FIITJEE RBT-6 for (JEE-Advanced)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 2 | **QP Code: 100962** | **PAPER - 2**

Time Allotted: 3 Hours **Maximum Marks: 195**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For Only One Part.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases**.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-A (08-14) –** Contains seven (07) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-A (15-18) -** This section contains Two paragraphs. Based on each paragraph, there are Two multiple choice questions. Each question has only one correct answer and carries **+4 marks** for the correct answer and **– 2 marks** for wrong answer.

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

BATCH – Two Year CRP325 batches

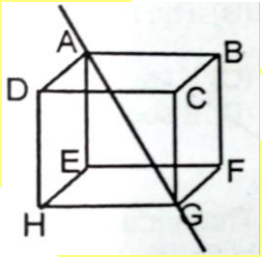
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. An infinite line charge carrying a uniform line charge of density λ is placed along the body diagonal AG of a cube of side 'a' as shown. Then



(A) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\lambda a}{2\sqrt{3}\varepsilon_0}$

(B) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\sqrt{3}\lambda a}{2\varepsilon_0}$

(C) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\lambda a}{4\sqrt{3}\varepsilon_0}$

(D) The flux of the electric field through the face ABFE is same as that through BCGF.

2. Four waves of the equation given by

$y_1 = 5A \sin (wt - Kx + \pi/2)$

$y_2 = 2A \sin (wt - Kx + 3\pi/2)$

$y_3 = 6A \sin (wt - Kx)$

and $y_4 = 2A \sin (wt - Kx + \pi)$

(A) The resulted wave will have amplitude 5A.

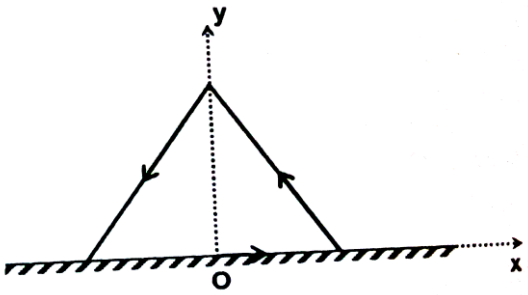
(B) It will make a phase difference of 37^o with y_3.

(C) Its equation will be $y = 5A \sin (wt + 37^o)$.

(D) Its equation will be $y = 5A \sin (wt - Kx + 37^o)$.

Space For Rough Work

3. A conducting frame in the shape of an equilateral triangle (mass m, side a) carrying a current I is placed vertically on a horizontal rough surface (coefficient of friction is μ). A magnetic field exists such that $\vec{B} = -B_0 y\hat{i}$. Then



(A) The maximum value of B_0 so that the frame does not rotate $\frac{2\mu mg}{la^2}$

(B) The maximum value of B_0 so that the frame does not rotate $\frac{\mu mg}{la^2}$

(C) If seen from the top, the frame will have a tendency to rotate counter clockwise.

(D) If seen from the top, the frame will have a tendency to rotate clockwise.

4. A source is moving across a circle given by the equation $x^2+y^2 = R^2$, with constant speed $v = \frac{330\pi}{6\sqrt{3}}$ m/s, in anti-clockwise sense. A detector is at rest at point (2R, 0) w.r.t. the centre of the circle. If the frequency emitted by the source is f and the speed of sound, C = 330 m/s. Then

(A) the position of the source when the detector records the maximum frequency $\left(+\frac{\sqrt{3}}{2}R, -\frac{R}{2}\right)$

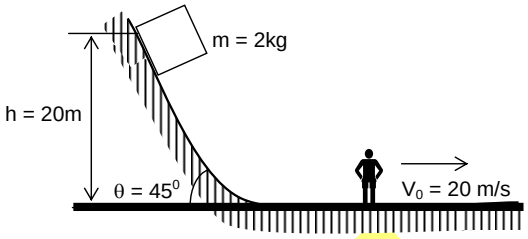
(B) the co-ordinate of the source when the detector records minimum frequency is (0, R)

(C) the maximum frequency recorded by the detector is $\frac{6\sqrt{3}}{\pi+6\sqrt{3}}f$

(D) the minimum frequency recorded by the detector is $\frac{6\sqrt{3}}{6\sqrt{3}-\pi}f$

Space For Rough Work

5. A block of mass m is released from top of an inclined plane of inclination $\theta = 45^0$ as shown in the figure. An observer is moving on the horizontal floor with constant velocity 20 m/s as shown, when the block reaches to horizontal floor.

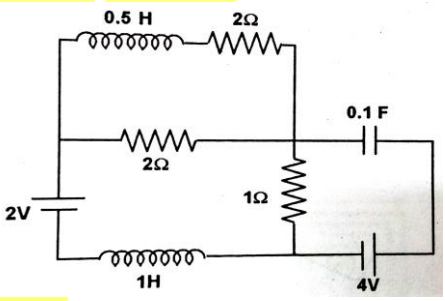


All surfaces are smooth
take $g = 10m/s^2$

(A) Velocity observed by observer will be 20 m/s
(B) Change in kinetic energy of the block will be 400J as observed by observer
(C) Work energy theorem is not applicable in moving observer frame
(D) Work done by normal reaction is – 800 J as observed by the observer

6. The kinetic energy of particle continuously increases with time :
(A) The resultant force on the particle must be parallel to the velocity at all the instant
(B) The resultant force on the particle must be at an angle less than 90^0 all the times
(C) Its height above the ground level must continuously decrease
(D) The magnitude of its linear momentum increases continuously

7. The circuit shown in the figure has reached its steady state.

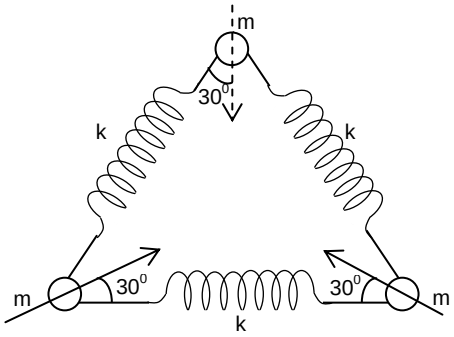


(A) The charge on the capacitor is 0.1 C.
(B) The charge on the capacitor is 0.3 C.
(C) Power developed by the 2 Volts battery is 1 W.
(D) Power developed by the 2 Volts battery is 2 W.

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. Three identical point masses are placed at the vertices of an equilateral triangle and joined through identical spring of spring constant K. The system is placed on an smooth table. If the masses are displaced along line as shown in figure, then period of their oscillation will be



(A) $2\pi\sqrt{\frac{m}{k}}$ (B) $2\pi\sqrt{\frac{m}{3k}}$

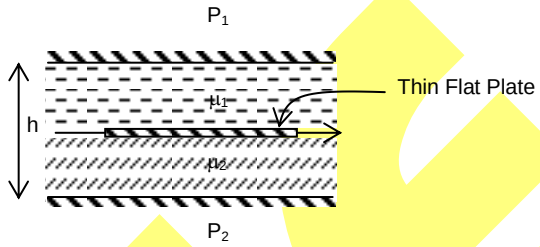
(C) $2\pi\sqrt{\frac{m}{2k}}$ (D) $2\pi\sqrt{\frac{m}{5k}}$

Space For Rough Work

9. A chain of length ℓ and mass M is lumped over the hole in a horizontal plate and a short length hangs down the hole when the chain is at rest. If it is released from this position, find the velocity when the last link of the chain leaves the hole

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

10 A thin plate is placed between two flat surfaces, h cm apart such that the viscosity of liquids on top and bottom of the plate are μ_1 and μ_2 respectively. Find the distance of the plate from the upper surface P_1 such that the viscous resistance to uniform motion of the thin plate is minimum, [Assume h to be very small] is



(A) $y = \frac{\sqrt{\mu_2}\, h}{\sqrt{\mu_1}+\sqrt{\mu_2}}$ (B) $y = \frac{\sqrt{\mu_1}\, h}{\sqrt{\mu_1}+\sqrt{\mu_2}}$

(C) $y = \frac{\sqrt{\mu_1}\, h}{\sqrt{\mu_1}-\sqrt{\mu_2}}$ (D) $y = \frac{\sqrt{\mu_2}\, h}{\sqrt{\mu_1}-\sqrt{\mu_2}}$

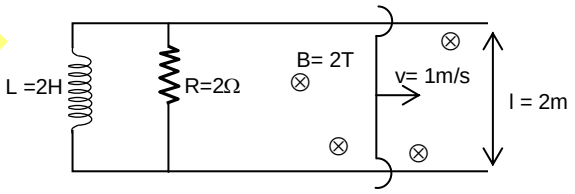
11. An a. c. source producing emf $V=V_0$ [sin ωt + cos $2\omega t$] is connected in series with a capacitor and a resistor. The current found in the circuit is $i=i_1 \sin(\omega t + \phi_1) + i_2 \cos(2\omega t + \phi_2)$. Then

(A) $i_1 = i_2$
(B) $i_1 < i_2$
(C) $i_1 > i_2$
(D) i_1 may be less than, equal to or greater than i_1

12. Two long straight wires with equal cross-sectional radii a are located parallel to each other in air at a large distance b from each other. The capacitance per unit length of the wires will be

(A) $\frac{\pi\varepsilon_0}{\ln\left(\frac{a}{b-a}\right)}$ (B) $\frac{\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$ (C) $\frac{2\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$ (D) $\frac{4\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$

13. The given figure shows an inductor and resistance fixed on a conducting wire. A movable conducting wire PQ starts moving on the fixed rails from t = 0 with constant velocity 1 m/s. The work done by the external force on the wire PQ in 2 seconds is



(A) 16 J (B) 32 J
(C) 48 J (D) 64 J

Space For Rough Work

14. A hemisphere of mass 3m and radius R is free to slide with its base on a smooth horizontal table. A particle of mass m is placed on the top of the hemisphere. If particle is displaced with a negligible velocity, then find the angular velocity of the particle relative to the centre of the hemisphere at an angular displacement θ, when velocity of hemisphere is v.

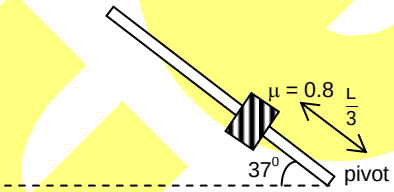
(A) $\frac{4v}{R\cos\theta}$ (B) $\frac{3v}{R\cos\theta}$ (C) $\frac{5v}{R\cos\theta}$ (D) $\frac{2v}{R\cos\theta}$

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

A cylindrical rod of mass m and length L is pivoted about a horizontal axis through one end and released from rest at an angle 37^0 with the horizontal. A small ring of same mass is kept on the rod as shown in figure



15. Angular velocity of rod about the pivot when it passes through horizontal position is

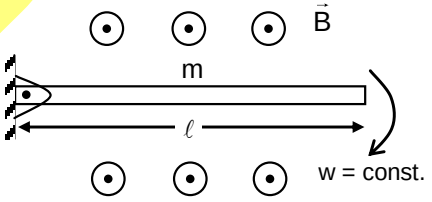
(A) $\sqrt{\frac{9g}{4L}}$ (B) $\sqrt{\frac{4g}{3L}}$ (C) $\sqrt{\frac{12g}{7L}}$ (D) $\sqrt{\frac{2g}{3L}}$

16. Tangential acceleration of CM at the instant it passes through horizontal position is

(A) $\frac{42g}{7}$ (B) $\frac{6g}{7}$ (C) $\frac{25g}{32}$ (D) $\frac{7g}{16}$

Paragraph for Question no. 17 to 18

A uniformly charged non-conducting rod of mass M and linear charge density λ(C/m) is rotating in horizontal plane in gravity free space with constant angular velocity w rad/sec. The rod is hinged at one end as shown in figure. A uniform magnetic field $\vec{B}$ exists in the region along vertically upward direction. Area of cross-section of rod is A.



17. Find out net force applied by hinge on the rod $\left(\text{when } W > \frac{B\lambda\ell}{m}\right)$

(A) $\frac{mw^2\ell}{2} - \frac{B\lambda w\ell^2}{2}$ (B) 0 (C) $\frac{B\lambda w\ell^2}{2}$ (D) $\frac{mw^2\ell}{2}$

18. Tension in the rod at the mid point of rod. When $W = \frac{B\lambda\ell}{M}$

(A) $\frac{B\lambda w\ell^2}{8A}$ (B) $\frac{w\ell}{4A}(B\lambda\ell - mw)$ (C) $\frac{mw^2\ell}{4A}$ (D) 0

Space For Rough Work

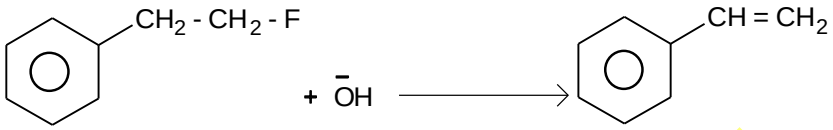
SECTION-2 : CHEMISTRY

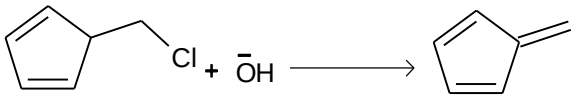
PART – A

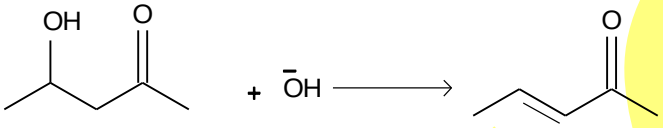
(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which is/are example involve E_{CB}^{1} as major mechanism?

(A) 

(B) 

(C) 

(D) $CH_3CH_2Cl + {}^{-}OH \longrightarrow CH_2 = CH_2$

2. Which of the following statement(s) is/are incorrect if temperature is increased?
(A) pK_w increases (B) K_w increases
(C) pH of pure water increases (D) pOH of pure water increases

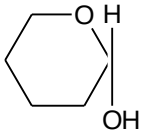
3. Which of the following is/are correct option?
(A) Tetrapeptide represents, 4 peptide bond in a molecule of polypeptide.
(B) Glucose & Fructose can be differentiated by Tollen's reagent & Fehling's solution.
(C) One mole of glucose reacts with maximum of 3 mole of phenylhydrazine.
(D) Trehalose(also known as mycose) is the disaccharide which is non-reducing in nature.

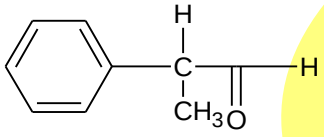
4. Which of the following statement(s) is/are false?
(A) All adiabatic processes are isoentroic(or isentropic) process
(B) When $(\Delta G_{system})_{T,\,P} < 0$ the reaction must be exothermic
(C) dG = VdP – SdT is applicable for closed system, both PV and non-PV work
(D) The heat of vaporization of water at 100°C is 40.6 kJ.mol. When 9 g of water vapour condenses to liquid at 100°C and 1 atm, then system ΔS_{system} = 54.42 J/K

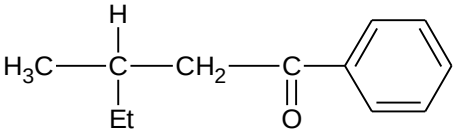
Space For Rough Work

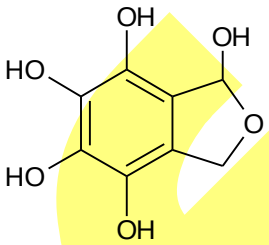
5. Which is true about Scandium compound?
(A) The Scandium carbide(ScC_2), reacts with water, liberating ethyne
(B) Oxidation number of Scandium is +3 in Scandium carbide
(C) Anhydrous $ScCl_3$ differs from $AlCl_3$ as $ScCl_3$ is monomeric while $(AlCl_3)_2$ is dimeric
(D) $2ScCl_3.7H_2O$ on heating gives anhydrous $ScCl_3$

6. In which of the following compounds, there will be either loss of optical activity or change of optical rotation, while keeping in very dilute acidic or basic aqueous solution?

(A) 

(B) 

(C) 

(D) 

7. Select the false statement(s)?
(A) Brownian motion and Tyndall effect are shown by true solution
(B) Sorption process is combinations of adsorption and absorption process
(C) Micelle formation is mainly enthalpy driven process at normal temperature
(D) Higher is the gold number greater will be the protective power of a colloid

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

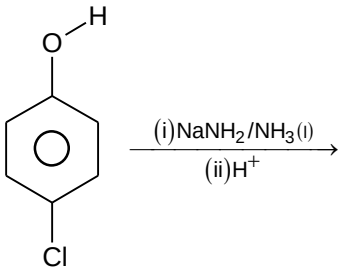
8. Correct order for relative rate of hydrolysis

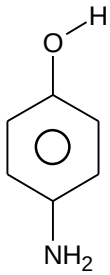
CH_3CH_2Cl (I) $\quad CH_3OCH_2CH_2Cl$ (II) $\quad CH_3SCH_2CH_2Cl$ (III)

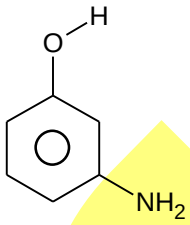
(A) I > II > III
(B) II > I > III
(C) III > II > I
(D) I > III > II

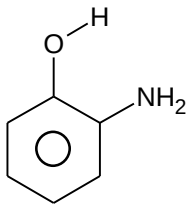
Space For Rough Work

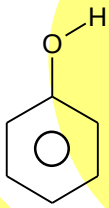
9. Major product in the given reaction is:



(A)


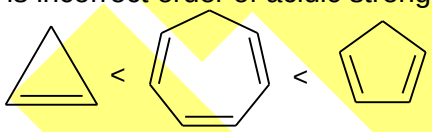
(B)


(C)


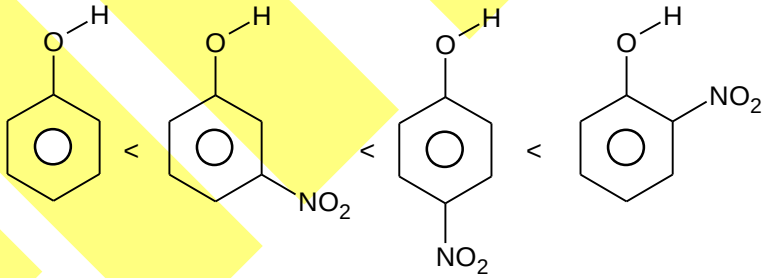
(D)


10 Cyclohexene reacts with limited amount of bromine in the presence of light to form product X (C_6H_9Br). The statement correct about X is
(A) It is racemate
(B) It is a product of an addition reaction
(C) It is formed through a cationic intermediate
(D) It is optically active

11. Which is incorrect order of acidic strength?

(A)


(B) $CHF_3 < CHCl_3 < CHBr_3$

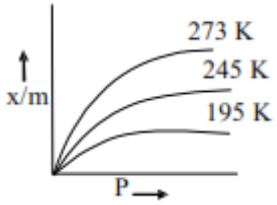
(C)


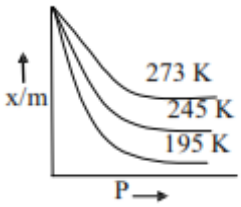
(D) $BF_3 < BCl_3 < BBr_3 < BI_3$

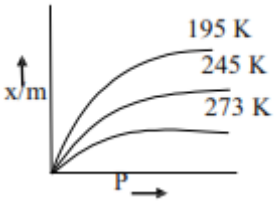
Space For Rough Work

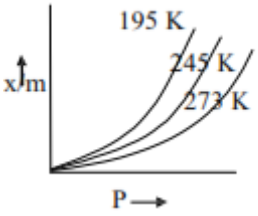
12. When an apple is cut, the exposed part begins to turn brown. Often the browning action can be arrested by adding a few drops of lemon juice to the exposed area. The basis for this treatment is
(A) lemon juice is an antioxidant
(B) denaturation of proteins of the enzymes
(C) decolourization due to lemon juice
(D) activation of decolourizing enzymes under acidic medium

13. Freundlich adsorption isotherms are properly represented as in

(A) 

(B) 

(C) 

(D) 

14. A nonapeptide in rat on hydrolysis gave the following identifiable tripeptides: Gly-Ala-Phe, Ala-Leu-Val, Gly-Ala-Leu, Phe-Glu-His, and His-Gly-Ala, The sequence in the nonapetide is
(A) Gly-Ala-Leu-Val-Phe-Glu-His-His-Gly
(B) Ala-Phe-Leu-Val-Gly-Leu-Phe-Glu-His
(C) Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val
(D) Phe-Ala-Leu-Val-Gly-Glu-His-Gly-Ala

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

P_4O_{10} is one of very important phosphoric oxide having oxidation state of phosphorus as (+V). P_4O_{10} is having cyclic structure P_4O_{10} on hydrolysis consume 6 moles of H_2O in step wise manner involving different intermediate.

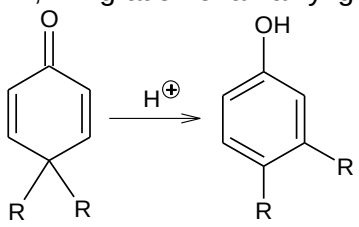
15. P_4O_{10} (1 mole) when reacts with 2 moles of H_2O gives
(A) dibasic acid (B) tribasic acid
(C) tetrabasic acid (D) monobasic acid

16. P_4O_{10} (1 mole) when reacts with 3 moles of H_2O gives
(A) dibasic acid (B) tetrabasic acid
(C) hexabasic acid (D) octabasic acid

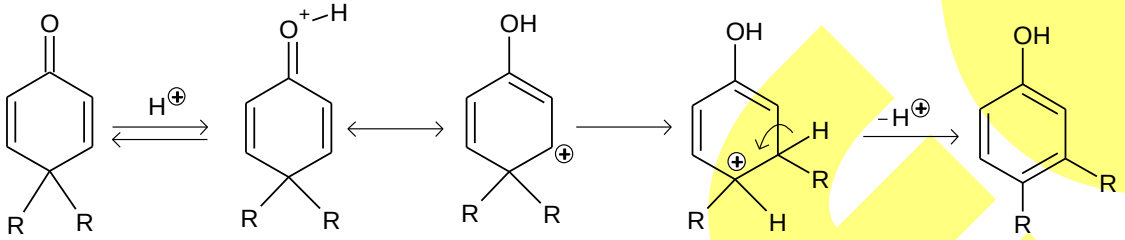
Space For Rough Work

Paragraph for Question no. 17 to 18

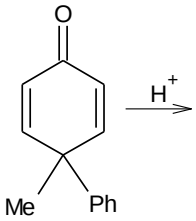
A rearrangement essentially, reversal of the pinacol/pinacolone change, a retro pinacol reaction, is the dienone-phenol rearrangement in which protonation of the initial dienone allows reattainment of the wholly aromatic condition through 1,2-migration of an alkyl group

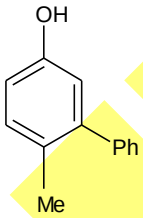


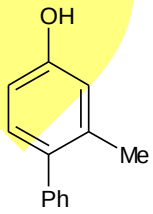
Mechanism is as follows:

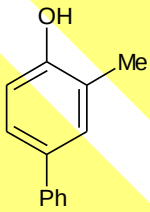


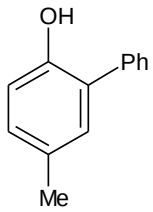
17. In the reaction given below major product will be:



(A) 

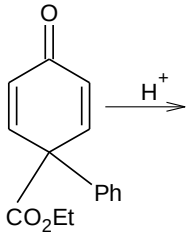
(B) 

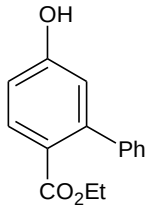
(C) 

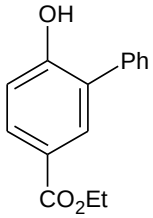
(D) 

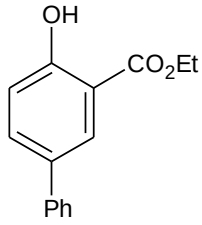
Space For Rough Work

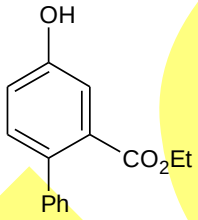
18. In the reaction given below major product will be:



(A) 

(B) 

(C) 

(D) 

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. A function $y = f(x)$ satisfies the following conditions

(i) $f(1) = 1$

(ii) The tangent at any point of the graph of $f(x)$ cuts off on the y – axis an intercept equal to the square of the abscissa of the point of tangency.

Which of the following are correct?

(A) The graph of $y = f(x)$ passes through the origin

(B) $y = f(x)$ denotes a conic where coordinates of focus are $\left(1, \frac{3}{4}\right)$

(C) The area enclosed by $f(x)$, and the line $y + 3 = 0$ is $\frac{32}{3}$.

(D) $y = f(x)$ has no maxima

2. The line of intersection of the plane $\vec{r}.(3\hat{i} - \hat{j} + \hat{k}) = 1$ and $\vec{r}.(\hat{i} + 4\hat{j} - 2\hat{k}) = 2$ is parallel to the vector

(A) $2\hat{i} + 7\hat{j} + 13\hat{k}$ (B) $-2\hat{i} + 7\hat{j} + 13\hat{k}$

(C) $-2\hat{i} - 7\hat{j} + 13\hat{k}$ (D) $2\hat{i} - 7\hat{j} - 13\hat{k}$

3. In the expansion of $(2x - 3y + z)^{10}$, then which of the following statement(s) is/are **correct**?

(A) The expansion will contain 66 terms

(B) Sum of all the coefficients is 0

(C) The coefficient of $x^2y^3z^5$ equals $\left(\frac{-10! \times 9}{5!}\right)$

(D) None of these

Space For Rough Work

4. Let $f(x)=(x^2+2x+3)^2+2(x^2+2x+3)+3$, then which of the following statement (s) is (are) correct?

(A) The equation $f(x)=0$ has no real roots.

(B) The equation $f(x)=0$ has two real roots and two imaginary roots.

(C) The minimum value of $f(x)$ equals 11

(D) The minimum value of $f(x)$ equals 12

5. If ${}^{100}C_6+4\,{}^{100}C_7+6\,{}^{100}C_8+4\,{}^{100}C_9+{}^{100}C_{10}$ has the value equal to ${}^{x}C_y$, then the value of $(x+y)$ can be

(A) 114 (B) 115 (C) 198 (D) 199

6. Which of the following is (are) correct?

(A) $\lim\limits_{n\to\infty}\left(\dfrac{2n^2-3}{2n^2-n+1}\right)^{\frac{n^2-1}{n}}$ is equal to $\sqrt{e}$.

(B) $\lim\limits_{x\to\infty} x\left(\dfrac{1}{e}-\left(\dfrac{x}{x+1}\right)^x\right)$ equal to $\dfrac{-1}{2e}$.

(C) The coefficient of x^{50} in $(1+x^2)^{25}(1+x^{25})(1+x^{40})(1+x^{45})(1+x^{47})$ is equal to $1+{}^{25}C_5$.

(D) If A, B are non – singular and symmetric matrices such that AB = BA then $A^{-1}B^{-1}$ is symmetric matrix.

7. Let the complex number $z=x+iy$ (where $x,y\in R$) satisfy $\cot^{-1}(\log_3|2z+1|)>\cot^{-1}(\log_3|2z-1|)$, then x can be

(A) –1 (B) –2 (C) 1 (D) 2

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. Consider two concentric circle $C_1: x^2+y^2-1=0$ and $C_2: x^2+y^2-4=0$. A parabola is drawn through the points where 'C_1' meets the x – axis and having arbitrary tangent of 'C_2' as it's directrix. Find the locus of the focus of drawn parabola.

(A) $\left(\dfrac{3}{4}\right)x^2-y^2=3$ (B) $\left(\dfrac{3}{4}\right)x^2+y^2=3$

(C) $\left(\dfrac{3}{2}\right)x^2+y^2=3$ (D) $\left(\dfrac{3}{4}\right)x^2+y^2=\dfrac{3}{2}$

Space For Rough Work

9. Let $M=\begin{bmatrix}\sin^4\theta & -1-\sin^2\theta \\ 1+\cos^2\theta & \cos^4\theta\end{bmatrix}=\alpha I+\beta M^{-1}$

Where $\alpha=\alpha(\theta)$ and $\beta=\beta(\theta)$ are real numbers, and I is the 2×2 identity matrix. If

α^* is the minimum of the set $\{\alpha(\theta):\theta\in[0,2\pi]\}$ and

β^* is the minimum of the set $\{\beta(\theta):\theta\in[0,2\pi]\}$

Then the value of $\alpha^*+\beta^*$ is

(A) $-\frac{37}{16}$ (B) $-\frac{31}{16}$ (C) $-\frac{17}{16}$ (D) $-\frac{29}{16}$

10. Given $2x-y-2z=2,\ x-2y+z=-4, x+y+\lambda z=4$ then the value of λ such that the given system of equation has NO solution, is

(A) 3 (B) 1
(C) 0 (D) –3

11. If $x=\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}$ and $y=\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{8\pi}{7}$, then x^2+y^2 is

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

12. The number of solutions of the equation $\sin^{-1}\left(\frac{x^2}{x^2+1}\right)+\cos^{-1}\left(\frac{x^2-1}{x^2+1}\right)=\pi$ is

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

13. $\sum_{r=1}^{\infty}\tan^{-1}\left(\frac{1}{r^2+5r+7}\right)$ equals to

(A) $\tan^{-1}3$ (B) $\frac{\pi}{4}$ (C) $\sin^{-1}\frac{1}{\sqrt{10}}$ (D) $\cot^{-1}2$

14. One of the sides of a triangle is divided into segments of 6 and 8 units by the point of tangency of the inscribed circle. If the radius of the circle is 4 units, then the length of the shortest side is

(A) 12 units (B) 13 units
(C) 14 units (D) 15 units

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Let z_1 and z_2 are two complex numbers satisfying the equation $3z_1^2 - 2z_1z_2 + 2z_2^2 = 0$ and also $\text{Re}\left(\frac{z_1 - 2}{z_1 + 2}\right) = 0$. Also, P_1, P_2 and O are points in complex plane corresponding to z_1, z_2 and origin respectively.

15. The value of $|z_1|$ is equal to

(A) 1 (B) $\sqrt{5}$

(C) 2 (D) $2\sqrt{2}$

16. Area of triangle OP_1P_2 is

(A) $\sqrt{5}$ (B) $2\sqrt{5}$

(C) $3\sqrt{5}$ (D) $4\sqrt{5}$

Paragraph for Question no. 17 to 18

Let $P(x) = x^5 - 9x^4 + px^3 - 27x^2 + qx + r \left(p, q, r \in R\right)$ be divisible by x^2 and α, β and γ are the positive roots of the equation $\frac{P(x)}{x^2} = 0$.

17. The value of $(p + q + r)$ is equal to

(A) 9 (B) 27

(C) 81 (D) 108

18. If $\alpha - 1, \beta + 3$ and $\gamma + 7$ are the first three terms of a sequence whose sum of first n terms is given by S_n then $\sum_{n=2}^{\infty} \frac{1}{\sqrt{S_n . S_{n-1}}}$ is equal to

(A) 1 (B) $\frac{1}{4}$

(C) $\frac{1}{2}$ (D) 2

Space For Rough Work

Q.P. Code: 100962

Answers

SECTION-1 : PHYSICS
PART – A

1.	AD	2.	ABD	3.	AD	4.	AB
5.	BD	6.	BD	7.	BD	8.	B
9.	C	10.	B	11.	B	12.	B
13.	B	14.	A	15.	A	16.	C
17.	A	18.	D				

SECTION-1 : CHEMISTRY
PART – A

1.	ABC	2.	ACD	3.	CD	4.	ABCD
5.	ABC	6.	ABD	7.	ACD	8.	C
9.	B	10.	A	11.	C	12.	A
13.	C	14.	C	15.	C	16.	C
17.	A	18.	D				

SECTION-1 : MATHEMATICS
PART – A

1.	ABC	2.	BD	3.	ABC	4.	AC
5.	AC	6.	ABCD	7.	AB	8.	B
9.	D	10.	D	11.	B	12.	A
13.	C	14.	B	15.	C	16.	A
17.	B	18.	C				

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **AD**

Sol. Use Gauss law.

2. **ABD**

Sol. Amplitude added vectorily.

3. **AD**

Sol. $\vec{\tau} = \vec{M} \times \vec{B} = \frac{IB_0a^3}{8}$

$\tau_{friction} = \frac{\mu mga}{4}$

4. **AB**

Sol. For maximum frequency velocity of source towards detector & for minimum frequency velocity of source away from detector.

5. **BD**

Sol. Use work energy theorem.

6. **BD**

Sol. For KE to increase power should be positive

$\vec{f}, \vec{v} > 0 \Rightarrow \theta < 90^0$

$P = \sqrt{2Km} \Rightarrow P \propto \sqrt{K}$

7. **BD**

Sol. Voltage across capacitor = 3 V

$q_C = 3 \times 0.1 = 0.3$ C

$P = \frac{(2)^2}{2} = 2$ W.

8. **B**

Sol. $3 \times \frac{1}{2} k \left(x\sqrt{3} \right)^2 + \frac{1}{2} 3 \times mv^2 = \text{const}$

differentiating w.r.t time

$3kx + ma = 0$

$a = -\left(\frac{3k}{m} \right) x$

$T = 2\pi \sqrt{\frac{m}{3k}}$

9. **C**

Sol. Use concept of variable mass system

$V = \sqrt{\frac{2gx}{3}}$

10. **B**

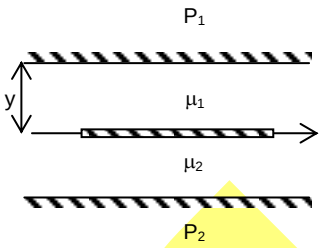
Sol. Force on both sides of the plate

$$F = v\left[\frac{\mu_1}{y} + \frac{\mu_2}{h-y}\right]A$$

Where A = area of the thin plate

For F to be minimum $\frac{dF}{dy} = 0$

$$y = \frac{\sqrt{\mu_1}\, h}{\sqrt{\mu_1} + \sqrt{\mu_2}}$$



11. **B**

Sol. $i_1 = \frac{V_o}{\sqrt{R^2 + \frac{1}{\omega^2 c^2}}}$; $i_2 = \frac{V_o}{\sqrt{R^2 + \frac{1}{4\omega^2 c^2}}}$

12. **B**

Sol. $C = \frac{\lambda}{\Delta V}$

$$C = \frac{\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$$

13. **B**

Sol. Energy stored in inductor

$$= \frac{B^2V^2l^2t^2}{2L} = 16J$$

energy dissipated in resistor

$$= \frac{V^2B^2l^2t}{R} = 16J$$

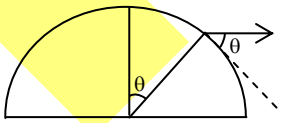
So work done by external agent = 16J + 16J = 32 J

14. **A**

Sol. By COM

$0 = 3mv + mv_x \quad \Rightarrow v_x = 3v$

wrt sphere $v_x' = 4v$



15. **A**

16. **C**

Sol. By COME

$$\left[mg\left(\frac{L}{3}\right) + mg\frac{L}{2}\right] \times \frac{3}{5} = \frac{1}{2}\left[\frac{mL^2}{3} + \frac{mL^2}{9}\right]\omega^2$$

$$\Rightarrow \omega = \sqrt{\frac{9g}{4L}} = \frac{3}{2}\sqrt{\frac{g}{L}}$$

By $\tau = I\alpha$

$2mg - N = 2ma_t$

$$N\frac{5L}{12} = \left[\frac{mL^2}{12} + m\left(\frac{L}{12}\right)^2 + m\left(\frac{L}{12}\right)^2\right]\alpha$$

$$\alpha\frac{5L}{12} = a_t$$

$$\Rightarrow a_t = \frac{25g}{32} \text{ and } N = \frac{7}{16}mg$$

$$F_{ac} = (2m)\omega^2\left(\frac{5L}{12}\right) = \frac{15mg}{8}$$

Net reaction force = $= \sqrt{N^2 + F_{ac}^2} = \frac{\sqrt{949}}{16}mg$

17. **A**

Sol. $F_{Hinge} + F_{Mag} = m\omega^2\frac{\ell}{2}$

18. **D**

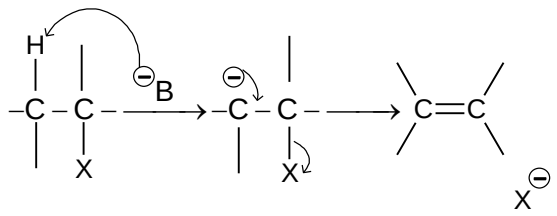
Sol. $T + F_{mag} = \frac{M}{2}\omega^2\left(\frac{3\ell}{4}\right)$

SECTION-2 : CHEMISTRY

PART – A

1. ABC

Sol.



2. ACD

Sol. $H_2O \rightleftharpoons H^+ + OH^- \quad K_w = [H^+][OH^-]$

$T \uparrow \Rightarrow K_w \uparrow$

3. CD

Sol. (A) 4 amino acids
(B) Both shows positive
(C) Osazone
(D) No free hemiacetal

4. ABCD

Sol. Theoretical
ΔS_{system} should be negative.

5. ABC

Sol. $Sc^{3+}.C_2^{2-}$ & factual

6. ABD

Sol. Enolisation & hemiacetal

7. ACD

Sol. Theoretical

8. C

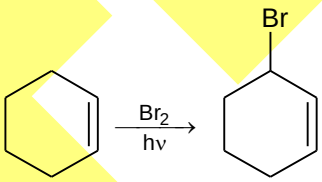
Sol. Electronegativity & nucleophilicity.

9. B

Sol. Benzyne mechanism

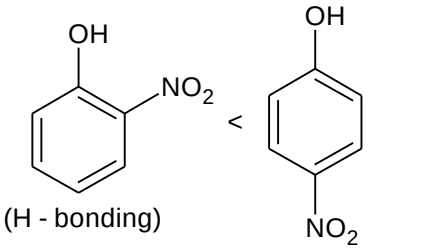
10. A

Sol.



11. C

Sol.



(H - bonding) (Acidic strength)

12. A
Sol. Factual

13. C
Sol. Conceptual

$\frac{x}{m} \alpha P^{0-1}$ and $\frac{x}{m} \alpha \frac{1}{T}$

14. C
Sol. Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val

15. C
Sol. Tetrametal Phosphoric acid $H_4P_4O_{12}$

16. C
Sol. Tetra Poly Phosphoric acid $H_6P_4O_{13}$

17. A
Sol. Migratory aptitude -Ph > -Me

18. D
Sol. –COOEt will migrate
Stability of carbocation concerned.

SECTION-3 : MATHEMATICS

PART – A

1. ABC

Sol. $Y-y=m(X-x)$

Put $X=0$

$Y=y-mx$

$\therefore y-mx=x^2$

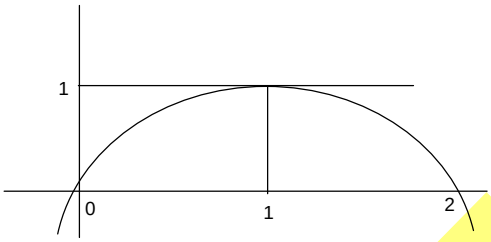
$\frac{dy}{dx}-\frac{1}{x}y=-x$ (linear DE)

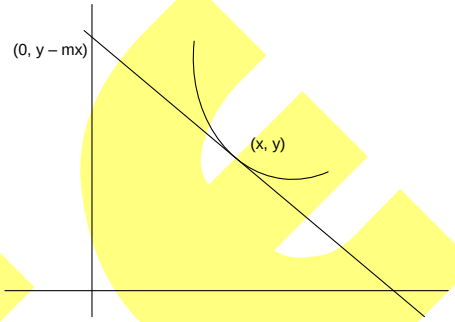
solving $y=-x^2+cx$

$x=1,\ y=1$

$\Rightarrow \quad c=2$

$y=2x-x^2$





2. BD

Sol. $\vec{V}-\vec{n_1}\times\vec{n_2}=\left(3\hat{i}-\hat{j}+\hat{k}\right)\times\left(\hat{i}+4\hat{j}-2\hat{k}\right)=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\3&-1&1\\1&4&-2\end{vmatrix}$

$=\hat{i}(2-4)-\hat{j}(-6-1)+\hat{k}(12+1)=-2\hat{i}+7\hat{j}+13\hat{k} \quad \Rightarrow$ B and D

3. ABC

Sol. $(2x-3y+z)^{10}$

General term = $\sum_{\alpha+\beta+\gamma=10}\frac{10!(2x)^{\alpha}(-3y)^{\beta}(z)^{\gamma}}{\alpha!\beta!\gamma!}$ .....(i)

$\therefore$ Number of terms $=\frac{12!}{10!2!}=\frac{12\times11}{2}=66$.

Put $x=y=z=1$ in (1), we get

Sum of all the coefficients 0.

Put $\alpha=2,\beta=3,\ \gamma=5$ in (1),

We get coefficient of $x^2y^3z^5=\frac{10!}{2!.3!.5!}(2)^2(-3)^2=\frac{-10!\times4\times27}{2\times6\times120}=\frac{-10!\times9}{5!}$

4. AC

Sol. $f(x)=\left(x^2+2x+3\right)^2+2\left(x^2+2x+3\right)+3$

$x^2+2x+3>0\ \forall\ x\in R$

$\therefore f(x)>0\ \forall\ x\in R$.

Assume $x^3+2x+3=y$

$f(x)=y^2+2y+3=(y+1)^2+2\Rightarrow f(x)=\left(x^2+2x+4\right)^2+2\Rightarrow f(x)=\left[(x+1)^2+3\right]^2+2$

$f(x)\geq9+2=11\Rightarrow f(x)\big|_{min}=11$

5. AC

Sol. ${}^4C_4\,.\,{}^{100}C_6+{}^4C_3\,.\,{}^{100}C_7+{}^4C_2\,.\,{}^{100}C_8+{}^4C_1\,.\,{}^{100}C_9+{}^4C_0\,.\,{}^{100}C_{10}$

Out of 104 students of which 100 are boys and 4 are girls, we have to select 10 students.

This can be done in ${}^{104}C_{10}={}^{104}C_{94}$

Hence, $x+y=114$ or 198

6. ABCD

Sol.

(A) $I=e^{\lim\limits_{n\to\infty}\frac{n^2-1}{n}\left(\frac{2n^2-3}{2n^2-n+1}-1\right)}=e^{\lim\limits_{n\to\infty}\left(\frac{n-4}{2n^2-n+1}\right)\left(\frac{n^2-1}{n}\right)}=e^{\frac{1}{2}}=\sqrt{e}$

$\ln I=\frac{1}{2}$

(B) $\lim\limits_{x\to\infty}x\left(\frac{1}{e}-\left(\frac{x}{x+1}\right)^x\right)$

Let $x=\frac{1}{t}$

$$\therefore \lim_{t\to0}\frac{1}{t}\left(\frac{1}{e}-\left(\frac{1}{1+t}\right)^{1/t}\right)=\frac{1}{e}\lim_{t\to0}\frac{(1+t)^{1/t}-e}{t.(1+t)^{1/t}}=\frac{1}{e^2}\lim_{t\to0}\frac{e^{\frac{\ln(1+t)}{t}}-e}{t}$$

$$=\frac{1}{e}\lim_{t\to0}\frac{e^{\frac{\ln(1+t)}{t}}-1}{\left(\frac{\ell n(1+t)}{t}-1\right)}.\left(\frac{\ell n(1+t)}{t}-1\right)=\frac{1}{e}\lim_{t\to0}\frac{\ell n(1+t)-t}{t^2}=\frac{-1}{2e}$$

(C) As we are interested in coefficient of x^{50}, we shall ignore all the terms with exponent more than 50.

So, $\left(1+x^2\right)^{25}\left(1+x^{25}\right)\left(1+x^{40}\right)\left(1+x^{45}\right)\left(1+x^{47}\right)$

$=\left(1+{}^{25}C_1x^2+....+{}^{25}C_{25}x^{50}\right)\times\left(1+x^{25}+x^{40}+x^{45}+x^{47}\right)={}^{25}C_{25}+{}^{25}C_5=1+{}^{25}C_5$.

(D) $\left(A^{-1}B^{-1}\right)^T=\left(B^{-1}\right)^T\left(A^{-1}\right)^T=\left(B^T\right)^{-1}\left(A^T\right)^{-1}=B^{-1}A^{-1}=(AB)^{-1}=(BA)^{-1}=A^{-1}B^{-1}$

$\Rightarrow A^{-1}B^{-1}$ is symmetric matrix.

7. AB

Sol. $\log_3|2z+1|<\log_3|2z-1|$ (as $\cot^{-1}x$ is a decreasing function)

$\therefore |2z+1|<|2z-1|$

or $(2z+1)\left(2\bar{z}+1\right)<(2z-1)\left(2\bar{z}-1\right)$

$2\left(z+\bar{z}\right)<-2\left(z+\bar{z}\right)$

$z+\bar{z}<0$

$2\mathrm{Re}(z)<0$

$\therefore \mathrm{Re}(z)<0$

8. B

Sol. Clearly the parabola should pass through (1, 0) and (–1, 0). Let directrix of this parabola be, $x\cos\theta + y\sin\theta = 2$

If $S(h,k)$ be the focus of this parabola, then distance of $(\pm 1, 0)$ from 'S' and from the directrix should be same.

$\Rightarrow (h-1)^2 + k^2 = (\cos\theta - 2)^2$ .....(1)

and $(h+1)^2 + k^2 = (\cos\theta + 2)^2$ .....(2)

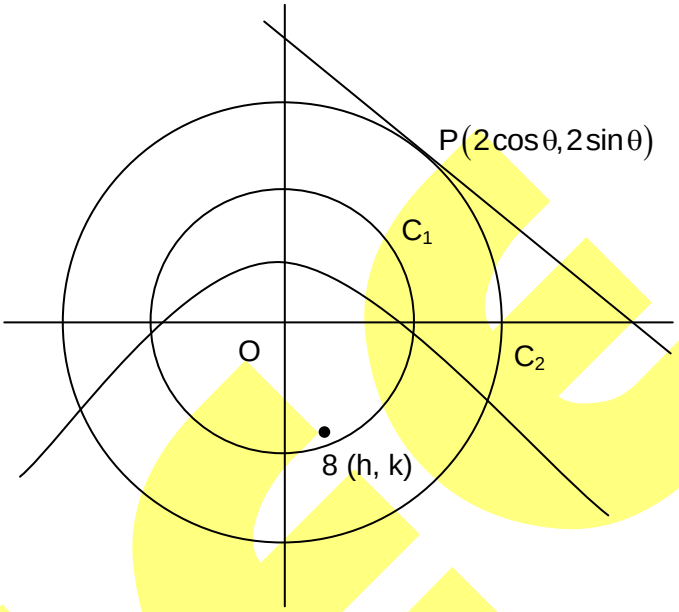
(2) – (1) gives us; $4h = 8\cos\theta$

$\Rightarrow \cos\theta = \frac{h}{2}$

(2) + (1) gives us; $2(h^2 + k^2 + 1) = 2(\cos^2\theta + 4)$

$\Rightarrow h^2 + k^2 + 1 = 4 + \frac{h^2}{4} \Rightarrow \frac{3}{4}h^2 + k^2 = 3$

Hence locus of focus is: $\left(\frac{3}{4}\right)x^2 + y^2 = 3$.



9. D

Sol. $M = \alpha I + \beta M^{-1}$

Equate trace on both sides

$\sin^4\theta + \cos^4\theta = 2\alpha + \beta\left(\frac{\sin^4\theta + \cos^4\theta}{|M|}\right)$

Equate sum of elements of non principal diagonal

$\cos^2\theta - \sin^2\theta = \beta\left(\frac{\sin^2\theta - \cos^2\theta}{|M|}\right)$

$\therefore \beta = -|M| = -\left[\sin^4\theta\cos^4\theta + \sin^2\theta\cos^2\theta + 2\right]$

$\alpha = \sin^4\theta + \cos^4\theta$

$\alpha^* = \alpha_{min} = \frac{1}{2}$

$\beta^* = \beta_{min} = -\frac{37}{16}$

$\therefore \alpha^* + \beta^* = \frac{1}{2} - \frac{37}{16} = -\frac{29}{16}$

10. D

Sol. As $\Delta_z \neq 0$, for no solution $\Delta = 0 \Rightarrow \begin{vmatrix} 2 & -1 & -2 \\ 1 & -2 & 1 \\ 1 & 1 & \lambda \end{vmatrix} = 0 \Rightarrow \lambda = -3$.

11. B

Sol. $x^2 + y^2 = 3 + 2\left(\cos\frac{2\pi}{7} + \cos\frac{4\pi}{7} + \cos\frac{6\pi}{7}\right)$

$= 3 + \frac{2\cos\frac{4\pi}{7}\sin\frac{3\pi}{7}}{\sin\frac{\pi}{7}} = 3 - 1 = 2$.

12. A

Sol. $\sin^{-1}\left(\frac{x^2}{x^2+1}\right)=\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

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

On squaring and solving, we get, $x=0$.

13. C

Sol. $a_n=\tan^{-1}\left(\frac{1}{1+(n+3)(n+2)}\right)$

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

$=\tan^{-1}(n+3)-\tan^{-1}(n+2)$

$S_n=f(n)-f(0)=\tan^{-1}(n+3)-\tan^{-1}3$

$S_n=\frac{\pi}{2}-\tan^{-1}3=\cot^{-1}3=\sin^{-1}\frac{1}{\sqrt{10}}$.

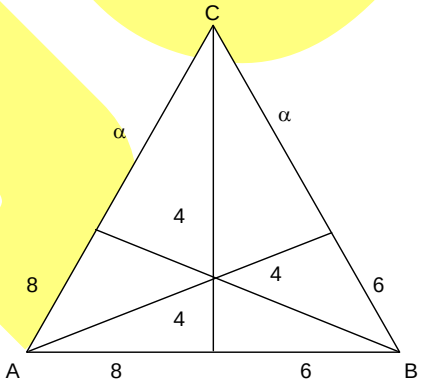
14. B

Sol. $\tan\frac{A}{2}=\frac{1}{2}$

$\tan\frac{B}{2}=\frac{2}{3}$

$\Rightarrow\tan\frac{C}{2}=\frac{4}{7}$

$\Rightarrow\alpha=7\Rightarrow$ the shortest side is 14.



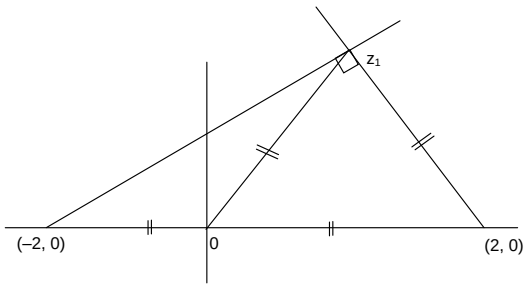
15. C

16. A

(Sol. 15 & 16)

Since $\text{Re}\left(\frac{z_1-2}{z_1+2}\right)=0$

$\frac{z_1-2}{z_1+2}$ is P.I.



$\Rightarrow$ line joining (2, 0), z_1 and $(-2,0), z_1$ are perpendicular

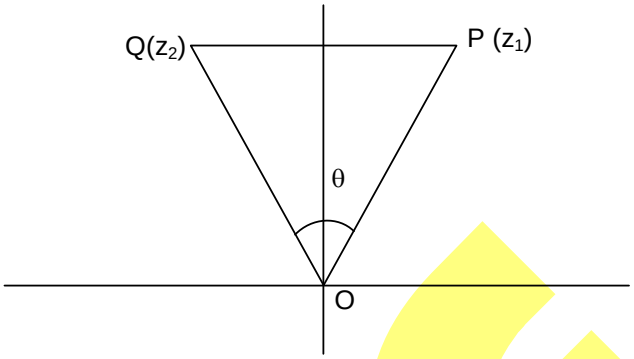
$\therefore\ |z_1|=2$

Also, $2z_2^{\,2}-2z_1z_2+3z_1^{\,2}=0$

$z_2=\left(\frac{1+\sqrt{5}i}{2}\right)z_1$

$\therefore |z_2|=\frac{\sqrt{6}}{2}|z_1|$.

Also, $\frac{z_2}{|z_2|} = \frac{z_1}{|z_1|} e^{i\theta}$



17. B

18. C

(Sol. 17 & 18)

$P(x) = x^5 - 9x^4 + px^3 - 27x^2 + qx + r$

$\because$ $P(x)$ is divisible by x^2

$\therefore q = r = 0$

$P(x) = x^5 - 9x^4 + px^3 - 27x^2$

$\frac{P(x)}{x^2} = x^3 - 9x^2 + px - 27 = 0$

$\alpha, \beta, \gamma \in R^+$

$\alpha + \beta + \gamma = 9,\ \alpha\beta\gamma = 27$

A.M. of $\alpha, \beta, \gamma = \frac{\alpha + \beta + \gamma}{3} = 3$

G.M. of $\alpha, \beta, \gamma = (\alpha\beta\gamma)^{1/3} = (27)^{1/3} = 3$

$\because$ A.M. $=$ G.M. $\Rightarrow \alpha = \beta = \gamma$

$\therefore 3\alpha = 9 \Rightarrow \alpha = 3 = \beta = \gamma$

$p = \alpha\beta + \beta\gamma + \gamma\alpha = 27$

(i) $p + q + r = 27 + 0 + 0 = 27$

(ii) $\alpha - 1 = 2,\ \beta + 3 = 6,\ \gamma + 7 = 10$

$\therefore S_n = 2 + 6 + 10 + \ldots + \text{to n terms} = 2(1 + 3 + 5 + \ldots \text{to n terms}) = 2n^2$

Now, $\sum_{n=2}^{\infty} \frac{1}{\sqrt{S_n . S_{n-1}}} = \sum_{n=2}^{\infty} \frac{1}{\sqrt{2n^2 . 2(n-1)^2}} = \frac{1}{2} . \sum_{n=2}^{\infty} \frac{1}{n(n-1)}$

$= \frac{1}{2} \sum_{n=2}^{\infty} \left(\frac{1}{n-1} - \frac{1}{n} \right)$

$= \frac{1}{2} \left(\frac{1}{1} - \frac{1}{2} + \frac{1}{2} - \frac{1}{3} + \ldots \infty \right) = \frac{1}{2}$