JEE-ADVANCED PAPER-I

Time: 09:00 AM to 12:00 Noon **IMPORTANT INSTRUCTIONS** **Max Marks: 180**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 10)	Questions with Multiple Correct Choice	3	0	10	30
Sec – II(Q.N : 11 – 20)	Questions with Integer Answer Type	3	0	10	30
Total				**20**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 30)	Questions with Multiple Correct Choice	3	0	10	30
Sec – II(Q.N : 31 – 40)	Questions with Integer Answer Type	3	0	10	30
Total				**20**	**60**

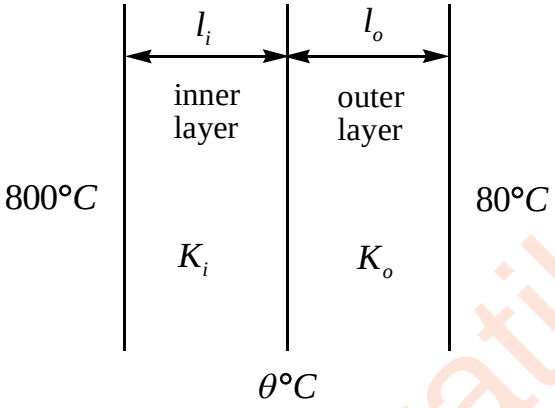
MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 41 – 50)	Questions with Multiple Correct Choice	3	0	10	30
Sec – II(Q.N : 51 – 60)	Questions with Integer Answer Type	3	0	10	30
Total				**20**	**60**

Section-1
(One or More options Correct Type)

This section contains 10 multiple choice equations. Each question has four choices (A) (B),(C) and (D) out of which **ONE** or **MORE THAN ONE** are correct.

1. A furnace has a two layered wall as shown schematically. Each layer has the same area of cross section. The temperature θ at the interface of two layers can be reduced by



A) increasing the thermal conductivity of outer layer

B) decreasing the thermal conductivity of inner layer

C) by increasing the thickness of inner layer

D) by decreasing the thickness of outer layer

2. A particle of mass m moves from rest along a straight line under the action of a force f varying with time as $f = f_0\left[1-\left(\frac{t-T}{T}\right)^2\right]$ where f_0 and T are positive constants. Then,

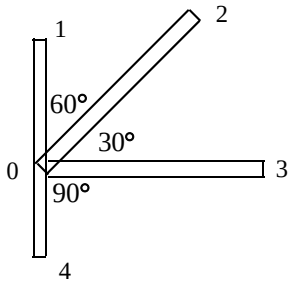
A) The speed of the particle after a time 2T is $\frac{4f_0T}{3m}$

B) After time interval of 3T, the particle starts moving backwards

C) Between time instants 0 and 2T, the acceleration first increases and then decreases

D) The particle stops at t = 3T

3. A thin rod free to rotate about a horizontal axis through one end O is initially in unstable equilibrium position 1 and falls due to gravity on being displaced slightly. In positions 2,3 and 4 it makes $60°, 90°$ and $180°$ with the upward vertical. Let ω_2, ω_3 and ω_4 be angular velocities of the rod in theses positions then :



A) $\omega_4 = 2\omega_3$ B) $\omega_4 = 2\omega_2$ C) $\omega_3 = 1.5\omega_2$ D) $\omega_3 = \omega_2\sqrt{2}$

4. Potential at a point x is 5V and at a point y is -5V. A proton is moving towards x from y, then

A) It must have K.E. equal to or more than 10eV to reach x from y

B) Work done by $\vec{E}$ in motion from x to y is +10eV

C) Work done by $\vec{E}$ in motion from y to x is 0

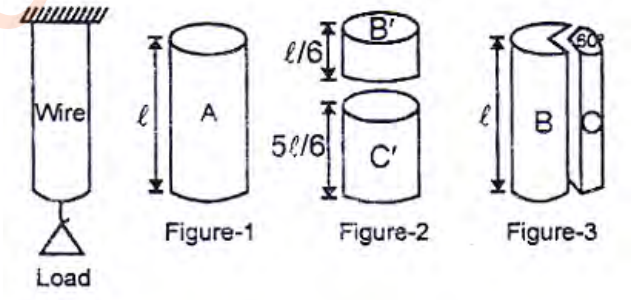
D) K.E. at y is more than K.E. at x, if particle is released at x

5. Let E be the electric field intensity and V the electrostatic potential at a point in an electric field. Which of the following statements are true ?

A) E must be zero when V is zero B) V can be zero when E is zero

C) E can be nonzero when V is zero D) V can be nonzero when E is zero

6. A light wire of length *l* (figure-1) is cut into two pieces in two different ways as shown in (figure-2 & 3). Different pieces can be arranged in place of wire as shown and a load can be placed on the mass less hanger. Choose the correct statement(s).



A) The load required to break the wire B' is 6 times that required to break B

B) The stress required to break the wire B and C is same but to break B and B' is different

C) The stress required to break C and C' is same

D) The load required to break A and is same, but different for B and B'

7. A smooth sphere A of mass 0.1 kg is moving with speed 5m/s when it collides head on with another smooth stationary sphere B.A is brought to rest by the impact and e = 1/2,

A) mass of B is 0.2 kg

B) the velocity of B after the collision is 5m/s

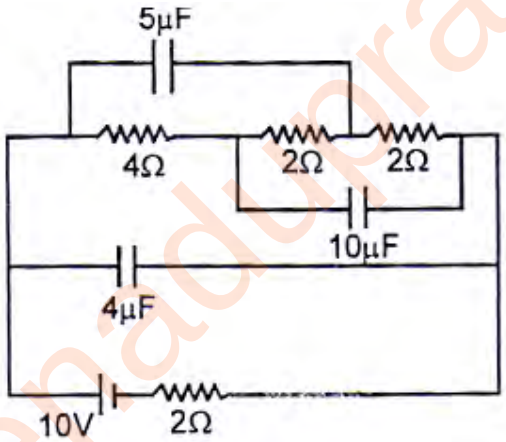
C) the magnitude of impulse on B is 0.5 Ns

D) mass of B is 0.1 kg

8. Imagine that a dipole is at the centre of a spherical non conducting surface. If magnitude of electric field at a certain point on the surface of sphere is 10 N/C, then which of the following cannot be the magnitude of electric field anywhere on the surface of sphere

A) 4 N/C B) 8 N/C C) 16 N/C D) 32N/C

9. In the circuit shown in the figure, in steady state



A) The charge in $5\mu F$ capacitor $30\mu C$

B) The charge in $10\mu F$ capacitor is $40\mu C$

C) The charge in $4\mu F$ capacitor is $32\mu C$

D) The current drawn from the battery is 1A

10. The maximum thickness of a plano convex lens, when viewed normally through the plane surface, appears to be 6 cm and when viewed normally through the curved surface appears to be 7.2 cm. The actual maximum thickness is 9 cm. Then

A) The radius of curvature of lens is 18 cm

B) the refractive index of material of lens is 1.5

C) The focal length of the lens when its plane surface is silvered is 22 cm

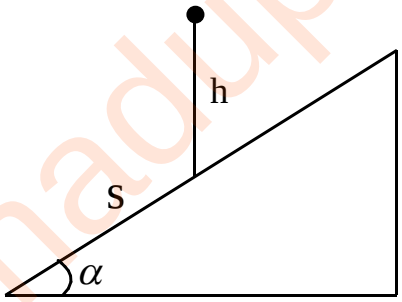
D) the focal length of the lens when its curved surface is silvered is 8 cm

Section-2
(Integer Value Correct Type)

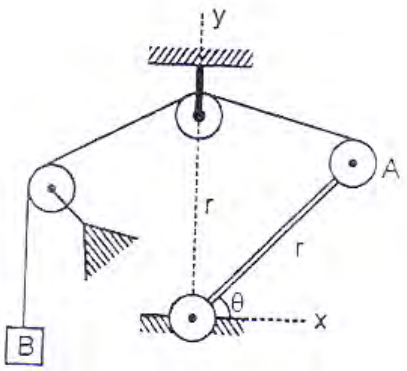
This section contains 10 questions. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive).

11. A particle moves in x-y plane with y-component of velocity in meters per second given by $v_y = 8t$ with t in seconds. The acceleration of the particle in the x-direction in metres per second square is given by $a_x = 4t$ with t in seconds. When $t = 0, y = 2m, x = 0$ and $v_x = 0$. If the magnitude of the velocity v of the particle for the instant when its x co-ordinate reaches 18 m is 5x m/s, find the value of x.

12. As the figure shows, a small object is dropped to a fixed, frictionless slope of angle of elevation $\alpha = 30°$ from a height h. The time of the fall is t_1. After a totally inelastic collision the object slides down the slope. It covers the same distance s =h on the slope during the time t_2. If the ratio $\frac{t_1}{t_2}$ equals $\left(\frac{1+\sqrt{x}}{2}\right)$ find x.



13. The particle A is mounted on a light rod pivoted at O and therefore is constrained to move in a circular are radius r. If the velocity of A in terms of the downward velocity v_B of the counterweight for $\theta = 30°$ is $\frac{xv_B}{3\sqrt{3}}$, then find x.

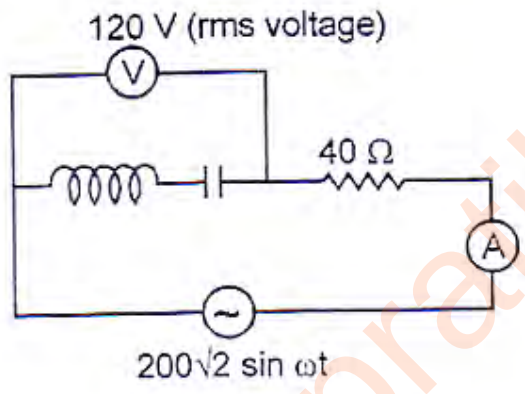


14. Two cylinders of equal masses, one made of material A and the other of material B, are heated to $50°C$ and placed on two large blocks of ice at $0°C$. If both the cylinders have the same height, find the ratio $\left(h_A / h_B\right)$ on their maximum depths of penetration in the ice. Assume that no heat is lost to the surroundings and change in gravitational potential energy is not considered.

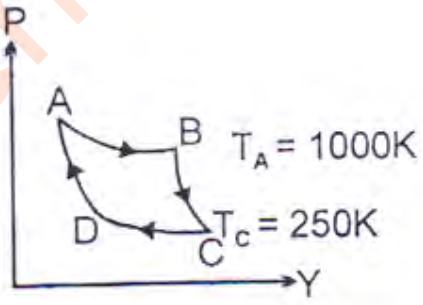
$S_A = 0.2 cal\,g^{-1}\left(C°\right)^{-1}; \rho_A = 4g\,cm^{-3}$

$S_B = 0.1 cal\,g^{-1}\left(C°\right)^{-1}; \rho_B = 2g\,cm^{-3}$

15. In the given LCR series circuit, find the reading (in A) of the hot wire ammeter.



16. A monatomic ideal gas is used as the working substance for the cycle shown in the figure. Preocesses $A \to B$ and $C \to D$ are isothermal, while processes $B \to C$ and $D \to A$ are adiabatic. During process $A \to B$, there is 400 J of work done by the gas on the surroundings. Calculate how much heat (in 100 Joules) is expelled by the gas during process $C \to D$?

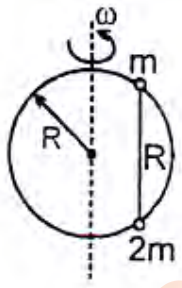


17. A certain crude oil has an index of refraction of 1.25. A ship dumps $1m^3$ of this oil into the ocean and oil spreads into a thin uniform film on water surface $\left(\mu = \frac{4}{3}\right)$. When light of wavelength 500 nm is incident on it, the reflected light shows maxima. What is the area $\left(in\ km^2\right)$ covered by the spilled oil? Assume that the thickness of film is minimum required to satisfy this criterion.

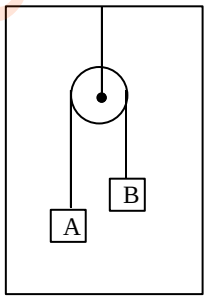
18. In a YDSE setup, one of the slit width is four times that of the other. The separation between the slits is d = 1 mm and the distance between slits and screen is D = 5 m. A monochromatic light of wavelength $\lambda = 6000\ \overset{0}{\text{A}}$ incidents on slits normally. The intensity of light only due to narrow slit on screen is I_0. If the intensity of light on screen at a point infront of the narrow slit is nI_0, find n.

19. Two beads of mass m and 2m are connected by a massless rod of length R and threaded onto a smooth circular wire of radius R. When the wire rotates uniformly about a vertical diameter, the beads do not slide on it and rod remains vertical as shown. What must be the angular velocity (in rad/s) of the wire ?

Radius $R = \frac{5}{3}m$.



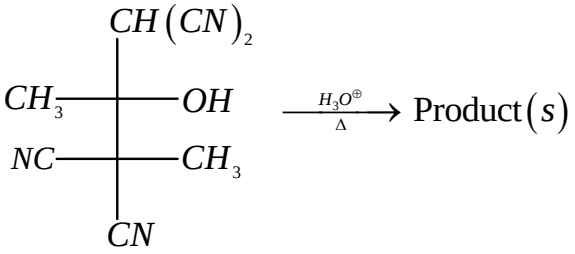
20. An atwood machine is setup in an elevator moving upward at 5m/s and slowing down at $2m/s^2$. The initial velocity of block B is 2 m/s upward and the acceleration of block A is $3m/s^2$ downwards. Find the time (in sec.) at which block B will return to its initial position. Assume the string remains taut and the acceleration of the elevator does not change during the required time interval.



Section-1
(One or More options Correct Type)

This section contains 10 multiple choice equations. Each question has four choices (A) (B)(C) and (D) out of which ONE or MORE are correct.

21.



A) Number of products including stereoisomers are two.

B) Products can be separate by fractional distillation.

C) Products are diastereomers of each other.

D) 4 moles of CO_2 gas evolved.

22. Pair(s) of coordination compounds having different colour:

A) $\left[CoBr\left(NH_3\right)_5\right]SO_4, \left[Co\left(SO_4\right)\left(NH_3\right)_5\right]Br$

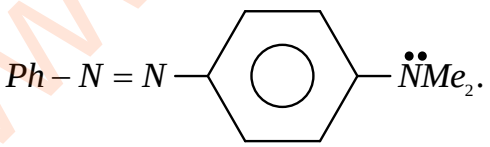
B) $\left[Cr\left(NO_2\right)_3\left(H_2O\right)_3\right], \left[Cr\left(ONO\right)_3\left(H_2O\right)_3\right]$

C) $Cis-\left[PtBrCl\left(NH_3\right)_4\right]^{2+}, Trans-\left[PtBrCl\left(NH_3\right)_4\right]^{2+}$

D) $\left[Zn\left(NH_3\right)_4\right]^{2+}, \left[Cd\left(CN\right)_4\right]^{2-}$

23. Find the correct statement(s):

A) $Ph\overset{\oplus}{N}_2$ undergoes diazocoupling with $\text{Ph-}\ddot{\text{N}}\text{Me}_2$ to give



B) $Ph\overset{\oplus}{N}_2$ undergoes diazocoupling with phenol to give orange colour dye.

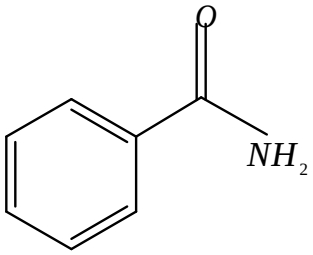
C) $Ph\overset{\oplus}{N}_2$ does not undergoes diazocoupling with $Ph-NO_2$.

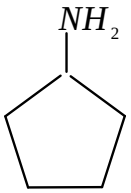
D) $Ph\overset{\oplus}{N}_2$ undergoes diazocoupling with $\beta-$ Naphthol give Blue colour dye.

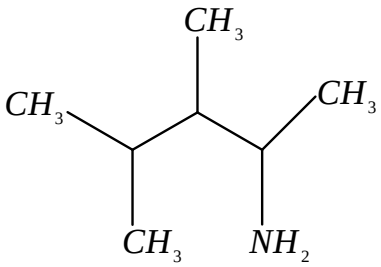
24. $Fe^{3+}(aq)$ undergoes redox reaction with solution of

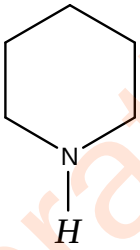
A) KCN B) NH_4SCN C) KI D) $Na_2S_2O_3$

25. Identify the compounds give clear solution with Hinsberg reagent $(C_6H_5SO_2Cl)$ in KOH.

A) 

B) 

C) 

D) 

26. Compound X_2Y have ideal antifluorite structure.

Given Radius of anion is 400 pm.

Which is/are correct statement(s)?

A) The distance between cation and anion is 490 pm.

B) The minimum distance between two cation is $\frac{980}{\sqrt{3}}$ $pm.$

C) The maximum distance between two cation is $980\,pm.$

D) The fraction of edge occupied by the particles is $0.707.$

27. Roasting of which of the following sulphide ores is /are thermodynamically feasible:

A) FeS_2 B) Cu_2S C) Ag_2S D) ZnS

28. A 34.2 % w/w aqueous solution of sucrose has undergone partial inversion according to following first order reaction.

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

After 10 min boiling point of solution is $108.3°C$.

Given boiling point of pure water $=100°C$, $K_b(H_2O) = 0.52 Kg\,mol^{-1}$

Which is /are correct statement?

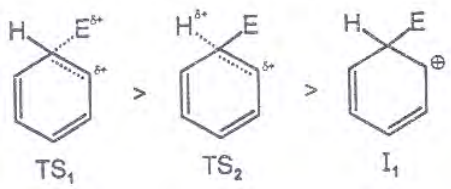
A) Half life period of reaction is 10 min

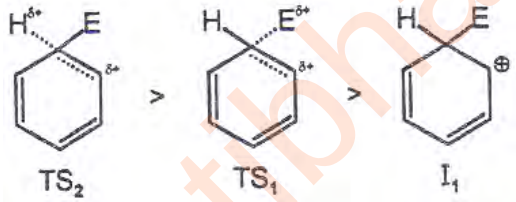
B) Half life period of reaction is 20 min.

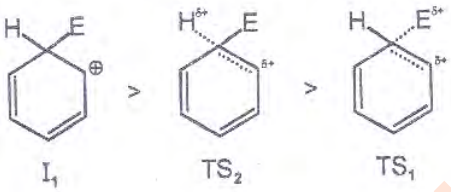
C) Fraction of sucrose inverted is 0.25 after 10 min.

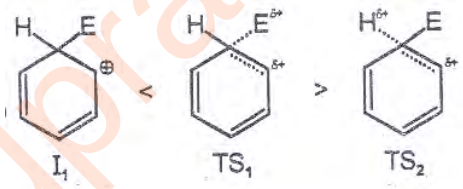
D) The observed molecular mass is 234 after 10 min.

29. Arrange the following species in order of decreasing energy formed during electrophilic aromatic substitution?

A) 

B) 

C) 

D) 

30. When conc. aqueous solution of $NaCl$ is electrolysed using graphite electrode. The correct statement is/are

A) Cl_2 gas is liberated at anode.

B) Cl_2 gas is liberated at cathode.

C) pH of solution increases around cathode during electrolysis.

D) H_2 gas is liberated at anode.

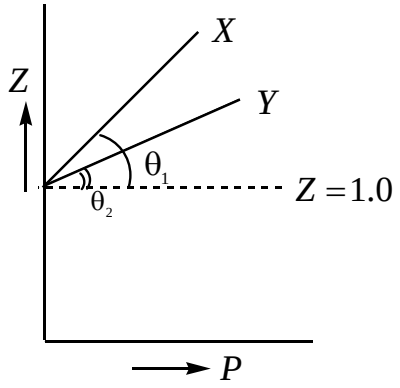
Section-2

(Integer Value Correct Type)

This section contains 10 questions. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive).

31. How many tripeptides are possible by alanine, glycine and tyrosine if each is used only once in each tripeptide?

32. The second virial coefficient of gas X is 9 $litre^2mol^{-2}$ and third virial coefficient of gas Y is $8lit^3mol^{-3}$ following graph are plotted at $300K$ temperature.

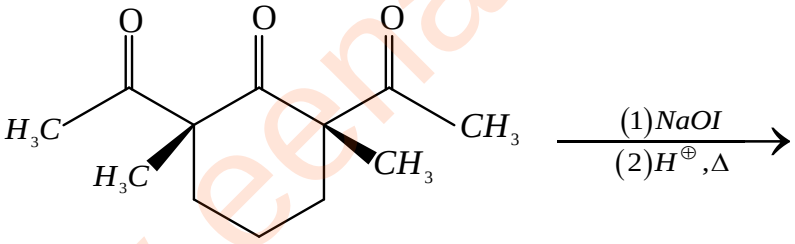


Calculate the value W.

Where $W = 24.63\left(\tan\theta_1 - \tan\theta_2\right)$

33. Find out total number of cation(s), which produce soluble compound with excess of KCN solution $Pb^{2+}(aq)$, $Hg^{2+}(aq)$, $Cr^{3+}(aq)$, $Cu^{2+}(aq)$, $Au^{+}(aq)$, $Co^{2+}(aq)$, $Cd^{2+}(aq)$, $Zn^{2+}(aq)$, $Ni^{2+}(aq)$

34. 63.5 gm of bleaching powder sample suspended in 1000 ml of water. 100 ml of suspension on treatment with KI and HCl liberated I_2 which reacts with 50 ml 0.1 M hypo solution. Calculate percentage of bleaching powder in sample.

35. 

Number of products possible including stereoisomer.

36. Find out the value of expression $|x+y|$ for complex ion $\left[Co(EDTA)\right]^-$

Where, $x =$ Total number of six membered ring(s)

$y =$ Total number of five membered ring(s) having oxygen donor atom(s) only.

37. The solubility of $Fe(OH)_2$ $\left(K_{sp} = 10^{-24}\right)$ in a buffer solution containing 0.1 M BOH and 0.1 M BOH is 10^{-12}. Calculate pKa of B^+

38. X = sum of carbon, hydrogen and oxygen present in tetrose tetrasaccharide. Find the value of

$$Y = \frac{X}{11}$$

39. Find out tatal number of metals cation(s) which form coloured metaborates:

$Al^{3+}(aq),\ Fe^{3+}(aq),\ Pb^{2+}(aq),\ Cd^{2+}(aq),\ Mg^{2+}(aq),\ Cr^{3+}(aq),\ Ag^{+}(aq),$

$Zn^{2+}(aq),\ Mn^{2+}(aq)$

40. Calculate ring strain energy (in kJ mol^{-1}) of cyclopropane (g)

Given:

$$\left(\Delta_f H\right)_{CO_2(g)} = -390\,kJmol^{-1}, \left(\Delta_f H\right)_{H_2O(l)} = -280kJmol^{-1} \left(\Delta_{comb} H\right)_{C_3H_6(g)} = -2050\,kJ\,mol^{-1},$$

$$\left(\Delta_f H\right)_{cyclopropane} = 48\,kJ\,mol^{-1}$$

PART-III_MATHEMATICS **Max Marks : 60**

Section-1
(One or More options Correct Type)

This section contains 10 multiple choice equations. Each question has four choices (A) (B)(C) and (D) out of which ONE or MORE are correct.

41. The non real roots of the equation $x^3 - 4x^2 + 8x - 8 = 0$ are α & β. If $\alpha^n + \beta^n$ is a real number then n may be equal to

A) 9 B) 36 C) 64 D) 144

42. Let $y = f(x)$ be a twice differentiable function such that $f(x) = f(2-x), \forall x \in R, f(0) = 0.$ Then which of the following is/are correct?

A) $f'(x) = 0$ has at least three real roots

B) $f'(x) = 0$ has at least one real root

C) $f''(x) = 0$ has at least two real roots

D) $f(x) = 0$ has at least two real roots

43. Let a,b and c be three positive numbers in G.P. If the equations $ax^2 + bx + c = 0$ and $x^2 + 2x + b = 0$ have common root than which of the following is/are must be true?

A) If common root is α then $\alpha^3 = 8$ B)ab = c

C) 2a+b=c D) None of these

44. let a,b and c be three natural numbers such that all are not equal. Let $\vec{X} = a\hat{i} + b\hat{j} + c\hat{k}, \vec{Y} = b\hat{i} + c\hat{j} + a\hat{k}$ and $\vec{Z} = c\hat{i} + a\hat{j} + b\hat{k}$ be three vectors such that the value of $\left(\vec{X} \times \vec{Y}\right).\left[\left(\vec{Y} \times \vec{Z}\right) \times \left(\vec{Z} \times \vec{X}\right)\right]$ is minimum.Then which of the following is/are correct?

A) volume of a parallelopiped with sides $\vec{X}, \vec{Y}$ and $\vec{Z}$ is 4

B) The acute angle between $\vec{X}$ and $\vec{Y}$ is $\cos^{-1}\frac{5}{6}$

C) Volume of a parallelopiped with sides $\vec{X}, \vec{Y}$ and $\vec{Z}$ is $\frac{9}{2}$

D) $\left(\vec{X} + \vec{Y}\right).\left[\left(\vec{Y} + \vec{Z}\right) \times \left(\vec{Z} + \vec{X}\right)\right] = 9$

45. If all roots of the equation $x^4 + (1-2a)x^2 + 2x + \left(a^2 - 5a + 6\right) = 0$ are real $(a \in R)$, then a may be equal to

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

46. Three circles with radii 1,2 and 3 touch each other externally at points A,B and C then

A) Area of $\Delta ABC = 6/5$

B)Area of $\Delta ABC = 7/5$

C) Circum-radius of $\Delta ABC = \frac{5}{4}$

D) Circum-radius of $\Delta ABC = 1$

47. Let $y = f(x)$ be a continuous and twice differentiable function such that

$f(1) = f(3) = f(5) = 0$

A) $2f(x) = f'(x)$ has at least 2 real roots

B) $2f(x) = f'(x)$ has at least 1 real root

C) $f''(x) - 4f'(x) + 4f(x) = 0$ has a real root

D) $f''(x) = 0$ has a real root

48. Let S=0 and $S' = 0$ be two given circles with centres C_1, C_2 and radii r_1, r_2 respectively. Let P be the centre of a variable circle which touches both circles externally. Then locus of point P will be

(A) Straight line if $r_1 = r_2$ and $C_1C_2 > r_1 + r_2$

(B) Straight line if $r_1 = r_2$ and $C_1C_2 = r_1 + r_2$

(C) Hyperbola if $r_1 \neq r_2$ and $C_1C_2 > r_1 + r_2$

(D) Hyperbola if $r_1 \neq r_2$ and $C_1C_2 = r_1 + r_2$

49. Let A,B and C be three pair-wise independent events such that $P(A \cup B \cup C) = 1$

Then which of the following is/ are must be correct?

(A) $1 \leq P(A) + P(B) + P(C) \leq 3$

(B) $P(\overline{A} \cap \overline{B} \cap \overline{C}) = 0$

(C) $P(A) = P(B) = P(C) = 1$

(D) $P(A \cap B \cap C) = P(A).P(B).P(C)$

50. Let a,b and c be p^{th}, q^{th} and r^{th} terms of an H.P. If p,q and r are in G.P. then the common ratio of the G.P is

(A) $\frac{q}{p}$ (B) $\frac{r}{q}$ (C) $\frac{(b-c)a}{(a-b)c}$ (D) $\left(\frac{r-q}{q-p}\right)$

Section-2
(Integer Value Correct Type)

This section contains 10 questions. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive).

51. Let a and b two natural numbers such that $\frac{1}{a}+\frac{1}{b}=\frac{1}{2015}$. If $a \geq b$ then total number of pairs of type (a,b) is

52. One vertex of a cube is (0,0,0) and the sides are parallel to x,y and z – axis. Three planes $x = y, y = z$ and $z = x$ cut the cube in 'n' parts. The value of 'n' is

53. Let $y = f(x)$ be a function such that $(f(x))^2 = 1, \forall x \in [0,4]$. If there are n such functions which are discontinuous at integral points. Then number of prime divisors of n is

54. Let $y = f(x)$ and $y = g(x)$ be two differentiable functions such that $f'(x) = g(x)$ and $g'(x) = f(x), \forall x \in R$ $f(0) = 0, g(0) = 2$ and $I = \int_0^1 (f(x) + g(x))dx$ then [I] equals ([.]is GIF).

55. Let $y = f(x)$ be a function such that $f(x) + f\left(\frac{2x-3}{x-2}\right) = x,$ then number of integers in the domain of $f(x)$ is /are

56. Let $y = f(x)$ and $y = g(x)$ be two linear on-to functions from $[-1,1]$ to $[0,2]$. Let $h(x) = \frac{f(x)}{g(x)}(x \neq -1,0,1)$ be a function. $n = \left[\left| h(h(x) + h\left(h\left(\frac{1}{x}\right)\right)\right|\right]$ ([.]is GIF) then minimum value of n is.

57. Let $y = f(x)$ be a continuous function such that $f(x) - f(y) < x - y, \forall x < y.$ If the line $y = x + 3$ cuts the curve at 'n' points than maximum value of 'n' is

58. If $\int_a^b \tan^{-1} x\, dx = P\left(a, b \in R \text{ and } a+b=1\right)$ and $\int_a^b \cot^{-1}\left(1-x+x^2\right)dx = nP$

then 'n' equals $\left(P \neq 0\right)$

59. Let z be a complex number such that $\left|z-\left(2+7i\right)\right| \leq 5$ then the least value of

$\left|3z-\left(6+i\right)\right|$ is

60. Let a and b be two positive numbers such that the equation $x^3 - ax^2 + bx - 8 = 0$ has three positive real roots than the least value of 'a' is

SOLUTIONS

PHYSICS

1. (A, B, C, D)

Sol. Rate of heat flow $H = \dfrac{800-80}{\left(\dfrac{l_t}{K_i A}\right)+\left(\dfrac{l_0}{K_0 A}\right)}$ which is also equal to $\dfrac{800-\theta}{\left(\dfrac{l_t}{K_i A}\right)}$. Using these two relations we get, $\theta = 800 - \dfrac{720}{1+\left(\dfrac{K_i}{K_0}\right)\left(\dfrac{l_0}{l_t}\right)}$. Thus one can reduce the temperature at the interface by any of the four options given.

2. (A, B, C, D)

Sol. Use the given expression for force to get an expression for acceleration. Integrate this to get an expression for velocity. Unless otherwise stated about the initial conditions, the velocity turns out to be $V = \dfrac{f_0}{3mT^2}\left[3t^2T - t^3\right]$. Use this to get the required results.

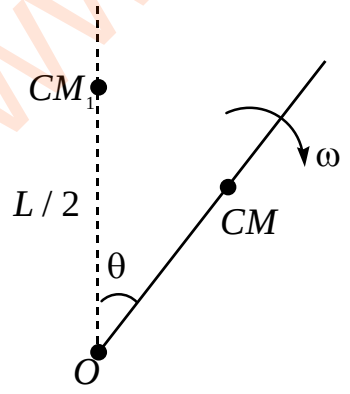
3. (B, D)

Sol. When rod falls by 'θ'

$$Mg\frac{L}{2}(1-\cos\theta) = \frac{1}{2}\left(\frac{ML^2}{3}\right)\omega^2$$

$$\Rightarrow \omega = \left[\frac{3g(1-\cos\theta)}{L}\right]^{1/2}$$

$$\therefore \omega_2 = \sqrt{\frac{3g}{2L}}, \quad \omega_3 = \sqrt{\frac{3g}{L}}; \quad \omega_4 = \sqrt{6g/L}$$



4. (A, B, D)

Sol. $W_{E_{x\to y}} = U_x - U_y = e\left(V_x - V_y\right) = 10eV = K.E_y - KE_x \Rightarrow K.E._x$

5. (B, C, D)

6. (C, D)

Sol. Breaking stress is material dependent and hence same in all cases.

While breaking load = stress × cross sectional area.

7. (A, C)

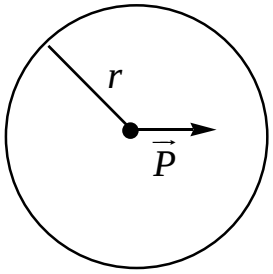
Sol. $\vec{P_i} = \overrightarrow{P_f} \Rightarrow 0.1(5) = m_B v_B$ and $v_B - 0 = -\frac{1}{2}(0-5)$

Solving $m_B = 0.2kg, v_B = 2.5m/s$

$\therefore J_B = m_B v_B - 0 = 0.5Ns$

8. (A, D)

Sol.



$E_{surface\max} = \frac{2kp}{r^3}$

$E_{surface\min.} = \frac{kp}{r^3}$

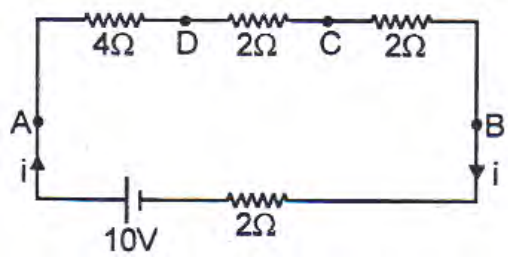
Given $E = 10N/C$ at a point.

$\therefore$ If $E_{\max} = 10 \Rightarrow E_{\min} = 5 \Rightarrow 4N/C$ not possible.

$\therefore$ If $E_{\min} = 10 \Rightarrow E_{\max} = 20 \Rightarrow 32N/C$ not possible.

9. (A, B, C, D)

Sol.



At steady state, all capacitors are open circuited.

$$i = \frac{10}{10} = 1A$$

$$q_{10} = (10\mu F)(V_{DB}) = 10(4i) = 40\mu C$$

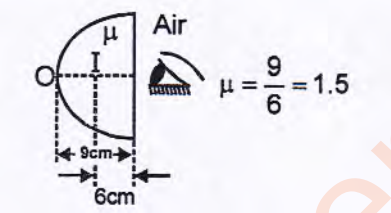
$$q_5 = (5\mu F)(V_{AC}) = 5(6i) = 30\mu C$$

$$q_4 = (4\mu F)(V_{AB}) = 4(8i) = 32\mu C$$

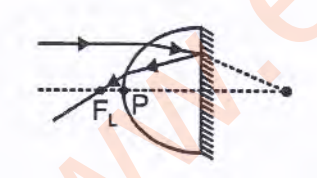
10. (A, B)

Sol. When viewed through :

(i) Plane surface :



When plane surface is silvered,



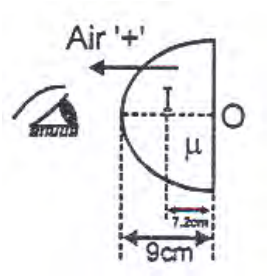
Using refraction and reflection equations

$$PF_L = \frac{72}{5} cm$$

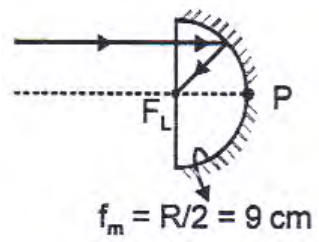
F_L is focus of the system.

(ii) Curved surface :

$$\frac{1}{-7.2} - \frac{1.5}{-9} = \frac{1-1.5}{-R} \Rightarrow R = 18 cm.$$



When curved surface is silvered,



$PF_L = 9cm.$

11. 6

Sol. $a_x = 4t \Rightarrow v_x = \int_0^t 4tdt = 2t^2 \Rightarrow x = \int_0^t 2t^2 dt = \frac{2t^3}{3} = 18$ when $t = 3$

$\therefore\ v_x = 2(3)^2 = 18$

$v_y = 8t = 24$

$\therefore\ v = \sqrt{v_{x^2} + v_{y^2}} = 30m/s$

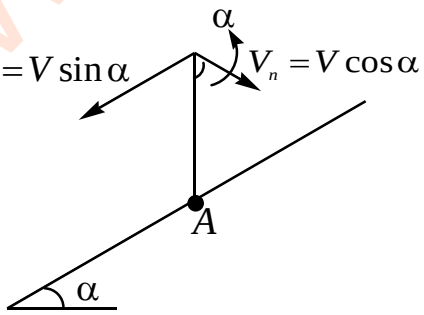
12. 3

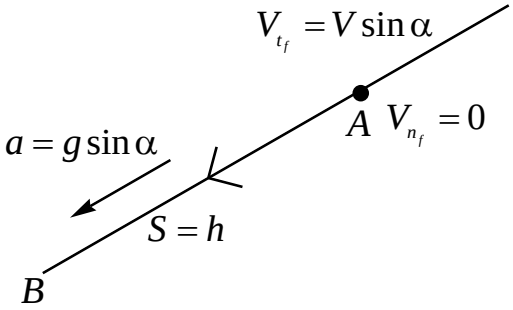
Sol: After falling through 'h' $= \frac{1}{2}gt_1^2$ speed is

$V = \sqrt{2gh} = gt_1$ and after collision

$\therefore\ h = (V\sin\alpha)t_2 + \frac{1}{2}(g\sin\alpha)t_2^2$

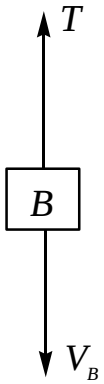
$\Rightarrow \frac{1}{2}gt_1^2 = \frac{gt_1t_2}{2} + \frac{gt_2^2}{4} \qquad \Rightarrow \frac{t_1}{t_2} = \frac{1+\sqrt{3}}{2}$

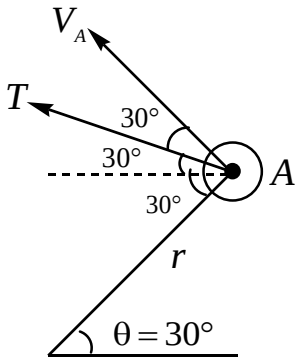




13. 6

Sol.





$W_T = 0$

$TV_A \cos 30° - T(V_B) = 0 \Rightarrow \frac{V_A\sqrt{3}}{2} = V_B \Rightarrow V_A = \frac{2V_B}{\sqrt{3}}$

Comparing with $\frac{xV_B}{3\sqrt{3}}$

14. 4

Sol. Heat lost by cylinder = Heat gained by ice $\Rightarrow MS(50) = M_{ice}(80)$

$\therefore$ For cylinders A and B, if ice melted be m_{iA} and m_{iB}, then, $\frac{S_A}{S_B} = \frac{m_{iA}}{m_{iB}}$

$\Rightarrow 2 \times h_B a_B \rho_{ice} = h_A a_A \rho_{ice}$ ----------(1)

$\because$ Heights of both cylinders were same say 'H'.

$\therefore m = a_A H_{\rho_A} = a_B H \rho_B \Rightarrow \frac{a_B}{a_B} = 2$

$\therefore$ From (1), $\frac{h_A}{h_B} = 2 \times 2 = 4$

15. 4

Sol. $V_x = 120V(r.m.s.)$

$V^2 = \left(\frac{200\sqrt{2}}{\sqrt{2}}\right)^2 = F_R^2 + V_x^2 \Rightarrow 200^2 - 120^2 = I^2(40)^2 = I = 4A.$

16. 1

Sol. $\because$ The cycle is carnot.

$$\therefore \left|\frac{Q_{rejected}}{Q_{\sup plied}}\right| = \frac{T_C}{T_A} \Rightarrow \frac{Q_{rejected}}{W_{AB}} = \frac{250}{1000}\left(\because AB \to \text{isothermal}\right) \Rightarrow Q_{rejected} = 100J.$$

17. 5

Sol. $\because$ Light is reflected twice by denser medium (first at air – oil in terface and then at oil – water interface),

$\therefore \Delta x_{net} = 2\mu_{oil} t = n\lambda$ (for maxima), for $t_{\min}, n = 1 \Rightarrow t = 2 \times 10^{-7} m$

If area of oil film = a, then $1m^3 =$ at $\Rightarrow 5 \times 10^6 m^2 = 5km^2$.

18. 7

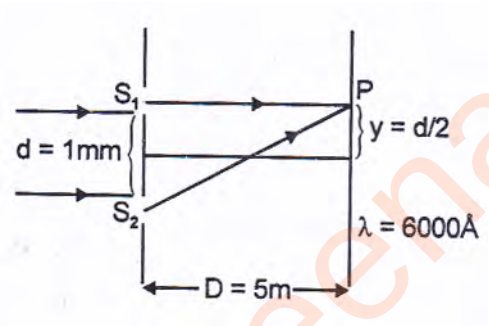
Sol. Clearly, $I_1 = I_0 \Rightarrow I_2 = 4I_0$

Now,

$$\therefore \Delta x_p = \frac{dy}{D} = \frac{d^2}{2D} = \frac{10^{-6}}{10} = 10^{-7} m$$

$$\therefore \phi_P = \frac{2\pi}{\lambda}\Delta x_p = \frac{\pi}{3}$$

$$\therefore I_p = nI_0 = I_0 + 4I_0 + 2\sqrt{I_0}\sqrt{4I_0}\cos\frac{\pi}{3} = 7I_0 \Rightarrow n = 7.$$



19. 6

Sol. $\left(N^1 - N\right)\cos 60 = 3mg$ ----------(i)

$N^1 \cos 30 = 2mr\omega^2$

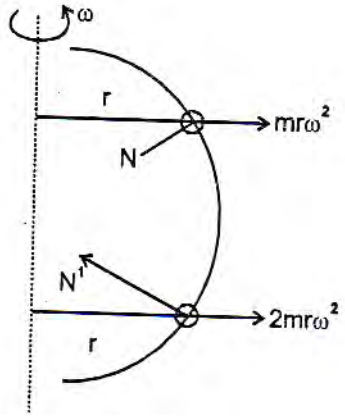
$N\cos 30 = mr\omega^2$

$$\left(N^1 - N\right) = mr\omega^2 \frac{2}{\sqrt{3}} = mR\omega^2$$

From (i)

$$mR\omega^2 \times \frac{1}{2} \times = 3mg$$

$$\omega = \sqrt{\frac{6g}{R}}$$



20. 4

Sol. Acceleration of B let a

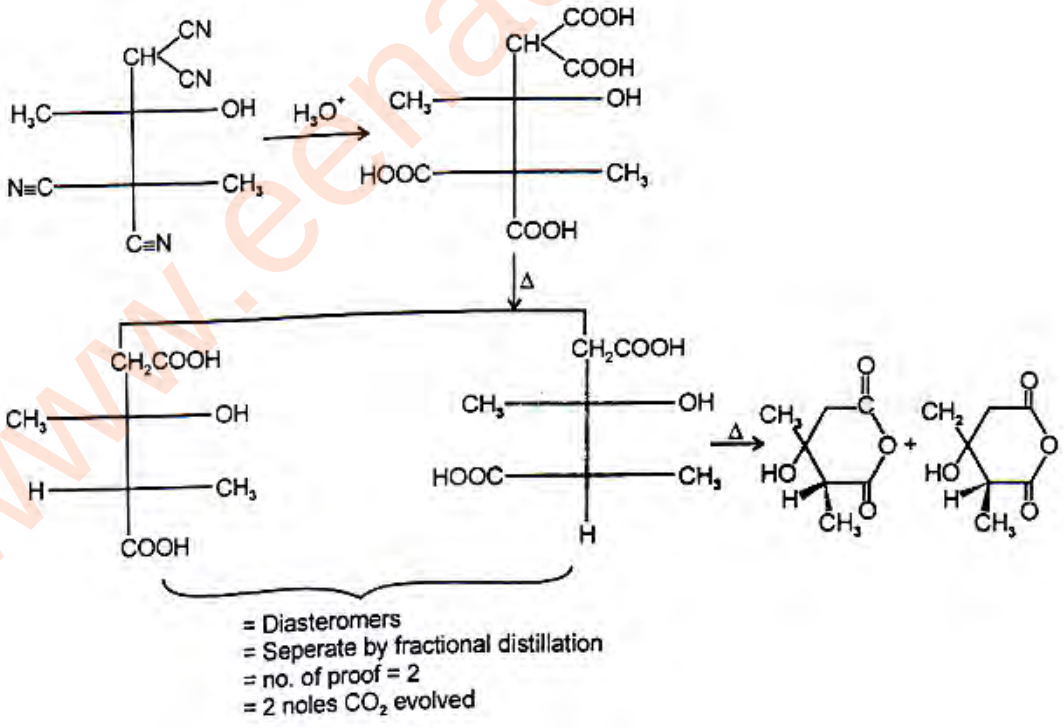
$$a+3=2\times 2 \qquad a=1m/s^2\downarrow$$

So $$s=2\times t-\frac{1}{2}\times 1\times t^2=0$$

$$t=4\text{sec.}$$

CHEMISTRY

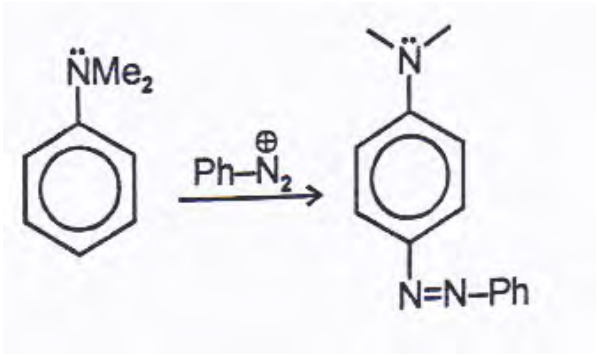
21. (A,B,C)



22. (A,B,C)

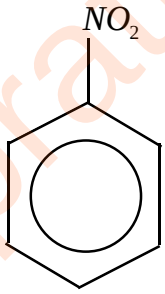
Zn^{2+} , $Cd^{2+} \rightarrow d^{10}$, configuration hence d-d transition does not occur and they do not exhibit colour. While other metal cations have configuration d^{1-9}, but due to presence of different ligands or geometrical isomeris they exhibit different colout in respective pair.

23. (A,B,C)



A)

B) PhN_2^+ undergoes diazocoupling with phenol to give orange dye.



C) $Ph-\overset{+}{N}_2$ does not undergoes diazicoupling with because of weak- E^+ and weak Nu interaction.

D) β -Naphthal gives red colourdye with $Ph-N_2^+$ (not blue dye).

24. (C,D)

$Fe^{3+}(aq)+KCN \rightarrow Fe(CN)_3\downarrow$

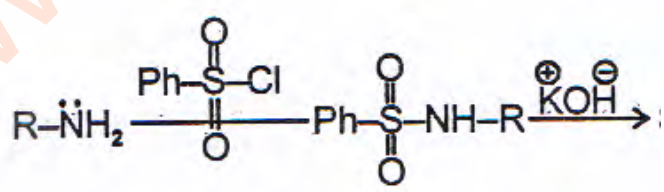
$Fe^{3+}(aq)+SCN^-(aq) \rightarrow \left[Fe(H_2O)_5(SCN)\right]^{2+}$

$Fe^{3+}(aq)+I^-(aq) \rightarrow Fe^{2+}(aq)+I_3^-(aq)$

$Fe^{3+}(aq)+S_2O_3^{2-}(aq) \rightarrow Fe^{2+}(aq)+S_4O_6^{2-}(aq)$

25. (B,C)

1° amine give clear solution with Hinsberg reagent in KOH



Soluble due to acidic (-H)

26. (A,B,C,D)

Cation : X^+ : Tetrahedral void.

Anion : Y^- : CCP

Distance between cation and anion $= r_{cation} + r_{anion} = 90 + 400 = 490\ pm$

$r_{cation} = 0.225\ r_{anion} = 0.225 \times 400 = 90\ pm$

$a\frac{\sqrt{3}}{4} = 490 \Rightarrow a = \frac{1960}{\sqrt{3}}\ pm$

Minimum distance between two cation $= \frac{a}{2} = \frac{1960}{2\times\sqrt{3}} = \frac{980}{\sqrt{3}}\ pm$

Maximum distance between two cation $= a\frac{\sqrt{3}}{2} = \frac{1960}{\sqrt{3}} = \frac{\sqrt{3}}{2} = 980\,pm$

Fraction of edge occupied by particle $= \frac{2\times r_p}{a} = \frac{2\times 400}{1960}\times\sqrt{3} = 0.707$

27. (A,B,D)

Silver has more affinity for sulphur in comparison of oxygen.

28. (A,D)

$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

0.1	0	0
0.1-x	x	x

$k = \frac{1}{t}.ln\frac{0.1}{0.1-x}$ .....(1)

$\Delta T_b = k_b \times \frac{1000}{w}\left(n_S + n_G + n_F\right)$

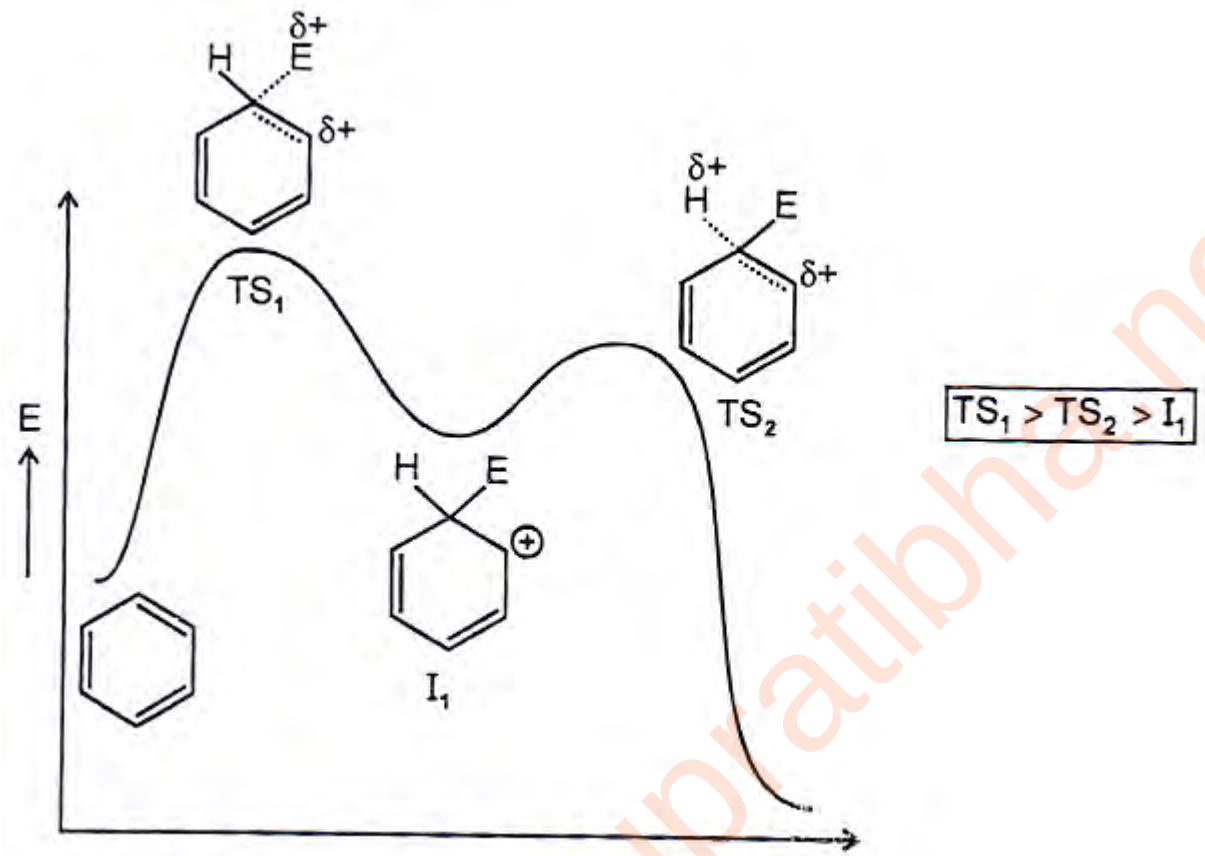
$8.3 = 0.52\times\frac{1000}{65.8}\left(0.1-x+x+x\right)$

$0.1+x = 1.05 \Rightarrow x = 0.05$

$k = \frac{1}{10}\times ln\frac{0.1}{0.1-0.05} = \frac{\ln 2}{10}\frac{ln2}{t_{0.5}} \Rightarrow t_{0.5} = 10\,\text{min}$

$M_{obs} = \frac{342\times 0.05 + 180\times 0.05 + 180\times 0.05}{0.1-0.05+0.05+0.05} = 234$

29. (A,D)



30. (A,C)

$2Cl^- \rightarrow Cl_2(g) + 2e^-$ Anode

$2e^- + 2H_2O \rightarrow H_2(g) + 2OH^-$ Cathode

$[OH^-] \uparrow \; pOH \downarrow \; pH \uparrow$

31. 6

Tripeptides possible & reach amino acid is used only once in each tripeptide

i. Ala-Gly-Tyr

ii. Ala-Tyr-Gly

iii. Gly-Ala-Tyr

iv. Gly-Tyr-Ala

v. Tyr-Ala-Gly

vi. Tyr-Gly-Ala

32. $\tan\theta = \frac{b}{RT}$

$$24.63\left(\tan\theta_1 - \tan\theta_2\right) = \frac{24.63}{0.0821\times 300}\times\left(3-2\right) = 1.0$$

33. 8

All d-block metal cations form water soluble cyano complex with excess of KCN due to complex formate while $Hg\left(CN\right)_2$ is water soluble but does not dissociate.

34. 5

$$CaOCl_2 \rightarrow Cl_2$$

$$Cl_2 + 2KI \rightarrow 2KCl + I_2$$

$$I_2 + S_2O_3^{2-} \rightarrow S_4O_6^{-2} + 2I^-$$

$$x_{I_2} = x_{Hypo}$$

$$2\times n_{I_2} = 1\times\frac{0.1\times 50}{1000}$$

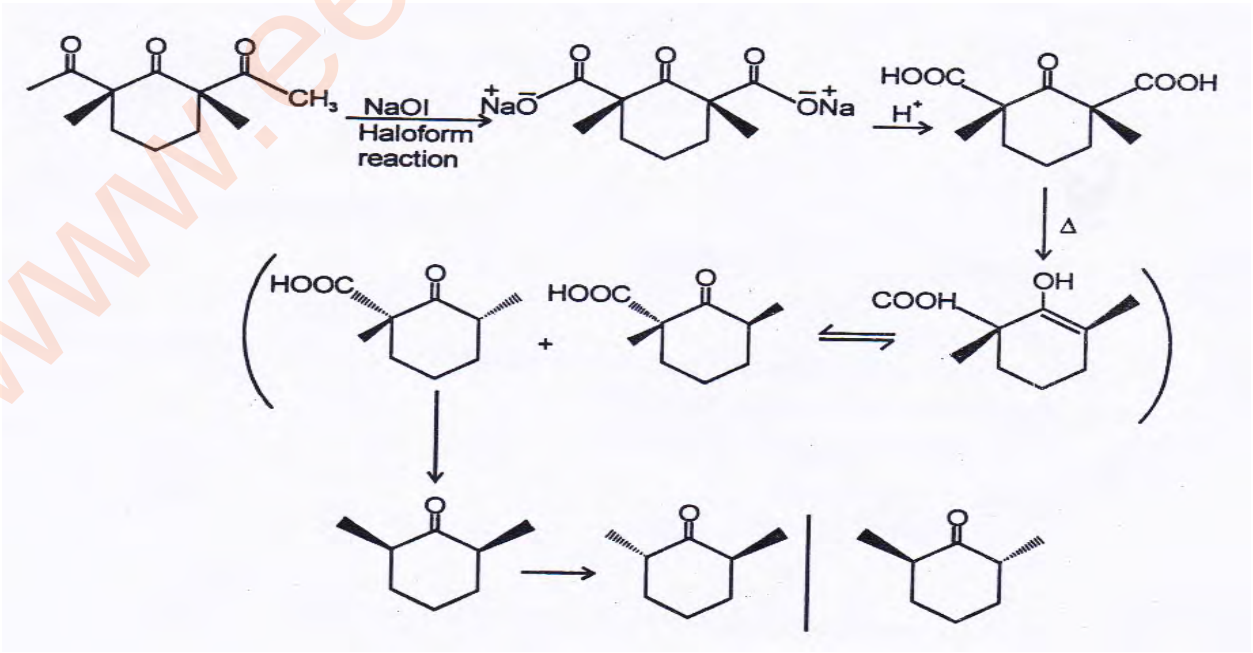
$$n_{I_2} = 2.5\times 10^{-3} = n_{Cl_2}$$

POAC 'Cl' $\quad 2\times n_{CaOCl_2} = 2\times n_{Cl_2}$

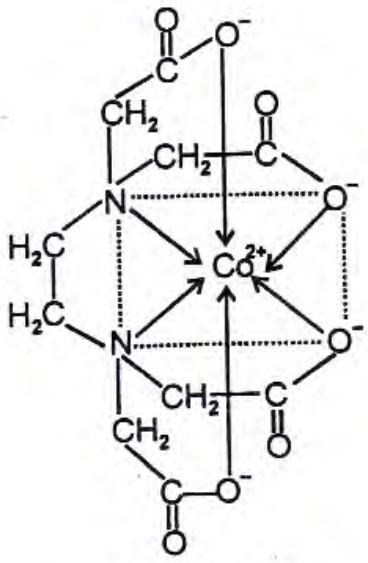
In given sample $M_{CaOCl_2} = 2.5\times 10^{-3}\times 127\times 10$

$$\%CaOCl_2 = \frac{2.5\times 127\times 10^{-3}\times 10}{63.5}\times 100 = 5$$

35. 3



36. 0



x = 0, y = 0

37. 8

$$K_{sp} = \left[Fe^{+2}\right]\left[OH^-\right]^2$$

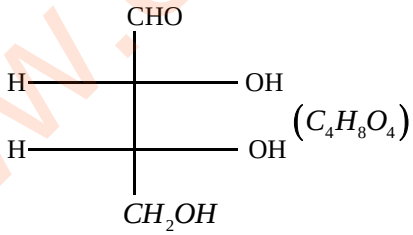
$$\left[OH^-\right]^2 = \frac{10^{-24}}{10^{-12}} = 10^{-12} \quad \Rightarrow \quad \left[OH^-\right] = 10^{-6} M$$

$$pOH = pK_b + \log\frac{0.1}{0.1} = 6$$

$$pK_b = 6$$

$$pK_a + pK_b = pK_w \quad \Rightarrow \quad pK_a = 14 - 6 = 8$$

38. 5



$(C_4H_8O_4)$

Tetrose is

In formation of disaccharide 1 mole of H_2O is lost and in formation of tetrasaccharide 3 moles of H_2O are lost. So formula of tetrose tetrasaccharide is –

$$4\times\left(C_4H_8O_4\right) \xrightarrow[-3H_2O]{} \left(C_{16}H_{26}O_{13}\right)$$

Sum of C+H+O = 55

X = 55, Y = 5

39. 3

Transition metal cations that form coloured metaborates : $Fe^{3+}, Cr^{3+}, Mn^{2+}$.

40. 8

$$C_3H_6 + 4.5O_2(g) \rightarrow 3CO_2(g) + 3H_2O(l)$$

$$-2050 = 3\times(-390) + 3(-280) - (\Delta_f H)_{C_3H_6}$$

$$(\Delta_f H)_{C_3H_6} = 40$$

Ring strain energy = 48 – 40 = 8

MATHEMATICS

41. (A,B,C,D)

$$x^3 - 4x^2 + 8x - 8 = 0 \Rightarrow (x-2)(x^2 - 2x + 4) = 0$$

$$\Rightarrow \alpha = \frac{2+\sqrt{-12}}{2} = 1 + \sqrt{3i} = -2\omega^2$$

$$\beta = 1 - \sqrt{3i} = 2\omega$$

$$\alpha^n + \beta^n = (-2)^n(\omega^n + \omega^{2n}) \in R$$

42. (B,D)

$$f(x) = f(2-x) \Rightarrow f(0) = f(2) = 0$$

$$and\ f^1(x) = -f^1(2-x) \Rightarrow f^1(1) = 0$$

43. (A,B,C)

$$ax^2 + bx + c = 0$$

$$\Delta = b^2 - 4ac = -3ac \quad (b^2 = ac)$$

$$\Rightarrow D < 0\ (a\ \&\ c\ are\ positive)$$

$$\Rightarrow ax^2 + bx + c = 0$$

$and\ x^2+2x+b=0$ have both roots common

$$\Rightarrow \frac{a}{1}=\frac{b}{2}=\frac{c}{b}\Rightarrow a=2, b=4\ and\ c=8$$

44. (A,B)

$$\left(\vec{X}\times\vec{Y}\right).\left[\left(\vec{Y}\times\vec{Z}\right)\times\left(\vec{Z}\times\vec{X}\right)\right]=\left[\vec{X}\,\vec{Y}\,\vec{Z}\right]^2$$

$$=\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}^2=\left(\frac{(a+b+c)}{2}\left((a-b)^2+(b-c)^2+(c-a)^2\right)\right)^2\geq\left(\left(\frac{1+1+2}{2}\right)\left(1^2+1^2+0^2\right)\right)^2\geq 16$$

And this value will occure if two of them is 1 and the third is 2.

45. (B,C,D)

$$x^2+(1-2a)x^2+2x+\left(a^2-5a+6\right)=0$$

$$\Rightarrow a^2-\left(2x^2+5\right)a+\left(x^4+x^2+2x+6\right)=0$$

$$\Rightarrow a^2-\left[\left(x^2+2x+2\right)+\left(x^2-2x+3\right)\right]a+\left(x^2+2x+2\right)\left(x^2-2x+3\right)=0$$

$$\Rightarrow a=x^2+2x+2\Rightarrow a\geq 1\ \ .....(1)$$

$$on\ a=x^2-2x+3\Rightarrow a\geq 2\ \ .....(2)$$

From (1) and (2)

$$a\geq 2$$

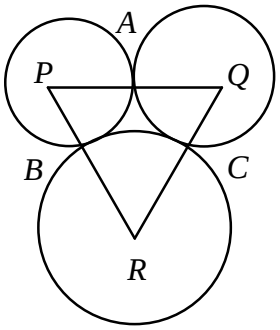
46. (A,D)

$$PA=PB=1$$

$$QA=QC=2$$

$$RB=RC=3$$

$\Rightarrow PQ = 3; QR = 5; PR = 4$



$\Rightarrow \Delta PQR$ will be a right angled triangle with $\angle P = 90°;$

$\angle Q = \sin^{-1}\frac{4}{5}$ *and* $\angle R = \sin^{-1}\frac{3}{5}$

$Area\ of\ \Delta ABC = A(\Delta PQR) - A(\Delta PAB) - A(\Delta QAC) - A(\Delta RBC)$

$= 6 - \left(\frac{1}{2}\right) - \frac{8}{5} - \frac{27}{10} = \frac{60 - 5 - 16 - 27}{10} = \frac{6}{5}$

Circum-radius of $\Delta ABC = 1$

47. (A,B,C,D)

$Let\ g(x) = f(x)e^{-2x}$

$g(1) = g(3) = g(5) = 0$

$\Rightarrow g^1(x) = e^{-2x}(f(x) - 2f(x)) = 0$ has atleast two roots

$\Rightarrow g^{11}(x) = e^{-2x}\left[f^1(x) - 4f^1(x) + 4f(x)\right] = 0$ has one real root

48. (A,B,C,D)

Let r be the radius of the variable circle then

$PC_1 = r + r_1\ ;\ PC_2 = r + r_2$

$|PC_1 - PC_2| = |r_1 - r_2| =$ Constant

49. (A,B,D)

Let $P(A)=a, P(B)=b, P(C)=c$

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

$\Rightarrow 1=a+b+c-ab-bc-ca+abc$

$\Rightarrow 1-(a+b+c)+(ab+bc+ca)-abc=0$

$\Rightarrow (1-a)(1-b)(1-c)=0 \Rightarrow$ at least one among a,b,c is 1

50. (A,B,C,D)

Let x be the first term and y be the common difference of H.P. then

$\frac{1}{a}=\frac{1}{x}+(p-1)y; \frac{1}{b}=\frac{1}{x}+(q-1)y;$

$\frac{1}{c}=\frac{1}{x}+(r-1)y$

$Common\,ratio=\frac{r-q}{q-p}=\frac{\frac{1}{c}-\frac{1}{b}}{\frac{1}{b}-\frac{1}{a}}=\frac{q}{p}=\frac{r}{q}$

$\Rightarrow Common\,ratio=\frac{q}{r}=\frac{r}{q}=\frac{(b-c)a}{(a-b)c}=\frac{r-q}{q-p}$

SECTION-II

Integer Answer Type

51. 8

$\frac{1}{a}+\frac{1}{b}=\frac{1}{2015} \Rightarrow 2015a+2015b=ab$

$\Rightarrow a=\frac{2015b}{b-2015}$

$\Rightarrow b-2015=1,5,13,31,65,165,403,2015 if\ (a\geq b)$

52. 6

x=y plane will cut the cube in two parts

y=z plane will cut in four parts

z=x will cut in 6 parts

53. 2

For x=0 two functions are possible

For x=1,2,3 there are three such functions

For x=4, one function

$n=2\times3\times3\times3\times1=2\times3^3$

54. 3

$f^1(x)g(x), g^1(x)=f^1(x), f(0)=0, f(0)=2$

$\Rightarrow f(x)=e^x-e^{-x}\quad g(x)=e^x+e^{-x}$

$I=\int_0^4 2e^x dx=2(e-1)$

$[I]=3$

55. 2

$f(x)+f\left(\frac{2x-3}{x-2}\right)=x\quad .....(1)$

$put\ x\rightarrow\frac{2x-3}{x-2}$

$f\left(\frac{2x-3}{x-2}\right)+f(x)=\frac{2x-3}{x-2}\quad .....(2)$

$from\ (1)\ and\ (2)$

$$x=\frac{2x-3}{x-2}\Rightarrow x^2-4x+3=0\Rightarrow x=3\ or 1$$

56. 2

Among $y=f(x)\ and\ y=g(x)$ one is passing through (-1,0) &(1,2) and other is passing through (-1,2) and (1,0)

$$\Rightarrow f(x)=1-x \quad \& \quad g(x)=1+x$$

$$f(x)=1+x \quad \& \quad g(x)=1-x$$

$$h(x)=\frac{1-x}{1+x} \qquad or\ \ h(x)=\frac{1+x}{1-x}$$

$$\Rightarrow h(h(x))=x \qquad or\ \ h(h(x))=-\frac{1}{x}$$

$$\Rightarrow \left|h(h(x)+h\left(h\left(\frac{1}{x}\right)\right)\right|>2$$

57. 1

$f(x)-f(y)<x-y,\forall x<y\Rightarrow f(x)-x<f(y)-y,\forall x<y\Rightarrow g(x)=f(x)-x$ is an increasing function $\Rightarrow g(x)=3$ has at most one real root.

58. 2

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

$$\int_a^b \cot^{-1}\left(1-x+x^2\right)dx=\int_a^b \tan^{-1}(1-x)dx+\int_a^b \tan^{-1}x\,dx=2P$$

59. 5

Let $\gamma\le\left|3z-(6+i)\right|$

$$\Rightarrow \left|z-\left(2+\frac{i}{3}\right)\ge\frac{\gamma}{3}\right| \ and\ \left|z-(2+7i)\right|\le 5$$

$$\left|\left(z-\left(2+\frac{i}{3}\right)\right)-\left(\frac{20i}{3}\right)\right|\le 5$$

$$-5\le\left|z-\left(2+\frac{i}{3}\right)\right|-\left|\frac{20i}{3}\right|\le 5$$

$$\Rightarrow\frac{5}{3}\le\left|z-\left(2+\frac{i}{3}\right)\right|\Rightarrow\frac{\gamma}{3}=\frac{5}{3}$$

60. 6

Let $\alpha,\beta\ and\ \gamma$ be the roots then $\alpha+\beta+\gamma=a\ and\ \alpha\beta\gamma=8$

Since $\alpha,\beta,\gamma>0\Rightarrow\frac{\alpha+\beta+\gamma}{3}\ge(\alpha\beta\gamma)^{1/3}\Rightarrow a\ge 6$

JEE-ADVANCED : KEY : PAPER-I

PHYSICS	KEY	CHEMISTRY	KEY	MATHEMATICS	KEY
1	ABCD	21	ABC	41	ABCD
2	ABCD	22	ABC	42	BD
3	BD	23	ABC	43	ABC
4	ABD	24	CD	44	AB
5	BCD	25	BC	45	BCD
6	CD	26	ABCD	46	AD
7	AC	27	ABD	47	ABCD
8	AD	28	AD	48	ABCD
9	ABCD	29	AD	49	ABD
10	AB	30	AC	50	ABCD
11	6	31	6	51	8
12	3	32	1	52	6
13	6	33	8	53	2
14	4	34	5	54	3
15	4	35	3	55	2
16	1	36	0	56	2
17	5	37	8	57	1
18	7	38	5	58	2
19	6	39	3	59	5
20	4	40	8	60	6