JEE ADVANCED - 2017

MODEL PAPER-II

Time: 2:00 P.M to 5:00 P.M **Max Marks: 237**

CHEMISTRY

SECTION – I(*Single Correct Choice Type)*

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. The reaction : $2NO + 2H_2 \longrightarrow N_2 + 2H_2O$ has been assigned to follow the following mechanism.

   I. $NO + NO \rightleftharpoons N_2O_2$ (fast)

   II. $N_2O_2 + H_2 \longrightarrow N_2O + H_2O$ (slow)

   III. $N_2O + H_2 \longrightarrow N_2 + H_2O$ (fast)

   The rate constant of step II is 1.2×10^{-4} $L\ mole^{-1}\ min^{-1}$ while equilibrium constant of step I is $1.4\times10^{-2}\ L\ mole^{-1}$

   What is the rate of reaction when concentration of NO and H_2 each is 0.5 mole L^{-1}

   (A) 2.1×10^{-7} mole L^{-1} min^{-1} (B) 3.2×10^{-6} mole L^{-1} min^{-1}

   (C) 3.5×10^{-4} mole L^{-1} min^{-1} (D) 6.4×10^{-6} mole L^{-1} min^{-1}

2. A stationary He^+ ion emitted a photon corresponding to the first line of the Lyman series. That photon liberated a photo electron from a stationary hydrogen atom in ground state. The velocity of photo electron is?

   A) 1.36×10^{9} cm sec^{-1} B) 6.18×10^{8} cm sec^{-1}

   C) 1.53×10^{8} cm sec^{-1} D) 3.09×10^{8} cm sec^{-1}

3. Which, amongst the following extraction processes, involves the principle of hydrometallurgy?

   A) $\underset{impure}{Ni} + 4CO \xrightarrow{330\,K} Ni(CO)_4 \xrightarrow{450\,K} \underset{Pure}{Ni} + 4CO$

   B) $4Au + 4NaCN + O_2 + 2H_2O \xrightarrow[-4\,KOH]{}$

   $4Na\left[\underset{soluble}{Au(CN)_2}\right] \xrightarrow{Zn} 2Na_2\left[Zn(CN)_4\right] + 4Au$

   C) $TiCl_4 + 2Mg \longrightarrow Ti + 2MgCl_2$

   D) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$

   $Cu_2S + 2Cu_2O \longrightarrow 6Cu + SO_2$

4. Xenon trioxide (XeO_3) forms xenate ion in alkaline medium.

$XeO_3 + NaOH \longrightarrow Na[HXeO_4]$

But the xenate ions slowly disproportionate in alkaline solution as

$Na[HXeO_4] + NaOH \longrightarrow Z + Xe + O_2 + H_2O$

The compound Z is expected to be

A) Na_2XeO_3 B) Na_2XeO_4 C) Na_4XeO_6 D) Na_4XeO_4

5. Consider the following species:

O_2, O_2^-, O_2^{2-}

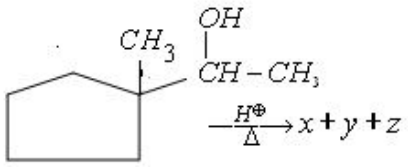
Which of the following statements is incorrect about these species?

A) KO_2 and K_2O_2 are diamagnetic while O_2 is paramagnetic

B) KO_2 and O_2 are paramagnetic while K_2O_2 is diamagnetic

C) Bond-length increases in the order : $O_2 < O_2^- < O_2^{2-}$

D) Bond enthalpy increases in the order : $O_2^{2-} < O_2^- < O_2$

6. 

x is the Hoffmann product, y is the 1, 2 – shift product and z is the ring expansion product.The stability of these three alkenes follows.

A) $x > y > z$ B) $x < y < z$ C) $z > x > y$ D) $z < x < y$

SECTION – II (*Integer Type)*

This section contains a group of 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The correct digit below the question no. in the ORS is to be bubbled.

7. The equilibrium constant for the following reaction is

$In^{2+} + Cu^{2+} \longrightarrow In^{3+} + Cu^{+}$ $(at\ 298K)$

$\left[Given\ E^0_{Cu^{2+}/Cu^+} = +0.15V\ ;\ E^0_{In^{3+}/In^+} = -0.42V\ ;\ E^0_{In^{2+}/In^+} = -0.40V\right] 10^{2x}$.

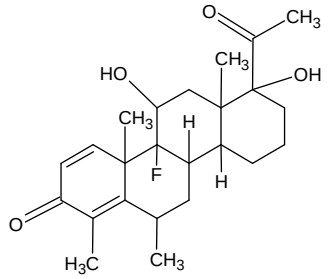
The value of $'x'$ is _____.

8. 200ml of 2M $FeSO_4$ is treated with 40ml. 1M $K_2Cr_2O_7$ in the presence of H_2SO_4. Then 1M $KMnO_4$ is added to oxidize remaining $FeSO_4$. The volume of $KMnO_4$ required is $(4\times y)$ ml. The value of $'y'$ is _____

9. Solubility $Pb(OH)_2$ in water is 298K is $6.7\times10^{-6}\ M$. Solubility of $Pb(OH)_2$ in a buffer of $pH = x$ at 298K is $1.2\times10^{-3}M$. What is $'x'$.

10. The degree of hardness of a sample of hard water is 500ppm. The hardness is due to only calcium chloride. The minimum concentration (in moles/lit) of sodium sulphate which must be added for removing the Ca^{2+} ions from this water sample is $\left(y \times 1.2 \times 10^{-3}\right)$. The value of 'y' is $[K_{sp}\ of\ CaSO_4 = 2.4 \times 10^{-5}]$

11. How many stereogenic centres does the following molecule contain?



SECTION – III (*Paragraph Type)*

This section contains 2 paragraphs. Based upon each of the paragraph 3 multiple choice questions have to be answered. Each of these questions has four choice (A), (B), (C) and (D), out of which ONLY ONE is correct.

Paragraph for Questions Nos. 12 to 14

Chlorine forms number of oxides such as Cl_2O, ClO_2, Cl_2O_6 and Cl_2O_7. Chlorine and oxygen do not combine directly with each other. So, these oxides are prepared by indirect methods.

For example, Cl_2O is prepared by passing Cl_2 through freshly prepared yellow HgO.

$HgO + Cl_2 \longrightarrow Cl_2O + Hg$

Some of these oxides undergo disproportionation rather easily.

For example.

$Cl_2O_6 + 2KOH \longrightarrow KClO_3 + KClO_4 + H_2O$

The oxides of chlorine are ocidic in nature. Cl_2O_7 is the anhydride of perchloric acid

$Cl_2O_7 + H_2O \longrightarrow 2HClO_4$.

12. Euchlorine is a mixture prepared by heating $KClO_3$ with concentrated HCl. Euchlorine is a mixture of

A) Cl_2 and Cl_2O_7 B) Cl_2O and ClO_2

C) Cl_2 and ClO_2 D) Cl_2O_5 and Cl_2

13. In the given chemical reaction,$AgClO_3 + [P] \longrightarrow [Q] + [R] + [S]$. What are [P], [Q], [R] and [S] if gas [P] can be prepared by dissolving red lead (Pb_3O_4) in hydrochloric acid?

A) Cl_2, AgCl, ClO_2, O_2 B) H_2, AgCl, H_2O, O_2

C) Cl_2, Ag, Cl_2O_6, O_2 D) HClO, AgCl, Cl_2O, O_2

14. Which of the given statements is incorrect?

A) ClO_3 exists in equilibrium with Cl_2O_6. The dimer is diamagnetic, while the monomer is paramagnetic.

B) Cl_2O is an angular molecule

C) Cl_2O_6 is mixed anhydride of chloric acid and perchloric acid.

D) ClO_2 reacts with KOH to give a mixture of Cl_2 and $KClO_2$

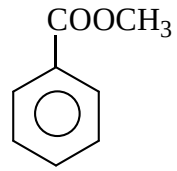
Paragraph for Questions Nos. 15 to 17

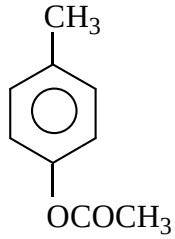
The isomeric compounds 'A' and 'B' with molecular formula C_7H_9N gave the following reactions. When B is acetylated and then brominated, it gave one monobromo derivative. 'A' when treated with $NaNO_2$ and HCl gave the compound 'C'. 'C' was heated with acetic acid in the presence of conc. H_2SO_4, a pleasant smelling liquid (D) was obtained. 'B' was treated with $NaNO_2$ and HCl in cold condition and treated with β - Naphthol in NaOH to give an orange red dye.

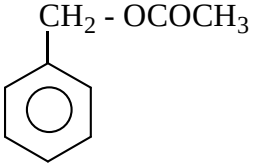
15. ' B ' is

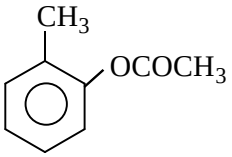
A) benzylamine B) p – toluidine C) o – toluidine D) m - toluidine

16. 'D' is

A) 

B) 

C) 

D) 

17. 'A' is

A) o – toluidine B) N – methylaniline

C) p – toluidine D) benzylamine

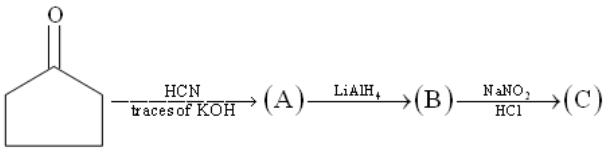
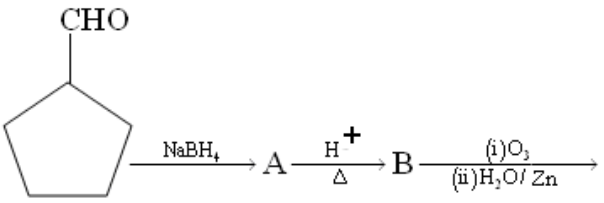
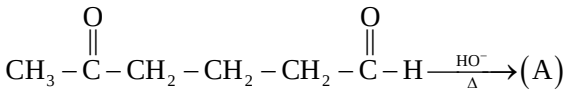
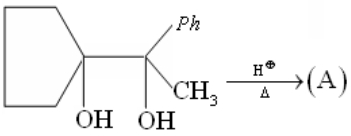
SECTION – IV
(*Matrix Type*)

This section contains 2 questions. Each question has four statements (A, B, C and D) given in Columns I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with one or more statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for that particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

18. Match the Column-I with Column-II

Column-I	Column-II
A) $[Fe(CN)_6]^{4-}$	p) Paramagnetic
B) $[FeF_6]^{3-}$	q) Diamagnetic
C) $[Co(NH_3)_6]^{3+}$	r) Inner orbital complex
D) $[Ni(CN)_4]^{2-}$	s) Outer orbital complex
	t) Octahedral

19. Match the Column-I with Column-II

Column I	Column II
(A) 	(p) Formation of six member ring takes place finally.
(B) 	(q) Final product is Ketone
(C) 	(r) Final product formed Will give positive Tollen's test
(D) 	(s) Final product formed will react with 2,4-DNP. (2,4-Di-nitrophenyl hydrazine)

MATHEMATICS

SECTION – I(*Single Correct Choice Type)*

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

20. In a sequence of $(4n+1)$ terms the 1^{st} $(2n+1)$ terms are in A.P. whose common difference is 2 and the last $(2n+1)$ terms are in G.P. whose common ratio is $\frac{1}{2}$. If the middle terms of the A.P. and G.P. are equal, then Middle term of the sequence is

A) $\frac{n.2^{n+1}}{2^n-1}$ B) $\frac{n.2^{n+1}}{2^{2n}-1}$ C) $n2^n$ D) $(n+1)2^{n+1}$

21. Four identical oranges and six distinct apples (each a different variety) are distributed randomly into five distinct boxes. The probability that each box gets a total of two objects is

A) $\frac{813}{109375}$ (B) $\frac{162}{21875}$ C) $\frac{323}{43750}$ D) $\frac{151}{21875}$

22. A license plate consists of '8' digits out of '10' digits 0,1,2,3,----,9.It is called even if it Contains an even number of '0's.The number of even license plates is

A) $\frac{10^8-8^8}{2}$ B) 10^8-8^{10} C) $\frac{10^8+8^8}{2}$ D) $\frac{10^8+8^{10}}{2}$

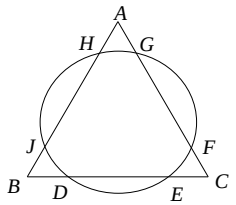
23. Let P be any point on the circle with OP as diameter (O being the origin) the points Q and R are on the same side of the diameter such that $\angle POQ = \angle QOR = \theta$, if P, Q and R be complex numbers z_1, z_2, z_3 respectively such that $2\sqrt{3}z_2^2 = \left(2+\sqrt{3}\right)z_1 z_3$, then the value of θ is

A) 15^0 B) 18^0 C) 30^0 D) 45^0

24. A tangent to the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ meets its director circle at P and Q. Then the product of the slopes of CP and CQ where 'C' is the origin is

A) $\frac{9}{4}$ B) $-\frac{4}{9}$ C) $\frac{2}{9}$ D) -1

25. In the given figure, the circle meets the sides of an equilateral triangle at six points. If $AG = 2,\ GF = 13,\ FC = 1$ and $HJ = 7$, then DE equals to



A) $2\sqrt{22}$ B) $7\sqrt{3}$ C) 9 D) 10

SECTION – II(*Integer Type)*

This section contains a group of 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The correct digit below the question no. in the ORS is to be bubbled.

26. Let $f(x)=\begin{cases}1+[x] & , x<-2\\ |x| & , x\geq -2\end{cases}$ where [ ] denotes the greatest integer function then $f\left(f(-2.5)\right)$ equals

27. Let $P = \lim\limits_{y\to 0}\frac{1}{y}\int_0^{\pi}\tan(y\sin x)dx$ and $Q = \lim\limits_{n\to\infty}\int_0^{n}\left(1-\frac{x}{n}\right)^n .e^{\frac{x}{3}}dx$ then $2(Q+P)$

28. Let 'X' be the set of three digit numbers, which when divided by 'sum of its digits' gives maximum value and 'Y' be the set of all possible real values of 'a' for which the equation $x^3+3ax^2+3(298a+299)x-2=0$ have a positive point of maxima, then the number of elements in '$X \cap Y$', is

29. Consider the equation $x+y-[x][y]=0$, where [.] denotes Greatest integer function. Number of the points of intersection between all the possible lines on which the non-integral solutions of the given equation lies, is

30. If $f(x)=a\cos(\pi x)+b,\ f'\left(\frac{1}{2}\right)=\pi$ and $\int_{1/2}^{3/2} f(x)dx=\frac{2}{\pi}+1$, then the value of 'b'is

SECTION – III (*Paragraph Type)*

This section contains 2 paragraphs. Based upon each of the paragraph 3 multiple choice questions have to be answered. Each of these questions has four choice (A), (B), (C) and (D), out of which ONLY ONE is correct.

Paragraph for Questions Nos. 31 to 33

If $z_1 = a + ib$ and $z_2 = c + id$ be two complex numbers such that $|z_1| = |z_2| = 1$ and $\text{Re}(z_1\overline{z_2}) = 0$.

31. If $a, b > 0$ and $c < 0$, then

A) $0 \le |z_1 - \overline{z_2}| \le 2$ B) $0 < |z_1 - \overline{z_2}| < \sqrt{2}$

C) $\sqrt{2} < |z_1 - \overline{z_2}| \le 2$ D) $\sqrt{2} < |z_1 - \overline{z_2}| < 2$

32. Let $k = |z_1 + z_2| + |a + ic|$, then the value of k is

A) $\sqrt{2} - 1$ B) 1 C) $\sqrt{2} + 1$ D) $2\sqrt{2}$

33. Let $W = a + ic$, then the locus of $\frac{W+1}{W-1}$ is (where $W \neq 1$)

A) circle with centre $(0,1)$ and radius 1 B) circle with centre $(0,-1)$ and radius 1

C) x-axis D) y-axis

Paragraph for Questions Nos. 34 to 36

A point P moves such that sum of the slopes of the normal's drawn from it to the hyperbola $xy = 16$ is equal to the sum of the ordinates of feet of normal. The locus of P is a curve C

34. The equation of the curve C is

A) $x^2 = 4y$ B) $x^2 = 16y$ C) $x^2 = 12y$ D) $y^2 = 8x$

35. If the tangent to the curve C cuts the co-ordinate axes at A and B, then the locus of the middle point of AB is

A) $x^2 = 4y$ B) $x^2 = 2y$

C) $x^2 + 2y = 0$ D) $x^2 + 4y = 0$

36. Area of the equilateral triangle, inscribed in the curve C, having one vertex as the vertex of the curve C is_____(in square units)

A) $778\sqrt{3}$ B) $776\sqrt{3}$

C) $762\sqrt{3}$ D) $768\sqrt{3}$

SECTION – IV(*Matrix Type)*

This section contains 2 questions. Each question has four statements (A, B, C and D) given in Columns I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with one or more statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for that particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

37. Let a,b,c and d be four real numbers satisfying the system of equations $a+b=8,\ ab+c+d=23,\ ad+bc=28$ and $cd=12$. Now match the following

Column –I	**Column – II**
A) $a+b+c+d$ equals	p) 15
B) $ab+cd$ equals	q) 16
C) $ac+bd$ equals	r) 27
D) ab equals	s) 28

38. Match the Following:

Column I	**Column II**
(A) If points of intersection of line $x + 3y + 1 = 0$ and circle $x^2 + y^2 - 2x + 4y + 1 = 0$ are A and B then tangents drawn at A and B to the circle intersect at P(H,K) then H - K=	(P) 2
(B) The length of the longest interval in which $f(x)=3\sin x-4\sin^3 x$ is increasing is $\frac{\pi}{k}$ *then* $k=$	(Q) 4
(C) An infinite G.P. is selected from $1,\frac{1}{2},\frac{1}{4},\frac{1}{8}\ldots$ to converge to $\frac{1}{7}$. If $\frac{1}{2^a}$ is the first term of such a G.P., then the value of 'a' is	(R) 3
(D) P(8,6) is a point on the circle $x^2+y^2=100$. Q,R are points on the circle such that $\lvert PQ\rvert=\lvert PR\rvert=4$ slope of the line QR is $-\frac{k}{3}$ then the value of 'k' is	(S) 0
	(T) 1

PHYSICS

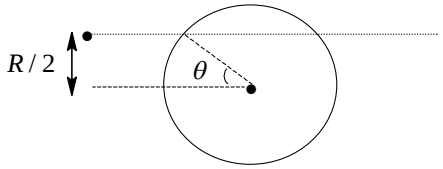
SECTION – I(*Single Correct Choice Type)*

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct**.**

39. When an ideal gas is heated at constant pressure, the fraction of heat energy supplied which increases the internal energy of the gas

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

40. A particle of mass m strikes elastically with a disc of mass m and radius R with a velocity V as shown in the figure. If the surface of contact is smooth, the speed of the disc just after collision is



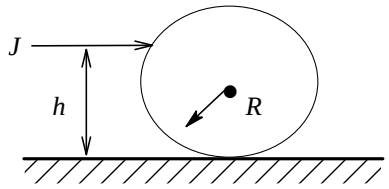
A) $\frac{2V}{\sqrt{3}}$ B) $\frac{\sqrt{3}V}{2}$ C) $\frac{V}{2}$ D) $2V$

41. A body falls from a large distance under the action of earths gravity in radial direction. Time taken by the body to cover its last height $h = R(= 6400\ km)$ distance before striking earth's surface is

A) $\frac{1}{2}\sqrt{\frac{2R}{g}\left(\sqrt{2}-1\right)}$ B) $\frac{1}{2}\sqrt{\frac{2R}{g}}\left(2\sqrt{2}-1\right)$

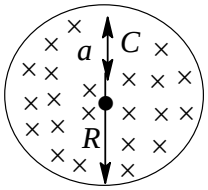
C) $\frac{1}{2}\sqrt{\frac{2R}{g}\frac{\sqrt{3}}{\left(\sqrt{2}-1\right)}}$ D) $\frac{1}{2}\sqrt{\frac{2R}{g}\left(\sqrt{3}-1\right)}$

42. A solid sphere of mass M and radius R is placed on a horizontal surface. It is struck by a horizontal Cue stick at a height h above the surface. The value of h, so that the sphere performs pure rolling motion immediately after it has been struck is



A) $\frac{2R}{5}$ B) $\frac{5R}{2}$ C) $\frac{7R}{5}$ D) $\frac{9R}{5}$

43. The given figure shows a cylindrical region of radius 'R' carrying uniform magnetic field B_0. A charged particle having charge q and mass m is placed at distance 'a' from the centre of this cylindrical region. Suddenly the magnetic field is switched off, then the impulse imparted to the particle is.



A) $\frac{qB_0a}{2}$ B) qB_0a C) qB_0pa^2 D) $\frac{qB_0\pi a^2}{2}$

44. A uniform square plate of mass $m=100g$ and side $a=24cm$ can rotate about a smooth vertical axis passing through one edge. It is initially at rest. A particle of mass $m=100g$ is moving horizontally and perpendicular to the plane of the plate with velocity $u=70cm/s$. It collides with the plate elastically at the centre of the plate. Find the angular velocity $(in\ rad/s)$ of the plate just after collision.

A) $\omega=\frac{12}{7}\frac{u}{a}$ B) $\omega=\frac{4}{7}\frac{u}{a}$ C) $\omega=\frac{3}{7}\frac{u}{a}$ D) $\omega=\frac{2}{7}\frac{u}{a}$

SECTION – II (*Integer Type)*

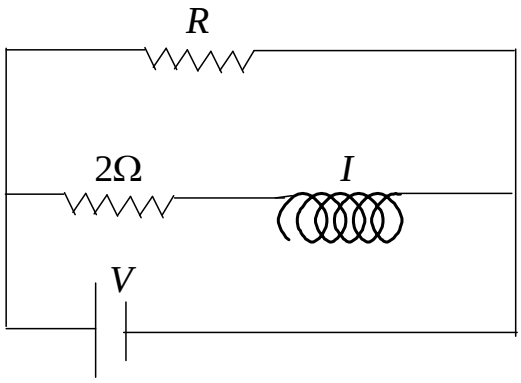
This section contains a group of 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The correct digit below the question no. in the ORS is to be bubbled.

45. In ground state, the ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom is

46. A point source S is placed at distance of 21 cm from a convex mirror of focal length 12 cm. What is the distance (in cm) of converging lens of focal length 10cm from mirror, placed between the source and the mirror to get the final image on the source itself ?

47. Parallel plate capacitor A of capacitance C is charged to a potential difference V. Another parallel plate capacitor B of capacitance 2C is charged to a potential difference. Charging battery is disconnected and two capacitors are connected in parallel such that positive terminal of A is connected to negative terminal of B. The electrostatic energy of the combination is now $6CV^2$. The potential difference to which capacitor B is charged initially is $x\times0.7\ V$. The value of $'x'$ is _____.

48. The ratio of time constants during current growth and current decay in the circuit as shown is $3/2$. The resistance 'R' is _____ 'Ω'.



49. Two sound sources are moving away from a stationary observer in opposite directions with velocity V_1 and V_2 $\left(V_1 > V_2\right)$. The frequency of both the series is 900Hz. V_1 and V_2 are both quite less than speed of sound, $V = 300\ m/\sec$. Find the value of $(V_1 - V_2)$, in m/sec, so that beat frequency observed by observer is 6 Hz.

SECTION – III (*Paragraph Type)*

This section contains 2 paragraphs. Based upon each of the paragraph 3 multiple choice questions have to be answered. Each of these questions has four choice (A), (B), (C) and (D), out of which ONLY ONE is correct.

Paragraph for Questions Nos. 50 to 52

A river of width 'a' with straight parallel banks flow due north with speed 'μ'. The point O and A are on opposite banks and A is due east of O. coordinate axes OX and OY are taken in the east and north directions respectively. A boat, whose speed is V relative to water, starts from O and crosses the river. If the boat is steered due east and its velocity 'u' varies with x as : $u = x(a-x)\dfrac{V}{a^2}$

50. Equation of trajectory of the boat is

A) $\dfrac{x^2}{2a} - \dfrac{x^3}{3a^2} = y$ B) $\dfrac{x^2}{2a} - \dfrac{x^3}{a^2} = y$ C) $\dfrac{x^2}{a} - \dfrac{x^3}{3a^2} = y$ D) $\dfrac{x^2}{5a} - \dfrac{x^3}{3a^2} = y$

51. Time taken to cross the river is

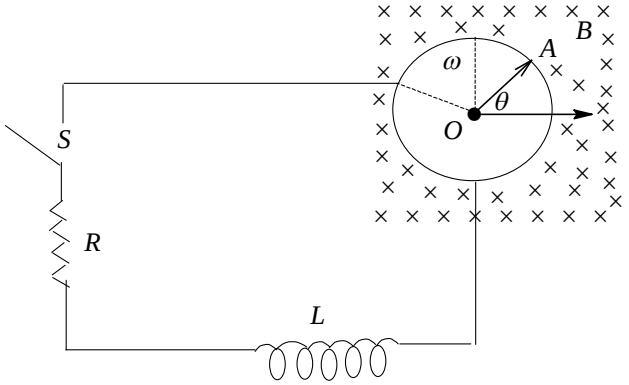
A) $a/2v$ B) a/v C) $3a/2v$ D) $4a/5v$

52. The displacement of boatman when he reaches the opposite bank from the initial position is

A) $\dfrac{\sqrt{35}}{9}a$ B) $\dfrac{\sqrt{21}}{5}a$ C) $\dfrac{\sqrt{33}}{7}a$ D) $\dfrac{\sqrt{37}}{6}a$

Paragraph for Questions Nos. 53 to 55

A metal rod OA of mass 'm' and length 'r' kept rotating with constant angular speed 'w' in a vertical plane about a horizontal axis at the O. The free end A is arranged to slide without friction along a fixed conducting circular ring in the same plane as that of rotations. A uniform and constant magnetic induction $\overline{B}$ is applied perpendicular and into the plane of rotation as shown in fig. An indicator 'L' and an external resistance R are connected through a switch 'S' between the point 'O' and a point 'C' on the ring and the rod. Initially, the switch is open



53. What is the induced emf across the terminal of the switch.

A) $\frac{Bwr^2}{8}$ B) $\frac{Bwr^2}{4}$

C) $\frac{Bwr^2}{2}$ D) Bwr^2

54. When switch 'S' is closed at time $t=0$, the expression for the current as a function of time will be

A) $\frac{Bwr^2}{8R}\left[1-e^{\frac{R}{L}t}\right]$ B) $\frac{Bwr^2}{2R}\left[1-e^{-\left[\frac{R}{L}\right]t}\right]$

C) $\frac{Bwr^2}{4R}e^{-\frac{R}{L}t}$ D) $\frac{Bwr^2}{R}e-\frac{L}{R}t$

55. In the steady state, obtain the time dependence of the torque required to maintain the constant angular speed. Given that the rod OA was along the positive x-axis at $t=0$

A) $\frac{B^2wr^4}{4R}+\frac{mg}{2}\sin\omega t$ B) $\frac{B^2wr^4}{3R}+\frac{mgr}{4}\sin\omega t$

C) $\frac{B^2wr^4}{4R}+\frac{mgr}{4}\cos\omega t$ D) $\frac{B^2wr^4}{2}+\frac{mg}{2r}\cos\omega t$

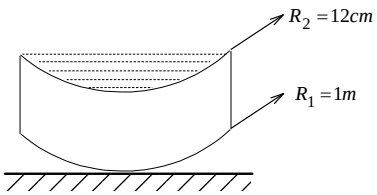
SECTION – IV

Matrix Type

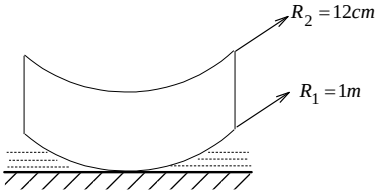
This section contains 2 questions. Each question has four statements (A, B, C and D) given in Columns I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with one or more statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for that particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

56. A convexo –concave lens of crown glass has a radii of curvature equal to 1m and 12cm. Its focal power in air is P_1. The lens is placed horizontally on a plane mirror and filled with water as shown in figure (i). Now its focal power is P_2. Then lens is placed on a horizontal plane mirror and the space between them is filled with water as shown in figure (ii). Now its focal power is P_3. Then the lens is filled with water as shown in figure (iii). Now its focal power is P_4.

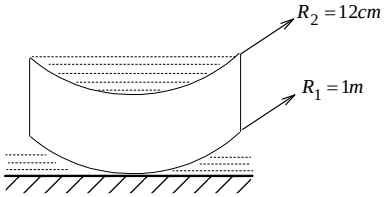
Column – I	**Column – II**
A) P_1	p) $-1.76\ D$
B) P_2	q) $-2.42\ D$
C) P_3	r) $-3.66\ D$
D) P_4	s) $-8\ D$



fig(i)



fig(ii)



fig(iii)

57. A body moves along a horizontal plane for which $s = t^3 - 9t^2 + 24t$, where t is time in seconds : (where υ denotes velocity)

Column – I	**Column – II**
A) For $t < 2$	p) υ is decreasing
B) For $2 < t < 4$	q) υ is increasing
C) For $t > 3$	r) s is decreasing
D) For $t < 3$	s) s is increasing

EENADU
PRATHIBHA NET

JEE-ADVANCED-2017
MODEL PAPER-II

Time: 2:00 P.M to 5:00 P.M **Max Marks: 237**

KEY SHEET

CHEMISTRY

1) A **2) D** **3) B** **4) C** **5) A** **6) B** **7) 5**

8) 8 **9) 8** **10) 4** **11) 8** **12) C** **13) A** **14) D**

15) B **16) C** **17) D**

18) a – qrt ; b – pst ; c –qrt; d – qr **19) a – pqs; b – rs; c – pqs; d – pqs**

MATHEMATICS :

20) A **21) B** **22) C** **23) A** **24) B** **25) A** **26) 2**

27) 7 **28) 7** **29) 0** **30) 1** **31) D** **32) C** **33) D**

34) B **35) C** **36) D**

37) a – pq ; b – rs; c – s; d – pq **38) a – t ; b – r; c – r; d – q**

PHYSICS :

39) A **40) B** **41) B** **42) C** **43) A** **44) A** **45) 8**

46) 6 **47) 5** **48) 1** **49) 2** **50) A** **51) B** **52) D**

53) C **54) B** **55) C**

56) a – r; b – p; c – s; d – q **57) a – s; b – r; c – q; d – p**

CHEMISTRY

1. $k_{obs} = k.k_c = 1.2 \times 10^{-4} \times 1.4 \times 10^{-2} = 1.68 \times 10^{-6}$ mole^{-2} L^2 min^{-1}

   Rate $= k_{obs}[NO]^2[H_2] = 1.68 \times 10^{-6} \times 0.5^2 \times 0.5$

   $= 2.1 \times 10^{-7}$ mole L^{-1} min^{-1}

2. photon energy liberated from $He^+ = \frac{hc}{\lambda} = hcR_H \times Z^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$ (for I line of lyman series)

$$= 6.626 \times 10^{-27} \times 3 \times 10^{10} \times 109678 \times 2^2 \times \frac{3}{4} = 6.54 \times 10^{-11} \text{erg}$$

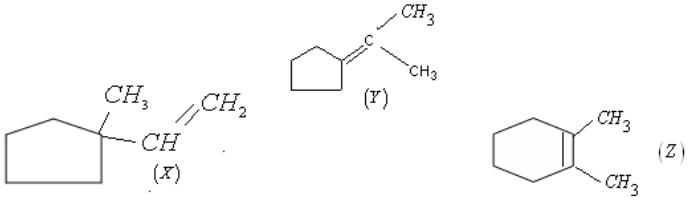
   This energy isused in liberating electron from H-atom from ground state

$$= 6.54 \times 10^{-11} - 13.6 \times 1.602 \times 10^{-12} = 4.362 \times 10^{-11} \text{erg} = 1/2mu^2$$

$$\therefore u = 3.09 \times 10^8 \text{cm.sec}^{-1}$$

4. In the compound $NaHXeO_4$, Xenon is in +6 oxidation state. If it disproportionates to give 'Xe' (zero) then Xe (VIII) must be formed. In this reaction $Na_4XeO_6 \cdot 8H_2O$ get precipitated.

6.



7. $In^{3+} + 2e^- \longrightarrow In^+;\ E^0 = -0.42V$

   $In^{2+} + e^- \longrightarrow In^+;\ E^0 = -0.40V$

   $\therefore$ For $In^{3+} + e^- \longrightarrow In^{2+};\ E^0 = -0.44V$

$$E^0_{cell} = 0.15 - (-0.44) = 0.59V$$

$$E^0_{cell} = \frac{0.059}{n}\log k$$

$$0.59 = \frac{0.059}{1}\log k \Rightarrow k = 10^{10}$$

8. $M.eq.of\ FeSO_4 = M.eq.of\ K_2Cr_2O_7 + M.eq.of\ KMnO_4$

$$200 \times 2 = 40 \times 1 \times 6 + V \times 1 \times 5$$

$$5V = 400 - 240 = 160$$

$\therefore$ Volume of $KMnO_4 = 32\,ml$

9. $K_{sp}\ of\ Pb(OH)_2 = 4s^3 = 4 \times \left(6.7 \times 10^{-6}\right)^3 = 1.2 \times 10^{-15}$

   $\therefore$ In buffer solution, solubility product is the product of $\left[Pb^{2+}\right]$ and $\left[OH^-\right]^2$

$$\therefore \left[Pb^{2+}\right]\left[OH^-\right]^2 = 1.2 \times 10^{-15}$$

$$\left[1.2 \times 10^{-3}\right]\left[OH^-\right]^2 = 1.2 \times 10^{-15}$$

$$\left[OH^-\right] = 10^{-6} \therefore pH = 8$$

10. degree of hardness (in ppm of $CaCO_3$) = no.of millimoles of salt/lit $\times 100$

$500 = n \times 100$ as $n = 5$

$\therefore$ Concentration of $CaCl_2 = 5 \times 10^{-3}$ *moles per lit*

$$\left[SO_4^{2-}\right] = \frac{K_{sp}}{\left[Ca^{2+}\right]} = \frac{2.4 \times 10^{-5}}{5 \times 10^{-3}} = 4.8 \times 10^{-3}$$

$\therefore \left[Na_2SO_4\right]$ *required* $= 4.8 \times 10^{-3} M$

12. $2KClO_3 + 4HCl \longrightarrow 2KCl + 2H_2O + ClO_2 + Cl_2$

A mixture of Cl_2 and ClO_2 is euchlorine.

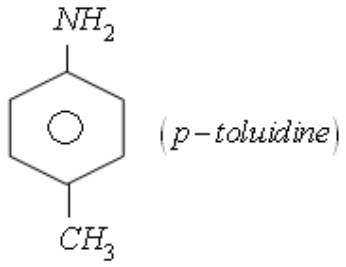
13. $Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + 4H_2O$

$2AgClO_3 + Cl_2 \longrightarrow 2AgCl + 2ClO_2 + O_2$

14. ClO_2 cannot give a mixture of Cl_2 and ClO_2 because both are reduced products.

$\overset{+4}{Cl}O_2 \longrightarrow \overset{0}{Cl_2} + K\overset{+3}{Cl}O_2$

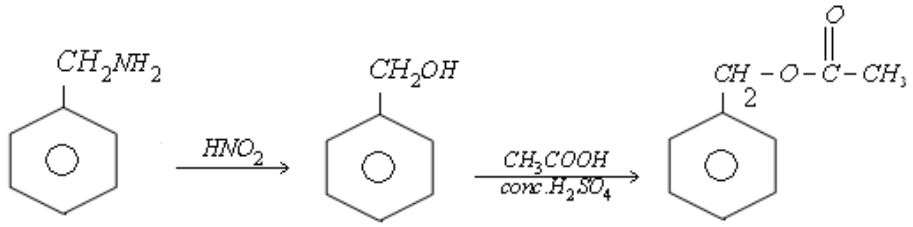
15.



$(p-toluidine)$

Two different monobromo derivatives. Answers the azodye test.

16.



17. A does not give azo dye test and gives alcohol and then ester. It is $C_6H_5CH_2NH_2$.

18. $\left[Fe(CN)_6\right]^{4-}$ – 0.*N* is +2-d^2sp^3(inner orbital complex diamagnetic)

$[FeF_6]^{3-}$ - O.N is +3-sp^3d^2(outer orbital complex, paramagnetic)

$\left[Co(NH_3)_6\right]^{3+}$ O.N. is +3; $d^2\ sp^3$ inner orbital complex, paramagnetic

$\left[Ni(CN)_4\right]^{2-}$ O.N. is +2; $d\ sp^2$-inner orbital complex; diamagnetic

MATHEMATICS

20. 1^{st} $(2n+1)$ terms of A.P. are A, $A+2$, …., $A+4n$.

Last $(2n+1)$ terms of G.P. are $(A+4n)$, $(A+4n)\frac{1}{2}$, ……., $(A+4n)\frac{1}{2^{2n}}$

$= A+2n = \frac{A+4n}{2^n} \Rightarrow A = \frac{4n-2n\,2^n}{2^n-1}$

Middle term of sequence $= T_{2n+1} = A+4n = \frac{n2^{n+1}}{2^n-1}$

21. The total number of ways to put four identical oranges and six distinct apples into five distinct boxes is

$\left({}^{5+4-1}C_4\right).5^6 = 70\times5^6$

To satisfy the criteria that each box contains two objects we make three cases(based on number

of oranges to go into a box)

1.Two oranges in each of the two boxes and no oranges in the other three boxes.

Number of ways $= {}^5C_2 \times \frac{\lfloor 6}{\lfloor 2\lfloor 2\lfloor 2} = 900$

2. Two oranges in one box, one orange in each of the two other boxes

$(5)\times\left({}^4C_2\right)\times\frac{\lfloor 6}{\lfloor 2\lfloor 2\lfloor 1\lfloor 1} = 5.6.180$

$= 5400$

3. One orange in each of the four boxes $= 5\,.\frac{\lfloor 6}{\lfloor 2\lfloor 1\lfloor 1\lfloor 1} = 5\times360 = 1800$

The total number of ways $= 900+5400+1800 = 8100$

Probability $= \frac{8100}{70\times5^6} = \frac{162}{21875}$

22. For an even license plate ,there must be 2 K zeros $(0\le K\le 4)$ and 8-2K non zero digits ,each of which has 9 choices .There are $8_{C_{2K}}$ ways to choose 2K places for 0's & $\left(8_{C_{2K}}\right)9^{8-2K}$ plates have exactly 2K zeroes therefore the required answer is

$\sum_{K=0}^{4}\left(8_{C_{2K}}\right)9^{8-2K} = 8_{C_0}9^8 + 8_{C_2}9^6 + 8_{C_4}9^4 + 8_{C_6}9^2 + 8_{C_8}$

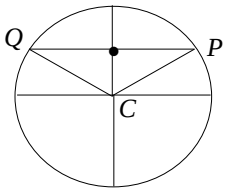
$= \frac{(9+1)^8+(9-1)^8}{2} = \frac{10^8+8^8}{2}$

23. Ans:- C

Hint:- $\left(\frac{z_2}{z_1}\right)^2 = \left(\frac{OQ}{OP}\right)^2 e^{i2\theta}$, $\frac{z_3}{z_1} = \frac{OR}{OP}e^{i2\theta} \Rightarrow \frac{z_2^2}{z_1z_3} = \frac{\cos^2\theta}{\cos2\theta} = \frac{2+\sqrt{3}}{2\sqrt{3}} \Rightarrow \theta = 15^\circ$

24. Key. B

The equation of the tangent at $(3\cos\theta, 2\sin\theta)$ on $\frac{x^2}{9}+\frac{y^2}{4}=1$ is



$\frac{x}{3}\cos\theta+\frac{y}{2}\sin\theta=1$ .....(i)

The equation of director circle is $x^2+y^2=9+4=13$ .....(ii)

The combined equation of CP and CQ is obtained by homogenizing equation (ii) with (i).

Thus combined equation is $x^2+y^2=13\left(\frac{x}{3}\cos\theta+\frac{y}{2}\sin\theta\right)^2$

$\Rightarrow\left(\frac{13}{9}\cos^2\theta-1\right)x^2+\frac{13}{3}\sin\theta\cos\theta xy+\left(\frac{13}{4}\sin^2\theta-1\right)y^2=0$

$\therefore$ Product of the slopes of CP and CQ

$=\frac{\text{coefficient of } x^2}{\text{coefficient of } y^2}=\frac{\frac{13}{9}\cos^2\theta-1}{\frac{13}{4}\sin^2\theta-1}=\frac{13\cos^2\theta-9}{13\sin^2\theta-4}\times\frac{4}{9}=\frac{13\cos^2\theta-9}{13-13\cos^2\theta-4}\times\frac{4}{9}=-\frac{4}{9}$

25. Key. A

Hint. Let $BD=x$, $EC=y$, $AH=z$

Now, $AG\times AF=AH\times AJ \Rightarrow 2\times15=z\times(z+7)\Rightarrow z^2+7z-30=0\Rightarrow z=3$

Since, $AC=AB\Rightarrow16=3+7+BJ\Rightarrow BJ=6$

Now, $BJ\times BH=BD\times BE\Rightarrow6\times13=x\times(16-y)$ .....(i)

Also, $CE\times CD=CF\times CG\Rightarrow y(16-x)=1\times14$ .....(ii)

On solving equations (i) and (ii) we get

$x=10-\sqrt{22},\ y=6-\sqrt{22}$

$\therefore\ DE=16-x-y=16-\left(10-\sqrt{22}\right)-\left(6-\sqrt{22}\right)=2\sqrt{22}$

26. Ans:- 2

Hint:- $f(-2.5)=1+[-2.5]=1-3=-2$

$\therefore\ f(f(-2.5))=f(-2)=|-2|=2$

27. $P=\lim\limits_{y\to0}\int_0^{\pi}\sin x\frac{\tan(y\sin x)}{y\sin x}dx=\int_0^{\pi}\sin x\,dx=2$

$Q=\lim\limits_{n\to\infty}\int_0^{n}\left(1-\frac{x}{n}\right)^n e^{x/3}dx=\lim\limits_{n\to\infty}\int_0^{n}e^{n\left(1-\frac{x}{n}-1\right)}e^{\frac{x}{3}}dx=\lim\limits_{n\to\infty}\int_0^{n}e^{-x}e^{\frac{x}{3}}dx=\frac{3}{2}$

28. Clearly X = {100, 200, 300, 400, 500, 600, 700, 800, 900}

And for the equation $x^3+3ax^2+(298a+299)x-2=0$ to have positive point of maxima.

The equation $f'(x)=0$ should have both the roots positive and unequal, which gives

$a>299$. $\therefore$ Y = {a; a > 299}

$\therefore$ Number of elements in $X\cap Y=7$.

29. For integral solution

$(x-1)(y-1)=1$, Solutions are $(0,0)$ or $(2,2)$

For non integral solution, Let $x=[x]+f_1$ and $Y=[y]+f_2$

$\therefore \quad [x][y]=[x]+f_1+[y]+f_2$

$([x]-1)([y]-1)=f_1+f_2+1$

Now $0 \le f_1+f_2<2$

$f_1+f_2=1 \Rightarrow ([x]-1)([y]-1)=2$

Which is possible for $[x]=3$ and $[y]=2$

or $[x]=2$ and $[y]=3$ or $[x]=-1$ and $[y]=0$

or $[x]=0$ and $[y]=-1$

$\therefore$ The $x+y=[x][y]$

becomes $x+y=6$ or $x+y=0$

$\therefore$ Non integral solution lies on $x+y=6$ or $x+y=0$.

No. of point of intersections is clearly zero

30 $f'(x)=-a\pi\sin(\pi x) \Rightarrow f'\left(\frac{1}{2}\right)=-a\pi\sin\frac{\pi}{2}=-a\pi=\pi \Rightarrow a=-1$

$$\int(a\cos\pi x+b)dx=\left(\frac{a\sin\pi x}{\pi}+bx\right)_{1/2}^{3/2}=\left(\frac{-a}{\pi}+\frac{3b}{2}\right)-\left(\frac{a}{\pi}+\frac{b}{2}\right)\Rightarrow -\frac{2a}{\pi}+b=\frac{2}{\pi}+1\Rightarrow b=1$$

31 $a,b>0$ and $c<0$

Angle between OA and OB is $\frac{\pi}{2}$.Since, z_2 lie in 2^{nd} quadrant.

$\Rightarrow z_1-\overline{z_2}$ will be 2^{rd} quadrant $\Rightarrow \sqrt{2}<|z_1-\overline{z_2}|<2$

Also, true if z_2 lies in 3^{rd} quadrant

32. $|z_1+z_2|=\sqrt{2}$

Since, OAB is right angled triangle and if z_1 is $(\cos\theta+i\sin\theta)$, then z_2 will be

$(-\sin\theta+i\cos\theta) \Rightarrow a=\cos\theta \ \ and \ \ c=-\sin\theta \qquad \Rightarrow |a+ic|-\sqrt{\cos^2\theta+\sin^2\theta}=1$

Hence, $k=\sqrt{2}+1$

33. $W=a+ic \Rightarrow |W|=1$

Let $z=\frac{W+1}{W-1}\Rightarrow W=\frac{z+1}{z-1} \ \Rightarrow |z+1|=|z-1| \Rightarrow$ Locus of z is y-axis

34. Any point on the given hyperbola is $(4t,4/t)$

Normal at this point is $y-4/t=t^2(x-4t)$.

If the normal passes through P(h,k),then $k-4/t=t^2(h-4t)$

$4t^4-t^3h+tk-4=0$

This equation has roots t_1,t_2,t_3,t_4 which are parameters of the four feet of normals on the hyperbola.

Therefore,

$\Sigma t_1=h/4$, $\Sigma t_1t_2=0$, $\Sigma t_1t_2t_3=-k/4$ and $t_1t_2t_3t_4=-1$

Therefore, $t_1^{-1}+t_2^{-1}+t_3^{-1}+t_4^{-1}=k/4$

$y_1+y_2+y_3+y_4=k$

According to the question,$t_1^2+t_2^2+t_3^2+t_4^2=h^2/16=k$

Hence, the locus of (h,k) is $x^2=16y$.

35. $x^2=16y$

Equation of tangent P is $x(4t) =16(y+t^2)/2$ is $tx=2y+2t^2$

Let tangents cuts x and y axes at A and B respectively. Let A=(2t,0) and B=$(0,-t^2)$

Let M(h,k) is the middle point of AB.

h=t, $k=-t^2 \Rightarrow h^2=-2k$

Therefore, locus of M(h,k) is $x^2+2y=0$.

36. Let OAB be the equilateral triangle with O as the vertex of the curve.

OB make an angle of 30°with y-axis.

Tan 30° = $4t_1/t_1^2 \Rightarrow t_1 =4\sqrt{3}$

Length of side is $8\sqrt{3}$.therefore,area will be $768\sqrt{3}$ sq.units

37. Ans:- $A \to p,q; B \to r,s$; $C \to s$; $D \to p,q$

Consider the multiplication of two quadratic expressions

$P(x)=\left(x^2+ax+c\right)\left(x^2+bx+d\right)$

$\Rightarrow \quad P(x)=x^2+8x^3+23x^2+28x+12$ or $\Rightarrow \quad P(x)=(x+1)(x+2)^2(x+3)$

$\Rightarrow \quad P(x)=\left(x^2+4x+3\right)\left(x^2+4x+4\right)$ or $\Rightarrow \quad P(x)=\left(x^2+3x+2\right)\left(x^2+5x+6\right)$

So, the ordered solutions for (a,b,c,d) can be

$(4,4,3,4)$; $(4,4,4,3)$; $(3,5,2,6)$; $(5,3,6,2)$

38. A) x + 3y + 1 = 0 is the chord of contact of point P (x_1, y_1)

$xx_1 + yy_1 (x + x_1) + 2 (y + y_1) + 1 = 0$

$x(x_1 - 1) + y (y_1 + 2) x_1 + 2y_1 + 1 = 0$

comparing

$$\frac{x_1-1}{1}=\frac{y_1+2}{3}=\frac{-x_1+2y_1+1}{1}=\frac{-x_1+2y_1+1+1(x_1-1)-2(y_1+2)}{1+1.1-2.3}=1\Rightarrow(x_1,y_1)=(2,1)$$

(B) $\quad f'(x)>0\Rightarrow\cos 3x>0 \quad \Rightarrow x\in\left(-\frac{\pi}{6},\frac{\pi}{6}\right).$

(C) Let common ratio is $\frac{1}{2^b}$ and $s_\infty=\frac{a}{1-r}=\frac{\frac{1}{2^a}}{1-\frac{1}{2^b}}=\frac{1}{7}$

$\Rightarrow b=3 \;\&\; a=b$, Hence $a=3$

(D) Circle with center at $(8,6)$ and radius'4' is

$(x-8)^2+(y-6)^2=16$

$\Rightarrow x^2+y^2-16x-12y+84=0.....(1)$

given circle is $x^2+y^2-100=0.....(2)$

Equation of QR is $4x+3y-46$

PHYSICS

39. $f = \dfrac{\Delta U}{\Delta Q} = \dfrac{nc_v \Delta T}{nc_p \Delta T} = \dfrac{1}{\gamma} = \dfrac{5}{7}$

40. Since no external force along the normal line hence we conserve the linear momentum of the system along the normal.

$\sin\theta = \dfrac{\frac{R}{2}}{R}$

$\theta = 30^0$

Velocity of the disc $= V\cos\theta = \dfrac{\sqrt{3}V}{2}$

41. At any radial distance r, let the speed of the body V_1 conserving total mechanical energy

$\dfrac{1}{2}mV^2 + \left[-\dfrac{GMm}{r}\right] = 0$ or $V = \sqrt{\dfrac{2gR^2}{r}}$ or $-\dfrac{dr}{dt} = \dfrac{\left(\sqrt{2g}\right)R}{\sqrt{r}}$ or $\dfrac{-1}{R\sqrt{2g}}\int_{R+n}^{R} r^{1/2}dr = \int_0^t dt$ or

$t = \dfrac{2}{3R\sqrt{2g}}\left[\left(R+h\right)^{3/2} - R^{3/2}\right]$

Putting = R

$t = \dfrac{1}{2}\sqrt{\dfrac{2R}{g}}\left(2\sqrt{2}-1\right) \qquad R = 6400\ km$

42. Let 'f' be the frictional force acting as shown in the figure.

Let 'α' be angular acceleration

Torque equation :- $f.r - f.R = I.\alpha = MK^2.\alpha$ .....(1)

Force equation :- $F + f = M.a = M.\left(R\alpha\right)$ .....(2)

Solving equation (1) and (2)

$f = \left(\dfrac{R.r - k^2}{k^2 + R^2}\right)F$

For solid sphere, $K^2 = \dfrac{2}{5}R^2$

For, $f = 0,\ Rr - k^2 = 0 \Rightarrow r = \dfrac{2}{5}R$

$h = R + \dfrac{2}{5}R = \dfrac{7R}{5}$

43. When the magnetic field is suddenly switched off then, induced electric field will be generated because of changing flux. Therefore the induced electric field at a distance 'a' from the centre is given by

$E = \dfrac{a}{2}\dfrac{dB}{dt}$ .....(1)

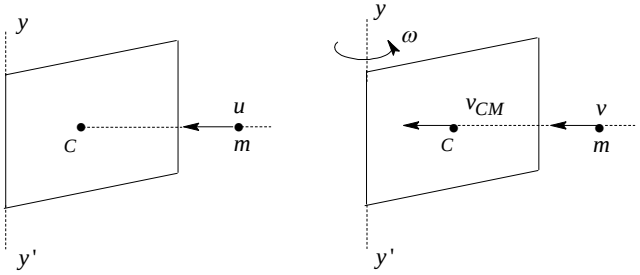
According to Newton's second law

$\int F\ dt = p_f - p_i$ .....(2)

$\int qE.\ dt = p_f - p_i$

$\int q\dfrac{a}{2}\dfrac{dB}{dt} = p_f - p_i = q\dfrac{a}{2}B_0$

44. The plate is free to rotate about vertical axis yy'.



Let υ, υ_{CM} and ω be the velocity of the particle , velocity of centre of mass of plate and angular velocity of plate just after collision.

$\therefore$ From conservation of angular momentum about vertical axis passing through O is

$$mu\frac{a}{2} = m\upsilon\frac{a}{2} + \frac{ma^2}{3}\omega \qquad \ldots\ldots\ldots\ldots\text{(i)}$$

Since, the collision is elastic, the equation of coefficient of restitution is

$$e = \frac{\upsilon_{CM} - \upsilon}{u} = 1 \qquad \ldots\ldots\ldots\ldots\text{(ii)}$$

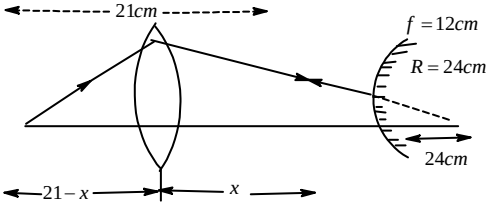
But, $\upsilon_{CM} = \frac{a\omega}{2}$ ……..(iii)

Solving equations (i) , (ii) and (iii) we get, $\omega = \frac{12}{7}\frac{u}{a}$

45 : $a = \frac{v^2}{r}$ *so,* $a \propto \frac{Z^2}{1/Z}$ *,Thus,* $a \propto Z^3$

$$\frac{a_1}{a_2} = \left(\frac{Z_1}{Z_2}\right)^3 = \left(\frac{2}{1}\right)^3$$

46.



$$\frac{1}{x+24} + \frac{1}{-(21-x)} = \frac{1}{10} \Rightarrow x = 6m$$

47. $E = \frac{1}{2}C'V'^2 = \frac{1}{2}(3C)V'^2 = 6CV^2\,(given)$

So $V' = 2V$, But $V' = \frac{Q'}{C'} = \frac{Q'}{3C} = 2V$

$Q' = 6CV$, But $Q' = Q_2 - Q_1 = Q_2 - CV = 6CV$

So, $Q_2 = 7CV$

$$V_2 = \frac{Q_2}{C_2} = \frac{7CV}{2C} = 3.5V \Rightarrow 0.7x = 3.5 \Rightarrow x = 5$$

48. Time constant during charging $= \tau L_1 = \frac{L}{2}$; Time constant during discharging $= \tau L_2 = \frac{L}{2+R}$

$$\frac{L/2}{\left[L/(2+R)\right]} = \frac{3}{2}(given) \Rightarrow \frac{2+R}{2} = \frac{3}{2} \Rightarrow R = 1\Omega$$

49. $f_1 = 900\left[\frac{300}{300+V_1}\right] = 900\left[1+\frac{V_1}{300}\right]^{-1} \approx 900\left[1-\frac{V_1}{300}\right] = 900-3V_1$

Like wise, $f_2 = 900-3V_2$

Given, $f_2 - f_1 = 6$

$3\left(V_1 - V_2\right) = 6 \Rightarrow V_1 - V_2 = 2m/\sec$

50. Let $\vec{V}_{br}$ be the velocity of boatman relative to river, $\vec{V}_r$ the velocity of river and $\vec{V}_b$ is the absolute velocity of boatman. The $\vec{V}_b = \vec{V}_{br} + \vec{V}_r$

Given $\left|\vec{V}_b\right| = V$ and $\left|\vec{V}_r\right| = \mu$

Now, $\left|\vec{V}_r\right| = \mu = V_y = \frac{dy}{dt} = x\left(a-x\right)\frac{V}{a^2}$

And $V = V_x = \frac{dx}{dt} = V$

From equation (i) and (ii) we get

$\frac{dy}{dx} = \frac{x\left(a-x\right)}{a^2}$ or $dy = \frac{x\left(a-x\right)}{a^2}dx$ or $\int_0^y dy = \int_0^y \frac{x\left(a-x\right)}{a^2}dx$ or $y = \frac{x^2}{2a} - \frac{x^3}{3a^2}$ .....(iii)

51. Time taken to cross the river $t = \frac{a}{v_x} = \frac{a}{v}$

52. From equation (iii) $y = \frac{a^2}{2a} - \frac{a^2}{3a^2} = \frac{a}{6}$ at $x = a$ (at opposite bank)

$\vec{S} = x\hat{i} + y\hat{k}$ or $a\hat{i} + \frac{a}{6}\hat{j} = \sqrt{37}/6\ a$

53. Consider small element of length dx of rod OA situated at a distance 'x' from O

Induced emf across element in 'B'

$de = B\left(xw\right)dx$

Total emf across OA

$e = \int_0^r B\left(xw\right)dx = Bw\frac{r^2}{2}$

$e = \frac{Bwr^2}{2}$

54. At constant emf of $PD_e = \frac{1}{2}Bw^2r^2$ is induced when switch 'S' is closed at $t = 0$

In case of growth of current in L – R current at any time 't' $i = i_0\left(e^{-Rt/L}\right)$

Here, $I_0 = \frac{1}{2}\frac{Bwr^2}{R} \Rightarrow L = \frac{L}{R}$

$i = \frac{Bwr^2}{2R}\left[1-e^{-Rt/L}\right]$

55. A constant net torque $\tau = 0$

The $i = i_0 = \dfrac{Bwr^2}{2R}$

A/C to FLHR, current will be inwards and F_m will be as shown.

$F = Bir = B.\dfrac{Bwr^3}{2R}$

Torque of F or about 'O'

$T_m = F\ r/2 = \dfrac{B^2wr^4}{4R}(\text{clock wise})$

Torque of weight (mg) about 'O'

$T_w = (mg)\dfrac{r}{1}\cos\theta = \dfrac{mgr}{1}\cos(\omega t)$

Net torque at any time 't' , about 'O' is

$T_{net} = T_m + T_w = \dfrac{B^2wr^4}{4R} + \dfrac{mgr}{2}\cos\omega t$

After steady state reached.

So external torque to be applied in anti-clockwise to maintain with constant speed $= T_{net}$

56. $P_1 = \left[\dfrac{3}{2} - 1\right]\left[\dfrac{1}{-0.12} - \dfrac{1}{(-1)}\right] = -3.66D$

$P_2 = 2P_W + 2P_L + 2P_M = 2\left[\dfrac{4}{3} - 1\right]\left[\dfrac{1}{\infty} - \dfrac{1}{(-0.12)}\right] + 2(-3.66) + 0 = -1.76D$

$P_3 = 2P_W + 2P_L = 2\left[\dfrac{4}{3} - 1\right]\left[\dfrac{1}{-1} - \dfrac{1}{\infty}\right] + 2(-3.66) = -8D$

$P_4 = 2\left[\dfrac{4}{3} - 1\right]\left[\dfrac{1}{\infty} - \dfrac{1}{(-0.12)}\right] + 2(-3.66) + 2\left[\dfrac{4}{3} - 1\right]\left[\dfrac{1}{-1} - \dfrac{1}{\infty}\right] = -2.42D$

57. $\upsilon = \dfrac{ds}{dt} = 3t^2 - 18t + 24 = 3(t-2)(t-4)$

And acceleration $a = \dfrac{d\upsilon}{dt} = 6(t-3)$

When $t < 2, \upsilon > 0$, So, s is increasing

When $2 < t < 4, \upsilon < 0,$ So, s is decreasing

When $t < 3, a < 0, \upsilon$ is decreasing