B) $R\sqrt{\dfrac{k_1}{\mathcal{D}_e}}$

(C) $R\sqrt{\dfrac{k_1 C_s}{\mathcal{D}_e}}$

(D) $R\sqrt{\dfrac{\mathcal{D}_e}{k_1}}$

Question Number : 19 **Correct : 1 Wrong : -0.33**

For a solid-catalyzed gas phase reversible reaction, which of the following statements is ALWAYS TRUE?

(A) Adsorption is rate-limiting
(B) Desorption is rate-limiting
(C) Solid catalyst does not affect equilibrium conversion
(D) Temperature does not affect equilibrium conversion

Question Number : 20 **Correct : 1 Wrong : -0.33**

Match the variables in Group-1 with the instruments in Group-2.

Group-1	Group-2
P) Temperature	I) Capacitance probe
Q) Liquid level	II) McLeod gauge
R) Vacuum	III) Chromatograph
S) Concentration	IV) Thermistor

Choose the correct set of combinations.

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

Question Number : 21 **Correct : 1 Wrong : -0.33**

An LVDT (Linear Variable Differential Transformer) is a transducer used for converting

(A) displacement to voltage
(B) voltage to displacement
(C) resistance to voltage
(D) voltage to current

Question Number : 22 **Correct : 1 Wrong : 0**

The cost of a new pump (including installation) is 24,000 Rupees. The pump has a useful life of 10 years. Its salvage value is 4000 Rupees. Assuming straight line depreciation, the book value of the pump at the end of 4^{th} year, rounded to the nearest integer, is _____ Rupees.

Question Number : 23 **Correct : 1 Wrong : -0.33**

The DCDA (Double Contact Double Absorption) process is used for the manufacture of

(A) urea (B) sulphuric acid (C) nitric acid (D) ammonia

Question Number : 24 **Correct : 1 Wrong : -0.33**

Match the polymerization processes in Group-1 with the polymers in Group-2.

Group-1	Group-2
P) Free radical polymerization	I) Nylon 6,6
Q) Ziegler Natta polymerization	II) Polypropylene
R) Condensation polymerization	III) Poly vinyl chloride

Choose the correct set of combinations.

(A) P-I, Q-II, R-III (B) P-III, Q-II, R-I (C) P-I, Q-III, R-II (D) P-II, Q-I, R-III

Question Number : 25 **Correct : 1 Wrong : -0.33**

The purpose of methanation reaction used in ammonia plants is to

(A) remove CO as it is a catalyst poison
(B) increase the amount of hydrogen
(C) remove sulphur as it is a catalyst poison
(D) utilize methane as a catalyst for ammonia synthesis

Question Number : 26 **Correct : 2 Wrong : 0**

For the initial value problem

$$\frac{dx}{dt} = \sin(t), \qquad x(0) = 0$$

the value of x at $t = \pi/3$, is _____.

Question Number : 27 **Correct : 2 Wrong : -0.66**

The Laplace transform of a function is $\frac{s+1}{s(s+2)}$

The initial and final values, respectively, of the function are

(A) 0 and 1

(B) 1 and $\frac{1}{2}$

(C) $\frac{1}{2}$ and 1

(D) $\frac{1}{2}$ and 0

Question Number : 28 **Correct : 2 Wrong : -0.66**

Match the problem type in Group-1 with the numerical method in Group-2.

Group-1	Group-2
P) System of linear algebraic equations	I) Newton-Raphson
Q) Non-linear algebraic equations	II) Gauss-Seidel
R) Ordinary differential equations	III) Simpson's rule
S) Numerical integration	IV) Runge-Kutta

Choose the correct set of combinations.

(A) P-II, Q-I, R-III, S-IV

(B) P-I, Q-II, R-IV, S-III

(C) P-IV, Q-III, R-II, S-I

(D) P-II, Q-I, R-IV, S-III

Question Number : 29 **Correct : 2 Wrong : 0**

A box has 6 red balls and 4 white balls. A ball is picked at random and replaced in the box, after which a second ball is picked.

The probability of both the balls being red, rounded to 2 decimal places, is _____.

Question Number : 30 Correct : 2 Wrong : 0

An aqueous salt-solution enters a crystallizer operating at steady state at 25°C. The feed temperature is 90°C and the salt concentration in the feed is 40 weight %. The salt crystallizes as a pentahydrate. The crystals and the mother liquor leave the crystallizer. The molecular weight of the anhydrous salt is 135. The solubility of the salt at 25°C is 20 weight %.

The feed flowrate required for a production rate of 100 kg/s of the hydrated salt, rounded to the nearest integer, is _____ kg/s.

Question Number : 31 Correct : 2 Wrong : 0

Reaction A → B is carried out in a reactor operating at steady state and 1 mol/s of pure A at 425°C enters the reactor. The outlet stream leaves the reactor at 325°C. The heat input to the reactor is 17 kW. The heat of reaction at the reference temperature of 25°C is 30 kJ/mol. The specific heat capacities (in kJ/mol.K) of A and B are 0.1 and 0.15, respectively.

The molar flowrate of B leaving the reactor, rounded to 2 decimal places, is _____ mol/s.

Question Number : 32 Correct : 2 Wrong : 0

The pressure of a liquid is increased isothermally. The molar volume of the liquid decreases from 50.45×10^{-6} m^3/mol to 48×10^{-6} m^3/mol during this process. The isothermal compressibility of the liquid is 10^{-9} Pa^{-1}, which can be assumed to be independent of pressure.

The change in the molar Gibbs free energy of the liquid, rounded to nearest integer, is _____ J/mol.

Question Number : 33 Correct : 2 Wrong : 0

A sparingly soluble gas (solute) is in equilibrium with a solvent at 10 bar. The mole fraction of the solvent in the gas phase is 0.01. At the operating temperature and pressure, the fugacity coefficient of the solute in the gas phase and the Henry's law constant are 0.92 and 1000 bar, respectively. Assume that the liquid phase obeys Henry's law.

The MOLE PERCENTAGE of the solute in the liquid phase, rounded to 2 decimal places, is _____.

Question Number : 34 Correct : 2 Wrong : 0

The vapour pressure of a pure substance at a temperature T is 30 bar. The actual and ideal gas values of g/RT for the saturated vapour at this temperature T and 30 bar are 7.0 and 7.7, respectively. Here, g is the molar Gibbs free energy and R is the universal gas constant.

The fugacity of the saturated liquid at these conditions, rounded to 1 decimal place, is _____ bar.

Question Number : 35 Correct : 2 Wrong : 0

Oil is being delivered at a steady flowrate through a circular pipe of radius 1.25×10^{-2} m and length 10 m. The pressure drop across the pipe is 500 Pa.

The shear stress at the pipe wall, rounded to 2 decimal places, is _____ Pa.

Question Number : 36 Correct : 2 Wrong : -0.66

The following table provides four sets of Fanning friction factor data, for different values of Reynolds number (Re) and roughness factor $\left(\frac{k}{D}\right)$.

	Re	10^2	10^3	10^5	10^5
	$\left(\frac{k}{D}\right)$	0	0.001	0	0.001
Set I	f	0.16	0.016	16×10^{-5}	16×10^{-5}
Set II	f	0.016	0.16	0.0055	0.0045
Set III	f	0.16	0.016	0.0045	0.0055
Set IV	f	0.0045	0.0055	0.016	0.16

Which of the above sets of friction factor data is correct?

(A) Set I (B) Set II (C) Set III (D) Set IV

Question Number : 37 Correct : 2 Wrong : 0

A propeller (diameter $D = 15$ m) rotates at $N = 1$ revolution per second (rps). To understand the flow around the propeller, a lab-scale model is made. Important parameters to study the flow are velocity of the propeller tip ($V = \pi ND$), diameter D and acceleration due to gravity (g). The lab-scale model is $1/100^{th}$ of the size of the actual propeller.

The rotation speed of the lab-scale model, to the nearest integer, should be _____ rps.

Question Number : 38 Correct : 2 Wrong : 0

Size analysis was carried out on a sample of gravel. The data for mass fraction (x_i) and average particle diameter (D_{pi}) of the fraction is given in the table below:

x_i	D_{pi} (mm)
0.2	5
0.4	10
0.4	20

The mass mean diameter of the sample, to the nearest integer, is _____ mm.

Question Number : 39 Correct : 2 Wrong : -0.66

Let $I_{b\lambda}$ be the spectral blackbody radiation intensity per unit wavelength about the wavelength λ.

The blackbody radiation intensity emitted by a blackbody over all wavelengths is

(A) $\frac{dI_{b\lambda}}{d\lambda}$

(B) $\frac{d^2 I_{b\lambda}}{d\lambda^2}$

(C) $\int_0^\infty I_{b\lambda} d\lambda$

(D) $\int_0^\infty \lambda I_{b\lambda} d\lambda$

Question Number : 40 Correct : 2 Wrong : -0.66

A fluid flows over a heated horizontal plate maintained at temperature T_w. The bulk temperature of the fluid is T_∞. The temperature profile in the thermal boundary layer is given by:

$$T = T_w + (T_w - T_\infty)\left[\frac{1}{2}\left(\frac{y}{\delta_t}\right)^3 - \frac{3}{2}\left(\frac{y}{\delta_t}\right)\right], \qquad 0 \le y \le \delta_t$$

Here, y is the vertical distance from the plate, δ_t is the thickness of the thermal boundary layer and k is the thermal conductivity of the fluid.

The local heat transfer coefficient is given by

(A) $\frac{k}{2\delta_t}$ (B) $\frac{k}{\delta_t}$ (C) $\frac{3}{2}\frac{k}{\delta_t}$ (D) $2\frac{k}{\delta_t}$

Question Number : 41 Correct : 2 Wrong : -0.66

In nucleate boiling, the pressure inside a bubble is higher than the pressure of the surrounding liquid. Assuming that both the liquid and vapour are saturated, the temperature of the liquid will ALWAYS be

(A) at 100 °C
(B) lower than the temperature of the vapour
(C) equal to the temperature of the vapour
(D) higher than the temperature of the vapour

Question Number : 42 Correct : 2 Wrong : 0

The vapor phase composition and relative volatilities (with respect to n-propane) on an ideal tray of a distillation column are

Component	Methane	Ethane	n-Propane
Mole fraction in vapour	0.12	0.28	0.60
Relative volatility	10	4	1

The mole fraction of n-propane in the liquid phase, rounded to 2 decimal places, is _____.

Question Number : 43 Correct : 2 Wrong : -0.66

The Sherwood number (Sh_L) correlation for laminar flow over a flat plate of length L is given by

$$Sh_L = 0.664\, Re_L^{0.5}\, Sc^{1/3}$$

where Re_L and Sc represent Reynolds number and Schmidt number, respectively.

This correlation, expressed in the form of Chilton-Colburn j_D factor, is

(A) $j_D = 0.664$

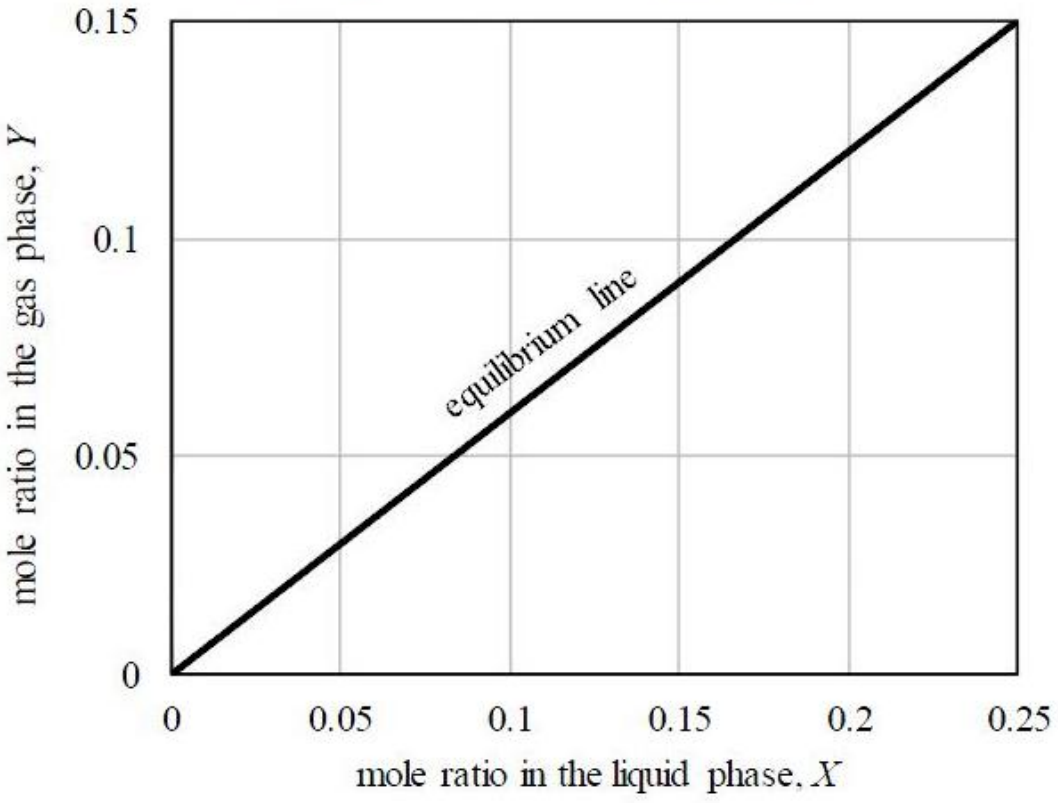
(B) $j_D = 0.664\, Re_L^{-0.5}$

(C) $j_D = 0.664\, Re_L$

(D) $j_D = 0.664\, Re_L^{0.5} Sc^{2/3}$

Question Number : 44 Correct : 2 Wrong : 0

In a countercurrent stripping operation using pure steam, the mole ratio of a solute in the liquid stream is reduced from 0.25 to 0.05. The liquid feed flowrate, on a solute-free basis, is 3 mol/s. The equilibrium line for the system is given in the figure below.



The MINIMUM flowrate of pure steam for this process, rounded to 1 decimal place, is _____ mol/s.

Question Number : 45 **Correct : 2 Wrong : 0**

In a batch adsorption process, 5 g of fresh adsorbent is used to treat 1 liter of an aqueous phenol solution. The initial phenol concentration is 100 mg/liter. The equilibrium relation is given by

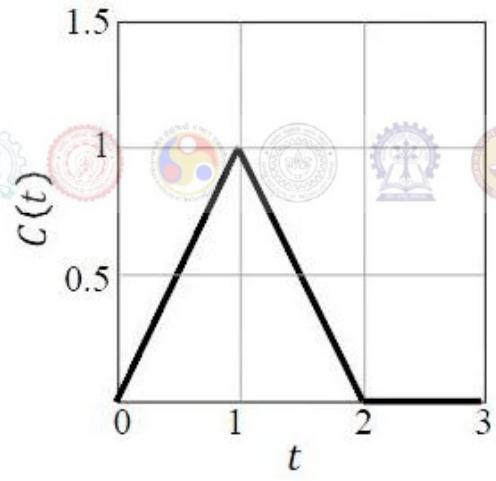
$$q^* = 1.3C$$

where q^* is the amount of phenol adsorbed in mg of phenol per gram of adsorbent; and C is the concentration of phenol in mg/liter in the aqueous solution.

When equilibrium is attained between the adsorbent and the solution, the concentration of phenol in the solution, rounded to 1 decimal place, is _____ mg/liter.

Question Number : 46 **Correct : 2 Wrong : 0**

The C-curve measured during a pulse tracer experiment is shown below. In the figure, $C(t)$ is the concentration of the tracer measured at the reactor exit in mol/liter at time t seconds.



The mean residence time in the reactor, rounded to 1 decimal place, is _____ s.

Question Number : 47 **Correct : 2 Wrong : 0**

The following liquid phase second-order reaction is carried out in an isothermal CSTR at steady state

$$A \rightarrow R \qquad (-r_A) = 0.005C_A^2 \text{ mol/m}^3.\text{hr}$$

where C_A is the concentration of the reactant in the CSTR. The reactor volume is 2 m^3, the inlet flowrate is 0.5 m^3/hr and the inlet concentration of the reactant is 1000 mol/m^3.

The fractional conversion, rounded to 2 decimal places, is _____ .

Question Number : 48 **Correct : 2 Wrong : 0**

The reversible reaction of t-butyl alcohol (TBA) and ethanol (EtOH) to ethyl t-butyl ether (ETBE) is

$$\text{TBA} + \text{EtOH} \rightleftharpoons \text{ETBE} + \text{Water}$$

The equilibrium constant for this reaction is $K_C = 1$. Initially, 74 g of TBA is mixed with 100 g of aqueous solution containing 46 weight% ethanol. The molecular weights are: 74 g/mol for TBA, 46 g/mol for EtOH, 102 g/mol for ETBE, and 18 g/mol for water.

The mass of ETBE at equilibrium, rounded to 1 decimal place, is _____ g.

Question Number : 49 **Correct : 2 Wrong : 0**

The following gas-phase reaction is carried out in a constant-volume isothermal batch reactor

$$\text{A} + \text{B} \rightarrow \text{R} + \text{S}$$

The reactants A and B as well as the product S are non-condensable gases. At the operating temperature, the saturation pressure of the product R is 40 kPa.

Initially, the batch reactor contains equimolar amounts of A and B (and no products) at a total pressure of 100 kPa. The initial concentrations of the reactants are $C_{A,0} = C_{B,0} = 12.5$ mol/m^3. The rate of reaction is given by $(-r_A) = 0.08\, C_A C_B$ mol/m^3.s.

The time at which R just starts condensing, rounded to 1 decimal place, is _____ s.

Question Number : 50 **Correct : 2 Wrong : 0**

The transfer function of a system is

$$\frac{1}{4s^2 + 1.2s + 1}$$

For a unit step increase in the input, the fractional overshoot, rounded to 2 decimal places, is _____.

Question Number : 51 **Correct : 2 Wrong : 0**

The open loop transfer function of a process with a proportional controller (gain K_C) is

$$G_{OL} = K_C \frac{e^{-2s}}{s}$$

Based on the Bode criterion for closed-loop stability, the ultimate gain of the controller, rounded to 2 decimal places, is _____.

Question Number : 52 **Correct : 2 Wrong : 0**

The characteristic equation of a closed-loop system is

$$6s^3 + 11s^2 + 6s + (1 + K) = 0, \quad \text{where } K > 0$$

The value of K beyond which the system just becomes unstable, rounded to the nearest integer, is _____.

Question Number : 53 **Correct : 2 Wrong : 0**

A bond has a maturity value of 20,000 Rupees at the end of 4 years. The interest is compounded at the rate of 5% per year.

The initial investment to be made, rounded to the nearest integer, is _____ Rupees.

Question Number : 54 **Correct : 2 Wrong : 0**

The total cost (C_T) of an equipment in terms of the operating variables x and y is

$$C_T = 2x + \frac{12000}{xy} + y + 5$$

The optimal value of C_T, rounded to 1 decimal place, is _____.

Question Number : 55 **Correct : 2 Wrong : -0.66**

Match the equipment in Group-1 with the process in Group-2

Group-1	Group-2
P) Fluidized bed	I) Paper-making
Q) Multistage adiabatic reactor with inter-stage cooling	II) Sodium hydroxide manufacture
R) Fourdrinier machine	III) SO_2 oxidation
S) Diaphragm cell	IV) Catalytic cracking

Choose the correct set of combinations.

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

Question Number : 56 **Correct : 1 Wrong : -0.33**

The bacteria in milk are destroyed when it _____ heated to 80 degree Celsius.

(A) would be (B) will be (C) is (D) was

Question Number : 57 **Correct : 1 Wrong : -0.33**

_____ with someone else's email account is now a very serious offence.

(A) Involving (B) Assisting (C) Tampering (D) Incubating

Question Number : 58 **Correct : 1 Wrong : -0.33**

Consider the following sentences:

All benches are beds. No bed is a bulb. Some bulbs are lamps.

Which of the following can be inferred?

i. Some beds are lamps.
ii. Some lamps are beds.

(A) Only i
(B) Only ii
(C) Both i and ii
(D) Neither i nor ii

Question Number : 59 **Correct : 1 Wrong : -0.33**

If the radius of a right circular cone is increased by 50%, its volume increases by

(A) 75% (B) 100% (C) 125% (D) 237.5%

Question Number : 60 **Correct : 1 Wrong : -0.33**

The following sequence of numbers is arranged in increasing order: $1, x, x, x, y, y, 9, 16, 18$. Given that the mean and median are equal, and are also equal to twice the mode, the value of y is

(A) 5 (B) 6 (C) 7 (D) 8

Question Number : 61 Correct : 2 Wrong : -0.66

The old concert hall was demolished because of fears that the foundation would be affected by the construction of the new metro line in the area. Modern technology for underground metro construction tried to mitigate the impact of pressurized air pockets created by the excavation of large amounts of soil. But even with these safeguards, it was feared that the soil below the concert hall would not be stable.

From this, one can infer that

(A) the foundations of old buildings create pressurized air pockets underground, which are difficult to handle during metro construction.
(B) metro construction has to be done carefully considering its impact on the foundations of existing buildings.
(C) old buildings in an area form an impossible hurdle to metro construction in that area.
(D) pressurized air can be used to excavate large amounts of soil from underground areas.

Question Number : 62 Correct : 2 Wrong : -0.66

Students applying for hostel rooms are allotted rooms in order of seniority. Students already staying in a room will move if they get a room in their preferred list. Preferences of lower ranked applicants are ignored during allocation.

Given the data below, which room will Ajit stay in?

Names	Student seniority	Current room	Room preference list
Amar	1	P	R, S, Q
Akbar	2	None	R, S
Anthony	3	Q	P
Ajit	4	S	Q, P, R

(A) P (B) Q (C) R (D) S

Question Number : 63 Correct : 2 Wrong : -0.66

The last digit of $(2171)^7 + (2172)^9 + (2173)^{11} + (2174)^{13}$ is

(A) 2 (B) 4 (C) 6 (D) 8

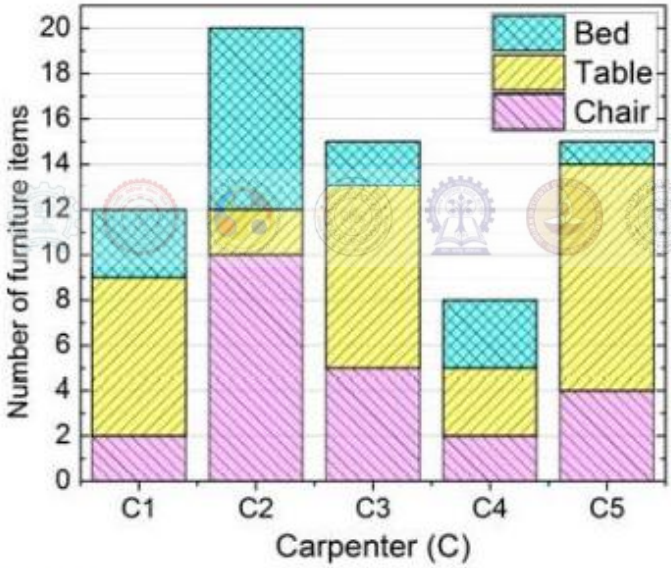
Question Number : 64 Correct : 2 Wrong : -0.66

Two machines M1 and M2 are able to execute any of four jobs P, Q, R and S. The machines can perform one job on one object at a time. Jobs P, Q, R and S take 30 minutes, 20 minutes, 60 minutes and 15 minutes each respectively. There are 10 objects each requiring exactly 1 job. Job P is to be performed on 2 objects, Job Q on 3 objects, Job R on 1 object and Job S on 4 objects. What is the minimum time needed to complete all the jobs?

(A) 2 hours (B) 2.5 hours (C) 3 hours (D) 3.5 hours

Question Number : 65 Correct : 2 Wrong : -0.66

The bar graph below shows the output of five carpenters over one month, each of whom made different items of furniture: chairs, tables, and beds.



Consider the following statements.

i. The number of beds made by carpenter C2 is exactly the same as the number of tables made by carpenter C3.

ii. The total number of chairs made by all carpenters is less than the total number of tables.

Which one of the following is true?

(A) Only i (B) Only ii (C) Both i and ii (D) Neither i nor ii

Q. 1 – Q. 5 carry one mark each.

Q.1 "When she fell down the _____, she received many _____ but little help."

The words that best fill the blanks in the above sentence are

(A) stairs, stares
(B) stairs, stairs
(C) stares, stairs
(D) stares, stares

Q.2 "In spite of being warned repeatedly, he failed to correct his _____ behaviour."

The word that best fills the blank in the above sentence is

(A) rational (B) reasonable (C) errant (D) good

Q.3 For $0 \leq x \leq 2\pi$, $\sin x$ and $\cos x$ are both decreasing functions in the interval _____.

(A) $\left(0, \frac{\pi}{2}\right)$ (B) $\left(\frac{\pi}{2}, \pi\right)$ (C) $\left(\pi, \frac{3\pi}{2}\right)$ (D) $\left(\frac{3\pi}{2}, 2\pi\right)$

Q.4 The area of an equilateral triangle is $\sqrt{3}$. What is the perimeter of the triangle?

(A) 2 (B) 4 (C) 6 (D) 8

Q.5 Arrange the following three-dimensional objects in the descending order of their volumes:

(i) A cuboid with dimensions 10 cm, 8 cm and 6 cm
(ii) A cube of side 8 cm
(iii) A cylinder with base radius 7 cm and height 7 cm
(iv) A sphere of radius 7 cm

(A) (i), (ii), (iii), (iv)
(B) (ii), (i), (iv), (iii)
(C) (iii), (ii), (i), (iv)
(D) (iv), (iii), (ii), (i)

Q. 6 – Q. 10 carry two marks each.

Q.6 An automobile travels from city A to city B and returns to city A by the same route. The speed of the vehicle during the onward and return journeys were constant at 60 km/h and 90 km/h, respectively. What is the average speed in km/h for the entire journey?

(A) 72 (B) 73 (C) 74 (D) 75

Q.7 A set of 4 parallel lines intersect with another set of 5 parallel lines. How many parallelograms are formed?

(A) 20 (B) 48 (C) 60 (D) 72

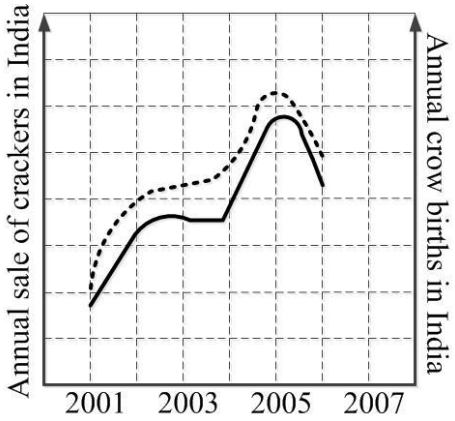
Q.8 To pass a test, a candidate needs to answer at least 2 out of 3 questions correctly. A total of 6,30,000 candidates appeared for the test. Question A was correctly answered by 3,30,000 candidates. Question B was answered correctly by 2,50,000 candidates. Question C was answered correctly by 2,60,000 candidates. Both questions A and B were answered correctly by 1,00,000 candidates. Both questions B and C were answered correctly by 90,000 candidates. Both questions A and C were answered correctly by 80,000 candidates. If the number of students answering all questions correctly is the same as the number answering none, how many candidates failed to clear the test?

(A) 30,000 (B) 2,70,000 (C) 3,90,000 (D) 4,20,000

Q.9 If $x^2 + x - 1 = 0$ what is the value of $x^4 + \frac{1}{x^4}$?

(A) 1 (B) 5 (C) 7 (D) 9

Q.10 In a detailed study of annual crow births in India, it was found that there was relatively no growth during the period 2002 to 2004 and a sudden spike from 2004 to 2005. In another unrelated study, it was found that the revenue from cracker sales in India which remained fairly flat from 2002 to 2004, saw a sudden spike in 2005 before declining again in 2006. The solid line in the graph below refers to annual sale of crackers and the dashed line refers to the annual crow births in India. Choose the most appropriate inference from the above data.

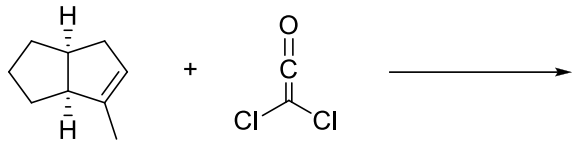


(A) There is a strong correlation between crow birth and cracker sales.
(B) Cracker usage increases crow birth rate.
(C) If cracker sale declines, crow birth will decline.
(D) Increased birth rate of crows will cause an increase in the sale of crackers.

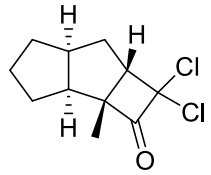
END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

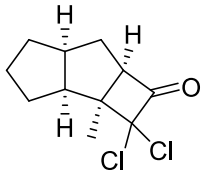
Q.1 The major product formed in the following reaction is



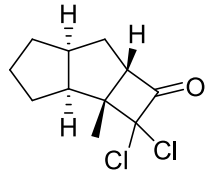
(A)



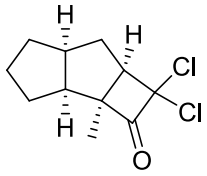
(B)



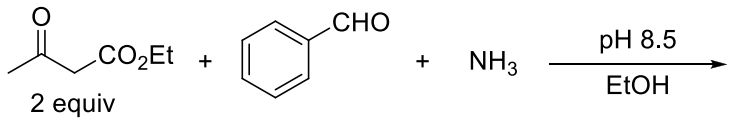
(C)



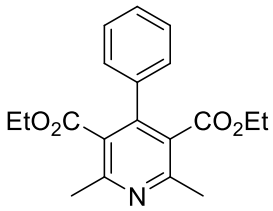
(D)



Q.2 The major product formed in the following reaction is



(A)



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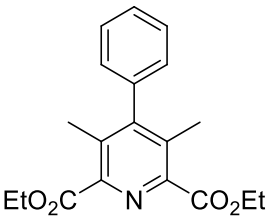
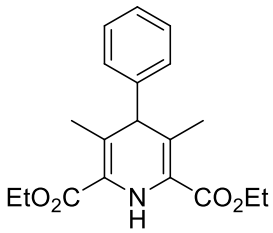


(C)



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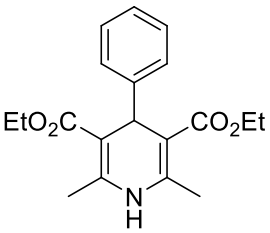
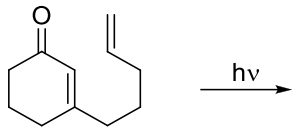
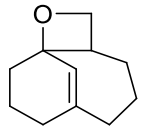


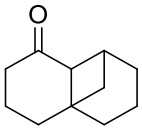
Q.3 The major product of the following intramolecular cycloaddition reaction is



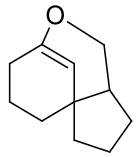
(A)



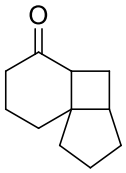
(B)



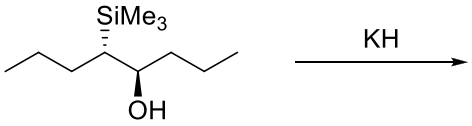
(C)



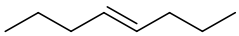
(D)



Q.4 The major product of the following reaction is



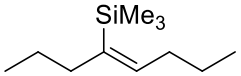
(A)



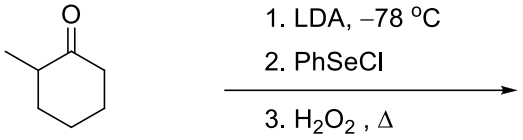
(B)

(C)

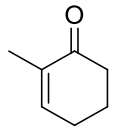
(D)



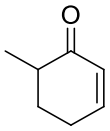
Q.5 The major product formed in the following reaction sequence is



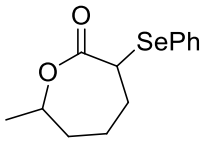
(A)



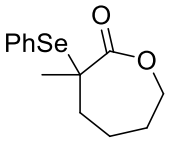
(B)



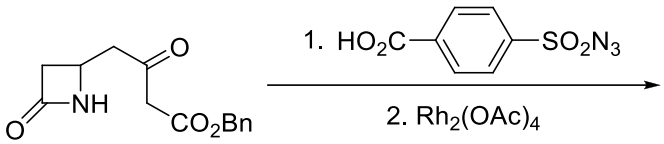
(C)



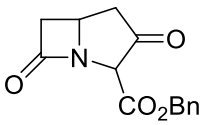
(D)



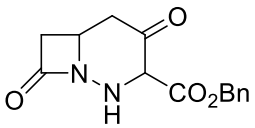
Q.6 The major product formed in the following reaction sequence is



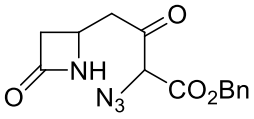
(A)



(B)



(C)



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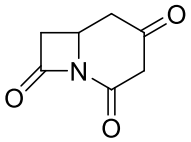


Q.7 The spherical harmonic function, $Y_{l,m}(\theta,\phi)$, with appropriate values of *l* and *m*, is an eigenfunction of $\hat{L}_x^{\,2} + \hat{L}_y^{\,2}$ operator. The corresponding eigenvalue is

(A) $\left(l\left(l+1\right)-m^2\right)\hbar^2$ (B) $\left(l\left(l+1\right)+m^2\right)\hbar^2$

(C) $l\left(l+1\right)\hbar^2$ (D) $m^2\hbar^2$

Q.8 Consider the operators, $\hat{a}_+ = \frac{1}{\sqrt{2}}\left(\hat{x} + i\hat{p}_x\right)$ and $\hat{a}_- = \frac{1}{\sqrt{2}}\left(\hat{x} - i\hat{p}_x\right)$, where $\hat{x}$ and $\hat{p}_x$ are the position and linear momentum operators, respectively. The commutator, $[\hat{a}_+, \hat{a}_-]$ is equal to

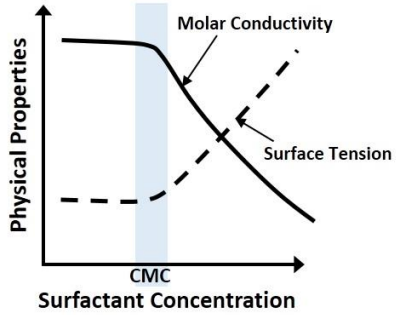
(A) $i\hbar$ (B) $-i\hbar$
(C) $\hbar$ (D) $-\hbar$

Q.9 The temperature derivative of electrochemical cell potential E at constant pressure, $\left(\frac{\partial E}{\partial T}\right)_P$, is given by

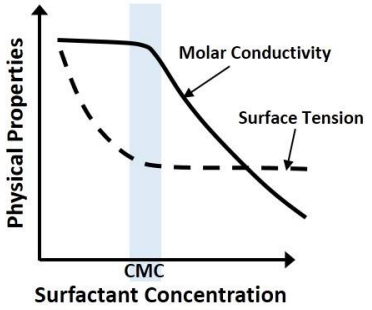
(A) $-\frac{\Delta S}{nF}$ (B) $\frac{\Delta S}{nF}$
(C) $\frac{\Delta S}{nFT}$ (D) $-\frac{\Delta S}{nFT}$

Q.10 For an ionic micelle-forming surfactant near its critical micelle concentration (CMC), the dependence of molar conductivity and surface tension on surfactant concentration is best represented by

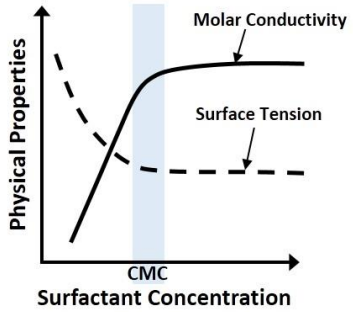
(A)



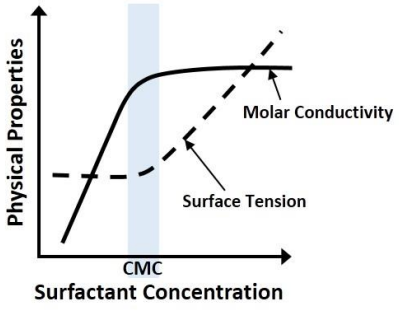
(B)



(C)



(D)



Q.11 According to Eyring transition state theory for a bimolecular reaction, the activated complex has

(A) no vibrational degrees of freedom.
(B) vibrational degrees of freedom but they never participate in product formation.
(C) one high frequency vibration that leads to product formation.
(D) one low frequency vibration that leads to product formation.

Q.12 Based on Wade's rule, the structure-type of $[B_5H_8]^-$ is

(A) *closo* (B) *nido* (C) *arachno* (D) *hypho*

Q.13 The coordination geometries around the copper ion of plastocyanin (a blue-copper protein) in oxidized and reduced form, respectively, are

(A) tetrahedral and square-planar
(B) square-planar and tetrahedral
(C) distorted tetrahedral for both
(D) ideal tetrahedral for both

Q.14 The water exchange rates for the complex ions follow the order

(A) $[V(H_2O)_6]^{2+} > [Co(H_2O)_6]^{2+} > [Cr(H_2O)_6]^{3+}$
(B) $[Cr(H_2O)_6]^{3+} > [Co(H_2O)_6]^{2+} > [V(H_2O)_6]^{2+}$
(C) $[Co(H_2O)_6]^{2+} > [Cr(H_2O)_6]^{3+} > [V(H_2O)_6]^{2+}$
(D) $[Co(H_2O)_6]^{2+} > [V(H_2O)_6]^{2+} > [Cr(H_2O)_6]^{3+}$

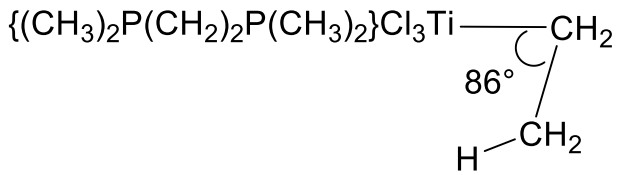
Q.15 The lowest energy $d \rightarrow d$ transition of the complexes follow the order

(A) $[Cr(H_2O)_6]^{3+} < [Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-}$
(B) $[Cr(CN)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(H_2O)_6]^{3+}$
(C) $[Cr(CN)_6]^{3-} < [Cr(H_2O)_6]^{3+} < [Cr(NH_3)_6]^{3+}$
(D) $[Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-} < [Cr(H_2O)_6]^{3+}$

Q.16 The symmetry label of valence *p* orbitals of a metal ion in an octahedral ligand field is

(A) t_{1g} (B) t_{1u} (C) $e_g + a_{1g}$ (D) t_{2g}

Q.17 The bond angle (Ti–C–C) in the crystal structure of



is severely distorted due to

(A) hydrogen-bonding interaction
(B) agostic interaction
(C) steric bulk of the phosphine ligand
(D) higher formal charge on metal

Q.18 The molar heat capacity of a substance is represented in the temperature range 298 K to 400 K by the empirical relation $C_{p,m} = 14 + bT$ J K^{-1} mol^{-1}, where *b* is a constant. The molar enthalpy change when the substance is heated from 300 K to 350 K is 2 kJ mol^{-1}. The value of *b* is_____ J K^{-2} mol^{-1}. (Up to two decimal places)

Q.19 For low partial pressure of ozone (O_3), the adsorption of ozone on graphite surface is fully dissociative in nature, and follows Langmuir isotherm. Under these conditions, if the dependence of the surface coverage of graphite (θ) on partial pressure of ozone $\left(P_{O_3}\right)$ is given by $\theta \propto \left(P_{O_3}\right)^x$, the value of x is_____. (Up to two decimal places)

Q.20 For the radioactive isotope ^{131}I, the time required for 50% disintegration is 8 days. The time required for the 99.9% disintegration of 5.5 g of ^{131}I is _____ days. (Up to one decimal place)

Q.21 Two moles of an ideal gas X and two moles of an ideal gas Y, initially at the same temperature and pressure, are mixed under isothermal-isobaric condition. The entropy change on mixing is _____J K^{-1}. (Up to one decimal place. Use R = 8.31 J K^{-1} mol^{-1})

Q.22 The energy of a hydrogen molecule in its ground state equilibrium configuration is –31.7 eV. Its dissociation energy is _____ eV. (Up to one decimal place)

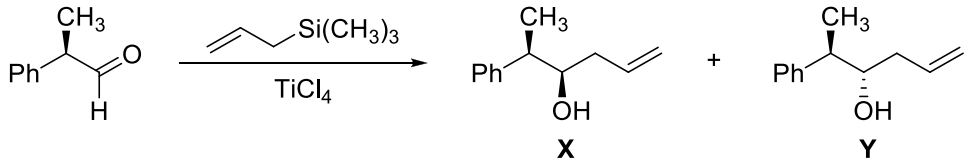
Q.23 The total number of valence electrons in W(η^3-Cp)(η^5-Cp)$(CO)_2$ is _____. (Atomic number of W = 74)

Q.24 In the ^1H NMR spectrum of an organic compound recorded on a 300 MHz instrument, a proton resonates as a quartet at δ 4.20 ppm. The individual signals of the quartet appear at δ 4.17, 4.19, 4.21 and 4.23 ppm. The coupling constant J in Hz is _____.

Q.25 In the electron ionization (EI) mass spectra, methyl hexanoate, methyl heptanoate and methyl octanoate give the same base peak. The m/z value of the base peak is _____.

Q. 26 – Q. 55 carry two marks each.

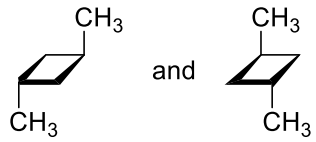
Q.26 In the following reaction,



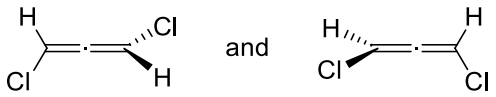
(A) **X** is the major product and **Y** is the minor product
(B) **X** is the only product
(C) **Y** is the only product
(D) **X** is the minor product and **Y** is the major product

Q.27 The enantiomeric pair, among the following, is

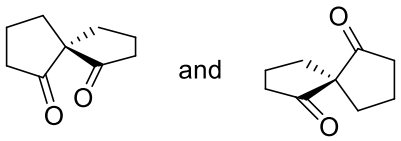
(A)



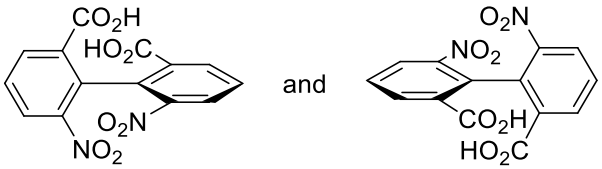
(B)



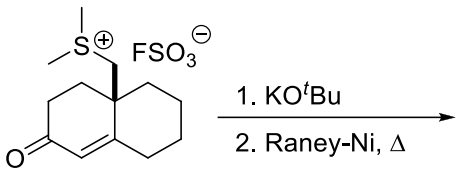
(C)



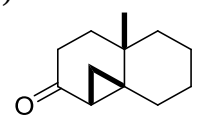
(D)



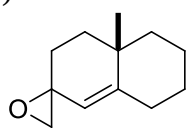
Q.28 The major product formed in the following reaction sequence is



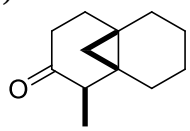
(A)



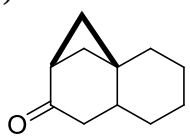
(B)



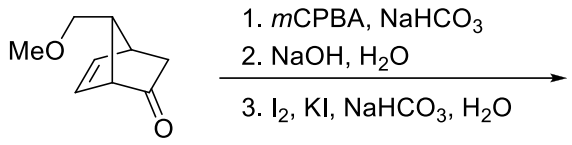
(C)



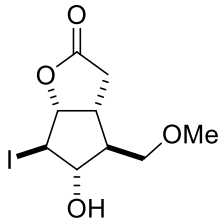
(D)



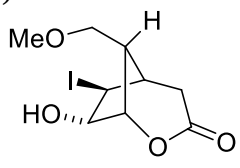
Q.29 The major product in the following reaction sequence is



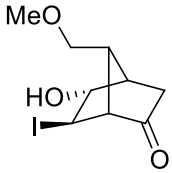
(A)



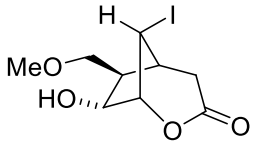
(B)



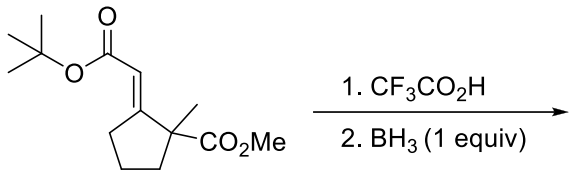
(C)



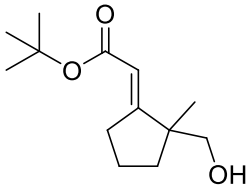
(D)



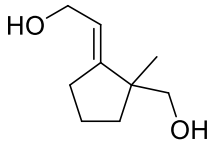
Q.30 The major product formed in the following reaction sequence is



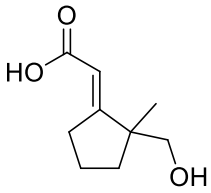
(A)



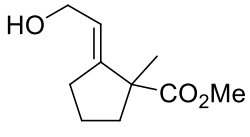
(B)



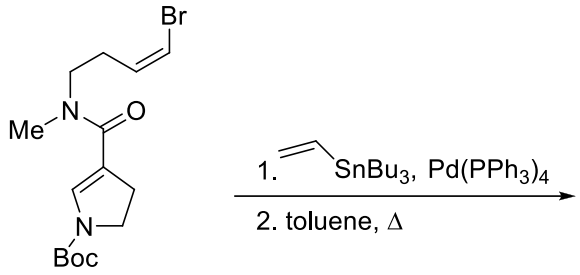
(C)



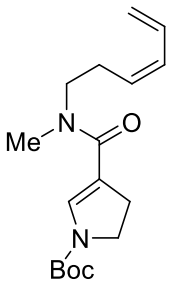
(D)



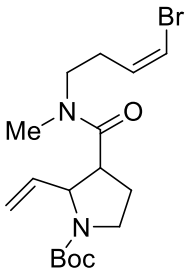
Q.31 The major product of the following reaction sequence is



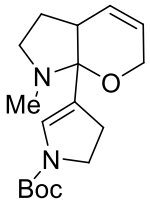
(A)



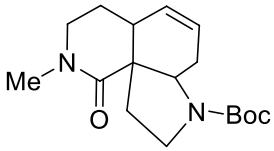
(B)



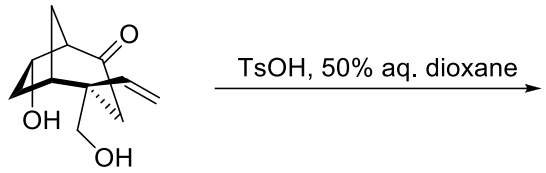
(C)



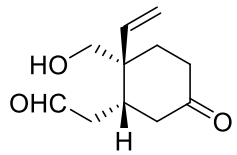
(D)



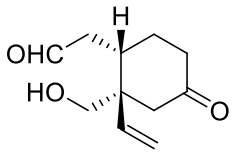
Q.32 The major product formed in the following retro-aldol reaction is



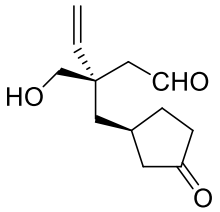
(A)



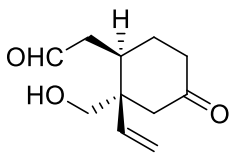
(B)



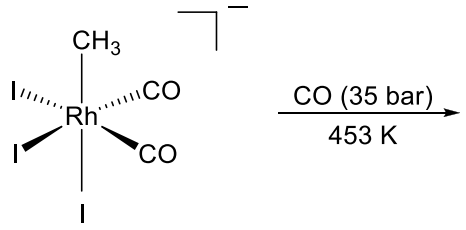
(C)



(D)



Q.33 The elimination product of the following reaction is



(A) I_2 (B) CH_3I (C) CH_3COI (D) I_3^-

Q.34 A one-dimensional anharmonic oscillator is treated by perturbation theory. The harmonic oscillator is used as the unperturbed system and the perturbation is $\frac{1}{6}\gamma x^3$ (γ is a constant). Using only the first order correction, the total ground state energy of the anharmonic oscillator is

(Note: For a one-dimensional harmonic oscillator $\psi_0(x)=\left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2};\ \alpha=\left(\frac{k\mu}{\hbar^2}\right)^{1/2}$)

(A) $\frac{1}{2}\hbar\left(\frac{k}{\mu}\right)^{1/2}$ (B) $\left(\frac{1}{2}+\frac{\gamma}{6}\right)\hbar\left(\frac{k}{\mu}\right)^{1/2}$

(C) $\left(\frac{1}{2}+\frac{\gamma}{3}\right)\hbar\left(\frac{k}{\mu}\right)^{1/2}$ (D) $\left(\frac{1}{2}+\frac{\gamma}{12}\right)\hbar\left(\frac{k}{\mu}\right)^{1/2}$

Q.35 The O_2 coordinated to metal ion centres in oxy-myoglobin and oxy-hemocyanin exists, respectively, as

(A) superoxide and peroxide
(B) superoxide and superoxide
(C) peroxide and peroxide
(D) superoxide and oxygen

Q.36 Spectroscopic ground state term symbols of cobalt ions in $[Co(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$, respectively, are

(A) $^2T_{1g}$ and $^4A_2$ (B) $^4T_{1g}$ and $^4A_2$
(C) $^4T_{2g}$ and $^4T_1$ (D) $^2T_1$ and $^4A_1$

Q.37 Generally, the coordination number and the nature of the electronic absorption band ($f \rightarrow f$ transition) of lanthanide(III) ion in their complexes are, respectively,

(A) greater than 6 and sharp (B) 6 and broad
(C) less than 6 and sharp (D) greater than 6 and broad

Q.38 Second-order rate constant for the reaction between $[Co(NH_3)_5X]^{n+}$ (n = 3 for X = NH_3 and H_2O; n = 2 for X = Cl^-) and $[Cr(H_2O)_6]^{2+}$ at room temperature varies with the X as

(A) $NH_3 > H_2O > Cl^-$
(B) $Cl^- > H_2O > NH_3$
(C) $NH_3 > Cl^- > H_2O$
(D) $H_2O > NH_3 > Cl^-$

Q.39 For the following reaction sequence,

$$3\ NH_4Cl + 3\ BCl_3 \xrightarrow[2.\ LiBH_4]{1.\ \Delta,\ C_6H_5Cl} \mathbf{X} \xrightarrow[RT]{3\ H_2O} \mathbf{Y}$$

X and **Y**, respectively, are

(A) $\{HB(NH)\}_3$ and $\{H(OH)B(NH_2)\}_3$
(B) $\{HB(NH)\}_3$ and $\{HB(NH_2OH)\}_3$
(C) $(NH_4)\{(H)_2(BH_2)_3\}$ and $\{H(OH)(NH_2OH)\}_3$
(D) $(NH_4)\{(H)_2(BH_2)_3\}$ and $\{HB(NH_2OH)\}_3$

Q.40 For an inverse spinel, AB_2O_4, the A and B, respectively, can be

(A) Ni(II) and Ga(III)
(B) Zn(II) and Fe(III)
(C) Fe(II) and Cr(III)
(D) Mn(II) and Mn(III)

Q.41 The reaction of PCl_3 with PhLi in 1:3 molar ratio yields **X** as one of the products, which on further treatment with CH_3I gives **Y**. The reaction of **Y** with *n*-BuLi gives product **Z**. The products **X**, **Y** and **Z**, respectively, are

(A) $[PPh_4]Cl$, $[Ph_2P{=}CH_2]$ and $Ph_2P(n\text{-}Bu)$
(B) PPh_3, $[Ph_3PI](CH_3)$ and $Ph_2P(n\text{-}Bu)_3$
(C) PPh_3, $[Ph_3P(CH_3)]I$ and $Ph_3P{=}CH_2$
(D) $[PPh_4]Cl$, $[Ph_3P{=}CH_2]$ and $[Ph_3P(n\text{-}Bu)]Li$

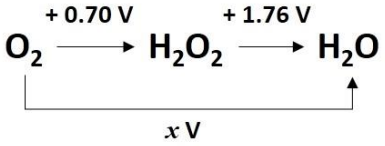
Q.42 The reaction of equimolar quantities of $Fe(CO)_5$ and OH^- gives a complex species **X** which on further reaction with MnO_2 gives species **Y**. **X** and **Y**, respectively, are

(A) $[Fe(CO)_5(OH)]^-$ and $Fe_2(CO)_9$
(B) $[Fe(CO)_4]^{2-}$ and $Mn_2(CO)_{10}$
(C) $[HFe(CO)_4]^-$ and Fe_2O_3
(D) $[HFe(CO)_4]^-$ and $Fe_3(CO)_{12}$

Q.43 The rate constant of a first order reaction, $X \rightarrow Y$, is 1.6×10^{-3} s^{-1} at 300 K. Given that the activation energy of the reaction is 28 kJ mol^{-1} and assuming Arrhenius behavior for the temperature dependence, the total time required to obtain 90% of Y at 350 K is_____ s. (Up to one decimal place. Use R = 8.31 J K^{-1} mol^{-1})

Q.44 The molar conductivity of a 0.01 M weak acid (HX) at 298 K, measured in a conductivity cell with cell constant of 0.4 cm^{-1}, is 64.4 S cm^2 mol^{-1}. The limiting molar conductivities at infinite dilution of H^+ and X^- at 298 K are 350 and 410 S cm^2 mol^{-1}, respectively. Ignoring activity coefficients, the pK_a of HX at 298 K is_____. (Up to two decimal places)

Q.45 The Latimer diagram of oxygen is given below. The value of *x* is _____ V. (Up to two decimal places)



Q.46 At temperature *T*, the canonical partition function of a harmonic oscillator with fundamental frequency (ν) is given by

$$q_{vib}(T) = \frac{e^{-h\nu/2k_BT}}{1-e^{-h\nu/k_BT}}$$

For $\frac{h\nu}{k_BT} = 3$, the probability of finding the harmonic oscillator in its ground vibrational state is _____. (Up to two decimal places)

Q.47 The enthalpy of vaporization of a liquid at its boiling point ($T_b = 200$ K) is 15.3 kJ mol^{-1}. If the molar volumes of the liquid and the vapour at 200 K are 110 and 12000 cm^3 mol^{-1} respectively, then the slope $\frac{dP}{dT}$ of the liquid-vapour boundary is _____ kPa K^{-1}. (Up to two decimal places. Note: 1 Pa = 1 J m^{-3})

Q.48 In a molecule XY, let ψ_X and ψ_Y denote normalized atomic orbitals of atoms X and Y, respectively. A normalized molecular orbital of XY is given by $\psi_+ = 0.56(\psi_X + \psi_Y)$. The value of the overlap integral of ψ_X and ψ_Y is _____. (Up to two decimal places)

Q.49 The absorption maxima of two dyes X and Y are 520 and 460 nm, respectively. The absorbance data of these dyes measured in a 1 cm path length cell are given in the table below.

Dye solution	*Absorbance at 460 nm*	*Absorbance at 520 nm*
X (9 mM)	0.144	0.765
Y (12 mM)	0.912	0.168
Mixture of X and Y	0.700	0.680

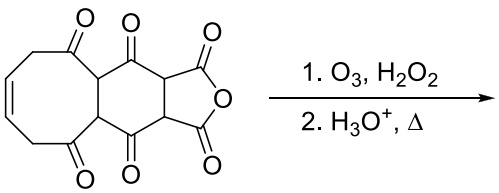
The concentration of Y in the mixture is _____ mM. (Up to two decimal places)

Q.50 The π electrons in benzene can be modelled as particles in a ring that follow Pauli's exclusion principle. Given that the radius of benzene is 1.4 Å, the longest wavelength of light that is absorbed during an electronic transition in benzene is _____ nm. (Up to one decimal place. Use $m_e = 9.1\times10^{-31}$ kg, $h = 6.6\times10^{-34}$ J s, $c = 3.0\times10^{8}$ m s^{-1})

Q.51 The spacing between the two adjacent lines of the microwave spectrum of $H^{35}Cl$ is 6.35×10^{11} Hz. Given that the bond length of $D^{35}Cl$ is 5% greater than that of $H^{35}Cl$, the corresponding spacing for $D^{35}Cl$ is _____$\times 10^{11}$ Hz. (Up to two decimal places)

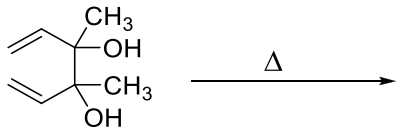
Q.52 For a diatomic vibrating rotor, in vibrational level υ = 3 and rotational level *J*, the sum of the rotational and vibrational energies is 11493.6 cm^{-1}. Its equilibrium oscillation frequency is 2998.3 cm^{-1}, anharmonicity constant is 0.0124 and rotational constant under rigid rotor approximation is 9.716 cm^{-1}. The value of *J* is _____. (Up to nearest integer)

Q.53 Number of carbonyl groups present in the final product of the following reaction sequence is _____.



Q.54 A tetrapeptide, made up of natural amino acids, has alanine as the N-terminal residue which is coupled to a chiral amino acid. Upon complete hydrolysis, the tetrapeptide gives glycine, alanine, phenylalanine and leucine. The number of possible sequences of the tetrapeptide is ____.

Q.55 The strongest band observed in the IR spectrum of the final product of the following reaction appears, approximately, at _____ × 100 cm^{-1}. (Up to one decimal place)



END OF THE QUESTION PAPER