FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

FULL TEST – IX

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- 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

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
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 black pen for each character of your Enrolment No. and write 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 All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

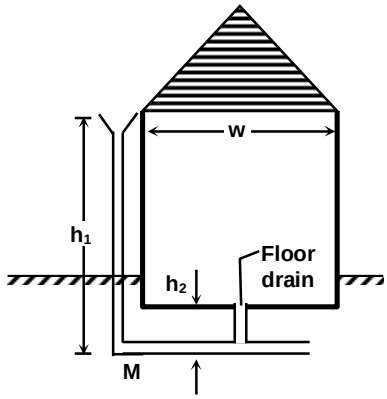
PART – I

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. A very simplified schematic of the rain drainage system for a home is shown in figure. Rain falling on the slanted roof runs off into gutters around the roof edge; it then drains through downspouts (only one is shown) into a main drainage pipe M below the basement, which carries the water to an even larger pipe below the street. In figure, a floor drain in the basement is also connected to drainage pipe M. Suppose the following apply:



(1) the downspouts have some height but water trickles slowly and many such spouts connect to the drainage pipe M,
(2) the floor drain has height $h_2 = 1.2$ m,
(3) pipe M has radius 3 cm,
(4) the house has side width w = 25 m and front length L = 80 m,
(5) all the water striking every part of the roof goes through pipe M,
(6) the speed of the water in a downspout is negligible, and
(7) the wind speed is negligible (the rain falls vertically). The possible rainfall rate, in centimeters per hour, when water from pipe M crosses the height of the floor drain and threatens to flood the basement, is

Note: For calculations, you may assume $\pi \approx \frac{22}{7}$ and $\sqrt{6} \approx \frac{4.9}{2}$

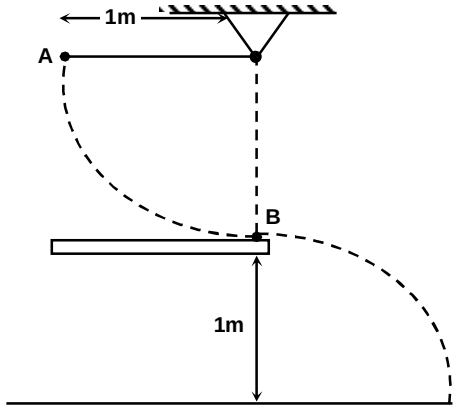
(A) 8 (B) 11
(C) 14 (D) 17

Space for rough work

2. Mark out the correct statement(s)
   (A) In alpha decay, the energy released is shared between alpha particle and daughter nucleus in the form of kinetic energy and share of alpha particle is more than that of the daughter nucleus.
   (B) In beta decay, the energy released is shared between electron and antineutrino.
   (C) A nuclide undergoes α decay then all the α particles emitted by that nuclide will have almost the same speed.
   (D) A nuclide undergoes β decay then all the β particles emitted by that nuclide may have widely different speeds.

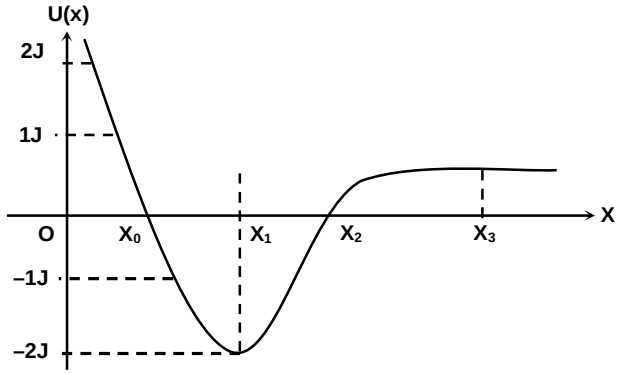
3. A bead is connected with a fixed disc of radius R by an inextensible massless string of length $\ell = \frac{\pi R}{2}$ in a smooth horizontal plane. If the bead is pushed with a velocity v_0 perpendicular to the string, the bead moves in a horizontal curve, and consequently collapses on the disc after a time t. Then
   (A) work done by the string on the bead is mv_0^2.
   (B) The average speed of the bead is v_0 and its average velocity for time t is $\frac{4v_0}{\pi}$
   (C) Tension in the string will increase continuously.
   (D) Kinetic energy of the bead increases gradually.

4. A small steel ball B is at rest on the edge of a plank at a height of 1m above the ground. Another steel ball A, used as the bob of a meter long simple pendulum, is released from rest with the pendulum horizontal, and swings against B as shown. The masses of the balls are identical and the collision is elastic.
   Consider the motion of B only until it first hits the ground.
   (A) Ball A is in motion for the longer time
   (B) Ball B is in motion for the longer time
   (C) Ball A has the greater path length
   (D) Ball B has the greater path length



Space for rough work

5. A conservative force has the potential energy function U(x) as shown. A particle moving in one dimension under the influence of this force has kinetic energy 1.0 J when it is at position X_1. Which of the following is/are correct statement(s) about the motion of the particle?



(A) It oscillates.
(B) It moves to the right of X_3 and never returns.
(C) It comes to rest at either X_0 or X_2.
(D) It cannot reach either X_0 or X_2.

6. Three charged particles are in equilibrium under their electrostatic forces only.
(A) The particle must be collinear.
(B) All the charges cannot have the same magnitude.
(C) All the charges cannot have the same sign.
(D) The equilibrium is unstable.

7. A straight segment OP of length L of a circuit carrying current I ampere is placed along x-axis. Two infinitely long straight wires A and B each extending from z = $-\infty$ to $+\infty$ are fixed at y = $-\ell$ meter to y = $+\ell$ meter respectively. Wires A and B, each carry current I ampere. Given that O is origin of the coordinate system. Possible values of magnitude of force on segment OP is/are:

(A) $\frac{\mu_0}{\pi} I^2 \ell n\left(1+\frac{L^2}{\ell^2}\right)$ (B) $\frac{\mu_0}{2\pi} I^2 \ell n\left(1+\frac{L^2}{\ell^2}\right)$

(C) $\frac{\mu_0}{\pi} I^2 \ell n\left(1+\frac{\ell^2}{L^2}\right)$ (D) zero

Space for rough work

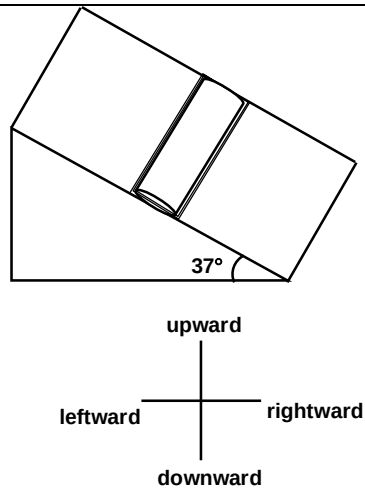
Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Figure shows a solid wooden cylinder of mass m = 0.250 kg and length L = 0.100 m with N = 10 turns of wire wrapped around it longitudinally, so that the plane of wire coil contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle θ to the horizontal, with the plane of the coil parallel to the inclined plane. A magnetic field B of different magnitudes and directions as per column-1 is applied in the region. The value of current through the coil is I and such that the direction of field in all cases produced by coil makes an acute angle with vertically upward direction. There is enough friction to ensure that the cylinder rolls without slipping. (take g = 10 m/s^2)

Answer the questions given below on the basis of given matrix.



Column - 1 B		Column - 2 I		Column - 3 Acceleration of CM of cylinder	
(I)	0 T	(i)	0 Amp	(P)	0 m/s^2
(II)	0.5 T upward	(ii)	1 Amp	(Q)	$\frac{2g}{15}$ m / s^2
(III)	0.5 T downward	(iii)	15/8 Amp	(R)	$\frac{4g}{5}$ m / s^2
(IV)	0.5 T leftward	(iv)	5/2 Amp	(S)	$\frac{5.6g}{3}$ m / s^2

8. In which case among the following cases will the cylinder remain stationary
(A) (II) (iii) (P) (B) (III) (ii) (P)
(C) (II) (iv) (P) (D) (III) (iv) (P)

9. In which case will the induced emf rise at the maximum rate initially?
(A) (III) (iv) (R) (B) (III) (iii) (S)
(C) (III) (iv) (S) (D) (II) (iv) (Q)

10. Among the given situations, when will the friction be a maximum?
(A) (IV) (iii) (P) (B) (III)(iv) (S)
(C) (II) (iii) (S) (D) (IV) (iv) (Q)

Space for rough work

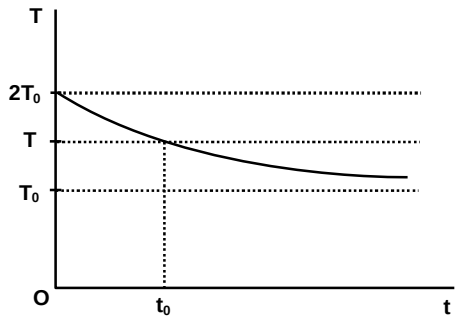
Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Column - 1		Column - 2		Column - 3	
(I)	Wien's displacement law	(i)	$\lambda_m T = b$	(P)	0.5
(II)	Stefan's law	(ii)	$E = e\sigma T^4$, E is emissive power	(Q	0.25
(III)	Kirchhoff's Law	(iii)	e = a, a is absorptivity	(R)	0.7
(IV)	Newton's law of cooling	(iv)	$-\frac{dT}{dt} = k(T - T_s)$	(S)	0.4

11. An object reflects a fraction of energy incident on it. The reflectivity of the object is 0.3. Which is the most suitable combination for the emissivity of that object?
(A) (II) (iii) (Q) (B) (I) (iv) (S)
(C) (III) (ii) (P) (D) (III) (iii) (R)

12. The filament of an incandescent bulb has length ℓ and radius of cross section r. It radiates a power $P = \frac{\pi\sigma e r \ell}{8}$, where σ and e are stefan's constant and emissivity. Which of the following is the most suitable combination for the temperature of the filament?
(A) (II) (ii) (P) (B) (IV)(iii) (R)
(C) (I) (iv) (Q) (D) (II) (ii) (S)

13. The temperature of a body in the surrounding of temperature T_0 versus time graph is shown. If $T = T_0[1 + 4xe^{-kt}]$, then the most appropriate combination for the value of x is
(A) (II) (iii) (S)
(B) (III)(i) (P)
(C) (IV) (iv) (Q)
(D) (IV) (iv) (R)



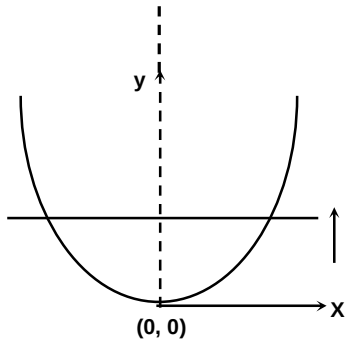
Space for rough work

SECTION – C

(One Integer Value Correct Type)

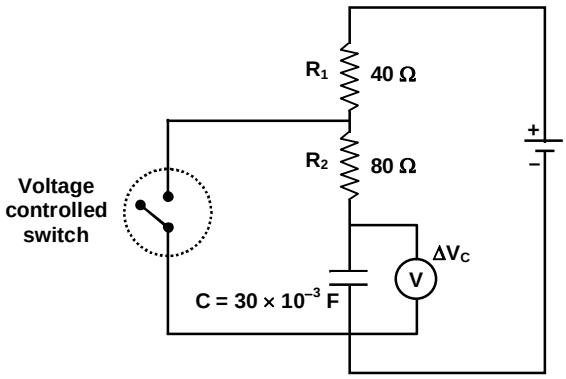
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

14. A uniform metallic wire is bent in the form of a parabola and is placed on a horizontal non-conducting floor. A vertical uniform magnetic induction B = 0.5 T exists in the region containing the parabolic wire. A straight conducting rod as shown in figure starts from rest at the vertex of the parabola at time t = 0, slides along the parabolic wire with its length perpendicular to the axis of symmetry of the parabola with a constant speed v = 2 m/s. Equation of parabolic wire is $y = x^2$ and consider that rod always touches wire. Induced emf in the rod at t = 2 will be (measured in volt).



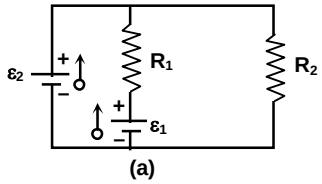
15. A horizontal oriented copper rod of length $\ell = \frac{2\sqrt{2}}{3\pi}$m is rotated about a vertical axis passing through its middle. Breaking strength of copper is $\sigma = 2.5\times10^8$ Pa and density of copper $\rho = 9\times10^3$ Kg / m^3. Rotation frequency measured in $\left(\sec^{-1}\right)$ at which the rod ruptures; is given by 50n, n is equal to

16. The switch shown in figure closes when $\Delta V_C > \frac{2V}{3}$ and opens when $\Delta V_C < \frac{V}{3}$. The ideal voltmeter reads a voltage as plotted in graph.
Given that
$R_1 = 40\Omega; R_2 = 80\Omega$ and $C = 30\times10^{-3}$F
Period of waveform is given by T = xℓn2. x is equal to

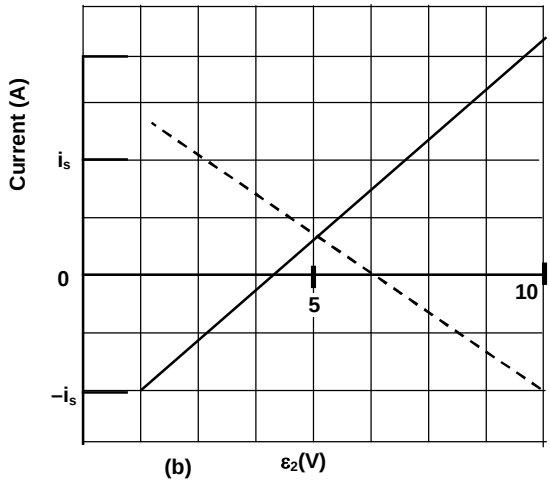


Space for rough work

17. Both batteries in figure (a) are ideal. Emf E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1 V and 10 V. The plots in figure (b) give the currents through the two batteries as a function of E_2. The vertical scale is set by i_s = 0.20 A. You must decide which plot corresponds to which battery, but for both plots, a negative current occurs when the direction of the current through the battery is opposite the direction of that battery's emf. Find E_1 in volts to the nearest integer.

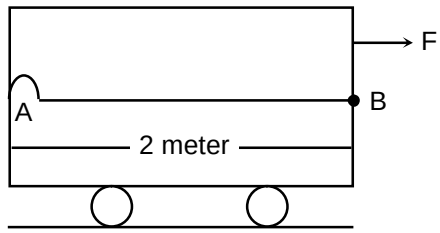


(a)



(b)

18. A string of mass m = 50 gm is tied at the point B; in a smooth trolley car which is acted upon by a horizontal force F = 20 N. At t = 0 let the car start from rest and a transverse pulse is generated at the free end, neglecting the effect of gravity at A. Mass of the trolley and length of the string are M = 9.950 Kg and $\ell = 2$ meter. Acceleration of the pulse with respect to ground is (in m/s^2)



Space for rough work

Chemistry PART – II

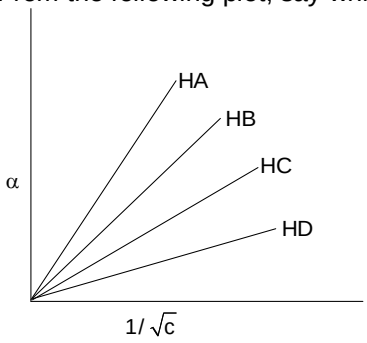
SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

19. What is the number of angular nodes in the second excited state of a hydride ion?
(A) 2 (B) 3
(C) 0 (D) 1

20. From the following plot, say which is the strongest electrolyte?



(A) HA (B) HB
(C) HC (D) HD

21. Which of the following structure is most stable?

(A) $H_2B - CH = CH - NH_2$ (B) $H_2B - CH - \ddot{\bar{C}}H = \overset{+}{N}H_2$

(C) $H_2\bar{B} = CH - \overset{+}{C}H - NH_2$ (D) $H_2\bar{B} = CH - CH = \overset{+}{N}H_2$

22. Which of the following statement is/are incorrect?
(A) For solid and liquid $\left(\frac{\delta H}{\delta T}\right)_P > \left(\frac{\delta U}{\delta T}\right)_V$.
(B) The gas following the equation $P(V - b) = RT$ can not be liquefied.
(C) The total energy of the ideal gas molecule is the kinetic energy.
(D) Below critical temperature, $z > 1$.

Space for rough work

23. Which of the following statement is/are wrong?
(A) Boron atom in borazine is sp^2 hybridised.
(B) Silicon does not form effective $p\pi$ - $p\pi$ bond with oxygen.
(C) In borax, boron atom is sp^2 hybridised only.
(D) Borax bead test is performed to identity transition metal cation.

24. Which of the following species are paramagnetic?
(A) KO_2 (B) NO
(C) Singlet carbene (D) O_2

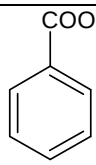
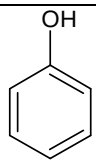
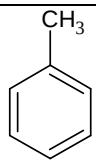
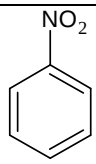
25. Which of the following statement(s) are correct?
(A) $CH_3CHO \xrightarrow[I_2]{OH^-} CHI_3 + HCOO^-$
Total four molecules of OH^- is consumed by one molecule of CH_3CHO.
(B) 1, 3, 5 trihydroxy phenol performs haloform reaction
(C) Rate of haloform reaction follows the given order : $Cl_2 > Br_2 > I_2$
(D) F_2 does not participate in haloform reaction.

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

Column - 1		Column - 2		Column - 3	
(I)		(i)	Strongly activated	(P)	Bromination in aqueous medium gives tribromo derivative
(II)		(ii)	Weakly activated	(Q)	Bromination gives para product (major)
(III)		(iii)	Weakly deactivated	(R)	Can be formed by oxidation of toluene
(IV)		(iv)	Strongly deactivated	(S)	Nitration with mixed acid gives the mixture of ortho and para product

26. Which of the following combination is CORRECT?
(A) (I) (i) (R) (B) (II)(i) (P)
(C) (III) (iii) (S) (D) (IV) (iv) (R)

27. Which of the following combination is CORRECT?
(A) (I) (iv) (R) (B) (II) (ii) (Q)
(C) (III) (iv) (P) (D) (IV) (iii) (R)

28. Which of the following combination is INCORRECT?
(A) (IV) (iv) (Q) (B) (III) (ii) (S)
(C) (III) (iv) (P) (D) None of the above

Space for rough work

Answer Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column - 1		Column - 2		Column - 3	
(I)	Molar kinetic energy	(i)	$\frac{a}{V^2}$	(P)	H_2 and He at room temperature
(II)	$\left(\frac{\delta U}{\delta V}\right)_T$	(ii)	Force of attraction is predominant	(Q)	Potential energy is negative
(III)	$Z < 1$	(iii)	Force of repulsion is predominant	(R)	Does not depend on the nature of gas at constant temperature
(IV)	$Z > 1$	(iv)	$\frac{3}{2}RT$	(S)	Potential energy is positive

29. Which of the following combination is CORRECT?
(A) (I) (i) (P) (B) (II)(i) (R)
(C) (III) (ii) (Q) (D) (II) (iv) (S)

30. Which of the following combination is CORRECT?
(A) (II) (iii) (R) (B) (III) (i) (P)
(C) (I) (iv) (R) (D) (IV) (iv) (R)

31. Which of the following combination is INCORRECT?
(A) (IV) (iii) (P) (B) (I) (iv) (R)
(C) (I) (i) (R) (D) (III) (ii) (Q)

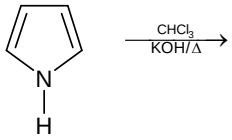
Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

32. What is the degree of unsaturation of the product formed?

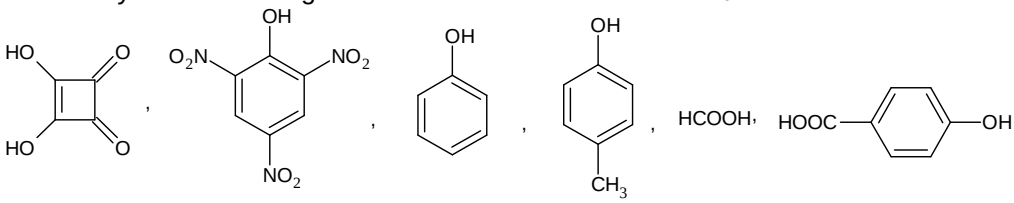


33. $XeF_6 \xrightarrow[\text{hydrolysis}]{\text{Partial}} A$

$XeF_6 \xrightarrow[\text{hydrolysis}]{\text{Complete}} B$

The sum of lone pairs on the central atoms in compound A and B are

34. How many of the following can react with NaOH and $NaHCO_3$ both?



35. What is the pH of the solution if 6 gm NaOH is added to a mixture of 500 ml 0.2 M CH_3COOH and 500 ml 0.2 M HCl. (Given pK_a of CH_3COOH = 5)

36. When 1 mole of glucose is treated with HIO_4, how many moles of HIO_4 is consumed?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

37. Let $f(x) = \dfrac{x^2 - 6x + 5}{x^2 - 5x + 6}$ then which of the following statement is true for 'f'

(A) f : $(-\infty, 2) \to \left(-\infty, 8 - 4\sqrt{3}\right)$ f is one-one onto

(B) f : $(2, 3) \to (12, \infty)$ f is many one into

(C) f : $(-\infty, 2) \to \left(-\infty, 8 - 4\sqrt{3}\right)$ f is many one onto

(D) f : $(3, \infty) \to (-\infty, 1]$ f is one-one onto

38. Let f: $R \to R$, g: $R \to R$ be two continuous function satisfying equation $f(x) + f(x + 1) = x + \{x\}$; $g(x) + g(2 - x) = 2$, then

(A) $\int_{-1}^{1} f(x+1)dx = 2$ (B) $\int_{-1}^{1} f(x+1)dx = 1$

(C) $\int_{1/2}^{3/2} g(g(x))dx = 2$ (D) $\int_{1/2}^{3/2} g(g(x))dx = 1$

39. Let g be a continuous and differentiable function defined as g: $[0, 1] \to R$; $g(x) = 4x(1 - x)$, and if the number of the solution of $g(g(x)) = 0$ is n_1 and the number of solution of $g(g(x)) = \dfrac{x}{2}$ is n_2, then

(A) $n_1 + n_2 = 6$ (B) $n_1 + n_2 = 7$

(C) $n_1 \times n_2 = 6$ (D) $n_1 \times n_2 = 12$

Space for rough work

40. A line $3x + y = 8$ touches a hyperbola $H = 0$ at P(1, 5) meets its asymptotes at A and B. If $AB = 2\sqrt{10}$, C(1, 1) be the centre of hyperbola, e and ℓ are eccentricity and latus rectum of hyperbola then

(A) $e = \frac{\sqrt{7}}{2}$ (B) $e = \frac{\sqrt{5}}{2}$

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

41. Let m and n be the number of red and black balls in an urn. A ball is drawn at random and is put back into the urn along with 5 additional balls of the same colour as that of the ball drawn. A ball is again drawn at random. If probability that the ball drawn is red is $\frac{1}{5}$ then correct options with possible values of m + n can be

(A) 10 (B) 12

(C) 15 (D) 18

42. Two tangents $2x + y = 2$ and $x - 2y = 3$ to a parabola touching it at A(2, –2) and B(5, 1) respectively. If focus of parabola is $S(\alpha, \beta)$ and latus rectum length is L then

(A) $\alpha - \beta = 3$ (B) $\alpha - \beta = 4$

(C) $L = \frac{27\sqrt{3}}{25}$ (D) $L = \frac{27\sqrt{2}}{25}$

43. The projection of line $3x - y + 2z - 1 = 0 = x + 2y - z - 2$ on the plane $3x + 2y + z = 0$ is/are

(A) $\frac{x+1}{11} = \frac{y-1}{-9} = \frac{z-1}{-15}$ (B) $\frac{x+12}{11} = \frac{y+8}{-9} = \frac{z+14}{15}$

(C) $3x - 8y + 7z + 4 = 0 = 3x + 2y + z$ (D) $3x - 8y + 7z + 4 = 0 = 3x + 2y + 2z$

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer Q.44, Q.45 and Q.46 by appropriately matching the information given in the three columns of the following table.

Column-1: locus of centre C of moving circle S
Column-2: locus of complex number Z
Column-3: required locus, match the following Column(s)
(**Note:** Here correct combination means if Column-1 is circle then Column-2 is also circle and Column-3 is also circle)

Column - 1	Column - 2	Column - 3
(I) If S touches always a line $x = 4$ and circle $(x-1)^2 + (y-2)^2 = 1$	(i) $\|z\| = \|z - 3 - 4i\|$	(P) ellipse
(II) If S touches both circles $(x-1)^2 + (y-2)^2 = 9$ and $(x-1)^2 + (y-1)^2 = 1$	(ii) $\|\|z\| - \|z - 4 - 5i\|\| = 3$	(Q) hyperbola
(III) If S touches both circles $x^2 + y^2 = 1$ and $(x-4)^2 + (y-5)^2 = 4$	(iii) $\|z - 1 - i\| + \|z - 1 - 2i\| = 4$	(R) parabola
(IV) If S touches both circles $x^2 + y^2 = 1$ and $(x-3)^2 + (y-4)^2 = 1$	(iv) $\|z - 1 - 2i\| = \|\text{Re}(z - 4) + 1\|$	(S) line

44. Which of the following is **CORRECT** combination?
(A) (I) (i) (P) (B) (I) (iv) (P)
(C) (I) (iv) (R) (D) (I) (ii) (R)

45. Which of the following is **CORRECT** combination?
(A) (II) (ii) (R) (B) (II) (iii) (P)
(C) (II) (iv) (P) (D) (II) (i) (R)

46. Which of the following is **CORRECT** combination?
(A) (III) (iii) (Q) (B) (III) (ii) (P)
(C) (III) (ii) (Q) (D) (IV) (i) (R)

Space for rough work

Answer Q.47, Q.48 and Q.49 by appropriately matching the information given in the three columns of the following table.

Match the following Column(s)
(**Note:** Correct combination means a correct option of each of Column-1, Column-2 and Column-3)

Column - 1	Column - 2	Column - 3
(I) If $\left[\vec{a}\ \vec{b}\ \vec{c}\right] = 2$ then $\left[\vec{a}+2\vec{b}-\vec{c}\quad \vec{a}-\vec{b}\quad \vec{a}-\vec{b}-\vec{c}\right] = 6$	(i) the number of solution of $3xe^x + 1 = 0$ is equal to 2	(P) If $f(x) = x\cos\frac{1}{x}$ then $\lim_{x\to\infty} f'(x) = 0$
(II) $\int_0^1 \frac{\tan^{-1}x}{\cot^{-1}\left(1-x+x^2\right)}dx = \frac{1}{2}$	(ii) the number of solution of $2\cos x - \lvert\sin x\rvert = 0$ in $[0, 4\pi]$ is 2	(Q) if $f(x) = x\cos\frac{1}{x}$ then $\lim_{x\to\infty} f'(x) = 1$
(III) Range of $f(x) = \sqrt{x^2+5x+8} - \sqrt{x^2-3x+4}$ is $[-4, 4]$, $x \in R$	(iii) the number of solution of $\sin \pi x = \lvert\ln\lvert x\rvert\rvert$ is 6	(R) if $\lim_{x\to0} \frac{x(1+a\cos x)-b\sin x}{\sin^3 x} = 1$ then $\lvert a-b\rvert = 1$
(IV) $\max\{x^2, 1-x^2\} + \min\{x^2, 1-x^2\} = 1$	(iv) the number of solution of $2^{\cos x} = \lvert\sin x\rvert$ in $[0, 2\pi]$ is 2	(S) if $L = \lim_{x\to0} \frac{\sin 2x + a\sin x}{x^3}$ is finite then $\frac{a}{L} = 3$

47. Which of the following option is the only **CORRECT** combination?
(A) (I) (ii) (Q) (B) (I) (ii) (P)
(C) (I) (i) (Q) (D) (I) (i) (S)

48. Which of the following option is the only **CORRECT** combination?
(A) (II) (iv) (Q) (B) (II) (iii) (S)
(C) (II) (iii) (R) (D) (III) (i) (P)

49. Which of the following option is the only **INCORRECT** combination?
(A) (I) (iii) (R) (B) (II) (i) (Q)
(C) (III) (iii) (P) (D) (IV) (i) (R)

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

50. If $\sum_{k=1}^{2017}\left(k^2+1\right)\underline{|k} = \underline{|a} - b\cdot\underline{|c}$ where a, b, c $\in$ N then the least value of a + b – c is _____

51. The coefficient of x^4 in the expansion of $(1 + 2x + 3x^2 + 4x^3 + ... \infty)^2$ (where $|x| < 1$) is m then number of total divisors of m is _____

52. If z = x + iy is a complex number satisfying $\left(z+\bar{z}\right)^2 = 12 - 4|z|^2$ then maximum value of 2Re(z) + Im(z) is _____

53. The number of solution of $x^3 – x^2(1 + \sin x) + x(\sin x – \cos x) + \cos x = 0$ in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ is _____

54. Let P be a 2 × 2 matrix such that $P\begin{bmatrix}1\\-1\end{bmatrix} = \begin{bmatrix}-1\\2\end{bmatrix}$ and $P^2\begin{bmatrix}1\\-1\end{bmatrix} = \begin{bmatrix}1\\0\end{bmatrix}$. If x_1 and x_2 are two values of x for which det(P – xI) = 0 where I is an identity matrix of order 2 then value of $x_1^2 + x_2^2$ is equal to _____

Space for rough work

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FULL TEST – IX

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B, C, D**	19.	**D**	37.	**B, C**
2.	**A, B, C, D**	20.	**A**	38.	**B, D**
3.	**C**	21.	**D**	39.	**B, D**
4.	**A, D**	22.	**A, D**	40.	**B, C**
5.	**A, D**	23.	**B, C**	41.	**A, C**
6.	**A, B, C, D**	24.	**A, B, D**	42.	**B, D**
7.	**B, D**	25.	**A, B, D**	43.	**A, C**
8.	**C**	26.	**B**	44.	**C**
9.	**A**	27.	**A**	45.	**B**
10.	**D**	28.	**C**	46.	**C**
11.	**D**	29.	**C**	47.	**C**
12.	**A**	30.	**C**	48.	**C**
13.	**C**	31.	**C**	49.	**C**
14.	**4**	32.	**4**	50.	**3**
15.	**5**	33.	**2**	51.	**4**
16.	**6**	34.	**4**	52.	**3**
17.	**6**	35.	**5**	53.	**3**
18.	**3**	36.	**5**	54.	**5**

Physics

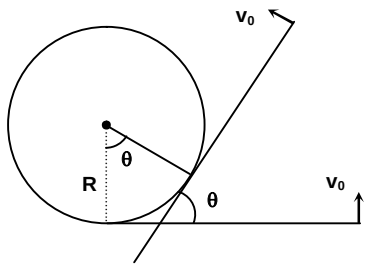
PART – I

SECTION – A

1. In order to flow up the floor drain, the KE of the fluid must be just sufficient to provide for the gravitational P.E. required:
$v_M^2 = 2gh_2$
The flow rate through M is :
$V = \left(\pi r_M^2\right) v_M;\ r_M = 3\,cm = 0.03\,m$
and this is the total discharge from the roof.
The rainfall rate is $\frac{V}{wL}$ (in m/s) and it can be converted to cm/h by multiplying by (100×3600).

2. All are based on true facts.

3. T and v are perpendicular so speed is constant.



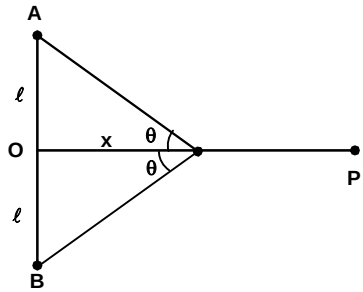
$\theta = \frac{\ell - x}{R}$
$\Rightarrow \frac{d\theta}{dt} = -\frac{dx}{Rdt}$
$\Rightarrow \frac{v_0}{x} = -\frac{dx}{Rdt}$
$\Rightarrow xdx = -Rv_0dt$
$\Rightarrow t = \frac{\ell^2}{2Rv_0}$
Now check the options.

4. Use horizontal & vertical velocity components for comparison.

5. Kinetic energy can never be negative.

6. Use of coulomb forces.

7. Net B at distance x from O along x-axis



$= \frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta$
$\Rightarrow \int dF = \int I\frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta dx$
$= \frac{\mu_0}{2\pi}I^2\ell n\left(1+\frac{L^2}{\ell^2}\right)$

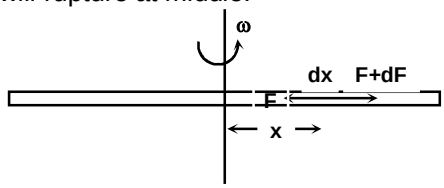
8-10. Along the incline plane net torque on the cylinder should be zero.
For emf $e = \frac{d\phi}{dt}$ and $\frac{de}{dt} = \frac{d}{dt}\left(\frac{d\phi}{dt}\right)$

11-13. In first column there are some laws and in second column associated formulae. By using these formulae solve the problems.

SECTION – C

14. at t = 2
$y = 2 \times 2 = 4$
so $y = x^2$
$\Rightarrow \; 4 = x^2$
$\Rightarrow \; x = 2$
$\Rightarrow$ emf $e = vB\ell$
$= 2 \times 0.5 \times 4 = 4$ Volt

15. Stress are zero at free ends and maximum at middle so rod will rupture at middle.
By Newton's second law



$F - (F + dF) = dmx\omega^2$
$-\int dF = \int \rho A\omega^2 \times dx$
Where ω is the speed of rotation

$$-[F]_0^F = \rho A\omega^2 \left[\frac{x^2}{z}\right]_{\ell/2}^{x}$$

$$+F = +\rho\frac{A\omega^2}{z}\left[\left(\frac{\ell}{2}\right)^2 - x^2\right]$$

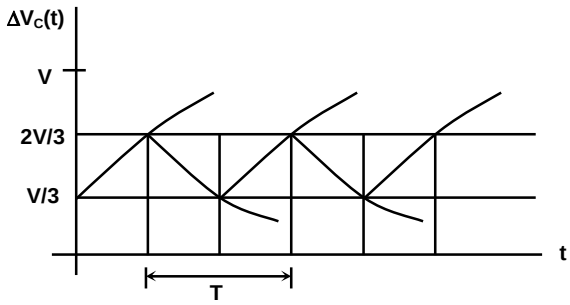
At $x = 0$ $F = \dfrac{\rho A\omega^2\ell^2}{8}$

$$\Rightarrow \quad \frac{F}{A} = \frac{\rho\omega^2\ell^2}{8}$$

For rupture $\dfrac{F}{A} = \sigma \;\Rightarrow\; \dfrac{\rho\omega^2\ell^2}{8} = \sigma$

$$\Rightarrow \quad n = \frac{1}{2\pi}\sqrt{\frac{8\sigma}{\rho\ell^2}}$$

16. Start with $\Delta V_C = \dfrac{2V}{3}$; By discharging formula



$$\Delta V_C(t) = \frac{2}{3}Ve^{-t_1/R_2C}$$

For $\Delta V_C(t) = \dfrac{V}{3}$ we get $t_1 = R_2C\ln 2$

After the switch opens voltage is $\dfrac{V}{3}$; increasing towards V with time constant $(R_1 + R_2)C$ so

$$\Delta V_C(t) = \Delta V - \frac{2}{3}\Delta V e^{-t_2/(R_1+R_2)C}$$

$$\Rightarrow \quad t_2 = (R_1 + R_2)C\ln 2$$

17. The current through E_2 is given by the solid line, while that through E_1 is given by the dotted line. We can choose points on the graph, apply KVL and KCL to the circuit and substitute these values to determine the unknowns. This gives $E_1 = 6\,V$.

18. Acceleration of system = $\frac{F}{M+m}$

Tension at distance x from A at t = t

$T = m'a = \frac{Fmx}{\ell(M+m)}$

$\Rightarrow$ Speed of pulse at x distance from A is

$v = \sqrt{\frac{Fmx}{\ell(M+m)}\frac{\ell}{m}} = \sqrt{\frac{Fx}{M+m}}$

$\Rightarrow \quad a = \frac{F}{2(M+m)}$

Chemistry PART – II

SECTION – A

19. Second excited state of H^- is 2p, which has one angular node.

20. $\alpha = \sqrt{\frac{K}{C}}$, greater be the value of K, stronger be the electrolyte.

21. Greater be the number of covalent bonds, greater be the stability.

22. For solid and liquid $C_P \approx C_V$.
Below critical point, gases may be liquefied through the application of pressure.
Thus, $z < 1$.

23. Si cannot form effective $p\pi$ - $p\pi$ bond with oxygen due to larger size of 3p orbital of Si. In borax, both sp^2 and sp^3 hybridised 'B' atoms are present.

24. Due to presence of unpaired electron.

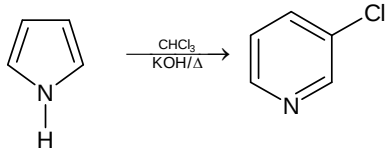
25. In the haloform reaction, extraction of proton is RDS. The reaction does not depend on nature and concentration of halogen.

26. - OH group of phenol is strongly activating and bromination in aqueous medium gives tribromo derivative.

27. - COOH is strongly deactivating and formed by oxidation of toluene.

28. $-CH_3$ is weakly activating.

SECTION – C

32. 

33. $XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF(\text{partial hydrolysis})$
$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF(\text{complete hydrolysis})$
Number of lone pair in $XeOF_4$ = 1
Number of lone pair in XeO_3 = 1
Total number of lone pairs = 2.

Mathematics PART – III

SECTION – A

37. $f(x) = 1 - \dfrac{x+1}{x^2 - 5x + 6}$

$f'(x) > 0 \Rightarrow x^2 + 2x - 11 > 0$

$x > 2\sqrt{3} - 1$ or $x < -2\sqrt{3} - 1$

$f \uparrow$ in $\left(-\infty, -2\sqrt{3} - 1\right) \cup \left(2\sqrt{3} - 1, 3\right) \cup (3, \infty)$

$f \downarrow$ in $\left(-2\sqrt{3} - 1, 2\right) \cup \left(2, 2\sqrt{3} - 1\right)$

$f\left(2\sqrt{3} - 1\right) = 8 + 4\sqrt{3}$

$f\left(-2\sqrt{3} - 1\right) = 8 - 4\sqrt{3}$

$\lim\limits_{x \to -\infty} f(x) = \lim\limits_{x \to \infty} f(x) = 1$

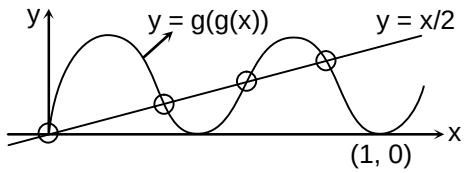
38. $\displaystyle\int_{-1}^{1} f(x+1)\,dx = \int_{-1}^{0} f(x+1)\,dx + \int_{0}^{1} f(x+1)\,dx = \int_{0}^{1} \left(f(x) + f(x+1)\right)dx = \int_{0}^{1} \left(x + \{x\}\right)dx = 1$

$\displaystyle I = \int_{1/2}^{3/2} g\left(g(x)\right)dx = \int_{1/2}^{3/2} g\left(g(2-x)\right)dx = \int_{1/2}^{3/2} g\left(2 - g(x)\right)dx = \int_{1/2}^{3/2} \left(2 - g\left(g(x)\right)\right)dx$

$\displaystyle I = \int_{1/2}^{3/2} dx = \frac{3}{2} - \frac{1}{2} = 1$

39. Now $g(x) = 0 \Rightarrow x = 0, 1$ also, $g\left(\dfrac{1}{2}\right) = 1$

So, $g(g(0)) = g(g(1)) = g\left(g\left(\dfrac{1}{2}\right)\right) = 0 \Rightarrow n_1 = 3$



Also, $g'(g(x))g'(x) = 0$

$\Rightarrow x = \dfrac{1}{2}$, $g(x) = \dfrac{1}{2} \Rightarrow x = \dfrac{1}{2} \pm \dfrac{1}{2\sqrt{2}}$

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

So, the number of solution is $4 \Rightarrow n_2 = 4$

40. By properties $PA = PB = \sqrt{10}$

$\dfrac{x-1}{-1/\sqrt{10}} = \dfrac{y-5}{3/\sqrt{10}} = \pm\sqrt{10}$

$\Rightarrow A \equiv (0, 8)$; $B \equiv (2, 2)$

Slopes of asymptotes are –7, and 1

If angle between asymptotes be θ then $\tan\theta = \left|\dfrac{-7-1}{1-7}\right| = \dfrac{4}{3}$

Now, $2\tan^{-1}\dfrac{b}{a} = \tan^{-1}\dfrac{4}{3} \Rightarrow \dfrac{\dfrac{2b}{a}}{1 - \dfrac{b^2}{a^2}} = \dfrac{4}{3}$

$\Rightarrow \frac{b}{a} = \frac{1}{2}$ ..... (1)

$\frac{b^2}{a^2} = e^2 - 1 \Rightarrow e = \frac{\sqrt{5}}{2}$

Also, area of $\Delta CAB = ab$

$ab = \left|\frac{1}{2}\left[1(8-2) + 0(2-1) + 2(1-8)\right]\right| = 4$ ..... (2)

$b^2 = 2$, $a = 2b = 2\sqrt{2}$ length of latus rectum $= \frac{2b^2}{a} = \frac{4}{2\sqrt{2}} = \sqrt{2}$

41. Required probability $= \frac{m}{m+n} \times \frac{m+5}{m+n+5} + \frac{n}{m+n} \times \frac{m}{m+n+5} = \frac{1}{5}$

$\frac{m(m+5)+mn}{(m+n)(m+n+5)} = \frac{1}{5}$

$4m^2 + 20m + 3mn = n^2 + 5n$

$m = 2 \Rightarrow n = 8$

$m = 3 \Rightarrow n = 12$

$m = 4 \Rightarrow n = 16$

42. As tangents are perpendicular to each other and its points of intersections $P\left(\frac{7}{5}, -\frac{4}{5}\right)$ lies on directrix. AB is focal chord

Equation of AB is $x - y = 4$, as focus is (α, β) so $\alpha - \beta = 4 \Rightarrow \beta = \alpha - 4$

Now $\angle ASP = 90^o$

$\Rightarrow \frac{-2-\alpha+4}{2-\alpha} \cdot \frac{-\frac{4}{5}-\alpha+4}{\frac{7}{5}-\alpha} = -1$

$\Rightarrow \frac{2-\alpha}{2-\alpha} \cdot \frac{\frac{16}{5}-\alpha}{\frac{7}{5}-\alpha} = -1$

$\Rightarrow \frac{16}{5} - \alpha = \alpha - \frac{7}{5}; \ \alpha = \frac{23}{10}$

$\Rightarrow$ Focus is $\left(\frac{23}{10}, -\frac{17}{10}\right)$

Also, $\ell_1 = AS = \frac{3\sqrt{2}}{10}$, $\ell_2 = BS = \frac{27\sqrt{2}}{10}$

$\frac{1}{a} = \frac{1}{\ell_1} + \frac{1}{\ell_2} \Rightarrow a = \frac{27\sqrt{2}}{100} \Rightarrow 4a = \frac{27\sqrt{2}}{25}$

43. Let plane containing line $3x - y + 2z - 1 = 0 = x + 2y - z - 2$ is

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

(1) must be perpendicular to $3x + 2y + z = 0$ ..... (2)

So that (1) and (2) will give required projected line

$(3 + \lambda)3 + (2\lambda - 1)2 + (2 - \lambda)1 = 0$

$9 + 3\lambda + 4\lambda - 2 + 2 - \lambda = 0$

$6\lambda + 9 = 0$

$\lambda = -\frac{3}{2}$

(1) becomes $3x - y + 2z - 1 - \frac{3}{2}(x + 2y - z - 2) = 0$

$6x - 2y + 4z - 2 - 3x - 6y + 3z + 6 = 0$

$3x - 8y + 7z + 4 = 0$

So, projected line $3x - 8y + 7z + 4 = 0 = 3x + 2y + z$

Also, its symmetrical form $\frac{x+1}{11} = \frac{y-1}{-9} = \frac{z-1}{-15}$

44. (I) Locus of centre of circle S is parabola

(iv) Put $z = x + iy$

$\sqrt{(x-1)^2 + (y-2)^2} = |x - 4 + 1|$

$x^2 - 2x + 1 + y^2 - 4y + 4 = x^2 - 6x + 9$

$\Rightarrow (y - 2)^2 = -4x + 8$ represents parabola

45. (II) S touches one circle externally and other circle internally so centre of S lies on ellipse. So locus is ellipse

(iii) $|z - 1 - i| + |z - 1 - 2i| = 4$

Represents ellipse whose foci are (1, 1), (1, 2) and major axis length $2a = 4$

46. (III) S touches given two isolated circle externally so locus of centre of S is hyperbola

(ii) $||z| - |z - 4 - 5i|| = 3$ represents hyperbola whose foci are (0, 0), (4, 5) and transverse axis length $(2a) = 3$

(IV) Represents line

(i) Represents line

47.-49. (I) $(\vec{a} + 2\vec{b} - \vec{c}) \cdot (\vec{a} - \vec{b}) \times (\vec{a} - \vec{b} - \vec{c}) = 3[\vec{a}\ \vec{b}\ \vec{c}] = 6$

(II) Let $I = \int_0^1 \frac{\tan^{-1} x}{\cot^{-1}(1 - x + x^2)} dx = \int_0^1 \frac{\tan^{-1} x}{\tan^{-1} x - \tan^{-1}(x-1)} dx = \int_0^1 \frac{\tan^{-1}(1-x)}{\tan^{-1}(1-x) + \tan^{-1} x} dx$

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

(III) Range of $f(x) = \sqrt{x^2 + 5x + 8} - \sqrt{x^2 - 3x + 4}$ is (–4, 4)

(IV) True

(ii) Number of solution of $2\cos x - |\sin x| = 0$ in $[0, 4\pi]$ is 4

(iv) Number of solution of $2^{\cos x} = |\sin x|$ is $[0, 2\pi]$ is 4

(P) is false

(Q) is true

(R) is true

(S) is false, correct answer $\frac{a}{L} = 2$

SECTION – C

50. $\sum_{k=1}^{2017} \left(k^2 + k - (k-1)\right) \underline{|k}$

$= \sum_{k=1}^{2017} \left(k\underline{|k+1} - (k-1)\underline{|k}\right)$

$= (1 \cdot \underline{|2} - 0) + (2\underline{|3} - 1 \cdot \underline{|2}) + (3\underline{|4} - 2\underline{|3}) + ...(2017\underline{|2018} - 2016\underline{|2017})$

$= 2017|\underline{2018} = |\underline{2019} - 2|\underline{2018}$

$a = 2019; b = 2; c = 2018$

$a + b - c = 3$

51. $(1 + 2x + 3x^2 + 4x^3 + ... \infty)^2$

$= \frac{1}{(1-x)^4} = (1-x)^{-4} = 1 + {}^4C_1x + {}^5C_2x^2 + {}^6C_3x^3 + {}^7C_4x^4 + ...$

Coefficient of $x^4 = {}^7C_4 = 35 = m$

Number of divisors of m is 4

52. $(2x)^2 = 12 - 4(x^2 + y^2)$

$8x^2 + 4y^2 = 12$

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

$x = \sqrt{\frac{3}{2}}\cos\theta ;\ y = \sqrt{3}\sin\theta$

$2Re(z) + Im(z) = 2x + y = \sqrt{6}\cos\theta + \sqrt{3}\sin\theta \le 3$

53. Given equation can be written as $(x - 1)(x^2 - x \sin x - \cos x) = 0$

Let $f(x) = x^2 - x \sin x - \cos x$

$f'(x) = x(2 - \cos x) = 0; x = 0$

$f(0) = -1$

$f\left(\frac{\pi}{2}\right) = \frac{\pi^2}{4} - \frac{\pi}{2} = \frac{\pi^2 - 2\pi}{4} > 0 ;\ f\left(-\frac{\pi}{2}\right) = \frac{\pi^2}{4} - \frac{\pi}{2} = \frac{\pi^2 - 2\pi}{4} > 0$

Total number of roots in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ is 3

54. Let $P = \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}$

Now $P\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$

$\Rightarrow \alpha_1 - \alpha_2 = -1$ ..... (1)

$\Rightarrow \beta_1 - \beta_2 = 2$ ..... (2)

Also, $P^2\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\Rightarrow P\left(P\begin{bmatrix} 1 \\ -1 \end{bmatrix}\right) = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \Rightarrow P\begin{bmatrix} -1 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\Rightarrow -\alpha_1 + 2\alpha_2 = 1$ ..... (3)

$\Rightarrow -\beta_1 + 2\beta_2 = 0$ ..... (4)

From equation (1), (2), (3) and (4)

$\alpha_1 = -1; \alpha_2 = 0; \beta_1 = 4; \beta_2 = 2$

Now $\det(P - xI) = 0$

$\Rightarrow \det\left(\begin{bmatrix} -1 & 0 \\ 4 & 2 \end{bmatrix} - x\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right) = 0 \Rightarrow \begin{vmatrix} -1-x & 0 \\ 4 & 2-x \end{vmatrix} = 0$

$\Rightarrow x = 2, -1$

$x_1^2 + x_2^2 = 4 + 1 = 5$