Sri Chaitanya

IIT Academy., India

2017 JEE-Main

Question Paper

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PAPER-1

MATHEMATICS, PHYSICS & CHEMISTRY

Read carefully the Instructions on the Back Cover of this Test Booklet.

Important Instructions

1. Immediately fill in the particulars on this page of the Test Booklet with only Black ball Point Pen provided in the examination hall.
2. The Answer Sheet is kept inside this Test Booklet When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.
3. The test is of 3 hours duration.
4. The Test Booklet consists of 90 questions. The maximum marks are 360.
5. There are three parts in the question paper A, B & C consisting of physics, mathematics and chemistry having 30 question in each part of equal weightage. Each question is allotted 4 (four) marks for each correct response.
6. Candidates will be awarded marks as stated above in instruction No.5 for correct response of each question. ¼ (one fourth) marks allotted to the question (i.e 1 mark) will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 6 above
8. For writing Particulars/marking responses on side-1 and side-2 of the Answer sheet use only Black Ball point Pen provided in the examination hall.
9. No candidate is allowed to carry any textual material, printed or written, bits of papers pager, mobile phone, any electronic device, etc except the Admit Card inside the examination room/hall.
10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in four pages (pages 20-23) at the end of the booklet.
11. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
12. The CODE for this Booklet is B. Make sure that the CODE printed on Side-2 of the Answer sheet and also tally the serial number of the Test Booklet and Answer sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to invigilator for replacement of both the test Booklet and the Answer Sheet.
13. **Do not fold or make any stray mark on the Answer Sheet.**

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PHYSICS

01. A particle is executing simple harmonic motion with a time period T. At time t=0, it is at its position is equilibrium. The kinetic energy - time graph of the particle will look like:

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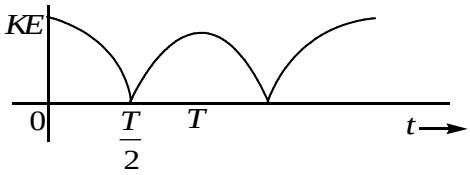

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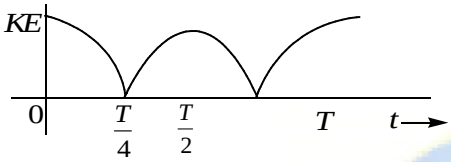

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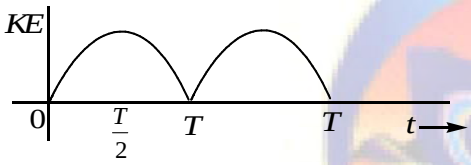

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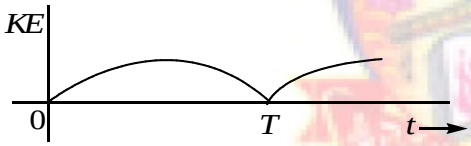


Key: 2

Sol: $x = A\sin(wt)$

$V = Aw\cos(wt)$

$K.E = \frac{1}{2}mA^2\omega^2\cos^2\omega(wt)$

02. The temperature of an open room of volume $30\ m^3$ increases from $17°C$ to $27°C$ due the sunshine. The atmospheric pressure in the room remains $1\times10^5\ Pa$. If n_i and n_f are the number of molecules in the room before and after heating, then $n_f - n_i$ will be

1) 2.5×10^{25}

2) -2.5×10^{25}

3) -1.61×10^{23}

4) 1.38×10^{23}

Key: 2

Sol: $PV = nRT$

$10^5(30) = n_1R(290)$

$10^5(30) = n_2R(300)$

$$\Delta n = \frac{10^5(30)}{R}\left(\frac{1}{300} - \frac{1}{290}\right) = \frac{10^5(30)}{8.314}\frac{10}{300\times 290}\times 6.023\times 10^{23}$$

03. Which of the following statements i, false?

1) A rheostat can be used as a potential divider.

2) Kirchhoff's second law represents energy conservation

3) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.

4) In a balanced wheatstone bridge it the cell and the galvanometer are exchanged, the null point is disturbed

Key: 4

Sol: Conceptual

04. The following observations were taken for determining surface tension T of water by capillary method.

diameter of capillary, $D = 1.25\times 10^{-2} m$ rise of water, $h = 1.45\times 10^{-2} m$. Using $g = 9.80 m/s^2$ and the simplified relation $T = \frac{rhg}{2}\times 10^3 N/m$, the possible error in surface tension is closest to:

1) 2.4%

2) 10%

3) 0.15%

4) 1.5 %

Key: 4

Sol: $D = 1.25\times 10^{-2} m$, $h = 1.4\times 10^2$

$$\frac{\Delta T}{T}=\frac{\Delta r}{r}+\frac{\Delta h}{h}=\frac{0.01}{1.25}+\frac{0.01}{1.45}$$

$$=0.8+0=1.489$$

05. In amplitude modulation, sinusoidal carrier frequency used is denoted by ω_c and the signal frequency is denoted by ω_m. The bandwidth $(\Delta\omega_m)$ of the signal is such that $\Delta\omega_m << \omega_c$. Which of the following frequencies is not contained in the modulated wave ?

1) $\omega_m+\omega_c$

2) $\omega_c-\omega_m$

3) ω_m

4) ω_c

Key: **3**

Sol: $y=A\sin(\omega_e t)+\frac{Am}{2}\left[\sin\left((\omega_c+\omega_n)t+\phi\right)+\sin\left((\omega_c-\omega_n)t-\phi\right)\right]$

06. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20cm. A beam of parallel light falls on the diverging lens. The final image formed is

1) real and at a distance of 40cm from the divergent lens

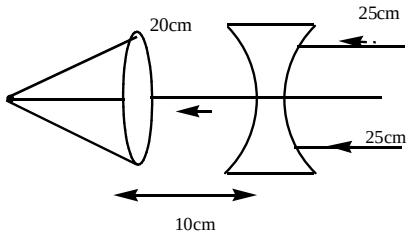
2) real and at a distance of 6.cm from the convergent lens

3) real and at a distance of 40 cm from convergent lens

4) virtual and at a distance of 40cm from convergent lens

Key: **3**

Sol: $f=-25cm$



$$\frac{1}{V}-\frac{1}{-40}=\frac{1}{20}\quad \frac{1}{V}=-\frac{1}{20}-\frac{1}{40}$$

07. The moment of inertia of a uniform cylinder of length l and radius R about its perpendicular bisector is I. What is the ratio l/R such that the moment of inertial is minium?

1) 1

2) $\frac{3}{\sqrt{2}}$

3) $\sqrt{\frac{3}{2}}$

4) $\frac{\sqrt{3}}{2}$

Key: **3**

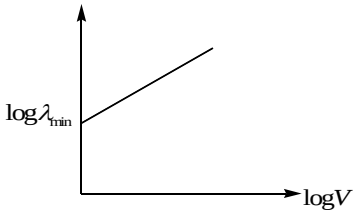
Sol: $I=\frac{ml^2}{12}+\frac{mR^2}{4}$ $\qquad V=\pi R^2L,\quad L=\frac{V}{\pi R^2}$

$$I=\frac{m}{12}.\frac{v^2}{n^2R^4}+\frac{mR^2}{4}\quad ,\frac{dI}{dR}=0\quad \frac{4mV^2}{12\pi^2R^5}=\frac{mR}{2},\frac{2V^2}{3\pi^2}=R^6$$

$$\frac{2}{3}.\frac{\pi^2R^4l^2}{\pi^2}=R^6, \qquad \frac{l}{R}=\frac{\sqrt{3}}{2}\quad l^2\propto 3R^2$$

08. An electron beam is accelerated by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If λ_{min} is the smallest possible wavelength of X-ray in the spectrum, the variation of $\log\lambda_{min}$ with log V is correctly represented in

1)



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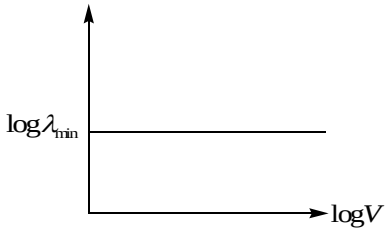

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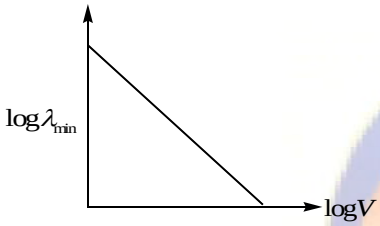

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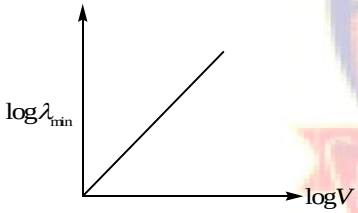


Key: **3**

Sol: by λ_{min} with $\log v$

$$\lambda_{min} = \frac{hc}{ev}$$

$$\lambda_{min} = \log hc - \log e - \log v$$

09. A radioactive nucleus A with a half life T, decays into a nucleus B, At t=0, there is no nucleus of B at some time t, the ratio the number of B to that of A is 0.3. Then, t is given by

1) $t = T\log(1.3)$

2) $t = \dfrac{T}{\log(1.3)}$

3) $t = \dfrac{T}{2}\dfrac{\log 2}{\log 1.3}$

4) $t = T\dfrac{\log 1.3}{\log 2}$

Key: **4**

Sol: $\frac{\left(1-e^{-\lambda t}\right)}{\left(e^{-\lambda 1-}\right)}=0.3 \qquad 1-e^{-\lambda t}=0.3\ e^{-\lambda t}$

$1.3e^{-\lambda t}-\lambda t=\log(1.3)$

$t=\frac{\log(1.3)}{\log 2}$

10. An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle θ with respect to x-axis. When subjected to an electric field $\vec{E_1}=E\hat{i}$, it experiences a torque $\vec{T_1}=\tau\hat{k}$. When subjected to another electric field $\vec{E_2}=\sqrt{3}E_1\hat{j}$ it experiences a torque $\vec{T_2}=-\vec{T_1}$. The angle θ is

1) 60°

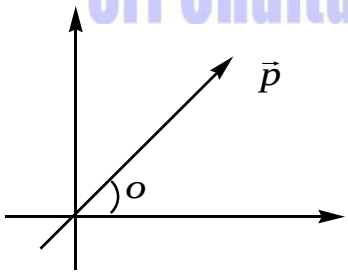
2) 90°

3) 30°

4) 45°

Key: **2**

Sol: $\vec{p}$



$\vec{E}_1=E\hat{i}$

$\vec{\tau}=\vec{P}\times\vec{E} \qquad \tau\hat{k}=\left(p\cos\theta\hat{i}+p\sin\theta\hat{j}\right)\times E\hat{i}$

$-\tau\hat{k}=\left(p\cos\hat{i}+p\sin\theta\hat{j}\right)\times E\sqrt{3}\hat{j}$

$-p\sin\theta\hat{j}=\tau \qquad \sqrt{3}p\cos\theta E=-\tau$

$\frac{1}{\sqrt{3}}\tan\theta=1 \qquad \tan=\sqrt{3}$

11. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and phase difference between the input and the output voltages will be

1) 135°

2) 180°

3) 45°

4) 90°

Key: **2**

Sol: 180°

12. C_p and C_v are specific heats at constant pressure and constant volume respectively. It is observed that $C_p - C_v = a$ for hydrogen gas $C_p - C_v = b$ for nitrogen gas

The correct relation between a and b is

1) $a = 14b$

2) $a = 28b$

3) $a = \frac{1}{14}b$

4) $a = b$

Key: **4**

Sol: $a = b$, molar specific heats

13. A copper ball of mass 100gm is at a temperature T. It is dropped in a copper calorimeter of mass 100gm, filled with 170gm of water at room temperature . subsequently, the temperature of the system is found to be $75°C$. T is given by

(Given : room temperature $= 30°C$, specific heat of copper $= 0.1 cal / gm°C$)

1) $1250°C$

2) $825°C$

3) $800°C$

4) $885°C$

Key: **4**

Sol: 100 gm T copper ball

m = 100 gm 170 gm of water $30°C$

100 gm (0.1cal) (T- 75°) = 100 gm (0.1) (75-30) +5+170gm (1) (75-30)

$T-75 = \frac{180(45)}{10}$

14. A body of mass $m = 10^{-2} kg$ is moving in a medium and experiences a frictional force $F = -kv^2$. Its initial speed is $v_0 = 10ms^{-1}$. If, after 10s, its energy is $\frac{1}{8}mv_0^2$ the value of k will be

1) $10^{-4} kgm^{-1}$

2) $10^{-1} kgm^{-1}s^{-1}$

3) $10^{-3} kgm^{-1}$

4) $10^{-3} kgs^{-1}$

Key: **4**

Sol: $\frac{dv}{dt} = -100kv^2$

$$\int_{0}^{dt} \frac{dv}{-100kv^2} = \frac{1}{100k} \times \frac{1}{v} = \frac{1}{100k}\left[\frac{1}{5} - \frac{1}{10}\right]$$

15. When a current of 5 mA is passed through a galvanometer having a coil of resistance 15Ω, it shows full scale deflection. The value of resistance to be put in series with the galvanometer to convert it into a voltmeter of range $0 - 10V$ is:

1) $2.535 \times 10^3 \Omega$

2) $4.005 \times 10^3 \Omega$

3) $1.985 \times 10^3 \Omega$

4) $2.045 \times 10^3 \Omega$

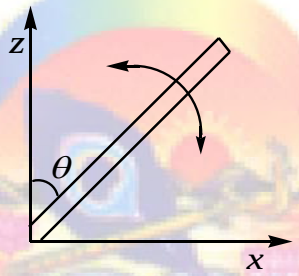
Key: 3

Sol: $V = I_g(R+G)$

$10 = 5\times10^{-3}(15+R)$

$200 - 15 = 1985$

16. A slender uniform rod of mass M and length l is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle θ with the vertical is:



1) $\frac{3g}{2l}\cos\theta$

2) $\frac{2g}{3l}\cos\theta$

3) $\frac{3g}{2l}\sin\theta$

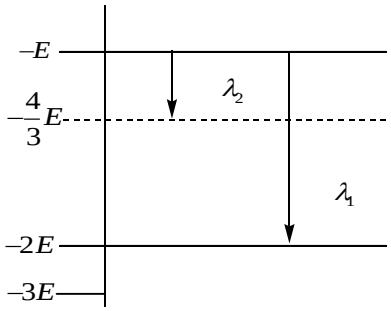
4) $\frac{2g}{3l}\sin\theta$

Key: 3

Sol: $mg\frac{l}{2}\sin\theta = \frac{ml^2}{3}\alpha$

$\alpha = \frac{3}{2}g\sin\theta$

17. Some energy levels of molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1 / \lambda_2$, is given by:



1) $r = \frac{3}{4}$

2) $r = \frac{1}{3}$

3) $r = \frac{4}{3}$

4) $r = \frac{2}{3}$

Key: **2**

Sol: $\frac{\lambda_2}{\lambda_1} = 3$

18. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of:

1) 81

2) $\frac{1}{81}$

3) 9

4) $\frac{1}{9}$

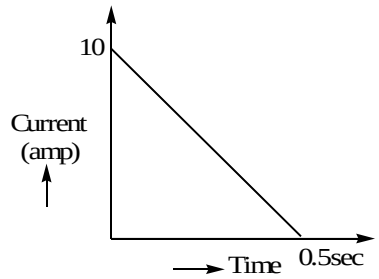
Key: **3**

Sol: $A_1\ell_1 = 10\ell_2 A_2 \qquad A_2 = \frac{1}{10}A_1$

$\text{Stars} = \frac{mg}{A_1} \quad \text{Strars} = \frac{mg}{A_1/10} = 10 \quad y = \frac{strers}{strain}$

$\Delta = 9$

19. In a coil of resistance 100Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is:



1) $250Wb$

2) $275Wb$

3) $200Wb$

4) $225Wb$

Key: **1**

Sol: $i = 10 - 20t$

$$\int idt = 10 \times 0.5 \times \frac{1}{2} = 2.5$$

$$\frac{\Delta\phi}{R} = Q_{flow} \Rightarrow \Delta\phi = 250\,wb$$

20. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is:

1) 9.75 mm

2) 15.6 mm

3) 1.56 mm

4) 7.8 mm

Key: **4**

Sol: $d = 0.5mm \quad D = 100mm$

$$\frac{yd}{D} = n_1(650) \qquad \frac{yd}{D} = n_2(520)$$

$$n_1 650 = n_2 520$$

$$\frac{n_1}{n_2} = \frac{120}{650} = \frac{4}{2}$$

$$n_1 = 4$$

21. A magnetic needle of magnetic moment $6.7\times10^{-2}\,Am^2$ and moment of inertia $7.5\times10^{-6}\,kg\,m^2$ is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is:

1) 6.98 s

2) 8.76 s

3) 6.65 s

4) 8.89 s

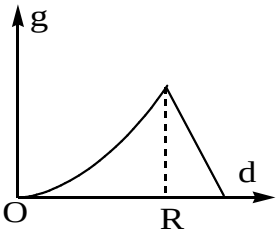
Key: **3**

Sol: $T = 2\pi\sqrt{\frac{I}{MB}} = 2\pi\times10^{-1}\sqrt{\frac{75}{6}}$,

$= 6.64$

22. The variation of acceleration due to gravity g with distance d from center of the earth is best represented by (R = Earth's radius):

1)



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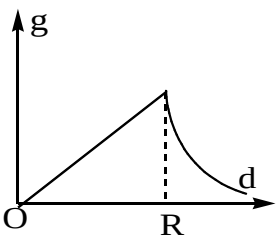

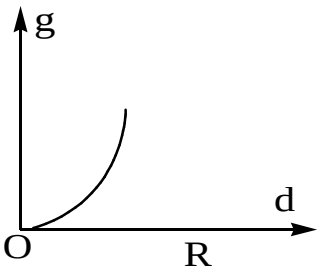

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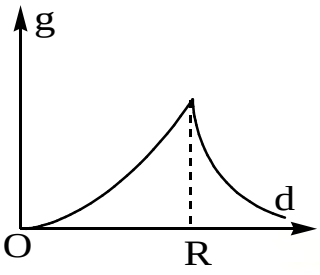
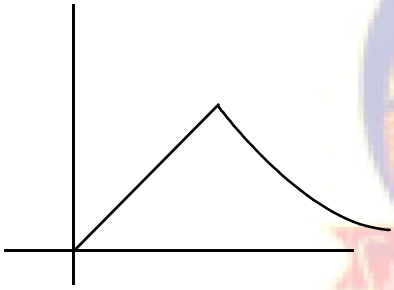


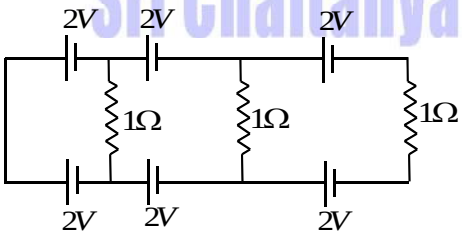
4)

Key: **2**

Sol:



23.



In the above circuit the current in each resistance is :

1) 0.5 A

2) 0 A

3) 1 A

4) 0.25 A

Key: **2**

Sol: Conceptual

24. A particle A of mass m and initial velocity v collides with a particle B of mass $\frac{m}{2}$ which is at rest. The collision is head on, and elastic. The ratio of the de-Broglie wavelengths λ_A to λ_B after the collision is:

1) $\frac{\lambda_A}{\lambda_B}=\frac{2}{3}$

2) $\frac{\lambda_A}{\lambda_B}=\frac{1}{2}$

3) $\frac{\lambda_A}{\lambda_B}=\frac{1}{2}$

4) $\frac{\lambda_A}{\lambda_B}=2$

Key: **4**

Sol: $m \to V$ $\qquad mV = mV_1 + \frac{m}{2}V_2$

$$\frac{-V}{2}=\frac{V_1}{2}-\frac{V_2}{2} \qquad \frac{V_1-V_2}{V-o}=-1 \; V_1 = V/3$$

$$\frac{V}{2}=\frac{3V_1}{2}$$

$V_2 = V_1 + V = 4/3$ $\qquad \frac{\lambda_A}{\lambda_B}=\frac{h}{nV}=2$

25. An external pressure P is applied on a cube at $0°C$ so that it is equally compressed from all sides. K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by:

1) $\frac{3\alpha}{PK}$

2) $3PK\alpha$

3) $\frac{P}{3\alpha K}$

4) $\frac{P}{\alpha K}$

Key: **3**

Sol: $\Delta V = V\gamma\Delta T$

$$K = \frac{-P}{\Delta V / V} \quad \frac{\Delta V}{V} = \rho / k$$

$$\frac{p}{k} = o(3\alpha)\Delta T$$

26. A time dependent force F = 6t acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be:

1) $9\,J$

2) $18\,J$

3) $4.5\,J$

4) $22\,J$

Key: **3**

Sol: $\vec{t} = 6t \int Fdn \quad v = \frac{a}{t}$

27. An observer is moving with half the speed of light towards a stationary microwave source emitting wave at frequency 10 GHz. What is the frequency of the microwave measured by the observer ? (speed of light = $3 \times 10^8 ms^{-1}$)

1) $17.3\,GHz$

2) $15.3\,GHz$

3) $10.1\,GHz$

4) $12.1\,GHz$

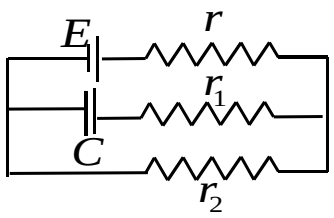
Key: **1**

Sol: $f^1 = f\sqrt{\frac{1+V/C}{1-V/C}}$

$$V = C/2 \quad f^1 = f\sqrt{\frac{1+\frac{1}{2}}{1-\frac{1}{2}}}$$

$$f^1 = f/3$$

28. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be:



1) $CE\dfrac{r_2}{(r+r_2)}$

2) $CE\dfrac{r_1}{(r_1+r)}$

3) CE

4) $CE\dfrac{r_1}{(r_2+r)}$

Key: **1**

Sol: $\left(\dfrac{E}{r+r_2}\right)r_2C$

29. A capacitance of $2\,\mu F$ is required in an electrical circuit across a potential difference of 1.0 kV. A large number of $1\,\mu F$ capacitors are available which can withstand a potential difference of not more than 300 V.

The minimum number of capacitors required to achieve this is :

1) 24

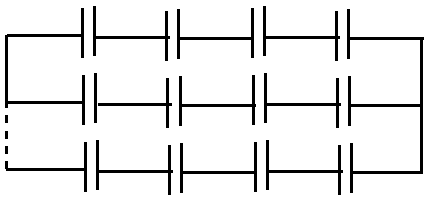
2) 32

3) 2

4) 16

Key: **2**

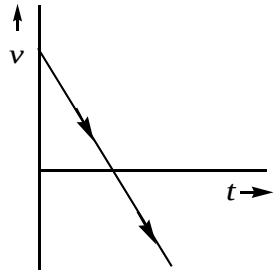
Sol:



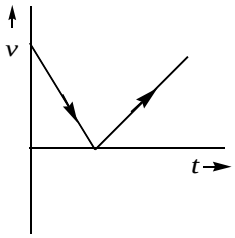
$4\times 8=32$

30. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time?

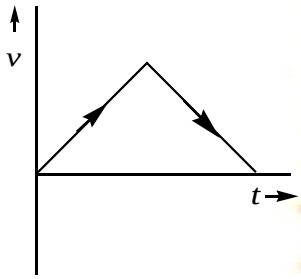
1)



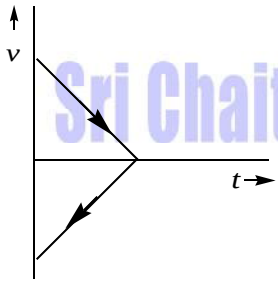
2)



3)

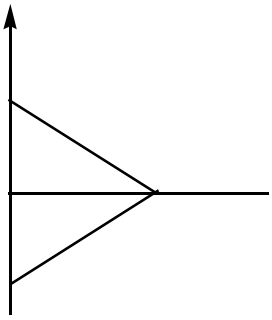


4)



Key: **4**

Sol:



MATHEMATICS

31. Let k be an integer such that the triangle with vertices $(k,-3k),(5,k)$ and $(-k,2)$ has area 28 sq. units. Then the orthocenter of this triangle is at the point:

1) $\left(2,\frac{1}{2}\right)$

2) $\left(2,-\frac{1}{2}\right)$

3) $\left(1,\frac{3}{4}\right)$

4) $\left(1,-\frac{3}{4}\right)$

Key: **1**

Sol: $\frac{1}{2}\begin{vmatrix} k & 5 & -k & k \\ -3k & k & 2 & -3k \end{vmatrix} = 28$

$\frac{1}{2}\left|\left(k^2+15k\right)+10+k^2+3k^2-2k\right| = 28$

$\frac{1}{2}\left|5k^2+13k+10\right| = 28$

$5k^2+13k+10 = 56$

$5k^2+13k-46 = 0$

$5k^2+23k-10k-46 = 0$

$k(5k+23)-2(5k+23) = 0$

$k = 2(or)-\frac{23}{5}$

$(2,-6)\ (5,2)\ (-2,2)$

Substitution are x=2 and $3x+8y-10=0$

$\therefore H\left(2,\frac{1}{2}\right)$

32. If, for a positive integer n, the quadratic equation,

$x(x+1)+(x+1)(x+2)+....+(x+\overline{n-1})(x+n)=10n$ has two consecutive integral solutions, then n is equal to ;

1) 11

2) 12

3) 9

4) 10

Key: **1**

Sol: $\sum x^2+(2n-1)n+(n^2-n)=10n$

$$nn^2+n^2\,n+\frac{n(n+1)(2n+1)}{6}-\frac{n(n+1)}{2}=10n$$

$$nn^2+n^2\,n+\frac{n(n+1)}{6}[2n+1-3]=10n$$

$$nn^2+n^2\,n+\frac{n(n+1)}{6}2[n-1]=10n$$

$$nn^2+n^2\,n+\frac{n(n^2-1)}{3}-10n=0$$

$$nn^2+n^2\,n+\frac{n^3-n-30n}{3}=0$$

$$n^4-4n\frac{(n^3-n-30n)}{3}=n^2$$

$$3n^4-4n^4+124n^2=3n^2$$

$$n^4-121n^2=0 \qquad n^2[n^2-121]=0 \qquad n=11$$

33. The function $f:R\to\left[-\frac{1}{2},\frac{1}{2}\right]$ defined as $f(x)=\frac{x}{1+x^2}$, is :

1) neither injective nor surjective

2) invertible.

3) injective but not surjective.

4) surjective but not injective.

Key: **4**

Sol: $f:R\to\left[\frac{1}{2},\frac{1}{2}\right]$

$f(x)=\frac{x}{1+x^2}$

$f^1(x)=\frac{(1+x^2)-x(2x)}{1+x^2}=\frac{1-x^2}{(1+x^2)^2}>0$ for $x\in(-1,1)$

<0 *for* $x\in(-\infty,-1)\cup(-1,1)$

Not one-one

$\frac{x}{1+x^2}=y \qquad x=y+x^2y$

$x^2y-x+y=0$

$1-4y^2\geq 0 \qquad y\in\left[-\frac{1}{2},\frac{1}{2}\right]$

34. The following statement

$(p\to q)\to[(\sim p\to q)\to q]$ is :

1) a fallacy

2) a tautology

3) equivalent to $\sim p\to q$

4) equivalent to $p\to\sim q$

Key: **1**

Sol:

p	$\sim p$	q	$\sim q$	$p\to q$	$\sim p\to q$	$(\sim p\to q)\to q$	$(p\to q)\to[(\sim p\to q)\to q]$
T	F	T	F	T	T	T	T
T	F	F	T	F	T	F	T
F	T	T	F	T	T	T	T
F	T	F	T	T	F	T	T

35. If S is the set of distinct values of 'b' for which the following system of linear equations

$x+y+z=1$

$x+ay+z=1$

$ax+by+z=0$

Has no solution, then S is :

1) a singleton

2) an empty set

3) an infinite set

4) a finite set containing two or more elements

Key: **1**

Sol: $\begin{bmatrix}1&1&1&1\\a&b&1&0\\1&a&1&1\end{bmatrix}$ $R_2 \to R_2 - R_1$ $R_3 \to R_3 - R_1$

$\begin{bmatrix}1&1&1&1\\a-1&b-1&0&-1\\0&a-1&0&0\end{bmatrix}$

If a=1 $\begin{bmatrix}1&1&1&1\\0&b-1&0&-1\\0&0&0&0\end{bmatrix}$ if $a \neq 1$

If b=1 no solution

36. The area (in sq. units) of the region $\{(x,y) : x \geq 0,\ x+y \leq 3,\ x^2 \leq 4y,\ and\ y \leq 1+\sqrt{x}\}$ is:

1) $\frac{5}{2}$

2) $\frac{59}{12}$

3) $\frac{3}{2}$

4) $\frac{7}{3}$

Key: **1**

Sol: $Area = \int_0^1 \left(1+\sqrt{x}\right)dx + \int_1^2 (3-x)\,dx - \int_0^2 \frac{x^2}{4}dx$

$= \left[x + \frac{2}{3}x^{\frac{3}{2}}\right]_0^1 + \left[3x - \frac{x^2}{2}\right]_1^2 - \frac{1}{12}\left[x^3\right]_0^2$

$= 1 + \frac{2}{3} + 4 - 3 + \frac{1}{2} - \frac{2}{3}$

$= \frac{5}{2}$

37. For any three positive real numbers a,b and c, $9\left(25a^2+b^2\right)+25\left(c^2-3ac\right)=15b\left(3a+c\right)$.

Then :

1) a, b and c are in G.P.

2) b, c and a are in G.P.

3) b, c and a are in A.P.

4) a, b and c are in A.P.

Key: **3**

Sol: $\frac{25a^2+b^2}{25}+\frac{c^2-3ac}{9}=\frac{b\left(3a+c\right)}{15}$

$a^2+\frac{b^2}{25}+\frac{c^2}{9}=\frac{ac}{3}+\frac{ab}{5}+\frac{bc}{15}$

$a^2+\left(\frac{b}{5}\right)^2+\left(\frac{c}{3}\right)^2=a.\frac{c}{3}+a.\frac{b}{5}+\frac{b}{5}.\frac{c}{3}$

$\frac{a}{1}=\frac{b}{5}=\frac{c}{3}=\lambda \qquad \lambda,3\lambda,5\lambda$

a,c,b or b c a are in A.P.

38. A man X has 7 friends, 4 of them are ladies and 3 are men. His wife Y also has 7 friends, 3 of them are ladies and 4 are men. Assume X and Y have no common friends. Then the total number of ways in which X and Y together can throw a party inviting 3 ladies and 3 men, so that 3 friends of each of X and Y are in this party, is :

1) 484

2) 485

3) 468

4) 469

Key: **2**

Sol:

$\frac{4(X)}{4L,3M}$	$\frac{W(Y)}{3L,4M}$	$3L,3M$
0 3	3 0	1*1*1*1=1
1 2	2 1	4*3*3*4=144
2 1	1 2	6*3*3*6=324
3 0	0 3	4*1*1*4=16
		485

39. The normal to the curve $y(x-2)(x-3)=x+6$ at the point where the curve intersects the y-axis passes through the point:

1) $\left(\frac{1}{2},\frac{1}{3}\right)$

2) $\left(-\frac{1}{2},-\frac{1}{2}\right)$

3) $\left(\frac{1}{2},\frac{1}{2}\right)$

4) $\left(\frac{1}{2},-\frac{1}{3}\right)$

Key: **3**

Sol: $y(x-2)(x-3)=x+6, y=\frac{6}{6}=1$

$$y=\frac{x+6}{x^2-5x+6}$$

$$y^1=\frac{\left(x^2-5x+6\right)-(x+6)(2x-5)}{\left(x^2-5x+6\right)^2}=\frac{\left(x^2-5x+6\right)-\left(2x^2+7x-30\right)}{\left(x^2-5x+6\right)^2}$$

$$y^1\Big|=\frac{-x^2-12x+36}{\left(x^2-5x+6\right)^2}=\left(x^2-5x+6\right)\Big|_{x=0}=1$$

$y-1=-1(x-0)\Rightarrow y=-x+1$

$$\frac{-\left(2x^2+7x-30\right)}{\left(x^2-5x+6\right)}$$

$\therefore$ normal slope =-1

40. A hyperbola passes through the poir $P\left(\sqrt{2},\sqrt{3}\right)$ and has foci at $(\pm 2,0)$. Then the tangent to this hyperbola at P also passes through the point :

1) $\left(-\sqrt{2},-\sqrt{3}\right)$

2) $\left(3\sqrt{2},2\sqrt{3}\right)$

3) $\left(2\sqrt{2},3\sqrt{3}\right)$

4) $\left(\sqrt{3},\sqrt{2}\right)$

Key: **3**

Sol: $P\left(\sqrt{2},\sqrt{3}\right)$ $(\pm 2,0)$

$ae=2$ $b^2=a^2\left(e^2-1\right)=4-a^2$

$\frac{x^2}{a^2}-\frac{y^2}{4-a^2}=1$

$\frac{2}{a^2}-\frac{3}{4-a^2}=1$

$8-2a^2-3a^2=4a^2-a^4$

$a^4-9a^2+8=0$

$a^2=1,8,\ a=1,2\sqrt{2}$

$e^2=\frac{4}{a^2}=4,\frac{1}{2}$

$\because e>1\ \therefore e^2=4, a^2=1, b^2=3$

$x^2-\frac{y^2}{3}=1$

$Tgt.\ at\ \left(\sqrt{2},\sqrt{3}\right)\equiv x\sqrt{2}-\frac{y}{\sqrt{3}}=1$

$\left(2\sqrt{2},3\sqrt{3}\right)$ statistics

41. Let a,b,c, $\in$R. If $f(x)=ax^2+bx+c$ is such that a+b+c=3 and $f(x+y)=f(x)+f(y)+xy,\forall x,y\in R,$ then $\sum_{n=1}^{10} f(n)$ is equal to :

1) 255

2) 330

3) 165

4) 190

Key: **2**

Sol: $f\left(x+y\right)=a\left(x+y\right)^2+b\left(x+y\right)+c$

$=\left(ax^2+bx+c\right)+\left(ay^2+by+c\right)+\left(2axy-c\right)$

$=f\left(x\right)+f\left(y\right)+xy$ $\Rightarrow c=0\ \&\ a=\frac{1}{2}$

$\because a+b+c=3\Rightarrow b=3-\frac{1}{2}=\frac{5}{2}$ $f\left(x\right)=\frac{1}{2}x^2+\frac{5x}{2}$

$\sum_{n=1}^{10} f\left(x\right)=\frac{1}{2}\sum_{n=1}^{10} n^2+\frac{5}{2}\sum_{n=1}^{10} n$

$=\frac{1}{2}\frac{10(11)(21)}{6}+\frac{5}{2}\times\frac{10\times 11}{2}$ $=\frac{385}{2}+\frac{275}{2}=\frac{660}{2}=330$

42. Let $\vec{a}=2\hat{i}+\hat{j}-2\hat{k}$ and $\vec{b}=\hat{i}+\hat{j}$. Let $\vec{c}$ be a vector such that $|\vec{c}-\vec{a}|=3$, $\left|(\vec{a}\times\vec{b})\times\vec{c}\right|=3$ and the angle between $\vec{c}$ and $\vec{a}\times\vec{b}$ be 30^0. Then $\vec{a}.\vec{c}$ is equal to:

1) $\frac{1}{8}$

2) $\frac{25}{8}$

3) 2

4) 5

Key: **3**

Sol: $\vec{a}=2\hat{i}+\hat{j}-2\hat{k}$ $\quad \hat{b}=\hat{i}+\hat{j}$

$|\vec{c}-\vec{a}|=3$ $\quad \left|(\vec{a}\times\vec{b})\times\vec{c}\right|=3$

$\left|(\vec{a}\times\vec{b})\right||\vec{c}|\sin\theta=3$

Where

$$\vec{a}\times\vec{b}=\begin{vmatrix} i & j & k \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix}$$

$|\vec{a}\times\vec{b}|=\left|2\hat{i}+2\hat{j}+\hat{k}\right|=3$

$$|\vec{c}|=\frac{3}{|\vec{a}\times\vec{b}|\sin 30^0}=\frac{3}{3\times\frac{1}{2}}=2$$

$|\vec{c}|^2+|\vec{a}|^2-2\vec{a}.\vec{c}=9$

$2(\vec{a}.\vec{c})=4+9-9=4$

$\vec{a}.\vec{c}=2$

43 . Let a vertical tower AB have its end A on the level ground. Let C be the mid-point of AB and P be a point on the ground such that $AP = 2AB$, If $\angle BPC = \beta$, then $\tan\beta$ is equal to:

1) $\frac{4}{9}$

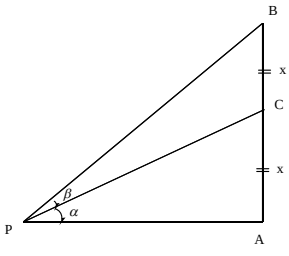
2) $\frac{6}{7}$

3) $\frac{1}{4}$

4) $\frac{2}{9}$

Key: **4**

Sol:



$AP = 2(AB)$

$AP = 2(2x)$

$= 4x$

$\tan\alpha = \frac{1}{4}; \tan(\alpha+\beta) = \frac{2x}{4x} = \frac{1}{2}$

$\frac{\frac{1}{4}+y}{1-\frac{1}{4}y} = \frac{1}{2} \qquad 2\left(\frac{1}{4}+y\right) = 1-\frac{y}{4}$

$\frac{1}{2}+2y = 1-\frac{y}{4} \qquad y\left(2+\frac{1}{4}\right) = \frac{1}{2}$

$y\frac{9}{4} = \frac{1}{2}$

$y = \frac{2}{9}$

44. Twenty meters of wire is available for fencing off a flower-bed in the form of a circle sector. Then the maximum area (in sq.m) of the flower-bed, is :

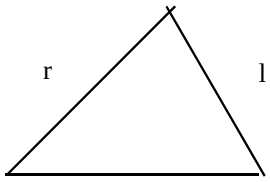
1) 30

2) 12.5

3) 10

4) 25

Key: **4**



Sol:

$2r+r\theta=20$

$r(2+\theta)=20$

$r=\frac{20}{2+\theta}$ $\quad \theta r=\frac{20-2r}{r}$

$\frac{dA}{dr}=10-2r=0 \quad 2r=10 \quad r=5$

$A=\frac{1}{2}r^2\left(\frac{20-2r}{r}\right)=\frac{1}{2}r(20-2r)$

$=\frac{1}{2}(20r-2r^2)=10r-r^2$

$A=\frac{1}{2}r^2\theta \quad \theta=\frac{20-10}{5}=\frac{10}{5}=2$

$=\frac{1}{2}25\times 2$

$A=25$

45. The integral $\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\frac{dx}{1+\cos x}$ is equal to:

1) -1

2) -2

3) 2

4) 4

Key: **3**

Sol: $\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\frac{dx}{1+\cos x} \qquad I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\frac{1}{1-\cos x}$

$2I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\left(\frac{1}{1+\cos x}+\frac{1}{1-\cos x}\right)=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\left(\frac{1-\cos x+1+\cos x}{\sin^2 x}\right)$

$$2I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}2\operatorname{cosec}^2x\ I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}(-\cot x)=-\left(\cot\frac{3\pi}{4}-\cot\frac{\pi}{4}\right)=-(-1-1)=2$$

46. If $(2+\sin x)\frac{dy}{dx}+(y+1)\cos x=0$ and $y(0)=1$, then $y\left(\frac{\pi}{2}\right)$ is equal to:

1) $\frac{4}{3}$

2) $\frac{1}{3}$

3) $-\frac{2}{3}$

4) $-\frac{1}{3}$

Key: **2**

Sol: $(2+\sin x)\frac{dy}{dx}+(y+1)\cos x=0$

$\frac{2+\sin x}{\cos x}+(y+1)\frac{dx}{dy}=0$ $\quad \ln(y+1)+\ln(2+t)=\ln c$

$(y+1)+(2+\sin x)=c$ $\quad$ x=0

$(1+1)(2)=C\Rightarrow C=4$ $\quad (y+1)+(2+\sin x)=4$

$x=\frac{\pi}{2}\Rightarrow(y+1)+(2+1)=4$ $\quad y+1=\frac{4}{3}\Rightarrow y=\frac{4}{3}-1=\frac{1}{3}$

47. Let $I_n=\int\tan^n x dx,(n>1)$. If $I_4+I_6=a\tan^5x+bx^5+C$, where C is a constant of integration, then the ordered pair (a,b) is equall to:

1) $\left(-\frac{1}{5},0\right)$

2) $\left(-\frac{1}{5},1\right)$

3) $\left(\frac{1}{5},0\right)$

4) $\left(\frac{1}{5},-1\right)$

Key: **3**

Sol: $I_n = \int Tan^n x$

$I_4 + I_6 = \int Tan^4 x + \int Tan^6 x = \int Tan^4 x\left(1 + Tan^2 x\right)dx$

$= \int Tan^4 x \sec^2 x dx \qquad = \int t^4 dt = \frac{t^5}{5} + c \qquad = \frac{1}{5}\tan^5 x + c$

$= a\tan^5 x + bx^5 + c \qquad \Rightarrow a = \frac{1}{5}, b = 0$

48. Let ω be complex number such that $2\omega + 1 = z$ where $z = \sqrt{-3}$.

If $\begin{vmatrix} 1 & 1 & 1 \\ 1 & -\omega^2 - 1 & \omega^2 \\ 1 & \omega_2 & \omega^7 \end{vmatrix} = 3k$ then k is equal to

1)1

2)–z

3)z

4) -1

Key: **2**

Sol: $2\omega + 1 = z. \qquad z = \sqrt{-3} = \sqrt{(3)(-1)} = \sqrt{3}i$

$2\omega + 1 = 3i \qquad \omega = \frac{-1 + \sqrt{3}i}{2}$

$\begin{vmatrix} 1 & 1 & 1 \\ 1 & \omega & \omega^2 \\ 1 & \omega^2 & \omega \end{vmatrix} \qquad \begin{vmatrix} 3 & 1 & 1 \\ 0 & \omega & \omega^2 \\ 0 & \omega^2 & \omega \end{vmatrix}$

$= 3\left(\omega^2 - \omega^4\right) = 3\left(\omega^2 - \omega\right)$

$= 3\left(-i\sqrt{3}\right) = 3(-z) - = -3z$

$k = -z$

49. The value of $\left({}^{21}C_1 - {}^{10}C_1\right)+\left({}^{21}C_2 - {}^{10}C_2\right)+\left({}^{21}C_3 - {}^{10}C_3\right)+\left({}^{21}C_4 - {}^{10}C_4\right)+\ldots+$ is

1) $2^{20}-2^{10}$

2) $2^{21}-2^{11}$

3) $2^{21}-2^{10}$

4) $2^{20}-2^{9}$

Key: **1**

Sol: $\left({}^{21}C_1+{}^{21}C_2+\ldots..+{}^{21}C_{10}\right)-\left({}^{10}C_1+{}^{10}C_2\ldots..+{}^{10}C_{10}\right)$

$=\left(2^{20}-1\right)-\left(2^{10}-1\right)$

$==2^{20}-2^{10}$

50. $\lim\limits_{x\to\frac{\pi}{2}}\dfrac{\cot x-\cos x}{(\pi-2x)^3}$ equals:

1) $\dfrac{1}{4}$

2) $\dfrac{1}{24}$

3) $\dfrac{1}{16}$

4) $\dfrac{1}{8}$

Key: **3**

Sol: $\lim\limits_{x\to\frac{\pi}{2}}\dfrac{\cot x-\cos x}{(\pi-2x)^3}$

$\lim\limits_{t\to0}\dfrac{-\tan t+\sin t}{(-2t)^3}=\lim\limits_{t\to0}\left(\dfrac{\tan t-\sin t}{8t^3}\right)$

$=\dfrac{1}{8}\times\dfrac{1}{2}=\dfrac{1}{16}$

51. if $5\left(\tan^2 x-\cos^2 x\right)=2\cos 2x+9$, then the value of $\cos 4x$ is:

1) $-\frac{7}{9}$

2) $-\frac{3}{5}$

3) $\frac{1}{3}$

4) $\frac{2}{9}$

Key: **1**

Sol: $5\left(\tan^2 x-\cos^2 x\right)=2\cos 2x+9$

$$5\left(\frac{\sin^2 x}{\cos^2 x}-\cos^2 x\right)=2\left(\cos^2 x-\sin^2 x\right)+9$$

$$5\left(\frac{1-\cos^2 x}{\cos^2 x}-\cos^2 x\right)=2\left(\cos^2 x-\left(1-\cos^2 x\right)\right)+9$$

$$\Rightarrow 9\cos^4 x+12\cos^2 x-5=0$$

$$\cos^2 x=\frac{1}{3} \text{ or } \cos^2 x=-\frac{5}{3}(\text{not possible})$$

$$\Rightarrow \sin^2 x=\frac{2}{3}$$

$$\cos 4x=2\cos^2 2x-1$$

$$=2\left(\frac{1}{9}\right)-1 \qquad =\frac{2}{9}-1=\frac{-7}{9}$$

52. If the image of the point $P(1,-2,3)$ in the plane, $2x+3y-4z+22=0$ measured parallel to the line, $\frac{x}{1}=\frac{y}{4}=\frac{z}{5}$ is Q, then PQ is equal to :

1) $6\sqrt{5}$

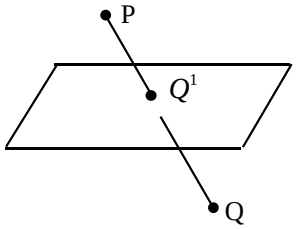
2) $3\sqrt{5}$

3) $2\sqrt{42}$

4) $\sqrt{42}$

Key: **3**

Sol: $\frac{x-1}{1}=\frac{y+2}{4}=\frac{z-3}{5}=\lambda$



$(1+\lambda,-2+4\lambda,3+5\lambda)$

Satisfy in plane

$2+2\lambda-6+12\lambda-12-20\lambda+22=0$

$-6\lambda+6=0 \quad \therefore \lambda=1$

$\therefore Q^1(2,2,8)$ $\qquad PQ^1=\sqrt{1^2+4^2+5^2}$

$=\sqrt{42}$ $\qquad \therefore PQ=2\sqrt{42}$

53. The distance of the point $(1,3,-7)$ from the plane passing through the point $(1,-1,-1)$, having normal perpendicular to both the line $\frac{x-1}{1}=\frac{y+2}{-2}=\frac{z-4}{3}$ and $\frac{x-2}{2}=\frac{y+1}{-1}=\frac{z+7}{-1}$ is:

1) $\frac{10}{\sqrt{74}}$

2) $\frac{20}{\sqrt{74}}$

\

3) $\frac{10}{\sqrt{83}}$

4) $\frac{5}{\sqrt{83}}$

Key: **3**

Sol: $a(x-1)+b(y+1)+c(z+1)=0$

$a-2b+3c=0 \qquad 2a-b-c=0$

$\frac{a}{5}=\frac{+b}{+7}=\frac{c}{3} \qquad 5x+7y+3z-5+7+3=0$

$5x+7y+3z+5=0$

$p=\left|\frac{5+21-21+5}{\sqrt{5^2+7^2+3^2}}\right|=\frac{10}{\sqrt{83}}$

54. If for $x \in \left(0, \frac{1}{4}\right)$, the derivative of $\tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right)$ is $\sqrt{x}.g(x)$, then $g(x)$ equals:

1) $\frac{3}{1+9x^3}$

2) $\frac{9}{1+9x^3}$

3) $\frac{3x\sqrt{x}}{1-9x^3}$

4) $\frac{3x}{1-9x^3}$

Key: **2**

Sol: $Tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right) = 2Tan^{-1}3x\sqrt{x}$

$f^{-1}(x) = \frac{9\sqrt{x}}{1+9x^3}$

$g(x) = \frac{9}{1+9x^3}$

55. The radius of a circle, having minimum area, which touches the curve $y = 4 - x^2$ and the lines, $y = |x|$ is:

1) $4\left(\sqrt{2}+1\right)$

2) $2\left(\sqrt{2}+1\right)$

3) $2\left(\sqrt{2}-1\right)$

4) $4\left(\sqrt{2}-1\right)$

Key: **4**

Sol:

There are two circles satisfying the given conditions. The circle shown is of least area.

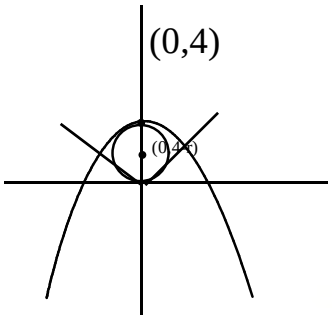
Let radius of circle is 'r'

$\therefore$ **co-ordinates of centre** $= = (0, 4-r)$

$\because$ **circle touches the line** $y = x$ **in first quadrant**

$$\therefore \left|\frac{0-(4-r)}{\sqrt{2}}\right| = r \Rightarrow r = 4 = \pm r\sqrt{2}$$

$$r = \frac{4}{\sqrt{2}+1} = 4\left(\sqrt{2}-1\right)$$



56. A box contains 15 green and 10 yellow balls. If 10 balls are randomly drawn, one-by-one, with replacement, then the variance of the number of green balls drawn is :

1) $\frac{6}{25}$

2) $\frac{12}{5}$

3) 6

4) 4

Key: **2**

Sol's: $n = 10, P = \frac{15}{25} = \frac{3}{5}, q = \frac{2}{5}$

Variance $= npq = 10 \times \frac{3}{5} \times \frac{2}{5} = \frac{12}{5}$

57. The eccentricity of an ellipse whose centre is at the origin is $\frac{1}{2}$. If one of its directrices is $x = -4$, then the equation of the normal to it at $\left(1, \frac{3}{2}\right)$ is:

1) $x + 2y = 4$

2) $2y - x = 2$

3) $4x - 2y = 1$

4) $4x + 2y = 7$

Key: **3**

$C=\frac{1}{2},\ ac=4$

$a=2,\ b=\sqrt{3}$

Sol: $normal\ at\left(1,\frac{3}{2}\right)is$

$$\frac{4x}{1}-\frac{\cancel{3}y}{\cancel{3}}\times 2=1$$

$$4x-2y-1$$

58. If two different numbers are taken from the set $\{0,1,2,3,...,10\}$; then the probability that their sum as well as absolute difference are both multiple of 4, is:

1) $\frac{7}{55}$

2) $\frac{6}{55}$

3) $\frac{12}{55}$

4) $\frac{14}{55}$

Key: **2**

Sol: $n(E)=6$

$\therefore (0,4),(0,8),(2,6),(2,10),(4,8),(6,10)$

$$probability=\frac{6}{11_{c_2}}=\frac{6}{55}$$

59. For three events A, B and C, P(Exactly one of A or B occurs) =P(Exactly one of B or C occurs) =P(Exactly one of C or A occurs) $=\frac{1}{4}$ and P(All the three events occurs simultaneously) $=\frac{1}{16}$.

Then the probability that at least one of the events occurs, is :

1) $\frac{3}{16}$

2) $\frac{7}{32}$

3) $\frac{7}{16}$

4) $\frac{7}{64}$

Key: **3**

Sol: $P(A\cup B)-P(A\cap B)=\frac{1}{4}\ P(B\cup C)-P(B\cap C)=\frac{1}{4}$

$P(A\cap C)-P(A\cap C)=\frac{1}{4}\ P(A\cap B\cap C)=\frac{1}{16}$

$P(A\cup B\cup C)=P(A)+P(B)+P(C)-P(A\cap B)-P(B\cap C)-P(A\cap C)+P(A\cap B\cap C)$

$=\frac{3}{8}+\frac{1}{16}=\frac{7}{16}\left(\because 2\{P(A)+P(B)+P(C)-P(A\cap B)-P(B\cap C)-P(C\cap A)\}=\frac{3}{4}\right)$

60. If $A=\begin{bmatrix}2 & -3\\ -4 & 1\end{bmatrix}$, then $adj\left(3A^2+12A\right)$ is equal to :

1) $\begin{bmatrix}72 & -63\\ -84 & 51\end{bmatrix}$

2) $\begin{bmatrix}72 & -84\\ -63 & 51\end{bmatrix}$

3) $\begin{bmatrix}51 & 63\\ 84 & 72\end{bmatrix}$

4) $\begin{bmatrix}51 & 84\\ 63 & 72\end{bmatrix}$

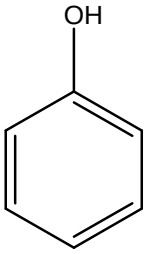
Key: **3**

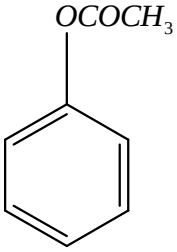
Sol: $A^2=\begin{bmatrix}2 & -3\\ -4 & 1\end{bmatrix}\begin{bmatrix}2 & -3\\ -4 & 1\end{bmatrix}=\begin{bmatrix}16 & -9\\ -12 & 13\end{bmatrix}\quad 3A^2+12A=\begin{bmatrix}48 & -27\\ -36 & 39\end{bmatrix}+\begin{bmatrix}24 & -36\\ -48 & 12\end{bmatrix}=\begin{bmatrix}72 & -63\\ -84 & 51\end{bmatrix}$

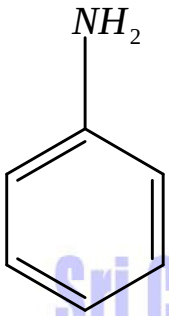
$ADJ\,(3A^2+12A)=\begin{bmatrix}51 & 63\\ 84 & 72\end{bmatrix}$

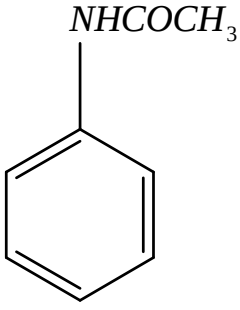
CHEMISTRY

61. Which of the following compounds w form significant amount of *meta* product during mono-nitration?

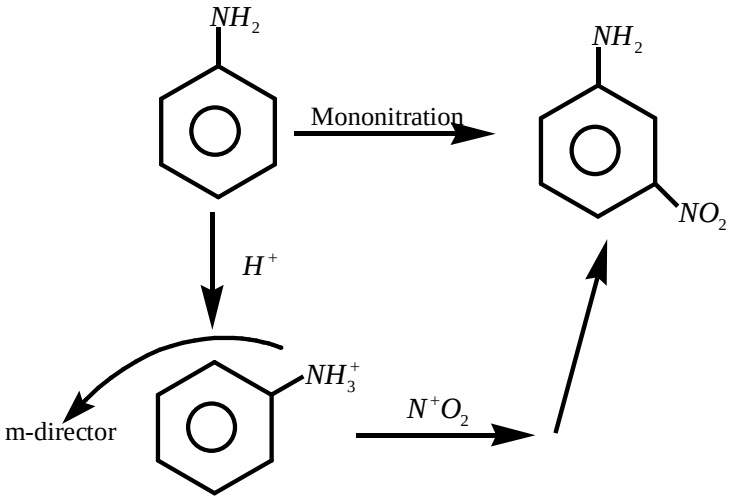
1) 

2) 

3) 

4) 

Key: **3**



Sol:

62. ΔU is equal to :

1) Isochoric work

2) Isobaric work

3) Adiabatic work

4) Isothermal work

Key: **3**

Sol: $q = 0$ in adiabatic proceses

63. The increasing order of the reactivity of the following halides for the S_N1 reaction is :

$CH_3\underset{\underset{Cl}{|}}{C}HCH_2CH_3$ $CH_3CH_2CH_2Cl$ $p-H_3CO-C_6H_4-CH_2Cl$

(I) (II) (III)

1) (III) < (II) < (I)

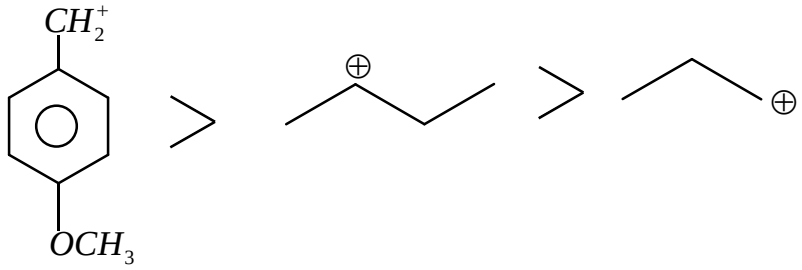
2) (II) < (I) < (III)

3) (I) < (III) < (II)

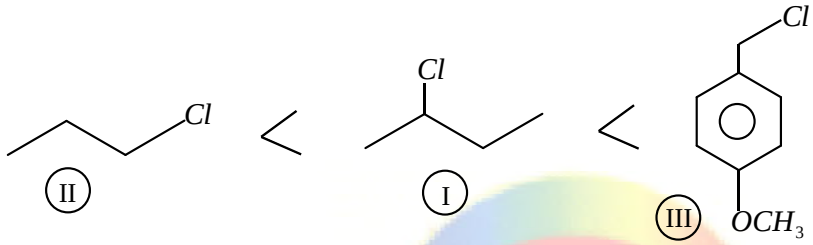
4) (II) < (III) < (II)

Key: **2**

Sol: Carbocation stability is as follows



Increasing order of reactivity of given molecules towards S_N1 reaction



64. The radius of the second Bohr orbit for hydrogen atom is:

(Planck's Const. $h = 6.6262 \times 10^{-34}\, Js$; mass of electron $= 9.1091 \times 10^{-31}\, kg$; charge of electron $e = 1.60210 \times 10^{-19}\, C$; permittivity of vacuum $\varepsilon_0 = 8.854185 \times 10^{-12}\, kg^{-1} m^{-3} A^2$)

1) $1.65\,\overset{0}{\text{A}}$

2) $4.76\,\overset{0}{\text{A}}$

3) $0.529\,\overset{0}{\text{A}}$

4) $2.12\,\overset{0}{\text{A}}$

Key: **4**

Sol: $r_n = 0.53 \times n^2 A^0 = 0.53 \times 4 = 2.12 A^0$

65. pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4, respectively. The pH of their salt (AB) solution is:

1) 7.2

2) 6.9

3) 7.0

4) 1.0

Key: **2**

Sol: Ka of HA more $\Rightarrow$ salt solution is slightly acidic.

66. The formation of which of the following polymers involves hydrolysis reaction?

1) Nylon 6

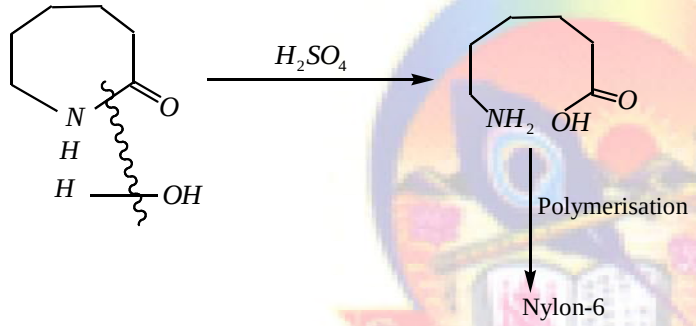
2)Bakelite

3)Nylon 6, 6

4)Terylene

Key: **1**

Sol: Nylon -6 is from caprolactam .Prior to polymerization caprolactam undergoes hydrolysis then undergoes condensation



67. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%); carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^{1}H atoms are replaced by ^{2}H atoms as:

1) 15 kg

2)37.5 kg

3)7.5 kg

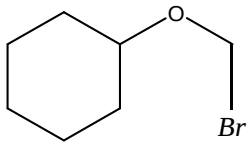
4) 10 kg

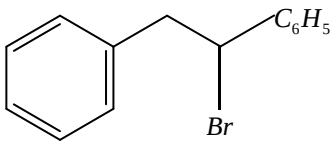
Key: **3**

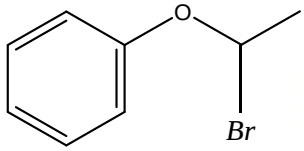
Sol: 10 :75Kg =7.5kg

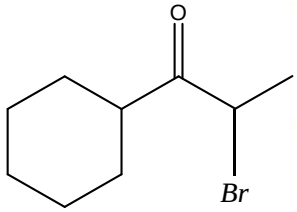
$\therefore$ Increase in 7.5 kg.

68. Which of the following upon treatment with tert-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine?

1) 

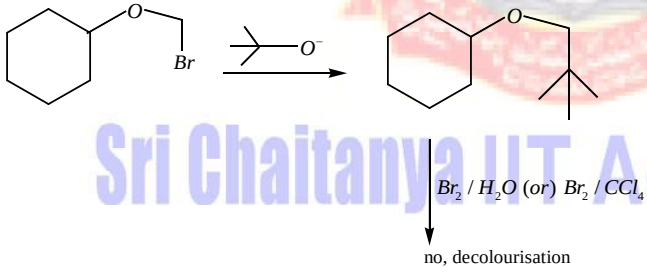
2) 

3) 

4) 

Key: **1**

Sol:



69. In the following reactions, ZnO is respectively acting as a/an:

a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$

b) $ZnO + CO_2 \rightarrow ZnCO_3$

1) base and acid

2) base and base

3) acid and acid

4) acid and base

Key: **4**

Sol: Conceptual

70. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is :

1) both form basic carbonates

2) both form soluble bicarbonates

3) both form nitrides

4) nitrates of both Li and Mg yield NO_2 and O_2 on heating

Key: **1**

Sol: Li can't form basic carbonate.

71. 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is :

1) Six

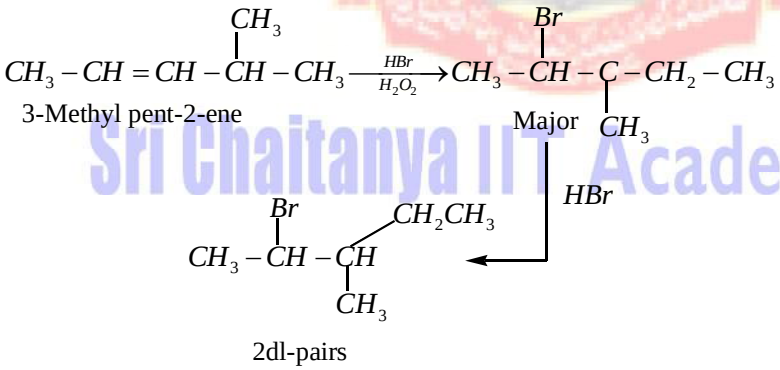
2) Zero

3) Two

4) Four

Key: **4**

Sol:



Total no.of stereoisomers=4

72. A metal crystallizes in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be:

1)2a

2) $2\sqrt{2}a$

3) $\sqrt{2}a$

4) $\frac{a}{\sqrt{2}}$

Key: **4**

Sol: Atoms touch along the face diagonal, length of face diagonal $=\sqrt{2}a$

73. Two reactions R_1 and R_2 have identical pro-exponential factors. Activation energy of R_1 exceeds that of R_2 by $10\,kJ\,mol^{-1}$. If k_1 and k_2 are rate constants for reactions R_1 and R_2 respectively at 300 K, then $\ln(k_2/k_1)$ is equal to:

$(R = 8.314\ J\ mol^{-}K^{-1})$

1) 8

2)12

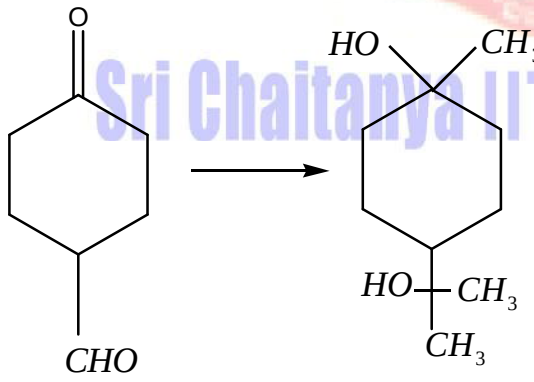
3)6

4) 4

Key: **4**

Sol: $\ln\frac{k_2}{k_1} = e^{\frac{10}{RT}}$

74. The correct sequence of reagents for the following conversion will be :



1) $\left[Ag(NH_3)_2\right]^+ OH^-, H^+ / CH_3OH, CH_3MgBr$

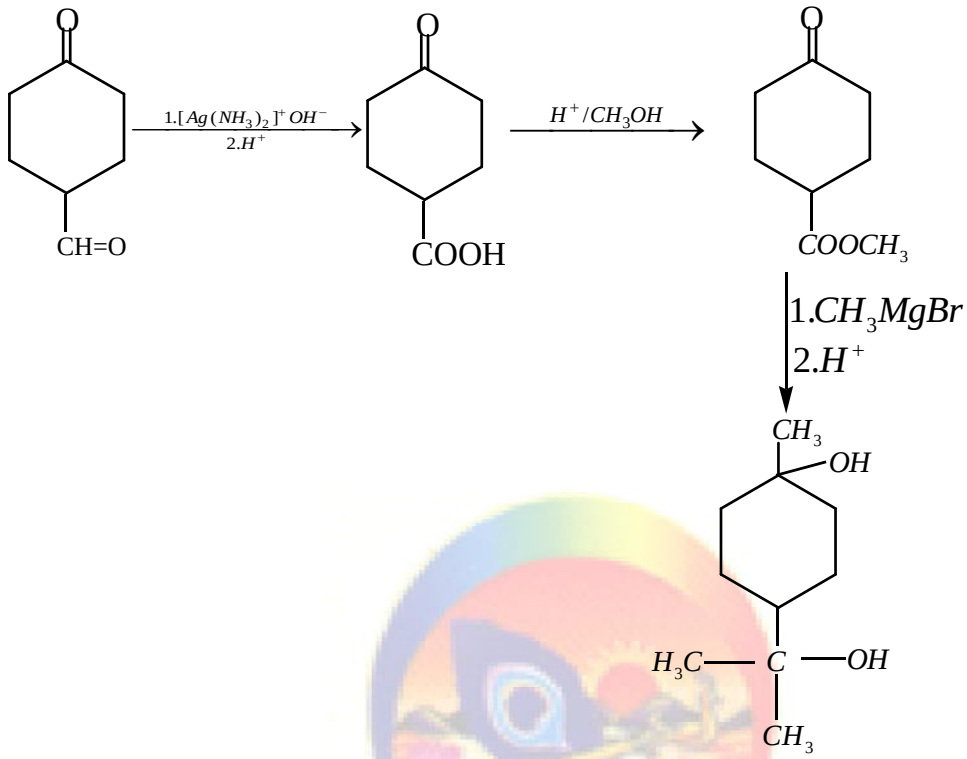
2) $CH_3MgBr,\ H^+ / CH_3OH, \left[Ag(NH_3)_2\right]^+ OH^-$

3) $CH_3MgBr, \left[Ag(NH_3)_2\right]^+ OH^-, H^+ / CH_3OH$

4) $\left[Ag(NH_3)_2\right]^+ OH^-, CH_3MgBr,\ H^+ / CH_3OH$

Key: **1**

Sol:



75. The Tyndall effect is observed only when following conditions are satisfied:

a) The diameter of the dispersed particles is much smaller than the wavelength of the light used.

b) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.

c) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.

d) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

1) (a) and (d)

2) (b) and (d)

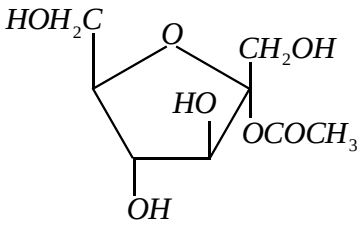
3) (a) and (c)

4) (b) and (c)

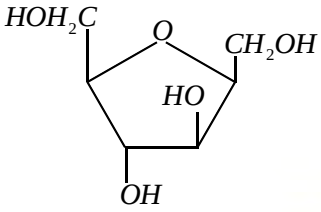
Key: **2**

Sol: Conceptual

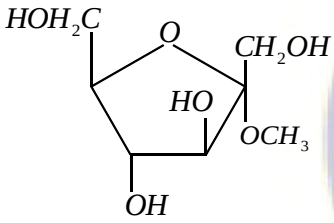
76. Which of the following compounds will behave as a reducing sugar in an aqueous KOH solution?



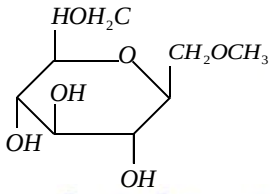
1)



2)



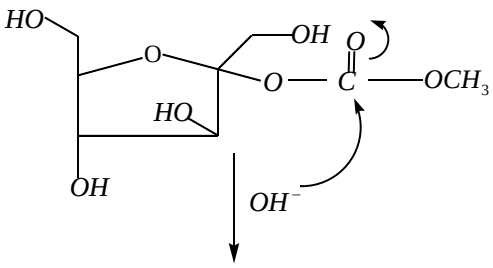
3)

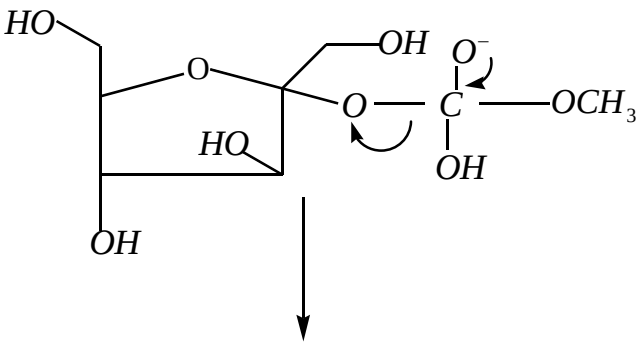


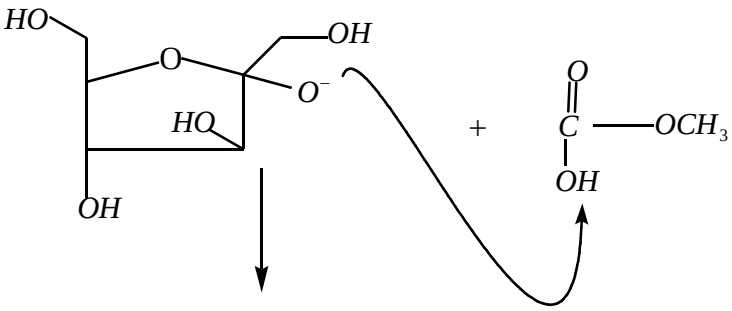
4)

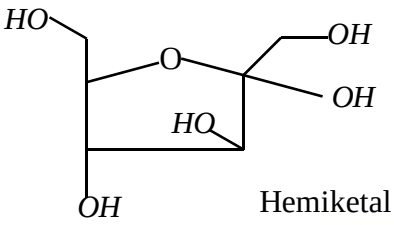
Key: **1**

Sol: (1)



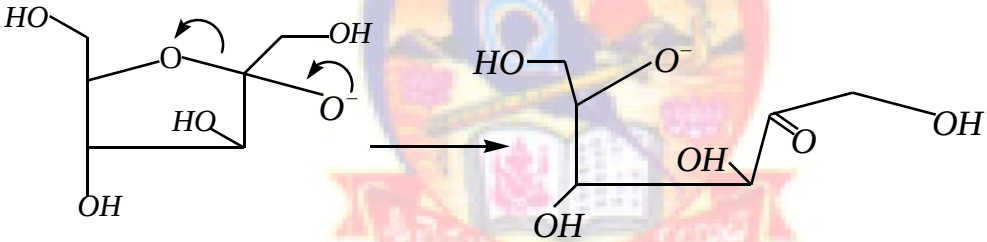




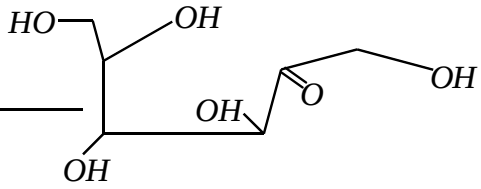


Hemiketal opens in the basic Medium

OH^-

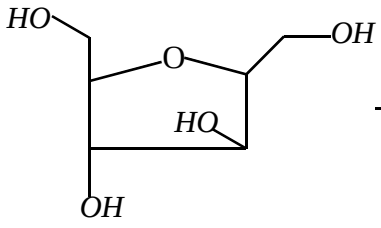


H_2O



α – *Hydroxyketone* &
is able to exhibit mutarotation

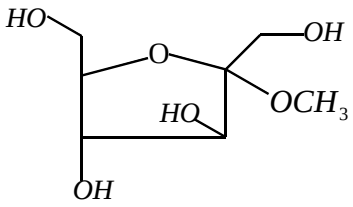
Above hemiketal acts as reducing sugar



→ ketal stable in basic medium

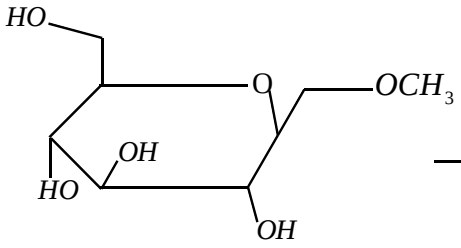
(2)

(3)



→ ketal stable in basic medium

(4)



→ ketal stable in basic medium

77. Given $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g)$;

$\Delta_r H^\circ = -393.5\,kJ\,mol^{-1}$;

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(I)$;

$\Delta_r H^\circ = -285.8\,kJ\,mol^{-1}$

$CO_2(g) + 2H_2O(I) \rightarrow CH_4(g) + 2O_2(g)$;

$\Delta_r H^\circ = +890.3\,kJ\,mol^{-1}$

Based on the above thermochemical equations, the value of $\Delta_r H^\circ$ at 298 K for the reaction.

$C_{(\text{graphite})} + 2H_2(g) \rightarrow CH_4(g)$ will be:

1) $+74.8\,kJ\,mol^{-1}$

2) $+144.0\,kJ\,mol^{-1}$

3) $-74.8\,kJ\,mol^{-1}$

4) $-144.0\,kJ\,mol^{-1}$

Key: **3**

Sol: $1+2\times2+3$

78. Which of the following reactions is an example of a redox reaction?

1) $XeF_4 + O_2F_2 \rightarrow XeF_2 + O_2$

2) $XeF_2 + PF_5 \rightarrow [XeF]^+ PF_6$

3) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

4) $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

Key: **1**

Sol: Conceptual

79. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are:

1) ClO^{-1} and ClO_3^-

2) ClO_2^- and ClO_3^-

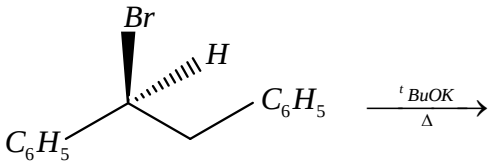
3) Cl^- and ClO^-

4) Cl^- and ClO_2^-

Key: **3**

Sol: Conceptual

80. The major product obtained in the following reactions is ;



1) $(\pm)C_6H_5CH(O^tBu)CH_2C_6H_5$

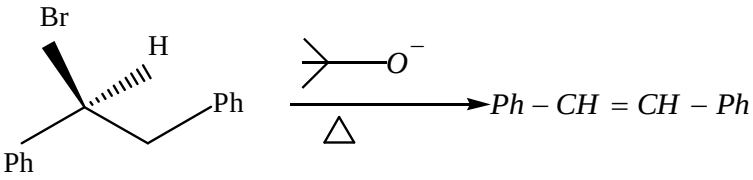
2) $C_6H_5CH = CHC_6H_5$

3) $(+)C_6H_5CH(O^tBu)CH_2C_6H_5$

4) $(-)C_6H_5CH(O^tBu)CH_2C_6H_5$

Key: **2**

Sol:



81. Sodium salt of an organic acid 'X' produced effervescence with $conc.H_2SO_4$. 'X' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises acidic solution of $KMnO_4$ 'X' is

1) C_6H_5COONa

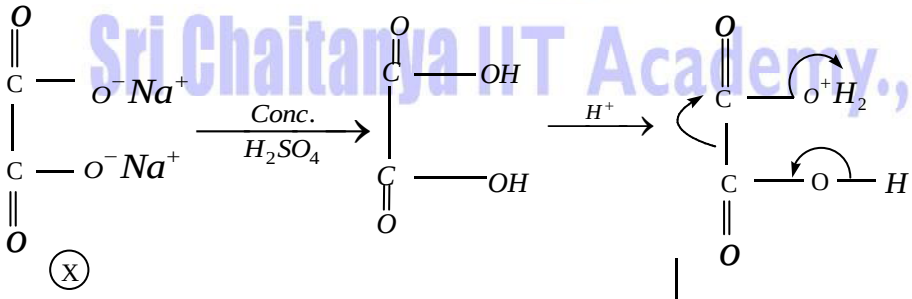
2) $HCOONa$

3) CH_3COONa

4) $Na_2C_2O_4$

Key: **4**

Sol:



$$CO + CO_2 + H_2O + H^+$$

Oxalate Gives effervescence with H_2so_4

$$\begin{matrix} COO^-Na^+ \\ | \\ COO^-Na^+ \end{matrix} \xrightarrow{CaCl_2} \begin{matrix} COO^- \\ | \\ COO^- \end{matrix} Ca^{2+} + 2NaCl \xrightarrow{White\ ppt} decolourieses \quad KHno_4 / H^+$$

82. Which of the following species is not paramagnetic?

1) NO

2)CO

3) O_2

4) B_2

Key: **2**

Sol: Conceptual

83. The freezing point of benzene decreases by $0.45°C$ when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associated to form a dimer in benzene, percentage association of acetic acid in benzene will be:

(K_f for benzene $= 5.12\,K\,kg\,mol^{-1}$)

1) 64.6 %

2)80.4 %

3)74.6%

4) 94.6%

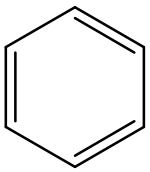
Key: **4**

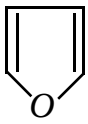
Sol:

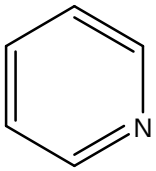
$$\Delta Tf = i K_f m$$

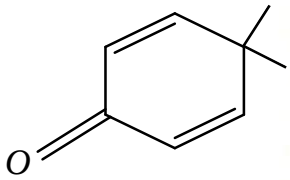
$$1-\frac{\alpha}{2} = i$$

84. which of the following molecules is least resonance stabilized?

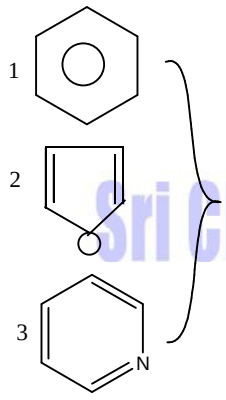
1) 

2) 

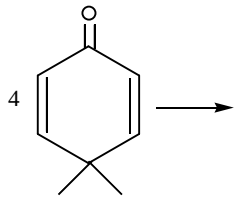
3) 

4) 

Key: **4**



Sol: All are aromatic & are highly resonance stabilised molecules.



Non –aromatic,less resonance stabilizead

85. On treatment of 100mL of 0.1M solution of $CoCl_3.6H_2O$ with excess $AgNC$, 1.2×10^{22} ions are precipitated. The complex is:

1) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

2) $[Co(H_2O)_3Cl_3].3H_2O$

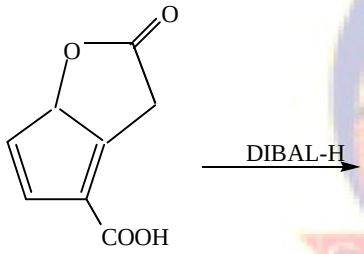
3) $[Co(H_2O)_6]Cl_3$

4) $[Co(H_2O)_5Cl]Cl_2.H_2O$

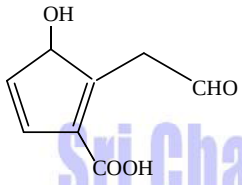
Key: **4**

Sol: 1 mol complex is gives 2 moles of Agcl

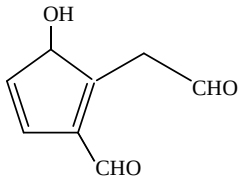
86. The major product obtained in the following reaction is:



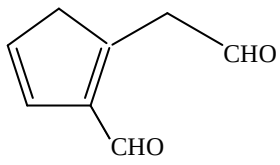
1)



2)



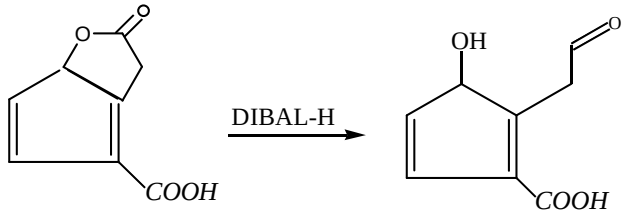
3)



4)

Key: **1**

Sol:



87. A water sample has ppm level concentration of following anions

$F^- = 10; SO_4^{2-} = 100; NO_3^- = 50$

The anion/anions that make /makes the water sample unsuitable for drinking is/are:

1) Only NO_3^-

2) both so_4^{2-} and NO_3^-

3)only F^-

4)only SO_4^{2-}

Key: **3**

Sol: Optimum value of $\bar{F}$ is 5-6ppm.

88. 1 gram of a carbonate M_2CO_3 on treatment with excess HCl produces 0.01186 mole of CO_2.

The molar mass of M_2CO_3 in g mol^{-1} is :

1)1186

2)84.3

3)118.6

4)11.86

Key: **2**

Sol: 1 mole M_2co_3 gives 1 mole CO_2

89. Given $E^o_{Cl_2/Cl^-} = 1.36V, E^o_{Cr^{3+}/Cr} = -0.74V$

$E^o_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V, E^o_{Mno_4^-/Mn^{2+}} = 1.51V$

Among the following , the strongest reducing agent is:

1) Cr

2) Mn^{2+}

3) Cr^{3+}

4) Cl^-

Key: **1**

Sol: highest –ve SRP value is for Cr^{3+}/Cr

90. The group having isoelectronic species is:

1) $O^{2-}, F^{-}, Na^{+}, Mg^{2+}$

2) O^{-}, F^{-}, Na, Mg^{+}

3) $O^{2-}, F^{-}, Na, Mg^{2+}$

4) $O^{-}, F^{-}, Na^{+}, Mg^{2+}$

Key: **1**

Sol: Conceptual