# JEE MAIN ONLINE PAPER 2021

## Held on July 20, 2021 (Evening)

### Instructions

1. This test will be a 3 hours Test.
2. This test consists of Physics, Chemistry and Mathematics questions with equal weightage of 100 marks.
3. Each question is of 4 marks.
4. In the question paper consisting of Physics (Q.no. 1 to 30), Chemistry (Q.no. 31 to 60) and Mathematics (Q.no. 61 to 90). There are two sections for each subject (Section-A : MCQ Type & Section-B : Numerical Response Type). Section-A consists of 20 multiple choice questions & Section-B consists of 10 Numerical Value type Questions. **Candidates have a choice to Answer 5 out of the 10 numerical value answer based questions per section.**
5. There will be only one correct choice in the given four choices in Section-A. For each question 4 marks will be awarded for correct choice, 1 mark will be deducted for incorrect choice and zero mark will be awarded for not attempted question. For Section-B questions 4 marks will be awarded for correct answer and zero for unattempted and incorrect answer.
6. Any textual, printed or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.
7. All calculations/written work should be done in the rough sheet provided.

## PHYSICS

### Section -A

**Q.1** If the Kinetic energy of a moving body becomes four times its initial Kinetic energy, then the percentage change in its momentum will be :

(1) 100% (2) 200%

(3) 300% (4) 400%

**Q.2** A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time $t_1$. If he remains stationary on a moving escalator then the escalator takes him up in time $t_2$. The time taken by him to walk up on the moving escalator will be :

(1) $\frac{t_1 t_2}{t_2 - t_1}$ (2) $\frac{t_1 + t_2}{2}$

(3) $\frac{t_1 t_2}{t_2 + t_1}$ (4) $t_2 - t_1$

**Q.3** A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius 1.02 R. The percentage difference in the time periods of the two satellites is :

(1) 1.5 (2) 2.0 (3) 0.7 (4) 3.0

**Q.4** With what speed should a galaxy move outward with respect to earth so that the sodium-D line at wavelength 5890 Å is observed at 5896 Å ?

(1) 306 km/sec (2) 322 km/sec

(3) 296 km/sec (4) 336 km/sec

**Q.5** The length of a metal wire is $\ell_1$, when the tension in it is $T_1$ and is $\ell_2$ when the tension is $T_2$. The natural length of the wire is :

(1) $\sqrt{\ell_1 \ell_2}$ (2) $\frac{\ell_1 T_2 - \ell_2 T_1}{T_2 - T_1}$

(3) $\frac{\ell_1 T_2 + \ell_2 T_1}{T_2 + T_1}$ (4) $\frac{\ell_1 + \ell_2}{2}$

**Q.6** In an electromagnetic wave the electric field vector and magnetic field vector are given as $\vec{E} = E_0\hat{i}$ and $\vec{B} = B_0\hat{k}$ respectively. The direction of propagation of electromagnetic wave is along :

(1) $(\hat{k})$ (2) $\hat{j}$

(3) $(-\hat{k})$ (4) $(-\hat{j})$

**Q.7** For a series LCR circuit with R = 100 Ω, L = 0.5 mH and C = 0.1 pF connected across 220 V–50 Hz AC supply, the phase angle between current and supplied voltage and the nature of the circuit is :

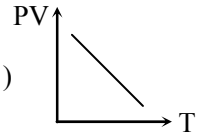
(1) 0°, resistive circuit

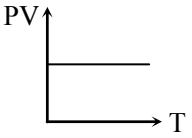
(2) ≈90°, predominantly inductive circuit

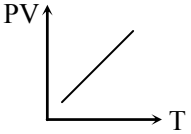
(3) 0°, m resonance circuit

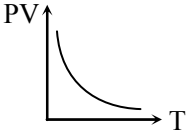
(4) ≈90°, predominantly capacitive circuit

**Q.8** Which of the following graphs represent the behavior of an ideal gas ? Symbols have their usual meaning.

(1) 


(2) 


(3) 


(4) 


**Q.9** A particle is making simple harmonic motion along the X-axis. If at a distances $x_1$ and $x_2$ from the mean position the velocities of the particle are $v_1$ and $v_2$ respectively. The time period of its oscillation is given as :

(1) $T = 2\pi\sqrt{\dfrac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$ (2) $T = 2\pi\sqrt{\dfrac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$

(3) $T = 2\pi\sqrt{\dfrac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$ (4) $T = 2\pi\sqrt{\dfrac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

**Q.10** An electron having de-Broglie wavelength λ is incident on a target in a X-ray tube. Cut-off wavelength of emitted X-ray is :

(1) 0 (2) $\dfrac{2m^2c^2\lambda^2}{h^2}$

(3) $\dfrac{2mc\lambda^2}{h}$ (4) $\dfrac{hc}{mc}$

**Q.11** A body rolls down an inclined plane without slipping. The kinetic energy of rotation is 50% of its translational kinetic energy. The body is :

(1) Solid sphere (2) Solid cylinder

(3) Hollow cylinder (4) Ring

**Q.12** If time ($t$), velocity ($v$), and angular momentum ($\ell$) are taken as the fundamental units. Then the dimension of mass (m) in terms of $t$, $v$ and $\ell$ is :

(1) $[t^{-1}v^1\ell^{-2}]$ (2) $[t^1v^2\ell^{-1}]$

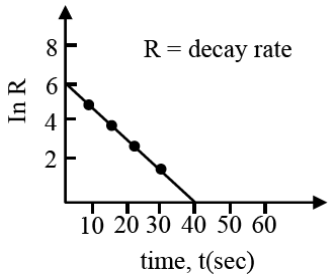
(3) $[t^{-2}v^{-1}\ell^1]$ (4) $[t^{-1}v^{-2}\ell^1]$

**Q.13** The correct relation between the degrees of freedom $f$ and the ratio of specific heat γ is :

(1) $f = \dfrac{2}{\gamma - 1}$ (2) $f = \dfrac{2}{\gamma + 1}$

(3) $f = \dfrac{\gamma + 1}{2}$ (4) $f = \dfrac{1}{\gamma + 1}$

**Q.14** For a certain radioactive process the graph between In R and t(sec) is obtained as shown in the figure. Then the value of half life for the unknown radioactive material is approximately




(1) 9.15 sec (2) 6.93 sec

(3) 2.62 sec (4) 4.62 sec

**Q.15** Consider a binary star system of star A and star B with masses $m_A$ and $m_B$ revolving in a circular orbit of radii $r_A$ and $r_B$, respectively. If $T_A$ and $T_B$ are the time period of star A and star B, respectively, then :

(1) $\frac{T_A}{T_B}=\left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$

(2) $T_A = T_B$

(3) $T_A > T_B$ (if $m_A > m_B$)

(4) $T_A > T_B$ (if $r_A > r_B$)

**Q.16** At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip :

(1) $\tan^{-1}\sqrt{3}$ (2) $\tan^{-1}\frac{1}{\sqrt{3}}$

(3) $\tan^{-1}\frac{2}{\sqrt{3}}$ (4) $\tan^{-1}\frac{\sqrt{3}}{2}$

**Q.17** A body at rest is moved along a horizontal straight line by a machine delivering a constant power. The distance moved by the body in time *'t'* is proportional to :

(1) $t^{\frac{3}{2}}$ (2) $t^{\frac{1}{2}}$ (3) $t^{\frac{1}{4}}$ (4) $t^{\frac{3}{4}}$

**Q.18** Two vectors $\vec{P}$ and $\vec{Q}$ have equal magnitudes. If the magnitude of $\vec{P}+\vec{Q}$ is n times the magnitude of $\vec{P}-\vec{Q}$, then angle between $\vec{P}$ and $\vec{Q}$ is -

(1) $\sin^{-1}\left(\frac{n-1}{n+1}\right)$ (2) $\cos^{-1}\left(\frac{n-1}{n+1}\right)$

(3) $\sin^{-1}\left(\frac{n^2-1}{n^2+1}\right)$ (4) $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

**Q.19** Two small drops of mercury each of radius R coalesce to form a single large drop. The ratio of total surface energy before and after the change is :

(1) $2^{\frac{1}{3}}:1$ (2) $1:2^{\frac{1}{3}}$

(3) 2 : 1 (4) 1 : 2

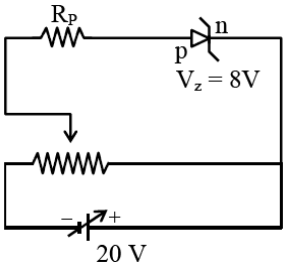
**Q.20** The magnetic susceptibility of a material of a rod is 499. Permeability in vacuum is $4\pi \times 10^{-7}$ H/m. Absolute permeability of the material of the rod is :

(1) $4\pi \times 10^{-4}$ H/m (2) $2\pi \times 10^{-4}$ H/m

(3) $3\pi \times 10^{-4}$ H/m (4) $\pi \times 10^{-4}$ H/m

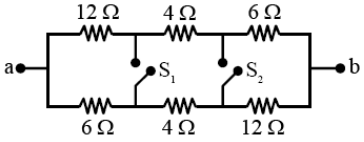
## Section -B

**Q.21** A zener diode having zener voltage 8 V and power dissipation rating of 0.5 W is connected across a potential divider arranged with maximum potential drop across zener diode is as shown in the diagram. The value of protective resistance $R_p$ is .....Ω.



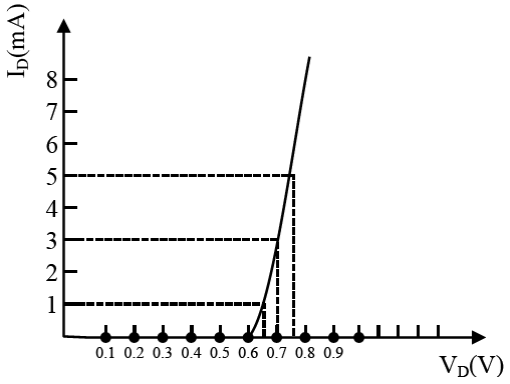

**Q.22** A body of mass '*m*' is launched up on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of x is _____.

**Q.23** In the given figure switches $S_1$ and $S_2$ are in open condition. The resistance across ab when the switches $S_1$ and $S_2$ are closed is _____Ω.




**Q.24** Two bodies, a ring and a solid cylinder of same material are rolling down without slipping an inclined plane. The radii of the bodies are same. The ratio of velocity of the centre of mass at the bottom of the inclined plane of the ring to that of the cylinder is $\frac{\sqrt{x}}{2}$. Then, the value of x is _____.

**Q.25** For the forward biased diode characteristics shown in the figure, the dynamic resistance at $I_D = 3$ mA will be_____Ω.

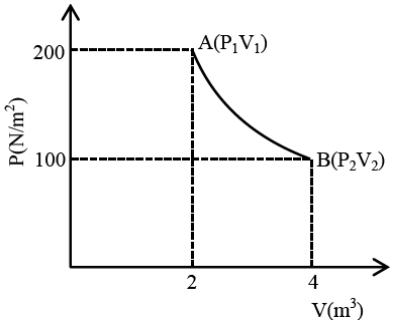



**Q.26** A series LCR circuit of R = 5Ω, L = 20 mH and C = 0.5 μF is connected across an AC supply of 250 V, having variable frequency. The power dissipated at resonance condition is_____$\times 10^2$ W.

**Q.27** One mole of an ideal gas at 27ºC is taken from A to B as shown in the given PV indicator diagram. The work done by the system will be____ $\times 10^{-1}$ J.

[Given : R = 8.3 J / mole K, $\ell n2 = 0.6931$]

(Round off to the nearest integer)




**Q.28** A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is $V_0$. The threshold wavelength of this surface for photoelectric effect is_____λ.

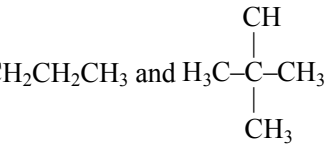
**Q.29** A body rotating with an angular speed of 600 rpm is uniformly accelerated to 1800 rpm in 10 sec. The number of rotations made in the process is___.

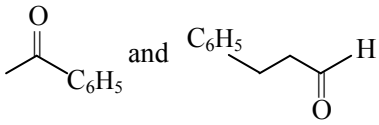
**Q.30** A radioactive substance decays to $\left(\frac{1}{16}\right)^{th}$ of its initial activity in 80 days. The half life of the radioactive substance expressed in days is____.

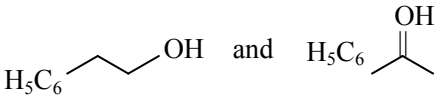
## CHEMISTRY

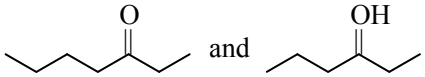
### Section -A

**Q.31** Which one of the following pairs of isomers is an example of metamerism ?

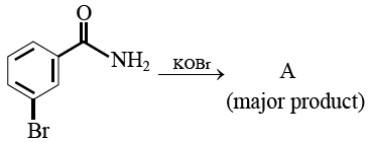
(1) $CH_3CH_2CH_2CH_2CH_3$ and 

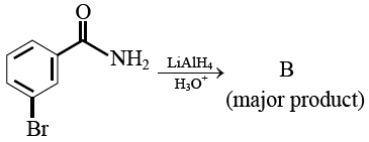
(2) 

(3) 

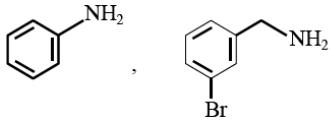
(4) 

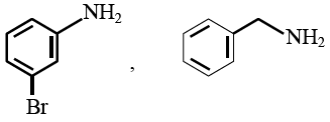
**Q.32**

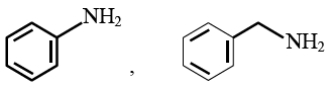


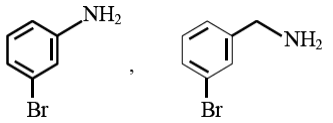




In the above reactions, product A and product B respectively are :

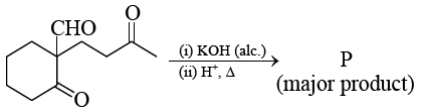
(1) 

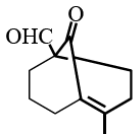
(2) 

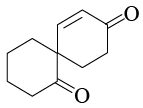
(3) 

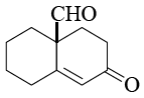
(4) 

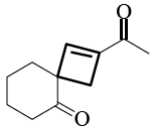
**Q.33** The major product (P) in the following reaction is




(1) 


(2) 


(3) 


(4) 


**Q.34** The single largest industrial application of dihydrogen is

(1) Manufacture of metal hydrides

(2) Rocket fuel in space research

(3) In the synthesis of ammonia

(4) In the synthesis of nitric acid

**Q.35** Consider two chemical reactions (A) and (B) that take place during metallurgical process :

(A) $ZnCO_{3(s)} \xrightarrow{\Delta} ZnO_{(s)} + CO_{2(g)}$

(B) $2ZnS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2ZnO_{(s)} + 2SO_{2(g)}$

The **correct** option of names given to them respectively is :

(1) (A) is calcination and (B) is roasting

(2) Both (A) and (B) are producing same product so both are roasting

(3) Both (A) and (B) are producing same product so both are calcination

(4) (A) is roasting and (B) is calcination

**Q.36** A solution is 0.1 M in $Cl^-$ and 0.001 M in $CrO_4^{2-}$. Solid $AgNO_3$ is gradually added to it Assuming that the addition does not change in volume and $K_{sp}(AgCl) = 1.7 \times 10^{-10}\ M^2$ and $K_{sp}(Ag_2CrO_4) = 1.9 \times 10^{-12}\ M^3$.

Select **correct** statement from the following :

(1) AgCl precipitates first because its $K_{sp}$ is high.

(2) $Ag_2CrO_4$ precipitates first as its $K_{sp}$ is low.

(3) $Ag_2CrO_4$ precipitates first because the amount of $Ag^+$ needed is low.

(4) AgCl will precipitate first as the amount of $Ag^+$ needed to precipitate is low.

**Q.37** Outermost electronic configuration of a group 13 element, E, is $4s^2$, $4p^1$. The electronic configuration of an element of p-block period-five placed diagonally to element, E is :

(1) [Kr] $3d^{10}\ 4s^2\ 4p^2$ (2) [Ar] $3d^{10}\ 4s^2\ 4p^2$

(3) [Xe] $5d^{10}\ 6s^2\ 6p^2$ (4) [Kr] $4d^{10}\ 5s^2\ 5p^2$

**Q.38** Metallic sodium does not react normally with :

(1) gaseous ammonia

(2) But-2-yne

(3) Ethyne

(4) tert-butyl alcohol

**Q.39** Spin only magnetic moment of an octahedral complex of $Fe^{2+}$ in the presence of a strong field ligand in BM is :

(1) 4.89 (2) 2.82

(3) 0 (4) 3.46

**Q.40** Which one of the following species **doesn't** have a magnetic moment of 1.73 BM, (spin only value) ?

(1) $O_2^+$ (2) CuI

(3) $[Cu(NH_3)_4]Cl_2$ (4) $O_2^-$

**Q.41** Which one of the following statements is not true about enzymes ?

(1) Enzymes are non-specific for a reaction and substrate.

(2) Almost all enzymes are proteins.

(3) Enzymes work as catalysts by lowering the activation energy of a biochemical reaction.

(4) The action of enzymes is temperature and pH specific

**Q.42** The hybridisations of the atomic orbitals of nitrogen in $NO_2^-$, $NO_2^+$ and $NH_4^+$ respectively are.

(1) $sp^3$, $sp^2$ and sp (2) sp, $sp^2$ and $sp^3$

(3) $sp^3$, sp and $sp^2$ (4) $sp^2$, sp and $sp^3$

**Q.43** Bakelite is a cross-linked polymer of formaldehyde and :

(1) PHBV (2) Buna-S

(3) Novolac (4) Dacron

**Q.44** Benzene on nitration gives nitrobenzene in presence of $HNO_3$ and $H_2SO_4$ mixture, where :

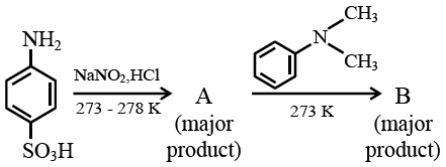
(1) both $H_2SO_4$ and $HNO_3$ act as a bases

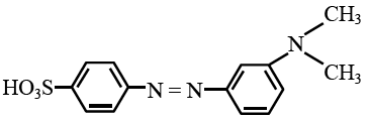
(2) $HNO_3$ acts as an acid and $H_2SO_4$ acts as a base

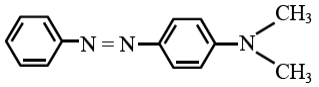
(3) both $H_2SO_4$ and $HNO_3$ act as an acids

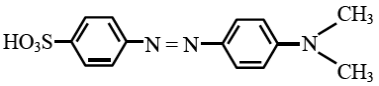
(4) $HNO_3$ acts as a base and $H_2SO_4$ acts as an acid

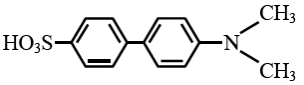
**Q.45**



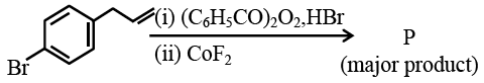

(1) 


(2) 

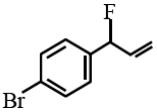

(3) 

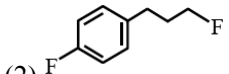

(4) 

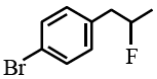

**Q.46**

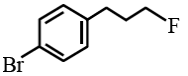



Major product P of above reaction is:

(1) 


(2) 


(3) 


(4) 


**Q.47** $Cu^{2+}$ salt reacts with potassium iodide to give

(1) $Cu_2I_2$ (2) $Cu_2I_3$

(3) CuI (4) $Cu(I_3)_2$

**Q.48** In Carius method, halogen containing organic compound is heated with fuming nitric acid in the presence of :

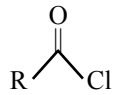
(1) $HNO_3$ (2) $AgNO_3$

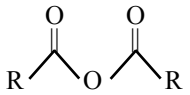
(3) $CuSO_4$ (4) $BaSO_4$

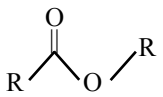
**Q.49** Which one of the following gases is reported to retard photosynthesis ?

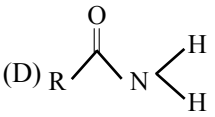
(1) CO (2) CFCs

(3) $CO_2$ (4) $NO_2$

**Q.50** (A) 


(B) 


(C) 


(D) 


The **correct** order of their reactivity towards hydrolysis at room temperature is :

(1) (A) > (B) > (C) > (D)

(2) (D) > (A) > (B) > (C)

(3) (D) > (B) > (A) > (C)

(4) (A) > (C) > (B) > (D)

## Section -B

**Q.51** For a given chemical reaction A → B at 300 K the free energy change is –49.4 kJ $mol^{-1}$ and the enthalpy of reaction is 51.4 kJ $mol^{-1}$. The entropy change of the reaction is _____ J $K^{-1}$ $mol^{-1}$.

**Q.52** The wavelength of electrons accelerated from rest through a potential difference of 40 kV is x × $10^{-12}$ m. The value of x is _____. (Nearest integer)

Given : Mass of electron = 9.1 × $10^{-31}$ kg Charge on an electron = 1.6 × $10^{-19}$ C Planck's constant = 6.63 × $10^{-34}$ Js

**Q.53** The vapour pressures of A and B at 25°C are 90 mm Hg and 15 mm Hg respectively. If A and B are mixed such that the mole fraction of A in the mixture is 0.6, then the mole fraction of B in the vapour phase is x × $10^{-1}$. The value of x is _____. (Nearest integer)

**Q.54** 4g equimolar mixture of NaOH and $Na_2CO_3$ contains x g of NaOH and y g of $Na_2CO_3$. The value of x is _____ g. (Nearest integer)

**Q.55** When 0.15 g of an organic compound was analyzed using Carius method for estimation of bromine, 0.2397 g of AgBr was obtained. The percentage of bromine in the organic compound is _____. (Nearest integer)

[Atomic mass : Silver = 108, Bromine = 80]

**Q.56** 100 ml of 0.0018% (w/v) solution of $Cl^-$ ion was the minimum concentration of $Cl^-$ required to precipitate a negative sol in one h. The coagulating value of $Cl^-$ ion is _____ (Nearest integer)

**Q.57** $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

In the above first order reaction the concentration of $PCl_5$ reduces from initial concentration 50 mol $L^{-1}$ to 10 mol $L^{-1}$ in 120 minutes at 300 K. The rate constant for the reaction at 300 K is $x \times 10^{-2}$ $min^{-1}$. The value of x is _____. [Given log5 = 0.6989]

**Q.58** Diamond has a three dimensional structure of C atoms formed by covalent bonds. The structure of diamond has face centred cubic lattice where 50% of the tetrahedral voids are also occupied by carbon atoms. The number of carbon atoms present per unit cell of diamond is _____.

**Q.59** An aqueous solution of $NiCl_2$ was heated with excess sodium cyanide in presence of strong oxidizing agent to form $[Ni(CN)_6]^{2-}$. The total change in number of unpaired electrons on metal centre is _____.

**Q.60** Potassium chlorate is prepared by electrolysis of KCl in basic solution as shown by following equation.

$6OH^- + Cl^- \rightarrow ClO_3^- + 3H_2O + 6e^-$

A current of xA has to be passed for 10h to produce 10.0g of potassium chlorate. the value of x is _____. (Nearest integer)

(Molar mass of $KClO_3$ = 122.6 g $mol^{-1}$, F = 96500 C)

## MATHEMATICS

### Section -A

**Q.61** For the natural numbers m, n, if $(1 - y)^m (1 + y)^n = 1 + a_1y + a_2y_2 + ....+ a^{m+n} y^{m+n}$ and $a_1 = a_2 = 10$, then the value of (m + n) is equal to :

(1) 88 (2) 64

(3) 100 (4) 80

**Q.62** The value of $\tan\left(2\tan^{-1}\left(\frac{3}{5}\right)+\sin^{-1}\left(\frac{5}{13}\right)\right)$ is equal to

(1) $\frac{-181}{69}$ (2) $\frac{220}{21}$

(3) $\frac{-291}{76}$ (4) $\frac{151}{63}$

**Q.63** Let $r_1$ and $r_2$ be the radii of the largest and smallest circles, respectively, which pass through the point (– 4,1) and having their centres on the circumference of the circle $x^2 + y^2 + 2x + 4y - 4 = 0$. If $\frac{r_1}{r_2} = a + b\sqrt{2}$, then a + b is equal to -

(1) 3 (2) 11

(3) 5 (4) 7

**Q.64** Consider the following three statements :

(A) If 3 + 3 = 7 then 4 + 3 = 8.

(B) If 5 + 3 = 8 then earth is flat.

(C) If both (A) and (B) are true then 5 + 6 = 17.

Then, which of the following statements is correct ?

(1) (A) is false, but (B) and (C) are true

(2) (A) and (C) are true while (B) is false

(3) (A) is true while (B) and (C) are false

(4) (A) and (B) are false while (C) is true

**Q.65** The lines x = ay – 1 = z – 2 and x = 3y –2 = bz – 2, ($ab \neq 0$) are coplanar, if:

(1) b = 1, $a \in R - \{0\}$ (2) a = 1, $b \in R - \{0\}$

(3) a = 2, b = 2 (4) a = 2, b = 3

**Q.66** If [x] denotes the greatest integer less than or equal to x, then the value of the integral $\int_{-\pi/2}^{\pi/2} [[x] - \sin x]dx$ is equal to -

(1) $-\pi$ (2) $\pi$

(3) 0 (4) 1

**Q.67** If the real part of the complex number $(1-\cos\theta+2i\sin\theta)^{-1}$ is $\frac{1}{5}$ for $\theta\in(0,\pi)$ then the value of the integral $\int_0^{\theta}\sin x\,dx$ is equal to

(1) 1 (2) 2 (3) –1 (4) 0

**Q.68** Let $f : \mathbf{R}-\left\{\frac{\alpha}{6}\right\}\to\mathbf{R}$ be defined by $f(x)=\frac{5x+3}{6x-\alpha}$. Then the value of $\alpha$ for which $(fof)(x) = x$, for all $x\in \mathbf{R}-\left\{\frac{\alpha}{6}\right\}$, is

(1) No such a exists (2) 5
(3) 8 (4) 6

**Q.69** If $f : \mathbf{R}\to\mathbf{R}$ is given by $f(x) = x + 1$, then the value of

$$\lim_{n\to\infty}\frac{1}{n}\left[f(0)+f\left(\frac{5}{n}\right)+f\left(\frac{10}{n}\right)+....+f\left(\frac{5(n-1)}{n}\right)\right]$$

is

(1) $\frac{3}{2}$ (2) $\frac{5}{2}$ (3) $\frac{1}{2}$ (4) $\frac{7}{2}$

**Q.70** Let A, B and C be three events such that the probability that exactly one of A and B occurs is (1 – k), the probability that exactly one of B and C occurs is (1 – 2k), the probability that exactly one of C and A occurs is (1 – k) and the probability of all A, B and C occur simultaneously is $k^2$, where $0 < k < 1$. Then the probability that at least one of A, B and C occur is :

(1) greater than $\frac{1}{8}$ but less than $\frac{1}{4}$

(2) greater than $\frac{1}{2}$

(3) greater than $\frac{1}{4}$, but less than $\frac{1}{2}$

(4) exactly equal to $\frac{1}{2}$

**Q.71** The sum of all the local minimum values of the twice differentiable function $f : \mathbf{R}\to\mathbf{R}$ defined by

$f(x)=x^3-3x^2-\frac{3f''(2)}{2}x+f''(1)$ is

(1) –22 (2) 5
(3) –27 (4) 0

**Q.72** Let in a right angled triangle, the smallest angle be $\theta$. If a triangle formed by taking the reciprocal of its sides is also a right angled triangle, then $\sin\theta$ is equal to :

(1) $\frac{\sqrt{5}+1}{4}$ (2) $\frac{\sqrt{5}-1}{2}$

(3) $\frac{\sqrt{2}-1}{2}$ (4) $\frac{\sqrt{5}-1}{4}$

**Q.73** Let y = y(x) satisfies the equation $\frac{dy}{dx}-|A|=0$ for all $x > 0$, where $A=\begin{bmatrix} y & \sin x & 1\\ 0 & -1 & 1\\ 2 & 0 & \frac{1}{x}\end{bmatrix}$.

If $y(\pi) = \pi+2$, then the value of $y\left(\frac{\pi}{2}\right)$ is -

(1) $\frac{\pi}{2}+\frac{4}{\pi}$ (2) $\frac{\pi}{2}-\frac{1}{\pi}$

(3) $\frac{3\pi}{2}-\frac{1}{\pi}$ (4) $\frac{\pi}{2}-\frac{4}{\pi}$

**Q.74** Consider the line L given by the equation $\frac{x-3}{2}=\frac{y-1}{1}=\frac{z-2}{1}$. Let Q be the mirror image of the point (2, 3, –1) with respect to L. Let a plane P be such that it passes through Q, and the line L is perpendicular to P. Then which of the following points is on the plane P ?

(1) (–1, 1, 2) (2) (1,1, 1)
(3) (1, 1, 2) (4) (1, 2, 2)

**Q.75** If the mean and variance of six observations 7, 10, 11, 15, a, b are 10 and $\frac{20}{3}$, respectively, then the value of $|a - b|$ is equal to-

(1) 9 (2) 11 (3) 7 (4) 1

**Q.76** Let $g(T) = \int_{-\pi/2}^{\pi/2} \cos\left(\frac{\pi}{4}t + f(x)\right)dx$, where

$f(x) = \log_e (x + \sqrt{x^2 + 1})$, $x \in \mathbf{R}$. Then which one of the following is correct?

(1) $g(1) = g(0)$ (2) $\sqrt{2}g(1) = g(0)$

(3) $g(1) = \sqrt{2}g(0)$ (4) $g(1) + g(0) = 0$

**Q.77** Let P be a variable point on the parabola $y = 4x^2 + 1$. Then, the locus of the mid-point of the point P and the foot of the perpendicular drawn from the point P to the line $y = x$ is :

(1) $(3x - y)^2 + (x - 3y) + 2 = 0$

(2) $2(3x - y)^2 + (x - 3y) + 2 = 0$

(3) $(3x - y)^2 + 2(x - 3y) + 2 = 0$

(4) $2(x - 3y)^2 + (3x - y) + 2 = 0$

**Q.78** The value of $k \in \mathbf{R}$, for which the following system of linear equations

$3x - y + 4z = 3$,

$x + 2y - 3z = -2$,

$6x + 5y + kz = -3$,

has infinitely many solutions, is :

(1) 3 (2) –5 (3) 5 (4) –3

**Q.79** If sum of the first 21 terms of the series ,

$\log_{9^{1/2}} x + \log_{9^{1/3}} x + \log_{9^{1/4}} x + \ldots\ldots$ ,

where $x > 0$ is 504, then x is equal to

(1) 243 (2) 9 (3) 7 (4) 81

**Q.80** In a triangle ABC, if $|\overrightarrow{BC}| = 3$, $|\overrightarrow{CA}| = 5$ and $|\overrightarrow{BA}| = 7$, then the projection of the vector $\overrightarrow{BA}$ on $\overrightarrow{BC}$ is equal to

(1) $\frac{19}{2}$ (2) $\frac{13}{2}$ (3) $\frac{11}{2}$ (4) $\frac{15}{2}$

## Section -B

**Q.81** Let $A = \{a_{ij}\}$ be a $3 \times 3$ matrix, where

$$a_{ij} = \begin{cases} (-1)^{j-i} & \text{if } i < j \\ 2 & \text{if } i = j \\ (-1)^{i+j} & \text{if } i > j \end{cases}$$

then $\det(3\text{Adj}(2A^{-1}))$ is equal to ____ .

**Q.82** The number of solutions of the equation $\log_{(x+1)}(2x^2 + 7x + 5) + \log_{(2x+5)}(x+1)^2 - 4 = 0$ $x > 0$, is

**Q.83** Let a curve $y = y(x)$ be given by the solution of the differential equation

$$\cos\left(\frac{1}{2}\cos^{-1}(e^{-x})\right)dx = \sqrt{e^{2x} - 1}dy$$

If it intersects y-axis at $y = -1$, and the intersection point of the curve with x-axis is $(\alpha, 0)$, then $e^{\alpha}$ is equal to _____.

**Q.84** For $p > 0$, a vector $\vec{v}_2 = 2\hat{i} + (p+1)\hat{j}$ is obtained by rotating the vector $\vec{v}_1 = \sqrt{3}p\hat{i} + \hat{j}$ by an angle $\theta$ about origin in counter clockwise direction. If $\tan\theta = \frac{(\alpha\sqrt{3} - 2)}{(4\sqrt{3} + 3)}$, then the value of $\alpha$ is equal to _____ .

**Q.85** Consider a triangle having vertices A(–2, 3), B(1, 9) and C(3, 8). If a line L passing through the circum-centre of triangle ABC, bisects line BC, and intersects y-axis at point $\left(0, \frac{\alpha}{2}\right)$, then the value of real number $\alpha$ is _____.

**Q.86** If the point on the curve $y^2 = 6x$, nearest to the point $\left(3, \frac{3}{2}\right)$ is $(\alpha, \beta)$, then $2(\alpha + \beta)$ is equal to _____ .

**Q.87** Let a function $g : [0, 4] \to \mathbf{R}$ be defined as

$$g(x)\begin{cases}\max\limits_{0\le t\le x}\{t^3-6t^2+9t-3 & ,0\le x\le 3\\ 4-x & ,3<x\le 4\end{cases}$$

then the number of points in the interval (0, 4) where g(x) is NOT differentiable, is _____.

**Q.88** For $k \in N$, let

$$\frac{1}{\alpha(\alpha+1)(\alpha+2).....(\alpha+20)}=\sum_{K=0}^{20}\frac{A_k}{\alpha+k},$$

where $\alpha > 0$, Then the value of $100\left(\frac{A_{14}+A_{15}}{A_{13}}\right)^2$ is equal to _____ .

**Q.89** Let $\{a_n\}_{n=1}^{\infty}$ be a sequence such that $a_1 = 1$, $a_2 = 1$ and $a_{n+2} = 2a_{n+1} + a_n$ for all $n \ge 1$. Then the value $47\sum_{n=1}^{\infty}\frac{a_n}{2^{3n}}$ is equal to _____ .

**Q.90** If $\lim\limits_{x\to 0}\frac{\alpha x e^x-\beta\log_e(1+x)+\gamma x^2e^{-x}}{x\sin^2 x}=10$,

$\alpha, \beta, \gamma \in \mathbf{R}$ then the value of $\alpha + \beta + \gamma$ is _____ .

# JEE MAIN ONLINE PAPER 2021

## Held on JULY 20, 2021 (Evening)

## Hints & Solutions

### PHYSICS

### Section -A

**1.[1]** $K_2 = 4K_1$

$\frac{1}{2}mv_2^2 = 4\frac{1}{2}mv_1^2$

$v_2 = 2v_1$

$p = mv$

$p_2 = mv_2 = 2mv_1$

$p_1 = mv_1$

$\%\ \text{change} = \frac{\Delta P}{P_1} \times 100 = \frac{2mv_1 - mv_1}{mv_1} \times 100$

$= 100\%$

**2.[3]** L = Length of escalator

$V_{b/esc} = \frac{L}{t_1}$

When only escalator is moving

$V_{esc} = \frac{L}{t_2}$

when both are moving

$V_{b/g} = V_{b/esc} + V_{esc}$

$V_{b/g} = \frac{L}{t_1} + \frac{L}{t_2} \Rightarrow \left[ t = \frac{L}{v_{b/g}} = \frac{t_1 t_2}{t_1 + t_2} \right]$

**3.[4]** $T^2 \propto R^3$

$T = kR^{3/2}$

$\frac{dT}{T} = \frac{3}{2}\frac{dR}{R}$

$= \frac{3}{2} \times 0.02 = 0.03$

% Change = 3%

**4.[1]** $f = f_0\sqrt{\frac{1+\beta}{1-\beta}} \qquad \beta = \frac{v}{c}$

$\frac{f}{f_0}\sqrt{\frac{1+\beta}{1-\beta}}$

$\left(1 + \frac{\Delta f}{f_0}\right)^2 = (1+\beta)(1-\beta)^{-1}$

$\beta$ is small compared to 1

$\left(1 + \frac{2\Delta f}{f_0}\right) = (1+2\beta)$

$\beta = \frac{\Delta f}{f_0} = \frac{v}{c}$

$v = 6 \times \frac{c}{5890} = 305.6\ \text{km/s}$

**5.[2]** $T_1 = k(\ell_1 - \ell_0)$

$T_2 = k(\ell_2 - \ell_0)$

$\frac{T_1}{T_2} = \frac{\ell_1 - \ell_0}{\ell_2 - \ell_0}$

$\frac{T_1\ell_1 - T_2\ell_1}{T_1 - T_2} = \ell_0$

**6.[4]** Direction of propagation = $\vec{E} \times \vec{B} = \hat{i} \times \hat{k} = -\hat{j}$

**7.[4]** $R = 100\Omega$

$X_L = \omega L = 50\pi \times 10^{-3}$

$X_C = \frac{1}{\omega C} = \frac{10^{11}}{100\pi}$

$X_C >> X_L$ & $|X_C - X_L| >> R$

**8.[3]** $PV = nRT$

$PV \propto T$

Straight line with positive slope(nR)

**9.[4]** $v^2 = \omega^2(A^2 - x^2)$

$A^2 = x_1^2 + \frac{v_1^2}{\omega^2} = x_2^2 + \frac{v_2^2}{\omega^2}$

$\omega^2 = \frac{v_2^2 - v_1^2}{x_1^2 - x_2^2}$

$T = 2\pi = \sqrt{\frac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$

**10.[3]** $\lambda = \frac{h}{mv}$

Kinetic energy, $\frac{P^2}{2m} = \frac{h^2}{2m\lambda^2} = \frac{hc}{\lambda_C}$

$\lambda_C = \frac{2m\lambda_2 c}{h}$

**11.[2]** $\frac{1}{2}I\omega^2 = \frac{1}{2}\times\frac{1}{2}mv^2$

$I = \frac{1}{2}mR^2$

Body is solid cylinder

**12.[4]** $m \propto t^a v^b \ell^c$

$m\propto [T]^a\,[LT^{-1}]^b\,[ML^2T^{-1}]^c$

$M^1L^0T^0 = M^CL^{b+2c}T^{a-b-c}$

comparing powers

$c = 1,\ b = -2,\ a = -1$

$m \propto t^{-1}v^{-2}\ell^1$

**13.[1]** $\gamma = 1+\frac{2}{f}$

$f = \frac{2}{\gamma-1}$

**14.[4]** $R = R_0e^{-\lambda t}$

$\ell nR = \ell nR_0 - \lambda t$

$-\lambda$ is slope of straight line

$\lambda = \frac{3}{20}$

$t_{1/2} = \frac{\ell n2}{\lambda} = 4.62$

**15.[2]** $T_A = T_B$ (since $\omega_A - \omega_B$)

**16.[4]** $A\tan\delta = \tan\delta\cos\theta$

$= \tan45°\cos30°$

$\tan\delta = 1\times\frac{\sqrt{3}}{2}$

$\delta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

**17.[1]** P = constant

$\frac{1}{2}mv^2 = Pt$

$\Rightarrow v \propto \sqrt{t}$

$\frac{dx}{dt} = C\sqrt{t}$ C = constant by integration

$x = C\frac{t_2^1 + t}{\frac{1}{2}+1}$

$x \propto t^{3/2}$

**18.[4]** $|\vec{P}| = |\vec{Q}| = x$ ...(i)

$|\vec{P}+\vec{Q}| = n|\vec{P}-\vec{Q}|$

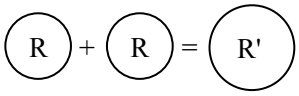
$P^2 + Q^2 + 2PQ\cos\theta = n^2(P^2 + Q^2 - 2PQ\cos\theta)$

Using (i) in above equation

$\cos\theta = \frac{n^2-1}{1+n^2}$

$\theta = \cos^{-1} = \left(\frac{n^2-1}{n^2+1}\right)$

**19.[1]**




$\frac{4}{3}\pi R^3 + \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R'^3$

$R' = 2^{\frac{1}{3}}R$ ... (i)

$A_i = 2[4\pi R^2]$

$A_f = 4\pi R'^2$

$\frac{U_i}{U_f} = \frac{A_i}{A_f} = \frac{2R^2}{2^{2/3}R^2} = 2^{1/3}$

**20.[2]** $\mu = \mu_0(1 + x_m)$

$= 4\pi \times 10^{-7} \times 500$

$= 2\pi \times 10^{-4}$ H/m

## Section -B

**21.[192]** $P = Vi$

$0.5 = 8i$

$i = \frac{1}{16}A$

$E = 20 = 8 + iR_P$

$R_P = 12 \times 16 = 192\Omega$

**22.[3]** $t_a = \frac{1}{2}t_d$

$\sqrt{\frac{2s}{a_a}} = \frac{1}{2}\sqrt{\frac{2s}{a_d}}$ .... (i)

$a_a = g\sin\theta + \mu g\cos\theta$

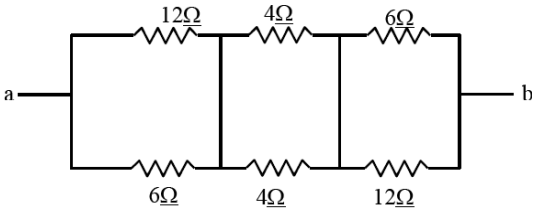
$= \frac{g}{2} + \frac{\sqrt{3}}{2}\mu g$

$a_d = g\sin\theta - \mu g\cos\theta$

$= \frac{g}{2} - \frac{\sqrt{3}}{2}\mu g$

using the above values of $a_a$ and $a_d$ and putting in equation (i) we will gate $\mu = \frac{\sqrt{3}}{5}$

**23.[10]** When switch $S_1$ and $S_2$ are closed




$\frac{12\times6}{12+6} + 2 + \frac{6\times12}{6+12}$

$\frac{72}{18} + 2 + \frac{72}{18} = 4 + 2 + 4 = 10\Omega$

**24.[3]** I in both cases in about point of contact Ring

$mgh = \frac{1}{2}I\omega^2$

$mgh = \frac{1}{2}(2mR^2)\frac{v_R^2}{R^2}$

$v_R = \sqrt{gh}$

Solid cylinder

$mgh = \frac{1}{2}I\omega^2$

$mgh = \frac{1}{2}\left(\frac{3}{2}mR^2\right)\frac{v_C^2}{R^2}$

$v_C = \sqrt{\frac{4gh}{3}}$

$\frac{v_R}{v_C} = \frac{\sqrt{3}}{2}$

**25.[25]** $R_d = \frac{dV}{di} = \frac{1}{di} = \frac{1}{\frac{5-1\times10^{-3}}{0.75-0.65}}$

$\frac{100}{4} = 25\Omega$

**26.[125]** $X_L = X_C$ (due to resonance)

$Z = R$ so $i_{rms} = \frac{V}{Z} = \frac{V}{R}$

$\frac{V^2}{R} = \frac{250\times250}{5} = 125\times10^2\,W$

**27.[17258]** Process of isothermal

$W = nRT\ell n\left(\frac{v_2}{v_1}\right)$

$= 1 \times 8.3 \times 300 \times \ell n2$

$= 17258 \times 10^{-1}J$

**28.[4]** $KE = \frac{hc}{\lambda} - \phi hc$

$e(3V_0) = \frac{hc}{\lambda_0} - \phi$ .... (i)

$eV_0 = \frac{hc}{2\lambda_0} - \phi$ ....(iii)

using (i) & (ii)

$\phi = \frac{hc}{4\lambda_0} = \frac{hc}{\lambda_t}$

$\lambda_t = 4\lambda_0$

**29.[200]** $\omega_f = \omega_0 + \alpha t$

$\alpha = 1200 \times 6$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$= 600\times\frac{10}{60} + \frac{1}{2}\times1200\times6\times\frac{1}{36}$

$\theta = 200$

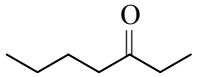
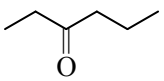
**30.[20]** $N_0 \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{2} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{4} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{8} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{16}$

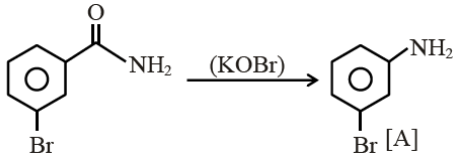
$4\times t_{1/2} = 80$

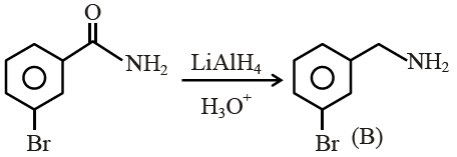
$t_{1/2} = 20$ days

## CHEMISTRY

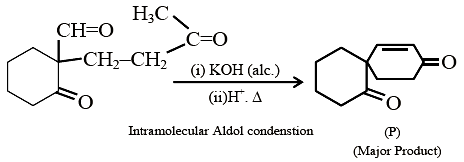
### Section -A

**31.[4]**  and  are metamers

**32.[4]** 

**33.[2]**




**34.[3]** Informative, according to ncert uses of di hydrogen. In fact $NH_3$ largest production in used to manufacture nitrogenous fertilisers.

**35.[1]** (A) $ZnCO_3(S) \xrightarrow{\Delta} ZnO_{(s)} + CO_{2(g)}$

Heating in absence of oxygen in calcination.

(B) $2Zns(s) + 3O_2(g) \rightarrow 2ZnO(g) + 2SO_2(g)$

heating in presence of oxygen in roasting

Hence (A) is calcination while (B) in roasting.

**36.[4]** **(i)** $[Ag^+]$ required to ppt AgCl(s)

$K_{sp} = IP = [Ag^+][Cl^-] = 1.7 \times 10^{-10}$

$[Ag^+] = 1.7 \times 10^{-9}$

**(ii)** $[Ag^+]$ required to ppt $Ag_2CrO_4(s)$

$K_{sp} = IP = [Ag^+]^2[CrO_4^{-2}] = 1.9 \times 10^{-12}$

$[Ag^+] = 4.3 \times 10^{-5}$

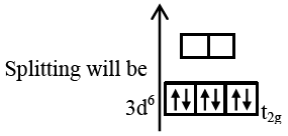
$[Ag^+]$ required to ppt AgCl is low so AgCl will ppt 1st.

**37.[4]** The element E is Ga and the diagonal element of 5th period is $_{50}Sn$ having outer electronic configuration will be [Kr] $5s^2\ 4d^{10}\ 5p^2$.

**38.[2]** Metallic sodium does not react with 2-butyne because 2-butyne does not have acidic hydrogen.

**39.[3]** In presence of SFL $\Delta_0 > P$ means pairing occurs therefore

For $Fe^{+2} \rightarrow 3d^6$




$\therefore$ No of unpaired $e^-$ (s) = 0

$\therefore\ \mu = \sqrt{n(n+2)}BM = 0$

[n = No of unpaired $e^-$(s)]

In NiCl2 $Ni^{+2}$ is having configuration $3d^8$

$\therefore$ Number of unpaired electron = 2

After formation of oxidised product

$[Ni(CN)_6]^{-2}$ $Ni^{+4}$ is obtained

$Ni^{+4} \Rightarrow 3d^6$ and $CN^-$ is strong field ligand

$\therefore$ number of unpaired electrons = 0

$\therefore$ The charge is 2 – 0 = 2

**40.[2]** Species must not contain single unpaired

$O_2^+ \rightarrow \sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma^*_{2s}{}^2 < \sigma_{2pz}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*1} = \pi_{2py}^*$

unpaired $e^- = 1\ \therefore\ \mu = 1.73$ BM

(1) $Cu^+I^-\ Cu^+ \rightarrow [Ar]3d^{10}\ \therefore$ unpaired $e^- = 0$

$I^- \rightarrow [Xe]\ \therefore$ unpaired $e^- = 0$

therefore $\mu = 0$

3. $[Cu(NH_3)_4]Cl_2$

$Cu \rightarrow [A]\ 3d^3\ \therefore$ unpaired = 1 $\therefore\ \mu = 1.73$ BM

4. $O_2^- \rightarrow$ d

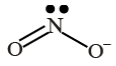
$\sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma^*_{2s}{}^2 < \sigma_{2p}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*1} = \pi_{2py}^*$

$(11e^-)$

$\therefore$ unpaired $\therefore\ \mu = 1.73$BM

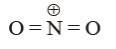
**41.[1]** Fact

**42.[4]**



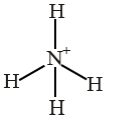
$2\sigma + 1$ lp

$\therefore\ sp^2$



$2\sigma + 0$ lp

$\therefore\ sp$



$4\sigma + 0$

$\therefore\ sp^3$

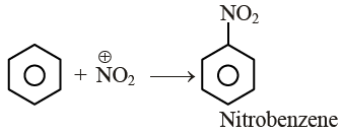
**43.[3]** Novolac (phenol formaldehyde Resin) $\rightarrow$ Bakelite

**44.[4]** Reagent for nitration of Benzene

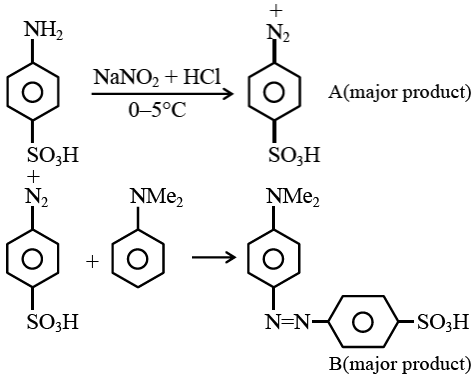
$$H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2\overset{+}{N}O_3$$

(Acid) (Base)

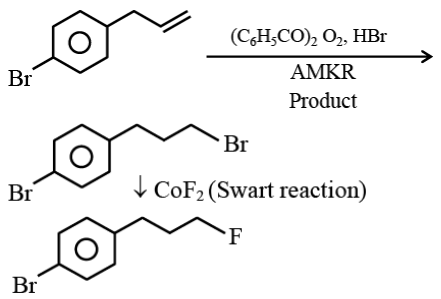
$$H_2\overset{+}{N}O_3 \rightleftharpoons H_2O + \overset{+}{N}O_2$$




**45.[3]**



**46.[4]**




**47.[1,3] Official Ans. by NTA (1)**

$2Cu^{+2} + 4I^- \longrightarrow Cu_2I_2(s) + I_2$

$2Cu^{+2} + 3I^- \longrightarrow 2CuI + I_2$

**48.[2]** Organic compound is heated with fuming nitric acid in the presence of silver nitrate in carius method.

Lunar caustic ($AgNO_3$) is used as reagent hare to distinguish $Cl^-$, Br and $I^-$ respectively as follows.

$Cl^-(aq) \xrightarrow{AgNO_3} AgCl\downarrow_{ppt}$ white

$Br^-(aq) \xrightarrow{AgNO_3} AgBr\downarrow_{ppt}$ pale yellow

$I^-(aq) \xrightarrow{AgNO_3} AgI\downarrow_{ppt}$ Dark yellow

**49.[4]** According to NCERT only $NO_2$ from the given options can retard the photosynthesis process in plants.

**50.[1]**

$$\underset{\text{O}}{\overset{\|}{\text{R–C–Cl}}} > \underset{\text{O}}{\overset{\|}{\text{R–C–O–}}}\underset{\text{O}}{\overset{\|}{\text{C–R}}} > \underset{\text{O}}{\overset{\|}{\text{R–C–OR}}} > \underset{\text{O}}{\overset{\|}{\text{R–C–NH}_2}}$$

Reactivity towards Hydrolysis A > B > C > D

## Section -B

**51.[360]** Given chemical reaction

$A \xrightarrow[T300K]{} B\ [\Delta G]_{P,T} = -49.4$ kJ/mol

$\Delta H_{rxn} = 51.4$ kJ/mol

$\Delta S_{rxn} = ?$

$\Rightarrow$ From the relation $[\Delta G]_{P,T} = DH - T\Delta S$

$$\Rightarrow \Delta S_{rxn} = \frac{\Delta H_{rxn} - [\Delta G]_{P,T}}{T}$$

$$= \frac{[51.4 - (-49.4)] \times 1000}{300} \frac{J}{molK}$$

$$\Rightarrow \Delta S_{rxn} = 336 \frac{J}{molK}$$

**52.[6]** De-broglie-wave length of electron:

$$\lambda_e = \frac{h}{\sqrt{2m(KE)}} \begin{cases} \because e^- \text{is accelerated} \\ \text{from rest} \\ \Rightarrow KE = q \times V \end{cases}$$

$$\lambda = \frac{h}{\sqrt{2mqv}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.6 \times 10^{-19} \times 9.1 \times 10^{-31} \times 40 \times 10^3}}$$

$= 0.614 \times 10^{-11}$ m

$= 6.14 \times 10^{-12}$ m

Nearest integer = 6

OR

$$\lambda = \frac{12.3}{\sqrt{V}} \text{Å}$$

$$= \frac{12.3}{200} = 6.15 \times 10^{-12} \text{m}$$

**53.[1]** Given $P_A^\circ = 90$ mm Hg, at 25°C

$P_B^\circ = 15$ mm Hg

and $\left.\begin{matrix} X_A = 0.6 \\ X_B = 0.4 \end{matrix}\right\} P_T = X_A P_A^\circ + X_B P_B^\circ$

$= (0.6 \times 90) + (0.4 \times 15)$

$= 54 + 6 = 60$ mm

Now mol fraction of B in the vapour phase

i.e. $Y_B = \frac{P_B}{P_T} = \frac{X_B P_B^\circ}{60} = 0.1 = 1 \times 10^{-1}$

therefore : x = 1

**54.[1]** Total mass = 4g

Now,

NaOH : a mol $\quad W_{NaOH} + W_{Na_2CO_3} = 4$

$Na_2CO_3$ : 'a' mol $\Rightarrow 40a + 106a = 4$

$$\Rightarrow a = \frac{4}{146} \text{mol}$$

$\Rightarrow$ therefore mass of NaOH is : $\frac{4}{146} \times 40$g

$= 1.095 \approx 1$

**55.[]** Moles of Br = Moles of AgBr obtained

$$\Rightarrow \text{Mass of Br} = \frac{0.2397}{188} \times 80\text{g}$$

therefore % Br in the organic compound

$$= \frac{W_{Br}}{W_T} \times 100$$

$$= \frac{0.2397 \times 80}{188 \times 0.15} \times 100 = 0.85 \times 80$$

$= 68$

$\Rightarrow$ Nearest integer is '68'

**56.[Bonus] Official ans. By NTA (1)**

**57.[1]** $PCl_{5(g)} \xrightarrow[300\,K]{\text{I order}} PCl_{3(g)} + Cl_{2(g)}$

t = 0 50 M

t = 120 min 10M

$\Rightarrow K = \frac{2.303}{t}\log\frac{[A_0]}{[A_1]}$

$\Rightarrow K = \frac{2.303}{t}\log\frac{50}{10}$

$\Rightarrow K = \frac{2.303}{120}\times 0.6989 = 0.013413\ min^{-1}$

$= 13413\times10^{-2}\ min^{-1}$

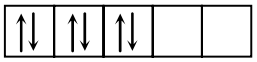
1.34 $\Rightarrow$ Nearest integer = 1

**58.[8]** Carbon atoms occupy FCC lattice points as well as half of the tetrahedral voids

therefore number of carbon atoms atoms per unit cell = 8

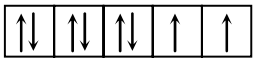
**59.[2]** $[Ni(CN)_6]^{2-}$

$Ni^{+4} \rightarrow d^6$ strong field ligand



Pairing will be there zero unpaired electron

$NiCl_2 \rightarrow Ni^{2+} \rightarrow d^8$



$\rightarrow$ two unpaired $e^-$

Change = 2

**60.[1]** Given balanced equation is

$60H + Cl \longrightarrow ClO_3^- + 3H_2O + 6e^-$

$\overset{\ominus}{6}0H + \overset{\ominus}{Cl} \longrightarrow ClO_3^- + 3H_2O + 6e^-$

$\rightarrow$ 10g $KClO_3 \Rightarrow \frac{10}{122.6}$ mol $KCO_{3\text{ in obtained}}$

$\rightarrow$ from the above reaction, it is concluded that by 6 F charge 1 mol $KClO_3$ is obtained

$\rightarrow$ By the passage of 6F charge = 1 mol $KClO_3$

$\therefore$ By the passage of $\frac{x\times10\times60\times60}{96500}$ F charge

$= \frac{1}{6}\times\frac{x\times10\times60\times60}{96500}$

Now $\frac{x\times10\times60\times60}{6\times96500} = \frac{10}{122.6}$

$\Rightarrow x = \frac{10\times965}{60\times122.6} = \frac{965}{735.6} = 1.311 \simeq 1$

OR

$W = \frac{E}{F}\times I\times t$

$10 = \frac{122.6}{96500\times6}\times x\times10\times3600$

X = 1.311

Ans(1)

## MATHEMATICS

### Section -A

**61.[4]** $(1-y)^m(1+y)^n$

Coefficient of y $(a_1) = 1.{}^nC_1 + {}^mC_1(-1)$

$= n - m = 10$ ....(i)

Coefficient of $y^2(a_2)$

$= 1.{}^nC_2 - {}^mC_1.{}^mC_1\cdot1.{}^mC_2 = 10$

$= \frac{n(n-1)}{2} - m.n + \frac{m(m-1)}{2} = 10$

$m^2 + n^2 - 2mn - (n+m) = 20$

$(n-m)^2 - (n+m) = 20$

$n + m = 80$ ....(ii)

By equation (1) & (2)

m = 35, n = 45

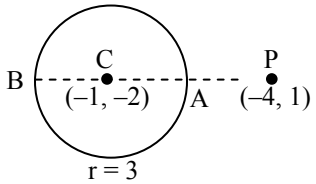
**62.[2]** $\underbrace{\tan^{-1}\frac{3}{5} + \tan^{-1}\frac{3}{5}}_{x>0,\ y>0,\ xy<1} + \tan^{-1}\frac{5}{12}$

$\tan^{-1}\frac{\frac{6}{5}}{1-\frac{9}{25}} = \underbrace{\tan^{-1}\frac{15}{8} + \tan^{-1}\frac{5}{12}}_{x>0,\ y>0,\ xy<1}$

$\tan^{-1}\frac{\frac{15}{8}+\frac{5}{12}}{1-\frac{15}{8}\cdot\frac{5}{12}} = \tan^{-1}\frac{220}{21}$

$\tan\left(\tan^{-1}\frac{220}{21}\right) = \frac{220}{21}$

**63.[3]**




Centre of smallest circle is A

Cenrtre of largest circle is B

$r_2 = |CP - CA| = 3\sqrt{2} - 3$

$r_1 = CP + CB = 3\sqrt{2} + 3$

$\frac{r_1}{r_2} = \frac{3\sqrt{2}+3}{3\sqrt{2}-3} = \frac{(3\sqrt{2}+3)^2}{9}$

$= (\sqrt{2}+1)^2 = 3 + 2\sqrt{2}$

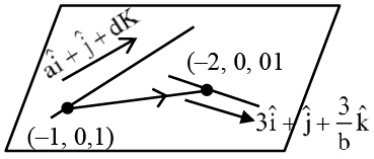
a = 3, b = 2

**64.[2]** Truth Table

| P | q | P→q |
|---|---|---|
| T | T | T |
| T | F | F |
| F | T | T |
| F | F | T |

**65.[1]** $\frac{x+1}{a} = y = \frac{z-1}{a}$

$\frac{x+2}{3} = y = \frac{z}{3/b}$




lines are co-planar

$\begin{vmatrix} a & 1 & a \\ 3 & 1 & \frac{3}{b} \\ -1 & 0 & -1 \end{vmatrix} = 0 \Rightarrow -\left(\frac{3}{b} - a\right) - 1(a-3) = 0$

$a - \frac{3}{b} - a + 3 = 0$

$b = 1,\ a \in R - \{0\}$

**66.[1]** $I = \int_{-\pi/2}^{\pi/2} ([x] + [-\sin x])dx$ .... (i)

$I = \int_{-\pi/2}^{\pi/2} ([-x] + [\sin x])dx$ .... (ii)

(King property)

$2I = \int_{-\pi/2}^{\pi/2} \left(\underbrace{[x] + [-x]}_{-1}\right) + \left(\underbrace{[\sin x] + [-\sin x]}_{-1}\right) dx$

$2I = \int_{-\pi/2}^{\pi/2} (-2)dx = -2(\pi)$

$I = -\pi$

**67.[1]** $z = \frac{1}{1 - \cos\theta + 2i\sin\theta}$

$= \frac{2\sin 2\frac{\theta}{2} - 2i\sin\theta}{(1-\cos\theta)^2 + 4\sin^2\theta}$

$= \frac{\sin\frac{\theta}{2} - 2i\cos\frac{\theta}{2}}{4\sin\frac{\theta}{2}\left(\sin^2\frac{\theta}{2} + 4\cos^2\frac{\theta}{2}\right)}$

$\text{Re}(z) = \frac{1}{2\left(\sin^2\frac{\theta}{2} + 4\cos 2\frac{\theta}{2}\right)} = \frac{1}{5}$

$\sin\frac{2\theta}{2} + 4\cos^2\frac{\theta}{2} = \frac{5}{2}$

$1 - \cos^2\frac{\theta}{2} + 4\cos\frac{\theta}{2} = \frac{5}{2}$

$3\cos^2\frac{\theta}{2} = \frac{3}{2}$

$\cos^2\frac{\theta}{2} = \frac{1}{2}$

$\frac{\theta}{2} = n\pi \pm \frac{\pi}{4}$

$\theta = 2n\pi \pm \frac{\pi}{2}$

$\theta = 2n\pi \pm \frac{\pi}{2}$

$\theta \in (0,\pi)$

$\boxed{\theta = \frac{\pi}{2}}$

$\int_0^{\frac{\pi}{2}} \sin\theta\, d\theta - [-\cos\theta]_0^{\frac{\pi}{2}}$

$= -(0 - 1)$

$= 1$

**68.[2]** $f(x) = \frac{5x+3}{6x-\alpha} = y$ ....( i)

$5x + 3 = 6xy - \alpha y$

$x(6y - 5) = \alpha y + 3$

$x = \frac{\alpha y + 3}{6y - 5}$

$f^{-1}(x) = \frac{\alpha x + 3}{6x - 5}$ ....(ii)

fo f(x) = x

$f(x) = f^{-1}(x)$

from equation (i) & (ii)

clearly ($\alpha = 5$)

**69.[4]** $I = \sum_{r=0}^{n-1} f\left(\frac{5r}{n}\right)\frac{1}{n}$

$I = \int_0^1 f(5x)dx$

$I = \int_0^1 (5x+1)dx$

$I = \left[\frac{5x^2}{2} + x\right]_0^1$

$I = \frac{5}{2} + 1 = \frac{7}{2}$

**70.[2]** $P(\overline{A} \cap B) + P(A \cap \overline{B}) = 1 - k$

$P(\overline{A} \cap C) + P(A \cap \overline{C}) = 1 - 2k$

$P(\overline{B} \cap C) + P(B \cap \overline{C}) = 1 - k$

$P(A \cap B \cap C) = k^2$

$P(A) + P(B) - 2P(A \cap B) = 1 - k$ .... (i)

$P(B) + P(C) - 2P(B \cap C) = 1 - k$ ....(ii)

$P(C) + P(A) - 2P(A \cap C) = 1 - 2k$ ....(iii)

(1) + (2) + (3)

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

$-P(C \cap A) = \frac{-4k+3}{2}$

So,

$P(A \cup B \cup C) = \frac{-4k+3}{2} + k^2$

$P(A \cup B \cup C) = \frac{2k^2 - 4k + 3}{2}$

$= \frac{2(k-1)^2 + 1}{2}$

$P(A \cup B \cup C) > \frac{1}{2}$

**71.[3]** $f(x) = x^3 - 3x^2 - \frac{3}{2}f''(2)x + f''(1)$ ... (i)

$f'(x) = 3x^3 - 6x^2 - \frac{3}{2}f''(2)$ ....(ii)

$f''(x) = 6x - 6$ ....(iii)

Now is 3rd equation

$f''(2) = 12 - 6 = 6$

$f''(11 = 0)$

Use (ii)

$f'(x) = 3x^2 - 6x - \frac{3}{2}f''(2)$

$f(x) = 3x^2 - 6x - \frac{3}{2} \times 6$

$f'(x) = 3x^2 - 6x - 9$

$f'(x) = 0$

$3x^2 - 6x - 9 = 0$

$\Rightarrow x = -1$ & 3

use (iii)

$f''(x) = 6x - 6$

$f''(-1) = -12 < 0$ maxima

$f''(3) = 12 > 0$ minima

Use (i)

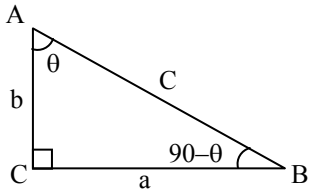
$f(x) = x^3 - 3x^2 - \frac{3}{2}f''(2)x + f''(1)$

$f(x) = x^3 - 3x^2 - \frac{3}{2} \times 6 \times x + 0$

$f(x) = x^3 - 3x^2 - 9x$

$f(3) = 27 - 27 - 9 \times 3 = -27$

**72.[2]**




$< A = \theta$

$< B = 90 - \theta$

a = smallest side

$c^2 = a^2 + b^2$

$\frac{1}{a^2} = \frac{1}{b^2} + \frac{1}{c^2}$

$\frac{b^2c^2}{a^2} = b^2 + c^2$

Use $a = 2R \sin A = 2R \sin \theta$

$b = 2R \sin B = 2R \sin (90-\theta) = 2R \cos\theta$

$c = 2R \sin C = 2 \sin 90° = 2R$

$\frac{4R^2\cos^2\theta}{4R^2\sin^2\theta} = 4R^2\cos^2\theta + 4R^2$

$\cos^2\theta = \sin^2\theta \cos^2\theta + \sin^2\theta$

$1 - \sin^2\theta = \sin^2\theta(1 - \sin^2\theta) + \sin^2\theta$

$\sin^2\theta = \frac{3-\sqrt{5}}{2}$

$\Rightarrow \sin\theta = \frac{\sqrt{5}-1}{2}$

**73.[1]** $|A| = -\frac{y}{x} + 2\sin x + 2$

$\frac{dy}{dx} = |A|$

$\frac{dy}{dx} = -\frac{y}{x} + 2\sin x + 2$

$\frac{dy}{dx} + \frac{y}{x} = 2\sin x + 2$

I.F. $= e^{\int \frac{1}{x}dx} = x$

$\Rightarrow yx = \int x(2\sin x + 2)dx$

$xy = x^2 - 2x\cos x + 2\sin x + c$ .....(i)

Now $x = \pi$, $y = \pi + 2$

Use in (i)

$c = 0$

Now (i) be comes

$xy = x^2 - 2x\cos x + 2\sin x$

put $x = \pi/2$

$\frac{\pi}{2}y = \left(\frac{\pi}{2}\right)^2 - 2 \cdot \frac{\pi}{2}\cos\frac{\pi}{2} + 2\sin\frac{\pi}{2}$

$\frac{\pi}{2}y = \frac{\pi^2}{4} + 2$

**74.[4]** Plane p is $\perp$ to line

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

& passes through pt. (2, 3) equation of plane p

$2(x-2) + 1(y-3) + 1(z+1) = 0$

$2x + y + z - 6 = 0$

pt (1, 2, 2) satisfies above equation

**75.[4]** $10 = \frac{7+10+11+15+a+b}{6}$

$\Rightarrow a + b = 17$ ....(i)

$\frac{20}{3} = \frac{7^2+10^2+11^2+15^2+a^2+b^2}{6} - 10^2$

$a^2 + b^2 = 145$ ....(ii)

Solve (i) and (ii)

$a = 9, b = 8$ or $a = 8, b = 9$ $|a - b| = 1$

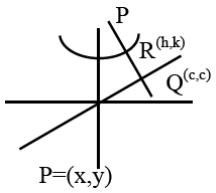
**76.[2]** $g(t) = \int_{-\pi/2}^{\pi/2} \left(\cos\frac{\pi}{4}t + f(x)\right)dx$

$g(t) = \pi\cos\frac{\pi}{4}t + \int_{-\pi/2}^{\pi/2} f(x)dx$

$g(t) = \pi\cos\frac{\pi}{4}t$

$g(1) = \frac{\pi}{\sqrt{2}}, g(0) = \pi$

**77.[2]**




$\frac{K-C}{h-C} = -1$

$C = \frac{h+K}{2}$ P(x,y)

$R = \left(\frac{x+C}{2}, \frac{y+C}{2}\right)$

$R = \left(\frac{x}{2}, \frac{h}{4} + \frac{K}{4}, \frac{y}{2} + \frac{h}{4} + \frac{k}{4}\right)$

$H = \frac{x}{2} + \frac{h}{4} + \frac{K}{4}$

$K = \frac{y}{2} + \frac{h}{4} + \frac{K}{4}$

$\Rightarrow x = \frac{3h}{2} - \frac{K}{2}$, $y = \frac{3K}{2} - \frac{h}{2}$

$y = 4x^2 + 1$

$\left(\frac{3k-h}{2}\right) = 4\left(\frac{3h-k}{2}\right)^2 + 1$

**78.[2]** $\begin{vmatrix} 3 & -1 & 4 \\ 1 & 2 & -3 \\ 6 & 5 & K \end{vmatrix} = 0$

$\Rightarrow 3(2K + 15) + K + 18 - 28 = 0$

$\Rightarrow 7K + 35 = 0 \Rightarrow K = -5$

**79.[4]** $s = 2\log_9 x + 3\log_9 x + 22\log_9 x$

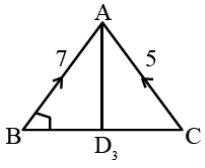
$s = \log_9 x\,(2 + 3 + ..... + 22)$

$s = \log_9 x\left\{\frac{21}{2}(2 + 22)\right\}$

Given $252\log_9 x = 504$

$\Rightarrow \log_9 x = 2 \Rightarrow x = 81$

**80.[3]**



Projection of $\overrightarrow{BA}$ on $\overrightarrow{BC}$ is equal to

$= |\vec{BA}| \cos\angle ABC$

$= 7\left|\frac{7^2+3^2-5^2}{2\times7\times3}\right| = \frac{11}{2}$

## Section -B

**81.[108]** $A\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$

$|A| = 4$

$|3\text{adj}(2A^{-1})| = |3.2^2\text{adj}(A^{-1})|$

$= 12^3 |\text{adj}(A^{-1})| = 12^3 |A^{-1}|^2 = \frac{12^3}{|A|^2} = \frac{12^3}{16} = 108$

**82.[1]** $\log_{(x+1)}(2x^2+7x+5) + \log_{(2x+5)}(x+1)^2 - 4 = 0$

$\log_{(x+1)}(2x+5)(x+1) + 2\log_{(2x+5)}(x+1) = 4$

$\log_{(x+1)}(2x+5) + 1 + 2\log_{(2x+5)}(x+1) = 4$

Put $\log(x+1)(2x+5) = t$

Put $\log_{(x+1)}(2x+5) = t$

$t + \frac{2}{t} = 3 \Rightarrow t^2 - 3t + 2 = 0$

$t = 1, 2$

$\log_{(x+1)}(2x+5) = 1$ & $\log_{(x+1)}(2x+5) = 2$

$x + 1 = 2x + 3$ & $2x + 5 = (x+1)^2$

$x = -4$ (rejected) $x^2 = 4 \Rightarrow x = 2, -2$ (rejected)

So, $x = 2$

No. of solution = 1

**83.[2]** $\cos\left(\frac{1}{2}\cos^{-1}(e^{-x})\right)dx = \sqrt{e^{2x}-1}\,dy$

Put $\cos^{-1}(e^{-x}) = \theta$, $\theta \in [0, \pi]$

$\cos\theta = e^{-x} \Rightarrow 2\cos^2\frac{\theta}{2} - 1 = e^{-x}$

$\cos\frac{\theta}{2} = \sqrt{\frac{e^{-x}+1}{2}} = \sqrt{\frac{e^x+1}{2c^x}}$

$\sqrt{\frac{e^{-x}+1}{2c^x}}dx = \sqrt{e^{2x}-1}\,dy$

$\frac{1}{\sqrt{2}}\int\frac{dx}{\sqrt{e^x}\sqrt{e^x-1}} = \int dy$

Put $e^x = t$, $\frac{dt}{dx} = e^x$

$\frac{1}{\sqrt{2}}\int\frac{dt}{e^x\sqrt{e^x}\sqrt{e^x-1}} = \int dy$

$\int\frac{dt}{t\sqrt{t^2-t}} = \sqrt{2}y$

Put $t = \frac{1}{z}$, $\frac{dt}{dz} = -\frac{1}{z^2}$

$\int\frac{-\frac{dz}{z^2}}{\frac{1}{z}\sqrt{\frac{1}{z^2}-\frac{1}{z}}} = \sqrt{2}y$

$-\int\frac{dz}{\sqrt{1-z}} = \sqrt{2}y$

$\frac{-2(1-z)^{1/2}}{-1} = \sqrt{2}y + c$

$2\left(1-\frac{1}{t}\right)^{1/2} = \sqrt{2}y + c$

$2(1-e^{-x})^{1/2} = \sqrt{2}y + c \xrightarrow{(0,-1)} \Rightarrow c = \sqrt{2}$

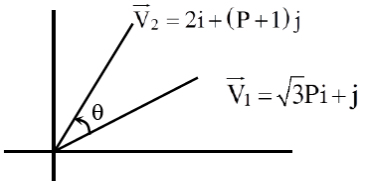
$2(1-e^{-x})^{1/2} = \sqrt{2}(y+1)$, passes through $(\alpha, 0)$

$2(1-e^{-\alpha})^{1/2} = \sqrt{2}$

$\sqrt{1-e^{-\alpha}} = \frac{1}{\sqrt{2}} \Rightarrow 1-e^{-\alpha} = \frac{1}{2}$

$e^{-\alpha} = \frac{1}{2} \Rightarrow e^{\alpha} = 2$

**84.[6]**




$|\vec{V}_1| = |\vec{V}_2|$

$3P^2 + 1 = 4 + (P+1)^2$

$2P^2 - 2P - 4 = 0 \Rightarrow P^2 - P - 2 = 0$

$P = 2, -1$(rejected)

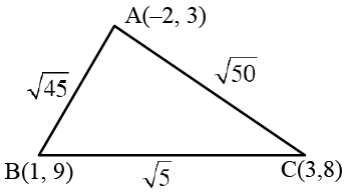
$\cos\theta = \frac{\vec{V}_1\cdot\vec{V}_2}{|\vec{V}_1||\vec{V}_2|} = \frac{2\sqrt{3}P + (P+1)}{\sqrt{(P+1)^2 + 4\sqrt{3P^2+1}}}$

$\cos\theta = \frac{4\sqrt{3}+3}{\sqrt{13}\sqrt{13}} = \frac{4\sqrt{3}+3}{13}$

$\tan\theta = \frac{\sqrt{112-24\sqrt{3}}}{4\sqrt{3}+3} = \frac{6\sqrt{3}-2}{4\sqrt{3}+3} = \frac{\alpha\sqrt{3}-2}{4\sqrt{3}+3}$

$\Rightarrow \alpha = 6$

**85.[9]**




$(\sqrt{50})^2 = (\sqrt{45})^2 + (\sqrt{5})^2$

$\angle B = 90°$

Circum-centre $= \left(\frac{1}{2}, \frac{11}{2}\right)$

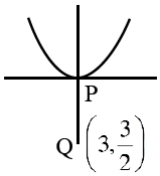
Mid point of $B = \left(2, \frac{17}{2}\right)$

Line : $\left(y - \frac{11}{2}\right) = 2\left(x - \frac{1}{2}\right) \Rightarrow y = 2x + \frac{9}{2}$

Passing though $\left(0, \frac{\alpha}{2}\right)$

$\frac{\alpha}{2} = \frac{9}{2} \Rightarrow \alpha = 9$

**86.[9]**




$P = \left(\frac{3}{2}t^2, 3t\right)$

Normal at point P

$tx + y = 3t + \frac{3}{2}t^3$

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

$\Rightarrow 3t + \frac{3}{2} = 3t + \frac{3}{2}t^3$

$P \equiv \left(\frac{3}{2}, 3\right) = (\alpha, \beta)$

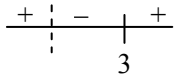
$\Rightarrow t^3 = 1 \Rightarrow t = 1$

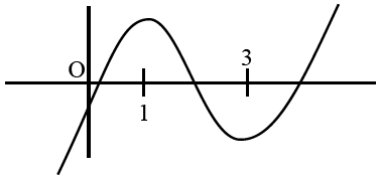
$2(\alpha + \beta) = 2\left(\frac{3}{2} + 3\right) = 9$

**87.[1]** $f(x) = x^3 - 6x^2 + 9x - 3$

$f'(x) = 3x^2 - 12x + 9 = 3(x - 1)(x - 3)$

$f(1) = 1$ $f(3) = -3$




$$g(x) = \begin{cases} f(x) & x \le x \le 1 \\ 0 & 1 \le x \le 3 \\ -1 & 3 < x \le 4 \end{cases}$$

g(x) is continuous

$$g'(x) = \begin{cases} 3(x-1)(x-3) & 0 \le x \le 1 \\ 0 & 1 \le x \le 3 \\ -1 & 3 < x \le 4 \end{cases}$$

g(x) is non-differentiable at x = 3

**88.[9]** $\frac{1}{\alpha(\alpha+1).....(\alpha+20)} = \sum_{k=0}^{20} \frac{A_k}{\alpha + k}$

$A_{14} = \frac{1}{(-14)(-13)...(-1)(1)....(6)} = \frac{1}{14! \cdot 6!}$

$A_{15} = \frac{1}{(-15)(-14)...(-1)(1)....(5)} = \frac{1}{15! \cdot 5!}$

$A_{13} = \frac{1}{(-13).....(-1)(1)....(7)} = \frac{-1}{13! \cdot 7!}$

$\frac{A_{14}}{A_{13}} = \frac{1}{14! \cdot 6!} \times -13! \times 7! = \frac{-7}{14} = -\frac{1}{2}$

$\frac{A_{15}}{A_{13}} = \frac{1}{15! \cdot 5!} \times -13! \times 7! = \frac{42}{15 \times 14} = -\frac{1}{5}$

$10\left(\frac{A_{14}}{A_{13}} + \frac{A_{15}}{A_{13}}\right)^2 = 100\left(-\frac{1}{2} + \frac{1}{5}\right)^2 = 9$

**89.[7]** $a_{n+2} = 2a_{n+1} + a_n$, let $\sum_{n=1}^{\infty} \frac{a_n}{8^n} = P$

Divide by $8^n$ we get

$\frac{a_{n+2}}{8^n} = \frac{2a_{n+1}}{8^n} + \frac{a_n}{8^n}$

$\Rightarrow 64\frac{a_{n+2}}{8^{n+2}} = \frac{16a_{n+1}}{8^{n+1}} + \frac{a_n}{8^n}$

$64\sum_{n=1}^{\infty} \frac{a_{n+2}}{8^{n+2}} = 16\sum_{n=1}^{\infty} \frac{a_{n+1}}{8^{n+1}} + \sum_{n=1}^{\infty} \frac{a_n}{8^n}$

$64\left(P - \frac{a_1}{8} - \frac{a_2}{8^2}\right) = 16\left(P - \frac{a_1}{8}\right) + P$

$\Rightarrow 64\left(P - \frac{1}{8} - \frac{1}{64}\right) = 16\left(P - \frac{1}{8}\right) + P$

$64P - 8 - 1 = 16P - 2 + P$

$47P = 7$

**90.[3]** $\lim\limits_{x\to 0}\dfrac{\alpha x\left(1+x+\dfrac{x^2}{2}\right)-\beta\left(x-\dfrac{x^2}{2}+\dfrac{x^3}{3}\right)+\gamma x^2(1-x)}{x^3}$

$\lim\limits_{x\to 0}\dfrac{x(\alpha-\beta)+x^2\left(\alpha+\dfrac{\beta}{2}+\gamma\right)+x^3\left(\dfrac{\alpha}{2}-\dfrac{\beta}{3}-\gamma\right)}{x^3}=10$

for limit to exist

$\alpha-\beta=0,\ \alpha+\dfrac{\beta}{2}+\gamma=0$

$\dfrac{\alpha}{2}-\dfrac{\beta}{2}-\gamma=10$ ....(i)

$\beta=\alpha,\ \gamma=-3\dfrac{\alpha}{2}$

Put in (i)

$\dfrac{\alpha}{2}-\dfrac{\alpha}{3}+\dfrac{3\alpha}{2}=10$

$\dfrac{\alpha}{6}+\dfrac{3\alpha}{2}=10\Rightarrow\dfrac{\alpha+9\alpha}{6}=10$

$\Rightarrow\alpha=6$

$\alpha=6,\beta=6,\gamma=-9$

$\alpha+\beta+\gamma=3$