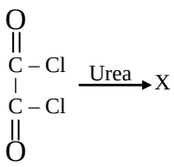
JEE(Advanced) PAPER - I

Time : 3 Hrs **Max. Marks : 240**

PART I : CHEMISTRY
SECTION – I (Total Marks:24)
(Single answer type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct**.** Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

1. 

Hence, compound X is

A) barbituric acid B) Malonic ester C) Paraboric acid D) Fumaric acid

2. Calculate the E_{H^+/H_2} if after keeping the $\left[H^+\right]$ constant the pressure is increased from 1 atm to 100 atm.

A) $-0.059V$ B) $0.59V$ C) $+0.059V$ D) $0.118V$

3. Two volatile components A and B form an ideal solution. The total vapour pressure in torr is given by the equation $P = 254 - 119x_A$ where x_A is the mole fraction of component A. The original vapour pressures of A and B are respectively

A) 135, 254 B)119, 254 C) 135, 135 D) None of these

4. What is the product formed when phosphorous trioxide reacts with cold water?

A) H_3PO_3 B) H_3PO_4 C) H_3PO_3 D) HPO_2

5. The correct order of acidic strength of following will be

$(i)\overset{\oplus}{N}H_3-CH_2-COOH, (ii)\, F-CH_2-COOH, (iii)\, CH_3CH_2COOH$

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

6. The rms velocity of a gas at T K is 'x'. The kinetic energy of the gas at the same temperature will be

A) $\frac{3RT}{x^2M}$ B) $\frac{4R^2T^2}{2M}$ C) $\frac{9R^2T^2}{x^2M}$ D) $\frac{Mx^2}{2}$

7. Molar heat capacity of CD_2O at constant pressure is $16\,cal\,mol^{-1}\,K^{-1}$ at 973K. Calculate the entropy change when 1.6 gm of CD_2O is obtained by cooling its vapours from 973 to 873 K

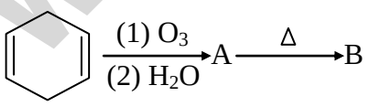
A) -0.0916 B) 0.0916 C) 0.916 D) 0.846

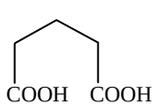
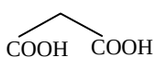
8. The effective nuclear charge of an element $(n = 3)$ if its ionization energy is 3642 k cal is

A) 8.0 B) 10.2 C) 2.8 D) 5.1

SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

9. 

A) A =  B) A =  C) B =  D) B is $CO_2 + H_2O$

10. For a first order parallel reaction $A \rightarrow C + D$ where $A \xrightarrow{k_1} C,\ A \xrightarrow{k_2} D$ at any time

A) $\frac{[C]}{[D]} = \frac{k_2}{k_1}$ B) $k_1 = k_2$ always

C) $[D]=\frac{k_1[A]_0}{k_1+k_2}\left(1-e^{-(k_1+k_2)t}\right)$ D) $\frac{d[C]}{dt}=k_3[A]$

11. The ratio of $\frac{[salt]}{[acid]}=r$. When to a 20ml of 0.1 M acetic acid, 0.1M NaOH is added from a burette. at what ratio is the pH changing with respect to 'r' when 5 ml to alkali is added.

A) $\frac{3}{2.303}$ B) $\frac{1}{3\times 2.303}$ C) $\frac{2.303}{3}$ D) 3

12. Which of the following salts on heating gives mixture of two gases?

A) $Ba(NO_3)_2$ B) $NaNO_3$ C) $RbNO_3$ D) KNO_3

SECTION – III (Total Marks: 24)
(Paragraph Type)

This section contains **2 paragraphs**. Each paragraph contains **3 multiple choice questions** Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 13 to 15

Group II cations are detected in the following way.

Original Solution $\xrightarrow{\text{dil. HCl}}$ ppt. Group-I ↑ / Filtrate ↓

Filtrate Obtained $\xrightarrow[H_2S]{}$ ppt. Group-II ↑ / Filtrate for Group III ↓

Group II ppt. + yellow ammonium sulphide $\xrightarrow[50°-60°C,\ \Delta]{}$ Residue + Filtrate

13. The residue contains

A) As^{3+} B) Sn^{3+} C) Sn^{2+} D) Pb^{2+}

14. The filtrate contains

A) tetrathionates B) sulphides C) thio complexes D) thiosulphates

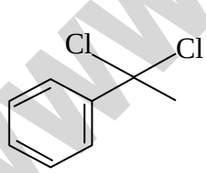
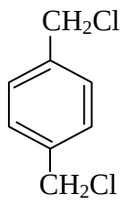
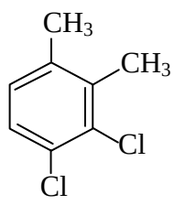
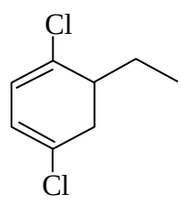
15. On treatment with dil. HCl the thio complexes decompose to

A) sparingly soluble sulphates B) sparingly soluble sulphites
C) sparingly soluble thiosulphates D) sparingly soluble sulphides

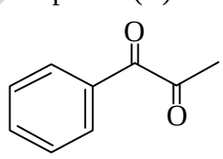
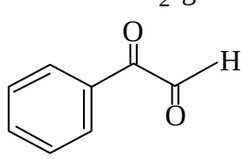
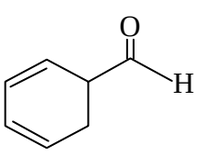
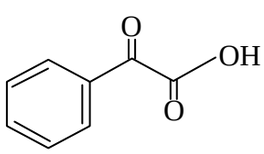
Paragraph for Question Nos. 16 to 18

A compound (A) of molecular formula C_8H_{10} on dichlorination in presence of sunlight gives (B) which on hydrolysis gives compound (C). The compound (C) gives positive iodoform test. Compound (C) on reaction with SeO_2 followed by OH^- gives (D)

16. The compound (B) is

A)  B)  C)  D) 

17. The compound (C) on reaction with SeO_2 gives

A)  B)  C)  D) 

18. The compound (D) contains

A) One chiral carbon B) two chiral carbons
C) one ketonic group D) one aldehydic group

SECTION – IV (Total Marks:16)
(Matrix-Match type)

This section contains **2 questions**. Each question has **four statements** (A, B, C and D) given in **Column 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 the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS. Each correct matching carries **2 Marks**. There is no negative marking.

19. Match the following:

Column-I	Column-II
A) CH_3OH	P) More acidic than water
B) CH_3COOH	Q) Give dis-proportionation reaction with NaOH
C) HCHO	R) Soluble in aqueous NaOH
D) HCl	S) Soluble in ammonia
	T) Reacts with alkenes

20. Match the following:

Column-I	Column-II
A) $Cl_2 + OH^-$	P) Hydrolysis
B) $NCl_3 + H_2O$	Q) Presence of vacant d-orbitals in Cl
C) $PCl_3 + H_2O$	R) Disproportionation reaction
D) $X_2O_3 + H_2O\ (X = Cl, Br, I)$	S) Presence of vacant d-orbitals in phosphorous
	T) HXO_2

PART II : MATHEMATICS
SECTION – I (Total Marks:24)
(Single answer type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct**.** Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

21. If $\theta = \frac{2\pi}{7}$ then the value of $\tan\theta \tan 2\theta + \tan 2\theta \tan 4\theta + \tan 4\theta \tan\theta$ is

A) 0 B) 7 C) – 7 D) 3

22. The major and minor axes of an ellipse are 10 and 8 respectively. The diameter of the circle which touches the ellipse internally and has centre at one of its foci if

A) 2 B) 4 C) 5 D) none of these

23. $\int \sec x \sqrt{\frac{1-\sin x}{1+\sin x}}\, dx$ is equal to

A) $\tan x + \sec x + C$ B) $\cot x - \sec x + C$
C) $\cot x - \operatorname{cosec} x + C$ D) $\tan x - \sec x + C$.

24. The number of points on the curve $y = x^3$, where the normal drawn is perpendicular to the line joining the points (–1, –1) and (2, 8) is

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

25. The equation to the projection of the line $\frac{x-1}{2} = \frac{y+1}{-1} = \frac{z-3}{4}$ on the plane $x + 2y + z = 12$ is

A) $\frac{x-4}{4} = \frac{y}{-7} = \frac{z-8}{10}$ B) $\frac{x-4}{4} = \frac{y}{-7} = \frac{z-8}{-10}$
C) $\frac{x-4}{4} = \frac{y}{4} = \frac{z-3}{-1}$ D) none of these

26. A and B are two fixed points on a given circle and C is a variable point on the circle such that $AC^2 + BC^2$ is maximum. Then the triangle ABC must be

A) right angled B) isosceles C) equilateral D) none of these

27. The area bounded by y-axis and the curve which is the solution of the differential equation, $\begin{vmatrix} \frac{1}{y} & 1 & \frac{x}{dx} \\ \frac{-1}{y} & 1 & \frac{x}{dy} \\ \frac{dy}{y} & \frac{dy}{y} & \frac{dx}{dy} \end{vmatrix} = 1$, and passes through (1,1) is

A) $\frac{1}{6}$ sq. units B) $\frac{1}{12}$ sq. units C) $\frac{1}{24}$ sq. units D) none of these

28. The number of values of x in $[0, 5\pi]$, satisfying the equation $3\cos 2x - 10\cos x + 7 = 0$ is
A) 5 B) 6 C) 8 D) 10

SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

29. A and B are non zero matrices such that AB is a null matrix, then
A) A should be a singular matrix B) B should be a singular matrix
C) both A and B should singular matrices D) none of these

30. If A and B are two events then $P(A \cap B) - P(A) \cdot P(B)$ is equal to
A) $P(A)\,P(\bar{B}) - P(A \cap \bar{B})$ B) $P(\bar{A})\,P(B) - P(\bar{A} \cap B)$
C) $P(\overline{A \cup B}) - P(\bar{A}) \cdot P(\bar{B})$ D) $P(A \cup B) - P(A \cap B)$

31. Let $g(x, t) = x(t-1)$ when $x \le t$
$= t(x-1)$ when $x > t$.

f is a continuous function on [0, 1] such that $h(x) = \int_0^1 f(t)\, g(x, t)\, dt$ then

A) $h''(x) = f(x)$ for $x \in [0, 1]$ B) $h(1) = 0$
C) $h(0) = 0$ D) $h''(x) = f'(x)$ for $x \in [0, 1]$

32. If the lines $\{\bar{r} - (i + j + k)\} \times \{(1-\alpha)i + 3j - 2k\} = 0$ and
$\{\bar{r} - (3i - j - 5k)\} \times \{(3-\alpha)i + 4j - 8k\} = 0$, are coplanar then
A) $\alpha = 3$ B) $\alpha = -1$
C) the lines intersect at $3i - 2j + 3k$ D) none of these

SECTION – III (Total Marks:24)
(Paragraph Type)

This section contains **2 paragraphs**. Each paragraph contains **3 multiple choice questions** Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 33 to 35

$f(x) = x - 1$ for $-1 \le x < 0$
$= x^2$ for $0 \le x \le 1$ } and $g(x) = \sin x$.

Further $h(x) = f(|g(x)|) + |f \circ g(x)|$.

33. The domain of h(x) is
A) [–1, 0] B) [0, 1] C) [–1, 1] D) none

34. h(x) is
A) continuous at 0 B) differentiable at 0
C) always non negative D) one-one function.

35. The number of points of extremum of h(x) is
A) 0 B) 1 C) 2 D) 3

Paragraph for Question Nos. 36 to 38

Six different books are distributed among three students A, B, C such that every student gets at least one book.

36. The number of ways of doing it is
A) 180 B) 540 C) 90 D) none

37. The probability that all of them get the same number of books is
A) $\frac{1}{6}$ B) $\frac{1}{36}$ C) $\frac{1}{2}$ D) none of these

38. Given that exactly one of them got even number of books, the probability that A got 3 books is
A) $\frac{6}{11}$ B) $\frac{1}{11}$ C) $\frac{2}{15}$ D) none of these

SECTION – IV (Total Marks:16)
(Matrix-Match type)

This section contains **2 questions**. Each question has **four statements** (A, B, C and D) given in **Column 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 the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS. Each correct matching carries **2 Marks**. There is no negative marking.

39.

Column-I		Column-II	
A)	Normal to a curve at each point (x, y) on the curve passes through a fixed point; then the curve can be	P)	straight line
B)	If the area of triangle formed by tangent at any point on a curve with the coordinate axes is a constant, then the curve can be	Q)	circle
C)	If $\|z - 2 - i\| = \|z\| \|\sin(\arg z)\|$, then locus of z is	R)	parabola
D)	The locus of the point whose chord of contact with respect to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, touches the circle described on the line joining the foci as diameter is	S)	ellipse
		T)	hyperbola

40.

Column-I		Column-II	
A)	If both the roots of $x^2 - 2kx + k^2 - 1 = 0$ lie between –3 and 4 then k takes all the values in the interval	P)	$(1, 3^{1/4})$
B)	If the greatest term in the expansion of $(1 + x)^{30}$ has the greatest coefficient and x is positive, then the range of x is	Q)	(–1, 1)
C)	The sides of a triangle are in G.P. and the largest angle is twice the smallest. The range of the common ratio (> 1) is	R)	(1, 3]
D)	The function f(x) = $\frac{x^4 - x^2 - 2x + 8}{x^4 - x^2 - 2x + 4}$ takes all the values belonging to the interval	S)	$\left(\frac{15}{16}, \frac{16}{15}\right)$

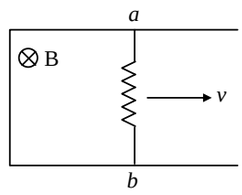
PART III : PHYSICS
SECTION – I (Total Marks:24)
(Single answer type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct**.** Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

41. A body is orbiting in a circular orbit with speed V_0 round the earth at a height above the surface equal to the radius of the earth. If the body is stopped suddenly in its orbit and allowed to move freely, then it hits the surface of earth with the speed

A) $2V_0$ B) $0.707\ V_0$ C) $1.414\ V_0$ D) $0.5\ V_0$

42. A conducting bar ab is pulled with a constant speed v on a smooth conducting rail. The region has a steady magnetic field B. If the speed of the bar is doubled, then the rate of heat dissipation in the resistance R will

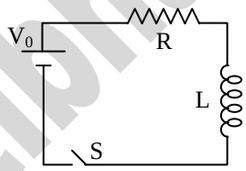


A) remain constant
B) become one fourth of the initial value
C) become four times the initial value
D) get doubled

43. A thin rod of length 1.5 m, clamped at one end is subjected to transverse vibrations in the second overtone mode. The maximum amplitude is 1 cm. The points having amplitude 0.5 cm are

A) x = 10 cm, 90 cm B) x = 20 cm, 110 cm
C) x = 50 cm, 70 cm D) x = 60 cm, 130 cm

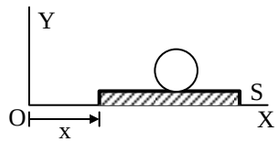
44. In the R-L circuit shown, the switch S is closed at time t = 0. The charge flown through the circuit in one time constant is



A) $\frac{V_0 L}{eR^2}$ B) $\frac{V_0 L}{R}(e-1)$

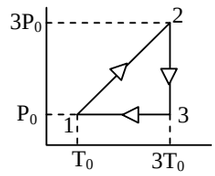
C) $\frac{V_0 L}{R^2}\left(1-\frac{1}{e}\right)$ D) $\frac{V_0 L}{R^2}\left(1-\frac{1}{e^2}\right)$

45. A solid cylinder of mass M freely rolls without slipping on a horizontal platform which executes SHM according to equation x = A sin ωt. The maximum friction force acting on the cylinder during its motion is



A) $MA\omega^2$ B) $MA\omega^2/3$
C) $2MA\omega^2/3$ D) $MA\omega^2/2$

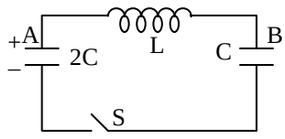
46. An ideal mono-atomic gas follows a cyclic process 1231 shown on the pressure p-temperature T diagram. The efficiency of the cycle is



A) $\frac{\ln 3}{1+\ln 3}$ B) $\frac{3\ln 3-2}{3(1+\ln 3)}$

C) $\frac{3\ln 3+2}{3(1+\ln 3)}$ D) $\frac{2\ln 3}{1+3\ln 3}$

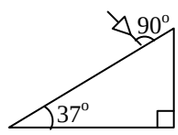
47. In the L-C circuit shown, capacitor A has an initial energy U_0. The induced emf across the inductance L, at the instant switch S is closed, is



A) $\sqrt{\frac{U_0}{C}}$ B) $\sqrt{\frac{U_0}{2C}}$

C) $2\sqrt{\frac{U_0}{C}}$ D) $\sqrt{\frac{2U_0}{C}}$

48. A ray of light is incident normally on the diagonal face of a right angled prism (μ = 5/3). The net deviation suffered by the ray when it emerges out of the prism is



A) 127^o B) 101^o
C) 90^o D) 74^o

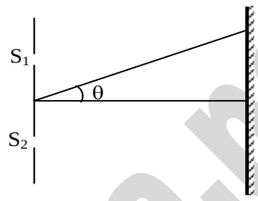
SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

49. Let the energy, magnitude of linear momentum and angular frequency of an electron in hydrogen atom be E, P and ω respectively and n the quantum number, then
A) ωEP is independent of n B) ωP varies as $\sqrt{n}$
C) ω/EP is independent of n D) E/ω varies as n

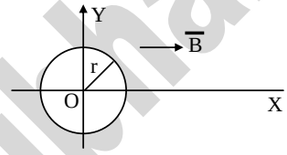
50. Capacitors C_1 = 1 μF and C_2 = 2μF are separately charged by the same battery. They are allowed to discharge separately through equal resistors at t = 0. Then
A) C_1 looses 50% of its initial charge sooner than C_2 losing 50% of its initial charge
B) The current in the two discharging circuits at t = 0 are unequal
C) The current in the two discharging circuits at t = 0 are equal and non zero
D) The current in the two discharging circuits at t = 0 are zero

51. In an interference arrangement, similar to YDSE, the slits S_1 and S_2 are illuminated with coherent sources S_1 and S_2 in phase with microwaves, of frequency 10^6 Hz. The intensity I is measured as a function of the angle θ. The maximum intensity is I_0.



A) I = I_0 for θ = 0 B) I = I_0/2 for θ = 30^o
C) I = I^0 for θ = 30^o D) I = $\frac{I_0}{\sqrt{2}}$ for θ = 45^o

52. A conducting loop of resistance R and radius r has its centre at the origin O. A uniform magnetic field $B_0\hat{i}$ exists in the region. The loop is rotated about OY axis through 90^o. The net charge flown through the loop is proportional to



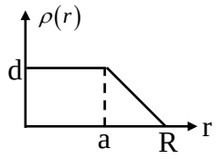
A) B_0 B) R
C) r^2 D) r

SECTION – III (Total Marks:24)
(Paragraph Type)

This section contains **2 paragraphs**. Each paragraph contains **3 multiple choice questions** Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **4 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 53 to 55

The nuclear charge (*Ze*) is non-uniformly distributed within a nucleus of radius *R*. The charge density $\rho(r)$ [charge per unit volume] is dependent only on the radial distance *r* from the centre of the nucleus as shown in figure. The electric field is only along the radial direction.



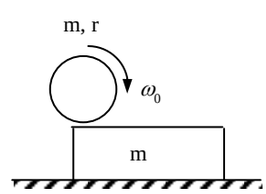
53. The electric field at *r* = *R* is :
A) independent of a B) directly proportional to a
C) directly proportional to a^2 D) inversely proportional to a

54. For a = 0, the value of *d* (maximum value of ρ as shown in the figure) is :
A) $\frac{3Ze}{4\pi R^3}$ B) $\frac{3Ze}{\pi R^3}$ C) $\frac{4Ze}{3\pi R^3}$ D) $\frac{Ze}{3\pi R^3}$

55. The electric field within the nucleus is generally observed to be linearly dependent on r. This implies:
A) a = 0 B) a = $\frac{R}{2}$ C) a = *R* D) a = $\frac{2R}{3}$

Paragraph for Question Nos. 56 to 58

In the figure shown a plank of mass *m* is lying at rest on a smooth horizontal surface. A disc of same mass *m* and radius *r* is rotated to an angular speed ω_0 and then gently placed on the plank. It is found that finally slipping cease, and 50% of total kinetic energy of the disc and plank system is lost. Assume that plank is long enough. μ is coefficient of friction between disc and plank.



56. Final velocity of the plank is :
A) $\frac{r\omega_0}{4}$ B) $\frac{r\omega_0}{\sqrt{10}}$ C) $\frac{r\omega_0}{2}$ D) $\frac{r\omega_0}{2\sqrt{10}}$

57. Magnitude of the change in angular momentum of the disk about centre of mass of the disc :

A) $\frac{3}{4}mr^2\omega_0$ B) $\frac{1}{4}mr^2\omega_0$ C) zero D) $\frac{1}{2}mr^2\omega_0$

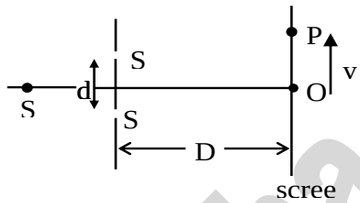
58. Distance moved by the plank from the placing of disc on the plank till the slipping ceases between disc and plank.

A) $\frac{r^2\omega_0^2}{16\mu g}$ B) $\frac{r^2\omega_0^2}{8\mu g}$ C) $\frac{r^2\omega_0^2}{32\mu g}$ D) $\frac{r^2\omega_0^2}{200\mu g}$

SECTION – IV (Total Marks:16)
(Matrix-Match type)

This section contains **2 questions**. Each question has **four statements** (A, B, C and D) given in **Column 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 the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS. Each correct matching carries **2 Marks**. There is no negative marking.

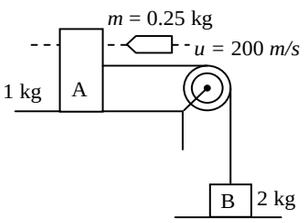
59. In a typical Young's double slit experiment, S_1 and S_2 are identical slits and equidistant from a point monochromatic source S of light having wavelength λ. The distance between slits is represented by d and that between slits and screen is represented by D.



P is a fixed point on the screen at a distance $y_0 = \frac{\lambda D_0}{2d_0}$ from central order bright on the screen: where D_0, d_0 are initial values of D and d respectively. In each statement of column-I some changes are made to above mentioned situation. The effect of corresponding changes is given in column-II. Match the statement in column-I with resulting changes in column-II.

Column-I		Column-II	
A)	The distance d between the slits is doubled keeping the source equidistant.	P)	Fringe width decreases
B)	The distance D between slit and screen is doubled by shifting screen to right	Q)	Magnitude of optical path difference between interfering waves at P will decrease
C)	The distance D between slit and screen is halved by shifting screen to left.	R)	Magnitude of optical path difference between interfering waves at P will increase
D)	The whole setup is submerged in water of refractive index $\frac{4}{3}$	S)	The intensity at P will increase
		T)	Intensity at P will decrease

60. A block A of mass = 1kg is kept on a smooth horizontal table and attached by a light thread to another block B of mass = 2kg. Block B is resting on ground, and thread and pulley are massless and frictionless. A bullet of mass m = 0.25 kg moving horizontally with velocity of u = 200 m/s penetrates through block A and comes out with a velocity of 100 m/s.



Column-I		Column-II	
A)	Velocity of the 2 kg block in m/s just after the bullet comes out.	P)	50 / 3
B)	Maximum displacements of block, A in m in left direction	Q)	20
C)	Impulse by the string on block B during penetration in $N-S$.	R)	25 / 3
D)	Impulse by the bullet on block A in $N-S$	S)	125 / 24
		T)	25

KEY

CHEMISTRY

1. C	2. A	3. A	4. C	5. C	6. D
7. A	8. B	9. B	10. C	11. A	12. A

13. D 14. C 15. D 16. A 17. B 18. D
19. A-PS; B-RS; C-QRS; D-PRST; 20. A-QR; B-PQ; C-PQS; D-PQT

MATHEMATICS

21. C 22. B 23. D 24. B 25. A 26. B
27. B 28. C 29. ABC 30. ABC 31. ABC 32. AC
33. C 34. C 35. B 36. B 37. A 38. C
39. A – Q, B – PT, C – R, D – S; 40. A – Q, B – S, C – PS, D – RP

PHYSICS

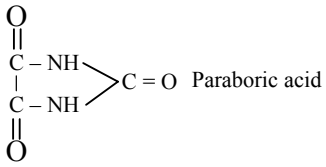
41. C 42. C 43. C 44. A 45. B 46. B
47. A 48. A 49. C, D 50. A, C 51. A, B 52. A, C
53. A 54. B 55. C 56. A 57. B 58. C
59. A-P,R,S; B-R,S; C-P,R,S; D-P,S 60. A-R; B-S; C-P; D-T

Paper-1
HINTS & SOLUTIONS

CHEMISTRY

1. C

Sol:



Paraboric acid

2. A

Sol: $E^\circ = -\frac{RT}{nF} \times 2.303 \times \log K = -\frac{0.0591}{1}\log(100)^{1/2}$

$H^+ + e^- = \frac{1}{2}H_2;\ K_p = P_{\frac{1}{2}H_2} = \left(P_{H_2}\right)^{1/2}$

3. A

Sol: If $x_A = 1, P = P_A^\circ = 254 - 119 = 135$

$x_A = 0, P = P_A^\circ = 254$

4. C

Sol: $P_4O_6 \xrightarrow{H_2O} P(OH)_3$

5. C

Sol: $\left[H^+\right] \propto \frac{1}{pK_a}$

6. D

Sol: $x = \sqrt{\frac{3RT}{M}}$ K.E. $= \frac{3}{2}RT = \frac{3}{2}R\frac{M \times x^2}{R3} = \frac{Mx^2}{2}$

7. A

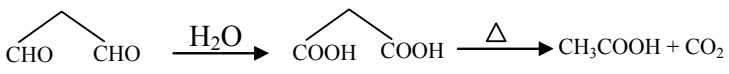
Sol: $\Delta H = mS\Delta T;\ \Delta S = \frac{\Delta H}{T} = \frac{80}{873}$

8. B

Sol: $Z_{eff} = \sqrt{\frac{IE \times n^2}{1312 kJ/mol}};\ IE = 3642 \times 4.18 kJ$

9. B

Sol:



10. C

Sol: $-\frac{d[A]}{dt} = (k_1 + k_2)[A];\ [A] = [A_0]e^{-(k_1+k_2)t}$

$$\frac{d[C]}{dt} = (k_1)[A] = (k_1)[A_0]e^{-(k_1+k_2)t}$$

$$\frac{d[D]}{dt} = (k_2)[A];\ \frac{d[D]}{d[C]+d[D]} = \frac{(k_2)[A_0]}{k_1+k_2}\left(1-e^{-(k_1+k_2)t}\right)$$

At any moment $[C] = [D]\ \therefore k_1 = k_2$

11. A

Sol: $n_{eq}\ NaOH = 5\times0.1\times10^{-3}$

$n_{eq}\ CH_3COOH = 20\times0.1\times10^{-3}$

$n_{eq}\ CH_3COONa = 0.5\times10^{-3}$

$n_{eq}\ CH_3COOH = 1.5\times10^{-3}$

$$\frac{[salt]}{[acid]} = \frac{1}{3};\ pH = pKa + \log\frac{1}{3}$$

12. A

Sol: $Ba(NO_3)_2 \xrightarrow{\Delta} BaO + NO_2 + O_2$

13. D
14. C
15. D

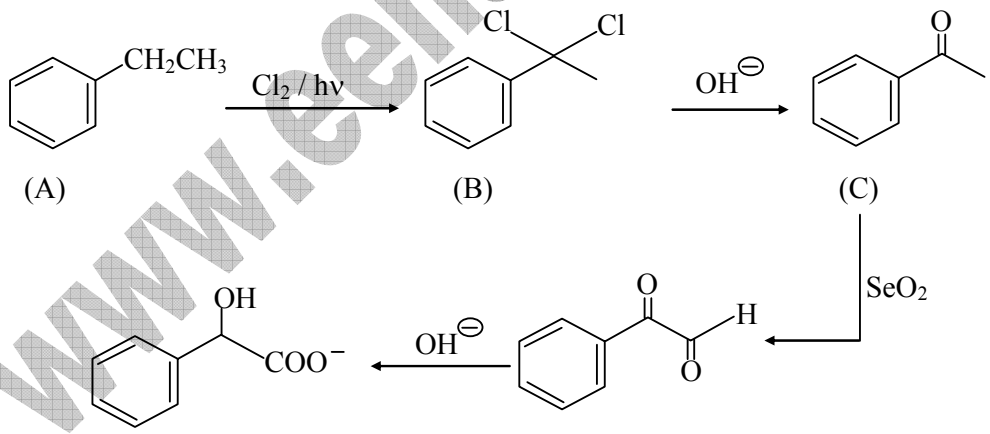
Sol: (13) Sulphides of $As^{3+}, Sb^{3+}, Sn^{2+}$ are soluble in $(NH_4)_2S$ but not of Pb^{2+}

(14) Filtrate contains polysulphides of $Sn^{2+}, As^{3+}, Bi^{3+}$

(15) Poly sulphides + dil. HCl $\rightarrow$ sparingly soluble sulphides.

16. A
17. B
18.

Sol:



19. A-PS; B-RS; C-QRS; D-PRST

Sol: CH_3OH is more acidic than water and soluble in ammonia due to Hydrogen bond. CH_3COOH and HCHO are less acidic than water but soluble in NaOH and NH_3. HCHO gives Cannizzaro reaction with NaOH. HCl is strong acid soluble in base and reacts with alkenes.

20. A-QR; B-PQ; C-PQS; D-PQT

Sol: $Cl_2 \xrightarrow{OH^-} Cl^- + ClO^-$; Cl has vacant d-orbitals

$NCl_3 + H_2O \rightarrow NH_3 + HOCl$; Cl has vacant d-orbitals

$PCl_3 + H_2O \rightarrow H_3PO_3 + HOCl$; P has vacant d-orbitals

$X_2O_3 + H_2O \rightarrow HXO_2 + HXO_3$

MATHEMATICS

21. Ans. : C

Sol. Let $Z_1 = \cos A + i \sin A$, $Z_2 = \cos 2A + i \sin 2A$ and $Z_3 = \cos 4A + i \sin 4A$.
Then $Z_1 . Z_2 . Z_3 = \cos(A + 2A + 4A)$.
$\therefore Z_1 . Z_2 . Z_3 = \cos 7A = \cos 2\pi + i \sin 2\pi = 1$.
$\rightarrow (\cos A + i \sin A)(\cos 2A + i \sin 2A)(\cos 4A + i \sin 4A) = 1$.
$\rightarrow \cos A . \cos 2A . \cos 4A(1 + i \tan A)(1 + i \tan 2A)(1 + i \tan 4A) = 1$.
Let $C = \cos \frac{2\pi}{7} . \cos \frac{4\pi}{7} . \cos \frac{8\pi}{7} = \cos A \cos 2A \cos 4A$ and

$S = \sin \frac{2\pi}{7} . \sin \frac{4\pi}{7} . \sin \frac{8\pi}{7}$. Then

$8C . S = \sin \frac{4\pi}{7} . \sin \frac{8\pi}{7} . \sin \frac{16\pi}{7}$. But $\sin \frac{16\pi}{7} = \sin\left(2\pi + \frac{2\pi}{7}\right)$

$= S . \rightarrow C = 1/8$.
$\therefore (1 + i \tan A)(1 + i \tan 2A)(1 + i \tan 4A) = 8$.
Simplify ans. **– 7**

22. Ans. : B

Sol. Diameter is $= 2(a – ae) = 2a – 2ae = 10 – 6 = 4$
Observe that $e = 3/5$.

23. Ans. : D

Sol. Multiply Nr and Dr by $\sqrt{(1 - \sin x)}$.

24. Ans. : C

Sol. If the normal drawn is $\perp$ to the line joining A(–1, –1) and B(2, 8). Tangent will be parallel to AB. If $C(x_1, y_1)$ is that point then using leg range's theorem to $f(x)\ x^3$ on [–1, 2], $f'(x_1) = \frac{f(2) - f(-1)}{2 - (-1)}$. We get x = -1 or 1

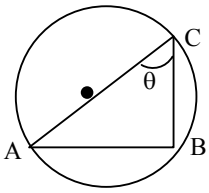
25. Ans. : A

Sol. The projection will be the line of intersection of the given plane, with the plane containing the given line and a lie $\perp$ to the given plane.
Plane containing the given line is $a(x – 1) + b(y + 1) + c(z – 3) = 0$.
Where $2a – b + 4c = 0$. This will be $\perp$ given plane if $a + 2b + c = 0$ on solving $\frac{a}{-4} = \frac{b}{2} = \frac{c}{5}$.
$\therefore$ The equation of the plane is $9x – 2y – 5z + 4 = 0$.
$\therefore$ The line is the line of intersection of (1) and $x + 2y + z – 12 = 0$. Let l, m, n be the d.cs of the line.
Then $9l – 2m – 5n = 0$ and $l + 2m + n = 0$.
$\rightarrow \frac{l}{4} = \frac{m}{-7} = \frac{n}{10}$
Substituting y = 0, any point on the line is (4, 0, 8).

$\therefore$ Equation is $\frac{x-4}{4} = \frac{y}{-7} = \frac{z-8}{10}$.

26. Ans. : B

Sol.



In Δle ABC, $AB^2 = AC^2 + BC^2 - 2AC.BC \cos\theta$

$AC^2 + BC^2$ is max $\rightarrow AB^2 + 2AC.BC \cos\theta$ is max. But for all positions of C, AB and O are constants. AC.BC maximum or ½ AC.BC sin θ is max.

$\therefore$ $AC^2 + BC^2$ max. implies Δ is max or ½ h × AB is maximum or h is maximum $\rightarrow$ height is the diameter.

$\therefore$ AC = CB or Δle is isosceles. Ans. : B.

27. Ans. : B

Sol. First apply $R_1 - R_2$ then $\frac{x}{dy}$. $C_2 - C_3$ and expand by R_1 to get $\frac{dx}{dy} - \frac{x}{y} = \frac{y}{2}$.

Solve by variable separable method to get $y^2 + cy = 2x$, a parabola.

If it passes through (1, 1) then C = 1.

Area = $\int_{-1}^{0} \frac{\left(y^2 + y\right)}{2} dy = \frac{1}{12}$ sq. units. Ans. : B.

28. Ans. : C

Sol. 8 . (cos x – 1) (3 cos x – 2) = 0. $\rightarrow$ cos x = 1 or 2/3.

29. Ans. : ABC

Sol. Given AB = 0. Let A be non singular, then A^{-1} exists.

$\therefore$ $A^{-1}(AB) = A^{-1}\,0 \rightarrow (A^{-1}A)B = 0$

$\rightarrow$ IB = 0 or B = 0, a contradiction as B is not a null matrix.

$\therefore$ A should be singular. Similarly B should be singular.

30. Ans. : ABC

Sol. Drawing Venn diagrams observe that $A - (A \cap B) = A \cap B^C$

$\therefore$ $P(A \cap B) - P(A) \,.\, P(B) = P(A) - P(A \cap \overline{B}\ \overline{B}) - P(A)\,(B)$

$= P(A)\,\{1 - P(B)\} - P(A \cap \overline{B}) = P(A)\ P(\overline{B}) - P(A \cap \overline{B})$.

Similarly B and C are true.

31. Ans. : ABC

Sol. $h(x) = \int_0^x f(t)t(x-1)dt + \int_x^1 f(t)x(t-1)dt$

$= (x - 1) \int_0^x tf(t)dt + x\int_x^1 (t-1) f(t)dt$

Different using product rule to get

$h'(x) = \int_0^1 tf(t)dt - \int_x^1 f(t)dt$ and $h''(x) = f(x)$

also h(0) = 0, h(1) = 0.

32. Ans. : AC

Sol. Given lines can be written as $\bar{r} = (i + j + k) + \lambda\{(1-\alpha)i + 3j - 2k\}$

and $\bar{r} = (3i + j - 5k) + \mu\{(3-\alpha)i + 4j - 8k\}$

Since these lines are coplanar, $\exists$ λ, μ for which

$(i + j + k) + \lambda\{(i - \alpha)I + 3j - 2k\} = (3i + j - 5k) + \mu\{(3 - \alpha)i + 4j - 8k\}$

Companing the coefficient of i, j, k, we get

$1 + \lambda(1 - \alpha) = 3 + \mu(3 - \alpha) \quad \rightarrow \lambda(1 - \alpha) + \mu(\alpha - 3) - 2 = 0$ …… (1)

$1 + 3\lambda = 1 + 4\mu \rightarrow 3\lambda - 4\mu = 0$ ……. (2) and

$1 - 2\lambda = -5 - 8\mu \quad \rightarrow -\lambda + 4\mu + 2 = 0$ ……. (3)

eliminating, λ, μ we get $\begin{vmatrix} 1-\alpha & \alpha-3 & -2 \\ 3 & -4 & 0 \\ -1 & 4 & 2 \end{vmatrix} = 0$

$\rightarrow \alpha = 3$ then $\lambda = -1$.

Then point of intersection is $\bar{r} = 3i - 2j + 3k$.

33. Ans. : C

34. Ans. : C

35. Ans. : B.

Sols. If $x \in [-1, 1]$, $f(g(x)) = \sin x - 1$ for $-1 \le x < 0$

$= \sin^2 x$ for $0 \le x \le 1$

$|g(x)| = -\sin x$ for $-1 \le x < 0$

$= \sin x$ for $0 \le x \le 1$

$f(|g(x)|) = \sin^2 x \; \forall \; x \in [-1, 1]$. Further

$|(g(x))| = 1 - \sin x$ for $-1 \le x < 0$

$= \sin^2 x$ for $0 \le x \le 1$.

$\therefore h(x) = \sin^2 x - \sin x + 1$ for $-1 \le x < 0$

$= 2\sin^2 x$ for $0 \le x \le 1$

$h'(x) = \sin 2x - \cos x$ for $-1 < x < 0$

$= 4\sin x \cos x$ for $0 < x < 1$. The value of h(x) at x =0 is less than the neighboring values.

So local minimum at x = 0

36. Ans. : B

Sol. $\frac{\lfloor 6}{\lfloor 4 \lfloor 1 \lfloor 1} \times \frac{1}{\lfloor 2} \times \lfloor 3 + \frac{\lfloor 6}{\lfloor 2 \lfloor 2 \lfloor 2} \times \frac{\lfloor 1}{\lfloor 3} \times \lfloor 3 + \frac{\lfloor 6}{\lfloor 3 \lfloor 2 \lfloor 1} \times \lfloor 3 = 540.$

37. Ans. : A

Sol. Total out comes = 540. Favourable out comes = $\frac{\lfloor 6}{\lfloor 2 \lfloor 2 \lfloor 2} \times \frac{1}{\lfloor 3} \times \lfloor 3 = 90$

Required probability = $\frac{90}{540} = \frac{1}{6}$

38. Ans. : C

Sol. Required probability = $\frac{\frac{\lfloor 6}{\lfloor 3 \lfloor 2 \lfloor 1}}{\frac{\lfloor 6}{\lfloor 4 \lfloor 1 \lfloor 1} \times \frac{1}{\lfloor 2} \times \lfloor 3 + \frac{\lfloor 6}{\lfloor 3 \lfloor 2 \lfloor 1} \times \lfloor 3} = = \frac{2}{15}$

39. Ans. : A – Q, B – PT, C – R, D – S;

Sol. A. By definition, it is a circle.

B. Equation of tangent at (x, y) is $\gamma - y = \frac{dy}{dx}(\gamma - x)$

γ – intercept = $x - y.\frac{dx}{dy}$, γ – intercept = $y - x.\frac{dy}{dx}$.

given $\left(x - y.\frac{dx}{dy}\right)\left(y - x.\frac{dy}{dx}\right) = C$

$\rightarrow 2xy - \dfrac{y^2}{\dfrac{dy}{dx}} - x^2\dfrac{dy}{dx} = C$

$\rightarrow x^2\left(\dfrac{dy}{dx}\right)^2 - 2xy\dfrac{dy}{dx} + y^2 + C\dfrac{dy}{dx} = 0.$

differentiate this with respect to x to get $\dfrac{d^2y}{dx^2}\left(x^2\dfrac{dy}{dx} - xy + C\right) = 0$

$\rightarrow \dfrac{d^2y}{dx^2} = 0$ or $\dfrac{dy}{dx} - \dfrac{y}{x} = \dfrac{-C}{x^2}$

on solving $y = \sin x + C$ or $xy - kx^2 = C$ a straight line or a hyperbola.

C. Given $|z - 2 - i| = |z|$. $|\sin \arg z|$. Let $z = x + iy$ and $\arg z = 0$, then $\tan\theta = y/x$

$\therefore \sqrt{(x-2)^2 + (y-1)^2} = \sqrt{x^2 + y^2}\ |\sin\theta|$.

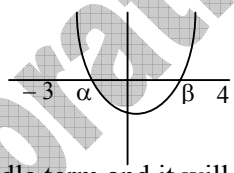
Squaring and simplifying we get $x^2 - 4x - 2y + 5 = 0$, a parabola.

D. Let the point be $P(x_1, y_1)$ then $\dfrac{xx_1}{a^2} - \dfrac{yy_1}{b^2} - 1 = 0$

touches $x^2 + y^2 = a^2c^2 = a^2 + b^2$. The locus is $\dfrac{x^2}{a^4} + \dfrac{y^2}{b^4} = \dfrac{1}{a^2 + b^2}$, an ellipse.

40. Ans. : A – Q, B – S, C – PS, D – RP

Sol. A. Let $f(x) = x^2 - 2kx + k^2 - 1 = 0$
use $f(-3) > 0$, $f(4) > 0$ and
discriminant > 0 to get $-1 < k < 1$.



B. In the expansion of $(1 + x)^{30}$, 16^{th} term is middle term and it will have greatest coefficient. It should be the greatest term $\rightarrow 15 < \dfrac{31x}{1+x} < 16$

$x \in \left(\dfrac{15}{16}, \dfrac{16}{15}\right)$.

C. Let the sides be a, ar, ar^2 and angles opposite to a and ar^2 be θ and 2θ, the using sine rule $\dfrac{\sin 2\theta}{ar^2} = \dfrac{\sin\theta}{a}$ or $r^2 = 2\cos\theta$. Obviously $2\theta > 60^o$ as 2θ is the largest angle.

$\therefore \cos 2\theta < ½$ $\therefore 2\cos^2\theta - 1 < ½$ or $\cos^2\theta < 3/4$. But $r^2 = 2\cos\theta$

$\rightarrow \dfrac{r^4}{4} < ¾$ $r < 3^{1/4}$.

But $r > 1$ $\therefore r \in (1, 3^{1/4})$.

D. $f(x) = \dfrac{x^4 - x^2 - 2x + 8}{x^4 - x^2 - 2x + 4} = 1 + \dfrac{4}{(x^2-1)^2 + (x-1)^2 + 2}$

$f(x)$ takes maximum value 3 when $x = 1$
and $f(x) \rightarrow 1$ as $x \rightarrow \pm\infty$ $\therefore f(x) \in (1, 3]$.