

Roll No:

Application No:

Name:

Exam Date: 06-Oct-2020

Exam Time: 09:00-12:00

Examination: 1. Course Code - M.A./M.Sc./M.C.A.

2. Field of Study - COMPUTATIONAL AND INTEGRATIVE SCIENCES Track-1 (TROM)

SECTION 1 - PART A**Question No.1 (Question Id - 1)**

The ratio between the speeds of the two trains is 7 : 8. If the second train runs 400 kms in 4 hours, then the speed of the first train is

- (A) 70 km/hr
(B) 75 km/hr
(C) 84 km/hr
(D) 87.5 km/hr (Correct Answer)

Question No.2 (Question Id - 8)

If $x + y = 10$ and $x - y = 5$, then $x^2 - y^2 =$

- (A) 50 (Correct Answer)
(B) 60
(C) 75
(D) 40

Question No.3 (Question Id - 2)

If two tailors X and Y are paid a total of ₹ 550 per week by their employer. If X is paid 120 percent of the sum paid to Y, how much is Y paid per week ?

- (A) 200
(B) 250 (Correct Answer)
(C) 300
(D) 400

Question No.4 (Question Id - 9)

$2^{12} + 2^{12} + 2^{12} + 2^{12} =$

- (A) 4^{12}
(B) 2^{14} (Correct Answer)
(C) 2^{16}
(D) 4^{16}

Question No.5 (Question Id - 7)

If $x = 2$ and $y = -3$, then $y^2 - \left(x - \left[y + \frac{1}{2} \right] \right) - 2 \times 3 =$

- (A) $-\frac{39}{2}$
(B) $-\frac{3}{2}$ (Correct Answer)
(C) 0
(D) 31

Question No.6 (Question Id - 4)

How many words with or without meaning, can be formed by using all the letters of the word, 'DELHI' using each letter exactly once ?

- (A) 10
- (B) 25
- (C) 60
- (D) 120 (Correct Answer)

Question No.7 (Question Id - 5)

In the two-digit number x, both the sum and the difference of its digits is 4. What is the value of x ?

- (A) 8
- (B) 16
- (C) 40 (Correct Answer)
- (D) 31

Question No.8 (Question Id - 10)

The average of four numbers is 20. If one of the number is removed, the average of the remaining number is 15. What number was removed ?

- (A) 10
- (B) 35 (Correct Answer)
- (C) 30
- (D) 12

Question No.9 (Question Id - 6)

A school has a total enrollment of 90 students. There are 30 students taking Physics, 25 taking English and 13 taking both. What percentage of the students are taking either Physics or English ?

- (A) 30%
- (B) 36%
- (C) 47% (Correct Answer)
- (D) 51%

Question No.10 (Question Id - 3)

In a Maths examination, the average for the entire class was 80 marks. If 10% of the students scored 95 marks and 20% scored 90 marks, what was the average marks of the remaining students of the class ?

- (A) 65.5
- (B) 72.5
- (C) 75 (Correct Answer)
- (D) 85

SECTION 2 - Physics

Question No.1 (Question Id - 32)

Consider four heat reservoirs A, B, C and D. The efficiency of a reversible engine working between A and C is half of the sum of the efficiencies of the same engine, when it is operated between A and B, and between A and D. The temperature of reservoir C is :

- (A) $T_C = \frac{1}{2} (T_A + T_D)$
- (B) $T_C = \frac{1}{2} (T_B + T_D)$ (Correct Answer)
- (C) $T_C = \frac{1}{2} (T_A + T_B)$
- (D) None of the above

Question No.2 (Question Id - 29)

An atom of mass 'm' can be excited to a state of mass 'm + Δ' by photon capture. The frequency of a photon, which can cause this radiation is :

- (A) $\frac{\Delta C^2}{2h}$
- (B)

- $\frac{\Delta C^2}{h}$
- (C) $\frac{\Delta^2 C^2}{2mh}$
- (D) $\frac{\Delta(\Delta+2m)C^2}{2mh}$ (Correct Answer)

Question No.3 (Question Id - 31)

Assuming the Boltzmann Entropy relation to be true, which of the statements become implied ?

- (A) If $\Omega = 1$, then $S = 0$
- (B) If $\Omega > 1$, then $S > 1$
- (C) If $S \rightarrow 0$, then $T \rightarrow 0$
- (D) All of the above (Correct Answer)

Question No.4 (Question Id - 33)

The partition function of an ideal monatomic gas containing N non-interacting particles is

given by $Z_N = \frac{V^N}{h^{3N}} (2\pi mk_B T)^{3N/2}$. Then F and p are :

$F = -Nk_B T \ln Z$; $P = \frac{Nk_B T}{Z} \left(\frac{\partial Z}{\partial V} \right)_T$. Thus, p is equal to :

- (A) $\frac{3}{2} RT$
- (B) $\frac{3}{2} R$
- (C) $\frac{nRT}{V}$ (Correct Answer)
- (D) $\frac{RT}{nV}$

Question No.5 (Question Id - 11)

Eigenvalues of the following matrix :

$$\begin{pmatrix} 0 & 0 & 2 \\ 0 & 2 & 0 \\ 2 & 0 & 3 \end{pmatrix}$$

are :

- (A) 2, -1, 4 (Correct Answer)
- (B) 3, -1, 4
- (C) 4, -1, 1
- (D) 1, 2, 4

Question No.6 (Question Id - 27)

de Broglie wavelength λ of a particle of mass m and velocity v is :

- (A) $\lambda = \frac{1}{2} mv^2$
- (B) $\lambda = \frac{h}{mv}$ (Correct Answer)
- (C) $\lambda = \frac{h}{mv^2}$
- (D) None of the above

Question No.7 (Question Id - 25)

Suppose a particle starts out in a linear combination of just two stationary states :

$\psi(x, 0) = C_1\psi_1(X) + C_2\psi_2(X)$, where C_1 and C_2 are real constants and states $\psi_1(X)$ and $\psi_2(X)$ are real.

Consider E_1 and E_2 are energies associated with ψ_1 and ψ_2 , respectively. Probability density at subsequent times :

- (A) $C_1 \psi_1^2 + C_2 \psi_2^2$
- (B) $C_1 \psi_1^2 - C_2 \psi_2^2$
- (C) $C_1^2 \psi_1^2 + C_2^2 \psi_2^2 + 2C_1 C_2 \psi_1 \psi_2 \cos \left[\frac{(E_2 - E_1)t}{\hbar} \right]$ (Correct Answer)
- (D) $(C_1 \psi_1 + C_2 \psi_2)^2$

Question No.8 (Question Id - 34)

In terms of pressure and volume of Bose-Einstein gas takes the form :

- (A) $pV^{3/2} = \text{Constant}$
- (B) $pV^{4/3} = \text{Constant}$ (Correct Answer)
- (C) $pV^{3/5} = \text{Constant}$
- (D) $pV^{5/3} = \text{Constant}$

Question No.9 (Question Id - 15)

The differential equation $\frac{dx}{dy} + xy = 4$, is of :

- (A) First order, linear
- (B) First order, non-linear (Correct Answer)
- (C) Second order, linear
- (D) Second order, non-linear

Question No.10 (Question Id - 26)

A particle in the infinite square well has the initial wave function $\psi(x, 0) = A(x - 2)$, for some constant A. What is the expectation value of momentum operator

- . ?
- (A) 0 (Correct Answer)
- (B) 1
- (C) -1
- (D) i

Question No.11 (Question Id - 21)

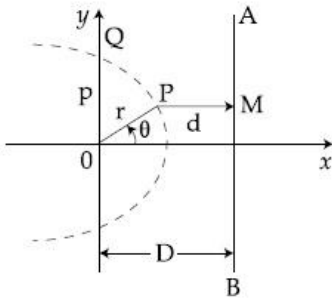
A planet of mass m and angular momentum L , moves in a circular orbit in a potential $V(r) = \frac{-k}{r}$, where k is constant. If it is slightly perturbed radially, the angular frequency of radial oscillations is :

- (A) $\frac{mk^2}{\sqrt{2} L^3}$
- (B) $\frac{mk^2}{L^3}$ (Correct Answer)
- (C) $\sqrt{2} mk^2/L^3$
- (D) $\sqrt{3} mk^2/L^3$

Question No.12 (Question Id - 19)

A central force is given by $f(r) = \frac{-K}{r^2}$, $K > 0$. The path of the particle in the force is

$r = \frac{P}{1 + \epsilon \cos\theta}$ in polar coordinates (r, θ) . If $\epsilon > 1$, the trajectory is :



- (A) Parabola
 (B) Ellipse
 (C) Hyperbola (Correct Answer)
 (D) None of the above

Question No.13 (Question Id - 20)

A cylinder axis vertical floats in a liquid of density ρ . It is pushed down vertically slightly and released. Time period of the oscillation if the cylinder has weight w and cross-section α ,

- (A) $\frac{2\pi\sqrt{\omega}}{g\sqrt{\alpha\rho}}$ (Correct Answer)
 (B) $\frac{2\pi}{g}\sqrt{\alpha\rho}$
 (C) $\frac{2\pi}{g}\sqrt{\frac{\omega}{\rho}}$
 (D) $\frac{2\pi}{g}\frac{\omega}{\rho}$

Question No.14 (Question Id - 39)

The difference in the coulomb energy between the mirror nuclei ${}^{49}_{24}\text{Cr}$ and ${}^{49}_{25}\text{Mn}$ is 6 MeV. Assuming that the nuclei have a spherically symmetric charge distribution and that $e^2 \approx 1.0$ MeV. fm, the radius of the ${}^{49}_{25}\text{Mn}$ nucleus is :

- (A) 4.9×10^{-13} m
 (B) 4.9×10^{-15} m (Correct Answer)
 (C) 5.1×10^{-13} m
 (D) 5.1×10^{-15} m

Question No.15 (Question Id - 37)

If the electrostatic potential in spherical polar coordinates is $\phi(r) = \phi_0 e^{-r/r_0}$, where ϕ_0 and r_0 are constants, then the charge density at a distance $r = r_0$ is :

- (A) $\frac{\epsilon_0 \phi_0}{e r_0^2}$ (Correct Answer)
 (B) $\frac{e \epsilon_0 \phi_0}{2 r_0^2}$
 (C) $\frac{-\epsilon_0 \phi_0}{e r_0^2}$
 (D) $\frac{-2e \epsilon_0 \phi_0}{r_0^2}$

Question No.16 (Question Id - 12)

The value of $(\hat{i} + 2\hat{j}) \cdot (3\hat{j} + 5\hat{k}) \times (\hat{i} + 6\hat{k})$ is :

- (A) 18
 (B) $5\hat{j}$
 (C) **28 (Correct Answer)**
 (D) 0

Question No.17 (Question Id - 24)

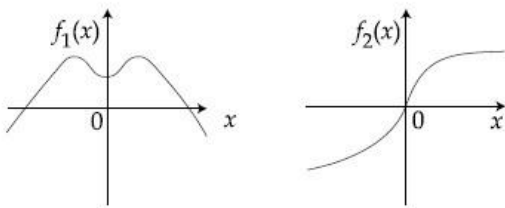
An electron of energy 200 eV is passed through a circular hole of radius equal to 10^{-4} cm. The uncertainty introduced in the angle of emergence:

[Mass of electron = 9.1×10^{-31} kg
 Planck's constant = 6.627×10^{-27} erg.sec.]

- (A) **6×10^{-6} radians (Correct Answer)**
 (B) 6×10^{-2} radians
 (C) 6×10^{-4} radians
 (D) 6×10^{-10} radians

Question No.18 (Question Id - 13)

Two functions are shown graphically below :



Which of the following are true ?

- (A) $f_1(x)$ and $f_2(x)$ are symmetric
 (B) $f_1(x)$ and $f_2(x)$ are anti-symmetric
 (C) $f_1(x)$ is anti-symmetric ; $f_2(x)$ is symmetric
 (D) **$f_1(x)$ is symmetric ; $f_2(x)$ is anti-symmetric (Correct Answer)**

Question No.19 (Question Id - 38)

If the electrostatic potential $V(r, \theta, \phi)$ in a charge free region has the form $V(r, \theta, \phi) = f(r) \cos\theta$, then the functional form of $f(r)$, with a and b as constants, is given by :

- (A) $ar^2 + \frac{b}{r}$
 (B) **$ar + \frac{b}{r^2}$ (Correct Answer)**
 (C) $ar + \frac{b}{r}$
 (D) $a \ln\left(\frac{r}{b}\right)$

Question No.20 (Question Id - 30)

The constant $\alpha = \frac{e^2}{4\pi\epsilon_0 \hbar c} \approx \frac{1}{137}$, is known as :

- (A) Rydberg constant
 (B) Bohr magneton
 (C) **Fine structure constant (Correct Answer)**
 (D) Land'e g-factor

Question No.21 (Question Id - 18)

A projectile is launched with initial speed v_0 at an angle α with the horizontal. The time taken to reach the maximum height reached :

- (A) $\frac{v_0 \sin\alpha}{g}$
- (B) $\frac{v_0^2 \sin 2\alpha}{2g}$
- (C) $\frac{v_0^2 \sin 2\alpha}{g}$
- (D) $\frac{2v_0 \sin\alpha}{g}$ (Correct Answer)

Question No.22 (Question Id - 28)

In hydrogen atom, the allowed energies are $E_n = \frac{E_1}{n^2}$, $n = 1, 2, 3, \dots$ where $E_1 = -13.6$ eV. The first excited state will have energy :

- (A) -3.4 eV, four degenerate states (Correct Answer)
- (B) -3.4 eV, two degenerate states
- (C) -13.6 eV, two degenerate states
- (D) -13.6 eV, non-degenerate

Question No.23 (Question Id - 23)

A proton which is confined to a nucleus of radius equal to 10^{-13} cm has uncertainty in its momentum. Kinetic energy of that proton inside the nucleus :

$$\left[\begin{array}{l} \text{Planck's constant} = 6.627 \times 10^{-27} \text{ erg.sec.} \\ \text{Mass of proton} = 1.67 \times 10^{-24} \text{ g} \end{array} \right]$$

- (A) 1 MeV
- (B) 20 MeV (Correct Answer)
- (C) 1 eV
- (D) 10 meV

Question No.24 (Question Id - 36)

The root mean square speed for gas molecule is given by :

- (A) $\sqrt{\frac{3k_B T}{2m}}$
- (B) $\sqrt{\frac{3k_B T}{m}}$ (Correct Answer)
- (C) $\sqrt{\frac{k_B T}{2m}}$
- (D) None of the above

Question No.25 (Question Id - 22)

In the free electron theory of metals, valence electrons can be approximately assumed to be free and confined inside a box. If $g(E)dE$ represents the number of states whose energy lies between E and $E + dE$, then $g(E)$ goes as :

- (A) E
- (B) $E^{\frac{3}{2}}$ (Correct Answer)
- (C) $E^{\frac{5}{2}}$
- (D) Independent of E

Question No.26 (Question Id - 16)

The angular speed of the earth about its axis is approximately :

- (A) 7.25×10^{-3} rad/s
 (B) 7.25×10^{-5} rad/s (Correct Answer)
 (C) 6.27×10^{-3} rad/s
 (D) 6.27×10^{-5} rad/s

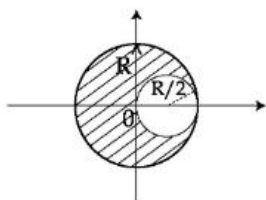
Question No.27 (Question Id - 35)

Ratio of molar heat capacity at constant pressure to molar heat capacity at constant volume, is given by :
 (Ideal gas monatomic)

- (A) $\gamma = \frac{5}{3}$ (Correct Answer)
 (B) $\gamma = \frac{3}{5}$
 (C) $\gamma = \frac{2}{5}$
 (D) $\gamma = \frac{5}{2}$

Question No.28 (Question Id - 17)

A small mass m with radius $R/2$ is cut from a uniform circular disc of mass M and radius R , as shown in the figure below :



Where will be its new center of mass ?

- (A) $\frac{R}{2}$, left to O
 (B) $\frac{R}{4}$, left to O
 (C) $\frac{R}{6}$, left to O (Correct Answer)
 (D) $\frac{R}{8}$, left to O

Question No.29 (Question Id - 40)

The intrinsic electric dipole moment of a nucleus ${}^A_Z X$,

- (A) increases with Z , but independent of A
 (B) decreases with Z , but independent of A
 (C) is always zero (Correct Answer)
 (D) increases with Z and A

Question No.30 (Question Id - 14)

Imaginary roots of $x^3 = 5$ would be [ω is the imaginary cube root of unity] :

- (A) $5\omega, 5\omega^2$
 (B) $\omega, 5\omega^2$
 (C) $\frac{1}{5^{1/3}}\omega, \frac{1}{5^{1/3}}\omega^2$ (Correct Answer)
 (D) $25\omega, 25\omega^2$

SECTION 3 - Chemistry

Question No.1 (Question Id - 49)

Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion ?

- (A) Work is done, no heat is absorbed
 (B) **No work is done, no heat is absorbed (Correct Answer)**
 (C) No work is done, heat is absorbed
 (D) Work is done, heat is absorbed

Question No.2 (Question Id - 43)

Which type of hybridisation in transition state of SeF_4 , when it undergoes in hydrolysis ?

- (A) sp^3d
 (B) **sp^3d^2 (Correct Answer)**
 (C) dsp^2
 (D) sp^3

Question No.3 (Question Id - 52)

What is the speed of light in atomic units given : $e = 1.602 \times 10^{-19} \text{ C}$, $m_e = 9.109 \times 10^{-31} \text{ kg}$, $\hbar = 1.05457 \times 10^{-34} \text{ Js}$, $\frac{1}{4\pi\epsilon_0} = 0.8987 \times 10^{-10} \text{ JC}^{-2}\text{m}$, $c = 2.9979 \times 10^8 \text{ ms}^{-1}$?

- (A) 274
 (B) **137 (Correct Answer)**
 (C) 3
 (D) 3×10^8

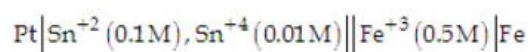
Question No.4 (Question Id - 60)

O_2 is paramagnetic because :

- (A) **It has two unpaired electrons in its HOMO (Correct Answer)**
 (B) It has two unpaired electrons in its LUMO
 (C) It has one spin unpaired electron
 (D) It has no unpaired electrons

Question No.5 (Question Id - 56)

Calculate the emf at 25°C of the cell found to be at equilibrium



- (A) - 0.157 V
 (B) **- 1.157 V (Correct Answer)**
 (C) 1.157 V
 (D) 0.157 V

Question No.6 (Question Id - 61)

The half-life of radium ${}^{226}_{88}\text{Ra}$ is 1600 years. How many disintegrations per second would be undergone by 1 g of radium ?

- (A) **$3.66 \times 10^{10} \text{ g}^{-1}\text{s}^{-1}$ (Correct Answer)**
 (B) $0.366 \times 10^{10} \text{ g}^{-1}\text{s}^{-1}$
 (C) $36.6 \times 10^{10} \text{ g}^{-1}\text{s}^{-1}$
 (D) $366 \times 10^{10} \text{ g}^{-1}\text{s}^{-1}$

Question No.7 (Question Id - 57)

What is the hybridisation of carbene : CCl_2 ?

- (A) sp
 (B) sp^2
 (C) **sp^3 (Correct Answer)**
 (D)

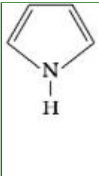
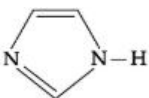
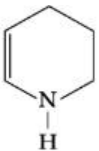
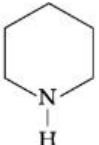
Question No.8 (Question Id - 46)

If any thermodynamic function follows $\oint dY = 0$ then :

- (A) **Y is a state function (Correct Answer)**
 (B) Y is a path function
 (C) Y is an extensive function
 (D) Y is an intensive function

Question No.9 (Question Id - 44)

Which one of the following is least basic in nature ?

- (A)  **(Correct Answer)**
 (B) 
 (C) 
 (D) 

Question No.10 (Question Id - 70)

For an isothermal expansion how does work done by a real gas compare to the same for ideal gas, at very low pressure :

- (A) Less
 (B) **More (Correct Answer)**
 (C) Same
 (D) Unpredictable

Question No.11 (Question Id - 59)

Debye-Hückel limiting law for a specific ion having charge Z_i in solution of ionic strength I , gives the relation :

- (A) $\ln(\gamma_i) = -A Z_i^2 \sqrt{I}$ **(Correct Answer)**
 (B) $\ln(\gamma_i) = -A Z_i \sqrt{I}$
 (C) $\ln(\gamma_i) = -A Z_i^2 I$
 (D) $\ln(\gamma_i) = -A Z_i I$

Question No.12 (Question Id - 50)

The isothermal compressibility, K of a Vander Waals gas $\left(P = \frac{RT}{\bar{v}-b} - \frac{a}{\bar{v}^2} \right)$ is given by :

- (A) $K = \frac{\bar{v}^2 (\bar{v} - b)^2}{RT\bar{v}^3 - 2a(\bar{v} - b)^2}$ **(Correct Answer)**
 (B) $K = \frac{R\bar{v}^2 (\bar{v} - b)}{RT\bar{v}^3 - 2a(\bar{v} - b)^2}$

- (C) $K = \frac{a}{\bar{v}}$
 (D) $K = \frac{2bT}{\bar{v}}$

Question No.13 (Question Id - 54)

2-Chlorocyclobutanone on treatment with sodium methoxide followed by hydrolysis gives :

- (A) Cyclobutane
 (B) Butanoic acid
 (C) **Cyclopropane carboxylic acid (Correct Answer)**
 (D) Cyclobutanone

Question No.14 (Question Id - 45)

The EAN of platinum in potassium hexachloroplatinate (IV) :

- (A) 46
 (B) **86 (Correct Answer)**
 (C) 36
 (D) 84

Question No.15 (Question Id - 55)

In a molecular orbital, probability of electron density is :

- (A) Minimum on the nodal plane
 (B) Maximum on the nodal plane
 (C) **Zero on the nodal plane (Correct Answer)**
 (D) Zero on the surface of the lobe

Question No.16 (Question Id - 58)

$Zn|Zn^{+2}(c = 0.1M)||Fe^{+2}(c = 0.01M)|Fe$. The emf of the cell is 0.2905 V. The equilibrium constant for this cell reaction is :

- (A) $10^{0.32/0.0591}$
 (B) **$10^{0.32/0.0295}$ (Correct Answer)**
 (C) $10^{0.26/0.0295}$
 (D) $e^{0.32/0.295}$

Question No.17 (Question Id - 63)

For the stoichiometric equation $A + 2B \rightarrow 2Z$, the rate of formation of Z at various concentrations of A and B are as.

[A] / mol dm ⁻³	[B] / mol dm ⁻³	Rate / mol dm ³ s ⁻¹
3.5×10^{-2}	2.3×10^{-2}	5×10^{-7}
7×10^{-2}	4.6×10^{-2}	2×10^{-6}
7×10^{-2}	9.2×10^{-2}	4×10^{-6}

and the rate equation is $v = k [A]^\alpha [B]^\beta$

- (A) (1) and (2)
 (B) (2) and (1)
 (C) **(1) and (1) (Correct Answer)**
 (D) (2) and (2)

Question No.18 (Question Id - 67)

For a vander Waal's gas to behave as an ideal gas :

- (A) **Second and higher virial coefficients are zero (Correct Answer)**
 (B) Second and higher virial coefficients are non-zero
 (C) Second and higher virial coefficients are imaginary
 (D) None of the above

Question No.19 (Question Id - 51)

Match the following with **List - I** and **List - II** :

List - I	List - II
A. $\left(\frac{\partial T}{\partial V}\right)_S$	i. $T\left(\frac{\partial^2 P}{\partial T^2}\right)_V$
B. $\left(\frac{\partial S}{\partial P}\right)_T$	ii. $-\left(\frac{\partial V}{\partial T}\right)_P$
C. $\left(\frac{\partial H}{\partial P}\right)_T$	iii. $-\left(\frac{\partial P}{\partial S}\right)_V$
D. $\left(\frac{\partial C_V}{\partial V}\right)_T$	iv. $-C_P\left(\frac{\partial T}{\partial P}\right)_H$

Choose the **correct** answer from the options given below :

- (A) A - II, B - I, C - IV, D - III
 (B) **A - III, B - II, C - IV, D - I (Correct Answer)**
 (C) A - III, B - IV, C - II, D - I
 (D) A - IV, B - III, C - II, D - I

Question No.20 (Question Id - 53)

The coordination number of Ni^{+2} is 4

$NiCl_2 + KCN$ (excess) \longrightarrow A (cyano complex)

$NiCl_2 + conc.HCl$ (excess) \longrightarrow B (chloro complex)

Which statement/s is/are correct ?

- A. Potassium tetracyanonickelate (II), Potassium tetrachloronickel (II)
 B. Both are diamagnetic
 C. dsp^2 , sp^3 respectively

Choose the **most appropriate** answer from the options given below :

- (A) (A) Only
 (B) (B) and (C) Only
 (C) (A) and (B) Only
 (D) **(A) and (C) Only (Correct Answer)**

Question No.21 (Question Id - 41)

What are products of the following reaction ?



- (A) $\overset{O}{\parallel}C-O^-$, $Ph-CH_2OH$ (Correct Answer)
 (B) CH_3-OH , $\overset{O}{\parallel}C-O^-$
 (C) CH_3OH , $Ph-OH$
 (D) $\overset{O}{\parallel}C-O^-$, $Ph-\overset{O}{\parallel}C-O^-$

Question No.22 (Question Id - 62)

For a consecutive reaction mechanism $A \xrightarrow{k_1} B \xrightarrow{k_2} Z$, where k_1 and k_2 are rate constants, determine the expression for $[Z]_t$ (Where $[A]_0$ is the initial concentration of A) :

- (A) $\frac{[A]_0}{k_1 - k_2} [k_2(1 - e^{-k_1 t}) - k_1(1 - e^{-k_2 t})]$
 (B)

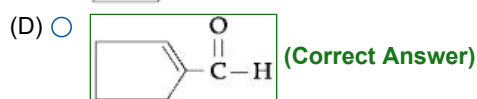
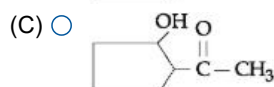
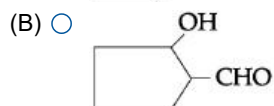
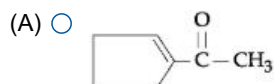
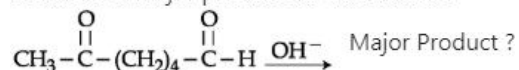
$$\frac{[A]_0}{k_1 - k_2} [k_2(1 - e^{-k_1 t}) - k_1(1 - e^{-k_2 t})]$$

(C) $\frac{[A]_0}{k_2 - k_1} [k_2(1 - e^{-k_1 t}) - k_1(1 - e^{-k_2 t})]$ (Correct Answer)

(D) $\frac{[A]_0}{k_2 - k_1} [k_2(1 - e^{k_1 t}) - k_1(1 - e^{-k_2 t})]$

Question No.23 (Question Id - 42)

What is the major product for the reaction



Question No.24 (Question Id - 48)

The molar enthalpies of combustion of isobutane and n-butane are $-2871 \text{ kJ mol}^{-1}$ and $-2878 \text{ kJ mol}^{-1}$ respectively at 298 K and 1 atm. Calculate ΔH for the conversion of 1-mole of n-butane to 1-mole of isobutane :

(A) -8 kJ mol^{-1} (Correct Answer)

(B) 8 kJ mol^{-1}

(C) $-5749 \text{ kJ mol}^{-1}$

(D) 5749 kJ mol^{-1}

Question No.25 (Question Id - 64)

Under what condition a reaction which follows first order kinetics goes to completion :

(A) $t_{1/2} = \frac{0.693}{k}$

(B) Never (Correct Answer)

(C) $t_{1/2} = \frac{1}{k}$

(D) Immediately

Question No.26 (Question Id - 69)

Fugacity (f) of a real gas is always :

(A) Greater than pressure of the gas with attractive internuclear potential.

(B) Lesser than pressure of the gas with attractive internuclear potential.

(Correct Answer)

(C) Lesser than pressure of the gas with repulsive internuclear potential.

(D) Equal to pressure of the gas with repulsive internuclear potential.

Question No.27 (Question Id - 65)

Calculate the number of molecules per m^3 in an ideal gas at standard temperature and pressure condition (i.e. 0°C and 1 atm) :

- (A) 2.69×10^{22}
 (B) 2.69×10^{25} (Correct Answer)
 (C) 44.65
 (D) 2.65×10^{23}

Question No.28 (Question Id - 66)

From the equipartition of energy principle, we can predict the specific heat capacity at constant volume (\bar{C}_v) for a diatomic molecule to be :

- (A) $3.5 R$ (Correct Answer)
 (B) $2 R$
 (C) $1.5 R$
 (D) R

Question No.29 (Question Id - 68)

Aqueous tension is the vapour pressure of _____ and depends only upon _____.

- (A) water, pressure
 (B) liquid, temperature
 (C) water, density
 (D) water, temperature (Correct Answer)

Question No.30 (Question Id - 47)

If equation of state is expressed by $P\bar{V} = RT + B(T)P$, then evaluate $\left(\frac{\partial \bar{H}}{\partial P}\right)_T$:

- (A) $B(T)$
 (B) $T \frac{dB}{dT}$
 (C) $B(T) - T \frac{dB}{dT}$ (Correct Answer)
 (D) $B(T) + T \frac{dB}{dT}$

SECTION 4 - Mathematics - Statistics

Question No.1 (Question Id - 97)

A player tosses two fair coins. He wins ₹ 5 if 2 heads occur, ₹ 2 if 1 head occurs and ₹ 1 if no head occurs. What is the expected gain of the player ?

- (A) 2.00
 (B) 2.50 (Correct Answer)
 (C) 5.00
 (D) 7.00

Question No.2 (Question Id - 71)

Let, A be any $n \times n$ matrix. If A' is the matrix that results when two rows of A are interchanged, then :

- (A) $\det(A') = \det(A)$
 (B) $\det(A') = -\det(A)$ (Correct Answer)
 (C) $\det(A') = \frac{1}{\det(A)}$
 (D) $\det(A') = \frac{-1}{\det(A)}$

Question No.3 (Question Id - 74)

Given the matrix A in reduced echelon form $A = \begin{bmatrix} 3 & -9 & 12 & -9 & 6 \\ 0 & 2 & -4 & 4 & 2 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$

The number of pivot and free column in the matrix A are :

- (A) (3,2) (Correct Answer)
(B) (2,3)
(C) (4,1)
(D) (3,1)

Question No.4 (Question Id - 89)

The general solution of $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 6y = 0$ is :

- (A) $y(x) = C_1xe^{3x} + C_2xe^{2x}$
(B) $y(x) = C_1xe^{3x} - C_2xe^{-2x}$
(C) $y(x) = C_1e^{3x} + C_2e^{-2x}$ (Correct Answer)
(D) $y(x) = C_1e^{-3x} + C_2e^{2x}$

Question No.5 (Question Id - 100)

If the chance of A hitting a target is 3 times out of 4 and of B 4 times out of 5 and of C 5 times out of 6. Each try once to hit the target, the probability that the target will be hit in two hits is :

- (A) 19/24
(B) 23/30
(C) 23/120
(D) 47/120 (Correct Answer)

Question No.6 (Question Id - 79)

a^p is a generator of a cyclic group of $(G, 0)$ of order n and generated by a if and only if :

- (A) $p = n$
(B) $p < n$
(C) p is prime to n
(D) $p < n$ and prime to n (Correct Answer)

Question No.7 (Question Id - 92)

For $n \geq 1$, let $f_n(x) = \frac{nx}{1+n^2x^2}$; $x \in [0, 1]$. Then :

- (A) $\{f_n\}$ converges pointwise to a function f on $[0, 1]$, but does not converge uniformly on $[0, 1]$ (Correct Answer)
(B) $\{f_n\}$ does not converge pointwise to any function on $[0, 1]$
(C) $\{f_n\}$ converges uniformly on $[0, 1]$
(D) $\{f_n\}$ converges uniformly on $(0, 1)$

Question No.8 (Question Id - 91)

$\lim_{n \rightarrow \infty} \frac{3n^2 + 2n + 1}{n^2 + 1}$ equals :

- (A) 0
(B) 1
(C) 2
(D) 3 (Correct Answer)

Question No.9 (Question Id - 77)

Let, order of a cyclic group be 3 and 'a' is it's generator. Then, order of 'a⁻¹' is :

- (A) 1
 (B) 3 (Correct Answer)
 (C) $\frac{1}{3}$
 (D) 0

Question No.10 (Question Id - 82)

For a polyhedron, which of the following is true ?

- (A) Every vertex is an extreme point, but not all extreme points are vertices
 (B) Every basic feasible solution is a vertex, but not all vertices are extreme points
 (C) Every extreme point is a vertex, every vertex is a basic feasible solution, but not every basic feasible solution is an extreme point
 (D) Every extreme point is a vertex, every vertex is a basic feasible solution, and every basic feasible solution is an extreme point
 (Correct Answer)

Question No.11 (Question Id - 98)

If $f(x) = ce^{-\frac{(x^2-8x+16)}{32}}$, $-\infty < x < \infty$ represents a normal distribution. The mean of this distribution is :

- (A) 2
 (B) 4 (Correct Answer)
 (C) 16
 (D) 32

Question No.12 (Question Id - 78)

A finite integral domain is a :

- (A) Ring but not field
 (B) Group but not ring
 (C) Commutative ring but not field
 (D) Field (Correct Answer)

Question No.13 (Question Id - 95)

Let $f(x) = x^2 + 2x + 1$ and the derivative of f at $x = 1$ is approximated by using the central-difference formula

$$f'(1) \simeq \frac{f(1+h) - f(1-h)}{2h} \text{ with } h = \frac{1}{2}.$$

Then the absolute value of the error in the approximation of $f'(1)$ is :

- (A) 1
 (B) 0 (Correct Answer)
 (C) $\frac{1}{2}$
 (D) $\frac{1}{3}$

Question No.14 (Question Id - 90)

The eigen values of the differential equation $\frac{d}{dx} \left(x \frac{dy}{dx} \right) + \frac{\lambda}{x} y = 0$; $y'(1) = 0 = y'(e^{2\pi})$

where $\lambda > 0$ are :

n being positive integer.

- (A) $\frac{n^2}{2}$
 (B) $\frac{n}{2}$
 (C) $\frac{n^2}{4}$ (Correct Answer)
 (D) $\frac{n}{4}$

Question No.15 (Question Id - 99)

A random variable X with moment generating function $M_X(t) = \left(\frac{2}{5} + \frac{1}{3}e^{2t} + \frac{4}{15}e^{3t}\right)$ is distributed with mean :

- (A) **22/15 (Correct Answer)**
- (B) 9/5
- (C) 2/5
- (D) 1/15

Question No.16 (Question Id - 75)

Let, $S = \{v_1, v_2, \dots, v_n\}$ be a set of n vectors in an n-dimensional space V, then which of the following is true :

- A. If S is a linearly independent vectors, then S is a basis for V.
- B. If S span V, then S is a basis for V.
- C. If S' is another basis for V, then S' has identical n vectors as that of S.
- D. There might exist a basis for V with number of vectors less than n.

Choose the **correct** answer from the options given below :

- (A) Only B is true
- (B) Only C is true
- (C) **Both A and B are true (Correct Answer)**
- (D) Both B and D are true

Question No.17 (Question Id - 72)

The inverse of $A = \begin{bmatrix} 3 & 4 \\ 5 & 6 \end{bmatrix}$ is :

- (A) $A^{-1} = \begin{bmatrix} -3 & 5/2 \\ 2 & 3/2 \end{bmatrix}$
- (B) $A^{-1} = \begin{bmatrix} -3 & 2 \\ 5/2 & -3/2 \end{bmatrix}$ **(Correct Answer)**
- (C) $A^{-1} = \begin{bmatrix} -3 & -2 \\ 5/2 & -3/2 \end{bmatrix}$
- (D) $A^{-1} = \begin{bmatrix} -3 & 5/2 \\ 2 & -3/2 \end{bmatrix}$

Question No.18 (Question Id - 73)

Let $A = \begin{bmatrix} 1 & -3 \\ 3 & 5 \\ -1 & 7 \end{bmatrix}$ and $U = \begin{bmatrix} 2 \\ -1 \end{bmatrix}$ define a transformation $T : \mathbf{R}^2 \rightarrow \mathbf{R}^2$ by $T(X) = AX$. The image of U under the transformation

T is :

- (A) $\begin{bmatrix} 5 \\ 1 \\ -9 \end{bmatrix}$ **(Correct Answer)**
- (B) $\begin{bmatrix} -5 \\ 3 \\ -1 \end{bmatrix}$
- (C) $\begin{bmatrix} 3 \\ 2 \\ 5 \end{bmatrix}$
- (D) $\begin{bmatrix} 2 \\ 2 \\ -5 \end{bmatrix}$

Question No.19 (Question Id - 94)

Let $f(x) = \sqrt{2+x}$ for $x \geq -2$ consider the iteration $x_{n+1} = f(x_n)$, $x_0 = 0$; $n \geq 0$. The possible limit of the iteration is :

- (A) 1
(B) -2
(C) 0
(D) $\sqrt{2 + \sqrt{2 + \sqrt{2 + \dots}}}$ (Correct Answer)

Question No.20 (Question Id - 83)

- Consider a standard form polyhedron $P = \{x : Ax = b, x \geq 0\}$
- Suppose A has dimension $m \times n$ and rank m

Which of the following is true ?

- (A) The set of all optimal solutions is bounded.
(B) At every optimal solution, no more than $n - m$ variables are zero.
(C) **At every optimal solution, no more than m variables are positive.** (Correct Answer)
(D) If $n = m + 1$, P has at most one basic feasible solution.

Question No.21 (Question Id - 80)

The ring R where $R = \left\{ \begin{bmatrix} a+ib & c+id \\ -c+id & a-ib \end{bmatrix} : a,b,c,d \in \mathbb{Z} \right\}$ has 8 units. Two of which are :

- (A) $\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}, \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix}$
(B) $\begin{bmatrix} 0 & -i \\ -i & 0 \end{bmatrix}, \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ (Correct Answer)
(C) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$
(D) $\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & i \\ -i & 0 \end{bmatrix}$

Question No.22 (Question Id - 96)

Let the correlation coefficient between two variables X and Y be unity. Then the relation between the regression coefficients β_{YX} and β_{XY} that always holds is :

- (A) $\beta_{YX} > \beta_{XY}$
(B) $\beta_{YX} < \beta_{XY}$
(C) $\beta_{YX} = \beta_{XY}$
(D) **$\beta_{YX} \cdot \beta_{XY} = 1$** (Correct Answer)

Question No.23 (Question Id - 85)

The integrating factor of the linear differential equation $x \cos x \frac{dy}{dx} + y(x \sin x + \cos x) = 1$ is :

- (A) $\frac{x}{\sin x}$
(B) $x \cos x$
(C) $x \sin x$
(D) $\frac{x}{\cos x}$ (Correct Answer)

Question No.24 (Question Id - 76)

The rank of the coefficient matrix (A) and the augmented matrix (C) of the following system

$$\begin{aligned} x + 2y - z &= 3 \\ 3x - y + 2z &= 1 \\ 2x - 2y + 3z &= 2 \\ x - y + z &= -1 \end{aligned}$$

is :

- (A) $\rho(A) = 2, \rho(C) = 3$

- (B) $\rho(A) = 3, \rho(C) = 2$
 (C) $\rho(A) = 2, \rho(C) = 2$
 (D) $\rho(A) = 3, \rho(C) = 3$ (Correct Answer)

Question No.25 (Question Id - 93)

The following numerical integration formula is exact for all polynomials of degree less than or equal to 3 :

- (A) Trapezoidal rule
 (B) Weddle's rule
 (C) Simpson's $\frac{1}{3}$ rd rule (Correct Answer)
 (D) Gauss-Legendre 4 point formula

Question No.26 (Question Id - 84)

Given a set of n vectors in \mathbf{R}^d , $n > 2d$ the number of vectors that can be affinely independent is :

- (A) n
 (B) d
 (C) $d + 1$ (Correct Answer)
 (D) $n - d$

Question No.27 (Question Id - 86)

The complementary function of the differential equation $\frac{d^2y}{dx^2} + 4y = x^2 \sin 2x$ is :

- (A) $C_1 + C_2e^{2x}$
 (B) $C_1x + C_2e^{2x}$
 (C) $C_1 + C_2x$
 (D) $C_1 \cos 2x + C_2 \sin 2x$ (Correct Answer)

Question No.28 (Question Id - 88)

The solution of $(1-x^2)\frac{dy}{dx} - 2xy = x - x^3$ is :

- (A) $y(1-x) = \frac{1}{2}x^2 - \frac{1}{4}x^4 + C$
 (B) $y(1-x^2) = \frac{1}{2}x^2 - \frac{1}{4}x^4 + C$ (Correct Answer)
 (C) $y(1-x) = \frac{1}{2}x - \frac{1}{4}x^3 + C$
 (D) $y(1-x^2) = \frac{1}{2}x - \frac{1}{4}x^3 + C$

Question No.29 (Question Id - 87)

The following non-linear differential equation $\frac{dy}{dx} + P(x)y = Q(x)y^n$, $n \neq 1$ is known as :

- (A) Clairaut's equation
 (B) Bernoulli's equation (Correct Answer)
 (C) Lagrange's equation
 (D) Cauchy-Euler equation

Question No.30 (Question Id - 81)

Given a polyhedron in standard form $AX = b$, $X \geq 0$ in \mathbf{R}^n , where A is an $m \times n$ matrix, the number of basic solutions is at most :

- (A) $\binom{n}{m}$ (Correct Answer)
 (B)

$$\binom{n-1}{m-1}$$

- (C) n - m
 (D) n + m

SECTION 5 - Computer Science - Programming

Question No.1 (Question Id - 124)

Consider the following CFG.

digit $\rightarrow 0 \mid 1 \mid \dots \mid 9$

digits $\rightarrow \text{digit digit}^*$

optional_true $\rightarrow \text{.digit} \mid 6$

optional_exp $\rightarrow (E(+ \mid - \mid E) \text{digits}) \mid E$

num $\rightarrow \text{digits optional_true}$

optional_exp

Which of the following strings can be derived from this ?

- (A) 6.33E4
 (B) 1.89E-4
 (C) 5280
 (D) **All the above (Correct Answer)**

Question No.2 (Question Id - 112)

A Turing machine with left-reset is similar to an ordinary Turing machine; but the transition function has the form

$\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{R, \text{Reset}\}$

If $\delta(q, a) = (r, b, \text{RESET})$, when the machine is in state q , reading a , the machine head jumps to the left-hand end of the tape after it writes b on the tape and enters state r . Note that these machines do not have the ability to move the head one symbol to the left. This class of languages recognizes. (Choose the largest class)

- (A) Regular languages
 (B) Context-free languages
 (C) Turing decidable languages
 (D) **Turing recognizable languages (Correct Answer)**

Question No.3 (Question Id - 125)

Which of the following regular expressions can be used to derive the strings "00, 010, 011110, 00000, ..." ?

- (A) $00(0 \mid 1)^*$
 (B) $00(01)^+$
 (C) **$0(0 \mid 1)^*0$ (Correct Answer)**
 (D) None of the above

Question No.4 (Question Id - 128)

The chmod command is used to specify appropriate permissions to a file. What is the chmod command along with appropriate permissions you would use such that its effective permissions is (rwx, r-x, ---) ?

- (A) **Chmod 0751 (Correct Answer)**
 (B) chmod 0721
 (C) chmod. 0761
 (D) none of the above

Question No.5 (Question Id - 129)

System calls differ from normal library routine in the following way :

- (A) System calls require more parameters in general, compared to API calls.
 (B) System calls are slower compared to library routines because they involve more processing.
 (C) **System calls are actually software interrupts/traps which are processed by the kernel, much the way it handles interrupts.**

(Correct Answer)

(D) None of the above

Question No.6 (Question Id - 113)

Which of the following languages are regular ?

- (A) $\{w : w \in \{0, 1\}^* \text{ is not a palindrome}\}$
- (B) $\{0^m 1^n : m \neq n\}$
- (C) **$\{w : w \text{ contains at least two 0's or at least two 1's}\}$ (Correct Answer)**
- (D) $\{0^n 1^m 0^n : m, n \geq 0\}$

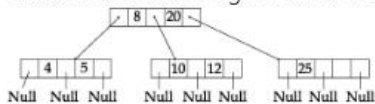
Question No.7 (Question Id - 102)

The instruction pointers/program counter is not used for which of the following :

- (A) **All based operations (Correct Answer)**
- (B) CALC/RET
- (C) JMP (and conditional jump) instructions
- (D) None of the above

Question No.8 (Question Id - 114)

Consider the following B-tree of order 3 :



The tree obtained after deleting 20 has _____ nodes.

- (A) 4
- (B) **3 (Correct Answer)**
- (C) 2
- (D) None of the above

Question No.9 (Question Id - 126)

The advantage of NFA over a DFA is as follows :

- (A) NFA takes care of only the important inputs of the DFA
- (B) NFA corresponding to a regular expression r , is of the order of $O(|r|)$
- (C) NFA is faster to traverse because of fewer states B & C
- (D) **All the above (Correct Answer)**

Question No.10 (Question Id - 130)

You have an email client that must periodically check for new emails arriving. May additionally also require traffic encryption or decryption via TLS connection. Which kind of scheduling policy must be applied for the same ?

- (A) Real time
- (B) **Round-robin with pre-emption (Correct Answer)**
- (C) FIFO (First-In-First-Out)
- (D) Shortest Job First (SJF)

Question No.11 (Question Id - 118)

The main difference between a process and a thread is as follows (particularly in the context of OSes like Linux and Free BSD).

- (A) Process can create more process but threads can't
- (B) A parent process shares only the stack (local variables) with the child process, while a thread shares everything.
- (C) **They are pretty much same, just that threads shares everything, except stack and code, while process make duplicates of all the data and code pages. (Correct Answer)**
- (D) None of the above

Question No.12 (Question Id - 122)

The following protocol is used to map MAC to IP.

- (A) **REVERSE_ARP protocol (Correct Answer)**
- (B) Mapping between absolute IP address and MAC via a fixed/dynamic table
- (C) There is no way to resolve MAC to the corresponding IP
- (D) The ARP socket is used for this

Question No.13 (Question Id - 104)

Order the following functions in increasing order of asymptotic growth.

A. $n-200$

B. $n^{3/2}$

C. $10^6 n \log n$

D. $n^2/\log n$

E. \sqrt{n}

Choose the **correct** answer from the options given below

- (A) **E, A, C, B, D (Correct Answer)**
- (B) E, A, D, B, C
- (C) E, A, B, C, D
- (D) D, A, B, C, E

Question No.14 (Question Id - 103)

Given a graph $G = (V, E)$, $W : E \rightarrow Q$, with positive and negative weights, and no negative weight cycle, we want to compute a shortest path to all vertices in G starting from a vertex $s \in V$. Suppose the negative weight edges are only adjacent to s , which of the following algorithms can be used to compute a solution in polynomial time ?

- (A) **Run Dijkstra's algorithm (Correct Answer)**
- (B) Run Kruskal's algorithm
- (C) There is no known polynomial time algorithm for this problem
- (D) Run one iteration of the Bellman-Ford algorithm :
 (i) Set $d(s) = 0$; $d(v) = \infty \forall v \in V$.
 (ii) For each $v \in V$
 (iii) If $d(u) + w(u, v) < d(v)$ set $d(v) = d(u) + w(u, v)$

Question No.15 (Question Id - 123)

C programming language :

Assume an integer array $a[] = \{0 \times 12345678, 0 \times 9ABCDEF0\}$

Assume a pointer $\text{char } *p$;

$p = (\text{char}^*) a$;

What is the output of the following (assuming little endian ordering) ?

`printf("%x %x", *p++, *p);`

- (A) **0 x 12 0 x 34 (Correct Answer)**
- (B) 0 x 12345678 0 x 9ABCDEF0
- (C) 0 x 4 0 x 43
- (D) Invalid Operation

Question No.16 (Question Id - 107)

Which of the following data structures could be used for implementing a document keyword index, e.g. what is used by popular search engines to match keywords to specific pages ?

- (A) **Hushtable (Correct Answer)**
- (B) Queue
- (C) Linked - list
- (D) Binary search tree

Question No.17 (Question Id - 109)

The main difference between a binary search tree and a fully balanced binary search tree (also called AVL tree) is that :

- (A) All operations in a regular binary search tree is in $O(\log n)$. Operations include (adding, deleting and searching for specific nodes)
- (B) Worst case complexity of AVL tree for all operations one is $O(n^2)$
- (C) Worst case complexity of a regular binary search tree is $O(n^2)$
- (D) **All operations in an AVL tree is always $O(\log n)$ (Correct Answer)**

Question No.18 (Question Id - 115)

In a relation scheme $R(A, B, C)$, if A is the primary key, then which normal form condition R will at least satisfy ?

- (A) 1NF
- (B) **2NF (Correct Answer)**
- (C) 3NF
- (D) BCNF

Question No.19 (Question Id - 105)

The time taken for DFS on a graph with n vertices and m edges is :

[Choose the best upper bound].

- (A) $O(m \log n)$
- (B) $O(n)$
- (C) $O(m + n \log n)$
- (D) **$O(m + n)$ (Correct Answer)**

Question No.20 (Question Id - 110)

A language is turing-decidable if :

- (A) There exists a turing machine that on any input string, accepts in finite time if the string is in the language, but can accept, or reject in finite time if the string is not in the language.
- (B) **There exists a turing machine that on any input string, accepts in finite time if the string is in the language, and rejects in finite time if the string is not in the language. (Correct Answer)**
- (C) There exists a turing machine that on any input string, accepts infinite time if the string is in the language, and loops forever if the string is not in the language.
- (D) There exists a turing machine that on any input string, rejects in finite time if the string is not in the language, and loops forever if the string is in the language.

Question No.21 (Question Id - 117)

The IP address range available to the subset $172.168.12.128/25$ is :

- (A) **172.168.12.128 – 172.168.12.255 (Correct Answer)**
- (B) 172.168.12.128 – 172.168.12.240
- (C) 172.168.12.129 – 172.168.12.240
- (D) None of the above

Question No.22 (Question Id - 108)

Which of the following information is true about the use of data structures ?

- (A) A heap sort required a heap structure but cannot be implemented using an array.
- (B) **Quick sort algorithm may be implemented without recursion. (Correct Answer)**
- (C) Binary search cannot be implemented with arrays.
- (D) None of the above.

Question No.23 (Question Id - 119)

Assume you have two relational database tables $T1$ and $T2$. $T1$ has 500 entries while $T2$ has 200 entries. The first step to the join operation ($T1 \bowtie T2$) is a cross-join operation. What is the number of entries in that cross-join set ?

- (A) 5000
- (B) 500
- (C) **100000 (Correct Answer)**

(D) 10000

Question No.24 (Question Id - 127)

The grammar $S \rightarrow SS + \mid SS^* \mid a$ can be used to derive which of the following strings :

- (A) **aa + a* (Correct Answer)**
(B) a + aa*
(C) a*a + a
(D) a + a*a

Question No.25 (Question Id - 116)

Which of the following is true for a HUB vs a Switch ?

- (A) **A switch broadcasts frames on all physical ports while a hub does'nt (Correct Answer)**
(B) A hub broadcasts frames on all physical ports while a switch does'nt
(C) Both broadcast each and every frame
(D) None of the above

Question No.26 (Question Id - 111)

A write-twice Turing machine is a single-tape turing machine that can alter each tape square at most twice; including the input part of the tape. This variant of a turing machine is equivalent to :

- (A) NFAs
(B) Context-free languages
(C) **Turing machines (Correct Answer)**
(D) Push-down automata

Question No.27 (Question Id - 120)

Assume there exists a table with name DEPT. and another one with name EMP. (employee details).

What does the following query retrieve ?

$RESEARCH_DEPT \leftarrow \sigma_{name='Research'}(DEPT)$

$RESEARCH_EMP \leftarrow (RESEARCH_DEPT \bowtie DNUMBER = DNO (RESEARCH_EMP)(EMP))$

$RESULT \leftarrow \pi_{FNAME, LNAME, ADDR}$

- (A) **List of all employees in research dept. (Correct Answer)**
(B) List of all employees in all depts.
(C) List of employees whose DNUMBER==DNO
(D) None of the above

Question No.28 (Question Id - 121)

Which of the following do you think would be suitable to used for UDP ?

- (A) **Voice over IP (Videostreaming) (Correct Answer)**
(B) File download (using HTTP)
(C) Email (using SMTP/IMAP or POP)
(D) Web browsing

Question No.29 (Question Id - 101)

Assume an architecture that uses little Indian storage format. Also, assume an array a [] with elements 0 X 12345678. How will the elements be stored in the array assuming little Indian order ?

- (A) **a[0]=0 X 12, a[1]=0 X 34, a[2]=0 X 56, a[3]=0 X 78 (Correct Answer)**
(B) a[0]=0 X 78, a[1]=0 X 56, a[2]=0 X 34, a[3]=0 X 12
(C) It could be stored in either ways a chosen optimal by the compiler. Endianess doesn't dictate the order of storage
(D) None of the above

Question No.30 (Question Id - 106)

The solution to the following recurrence :

$$T(n) = 6T(n/2) + 4n$$

T(1) = 1

is :

- (A) $\theta(n)$
- (B) $\theta(n \log n)$ (Correct Answer)
- (C) $\theta(n^2)$
- (D) $\theta(n^6)$

SECTION 6 - Life Science - Biotechnology

Question No.1 (Question Id - 147)

Restriction enzymes from different bacteria having the same recognition site but different cutting sites are called :

- (A) Isomers
- (B) **Isoschizomers (Correct Answer)**
- (C) Enantiomers
- (D) Isoforms

Question No.2 (Question Id - 148)

The products of which genes mediate the transfer of Agrobacterium T-DNA to the plant cell nucleus ?

- (A) **Vir (Correct Answer)**
- (B) *nif*
- (C) *ipt*
- (D) *nos*

Question No.3 (Question Id - 138)

What is the name of cofactor attached to cytochrome b ?

- (A) Mg
- (B) Cu and Ag
- (C) **Fe (Correct Answer)**
- (D) Cu

Question No.4 (Question Id - 158)

Which of the following electrophoresis techniques is used to resolve DNA molecules in the range of 50 kb to 10 Mb ?

- (A) Agarose gel electrophoresis
- (B) Poly acrylamide gel electrophoresis
- (C) **Pulsed field electrophoresis (Correct Answer)**
- (D) SDS-Poly acrylamide gel electrophoresis

Question No.5 (Question Id - 143)

Movement of a segment of DNA from one site to another in the genome is :

- (A) cleavage
- (B) replication
- (C) **transposition (Correct Answer)**
- (D) reversion

Question No.6 (Question Id - 152)

Plant can convert fatty acids to sugars by :

- (A) Glycolic acid cycle
- (B) **Glyoxylate cycle (Correct Answer)**
- (C) HMP pathway
- (D) Krebs cycle

Question No.7 (Question Id - 141)

The Pribnow box is located at :

- (A) **-10 position (Correct Answer)**
- (B) + 35 position
- (C) + 10 position

(D) - 35 position

Question No.8 (Question Id - 160)

Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion (A) :

Plasmids are circular double stranded extra chromosomal DNA material occurring in bacterial cytoplasm.

Reason (R) :

Plasmids carry antibiotic resistance and get incorporated in genomic DNA for its fundamental processes such as replication and expression of genes.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

- (A) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(B) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A**
(C) **A is correct, but R is not correct (Correct Answer)**
(D) **A** is not correct, but **R** is correct

Question No.9 (Question Id - 156)

Which of the following hormones are required for root and shoot development in plant tissue culture ?

- (A) Auxin and Ethylene
(B) Cytokinin and Gibberellic acid
(C) **Auxin and Cytokinin (Correct Answer)**
(D) Auxin and Gibberellic acid

Question No.10 (Question Id - 135)

Which of the following is not a method of plant transformation ?

- (A) Protoplast transformation
(B) Biolistics
(C) Agrobacterium mediated transformation
(D) **Southern Blotting (Correct Answer)**

Question No.11 (Question Id - 155)

In higher organisms, which of the following are the antigen processing cells ?

- (A) T-cells
(B) B-cells
(C) **macrophage (Correct Answer)**
(D) eosinophil

Question No.12 (Question Id - 150)

What is the role of T_4 polynucleotide kinase ?

- (A) addition of phosphate group at 3'-OH
(B) **addition of phosphate group at 5'-OH (Correct Answer)**
(C) removal of phosphate group at 3'-OH
(D) removal of phosphate at 5'-OH

Question No.13 (Question Id - 146)

Given below are two statements :

Statement I :

Sugar - phosphate bond is a characteristic feature of carbohydrates.

Statement II :

Glycosidic bond is present in polysaccharides.

In the light of the above statements, choose the **correct** answer from the options given below :

- (A) Both **Statement I** and **Statement II** are true
(B) Both **Statement I** and **Statement II** are false

- (C) **Statement I** is correct, but **Statement II** is false
(D) **Statement I is incorrect, but Statement II is true (Correct Answer)**

Question No.14 (Question Id - 151)

Given below are two statements :

Statement I :

Micropropagation technique of plant tissue culture can generate large number of plants from single callus.

Statement II :

Plants generated through micropropagation are always true to type (genetically similar).

In the light of the above statements, choose the **correct** answer from the options given below :

- (A) Both **Statement I** and **Statement II** are true
(B) Both **Statement I** and **Statement II** are false
(C) **Statement I is correct, but Statement II is false (Correct Answer)**
(D) **Statement I** is incorrect, but **Statement II** is true

Question No.15 (Question Id - 142)

Small nuclear RNAs (SnRNAs) are required for :

- (A) Replication
(B) Transcription
(C) **Splicing (Correct Answer)**
(D) Translation

Question No.16 (Question Id - 132)

The bacterial genome has :

- (A) Nucleus with fixed structural properties
(B) Nucleus with dynamic structural properties
(C) Nucleoid with fixed structural properties
(D) **Nucleoid with dynamic structural properties (Correct Answer)**

Question No.17 (Question Id - 139)

Golden rice is developed to address :

- (A) **Vitamin A deficiency (Correct Answer)**
(B) Vitamin D deficiency
(C) Vitamin C deficiency
(D) Vitamin E deficiency

Question No.18 (Question Id - 157)

In ABO Blood group system, if the allele A and B are dominant to O, how many different genotypes would be possible ?

- (A) 8
(B) 16
(C) **6 (Correct Answer)**
(D) 12

Question No.19 (Question Id - 149)

Transcription starts when :

- (A) DNA binds to promoter
(B) **RNA polymerase binds to promoter (Correct Answer)**
(C) DNA polymerase binds to promoter
(D) Transcription factor binds to RNA

Question No.20 (Question Id - 145)

Bacterial ribosomes are composed of :

- (A) a large subunit of 60s and a small subunit of 30s
(B) a large subunit of 50s and a small subunit of 40s
(C) **a large subunit of 50s and a small subunit of 30s (Correct Answer)**

(D) a large subunit of 60s and a small subunit of 40s

Question No.21 (Question Id - 140)

Semi-conservative mode of DNA replication was proved by :

- (A) **Meselson and Stahl (Correct Answer)**
(B) Chargaff
(C) Griffith
(D) Watson and Crick

Question No.22 (Question Id - 134)

Which of the following sequences is complementary to the given sequence below :
5'-ATTGGCGTGTTA-3'

- (A) 5'-TAACCGCACAAT-3'
(B) 5'-TAAGGCGACAAT-3'
(C) **5'-TAACAGCCAAT-3' (Correct Answer)**
(D) 5'-ATTGTGCGGTTA-3'

Question No.23 (Question Id - 131)

Which of the following is true for prostaglandins ?

- (A) They are formed through lipoxygenase pathway
(B) **They were first identified in human semen (Correct Answer)**
(C) They are derivatives of C₁₈ fatty acid
(D) Mammalian RBCs produce prostaglandins

Question No.24 (Question Id - 154)

Which of the following is quantified by measuring optical density at a wavelength of 260 nm ?

- (A) Protein
(B) **Nucleic Acid (Correct Answer)**
(C) Sugar
(D) Nitrogen

Question No.25 (Question Id - 136)

Which of the following statements is true about eukaryotic promoters ?

- A. TATA box is located ~30 bp upstream of the transcription start site
B. TATA box is located ~30bp downstream of the transcription start site
C. TATA box is located in the first exon of the gene
D. TATA box is located in the first intron of the gene.

Choose the **correct** answer from the options given below :

- (A) **A only (Correct Answer)**
(B) B only
(C) C only
(D) D only

Question No.26 (Question Id - 144)

The major DNA polymerase involved in DNA synthesis during repair reactions in E. coli is :

- (A) **DNA Polymerase I (Correct Answer)**
(B) DNA Polymerase II
(C) DNA Polymerase III
(D) DNA Polymerase IV

Question No.27 (Question Id - 133)

Which of the following is **not** the characteristic feature of Inflammatory response ?

- (A) Swelling
- (B) Pain
- (C) High temperature
- (D) **Bleeding (Correct Answer)**

Question No.28 (Question Id - 137)

Which of the following amino acids is **not** aromatic in nature ?

- (A) Phenylalanine
- (B) **Leucine (Correct Answer)**
- (C) Tyrosine
- (D) Tryptophan

Question No.29 (Question Id - 159)

Which of the following operons in prokaryotes are **not** inducible ?

- (A) Lactose operon
- (B) Galactose operon
- (C) **Tryptophan operon (Correct Answer)**
- (D) Maltose operon

Question No.30 (Question Id - 153)

ABCDE model explains development of which of the following organs of the plant ?

- (A) Leaf
- (B) Root
- (C) **Flower (Correct Answer)**
- (D) Fruit

SECTION 7 - Bioinformatics

Question No.1 (Question Id - 162)

Bond angle of water molecule can be calculated from :

- (A) Cartesian coordinates of the oxygen atom and bond lengths of the O-H bonds.
- (B) **Cartesian coordinates of the oxygen and the two hydrogen atoms. (Correct Answer)**
- (C) Spherical coordinates of the hydrogen atoms.
- (D) X-ray scattering factor of the hydrogen bond.

Question No.2 (Question Id - 184)

Genome refers to the :

- (A) **Entire genes of an organism (Correct Answer)**
- (B) DNA of an organism
- (C) Total DNA and RNA of an organism
- (D) Total DNA, RNA and cDNA of an organism

Question No.3 (Question Id - 179)

DNA sequencing followed by genome annotation are steps of :

- (A) Comparative genomics
- (B) **Structural genomics (Correct Answer)**
- (C) Functional genomics
- (D) Transcriptomics

Question No.4 (Question Id - 183)

Variation between individuals due to single base changes is called as :

- (A) ESTs
- (B) Contigs
- (C) **SNPs (Correct Answer)**
- (D) Transversion

Question No.5 (Question Id - 163)

Which sequence is generally used to construct phylogenetic tree ?

- (A) Sequence of Histone H1

- (B) **Sequence of ribosomal RNA (Correct Answer)**
 (C) Sequence of tRNA
 (D) Sequence of RNA pol σ -factor

Question No.6 (Question Id - 169)

The branching pattern of a tree like structure is termed as topology. If we have "n" taxonimiced units then the number of different possible unrooted tree is :

- (A) $\frac{n(n-1)}{2}$
 (B) $\frac{n!(n-1)!}{2}$
 (C) $\frac{(2n-5)!}{2^{n-3}(n-3)!}$ **(Correct Answer)**
 (D) $(2n-1)!n!$

Question No.7 (Question Id - 182)

Given below are two statements

Statement I:

If a gene is transcribed to make RNA, the corresponding RNA will always be translated to form protein.

Statement II:

In prokaryotes, transcription occurs in nucleus while translation occurs in the cytoplasm.

In the light of the above statements, choose the **correct** answer from the options given below :

- (A) Both **Statement I** and **Statement II** are true
 (B) **Both Statement I and Statement II are false (Correct Answer)**
 (C) **Statement I** is correct, but **Statement II** is false
 (D) **Statement I** is incorrect, but **Statement II** is true

Question No.8 (Question Id - 190)

Which of the following plant hormone acts on signaling molecule and is involved in fruit ripening ?

- (A) Gibberellic acid
 (B) **Ethylene (Correct Answer)**
 (C) Jasmonic acid
 (D) Cytokinin

Question No.9 (Question Id - 176)

Given below are two statements

Statement I:

Microarrays can be used to check expression of thousands of genes simultaneously.

Statement II:

Microarrays can only be used to check expression of those genes whose sequence is known.

In the light of the above statements, choose the **correct** answer from the options given below :

- (A) **Both Statement I and Statement II are true (Correct Answer)**
 (B) Both **Statement I** and **Statement II** are false
 (C) **Statement I** is correct, but **Statement II** is false
 (D) **Statement I** is incorrect, but **Statement II** is true

Question No.10 (Question Id - 180)

In an experiment, red blood cells were subjected to lysis and any unbroken cells were removed by centrifugation at 600 G. The supernatant was taken and centrifuged at 1,00,000 G, the pellet was extracted

with 5 M NaCl and again centrifuged at 1,00,000 G. Which of the following protein will be present in supernatant ?

- (A) Band 3
- (B) Glycophorin
- (C) G protein-coupled receptors
- (D) **Spectrin (Correct Answer)**

Question No.11 (Question Id - 167)

There is a difficulty in evaluating the significance of Multiple Sequence Alignment (MSA) produced by softwares such as clustalw, muscle, T-COFFEE etc. One of the generally employed approach considers.

- (A) **Sum of pairs of residues in the column of MSA (Correct Answer)**
- (B) Conserved residue in the column of MSA
- (C) Divergent residue in the column of MSA
- (D) Gaps in the column of MSA

Question No.12 (Question Id - 188)

Given below are two statements

Statement I:

Introns contribute to diversity of transcripts through alternative splicing.

Statement II:

Genes lacking introns are transcribed faster than those containing long introns.

In the light of the above statements, choose the **correct** answer from the options given below :

- (A) **Both Statement I and Statement II are true (Correct Answer)**
- (B) Both **Statement I** and **Statement II** are false
- (C) **Statement I** is correct, but **Statement II** is false
- (D) **Statement I** is incorrect, but **Statement II** is true

Question No.13 (Question Id - 186)

α -keratinin is a constituent protein in hair. It largely contains helices. While using iron on hair to straighten it, the structure affected is because of :

- A. Primary Structure
- B. Secondary Structure

Which one is true ?

- (A) A
- (B) **B (Correct Answer)**
- (C) A and B
- (D) None

Question No.14 (Question Id - 181)

What does 'e' stands for in eATP ?

- (A) extrachromosomal
- (B) **extracellular (Correct Answer)**
- (C) expanded
- (D) electrical

Question No.15 (Question Id - 170)

In perl, \$a=5
\$b=7

@array=("4", "3", "6")

What will be the value of push (@ array, \$a, \$b);

- (A) **("4", "3", "6", "5", "7") (Correct Answer)**
- (B) ("3", "4", "5", "6", "7")
- (C) ("4", "3", "6", "7", "5")
- (D) ("7", "6", "5", "4", "3")

Question No.16 (Question Id - 187)

A, B, Z are types of :

- (A) RNA
- (B) **DNA (Correct Answer)**
- (C) Helix
- (D) Sheets

Question No.17 (Question Id - 177)

TIP3P, SPC, TIP4P are examples of :

- (A) Protein models
- (B) **Water models (Correct Answer)**
- (C) Motifs
- (D) Domains

Question No.18 (Question Id - 168)

One of the following phylogenetic model is **not** true ?

- (A) Kimura
- (B) Jukes-cantor
- (C) **RGB (Correct Answer)**
- (D) HKY

Question No.19 (Question Id - 175)

In perl, for ($\$i = 4$; $\$ <= 20$; $i += 2$)
{print "\$i \n";} will print

- (A) All the odd number between 4 and 20
- (B) All the numbers from 5 to 20
- (C) **All the even numbers between 4 and 20 (Correct Answer)**
- (D) All the odd numbers between 5 to 20

Question No.20 (Question Id - 171)

In perl, @countries = ("Israel", "Norway", "France", "Argentina");
@sorted = sort (@countries);

What will be the value of print "@ sorted\n";

- (A) Argentina France Norway Israel
- (B) **Argentina France Israel Norway (Correct Answer)**
- (C) Israel Argentina France Norway
- (D) Norway Israel France Argentina

Question No.21 (Question Id - 173)

What is the linux command to search all lines in a file with the characters 1 through 9 ?

- (A) '^ [1 to 9]' file.txt
- (B) '^ [1 - 9]' file.txt
- (C) where is '^ [1 - 9]' file.txt
- (D) **grep '^ [1 - 9]' file.txt (Correct Answer)**

Question No.22 (Question Id - 166)

Gap extension penalty is generally kept smaller than gap opening penalty as :

- (A) Insertion/deletion of many amino acids in α -helical regions increase stability of globular proteins.
- (B) **Insertion/deletion of many amino acids in loop regions do not affect protein folding. (Correct Answer)**
- (C) Long stretches of β -strands give extra stability.
- (D) Insertion/deletion of few amino acids in α -helix or β -sheet are very likely.

Question No.23 (Question Id - 165)

Which of the following motif **does not** occur in RNA structure ?

- (A) Hairpin loop
- (B) Pseudoknot

- (C) **Helix bundle (Correct Answer)**
 (D) Bulge

Question No.24 (Question Id - 185)

Which of the following is **not** a Macro-nutrient in plants ?

- (A) N
 (B) K
 (C) P
 (D) **Mo (Correct Answer)**

Question No.25 (Question Id - 174)

What would following command in linux print ?

Cut -f 1, 2, 4 -7 file.txt
 print

- (A) 1st, 2nd, 3rd, 4th, 5th and 6th column of file
 (B) 1st, 2nd and 3rd column of file
 (C) **1st, 2nd, 4th, 5th, 6th and 7th column of file (Correct Answer)**
 (D) 1st, 2nd, 4th and 7th column of file

Question No.26 (Question Id - 178)

Infection of E. coli by bacteriophage λ is normally detected by :

- (A) Resistance of the bacteria to an antibiotic
 (B) The growth of single bacterial colonies on an agar plate
 (C) **The appearance of areas of lysed bacteria on an agar plate (Correct Answer)**
 (D) Restriction digest of the bacterial DNA

Question No.27 (Question Id - 161)

The first step of phylogenetic tree construction is :

- (A) Global pairwise alignment by dynamic programming
 (B) **Multiple sequence analysis (Correct Answer)**
 (C) Bootstrap procedure
 (D) Neighbour joining

Question No.28 (Question Id - 172)

Which of the following can be a similarity matrix of amino acids ?

- (A)

	L	V	C	E
L	6	2	-6	-3
V	2	4	-2	-2
C	-6	-2	12	-5
E	-3	-2	-5	4

(Correct Answer)
- (B)

	L	V	C	E
L	2	-5	1	1
V	-5	1	-1	-1
C	1	-1	1	-2
E	1	-1	-2	1
- (C)

	L	V	C	E
L	10	-6	2	3
V	-6	11	5	1
C	2	5	6	1
E	3	1	1	10
- (D)

	L	V	C	E
L	6	-2	2	3
V	2	4	-2	-2
C	-6	-2	12	-5
E	-3	2	5	4

Question No.29 (Question Id - 164)

Ramachandran's ϕ , ψ map is used to :

- (A) **Validate quality of a protein structure (Correct Answer)**
 (B) Computer aided drug design

- (C) Topology of protein - protein interaction network prediction
(D) Predict promoter sequence

Question No.30 (Question Id - 189)

If a given mRNA sequence is 666 nt long starting from start codon and ending with stop codon, what would be the length of protein encoded with this sequence ?

- (A) 220
(B) **221 (Correct Answer)**
(C) 222
(D) 223

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