If 120 is 20% of a number then 120% of that number will be :

(A) ○ 740

(B) ○ **720 (Correct Answer)**

(C) ○ 660

(D) ○ 120

Question No.2 (Question Id - 4)

An unbiased die is tossed. The probability of getting an outcome of multiple of 3 :

(A) ○ $\frac{1}{6}$

(B) ○ $\frac{3}{6}$

(C) ○ $\frac{1}{3}$ **(Correct Answer)**

(D) ○ $\frac{1}{4}$

Question No.3 (Question Id - 5)

In a simultaneous throw of two coins, the probability of getting at least one head is :

(A) ○ $\frac{1}{2}$

(B) ○ $\frac{1}{3}$

(C) ○ $\frac{2}{3}$

(D) ○ $\frac{3}{4}$ **(Correct Answer)**

Question No.4 (Question Id - 10)

A playground has 64 meters long and 48 meters wide and in a rectangular shape. Another playground has the same area of rectangular shape with 24 meters wide. Then what is the perimeter of the later ?

(A) ○ **304 (Correct Answer)**

(B) ○ 152

(C) ○ 256

(D) ○ 224

Question No.5 (Question Id - 9)

If 5x + 32 = 4 - 2x, then what is the value of x ?

(A) ○ - 3

(B) ○ **- 4 (Correct Answer)**

(C) ○ 4

(D) ○ 7

Question No.6 (Question Id - 2)

The average of four consecutive even numbers is 27. The largest of these numbers is :

(A) ○ 42

(B) ○ 40

(C) ○ **30 (Correct Answer)**

(D) ○ 36

Question No.7 (Question Id - 6)

If the circumference and the area of a circle are numerically equal, then the diameter is equal to :

(A) ○ $\frac{\pi}{2}$

(B) ○ 2π

(D) ○ 30°

Question No.9 (Question Id - 7)

The three sides of a triangle are 5 cm, 12 cm and 13 cm respectively. Then, its area is :

(A) ○ $10\sqrt{3}\ cm^2$

(B) ○ **30 cm^2 (Correct Answer)**

(C) ○ $10\sqrt{6}\ cm^2$

(D) ○ 20 cm^2

Question No.10 (Question Id - 1)

Assume numbers in a data set S have a standard deviation of 5. If a new data set is formed by adding 3 to each number in S, then what is the standard deviation of the numbers in the new data set ?

(A) ○ 3

(B) ○ 2

(C) ○ **5 (Correct Answer)**

(D) ○ 8

SECTION 2 - Physics

Question No.1 (Question Id - 21)

A planet of mass m moves in the inverse square central force field of the sun of mass M. If the semi-major and semi-minor axes of the orbit are 'a' and 'b' respectively, the total energy of the planet is :

(A) ○ $\boxed{-\frac{GMm}{2a}}$ **(Correct Answer)**

(B) ○ $-GMm\left(\frac{1}{a}+\frac{1}{b}\right)$

(C) ○ $-\frac{GMm}{a}\left(\frac{1}{b}-\frac{1}{a}\right)$

(D) ○ $-GMm\left(\frac{a-b}{(a+b)^2}\right)$

Question No.2 (Question Id - 38)

The free energy difference between the superconducting and normal states of a material is given by : $\Delta F = F_S - F_N = \alpha |\Psi|^2 + \frac{\beta}{2} |\Psi|^4$, where Ψ is an order parameter and α and β are constants such that $\alpha > 0$ in the normal and $\alpha < 0$ in the superconducting state, while $\beta > 0$ always. The minimum value of ΔF in the superconducting state is :

(A) ○ $-\frac{\alpha^2}{\beta}$

(B) ○ $\boxed{-\frac{\alpha^2}{2\beta}}$ **(Correct Answer)**

(C) ○ $-\frac{3\alpha^2}{2\beta}$

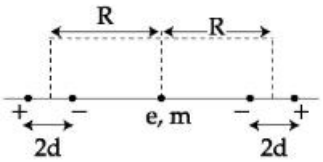
(D) ○ $-\frac{5\alpha^2}{2\beta}$

Question No.3 (Question Id - 29)

(C) ○ $\lambda = 2\cos nka$
(D) ○ $\lambda = 2\sin nka$

Question No.4 (Question Id - 18)

A particle of charge e and mass m is located at the midpoint of the line joining two mixed collinear dipoles with unit charges as shown below :



The particle is constrained to move only along the line joining the dipoles. Assuming that the length of the dipoles is much shorter than their separation, the natural frequency of oscillations of the particle is :

(A) ○ $\sqrt{\frac{6e^2R^2}{\pi\epsilon_0 md^2}}$

(B) ○ $\sqrt{\frac{6e^2R}{\pi\epsilon_0 md^4}}$

(C) ○ $\sqrt{\frac{6e^2d^2}{\pi\epsilon_0 mR^5}}$

(D) ○ $\sqrt{\frac{6e^2d}{\pi\epsilon_0 mR^4}}$ **(Correct Answer)**

Question No.5 (Question Id - 34)

A narrow beam of x-rays with wavelength 1.5 Å is reflected from an ionic crystal with an fcc lattice structure with a density of 3.32 gcm^{-3}. The molecular weight is 108 amu.
(1 amu ≡ 1.66 x 10^{-24} g). The lattice constant is :

(A) ○ **6.00 Å (Correct Answer)**
(B) ○ 4.56 Å
(C) ○ 4.00 Å
(D) ○ 2.56 Å

Question No.6 (Question Id - 27)

If the particle is represented by the normalised wave function :

$$\psi(x) = \begin{cases} \frac{\sqrt{15}\,(a^2 - x^2)}{4a^{5/2}} & \text{for } -a < x < a \\ 0 & \text{otherwise} \end{cases}$$

then the uncertainty Δp in its momentum is :

(A) ○ $\frac{2\hbar}{5a}$

(B) ○ $\frac{5\hbar}{2a}$

(C) ○ $\frac{\sqrt{10}\,\hbar}{a}$

(D) ○ $\frac{\sqrt{5}\,\hbar}{\sqrt{2}\,a}$ **(Correct Answer)**

Question No.7 (Question Id - 22)

Let *v*, p and E denote the speed, magnitude of the momentum and the energy of a free particle of rest mass m. Then, which of the following holds **true** ?

e eigen values of the matrix $M = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ are :

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

Question No.9 (Question Id - 16)

The area of a disc in its rest frame S is equal to 1 (in some units). The disc will appear distorted to an observer O moving with a speed 'u' with respect to S along the plane of the disc. The area of disc measured in the rest frame of the observer O is : (c ≡ speed of light in vacuum)

(A) ○ $\left(1-\frac{u^2}{c^2}\right)^{1/2}$ **(Correct Answer)**
(B) ○ $\left(1-\frac{u^2}{c^2}\right)^{-1/2}$
(C) ○ $\left(1-\frac{u^2}{c^2}\right)$
(D) ○ $\left(1-\frac{u^2}{c^2}\right)^{-1}$

Question No.10 (Question Id - 14)

The Fourier series for the function f (x) = x^2 for - π ≤ x ≤ π is $x^2 = \frac{\pi^2}{3} - 4\left(\cos x - \frac{\cos 2x}{2^2} + \frac{\cos 3x}{3^2} - \ldots\ldots\right)$. Which of the following is **True** ?

(A) ○ $\frac{\pi^2}{12} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \ldots\ldots$
(B) ○ $\frac{\pi^2}{12} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \ldots\ldots$
(C) ○ $\frac{\pi^2}{12} = 1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \ldots\ldots$ **(Correct Answer)**
(D) ○ None of the above

Question No.11 (Question Id - 35)

Consider that m gram of water at 0°C is mixed with an equal amount of water at 80°C. Consequently, the total change in entropy is given by :

(A) ○ 0.1367 m cal g^{-1} K^{-1}
(B) ○ **- 0.1203 m cal g^{-1} K^{-1} (Correct Answer)**
(C) ○ 0.0164 m cal g^{-1} K^{-1}
(D) ○ - 0.2570 m cal g^{-1} K^{-1}

Question No.12 (Question Id - 32)

In a single electron atom, corresponding to l =1 :

A. $J = \frac{3}{2}, m_j = -\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}, \frac{3}{2}$

B. $J = \frac{1}{2}, m_j = -\frac{1}{2}, \frac{1}{2}$

Which are **true** ?

(C) ○ ∞

(B) ○ $\frac{e^{ia}}{2ia}$ **(Correct Answer)**

(D) ○ 1

Question No.14 (Question Id - 19)

For the transformations :

A. Q = p, P = - q

B. Q = q tan p, P = *l*n sin p, whether :

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

(A) ○ Only A is canonical

(B) ○ Only B is canonical

(C) ○ **Both A and B are canonical (Correct Answer)**

(D) ○ Neither A nor B are canonical

Question No.15 (Question Id - 37)

Consider a one-dimensional Ising model with N spins, at very low temperatures when almost all the spins are aligned parallel to each other. There will be a few spin flips with each flip costing an energy 2 J.
In a configuration with r spin flips, the energy of the system is E = - NJ + 2rJ and the number of configuration is $^{N}C_{r}$; where r varies from 0 to N. The partition function is :

(A) ○ $\left(\frac{J}{K_B T}\right)^N$

(B) ○ $e^{-NJ/K_B T}$

(C) ○ $\left(\sinh\frac{J}{K_B T}\right)^N$

(D) ○ $\left(\cosh\frac{J}{K_B T}\right)^N$ **(Correct Answer)**

Question No.16 (Question Id - 39)

Bose condensation occurs in liquid He^4 kept at ambient pressure at 2.17 K. At which temperature will Bose condensation occur in He^4 gaseous state, the density of which is 1000 times smaller than that of liquid He^4 ?
(Assume that it is a perfect Bose gas)

(A) ○ 2.17 mK

(B) ○ **21.7 mK (Correct Answer)**

(C) ○ 21.7 μK

(D) ○ 2.17 μK

Question No.17 (Question Id - 23)

Four equal point charges are kept fixed at the four vertices of a square. How many neutral points (i.e., points where electric field vanishes) will be found inside the square ?

(A) ○ 3

(B) ○ 4

(C) ○ **5 (Correct Answer)**

(D) ○ 7

Question No.18 (Question Id - 17)

Question No.19 (Question Id - 40)

Consider a system of N particles and phase space consisting of only two states with energies 0 and ϵ (>0). The internal energy is given by :

(A) $\frac{N}{1+e^{\epsilon/K_BT}}$

(B) $\frac{N}{1-e^{-\epsilon/K_BT}}$

(C) $1 + e^{-\epsilon/K_BT}$

(D) $\frac{N\epsilon}{1+e^{\epsilon/K_BT}}$ **(Correct Answer)**

Question No.20 (Question Id - 26)

A permanently deformed even-even nucleus with $J^P = 2^+$ has rotational energy 93 keV. The energy of the next excited state is :

(A) 372 keV

(B) **310 keV (Correct Answer)**

(C) 273 keV

(D) 186 keV

Question No.21 (Question Id - 12)

Residue of $f(z) = \frac{z^2}{(z-a)(z-b)(z-c)}$ at $z = \infty$:

(A) ∞

(B) $-\infty$

(C) **- 1 (Correct Answer)**

(D) 0

Question No.22 (Question Id - 36)

At what temperature is the rms speed of hydrogen molecules equal to twice of that of oxygen molecules at 63°C ?
(Given that oxygen molecule is about 16 times heavier than a hydrogen molecule)

(A) - 179°C

(B) **- 189°C (Correct Answer)**

(C) - 199°C

(D) - 209°C

Question No.23 (Question Id - 30)

For $\mathbf{T} = \begin{pmatrix} 1 & 1-i \\ 1+i & 0 \end{pmatrix}$, which of the following are **true** ?

(A) **T** is hermitian

(B) **T** has real eigen values

(C) **T** is diagonalizable

(D) **All of the above (Correct Answer)**

Question No.24 (Question Id - 31)

Pauli spin matrices are defined as

$\sigma_x \equiv \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \sigma_y \equiv \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}, \sigma_z \equiv \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

Which one of the following is **true** ?

(C) ○ ab
(D) ○ ma (Correct Answer)

Question No.26 (Question Id - 24)

Consider the interference of the coherent electromagnetic waves, whose electric field vectors are given by $\overrightarrow{E_1} = \hat{i}\, E_0 \cos \omega t$ and $\overrightarrow{E_2} = \hat{j}\, E_0 \cos(\omega t + \phi)$, where ϕ is the phase difference. The intensity of resulting wave is given by $\frac{\epsilon_0}{2} \langle E^2 \rangle$, where $\langle E^2 \rangle$ is the time average of E^2. The total intensity is :

(A) ○ 0
(B) ○ $\epsilon_0 E_0^2$ **(Correct Answer)**
(C) ○ $\epsilon_0^2 E_0^2 \sin^2\phi$
(D) ○ $\epsilon_0 E_0^2 \cos^2\phi$

Question No.27 (Question Id - 33)

The magnetic energy V_m for an electron in the 2p state of a hydrogen atom using the Bohr model, whose n = 2 state corresponds to the 2p state is :

(A) ○ 2.3×10^{-3} eV
(B) ○ **2.3×10^{-5} eV (Correct Answer)**
(C) ○ 3.2×10^{-3} eV
(D) ○ 3.2×10^{-5} eV

Question No.28 (Question Id - 28)

Consider the three-dimensional infinite cubical well,

$$V(x, y, z) = \begin{cases} 0, \text{ if } 0<x<a, 0<y<a, 0<z<a \\ \infty, \text{ otherwise} \end{cases}$$

Now lets introduce a perturbation which is of the form

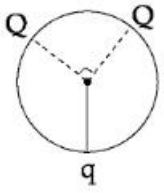
$$H' = \begin{cases} V_0 \text{ if } & 0<x<a/2 \\ & 0<y<a/2 \\ 0, & \text{otherwise} \end{cases}$$

The first order correction to the ground state energy is :

(A) ○ $V_0/2$
(B) ○ **$V_0/4$ (Correct Answer)**
(C) ○ $V_0/6$
(D) ○ $V_0/8$

Question No.29 (Question Id - 25)

Three charges are located on the circumference of a circle of radius R, as shown below.



The two charges Q subtend an angle 90° at the centre of the circle. The charge q is symmetrically placed with respect to the charges Q. If the electric field at the centre of circle is zero, what is the magnitude of Q ?

(A) ○ $q/\sqrt{2}$ **(Correct Answer)**

(B) ○ $\frac{1}{2}m\left[\left(1+a^2r^2\right)\dot{r}^2+r^2\dot{\phi}^2+gar^2\right]$

(C) ○ $\frac{1}{2}m\left(\dot{r}^2+r^2\dot{\theta}^2+r^2\sin\dot{\phi}^2-gar^2\right)$

(D) ○ $\frac{1}{2}m\left[\left(1+a^2r^2\right)\dot{r}^2+r^2\dot{\phi}^2-gar^2\right]$ **(Correct Answer)**

SECTION 3 - Chemistry

Question No.1 (Question Id - 63)

Term symbol for the ground electronic state of O_2 molecule is :

(A) ○ $^3\sum_g^-$ **(Correct Answer)**

(B) ○ $^3\sum_u^-$

(C) ○ $^1\sum_g^-$

(D) ○ $^1\sum_u^-$

Question No.2 (Question Id - 52)

Different gases having the same equation of state while described in terms of dimensionless reduced variables is called :

(A) ○ Franck-Condon principle

(B) ○ **Law of corresponding state (Correct Answer)**

(C) ○ Heisenberg's uncertainty principle

(D) ○ de-Broglie equation

Question No.3 (Question Id - 53)

The coefficient of compressibility (β) is :

(A) ○ $\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$

(B) ○ $\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

(C) ○ $\frac{1}{V}\left(\frac{\partial P}{\partial V}\right)_T$

(D) ○ $-\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$ **(Correct Answer)**

Question No.4 (Question Id - 42)

Cyclohexanone $\xrightarrow{A}$ $\xrightarrow{B}$ $\xrightarrow{C}$ Cyclohexylamine. Identify reagents A, B and C.

(A) ○ A ≡ Ph - CH_2NH_2/H^+, B ≡ H_3O^+, C ≡ t-BuOK

(B) ○ A ≡ H_3O^+, B ≡ Ph - CH_2NH_2/H^+ , C ≡ t-BuOK

(C) ○ A ≡ H_3O^+, B ≡ t-BuOK, C ≡ Ph - CH_2NH_2/H^+

(D) ○ **A ≡ $PhCH_2NH_2/H^+$, B ≡ t-BuOK, C ≡ H_3O^+ (Correct Answer)**

Question No.5 (Question Id - 58)

What is the value of square integrable quantum wave function at boundaries ?

(A) ○ *i*

(B) ○ ∞

(C) ○ - ∞

(D) ○ **0 (Correct Answer)**

Question No.6 (Question Id - 48)

(B) ○ 2
(C) ○ 0 (Correct Answer)
(D) ○ 1
(E) ○ 3

Question No.8 (Question Id - 65)

Calculate the proportions of I_2 molecules in their first excited vibrational state at 25°C. The vibrational wave number is 214.6 cm^{-1}.

(A) ○ **0.229 (Correct Answer)**
(B) ○ 1/0.229
(C) ○ 0.0229
(D) ○ 1/0.0229

Question No.9 (Question Id - 56)

For the chemical equilibrium $CaCO_3(s) = CaO(s) + CO_2(g)$ which pair of variables can determine ΔH, using a linear plot of data ?

(A) ○ $\log_e(P_{CO_2}), \frac{1}{T}$ **(Correct Answer)**
(B) ○ $\log_e(P_{CO_2}), T$
(C) ○ $\log_e(P_{CO_2}), \log_e(T)$
(D) ○ $P_{CO_2}, \frac{1}{T}$

Question No.10 (Question Id - 50)

In Boltzmann statistics, what is the possible number of microstates, given that total energy = 3ε and total number of particles = 3 among energy levels 0, ε, 2ε ?

(A) ○ 1
(B) ○ **2 (Correct Answer)**
(C) ○ 4
(D) ○ Infinite

Question No.11 (Question Id - 67)

Under the harmonics approximation, what is the force constant (K) for HCl molecule, if it shows a strong infrared absorption at 2991 cm^{-1} ?
(m_H = 1.0078250 amu, C = 2.998 x 10^8 ms^{-1}, 1 amu =1.661 x 10^{-27} kg,
m_{Cl} = 34.9688527 amu)

(A) ○ **516.3 Nm^{-1} (Correct Answer)**
(B) ○ 0.717 Nm^{-1}
(C) ○ 575 Nm^{-1}
(D) ○ 577 Nm^{-1}

Question No.12 (Question Id - 54)

At 700 K, CO_2 and H_2 react to form CO and H_2O, where K_c is 0.64. If a mixture of 0.45 mole of CO_2 and 0.45 mole of H_2 is heated to 700 K, what is the amount of each gas at equilibrium ?

(A) ○ 1 mole
(B) ○ 0.025 mole
(C) ○ **0.25 mole (Correct Answer)**
(D) ○ 40 mole

(C) ○ + 2, + 1 and - 2
(B) ○ 0, + 1 and + 2
(D) ○ -2, + 1 and -2

Question No.15 (Question Id - 66)

The values of $(n_1 + n_2)$ and $(n_2^2 - n_1^2)$ for He^+ ion in atomic spectra are 4 and 8 respectively. The wavelength of emitted photon when e^- jumps from n_2 to n_1 is :

(A) ○ $\frac{32}{9} R_H$

(B) ○ $\frac{9}{32} R_H$

(C) ○ $\frac{9}{32 R_H}$ **(Correct Answer)**

(D) ○ $\frac{32}{9 R_H}$

Question No.16 (Question Id - 44)

The expression for the reversible isothermal work of an expansion of one mole of Vander Waals gas is :

(A) ○ $-RT\, ln\left(\frac{V_2 - b}{V_1 - b}\right) - a\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

(B) ○ $RT\, ln\left(\frac{V_2 - b}{V_1 - b}\right) - a\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

(C) ○ $-RT\, ln\left(\frac{V_2 - b}{V_1 - b}\right) + a\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$ **(Correct Answer)**

(D) ○ $RT\, ln\left(\frac{V_2 - b}{V_1 - b}\right) + a\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

Question No.17 (Question Id - 45)

Under what conditions heat of reaction equal to enthalpy change ?

(A) ○ **Isobaric (Correct Answer)**

(B) ○ Isochoric

(C) ○ Isothermal

(D) ○ Adiabatic

Question No.18 (Question Id - 62)

Arrange the following compounds in the order of increasing conductance :
HCl, LiCl, NaCl, KCl :

(A) ○ $\Lambda_m(HCl) < \Lambda_m(KCl) < \Lambda_m(NaCl) < \Lambda_m(LiCl)$

(B) ○ $\Lambda_m(NaCl) < \Lambda_m(LiCl) < \Lambda_m(KCl) < \Lambda_m(HCl)$

(C) ○ **$\Lambda_m(LiCl) < \Lambda_m(NaCl) < \Lambda_m(KCl) < \Lambda_m(HCl)$ (Correct Answer)**

(D) ○ $\Lambda_m(LiCl) < \Lambda_m(HCl) < \Lambda_m(NaCl) < \Lambda_m(KCl)$

Question No.19 (Question Id - 69)

The absorbance, A of a sample at a given frequency of radiation is related to the percentage transmittance T% :

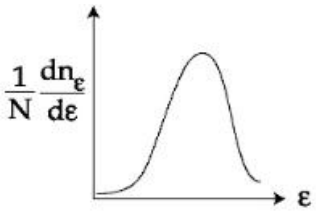
(A) ○ **A = 2 - log (T) (Correct Answer)**

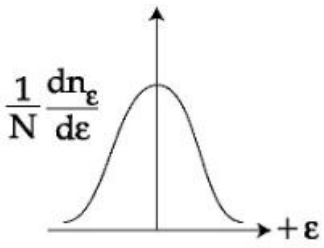
(B) ○ A = log (T)

(C) ○ $A = \left(\frac{1}{T}\right)$

(D) ○ $A = \left(\frac{2}{T}\right)$

(B) ○ 

(C) ○ 

(D) ○ 

Question No.21 (Question Id - 46)

If $C_V\left(\frac{\partial P}{\partial V}\right)_S = C_P\left(\frac{\partial P}{\partial V}\right)_T$, then for reversible adiabatic process of an ideal gas, we can write :

A. $\left(\frac{dP}{P}\right) + \gamma\left(\frac{dV}{V}\right) = 0$ where $\gamma = (C_P/C_V)$

B. $T.P^{(\gamma - 1)/\gamma}$ = Constant

C. $P(V - b)^{\gamma-1}$ = Constant

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

(A) ○ **A and B only (Correct Answer)**
(B) ○ A and C only
(C) ○ B and C only
(D) ○ A, B and C only

Question No.22 (Question Id - 61)

Calculate E^0 for the half cell reaction, $Fe^{3+}(aq.) + 3e \rightarrow Fe(s)$, given that $E^0_{Fe^{3+}/Fe^{2+}} = 0.771\ V$ and $E^0_{Fe^{3+}/Fe} = -0.447$.

(A) ○ 0.324 V
(B) ○ - 0.324 V
(C) ○ - 0.041 V
(D) ○ **0.041 V (Correct Answer)**

Question No.23 (Question Id - 59)

What is the eigen value for eigen function of $f(x) = x^2e^{6y}$, the operator $\hat{A} = \frac{\partial}{\partial y}$?

(A) ○ 2
(B) ○ 3
(C) ○ **6 (Correct Answer)**
(D) ○ 12

Question No.24 (Question Id - 57)

(A) ○ $mol^{n} L^{n-1} S^{-n}$
(B) ○ $mol\ L^{n-1} S^{-n}$
(C) ○ $mol^{1-n} L^{(n-1)} S^{-1}$ **(Correct Answer)**
(D) ○ $mol^{1-n} L^{(1-n)} S^{-1}$

Question No.26 (Question Id - 70)

The spin-quantum number of ^{13}C is :

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

Question No.27 (Question Id - 49)

Energy levels of a system is raised by 1 a.u., while internal energy of the system is raised by 1 a.u., change in entropy is :

(A) ○ Negative
(B) ○ **Zero (Correct Answer)**
(C) ○ Positive
(D) ○ Imaginary

Question No.28 (Question Id - 43)

Arrange the following molecules in order of increasing standard molar entropy for $CH_2Cl_2(g)$, $CHCl_3(g)$ and $CH_3Cl(g)$.

(A) ○ $S^0[CH_3Cl(g)] = S^0[CH_2Cl_2(g)] = S^0[CHCl_3(g)]$
(B) ○ $S^0[CH_2Cl_2(g)] > S^0[CH_3Cl(g)] > S^0[CHCl_3(g)]$
(C) ○ $S^0[CH_3Cl(g)] > S^0[CH_2Cl_2(g)] > S^0[CHCl_3(g)]$
(D) ○ **$S^0[CH_3Cl(g)] = S^0[CH_2Cl_2(g)] > S^0[CHCl_3(g)]$ (Correct Answer)**

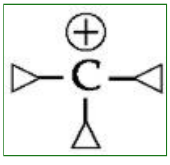
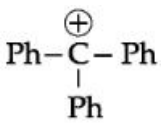
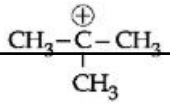
Question No.29 (Question Id - 68)

The rotational microwave spectrum constant (B) for HCl is 10.59342 cm^{-1}. What is the bond length of HCl ? Given : h = 6.626 x 10^{-34} Js, C = 2.998 x 10^{8} ms^{-1}, 1 amu = 1.661 x 10^{-27} kg, m_H = 1.0078250 amu, m_{Cl} = 34.96885270 amu.

(A) ○ **1.27455 x 10^{-10} m (Correct Answer)**
(B) ○ 7 x 10^{-10} m
(C) ○ 1.274551 m
(D) ○ 1.27455 x 10^{-15} m

Question No.30 (Question Id - 41)

Which carbocation is the most stable among them ?

(A) ○  **(Correct Answer)**
(B) ○ 
(C) ○ 

(C) ○ - (1 + log y) / (1 + log z) **(Correct Answer)**

(D) ○ - (1 + log x) / (1 +log z)

(D) ○ (1 + log y) / (1 +log x)

Question No.2 (Question Id - 88)

If X has the probability density function of the form

$$f(x) = e^{-\lambda x}\lambda^{\alpha}\frac{x^{\alpha-1}}{\Gamma(\alpha)}, x \geq 0$$

then it is said to have a gamma distribution with parameters $\alpha > 0$ and $\lambda > 0$, then one can write

$X \sim \Gamma(\alpha, \lambda)$

If we put $\alpha = 1$, then this gamma distribution reduces to :

(A) ○ log-normal

(B) ○ normal

(C) ○ **exponential (Correct Answer)**

(D) ○ binomial

Question No.3 (Question Id - 90)

If a vector space V has a basis of n elements then any set of n + 1 vectors is :

(A) ○ Also a basis of V

(B) ○ Linearly independent

(C) ○ **Linearly dependent (Correct Answer)**

(D) ○ Linear combination does not exists

Question No.4 (Question Id - 73)

Let $P_n(x)$ be the Legendre Polynomial of degree n, then using Rodrigue's formula, values of $P_3(x)$, $P_4(x)$ are :

(A) ○ $(5x^3 - 3x), (35x^4 - 30x^2 - 3)$

(B) ○ $\frac{1}{2}(5x^3 - 3x), \frac{1}{8}(35x^4 - 30x^2 + 3)$ **(Correct Answer)**

(C) ○ $\frac{1}{3}(5x^3 - 3x), \frac{1}{16}(35x^4 - 30x^2 - 3)$

(D) ○ $\frac{1}{4}(5x^3 + 3x), \frac{1}{16}(35x^3 - 30x^2 - 3)$

Question No.5 (Question Id - 98)

The number of odd degree vertices in a finite, simple, undirected graph is :

(A) ○ **Even (Correct Answer)**

(B) ○ Odd

(C) ○ Always a multiple of 3

(D) ○ Can be odd or even

Question No.6 (Question Id - 100)

A conic combination of a set of vectors $v_1, \ldots\ldots, v_n \in \mathbf{R}^d$ is :

(A) ○ $\left\{y \in \mathbf{R}^d : y = \sum_{i=1}^{n} \lambda_i v_i\right\}$

(B) ○ $\left\{y \in \mathbf{R}^d : y = \sum_{i=1}^{n} \lambda_i v_i, \lambda_i \geq 0, \sum \lambda_i = 1\right\}$

(C) ○ $\left\{y \in \mathbf{R}^d : y = \sum_{i=1}^{n} \lambda_i v_i, \sum \lambda_i = 0\right\}$

(D) ○ $\left\{y \in \mathbf{R}^d : y = \sum \lambda_i v_i, \lambda_i \geq 0\right\}$ **(Correct Answer)**

Question No.8 (Question Id - 74)

The form of the Legendre's differential equation is

(A) ○ $\left(1-x^2\right)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+n(n+1)y=0, n\in R$ **(Correct Answer)**

(B) ○ $\left(1+x^2\right)\frac{d^2y}{dx^2}+2x^2\frac{dy}{dx}+n(n+1)y=0, n\in R$

(C) ○ $\left(1-x^2\right)^2\frac{d^3y}{dx^3}+2x\frac{dy}{dx}+n(n-1)y=0, n\in R$

(D) ○ $\left(1-x^2\right)\frac{dy}{dx}-2x\left(\frac{dy}{dx}\right)^2+n(n+1)y=0, n\in R$

Question No.9 (Question Id - 84)

The probability distribution of a random variable X is given in the adjoining table.

x	:	-2	3	1
p(x)	:	1/3	1/2	1/6

If Y = (2X + 5), what is the variance of Y ?

(A) ○ 5

(B) ○ **20 (Correct Answer)**

(C) ○ 25

(D) ○ 0

Question No.10 (Question Id - 75)

The solution of $\frac{d^2y}{dx^2}\left(e^x+1\right)+\frac{dy}{dx}=0$ is

(A) ○ $C_1 \tan^{-1}x + C_2$

(B) ○ **$C_1 (x - e^{-x}) + C_2$ (Correct Answer)**

(C) ○ $x^2 + C_2x + C_1$

(D) ○ $C_1e^{\lambda_1 x} + C_2e^{\lambda 2x}$

Question No.11 (Question Id - 97)

Every graph G = (V, E) with m = |E| satisfies the following inequality on its chromatic number χ(G) :

(A) ○ $\chi(G)\le\sqrt{m+2}$

(B) ○ $\chi(G)\le\sqrt{2m+\frac{1}{4}}$

(C) ○ $\chi(G)\le\frac{1}{2}+\sqrt{2m}$

(D) ○ $\chi(G)\le\frac{1}{2}+\sqrt{2m+\frac{1}{4}}$ **(Correct Answer)**

Question No.12 (Question Id - 83)

According to the Chebyshev's theorem at least what percentage of the data values lies between $(\overline{X}\pm 2.3\sigma)$?

(A) ○ 43.48%

(B) ○ 56.52%

(C) ○ **81.10% (Correct Answer)**

(D) ○ 18.90%

Question No.13 (Question Id - 81)

The kinematic viscosity of a liquid is 6 stokes and specific gravity is 1.9. The viscosity of the liquid is :

(A) ○ 4 (Correct Answer)
(B) ○ 5
(C) ○ 6
(D) ○ n

Question No.15 (Question Id - 99)

Which of the following are equivalent to the following statement ?

T = (V, E) is a tree.

(A) ○ Any two vertices of T are connected by a simple path.
(B) ○ |V(T)| = |E(T)| - 1.
(C) ○ T is a maximally acyclic graph, i.e., T is acyclic, but adding any edge in $\binom{V}{2} \setminus E$ creates a cycle in T.
(Correct Answer)
(D) ○ **T is a minimally connected graph, i.e., T is connected, but T \ e is disconnected for any e ϵ E(T).**

(Correct Answer)

Question No.16 (Question Id - 77)

The solution of the differential equation $\frac{d^2y}{dx^2}+\frac{1}{x}\frac{dy}{dx}=\frac{12}{x^2}\log x$ is :

(A) ○ $C_1 \log x + C_2 + 2 \log x^3$
(B) ○ **$C_1 + C_2 \log x + 2 (\log x)^3$ (Correct Answer)**
(C) ○ $C_1 + xC_2 + (\log x)^3$
(D) ○ $C_1x + x^2C_2 + (\log x)$

Question No.17 (Question Id - 86)

The first four moments of a distribution about the origin are 1, 4, 10 and 46 respectively. The value of Karl Pearson's Coefficient β_1 is :

(A) ○ 100/64
(B) ○ 100/46
(C) ○ **0 (Correct Answer)**
(D) ○ 16/46

Question No.18 (Question Id - 89)

Let, W = {(x, y, z)ϵR^3 : x - 4y + 3z = 0}. The dimension of W is :

(A) ○ 1
(B) ○ **2 (Correct Answer)**
(C) ○ 3
(D) ○ 4

Question No.19 (Question Id - 79)

Equation of motions of a particle are given by : $\frac{dx}{dt}+\omega y=0$ and $\frac{dy}{dt}-\omega x=0$. It's path of motion is :

(A) ○ Hyperbola
(B) ○ Ellipse
(C) ○ Parabola
(D) ○ **Circle (Correct Answer)**

Question No.20 (Question Id - 87)

(A) ○ $A=\begin{pmatrix}\cos\varphi & \sin\varphi\\ \sin\varphi & -\cos\varphi\end{pmatrix}$

(B) ○ $A=\begin{pmatrix}\sin\varphi & -\sin\varphi\\ \cos\varphi & \cos\varphi\end{pmatrix}$

(C) ○ $A=\begin{pmatrix}\cos\varphi & -\sin\varphi\\ \sin\varphi & \cos\varphi\end{pmatrix}$ **(Correct Answer)**

(D) ○ $A=\begin{pmatrix}\sin\varphi & \cos\varphi\\ -\cos\varphi & -\sin\varphi\end{pmatrix}$

Question No.22 (Question Id - 92)

The quadratic surface whose equation is $4x^2 + 9y^2 - z^2 - 54y - 50z = 544$ is described by :

(A) ○ Hyperboloid of two sheets

(B) ○ Hyperboloid of one sheet

(C) ○ **Elliptic cone (Correct Answer)**

(D) ○ Elliptic paraboloid

Question No.23 (Question Id - 71)

The value of $x\,J_n'(x)$ is, when $J_n(x)$ is Bessel function of first kind and order n :

(A) ○ **$x\,J_{n-1}(x) - n\,J_n(x)$ (Correct Answer)**

(B) ○ $x\,J_{n+1}(x) - n^2\,J_n(x)$

(C) ○ $x^2\,J_{n-1}(x) + n\,J_n(x)$

(D) ○ $x\,J_{n-1}(x) - (n+1)\,J_n(x)$

Question No.24 (Question Id - 94)

Let $A=\begin{pmatrix}3 & 2 & 1\\ 2 & 3 & 1\\ 1 & 1 & 4\end{pmatrix}$.

The maximum value and the unit vector (subject to the constraint $X\cdot\bar{X}=1$) at which the maximum value is attained, is :

(A) ○ Maximum value = 6 ; unit vector = $\begin{pmatrix}1/\sqrt{3}\\ 1/\sqrt{3}\\ 1/\sqrt{3}\end{pmatrix}$ **(Correct Answer)**

(B) ○ Maximum value = 3 ; unit vector = $\begin{pmatrix}1/\sqrt{3}\\ 1/\sqrt{3}\\ 1/\sqrt{3}\end{pmatrix}$

(C) ○ Maximum value = 4 ; unit vector = $\begin{pmatrix}1/\sqrt{4}\\ 1/\sqrt{4}\\ 1/\sqrt{4}\end{pmatrix}$

(D) ○ Maximum value = 1 ; unit vector = $\begin{pmatrix}1\\ 1\\ 1\end{pmatrix}$

Question No.25 (Question Id - 72)

First order derivative of $x\,J_1(x)$ is given by :

Where $J_1(x)$ is the Bessel function of the first kind with order one.

(A) ○ **$x\,J_0(x)$ (Correct Answer)**

(B) ○ $-x\,J_0(x)$

(D) ◯ $y = C_1 \tan x + C_2$

Question No.27 (Question Id - 82)

The motion in which the velocity potential is single-valued is called :

(A) ◯ Laminar

(B) ◯ Turbulent

(C) ◯ Cyclic

(D) ◯ **Acyclic (Correct Answer)**

Question No.28 (Question Id - 76)

The solution of the differential equation $x\frac{dy}{dx} + 2y = 12x$ is :

(A) ◯ $x^2 + \frac{C}{4x}$

(B) ◯ $4x + \frac{C}{x^2}$ **(Correct Answer)**

(C) ◯ $4x + \frac{C}{x}$

(D) ◯ $4x^2 + \frac{C}{x^2}$

Question No.29 (Question Id - 95)

The tightest upper bound on the maximum number of edges in a planar bipartite graph with n vertices is at most :

(A) ◯ 2n - 6

(B) ◯ 3n - 6

(C) ◯ **2n - 4 (Correct Answer)**

(D) ◯ 2n - 3

Question No.30 (Question Id - 91)

Let, $A = \begin{pmatrix} -3 & 2 \\ -2 & 1 \end{pmatrix}$

Then :

(A) ◯ **A is not diagonalizable (Correct Answer)**

(B) ◯ A is diagonalizable

(C) ◯ The eigen space of A is 2-dimensional

(D) ◯ A has two distinct eigen values

SECTION 5 - Computer Science - Programming

Question No.1 (Question Id - 118)

Non-left recursive version of the following grammar
S → S + A | A
A → A - B | C
C → (S) | a
wil be :

(A) ◯ S → AS, S → + AS | ∈, A → CA, A → - B A | ∈, C → (S) | a

(B) ◯ S → AS', S' → + AS', A → CA', A' → - BA', C → (S) | a

(C) ◯ **S → AS', S' → + AS' | ∈, A → CA', A' → - BA'|∈, C → (S) | a (Correct Answer)**

(D) ◯ S → AS', S' → + AS' | ∈, A → CA, A → - BA|∈, C → (S) | a

Question No.2 (Question Id - 115)

Which one of the following is a top-down parser ?

(A) ◯ ~~Recursive descend parser (Correct Answer)~~

(B) ◯ Operator precedence parser

```
Wait (S);                    Signal (S);
critical section             critical section
Signal (S);                  Signal (S);
}                            }
while (true);                while (true);
```

Assuming that initial value of semaphore S is 1, find the maximum no. of possible processes that can be there in their critical section simultaneously :

(A) ○ 2
(B) ○ **20 (Correct Answer)**
(C) ○ 10
(D) ○ 8

Question No.4 (Question Id - 114)

Which set represents the language generated by the following grammar ?
S → 1A0
A → 1A0 |∈
Where S is the starting symbol, set of terminals is {0, 1}, set of non-terminals is {S, A}, ∈ is the null symbol.

(A) ○ $\{1^n 0^n \mid n \geq 0\}$
(B) ○ **$\{1^n 0^n \mid n > 0\}$ (Correct Answer)**
(C) ○ $\{1^m 0^n \mid m \geq 0, n \geq 0\}$
(D) ○ $\{1^m 0^n \mid m > 0, n > 0\}$

Question No.5 (Question Id - 105)

Which problem can't be solved efficiently using dynamic programming ?
(A) ○ Matrix-Chain Multiplication
(B) ○ Longest Common Subsequence
(C) ○ **Huffman Coding (Correct Answer)**
(D) ○ Optimal Binary Search Tree

Question No.6 (Question Id - 119)

Which of the CPU scheduling algorithm is suitable for multi-user system ?
(A) ○ Shortest Job First
(B) ○ **Round Robin (Correct Answer)**
(C) ○ Priority Algorithm
(D) ○ First Come First Serve

Question No.7 (Question Id - 116)

Choose the correct answer from the options given below :

(A) ○ A → II, B → III, C → IV, D → I

(B) ○ A → II, B → I, C → III, D → IV

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

(D) ○ A → I, B → IV, C → II, D → III

Question No.8 (Question Id - 113)

Which string belong to the regular expression (1 + 01)* ?

(A) ○ 1010

(B) ○ 1001

(C) ○ **1011 (Correct Answer)**

(D) ○ 0011

Question No.9 (Question Id - 128)

Total number of keys required for a set of 25 persons to be able to communicate with each other securely using symmetric key cryptosystem and public key cryptosystem, respectively are :

(A) ○ 600, 50

(B) ○ 600, 25

(C) ○ **300, 50 (Correct Answer)**

(D) ○ 300, 25

Question No.10 (Question Id - 104)

How many comparisons will be done in insertion sort for the following input ?
2 4 6 8 9 7 5 3 1

(A) ○ 24

(B) ○ 28

(C) ○ 30

(D) ○ **27 (Correct Answer)**

Question No.11 (Question Id - 130)

Person X is sending secure message to person Y. X encrypts message M, using Y's public key and also attaches his digital signature to the encrypted message. We have four security goals to achieve

I. Confidentiality

II. Authentication

III. Integrity

IV. Non-repudiation

Which security goals are achieved using given form of communication ?

(A) ○ Only I and II

(B) ○ **Only I, II and III (Correct Answer)**

(C) ○ Only II and III

(D) ○ Only I, III and IV

Question No.12 (Question Id - 106)

(A) ○ 2
(B) ○ 3
(C) ○ 1
(D) ○ **4 (Correct Answer)**

Question No.13 (Question Id - 127)

A bit-stuffing based protocol uses an 8-bit delimeter pattern 01111110. If the output bit string after bit-stuffing is 01111011111011101, then the input bit string is :

(A) ○ 0111101111101101
(B) ○ **0111101111111101 (Correct Answer)**
(C) ○ 011111011111011101
(D) ○ 01111111111011101

Question No.14 (Question Id - 120)

Assume that the current head position of the disk lies at track 30 and there are requests to process I/O operations at tracks - 36, 25, 40, 60, 55, 78 in queue. Find the total seek time for shortest seek time first algorithm, assuming that time taken to move head between two consecutive track is 1 millisecond :

(A) ○ **58 milliseconds (Correct Answer)**
(B) ○ 50 milliseconds
(C) ○ 78 milliseconds
(D) ○ 36 milliseconds

Question No.15 (Question Id - 117)

Transformation of the following grammar
S→iEtS| iEtSeS| iEtSeiEtS| a
into equivalent grammar using left factoring will be :

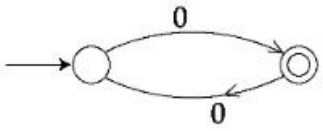
(A) ○ S→∈| iEtS|eS|eiEtS|a
(B) ○ S → iEtS |eiEtS|eS|a
(C) ○ S → iEtSS' | a
S' → eS | eiEtS
(D) ○ **S → iEtSS'|a**

S' → eiEtS|eS|∈

(Correct Answer)

Question No.16 (Question Id - 112)

The regular expression for the language recognized by the finite state automaton is :



(A) ○ 0
(B) ○ (000)*
(C) ○ **(00)*0 (Correct Answer)**
(D) ○ (00)*

Question No.17 (Question Id - 110)

Characters a, b, c, d of string “abcd” are pushed on to a stack in the same order, but character on stack top can be popped out at any time. Which one of the following strings cannot be generated as output ?

(C) ○ packet 3 has been received uncorrupted, but packets 0, 1, 2 are corrupted.
(D) ○ **packet 3 has been received uncorrupted, status of packets 0, 1, 2 are unknown (Correct Answer)**

Question No.19 (Question Id - 126)

Let R_1 & R_2 are two relation schemas such that $R_2 \subseteq R_1$. An schema $R_3 = R_1 - R_2$ is defined so that $R_3 \times R_2 \subseteq R_1$. Then what is the relationship between schemas R_1, R_2 & R_3 ?

(A) ○ **$R_3 = R_1 \div R_2$ (Correct Answer)**
(B) ○ $R_3 = R_1 \times R_2$
(C) ○ $R_3 = R_1 \bowtie R_2$
(D) ○ $R3 = R_1 - R_2$

Question No.20 (Question Id - 124)

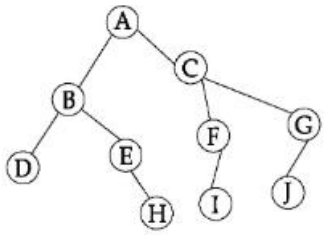
Consider three data items A, B, and C and the following execution schedule of transactions T_1, T_2 and T_3. In the diagram, R(D) and W(D) denote Reading & Writing the item respectively.

T_1	T_2	T_3
	R(C)	
	R(B)	
	W(A)	
		R(B)
		R(C)
R(A)		
W(A)		
		W(B)
		W(C)
	R(A)	
R(B)		
W(B)		
	W(A)	

(A) ○ The schedule is serializable as T_2; T_3; T_1
(B) ○ The schedule is serializable as T_2; T_1; T_3
(C) ○ The schedule is serializable as T_3; T_2; T_1
(D) ○ **The schedule is not serializable (Correct Answer)**

Question No.21 (Question Id - 108)

Which of the following traversal corresponds to a Preorder traversal for the given tree ?



(A) ○ ABCDEFGHIJ
(B) ○ **ABDEHCFIGJ (Correct Answer)**
(C) ○ DHEBIFJGCA
(D) ○ DBEHAIFCJG

Question No.22 (Question Id - 101)

Von Neumann computers belong to which one of the following classes of computer ?

(A) ○ SIMD
(B) ○ MIMD

Question No.24 (Question Id - 125)

Let R = (A, B, C, D, E, F) be a relation schema with the functional dependencies C → F, E → A, EC → D & A → B. Which of the following is a key of R ?

(A) ○ CD
(B) ○ **EC (Correct Answer)**
(C) ○ AE
(D) ○ AC

Question No.25 (Question Id - 109)

Which of the following stack configuration is not possible to solve the arithmetic expression - ((4 x 5) - (6 + 7)) ?

(A) ○

6
20

(B) ○

7
6
20

(C) ○

13
20

(D) ○

13
5
4

(Correct Answer)

Question No.26 (Question Id - 111)

Which statement is **true** about Turing Machine ?

(A) ○ It has read head only.
(B) ○ It has write head only.
(C) ○ **It has read/write head. (Correct Answer)**
(D) ○ It requires extra tape (storage) other than input tape.

Question No.27 (Question Id - 121)

Assume that main memory access time is 1 millisecond and associative memory access time is 1 microsecond, then find an estimated probability of associative memory hit if the effective main memory access time is not more than 100 microseconds :

(A) ○ 0.01
(B) ○ 0.001
(C) ○ **0.1 (Correct Answer)**
(D) ○ 0.0001

Question No.28 (Question Id - 103)

Time complexity of matrix multiplication is :

(A) ○ $\Theta(n^3)$ **(Correct Answer)**
(B) ○ $\Theta(n^2)$
(C) ○ $\Theta(n \lg n)$

service program starts.

(C) ○ Execution of the current instruction is completed and the interrupt service program starts.

(D) ○ Execution of current instruction is aborted and the interrupt service program starts.

Question No.30 (Question Id - 107)

What is the worst case time required to search a given element in a sorted linked list of length n ?

(A) ○ O(1)

(B) ○ $O(\log_2 n)$

(C) ○ **O(n) (Correct Answer)**

(D) ○ $O(n \log_2 n)$

SECTION 6 - Life Science - Biotechnology

Question No.1 (Question Id - 147)

Given below are two statements :

Statement I :

In two-dimensional gel electrophoresis, first dimension is SDS - PAGE.

Statement II :

In two-dimensional gel electrophoresis, the second dimension is Iso-electric Focusing (IF).

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.2 (Question Id - 138)

Which of the following is a consequence of incomplete removal of topological links during DNA replication ?

(A) ○ Ligation

(B) ○ **Catenation (Correct Answer)**

(C) ○ Fragmentation

(D) ○ Crossing Over

Question No.3 (Question Id - 152)

Given below are two statements :

Statement I :

RNA polymerase I synthesizes mRNA in the nucleoplasm.

Statement II :

RNA polymerase II synthesizes rRNA in the nucleolus.

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

hich of the following organelles could be engineered for multienzyme metabolic pathways in plants

(A) ◯ Peroxisomes and Lysosomes
(B) ◯ Pyrenoids and Lysosomes
(C) ◯ Lysosomes and Mitochondria
(D) ◯ **Peroxisomes and Pyrenoids (Correct Answer)**

Question No.6 (Question Id - 150)
The position of particular genes on the cytological map can be determined directly by the following technique :

(A) ◯ TILLING
(B) ◯ Chromosomal staining
(C) ◯ **In situ hybridization (Correct Answer)**
(D) ◯ Nuclease treatment

Question No.7 (Question Id - 142)
Given below are two statements :

Statement I :

Guide RNA is complementary to the sequence of DNA to be edited.

Statement II :

Protospacer Adjacent Motif (PAM) is essential for recognition of target sequence.

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.8 (Question Id - 157)
DNA fragmentation for genome sequencing can be done by :

A. Sonication

B. Chemical treatment

C. UV - treatment

D. EMS - treatment

E. Temperature treatment

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

(A) ◯ **A and B only (Correct Answer)**
(B) ◯ C only
(C) ◯ C and D only
(D) ◯ C and E only

Question No.9 (Question Id - 149)
DNA is attached to nuclear matrix at a site called :
(A) ◯ Chromosome territories
(B) ◯ **Scaffold attachment regions (Correct Answer)**
(C) ◯ Chromocenter
(D) ◯ Centromeric regions

Which of the following is the likely reason of origin and expansion of multigene families ?

(A) ○ Horizontal gene transfer
(B) ○ Endosymbiosis
(C) ○ **Gene duplication (Correct Answer)**
(D) ○ None of the above

Question No.12 (Question Id - 131)

Which of the following statements are **correct** ?

A. Nucleases hydrolize an ester bond within a phosphodiester bond.

B. Phosphatases hydrolize an ester bond in a phosphomonoester bond.

C. Restriction endonucleases can cleave DNA without sequence specificity.

D. Name of restriction endonucleases are typically derived from the bacterium from which they are discovered.

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

(A) ○ A, B and C only
(B) ○ **A, B and D only (Correct Answer)**
(C) ○ B, C and D only
(D) ○ A, C and D only

Question No.13 (Question Id - 136)

At which of the following steps of protein synthesis GTP is required ?

(A) ○ Attachment of mRNA to ribosomes
(B) ○ **Translocation of tRNA - nascent protein complex from A to P bit (Correct Answer)**
(C) ○ Attachment of ribosome to endoplasmic reticulum
(D) ○ Amino acyl-tRNA synthetase activation of amino acid

Question No.14 (Question Id - 135)

Which of the following methods provide a rapid route to optimize plant metabolic engineering and could act as a production platform ?

(A) ○ Transient expression in Arabidopsis
(B) ○ **Transient expression in Nicotiana (Correct Answer)**
(C) ○ Transient expression in Rice
(D) ○ Transient expression in Catharanthus

Question No.15 (Question Id - 155)

T4 polynucleotide kinase is used for :

(A) ○ **Labeling 5' end of DNA (Correct Answer)**
(B) ○ Labeling 3' end of DNA
(C) ○ Ligation of two DNA fragments
(D) ○ Restriction digestion of double stranded DNA

Question No.16 (Question Id - 140)

For which of the following crops, barnase/barstar based hybrid production system is available in India ?

(A) ○ Rice
(B) ○ **Mustard (Correct Answer)**
(C) ○ Maize
(D) ○ Sorghum

Question No.17 (Question Id - 144)

electrophoresis
autoradiography

D. cleavage

E. hybridization

Which would be the **correct** sequence of the steps ?

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

Question No.19 (Question Id - 156)

Which of the following are sequence databases ?

A. NCBI, GenBank and FASTA

B. FTP, FASTA, and NCBI

C. EMBL, DDBJ, and GenBank

D. EMBL, GenBank, and NCBI

E. FTP, GenBank, and NCBI

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

(A) ◯ A and D only
(B) ◯ B only
(C) ◯ **C only (Correct Answer)**
(D) ◯ A, D and E only

Question No.20 (Question Id - 141)

GATEWAY cloning system is based on :

(A) ◯ Restriction digestion
(B) ◯ Ligation reaction
(C) ◯ **Recombination reaction (Correct Answer)**
(D) ◯ Phosphorylation reaction

Question No.21 (Question Id - 160)

The most abundant secondary structure in a properly folded Myoglobin and haemoglobin is :

(A) ◯ Parallel β-sheets
(B) ◯ Antiparallel β-sheets
(C) ◯ Left handed α-helix
(D) ◯ **Right handed α-helix (Correct Answer)**

Question No.22 (Question Id - 134)

Non-sense mediated RNA decay in Eukaryotes :

(A) ◯ detects and degrades RNA transcript containing non-sense mutation
(B) ◯ regulates the expression of many genes carrying no non-sense mutation
(C) ◯ **both 1 and 2 (Correct Answer)**
(D) ◯ none of the above

Question No.23 (Question Id - 151)

Klenow fragment of E. coli DNA polymerase I possesses which of the following activities ?

(A) ◯ 5' - 3' exonuclease activity
(B) ◯ Reverse transcriptase and nick - translation activity
(C) ◯ **Polymerase activity and 3'-5'-exonuclease activity (Correct Answer)**

r Amplification of an Inroiless gene which of the following template can be used ?
(A) ◯ cDNA
(B) ◯ Genomic DNA

(C) ◯ None of the above
(D) ◯ **Both 1 and 2 (Correct Answer)**

Question No.26 (Question Id - 153)
Helical structure of DNA is determined by which of the following ?
(A) ◯ **X-Ray diffraction measurement (Correct Answer)**
(B) ◯ Neutron diffraction measurement
(C) ◯ Electron diffraction measurement
(D) ◯ Diffraction of Visible light

Question No.27 (Question Id - 159)
Given below are two statements :

Statement I :

The Eukaryotic ribosome contains three species of ribosomal RNA (rRNA) and ~50 different ribosomal proteins (r-proteins).

Statement II :

The Prokaryotic ribosome is an assembly of four rRNA, ~80 r-proteins and more than 150 non-ribosomal factors.

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.28 (Question Id - 148)
Cleavage site of Type I restriction endonuclease is :
(A) ◯ Same as recognition site
(B) ◯ 24 - 26 bp downstream of recognition site
(C) ◯ **Non-specific but at least 1000 bp away from the recognition site (Correct Answer)**
(D) ◯ Random

Question No.29 (Question Id - 137)
Which of the following are the most abundant DNA-based molecular markers in genome ?

(A) ◯ Amplified Fragment Length Polymorphism (AFLP)
(B) ◯ Random Amplified Polymorphic DNA (RAPD)
(C) ◯ **Single Nucleotide Polymorphisms (SNPs) (Correct Answer)**
(D) ◯ Simple Sequence Repeats (SSRs)

Question No.30 (Question Id - 133)
Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A :

Fire and Mello got the Noble prize for the discovery of RNA interference.

Reason R :

RNA interference is a novel gene silencing technique with tremendous applications in biotechnology.

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

(A) ○ Fuzzy logic
(B) ○ Ensemble
(C) ○ **Dynamic programming (Correct Answer)**
(D) ○ Decision tree

Question No.2 (Question Id - 189)
Four stranded nucleic acid is found in :
(A) ○ **3'-regions of chromosomal DNA (Correct Answer)**
(B) ○ Translation initiation site of ribosome
(C) ○ Micro RNA precursors
(D) ○ Intron-Exon boundaries

Question No.3 (Question Id - 179)
Major and Minor groves are :
(A) ○ Drug binding locations of proteins
(B) ○ Sites of lipid bilayer where water can be trapped
(C) ○ **Sites of specific interaction with DNA double helix (Correct Answer)**
(D) ○ Communication channel of trans-membrane proteins

Question No.4 (Question Id - 182)
In the Eukaryotic Gene finder program called “Gen Scan” one of the following computational framework is employed :

(A) ○ Markov Chain
(B) ○ **Hidden Markov Model (Correct Answer)**
(C) ○ Information theoretic
(D) ○ Game theoretic

Question No.5 (Question Id - 166)
One of the following method is not used in phylogenetic tree construction :
(A) ○ nearest neighbour
(B) ○ **B-tree (Correct Answer)**
(C) ○ UPGMA
(D) ○ Maximum likelihood

Question No.6 (Question Id - 171)
Minisequencing is performed to :
(A) ○ Determine unknown DNA sequences
(B) ○ **Provide evidence of very specific and exactly defined mutations (Correct Answer)**
(C) ○ Examine directly the base that is second-last to the 3’base of the primer
(D) ○ Investigate a small number of probes for a specific mutation

Question No.7 (Question Id - 169)
Which of the statement is **false** ?
(A) ○ Molecular clock hypothesis assumes uniform rate of mutation in the tree branches.
(B) ○ **The number of substitutions in each branch of a phylogenetic tree is generally assumed to vary according to Boltzmann distribution.**

(Correct Answer)
(C) ○ Basal node represents a common ancestor of all the other sequences.
(D) ○ The sum of all the branched lengths in a tree is the tree length.

Question No.8 (Question Id - 175)
For assembly of sequence of total length ‘G’, from ‘N’ reads of equal length ‘L’, the coverage a = NL/G has to be :

(A) ○ **> 1 (Correct Answer)**

Question No.10 (Question Id - 188)

Large scale gene expression are carried out with microarray technologies and values can be expressed in n x m matrix form where n is the number of genes and m represents the conditions or time. If we find gene transcripts with similar expression patterns this means :

(A) ○ under expression
(B) ○ **co-expression (Correct Answer)**
(C) ○ over-expression
(D) ○ no expression

Question No.11 (Question Id - 184)

The genome wide binding of protein or transcription factor is studied experimentally through CHIP-SEQ. The Reads are aligned to the reference genome and one of the software tool is used to derive common motif :

(A) ○ NGS-TOF
(B) ○ BOWTIE
(C) ○ **MEME (Correct Answer)**
(D) ○ Fast Q

Question No.12 (Question Id - 174)

One can use the following formula for calculation of melting temperature (T_m) of DNA double helix :

(A) ○ $T_m = \frac{\Delta H}{\Delta S}$ **(Correct Answer)**
(B) ○ $T_m = \frac{\Delta G}{\Delta H - RT\ln[c]}$
(C) ○ $\Delta G T_m = \frac{\Delta S}{\Delta H} + \ln[c]$
(D) ○ $T_m = \frac{\exp(-\Delta G/kT)}{\sum \exp(-\Delta G/kT)}$

Question No.13 (Question Id - 181)

Randomized sequences with same composition are constructed to :

(A) ○ construct SNP variants
(B) ○ determine promoter sequence
(C) ○ **ascertain homology of two protein sequences having medium similarity (Correct Answer)**
(D) ○ determine histone binding sequences

Question No.14 (Question Id - 173)

The average multiplication factor per cycle in PCR is approximately :

(A) ○ 2.1
(B) ○ 1.1
(C) ○ **1.6 (Correct Answer)**
(D) ○ 1

Question No.15 (Question Id - 186)

The first completed genome sequencing project was of :

(A) ○ E. coli
(B) ○ Haemophilus influenza
(C) ○ **PhiX174 (Correct Answer)**
(D) ○ Drosophila melanogaster

Question No.16 (Question Id - 162)

Which of the following structural motif occurs in RNA predicted structure only ?

(A) ○ Pleated sheet

C Sequence analysis
Topology analysis

Which combination is **true** ?

(A) ◯ A and B
(B) ◯ B and C
(C) ◯ C and D
(D) ◯ **A and C (Correct Answer)**

Question No.18 (Question Id - 190)

If we consider two gene expression profiles for the time series A = (0, 2, - 2, 3, - 3) and another time series B = (0, 1, - 1, 10, - 10). It may be noted that the expression pattern looks similar. If we are computing the Pearson Correlation Coefficient (PCC) for the time series A and B using the above mentioned values yields :

(A) ◯ 0.66
(B) ◯ **0.88 (Correct Answer)**
(C) ◯ 0.77
(D) ◯ 0.55

Question No.19 (Question Id - 180)

Which of the following sets of amino acids tend to remain conserved in a given family ?

(A) ◯ Cys, His and Val
(B) ◯ Asp, Glu and Gln
(C) ◯ His, Pro and Phe
(D) ◯ **Cys, Gly and Pro (Correct Answer)**

Question No.20 (Question Id - 183)

If we consider a typical Hidden Markov Model framework first a sequence of states visited denoted by q_1, q_2, q_3 ..... and second a sequence of emitted symbols o_1, o_2 .... Their generation can be visualized as a two step process. What is the name of the algorithm in the HMM framework determines the state path ?

(A) ◯ Forward algorithm
(B) ◯ Backward algorithm
(C) ◯ **Viterbi algorithm (Correct Answer)**
(D) ◯ Baum-Welsch algorithm

Question No.21 (Question Id - 168)

One of the following is **not** the usual axioms of distance :

(A) ◯ non-negativity
(B) ◯ symmetry
(C) ◯ triangle property
(D) ◯ **degeneracy (Correct Answer)**

Question No.22 (Question Id - 170)

Assuming the following phylogenetic distance table.

Species	A	B	C	D
A	-	4	7	8
B	-	-	6	7
C	-	-	-	3
D	-	-	-	-

Which are the closest species ?

(A) ◯ A and B

Question No.24 (Question Id - 172)
Molarity of urea used in sequencing is :

(A) ◯ 1 M
(B) ◯ 3 M
(C) ◯ 5 M
(D) ◯ **7 M (Correct Answer)**

Question No.25 (Question Id - 164)
In the progressive multiple alignment method, for the given set of sequences, the first step is to order the sequences :

(A) ◯ by length
(B) ◯ **by distances (Correct Answer)**
(C) ◯ by compositions
(D) ◯ by k-mer

Question No.26 (Question Id - 177)
Ainfensin's experiment deals with :

A. Spontaneous folding

B. Denaturing of protein

C. Entropic trap

D. Misfolding

Which of the following is **true** ?

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

Question No.27 (Question Id - 178)
Vander Waals potential acts between :

(A) ◯ **Any types of pairs of atoms, including those of inert gas (Correct Answer)**
(B) ◯ C = O and H - N atoms of two peptides
(C) ◯ Only between side chain atoms of proteins
(D) ◯ Between negatively charged phosphate groups of DNA or RNA

Question No.28 (Question Id - 163)
The entries in the substitution matrices such as PAM, BLOSUM are nothing but :

(A) ◯ odds ratio
(B) ◯ **log odds ratio (Correct Answer)**
(C) ◯ amino acid count
(D) ◯ amino acid weights

Question No.29 (Question Id - 176)
Peptide bond between amino acids can be classified as :

(A) ◯ a type of hydrogen bond
(B) ◯ a covalent bond about which φ, Ψ torsional rotations are possible
(C) ◯ a bond important for side chain rotameric states
(D) ◯ **a covalent bond with partial double bond character (Correct Answer)**

Question No.30 (Question Id - 167)
There are several ways of building a tree with "n" species. In phylogenetic tree if one is interested in only for possible rooted tree then the number is given by :

(A) ◯

The coding efficiency is given by :
(B) ◯ 1 - Redundancy (Correct Answer)
(C) ◯ 1 + Redundancy
(C) ◯ 1/(1 - Redundancy)
(D) ◯ 1/(1 + Redundancy)

Question No.2 (Question Id - 208)
As the bandwidth approaches infinite, the channel capacity becomes (S is the average signal power and η is the spectral power density) :

(A) ◯ Infinite
(B) ◯ Zero
(C) ◯ $1.44\frac{S}{\eta}$ **(Correct Answer)**
(D) ◯ 1

Question No.3 (Question Id - 198)
Which of the following statement is **not** correct ?
(A) ◯ MESFETs and JFETs are always buried channel devices
(B) ◯ MODFETs are surface channel devices
(C) ◯ MOSFETs and MISFETs are mostly surface channel devices
(D) ◯ **In MOSFETs the source and drain are common formed by thermal oxidation process (Correct Answer)**

Question No.4 (Question Id - 192)
A network contains linear resistors and ideal voltage source. If values of all the resistor are doubled then the voltage across each resistor is :

(A) ◯ Halved
(B) ◯ Doubled
(C) ◯ Increased by four times
(D) ◯ **Remain unchanged (Correct Answer)**

Question No.5 (Question Id - 215)
The radiation resistance of half-wave dipole is :
(A) ◯ 14.6 ohm
(B) ◯ **73 ohm (Correct Answer)**
(C) ◯ 36.5 ohm
(D) ◯ 100 ohm

Question No.6 (Question Id - 195)
The LED (Light Emitting Diode) operates under :
(A) ◯ **Forward bias condition (Correct Answer)**
(B) ◯ Reverse bias condition
(C) ◯ Independent of bias
(D) ◯ Both forward and reverse bias

Question No.7 (Question Id - 200)
The voltage gain of an amplifier is 100 on applying negative feedback with β = 0.03, its gain will be reduced to :

(A) ◯ 70
(B) ◯ 99.97
(C) ◯ **25 (Correct Answer)**
(D) ◯ 3

Question No.8 (Question Id - 212)
If the electric field intensity is given by E = $xa_x + ya_y + za_z$ volt/meter, the potential difference between

(A) ○ $\frac{2\tau}{1+\omega^2\tau^2}$ (Correct Answer)

(B) ○ $\frac{2}{1+\omega^2\tau^2}$

(C) ○ $\frac{\tau}{1+\omega^2\tau^2}$

(D) ○ $\frac{\tau}{1-\omega^2\tau^2}$

Question No.10 (Question Id - 193)

Identify the signal $e^{-5t}u(t)$ is :

(A) ○ Periodic signal

(B) ○ Power signal

(C) ○ **Energy signal (Correct Answer)**

(D) ○ Neither an energy nor power signal

Question No.11 (Question Id - 204)

The output Q(t + 1) of a JK flip-flop is 1. It changes to 0, when a clock pulse is applied. The input J and K are respectively :

(A) ○ X and 0

(B) ○ 0 and 1

(C) ○ **X and 1 (Correct Answer)**

(D) ○ 1 and X

Question No.12 (Question Id - 201)

The minimum number of bits requires to represent negative number in the range of - 1 to - 11 using 2's complements arithmetic is :

(A) ○ 2

(B) ○ 3

(C) ○ 4

(D) ○ **5 (Correct Answer)**

Question No.13 (Question Id - 220)

Which multiple access technique is used by IEEE 802.11 standard for wireless LAN ?

(A) ○ CDMA

(B) ○ **CSMA/CA (Correct Answer)**

(C) ○ ALOHA

(D) ○ CSMA/CD

Question No.14 (Question Id - 199)

The voltage divider method of biasing is used in amplifier to :

(A) ○ Limit the input ac signal going to the base

(B) ○ **Make the operating point almost independent of β (Correct Answer)**

(C) ○ Reduced the dc base current

(D) ○ Reduced the cost of the circuit

Question No.15 (Question Id - 213)

While defining polarization of a wave, we consider :

(A) ○ The orientation of electric and magnetic field components

(B) ○ **The orientation of electric field components (Correct Answer)**

(C) ○ The orientation of magnetic field components

(D) ○ Neither the orientation of electric nor magnetic field components

Question No.16 (Question Id - 214)

A sphere of 2 meter radius has a point charge of 8 nC at its centre. Find the electric flux passing through that part of the sphere between ± 60° latitude and ± 20° longitude. Note that latitude are

(C) ○ 2 : 1 MUX
(D) ○ 64 : 1 MUX

Question No.18 (Question Id - 216)

The current amplitude of a uniform 4-element end-fire array having an element with spacing of λ/4 and a progressive shift α = - π/2 is :

(A) ○ 1 : 3 : 3 : 1
(B) ○ 1 : 4 : 4 : 1
(C) ○ **1 : 2 : 2 : 1 (Correct Answer)**
(D) ○ 1 : 5 : 5 : 1

Question No.19 (Question Id - 206)

Four independent messages have bandwidth of 100 Hz, 100 Hz, 200 Hz and 400 Hz, respectively. Each is sampled at Nyquist rate and transmitted sample rate (in Hz) is :

(A) ○ 800
(B) ○ 1600
(C) ○ 400
(D) ○ **3200 (Correct Answer)**

Question No.20 (Question Id - 219)

Ethernet frame consists of :

(A) ○ **MAC address (Correct Answer)**
(B) ○ IP address
(C) ○ Default mask
(D) ○ Network address

Question No.21 (Question Id - 207)

A Quaternary source generates information with probabilities $P_1 = 0.1$, $P_2 = 0.2$, $P_3 = 0.3$ and $P_4 = 0.4$. The entropy (bits/message) of the system is :

(A) ○ 1.8564
(B) ○ 1.8569
(C) ○ **1.8464 (Correct Answer)**
(D) ○ 2

Question No.22 (Question Id - 211)

Quarter wave-length line is a/an :

(A) ○ Impedance to resistance conversion line
(B) ○ **Impedance transformer (Correct Answer)**
(C) ○ Line to separate source and load
(D) ○ Stub matching line

Question No.23 (Question Id - 217)

Transmit antenna of 75 meter height radiates 35 kW at 90 MHz uniformly in horizontal plane, the maximum line-of-sight range and strength of the signal at received antenna of 10 km at the distance of 8 km is :

(A) ○ **48.70 km (Correct Answer)**
(B) ○ 57.68 km
(C) ○ 75.60 km
(D) ○ 50.75 km

Question No.24 (Question Id - 218)

A lossless 100 ohm transmission line is terminated in 50 + *j* 75 Ω, the voltage reflection coefficient and VSWR are :

(B) ◯ On present input
(C) ◯ **On past and present input both (Correct Answer)**
(D) ◯ On future input

Question No.26 (Question Id - 197)
The MODFET (Modulation Doped Field Effect Transmitter) is also known as :
(A) ◯ MOSFET
(B) ◯ JBT
(C) ◯ **HEMT (Correct Answer)**
(D) ◯ IMPATT

Question No.27 (Question Id - 196)
In n-type semiconductor the Fermi energy level lies near to the :
(A) ◯ Valance band level
(B) ◯ **Conduction band level (Correct Answer)**
(C) ◯ Centre of energy band gap
(D) ◯ Neither conduction nor valance band

Question No.28 (Question Id - 202)
The dual of a Boolean expression is obtained by :
(A) ◯ Interchanging all 0's and 1's
(B) ◯ **Interchanging all 0's, 1's, all ' + ' & '.' sign (Correct Answer)**
(C) ◯ Interchanging all 0's, 1's, all '+' & '.' sign and complementing all the variables
(D) ◯ Interchanging all '+' & '.' sign and complementing all the variables

Question No.29 (Question Id - 209)
_____ is used in satellite communication.
(A) ◯ High noise amplifier
(B) ◯ Push-pull amplifier
(C) ◯ Parametric amplifier
(D) ◯ **Low noise amplifier (Correct Answer)**

Question No.30 (Question Id - 210)
Which of the following statement is **not** correct ?
(A) ◯ Geo-synchronous satellite remains practically stationary relative to earth antenna.
(B) ◯ Geo-synchronous satellite means the samething as Geo-stationary satellite.
(C) ◯ **There is trade-off between the cost of a communication satellite and the cost of its earth stations. (Correct Answer)**
(D) ◯ Three Geo-synchronous satellites cannot give 100% global coverage.

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