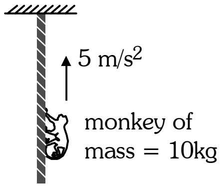
# PHYSICS

## Section-I(SC)

**Q1.** A monkey of mass 10 kg moving vertically upward with an acceleration 5 $m/s^2$, the tension in massless string which is above the monkey is ($g = 10\ m/s^2$)




(A) 150 N (B) 50 N (C) 100 N (D) None of these

**Ans. (A)**

**Sol.** $T = m(g + a)$

$= 10(10 + 5) = 150$ N

**Q2.** Two vectors are given by $\vec{A} = 3\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{B} = 3\hat{i} + 5\hat{j} - 2\hat{k}$. Find the third vector C if

$\vec{A} + 3\vec{B} - \vec{C} = 0$

(A) $12\hat{i} + 14\hat{j} + 12\hat{k}$ (B) $13\hat{i} + 17\hat{j} + 12\hat{k}$

(C) $12\hat{i} + 16\hat{j} - 3\hat{k}$ (D) $15\hat{i} + 13\hat{j} + 4\hat{k}$

**Ans. (C)**

**Sol.** $\vec{A} + 3\vec{B} - \vec{C} = 0$

$\vec{C} = \vec{A} + 3\vec{B}$

$= 3\hat{i} + \hat{j} + 3\hat{k} + 3(3\hat{i} + 5\hat{j} - 2\hat{k})$

$= 12\hat{i} + 16\hat{j} - 3\hat{k}$

**Q3.** A point initially at rest moves along x-axis. Its acceleration varies with time as $a = (6t + 5)\ m/s^2$. If it starts from origin, the distance covered in 2s is:

(A) 20 m (B) 18 m (C) 16 m (D) 25 m

**Ans. (B)**

**Sol.** $a = 6t + 5$

$\frac{dv}{dt} = 6t + 5$

$v = \frac{6t^2}{2} + 5t + c$

at t=0, v = 0 so c = 0

$v = 3t^2 + 5t$

$dx = (3t^2 + 5t)dt$

$x = t^3 + \frac{5}{2}t^2 + c$

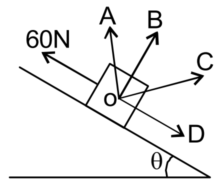
at $t = 0$, $x = 0$ so $c = 0$

$x = t^3 + \frac{5}{2}t^2$

at $t = 2$ sec

$x = 8 + 10 = 18$m.

**Q4.** A body of mass 10 kg lies on a rough inclined plane of inclination $\theta = \sin^{-1}\frac{3}{5}$ with the horizontal. When a force of 60 N is applied on the block parallel to & upward the plane, the total reaction by the plane on the block is nearly along:

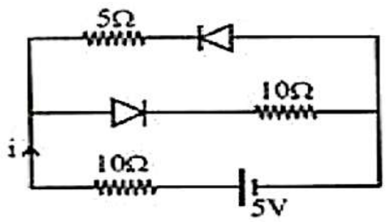



(A) OA (B) OB (C) OC (D) OD

**Ans.** (B)

**Sol.** Frictional force on the block is zero so only normal is applied by the inclined on the block.

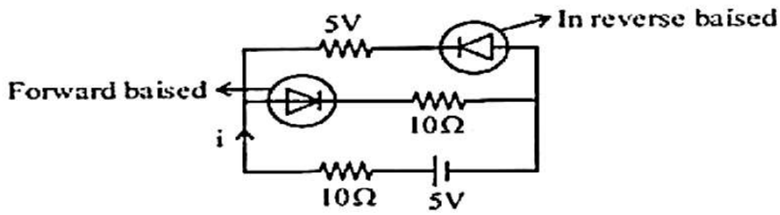
**Q5.** If junction diodes are ideal, current i in the given circuit will be :



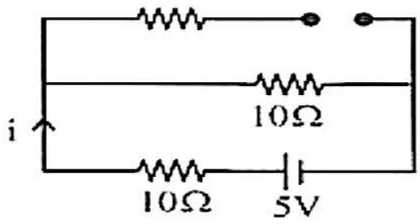

(A) $\frac{1}{3}$A (B) $\frac{1}{4}$A (C) $\frac{3}{8}$A (D) $\frac{1}{8}$A

**Ans.** (B)

**Sol.**




$\therefore$




$$i = \frac{5}{10+10}$$

$$i = \frac{5}{20}$$

$$i = \frac{1}{4}A$$

**Q6.** Water rises in a capillary tube to a height of 2.0cm. In another capillary tube whose radius is one third of it, what is the hight (in cm) upto which water will rise?

(A) 6 (B) 3 (C) 9 (D) 12

**Ans.** (A)

**Sol.** $h = \frac{2T\cos\theta}{r\rho g}$ $\therefore hr = \frac{2T\cos\theta}{\rho g} =$ constant

$$\therefore h_1r_1 = h_2r_2 \Rightarrow h_2 = \frac{h_1r_1}{r_2} \therefore \left(\frac{r_2}{r_1} = \frac{1}{3}\right)$$

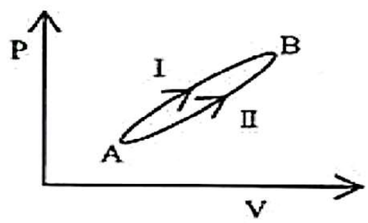
Substituting the values $h_2 = (2.0) \quad (3) = 6.0\,cm$

**Q7.** A system of certain amount of an ideal gas is taken from state A to state B once by process I and next by process II. The amount of heat absorbed by gas is $Q_1$ and $Q_2$ respectively in the two processes.

Given below are two statements :

Statement-I: $Q_1 = Q_2$

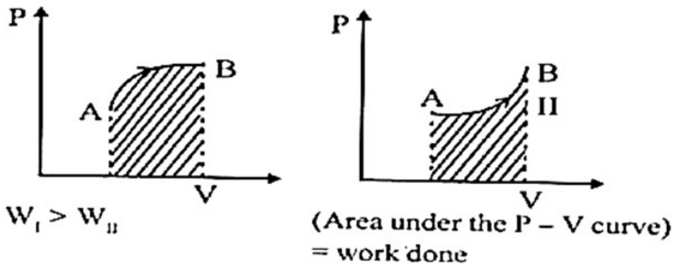
Statement-II : Change in internal energy in both processes are equal and work done in both processes are unequal.




(A) Both Statement-I and Statement-II are correct.
(B) Both Statement-I and Statement-II are incorrect.
(C) Statement-I is correct and Statement-II is incorrect.
(D) Statement-I is incorrect and Statement-II is correct.

Ans. (D)

Sol.




Both the process have same initial and final state.

$\therefore \Delta U_I = \Delta U_{II}$

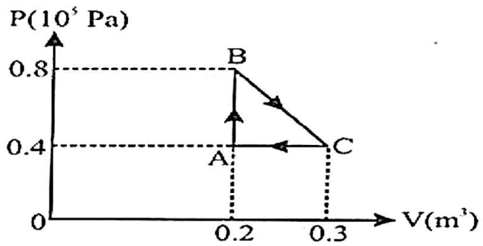
$\therefore Q = \Delta U + W$

$Q_I = \Delta U_I + W_I$

$Q_I = \Delta U_{II} + W_{II} \quad (\because \Delta U_I = \Delta U_{II}, W_I > W_{II})$

$\therefore \quad Q_I > Q_{II}$

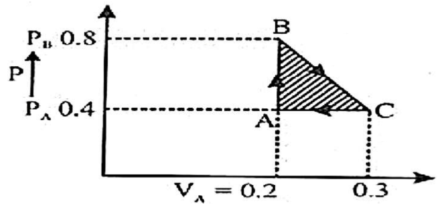
**Q8.** An ideal gas undergoes a cycle ABCA in which its pressure 'P' and volume 'V' are indicated in the P-V diagram shown. It is known that the area under the P-V graph is the work done by the gas during expansion. Find the net work done by the gas in the cycle ABCA .




(A) 6000 J (B) 4000 J (C) 3000 J (D) 2000 J

**Ans.** (D)

Sol.




$\Delta V = V_B - V_A = 0.3 - 0.2 = 0.1$

$\Delta P = P_B - P_A$

$= (0.8 - 0.4) \times 10^5 \text{ Pa}$

$= 0.4 \times 10^5 \text{ Pa}$

Work done $= \frac{1}{2} \times \Delta P \times \Delta V$

$= \frac{1}{2} \times 0.4 \times 10^5 \times 0.1$

=2000J

**Q9.** Two concentric coils of 10 turns each are placed in the same plane. Their radii are $20\,\text{cm}$ and $40\,\text{cm}$ and carry $0.2\,\text{A}$ and $0.3\,\text{A}$ current respectively in opposite directions. The magnetic induction (in tesla) at the center is ($\mu_0$ is permeability of free space).

(A) $\frac{3}{4}\mu_0$ (B) $\frac{5}{4}\mu_0$ (C) $\frac{7}{4}\mu_0$ (D) $\frac{9}{4}\mu_0$

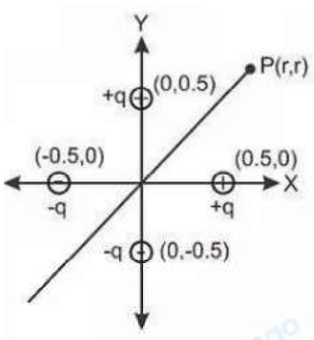
**Ans.** (B)

**Sol.** Two coils carry currents in opposite directions, hence net magnetic field at centre will be difference of the two fields.

ie, $B_{net} = \frac{\mu_0}{4\pi} \cdot 2\pi N \left[\frac{i_1}{r_1} - \frac{i_2}{r_2}\right]$

$= \frac{10\mu_0}{2}\left[\frac{0.2}{0.2} - \frac{0.3}{0.4}\right] = \frac{5}{4}\mu_0$

**Q10.** Four charges +q,+q,-q, and -q are placed on X-Y plane at the points whose coordinates are (0.5,0),(0,0.5),(-0.5,0) and (0,-0.5) respectively.




The electric field due to these charges at a point $P(r, r)$, where $r >> 0.5$, will be

(A) $\frac{1}{4\pi\varepsilon_0} \times \frac{q}{2r^3}$ (B) $\frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^3}$ (C) $\frac{1}{4\pi\varepsilon_0} \times \frac{3q}{r^3}$ (D) $\frac{1}{\pi\varepsilon_0} \times \frac{q}{r^3}$

**Ans.** (B)

**Sol.** The four charges can be considered two dipoles of equal magnitude and directed along the +x axis and $+x+y$ axis. The magnitude of dipole moment $= q \times$ (distance between positive and negative charges on x-axis) $p = q \times 1 = q$

The resultant dipole moment of these two dipoles with be, $p_r = \sqrt{q^2 + q^2} = q\sqrt{2}$

The direction of the resultant dipole moment will be at $45^\circ$ from the x-axis

The distance of the point (r, r) from the dipole is $r\sqrt{2}\,\text{m}$ The resultant electric field is

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{2p_r}{(r\sqrt{2})^3}$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{2 \times q\sqrt{2}}{2\sqrt{2}r^3}$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^3}$$

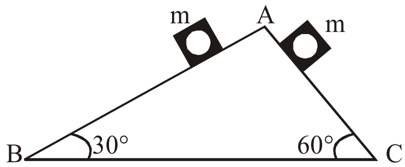
**Q11.** In a seconds pendulum, mass of the bob is 30g. If it is replaced by 90g mass, then its time period will be :-

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

**Ans.** (B)

**Sol.** Time period is independent of mass.

**Q12.** Two blocks of equal masses m are released from the top of a smooth fixed wedge as shown in the figure. The acceleration of the centre of mass of the two blocks is :-




(A) g (B) g/2 (C) 3g/4 (D) $g/\sqrt{2}$

**Ans.** (B)

**Sol.** $a = \sqrt{\left(\frac{g}{2}\right)^2 + \left(\frac{\sqrt{3}g}{2}\right)^2} = g$

**Q13.** What is the focal length (in cm ) of a convex lens having radii 20 cm and 30 cm and refractive index $\mu = 4/3$.

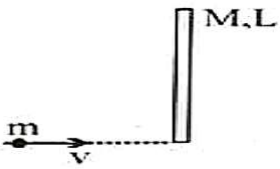
(A) 26 (B) 30 (C) 36 (D) 40

Ans. (C)

**Sol.** $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left(\frac{1}{3}\right) \times \left(\frac{1}{30} + \frac{1}{20}\right) \Rightarrow f = 36$

**Q14.** A uniform stick of length L and mass M lies on a frictionless horizontal surface. A point particle of mass m approaches the stick with speed v on a straight line passing through one end and perpendicular to the stick, as shown in figure. After the collision, which is elastic, the particle comes to rest. The speed of the centre of mass of the stick after the collision is



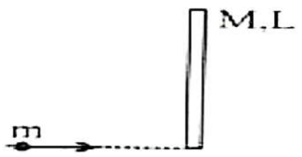

(A) $\frac{m}{M}v$ (B) $\frac{m}{M+m}v$

(C) $\sqrt{\frac{m}{M}}v$

(D) $\sqrt{\frac{m}{M+m}}v$

**Ans.** (A)

**Sol.**




Considering stick and the point mass m as a system then net force on the system is zero $\therefore$ linear momentum of the system will remain conserved.

$mV + M(0) = m(0) + MV'$

($\therefore$ given that point mass comes to rest after collision)

$V' = \frac{m}{M}v$

**Q15.** Two satellites $S_1$ and $S_2$ describe circular orbits of radius r and 2r respectively around a planet. If the orbital angular velocity of $S_1$ is $\omega$, that of $S_2$ is:

(A) $\frac{\omega}{2\sqrt{2}}$

(B) $\frac{\omega\sqrt{2}}{3}$

(C) $\frac{\omega}{2}$

(D) $\frac{\omega}{\sqrt{2}}$

Ans. (A)

Sol. According to kepler's law

$T^2 \propto r^3$ (T:Time period, r = radius of circular path)

$\left(\frac{2\pi}{\omega}\right)^2 \propto r^3$ $\left(\because T = \frac{2\pi}{\omega}\right)$

$\omega^2 r^3 \propto 4\pi^2$

$\omega^2 r^3 = \text{constant}$

$\omega_1^2 r_1^3 = \omega_2^2 r_2^3$

$\omega^2 r^3 = \omega_2^2 (2r)^3$

$\omega_2^2 = \frac{\omega^2}{2^3}$

$\omega_2 = \frac{\omega}{2\sqrt{2}}$

**Q16.** The speed of sound in neon (Ne) at a certain temperature is $V ms^{-1}$. The speed of sound in hydrogen $(H_2)$ at the same temperature will be (assume both gases to be ideal)

(A) $V\sqrt{\frac{42}{5}}\,ms^{-1}$ (B) $V\sqrt{\frac{5}{42}}\,ms^{-1}$

(C) $V\sqrt{5}\,ms^{-1}$ (D) $\frac{V}{\sqrt{5}}\,ms^{-1}$

Ans. (A)

Sol. Speed of sound is given by the formula

$$V = \sqrt{\frac{\gamma RT}{M}}$$

For Neon : $\gamma = \frac{5}{3}, M = 20$

For Hydrogen $\gamma = \frac{7}{5} M = 2$

$$\frac{V_{Ne}}{V_{H_2}} = \sqrt{\frac{\gamma_{Ne}}{\gamma_{H_2}} \times \frac{M_{H_3}}{M_{Ne}}}$$

$$\frac{V}{V_{H_2}} = \sqrt{\frac{\frac{5}{3}}{\frac{7}{5}} \times \frac{2}{20}}$$

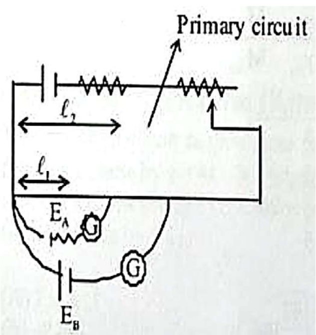
$$V_{H_2} = V\sqrt{\frac{42}{5}}\,ms^{-1}$$

**Q17.** In potentiometer experiment a cell (A) is balanced at length 100 cm. Another cell (B) is balanced at 200 cm then ratio of emfs of cell A and B is

(A) $\frac{1}{2}$ (B) $\frac{2}{1}$ (C) 1:1 (D) $\frac{4}{1}$

**Ans.** (A)

**Sol.**




Keeping the primary circuit fixed, if different cells are connected in secondary circuit then emf of the cell is given by

$E = x\ell_0$ (x = potenital gradient)

As potenital gradient is calculated from the primary circuit, So, it remains constant for cells connected in the secondary circuit.

$E_A = x\ell_1$ ............(i)

$E_B = x\ell_2$ ............(ii)

Dividing equation (1) &(2)

$$\frac{E_A}{E_B} = \frac{\ell_1}{\ell_2}$$

$$\frac{E_A}{E_B} = \frac{100}{200}$$

$$\therefore \frac{E_A}{E_B} = \frac{1}{2}$$

**Q18.** If $200\text{MeV}$ energy is released in the fission of a single nucleus of $_{92}U^{235}$. How many fissions must occur per second to produce a power of $1\text{kW}$?

(A) $3.125\times10^{13}$ (B) $6.250\times10^{13}$ (C) $1.525\times10^{13}$ (D) None of these

**Ans.** (A)

**Sol.** We know that $1\text{kW} = 1\times10^3\,\text{Js}^{-1}$

Also, $1.6\times10^{-9}\,\text{J} = 1\text{eV}$

$\therefore 200\text{MeV} = 200\times1.6\times10^{-19}\times10^6\,\text{J}$

$$\text{Number of fissions } = \frac{\text{Power}}{\text{Energy released}}$$

$$= \frac{10^3}{200\times1.6\times10^{-13}} = 3.125\times10^{13}$$

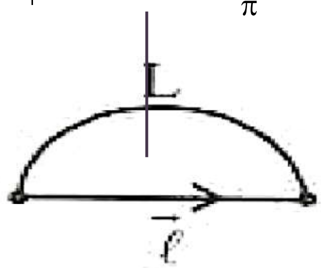
**Q19.** A steel wire of length L has a magnetic moment M. It is then bent into a semi-circular arc. If the new magnetic moment is given by $\frac{\alpha\times M}{\pi}$, the value of $\alpha$ is:

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

**Ans.** (C)

**Sol.** $\vec{M} = m\vec{\ell}$ $\pi R = L$

$|\vec{\ell}| = 2R$ $R = \frac{L}{\pi}$




$$|\vec{\ell}| = \frac{2L}{\pi}$$

$$\vec{M} = m\left(\frac{2L}{\pi}\right)$$

$= \frac{2(ML)}{\pi} = \frac{2M}{\pi}$

$\therefore \alpha = 2$

**Q20.** An electromagnetic wave travelling in the x-direction has frequency of $2\times10^{14}$ Hz and electric field amplitude of $27\,V\,m^{-1}$. From the options given below, which one describes the magnetic field for this wave ?

(A) $\vec{B}(x,t) = (3\times10^{-8}\,T)\hat{j}\sin\left[2\pi\left(1.5\times10^{-8}x - 2\times10^{14}t\right)\right]$

(B) $\vec{B}(x,t) = (9\times10^{-8}\,T)\hat{k}\sin\left[2\pi\left(1.5\times10^{-6}x - 2\times10^{14}t\right)\right]$

(C) $\vec{B}(x,t) = (9\times10^{-8}\,T)\hat{i}\sin\left[2\pi\left(1.5\times10^{-8}x - 2\times10^{14}t\right)\right]$

(D) $\vec{B}(x,t) = (9\times10^{-8}\,T)\hat{j}\sin\left[1.5\times10^{-6}x - 2\times10^{14}t)\right]$

Ans. (B)

Sol. $v = 2\times10^{14}$ Hz; $E_0 = 27Vm^{-1}$

We know, $\frac{E_0}{B_0} = c$ so $B_0 = \frac{27}{3\times10^8} = 9\times10^{-8}T$

$\lambda = \frac{c}{u} = \frac{3\times10^8}{2\times10^{14}} = 1.5\times10^{-6}$ m

$B = B_0 \sin 2\pi\left(\frac{x}{\lambda} - vt\right)$

$B = (9\times10^{-8}\,T)\sin 2\pi\left(\frac{x}{1.5\times10^{-6}} - 2\times10^{14}t\right)$

Oscillation of B can be along either $\hat{j}$ or $\hat{k}$ direction.

* None of the given options is correct.

## Section-II(NV)

**Q21.** A power transmission line feeds input power at $2400\,V$ to a step-down transformer and which delivers power at $240\,V$ with its primary windings having 5000 turns. If the current in the primary coil of the transformer is $5\,A$ and its efficiency is 80%, then what is the output current (in A)?

**Ans.** (40)

**Sol.** $\varepsilon_p = 2400\,V, N_p = 5000$

$\varepsilon_s = 240\,V, I_p = 5\,A$

efficiency, $\eta = 80\% = 0.8, I_s = ?$

$$\eta = \frac{P_0}{P_i} = \frac{\varepsilon_s I_s}{\varepsilon_p I_p}$$

$$\Rightarrow I_s = \frac{\eta \varepsilon_p I_p}{\varepsilon_s} = \frac{0.8 \times 2400 \times 5}{240} = 40\,A$$

**Q22.** In a standard Young's double-slit experiment, how many maxima can be obtained on a screen (including central maxima), if the distance between the silts is $d = \frac{5\lambda}{2}$ (where $\lambda$ is the wavelength of light)?

**Ans.** (5)

**Sol.** In YDSE, path difference, $\Delta x = d \sin\theta$

For maxima, $\Delta x = n\lambda$, where $n = 0, \pm1, \pm2 \ldots$

$$\frac{5\lambda}{2}\sin\theta = n\lambda \left(\text{given that } d = \frac{5\lambda}{2}\right)$$

$$\Rightarrow \sin\theta = \frac{2n}{5} \ldots \text{(i)}$$

since, $-1 \le \sin\theta \le 1$ From (i) $\Rightarrow -1 \le 2n/5 \le 1$

So, $-\frac{5}{2} \le n \le \frac{5}{2}$

So, possible values of n are -2,-1,0,1,2 Thus a total of 5 maximas will be obtained.

**Q23.** The potential difference across a Coolidge tube is $20\text{kV}$ and $10\,\text{mA}$ current flows through the voltage supply. Only $0.5\%$ of the energy, carried by electrons striking the target, is converted into X-ray. Then the power carried by X-ray beam (in W) is

**Ans.** (1)

**Sol.** $P = VI$

Total power drawn by the tube $= P_T = VI = 200\,W$

As $0.5\%$ of energy is carried by electrons, the power of X-ray will be $0.5\% \times P_T = 1\,W$

**Q24.** Rain drops fall vertically at a speed of $20\,\text{ms}^{-1}$. At what angle (in degree) do they fall on the wind screen of a car moving with a velocity $15\,\text{ms}^{-1}$, if the wind screen is inclined at an angle of $23^\circ$ to the vertical? $\left[\tan^{-1}(0.75) \approx 37^\circ\right]$

**Ans.** (60)

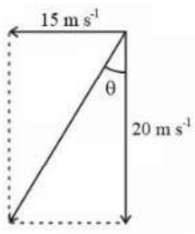
**Sol.** $\tan\left(90^\circ - \theta\right) = \frac{20}{15}$

$\therefore \cot\theta = \frac{20}{15} = \frac{4}{3}$

$\Rightarrow \theta = 37^\circ$

$\therefore \phi = 37^\circ + 23^\circ = 60^\circ$

(Angle made with the windscreen)




Q25. Under standard conditions, the density of a gas is $1.3 mgcm^{-3}$ and the velocity of propagation of sound in it is $330\,ms^{-1}$. The number of degrees of freedom of gas is

Ans. 5

$V_{sound} = \sqrt{\frac{\gamma P}{\rho}}$ and $\gamma = 1 + \frac{2}{f}$

$\therefore 1 + \frac{2}{f} = \frac{v_{sound}^2 \times \rho}{P}$

Sol. $1 + \frac{2}{f} = \frac{(330)^2 \times (1.3)}{1.01 \times 10^5}$

$1 + \frac{2}{f} = 1.40$

$f = 5$

## CHEMISTRY

## Section-I(SC)

**Q1.** In nucleic acid, corresponding nucleotides are linked together by -

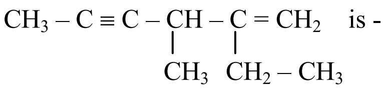
(A) $C_1' - C_5'$ glycosidic bond (B) $C_2' - C_5'$ phosphodiester bond

(C) $C_3' - C_5'$ phosphodiester bond (D) $C_4' - C_5'$ peptide linkage

**Ans.** **[C]**

**Sol.** Phosphate linked to $C_5'$ in a nucleotide is attached to $C_3'$ of the next nucleotide.

**Q2.** IUPAC name of the given compound




(A) 3-Methylene-4-methyl-5-heptene

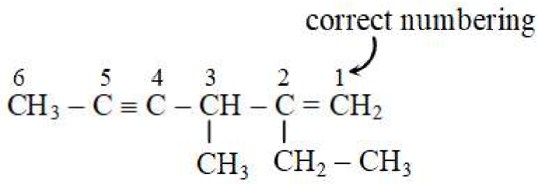
(B) 2-Ethyl-3-methyl-1-hexen-4-yne

(C) 5-Methylene-5-ethyl-4-methyl-2-heptyne

(D) 5-Ethyl-4-methyl-2-hexyn-5-ene

**Ans.** **[B]**

**Sol.**




**Q3.** Which one of the following has the maximum heat of hydrogenation?

(A) 1-Butene (B) trans-2-Butene

(C) cis-2-Butene (D) 1,3-Butadiene

**Ans.** **[D]**

**Sol.** H.O.H $\propto$ Number of $\pi$ bonds.

**Q4.** Which of the following statements is not correct ?

(A) A meso compound has chiral centers but exhibits no optical activity

(B) A meso compound has no chiral centers and thus are optically inactive

(C) A meso compound has molecules which are superimposable on their mirror images even though they contain chiral centers

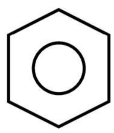
(D) A meso compound is optically inactive due to the presence of plane of symmetry in it.

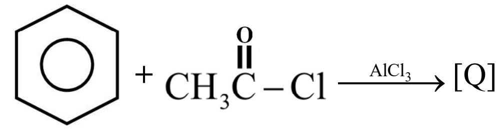
**Ans.** **[B]**

**Q5.** Butene-1 may be converted to butane by reaction with –

(A) zn – Hg (B) Pd / $H_2$ (C) Zn – HCl (D) Sn – HCl

**Ans.** **[B]**

**Q6.**  $+ CO + HCl \xrightarrow{AlCl_3} [P]$




P and Q are differentiate by:

I -Tollen's

II - Fehling Solution

III - NaOI

IV - $NaHCO_3$

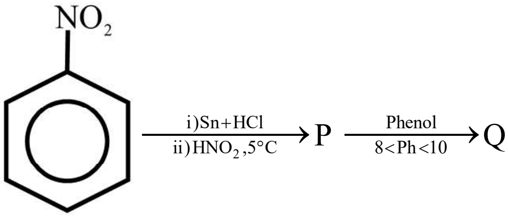
(A) I,II and III

(B) I and III

(C) II and IV

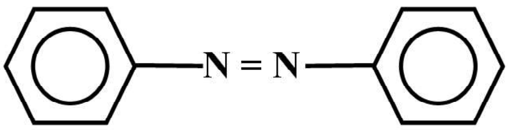
(D) I,II,III and IV

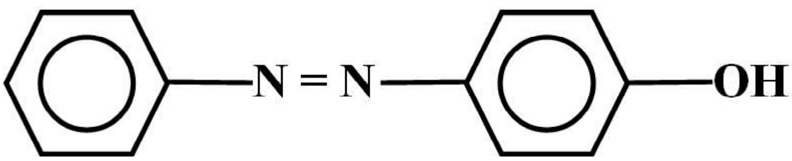
Ans. (B)

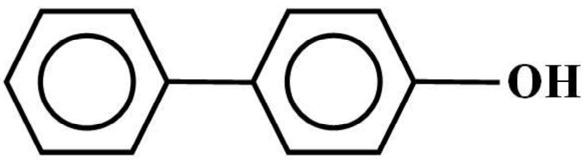
**Q7.** 


In given reaction product (Q) is :

(A) 

(B) 

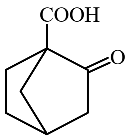

(C) 


(D) 


**Ans. [C]**

**Q8.** Which of the following is most difficult to be decarboxylated on heating ?

(A) $CH_2 = CHCH_2COOH$ (B) $O_2NCH_2COOH$

(C) 


(D) $EtOOC - CH_2 - COOH$

**Ans.** **[C]**

**Sol.** Bredt's Rule

**Q9.** The radius of $2^{nd}$ orbit of $Li^{+2}$ in terms of Bohr Orbit radius ($a_0$) is ?

(A) $\frac{4a_0}{3}$ (B) $\frac{4a_0}{9}$ (C) $\frac{2a_0}{3}$ (D) $\frac{2a_0}{9}$

**Ans.** (A)

**Sol.** $r_n = a_0 \times \frac{n^2}{z} = a_0 \times \frac{2^2}{3} = \frac{4a_0}{3}$

**Q10.** Al and Ga have nearly same covalent radii because of :-

(A) Poor shielding power of d-electrons of Ga atoms

(B) Greater shielding power of d-electrons of Ga atoms

(C) Greater shielding power of s-electrons of Ga atoms

(D) Poor shielding power of s-electrons of Ga atoms

**Ans.** **[A]**

**Sol.** Poor shielding power of d-electrons of Ga atoms which is known as transition contraction.

**Q11.** Which of the following statements is correct about $N_2$ molecule:

(A) It has a bond order of 3

(B) The number of unpaired electrons present in is zero and hence it is diamagnetic

(C) The order of filling of MO is $[\pi(2p_x) = \pi(2p_y)]$, $\sigma(2p_z)$

(D) All the above three statements are correct

**Ans.** **[D]**

**Q12.** Carbon monoxide acts as a Lewis base because it has :

(A) A double bond between C and O atoms

(B) A triple bond between C and O atoms

(C) A lone pair of electrons on the C atom

(D) Two lone pairs of electrons on the O atom

**Ans.** **[C]**

**Q13.** The atomic number of element unnilennium

(A) 119 (B) 109 (C) 108 (D) 102.

**Ans.** (B)

**Q14.** The compound which does not show paramagnetism :

(A) $[Cu(NH_3)_4]Cl_2$ (B) $[Ag(NH_3)_2]Cl$

(C) NO (D) $NO_2$

**Ans.** **[B]**

**Sol.** Aq+ $\rightarrow$ No unpaired $e^-$

**Q15.** $[X]+H_2SO_4 \rightarrow [Y]$ a colourless gas with suffocating smell $[Y]+K_2Cr_2O_7+H_2SO_4 \rightarrow$ green solution [X] and [Y] is -

(A) $SO_3^{2-}, SO_2$ (B) $Cl^-, HCl$

(C) $S^{2-}, H_2S$ (D) $CO_3^{2-}, CO_2$

**Ans.** [A]

**Sol.** A colourless suffocating gas, which on passing through acidified $K_2Cr_2O_7$ solution, turns the solution green. Thus, the gas would be $SO_2$ and the salt must be $SO_3^{2-}$ (sulphite).

**Q16.** In the first transition series the melting point of Zn is low, because :-

(A) Metallic bonds are strong due to $d^{10}$ configuration.

(B) Metallic bonds are weak due to $d^5$ configuration.

(C) Metallic bonds are weak due to stable $d^{10}$ configuration and no unpaired electrons.

(D) More number of electrons in d-orbitals.

**Ans.** [C]

**Sol.** Weak metallic bond due to $d^{10}$ configuration and weak metallic bond.

**Q17.** Among the following, which is not a state variable?

(A) Internal Energy (U) (B) Volume (V)

(C) Heat (q) (D) Enthalpy (H)

**Ans.** (C)

**Sol.** Heat (q) is a path function.

**Q18.** The solubility of $Ca(OH)_2$ in water is ?

(A) $k_{sp}/4$ (B) $(k_{sp}/4)^{1/2}$ (C) $(k_{sp}/4)^{1/3}$ (D) $(k_{sp}/8)^{1/3}$

Ans. (C)

Sol. $k_{sp} = 4s^3$

$s = (k_{sp}/4)^{1/3}$

**Q19.** For a reaction $2A + B \rightarrow$ Product, rate law is $\frac{-d[A]}{dt} = k[A]^1$. At a time when $t = \frac{1}{k}$, concentration of reactant is: ($C_0$ = intial concentration)

(A) $\frac{C_0}{e}$ (B) $C_0e$ (C) $\frac{C_0}{e^2}$ (D) $\frac{1}{C_0}$

Ans. (A)

Sol. $-\frac{d[A]}{dt} = k[A]$

$C_t = C_0e^{-kt}$

$= C_0e^{-k \times \frac{1}{k}}$

$= \frac{C_0}{e}$

**Q20.** A particle having a mass of 1.0mg has a velocity of 3600 km/h. Calculate the wavelength of the particle ?

(A) $6.626 \times 10^{-31}$ m (B) $6.626 \times 10^{-30}$ m

(C) $6.626 \times 10^{-29}$ m (D) $6.626 \times 10^{-28}$ m

**Ans.** (A)

**Sol.** $v = 3600\,km/hr = 1000\,m/s$

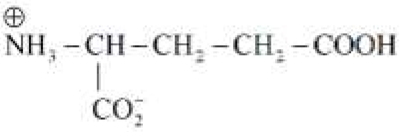
$$p = mv = \left(1\times10^{-6}\,kg\right)(1000\,m/s) = 10^{-3}\,kg\,m/s$$

Use de broglie's relation.

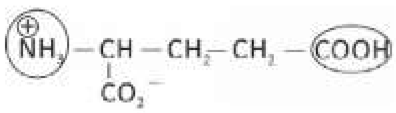
$$\lambda = h/mv = \frac{\left(6.626\times10^{-34}\,J-s\right)}{\left(1\times10^{-3}\,kg\right)} = 6.626\times10^{-31}\,m$$

## Section-II(NV)

**Q21.** How many acidic group is present in given amino acid



**Ans.** (2)

**Sol.**  Two group have acidic hydrogen

**Q22.** At 40°C, the vapour pressure (in torr) of methyl alcohol (A) and ethyl alcohol (B) solution is represented by : P = 120 $X_A$ + 138 ; where $X_A$ is mole fraction of methyl alcohol. The value of $\lim\limits_{x_A \to 0} \frac{P_B^0}{X_B}$ is?

**Ans. (138)**

**Sol.** If $X_A$ = 0, then pure B

$\therefore P^o_B = 138$

If $X_A$ = 1, then pure A

$\therefore P^o_A = 120 + 138 = 258$

**Q23.** Standard entropy of $X_2, Y_2$ and $XY_3$ are 60,40 and 50 $JK^{-1}mol^{-1}$ respectively. For the reaction $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightleftharpoons XY_3, \Delta H^\circ = -30KJ$ to be at equilibrium, the temperature (in K) will be ?

**Ans.** (750)

**Sol.** $$\Delta S^\circ = S^\circ_{XY_3} - \frac{1}{2}\times S^\circ_{X_2} - \frac{3}{2}\times S^\circ_{Y_2}$$

$$= 50 - \frac{1}{2}\times60 - \frac{3}{2}\times40$$

$= 50 - 30 - 60 = -40\,J\,K^{-1}mol^{-1}$

$$T_{eq} = \frac{\Delta H}{\Delta S} = \frac{-30\times10^3}{-40} = 750K$$

**Q24.** For a reaction, the dependency of rate constant on temperature is given as $\ell nK = 10 - \frac{2}{T}$.

The activation energy of reaction is __________calorie?

**Ans.** (4)

**Sol.** From Arrhenius equation:

$$\ell nK = \ell nA - \left(\frac{Ea}{R}\right)\frac{1}{T}$$

$$\frac{-Ea}{R} = -2$$

$Ea = 2R = 2\times2 = 4$ Cal.

**Q25.** How many of the following exhibit colour due to charge transfer phenomenon, but not due to d-d transition?

$Cr_2O_7^{2-}$, $MnO_4^-$, $CrO_4^{2-}$, $[Ti(H_2O)_6]Cl_3$, $[Fe(H_2O)_5NO]SO_4$, $Na_2[Fe(CN)_5NO]$

**Ans.** (3)

## MATH

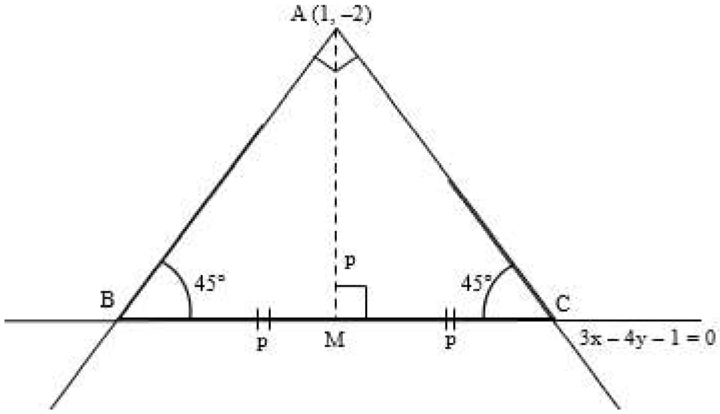
## Section-I (SC)

Q1. From the point (1,-2) two mutually perpendicular straight lines are drawn which form an isosceles triangle together with the straight line $3x - 4y - 1 = 0$. Then find the area of the triangle.

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

Ans. (A)

Sol.




Length of perpendicular from point A(1,–2) on the line 3x – 4y –1 = 0 is

$p=\left|\frac{3+8-1}{\sqrt{9+16}}\right|=2$

Now, area of $\Delta ABC=\frac{1}{2}\times 2p\times p=p^2=4$

**Q2.** The solution of the differential equation $x\cos y\frac{dy}{dx}+\sin y=1$ is (Here, $x>0$ and $\lambda$ is an arbitrary constant)

(A) $x-x\cos x=\lambda$ (B) $x+x\cos x=\lambda$

(C) $x-x\sin y=\lambda$ (D) $x+x\cos y=\lambda$

Ans. (C)

Sol. Let, $\sin y=t\Rightarrow \cos y\frac{dy}{dx}=\frac{dt}{dx}$

$\therefore$ the equation becomes

$x\frac{dt}{dx}+t=1$ or $x\frac{dt}{dx}=1-t$

$\Rightarrow \frac{dt}{1-t}=\frac{dx}{x}$

On integrating, we get,

$-\ln|1-t|=\ln x+\ln C$

or $\frac{1}{1-t}=Cx$

i.e. $(1-\sin y)x=\frac{1}{C}=\lambda$ (Say)

Q3. The distance of the point (2,3) from the line x + y + 1 = 0 is equal to

(A) $2\sqrt{2}$ (B) $3\sqrt{2}$ (C) $\sqrt{2}$ (D) $4\sqrt{2}$

Ans. (B)

Sol. $D = \frac{6}{\sqrt{2}} = 3\sqrt{2}$

Q4. $\ell im_{x \to 0} \frac{1-\cos(2x)}{x^2}$ is equal to

(A) 1 (B) $\frac{1}{2}$ (C) 2 (D) 0

Ans. (C)

Sol. $\lim_{x \to 0} \frac{1-\left(1-2\sin^2 x\right)}{x^2} = 2\lim_{x \to 0}\left(\frac{\sin x}{x}\right)^2 = 2$

Q5. $\lim_{x \to 0} \frac{\int_0^x \sin t^2 dt}{x^3}$ is equal to

(A) $\frac{1}{3}$ (B) 2 (C) $\frac{1}{2}$ (D) $\frac{2}{3}$

Ans. (A)

Sol. $\lim_{x \to 0} \frac{\sin x^2}{3x^2} = \frac{1}{3}$

Q6. If $\vec{x}$ and $\vec{y}$ are two nonzero, non collinear vectors satisfying $a_1\vec{x} + b_1\vec{y} = a_2\vec{x} + b_2\vec{y}$ then the value $\frac{a_1 - a_2}{b_1^2 + b_2^2 + 1}$ is equal to (where $a_1, a_2, b_1, b_2$ are real numbers).

(A) 5 (B) 0 (C) 1 (D) 2

Ans. (B)

Sol. Clearly $a_1 = a_2, b_1 = b_2$

Q7. The lengths of the tangents from any point on the circle $x^2 + y^2 + 8x + 1 = 0$ to the circles $x^2 + y^2 + 7x + 1 = 0$ and $x^2 + y^2 + 4x + 1 = 0$ are in the ratio

(A) 1: 2 (B) 1: 3 (C) 1: 4 (D) $1:\sqrt{2}$

Ans. (A)

Sol. Let the point on $x^2+y^2+8x+1=0$ is $(h,k)$

$\Rightarrow h^2+k^2+8h+1=0$

Now ratio of the lengths of the tangents from (h, k) to the circles

$x^2+y^2+7x+1=0$ and $x^2+y^2+4x+1=0$ is

$$\sqrt{\frac{h^2+k^2+7h+1}{h^2+k^2+4h+1}}=\sqrt{\frac{7h-8h}{4h-8h}}$$

$$=\frac{1}{2}=1:2$$

Q8. An ellipse has foci (4,2), (2,2) and it passes through the point P (2,4). The eccentricity of the ellipse is

(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2}$ (C) $\frac{1}{\sqrt{3}}$ (D) $\sqrt{2}-1$

Ans. (D)

Sol. Let, $(4,2)=S_1$ and $(2,2)=S_2$ and eccentricity of ellipse is e

then $S_1S_2=2ae$ and $PS_1+PS_2=2a$

(where 2a is length of major axis)

$$\Rightarrow e=\frac{S_1S_2}{PS_1+PS_2}=\frac{2}{2\sqrt{2}+2}$$

$$\Rightarrow e=\frac{1}{\sqrt{2}+1}=\sqrt{2}-1=\tan\frac{\pi}{8}$$

Q9. The value of $\int_{\pi}^{2\pi}[\sin x]\,dx$ is equal to (where [.] represents the greatest integer function).

(A) $\frac{-2\pi}{3}$ (B) $\frac{5\pi}{3}$ (C) $-\pi$ (D) $-2\pi$

Ans. (C)

Sol. $\int_{\pi}^{2\pi}[\sin x]dx=-\int_{\pi}^{2\pi}dx=-\pi$

$(\sin x\in[-1,0)$ where $x\in(\pi,2\pi))$

Q10. The coefficient of fifth term in the expansion of $(1+x)^{10}$ is

(A) ${}^{10}C_3$ (B) ${}^{10}C_2$ (C) ${}^{10}C_4$ (D) ${}^{10}C_5$

Ans. (C)

Sol. $T_{r+1} = {}^{10}C_r x^r \Rightarrow T_5 = {}^{10}C_4 x^4$

Q11. Let $\alpha$ and $\beta$ be the roots of the equation $x^2 + ax + 1 = 0$, $a \neq 0$. Then the value of $\frac{\alpha^2+\beta^2}{\alpha\beta}$ is

(A) $a^2$ (B) $a^2 - 1$ (C) $a^2 - 2$ (D) $a^2 - 4$

Ans. (C)

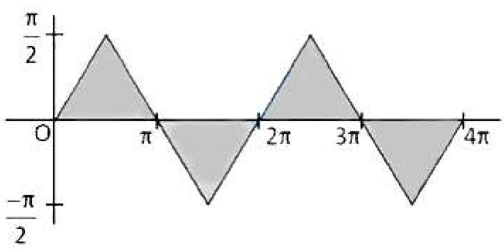
Sol. $\frac{\alpha^2+\beta^2}{\alpha\beta} = \frac{(\alpha+\beta)^2 - 2\alpha\beta}{\alpha\beta} = a^2 - 2$

Q12. The area bounded by the curve $y = \sin^{-1}(\sin x)$ and the x-axis from x = 0 to x = $4\pi$ is equal to the area bounded by the curve $y = \cos^{-1}(\cos x)$ and the x -axis from $x = -\pi$ to $x = a$, then the value of a is equal to

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

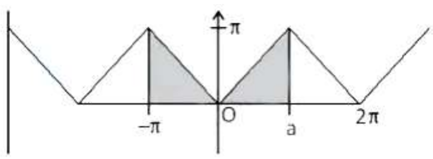
Ans. (C)

Sol. Graph of y = $\sin^{-1}(\sin x)$




Area $= 4 \times \left(\frac{1}{2}\right) \times (\pi) \times \left(\frac{\pi}{2}\right) = \pi^2$

Graph of $y = \cos^{-1}(\cos x)$ is



Given, $\pi^2 = \frac{1}{2}\times\pi\times\pi+\frac{1}{2}\times a\times a$

$\frac{\pi^2}{2}=\frac{a^2}{2}\Rightarrow a=\pi$

Q13. If the focus of a hyperbola is $(\pm 3,0)$ and the length of transverse axis is 4 then eccentricity of hyperbola is

(A) $\frac{3}{2}$ (B) 2 (C) $\frac{5}{2}$ (D) $\sqrt{2}$

Ans. (A)

Sol. $2ae=6, 2a=4\Rightarrow e=\frac{3}{a}=\frac{3}{2}$

Q14. Number of roots of the equation $\sin x=\frac{1}{\sqrt{2}}$ in $[0,4\pi]$ is

(A) 2 (B) 4 (C) 6 (D) 0

Ans. (B)

Sol. $\sin x=\frac{1}{\sqrt{2}}\Rightarrow x=\frac{\pi}{4},\frac{3\pi}{4},\frac{9\pi}{4},\frac{11\pi}{4}$

Q15. The relation R given by
$\{(x,y): x^2-3xy+2y^2=0, \forall x,y\in R\}$ is

(A) reflexive but not symmetric (B) symmetric but not transitive

(C) symmetric and transitive (D) an equivalence relation

Ans. (A)

Sol.

$\because x^2-3xy+2y^2=0$
$\Rightarrow x^2-xy-2xy+2y^2=0$
$\Rightarrow x(x-y)-2y(x-y)=0$
$\Rightarrow (x-2y)(x-y)=0$
$\Rightarrow x=y \text{ or } x=2y$

$\therefore$ Now, in R all ordered pairs (x, x) are present

$\therefore$ It is reflexive

Now, (4,2) $\epsilon$ in R as 4 = 2 (2)

but $(2,4)\notin R$ as $2\neq 2(4)$

$\therefore$ It is not symmetric

Also $(4,2)$ $(2,1) \in R$ but $(4,1) \notin R$

$\therefore$ It is not transitive

Q16. Let $f: R \rightarrow B$ be a function defined by f(x) = sin(2x) then f is onto when B is in the interval

(A) $\left(0, \frac{\pi}{4}\right)$ (B) (-1,1) (C) [-1,1] (D) $\left(-\frac{\pi}{4}, \frac{\pi}{4}\right)$

Ans. (C)

Sol. $-1 \leq f(x) \leq 1 \Rightarrow B = [-1,1]$

Q17. One number is randomly chosen from the set $\{1,2,3,4,5\}$. Probability that number chosen is even.

(A) $\frac{2}{3}$ (B) $\frac{3}{7}$ (C) $\frac{2}{5}$ (D) $\frac{4}{5}$

Ans. (C)

Sol. P(even) = $\frac{2}{5}$

Q18. Distance between the planes x + y + z + 1 = 0 and x + y + z + 2 = 0 is equal to

(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{\sqrt{5}}$ (C) $\frac{1}{\sqrt{3}}$ (D) $\frac{1}{2}$

Ans. (C)

Sol. $\text{Dis} = \frac{2-1}{\sqrt{3}} = \frac{1}{\sqrt{3}}$

Q19. $\int x^2 \sin\left(x^3\right) dx$ is equal to (where C is the constant of integration)

(A) $-\frac{\cos\left(x^2\right)}{3} + C$ (B) $-\frac{\cos x}{3} + C$

(C) $-\frac{\cos\left(x^3\right)}{3} + C$ (D) $-\frac{\sin\left(x^3\right)}{3} + C$

Ans. (C)

Sol. $x^3 = t \Rightarrow \frac{1}{3}\int \sin t\,dt = -\frac{\cos\left(x^3\right)}{3} + C$

Q20. Let $A = \left[a_{ij}\right]$ be a 3 × 3 matrix where $a_{ij} = \begin{cases} 0 & ; & i < j \\ 1 & ; & i > j \\ 2 & ; & i = j \end{cases}$ then the value of |A| is

(A) $-7$ (B) 7 (C) $-8$ (D) 8

Ans. (D)

Sol. $A = \begin{bmatrix} 2 & 0 & 0 \\ 1 & 2 & 0 \\ 1 & 1 & 2 \end{bmatrix} \Rightarrow |A| = 8$

## Section-II(NV)

Q21. Let S(a,b) be the focus of $y^2 = 4x$. If the distance between the points S(a,b) and $P(\alpha,1)$ is $\sqrt{2}$ then the positive value of $\alpha$ is

Ans. (2)

Sol. S(1,0) $P(\alpha,1) \Rightarrow \sqrt{2} = \sqrt{(\alpha-1)^2 + 1} \Rightarrow \alpha = 2$

Q22. Let $A = \{a_1, a_2, a_3, a_4, a_5\}$ and $B = \{1,2,3,4,5\}$, then find the number of injective functions $f : A \to B$.

Ans. (120)

Sol. Total no. of required functions = 120 = 5!

Q23. If $z + \bar{z} = 2$ where z is a complex number then the minimum value of |z| is equal to

Ans. (1)

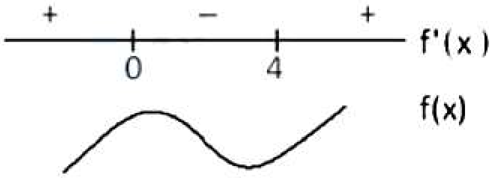
Sol. $z + \bar{z} = 2x = 2 \Rightarrow x = 1$ (z = x+iy)

$|z| = \sqrt{1 + y^2} \geq 1$

Q24. The function $f(x) = e^{x^3 - 6x^2 + 10}$ attains local extremum at x = a and x = b (a < b), then the value of a + b is equal to

Ans. (4)

Sol. $f'(x) = e^{x^3-6x^2+10}\left(3x^2-12x\right)$




Thus, f(x) attains extremum at

x = 0 & x=4

i.e. $a = 0$ & $b = 4$

$\Rightarrow a + b = 4$

Q25. The ratio of the variance of first n positive integral multiples of 4 to the variance of first n positive odd numbers is

Ans. (4)

Sol Let the variance of first n natural numbers is $\sigma^2$ then the variance of first n integral of 4 is $16\sigma^2$ and the variance of first n odd natural numbers is $4\sigma^2$ Then, the required ratio is

$$\frac{16\sigma^2}{4\sigma^2} = 4$$