MOCK TEST PAPER - 2 (KEY)

Physics

1) **4**	2) **1**	3) **3**	4) **1**	5) **4**	6) **3**	7) **2**	8) **3**	9) **4**	10) **2**
11) **3**	12) **4**	13) **4**	14) **4**	15) **3**	16) **2**	17) **4**	18) **3**	19) **1**	20) **1**
21) **1**	22) **3**	23) **2**	24) **4**	25) **4**	26) **2**	27) **1**	28) **4**	29) **3**	30) **3**
31) **1**	32) **4**	33) **3**	34) **3**	35) **2**	36) **2**	37) **2**	38) **2**	39) **2**	40) **3**
41) 4	42) **2**	43) **1**	44) **3**	45) **4**	46) **1**	47) **1**	48) **3**	49) **3**	50) **4**
51) **1**	52) **3**	53) **4**	54) **2**	55) **4**	56) **3**	57) **2**	58) **4**	59) **2**	60) **1**

Chemistry

61) **3**	62) **2**	63) **3**	64) **1**	65) **3**	66) **1**	67) **1**	68) **3**	69) **2**	70) **1**
71) **1**	72) **4**	73) **4**	74) **4**	75) **1**	76) **4**	77) **1**	78) **3**	79) **2**	80) **2**
81) **2**	82) **3**	83) **2**	84) **4**	85) **2**	86) **3**	87) **1**	88) **1**	89) **1**	90) **2**
91) **2**	92) **4**	93) **3**	94) **1**	95) **3**	96) **2**	97) **4**	98) **4**	99) **1**	100) **4**
101) **1**	102) **1**	103) **4**	104) **2**	105) **2**	106) **1**	107) **1**	108) **4**	109) **4**	110) **2**
111) **1**	112) **3**	113) **2**	114) **4**	115) **4**	116) **2**	117) **1**	118) **2**	119) 4	120) **3**

Mathematics

121) **3**	122) **2**	123) **2**	124) **4**	125) **3**	126) **1**	127) **4**	128) **2**	129) **4**	130) **4**
131) **3**	132) **1**	133) **2**	134) **4**	135) **4**	136) **3**	137) **2**	138) **3**	139) **1**	140) **3**
141) **2**	142) **1**	143) **4**	144) **1**	145) **3**	146) **1**	147) **2**	148) **4**	149) **2**	150) **3**
151) **3**	152) **1**	153) **1**	154) **3**	155) **4**	156) **2**	157) **3**	158) **3**	159) **1**	160) **3**
161) **2**	162) **2**	163) *	164) **3**	165) **3**	166) **4**	167) **2**	168) **1**	169) **2**	170) **3**
171) **4**	172) **2**	173) **4**	174) **1**	175) **3**	176) **2**	177) **2**	178) **1**	179) **3**	180) **3**

HINTS AND SOLUTIONS

SUBJECT : PHYSICS

1. **(4)** Two waves $y_1 = A\sin(kx - 2\pi vt)$

$y_2 = A\sin(kx - 2\pi vt + \phi)$

after superposition resultant wave is

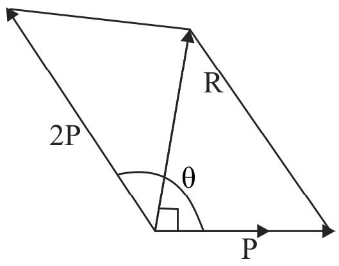
$$y = \left(2A\cos\frac{\phi}{2}\right)\sin\left(kx - 2\pi vt + \frac{\phi}{2}\right)$$

As given, A = $2A\cos\frac{\phi}{2}$

$$\Rightarrow \cos\frac{\phi}{2} = \frac{1}{2} \Rightarrow \frac{\phi}{2} = \frac{\pi}{3} \Rightarrow \phi = \frac{2\pi}{3}$$

phase differnce between two waves

2. **(1)** $\vec{R}$ is the resultant of $\vec{P}$ and 2 $\vec{P}$ is perpendicular to the vector $\vec{P}$



Let θ be the angle between the two vectors $\vec{P}$ and 2 $\vec{P}$

Then $\tan 90^o = \dfrac{2P\sin\theta}{P + 2P\cos\theta}$

$$\therefore P + 2P\cos\theta = 0$$

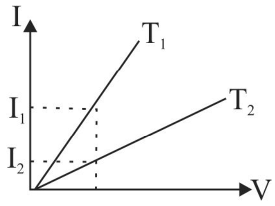
$$\Rightarrow \cos\theta = 1/2$$

$$\Rightarrow \cos\theta = 1/2$$

3. **(3)**

4. **(1)**

From the figure, it is clear that for the same potential difference current throught the conductor at temperature T_1 is more than that at the temperature T_2.



$\therefore$ The resistance of the metallic conductor is more in case of temperature T_2

Also, we know that the resistance of a conductor increase with temperature

Therefore, $T_2 > T_1$

5. **(4)**

It impllies the combination of 10cm of liquid A and 20cm of liquid B

$\therefore$ Rotation $\dfrac{38}{2} - \dfrac{24}{3} \times 2 = 3^o$ right handed

6. **(3)**

Thickness of dielectic slab t = $\dfrac{d}{2}$. Let its dielectric constant be K. Then,

$$C' = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}} = \frac{\varepsilon_0 A}{d - \frac{d}{2} + \frac{d}{2K}}$$

$$= \frac{\varepsilon_0 A}{\frac{d}{2}\left(1 + \frac{1}{K}\right)} = \frac{4}{3}\frac{\varepsilon_0 A}{d} \text{ (given)}$$

$$\Rightarrow K = 2$$

7. **(2)**

In Young's double slit experiment, the central bright fringe can be identified by using whitelight instead of monochromatic light because if the slit is illuminated with white light, then a central white fringe is obtained surrounded with a few coloured fringes.

8. (3)

Susceptibility of diamagnetic substance is negative and it does not change with temperature

9. (4)

A hydrogen atom emits a photon in the Balmer series. When the electron jumps from excited state to (n > 2) to the lower energy state corresponding to the pricipal quantum n = 2. Bit still it is in excited state and it tries to emit another photon to reach the ground state (n = 1) where the energy is least. Therefore, it must emit another photon in Lyman series

10. (2)

$$R = \frac{V}{i_g} - G = \frac{10V}{10\times10^{-3} - 1} = 999\Omega$$

11. (3)

The SI unit of radioactivity is Becqueral

12. (4)

Induced emf in rectangular coil is given by

$e = nBA\omega \sin\theta$

$= 300\times4\times10^{-2}\times25\times10\times10^{-4}\times2\pi\times50\times\sin 90^o$

$= 30\pi\times10^{6}\times10^{-6} = 30\pi$

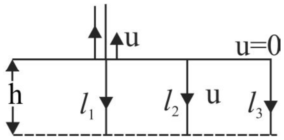
13. (4)

Guass's law states that the electric flux ϕ_E through any closed surface is equal to $1/\varepsilon_0$ times the net charge q enclosed by the surface. That is

$$\phi_E = \oint \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$$

14. (4)

Let h be the height of the tower. Then from the laws of motion (under gravity), we get



$h = -ut_1 + \frac{1}{2}gt_1^2$ (1) ; when projected upwards with velocity u

$h = -ut_2 + \frac{1}{2}gt_2^2$ (2) ; when thrown downwards with velocity u

Also $h = \frac{1}{2}gt_3^2$ (3) ; when released from rest

From (1), we get $\frac{h}{t_1} = -u + \frac{1}{2}gt_1$ (4)

From (2), we get $\frac{h}{t_2} = u + \frac{1}{2}gt_2$ (5)

Adding (4) and (5) we get

$$h\left(\frac{1}{t_1} + \frac{1}{t_2}\right) = \frac{1}{2}g\left(t_1 + t_2\right)$$

putting the values of h from (3)

$$\Rightarrow t_3 = \sqrt{t_1 t_2}$$

15. (3)

A stream lined body has less resistance due to air

16. (2)

Escape velocity $= v_e = \sqrt{\frac{2GM}{R}}$

where M and R are the mass and radius of the planet respectively.

The initial kinetic energy of the body $= \frac{1}{2}mv^2$

$$=\frac{1}{2}m\left(\frac{v_e}{2}\right)^2=\frac{1}{2}m\frac{2GM}{R}=\frac{GMm}{4R}$$

Initial potential energy on the surface of the planet = $-\frac{GMm}{R}$

$\therefore$ Total energy $=\frac{GMm}{4R}-\frac{GMm}{R}=-\frac{3}{4}\frac{GMm}{R}$

Let the maximum height attained by the body be h. The kinetic energy at that point is zero

Potential energy at that height = $-\frac{GMm}{R+h}$

$\therefore$ Total energy $=0-\frac{GMm}{R+h}=\frac{GMm}{R+h}$

$\therefore$ From the principle of conservation of energy

$$-\frac{GMm}{R+h}=-\frac{3}{4}\frac{GMm}{R}$$

$$\Rightarrow 3R+3h=4R\Rightarrow h=R/3$$

17. (4)

$$\omega^2=\omega_0^2+2\alpha\theta$$

after 36 rotations $\omega=\omega_0/2$

$$\frac{\omega_0^2}{4}=\omega_0^2+2\alpha\theta$$

$$\therefore \omega_0^2=-\frac{8\alpha\theta}{3}$$

Now $\omega_1=0$ (after it comes to rest)

$$\therefore \omega_0^2=2\alpha\theta_1 \text{ or } \frac{8\alpha\theta}{3}=2\alpha\theta_1$$

$$\therefore \theta=\theta_1\times\frac{6}{8}$$

No. of rotations = $\frac{8}{6}\times 36=48$

No. of rotations more = 48 - 36 = 12

18. (3) According to the Stefan's law , the total energy emitted per second by a unit area of a black body is proportional to the fourth power of its absolute temperature. Thus blue glass is at high temperature than red glass therefore it shines brighter than red glass.

19. (1)

Efficiency of Carnot's engine is given by

$$\eta=1-\frac{T_2}{T_1}$$

Where T_1 is the source (higher) temperature and T_2 is the sink (lower) temperature in Kelvin

$$\therefore \eta_1=1-\frac{0+273}{200+273}=0.423$$

$$\eta_2=1-\frac{-200+273}{0+273}=0.732$$

$$\therefore \eta_1=\eta_2=\frac{0.423}{0.732}=\frac{1}{1.73}=1:1.73$$

20. (1)

Apparent weight when submerged in water

= 50.7 - 0.0075 x 1000

= 50.7 - 7.5kg = 43.2kg

Now as $v=\frac{1}{2l}\sqrt{\frac{T}{M}}$

$$\therefore \frac{v_2}{v_1}=\sqrt{\frac{T_2}{T_1}}$$

or $\frac{v_2}{260}=\sqrt{\frac{43.2}{50.7}}$

$$\therefore v_2=240Hz$$

21. (1)

Flux = E . dx

where dx is area vector.

Since the angle between the electric field and surface of cylinder is 90^o. Therefore total flux fro surface of cylinder is zero

22. **(3)**

A superconductor exhibits perfect diamagnetism

23. **(2)**

24. **(4)**

The work done in carrying a charge round a closed path is zero, because the path is equipotential

25. **(4)**

The wavelength of light is very small $\left(4\times10^{-5} to 7\times10^{-5} cm\right)$ compared to the sizes of the obstacles or apertures ordinarily used and as a result no diffraction (bending of light rays) can be detected

26. **(2)**

27. **(1)**

Power = V x i

As they are connected in parallel, V is the same

$$\therefore \frac{power}{V}=i;\frac{100}{V}>\frac{60}{V}$$

$\therefore$ 100 watts bulb draws more current than the 60 watt bulb

28. **(4)**

Consider the fission reaction suggested by Hahn and Strassman

$${}_{92}U^{235}+{}_0n^1\rightarrow{}_{56}Ba^{141}+{}_{36}Kr^{92}+3{}_0n^1$$

For the reaction,

Initial masses,

$${}_{92}U^{235}-235.0439 a.m.u$$
$${}_0n^1-1.0087 a.m.u$$
$$Total=236.0526 a.m.u$$

Final masses

$${}_{56}Ba^{141}-140.9139 a.m.u$$
$${}_{36}Kr^{92}-91.8973 a.m.u$$
$$3{}_0n^1-3.0261 a.m.u$$
$$Total=235.8373 a.m.u$$

$\therefore$ Percentage of mass converted into energy

$$=\frac{236.0526-235.8373}{236.0526}=0.0912\%\simeq0.1\%$$

29. **(3)**

$$180 \text{km/h}=50 \text{m/s}$$

Induced emf = Blv

$$=0.2\times10^{-4}\times1.5\times50=1.5mV$$

30. **(3)**

At resonance of LC circuit

$$\omega=\frac{1}{\sqrt{LC}} \text{ or } T=2\pi\sqrt{LC}$$

$\therefore \sqrt{LC}$ has a dimension of time

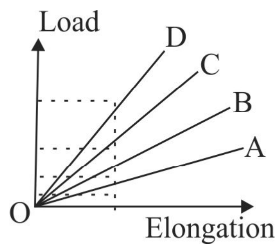
31. **(1)** Intrinsic

32. **(4)**

33. **(3)**

Young's modulus $=\dfrac{stress}{strain}$

Since Young's modulus is fixed for a material, stress will be same for the same strain (elongation per unit length)



Also, stress = $\dfrac{load}{cross-sectionareaofthewire}$

Now, for the same elongation, the load is minimum for the line OA. So the thinnest wire is represented by OA

34. (3)

35. (2)

Dimensions of Planck's constant = ML^2T^{-1}

Dimension of angular momentum = ML^2T^{-1}

36. (2)

37. (2)

Let T_1 and T_2 be the initial and final temperatures of the black body

$$\therefore T_1\lambda_0 = T_2 \times \frac{3}{4}\lambda_0$$

(from Wein's displacement law)

$$\therefore T_1 = \frac{3}{4}T_2 \text{ or } \frac{T_2}{T_1} = \frac{4}{3}$$

Now, initial radiated power = σT_1^4

Final radiated power = σT_2^4

(where σ is Stefan Boltzmann constant)

$\therefore$ The factor by which the radioactive power increases

$$= \frac{\sigma T_2^4}{\sigma T_1^4} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{4}{3}\right)^4 = \frac{256}{81}$$

38. (2)

Induction coil is a device used to produce high potential difference using a source of low potential difference. It is based on the principle of mutual induction

39. (2)

For photoelectric emission the wavelength of incident light should be smaller than threshold wavelength . The wavelength of ultraviolet light is about $4000\overset{o}{A}$

40. (3)

$$\vec{A}.\vec{B} = 0 \Rightarrow \vec{A} \perp \vec{B}$$

$$\vec{A}.\vec{C} = 0 \Rightarrow \vec{A} \perp \vec{C}$$

i.e., $\vec{A}$ is perpendicular to both $\vec{B}$ and $\vec{C}$, i.e., $\vec{A}$ is parallel to $\vec{B} \times \vec{C}$

41. (4)

42. (2)

Under the same conditions of temperature and pressure the velocities of sound in differenct gases are inversely proportional to the square root of their densities

$$\therefore \frac{v_H}{v_O} = \sqrt{\frac{\rho_O}{\rho_H}} = \sqrt{\frac{16}{1}}$$

Since density of oxygen (ρ_O) is 16 times that of hydrogen (ρ_H)

$$\therefore v_H = 4v_O$$

43. (1)

44. (3)

45. **(4)**

From equation of motion, $h = ut + \frac{1}{2}gt^2$

as direction of balloon is upward from which stone is thrown down. Thus,

$$h = -ut + \frac{1}{2}gt^2 = 29 \times 10 + \frac{1}{2} \times 98 \times 10^2$$

= - 290 + 490 = 200m

46. (1)

Observed rotation for the dextrorotatory solution, $\alpha_1 = [\alpha]_D lC$, where

$[\alpha]_D$ = specific rotation = $0.01 rad m^2 kg^{-1}$

C = concentration = $60 kg m^{-3}$

l = length of the polarimeter tube = 0.29m

$\therefore \alpha_1 = 0.01 \times 0.29 \times 60 = 0.174 rad$

Similarly, observed rotation for laevo rotatory solution, $\alpha_2 = -[\alpha]_L lC$

Here, $[\alpha]_L$ = specific rotation = $0.02 rad m^2 kg^{-1}$

C = $30 kg m^{-3}$, l = 0.29m

$\alpha_2 = -0.02 \times 0.29 \times 30 = -0.174 rad$

The rotations for dextrorotatory and laveo rotatory are in opposite directions. Therefore, observed rotations for the two solutions are of opposite sign

$\therefore$ Net rotation = $\alpha_1 + \alpha_2 = 0.174 - 0.174$

$= 0^o$

47. (1)

48. (3)

Maximum particle velocity , $v = A\omega = 2\pi v A$

But $V = v\lambda$

If V = v, then $v\lambda = 2\pi v A$ or $\lambda = 2\pi A$

49. (3)

Pressure insidea bubble is greater than the atmospheric pressure, P = 4T/R. If a hole is made in A, air will escape through A . The thread will be bent towards A making a convex line looking from A. From B towards A it is concave

50. (4)

This is a balance Wheatstone bridge so current passes through the 7Ω resistance and the effective circuit is

$$\therefore R_{eq} = \frac{5 \times 10}{5+10} = \frac{10}{3}\Omega$$

51. (1)

Normally, blowing suddenly is an adiabatic process. But as the mouth is open, pressure inside and outside is the same. Therefore blowing air with an open mouth is isobaric, as it is also not gives that it is sudden

52. (3)

As $v_e = \sqrt{\frac{2GM}{R_E}}$. If both decrease by 1% then escape velocity remain unchanged

But $g = GM / R^2$

$$\therefore g' = \frac{G\left(\frac{99}{100}M\right)}{\left(\frac{99}{100}R\right)^2} = \frac{100}{99}\frac{GM}{R^2} = \frac{100}{99}g$$

53. (4)

If a capacitor of capacitance C is charged with the help of a charging battery of constant voltage V, then energy supplied by the battery = QV = CV^2

Energy stored in the capacitor = $\frac{1}{2}QV = \frac{1}{2}CV^2$

Hence 50% of the energy drawn from the battery is stored in the capacitor

54. (2)

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

Substituting units of all

$$\Rightarrow N = \frac{1}{\varepsilon_0}\frac{C^2}{m^2} \Rightarrow \varepsilon_0 = C^2 m^{-2} N^{-1}$$

55. (4)

$$R = \sqrt{(3P)^2 + (2P)^2 + 12P^2\cos\theta}$$

$$R = P\sqrt{13 + 12\cos\theta}$$

$$R_1 = \sqrt{(6P)^2 + (2P)^2 + 24P^2\cos\theta}$$

$$= p\sqrt{40 + 24\cos\theta}$$

$$\therefore \frac{R_1}{R} = \sqrt{\frac{40+24\cos\theta}{13+12\cos\theta}} = 2$$

or $40+24\cos\theta = 52+48\cos\theta$

or $24\cos\theta = -12 \qquad \theta = 120^o$

56. (3)

V = Q/C

Q = amount of charge

C = capacitance which depends on geometry and size of conductor

57. (2)

$$V = \sqrt{\frac{T}{m}} \qquad \therefore \frac{v_A}{v_B} = \sqrt{\frac{T_A}{T_B}.\frac{m_B}{m_A}}$$

$$m_A = 4m_B \left(m \propto r^2\right)$$

$$\therefore \frac{v_A}{v_B} = \sqrt{\frac{1}{2}.\frac{1}{4}} = \sqrt{\frac{1}{8}}$$

58. (4)

Number of beats formed by two forks is equal to the difference in their frequencies

Therefore, the frequencies of the forks form a arithmetic progression with common differnce (4) is equal to 5 and number of terms is equal to 41. Let f be the frequency of the first fork.

Then 2f = f + (41 - 1) x 5

f = 200Hz

59. (2)

E = 2.2 volt, $R = 5\Omega$, V = 1.8volt

$$\therefore I = \frac{V}{R} = \frac{1.8}{5} = 0.36A$$

Fall in potential = 2.2 - 1.8 = 0.4volt

$$\therefore I_r = 0.4$$

$$r = \frac{0.4}{0.36} = \frac{10}{9} ohm$$

60. (1)

Netural point: It is that point, where the magnetic field due to a bar magnet is completely cancelled by the horizontal component of earth's magnetic field

Magnetic field at a centre of circular coil

$$\frac{\mu_0}{4\pi}\frac{2\pi nl}{a} = B_H$$

$$\Rightarrow 10^{-7} \times \frac{2\times3.14\times10\times I}{0.1} = 0.314\times10^{-4}$$

$$\Rightarrow I = \frac{0.314\times10^{-4}\times0.1}{2\times3.14\times10^{-7}\times10}$$

$$= \frac{1}{2}\times0.1\times0.1\times10^{-4}\times10^{6} = 0.5A$$

SUBJECT : CHEMISTRY

61. (3) As we know that

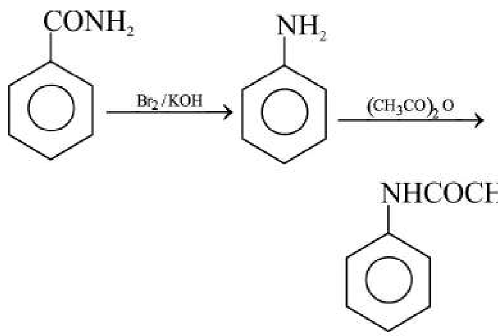
Atomic mass = Equivalent weight × Valency of element

Atomic mass = $20\times3 = 60$

Hence its oxide formula is M_2O_3 (M is symbol of element)

$$= (2\times60)+(3\times16) = 168$$

62. (2) :



acetanilide

Acetanilide has been used in medicine as antifiberin for lowering body temperature (antipyretic) and to relieve headache. On account of its toxic nature, its use as a drug is not finding favour and is replaced by more effective and less toxic drugs.

63. **(3)** Octane number is zero for n-heptane.

64. **(1)** We know

Size of cation $\propto$ hydration energy

Therefore, Cu^{2+} is more stable than Cu^{+} as the size of Cu^{2+} is smaller than the size of Cu^{+}, hence, the hydration energy will be higher for $CuCl_2$.

65. **(3)** In radioactive decay, α and β particles are not emitted simultaneously, either α or β particle is emitted, one at a time.

66. **(1)** Sometimes one of the products of a reaction is capable of accelerating the rate of a reaction. Such a reaction is called an autocatalytic reaction. For example oxidation of oxalic acid by $KMnO_4$ solution in which the product Mn^{2+} ions act as catalyst, the reaction becoming faster and faster with time.

67. **(1)** Froth floatation process is based on the preferential wetting properties with the frothing agent i.e., oil and water.

68. **(3)** Hydrometallurgy is the process of dissolving the metal or its ore by the action of a suitable chemical reagent followed by recovery of the metal either by electrolysis or by the use of a suitable precipitating agent.

$$4Au + 8KCN + 2H_2O + \underset{\text{air}}{O_2} \rightarrow$$

$$4K\left[Au(CN)_2\right] + 4KOH$$

$$2K\left[Au(CN)_2\right] + Zn \rightarrow 2Au + K_2\left[Zn(CN)_4\right]$$

69. **(2)** P_4O_{10} being acidic & NH_3 is basic, so they react with each other in presence of moisture giving ammonium phosphate. Hence P_4O_{10} can't be used for drying of NH_3.

$$P_4O_{10} + 12NH_3 \rightarrow \left[4(NH_4)_3PO_4\right] + 6H_2O.$$

70. **(1)** EAN = Z - Oxidation number of metal + (2 $\times$ No. of monodentate ligands)

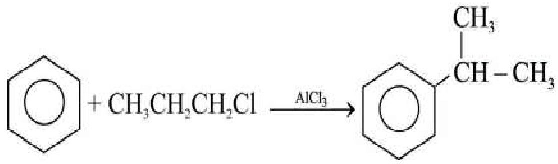
If EAN value is equal to atomic number of next nearest noble gas, then the given complex obeys EAN rule strictly.

In $K_4[Fe(CN)_6]$,

EAN of Fe = 26 - 2 + (2 x 6) = 36 (Kr)

So, the above complex strictly obeys EAN rule.

71. **(1)** Cumene is isopropyl benzene or 1-methylethyl benzene which can be prepared as follows.



1-methylethyl benzene
or cumene

72. **(4)**

2-acetoxy benzoic acid or aspirin is used as antipyretic

73. **(4)** $\Delta T_b = iK_b m = i \times K_b \times \dfrac{w_2 \times 1000}{M_2 \times w_1}$

$$M_2 = \frac{i \times K_b \times w_2 \times 1000}{\Delta T_b \times w_1}$$

Since, solute 'X' dimerizes in water at extent of 80%, i.e., $\alpha = 0.8$

$$i = 1 - \frac{\alpha}{2} = 1 - \frac{0.8}{2} = 0.6$$

$$\therefore \quad M_2 = \frac{0.6 \times 0.52 \times 2.5 \times 1000}{0.3 \times 100} = 269/mol$$

74. **(4)** Option (1): Due to the resonance in CH_3COO^-, it is a weak acid.

Option (2): Since, Cl^- is a passive ion, therefore it is a weak base.

Option (3): OH^- has small size, therefore, it is strong base than Cl^- and CH_3COO^-

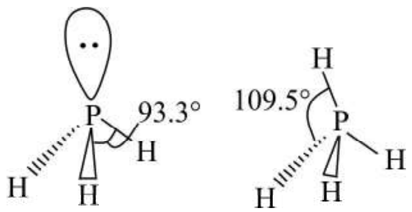
Option (4): Due to the *+I* effect of CH_3 in CH_3O^-, it is the strongest base among the given species.

75 **(1)** Among the given carbohydrates sucrose, lactose and maltose are disaccharides. Galactose is a monosaccharide

76. **(4)** Conjugate bases are the species which have one less hydrogen atom than its parent species. $NH_3 \xrightarrow{-H} NH_2^-$

Therefore, conjugate base of NH_3 is NH_2^-.

77. **(1)** PH_3 is a Drogo compound, in which only *p*-orbital participate in bonding, therefore, the bond angle in PH_3 is 93.3°. Whereas, in PH_4^+, the P is sp^3 hybridized. Therefore, due to the lone pair - bond pair repulsion, the bond angle in PH_3 and PH_4^+ are different.



78. **(3)** As we move from left to right across a period, there is regular decrease in atomic radii of the representative elements. Thus Na is larger in size than Mg.

The ionic radii of a cation is always less than the atomic radii of that very atom.

Na	Na^+	Mg	Mg^{2+}
1.54 $\overset{0}{A}$	0.95 $\overset{0}{A}$	1.36 $\overset{0}{A}$	0.65 $\overset{0}{A}$

79. **(2)** Since, in Debye - Huckel - Onsagar equation, the value of constant A depends upon the nature and charges on the cation and anion produced on dissociation of the electrolyte in the solution, thereofore, NH_4Cl and NaBr possess same value of constant A.

$NH_4Cl \rightarrow NH_4^+ + Cl^-$

$NaBr \rightarrow Na^+ + Br^-$

80. **(2)**

$X: CH_3CH_2Br \qquad Z: CH_3CH_2CH_2NH_2$

$Y: CH_3CH_2CN$

81. **(2)** According to question,

$2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3$;

$\Delta H = -1596\,kJ \qquad (1)$

$2\,Cr + \frac{3}{2}O_2 \rightarrow Cr_2O_3$;

$\Delta H = -1134\,kJ \qquad (2)$

From (1) – (2)

$2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr; \Delta H = -462\,kJ$

82. **(3)** $pK_{a(A)} = -\log K_{a(A)} = 10^{-4}$

$pK_{a(B)} = -\log K_a(B) = 10^{-5}$

By comparing, $K_{a(A)} = 10K_{a(B)}$

83. **(2)** The rate of a forward reaction is two times that of reverse reaction at a given temperature

rate of forward reaction = 2 × rate of backward reaction

$k_f = 2 \times k_b \; k_f/k_b = K_{equilibrium} = 2$

84. **(4)** For $2p \rightarrow \boxed{\pm\frac{1}{2}}\boxed{\pm\frac{1}{2}}\boxed{\pm\frac{1}{2}}$

i.e., the number of 2p electrons having spin quantum number, s = –1/2 are 3.

85. **(2)** Case hardening

86. **(3)** Electronic configuration of nitrogen atom is $1s^2 2s^2 2p^3$. Only three unpaired electrons of p orbital take part in bonding so trivalence is stable in this case. Since there is no d-orbtial in second orbit pentavalence is not stable.
Electronic configuration of phosphorus atom $1s^2 2s^2 2p^6 3s^2 3p^3 3d^0$. It can use three unpaired electrons of 3p orbital to exhibit trivalency and also can use 3d orbital to exhibit

$\left[1s^2 2s^2 2p^6 3s^1 3p^3 3d^1\right]$

87. **(1)** When an alkyl halide is heated with alcoholic solution of caustic potash dehyrohalogenation occurs, a molecule of hydrogen halide is eliminated from the adjacent carbon atoms, producing a double bond.

$$K^+ + OH^- + -\overset{\overset{\large H}{|}}{\underset{|}{C}}-\overset{\overset{\large Cl}{|}}{\underset{|}{C}}- \longrightarrow \;>C=C< \; + KCl + H_2O$$

88. **(1)**

$$CH_3-\overset{\overset{\large CH_3}{|}}{CH}-CH_3 \leftarrow \underset{\text{chloromethane}}{CH_3Cl} + Na + \underset{\text{2 – chloropropane}}{\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{CH}}-Cl}$$

89. **(1)** According to IUPAC rules

90. **(2)** The peptide bond is formed between two amino acids by the elimination of a water molecule. A dipeptide contains one peptide linkage. A tripeptide contains two peptide linkages. Similarly, a nanopeptide contains 8 peptide linkages.

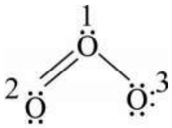
91. **(2)** The emf of the cell is measured either by a calibrated potentiometer or by a high resistance voltmeter.

92. **(4)** We know

F.C. = Total valence electron - Total non-bonding electrons

$-\dfrac{\text{Total Bonding electrons}}{2}$

For ozone molecule,



The formal charge on central atom of ozone is

F.C. = $6-2-\dfrac{6}{2}$

F.C. = $6-5=+1$

93. **(3)** $A+B \rightarrow C$,

On doubling the concentration of A rate of reaction increases by 4. Rate $\propto [A]^2$

However on doubling the concentration of B, rate of reaction increases two times. Rate $\propto [B]$. Thus, overall order of reaction

= 2 + 1 = 3.

94. **(1)** From the given formula of oxide, $M_{0.96}O$ and can also be written as $M_{96}O_{100}$.

Since, it is a mixed oxide, therefore, it contains x number of M^{2+} and $(96-x)$ number of M^{3+}.

As oxide is a neutral compound, therefore, charge on cation is equal to charge on anion.

$\Rightarrow 2x + 3(96-x) = 2\times 100$

$\Rightarrow 2x + 288 - 3x = 200$

$\Rightarrow x = 288 - 200$

$\Rightarrow x = 88$

Number of M^{3+} ions = 96 – 88 = 8

Therfore, the percentage of M^{3+} ions in $M_{0.96}O$

is $=\dfrac{8}{96}\times 100 = 8.3\%$

95. **(3)** The original solution must be free from any oxidising agent otherwise H_2S gets oxidised with precipitation of free sulphur. This is done by heating the mixture with concentrated HCl for sufficient time during preparation of original solution.

96. (2) Let the oxidation number of N be 'x'.

In NH_4^+

$$x + 4(1) = +1$$

$$x = 1 - 4$$

$$x = -3$$

In NO_3^-

$$x + 3(-2) = -1$$

$$x + -6 = -1$$

$$x = -1 + 6$$

$$x = +5$$

97. **(4)** Cl^- and K^+ are isoelectric species having same number of electrons (= 18). Greater the nuclear charge of an ion, more will be force of attraction for same number of electrons. K^+ have greater nuclear charge than Cl^- so attractive pull exerted by the nucleus is more and the size is smaller in K^+ ion.

98. (4) When silicon doped with gallium (dopant) *p*-type semiconductor is formed. Since, gallium is an acceptor element of Group 13, hence forms *p*-type semiconductors as the holes are the majority carriers and electrons are minority carriers..

99. **(1)** Alcoholic potash is used for the preparation of alkenes from by following dehydrohalogenation.

$$R-CH_2-\underset{\displaystyle \overset{|}{Cl}}{CH}-R' \xrightarrow{\text{alc.}KOH} R-CH=CH-R' + KCl + H_2O$$

100. (4) Benzyl chloride is more reactive than vinyl chloride.

101. (1) Metal that produces H_2 with dil. HCl and NaOH is Zn because this is amphoteric which can react with acids and bases.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$$

$$Zn + 2NaOH \rightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2 \uparrow$$

102. (1) ${}^{14}_{5}A \xrightarrow{-2\beta} {}^{14}_{7}N$

Number of neutrons in parent nucleus

= 14 - 5 = 9.

103. (4) Ethyl acetate is a good stimulant. It is used externally in the treatment of skin diseases.

104. (2) For first order kinetics, we have

$$k = \frac{2.303}{t}\log\left(\frac{a}{a-x}\right)$$

For $t_{60\%} = 50\,\text{min}$

$$k = \frac{2.303}{50}\log\left(\frac{100}{40}\right) \qquad (1)$$

For $t_{93.6\%} = ?\ \text{min}$

$$k = \frac{2.303}{t_{93.6\%}}\log\left(\frac{100}{6.4}\right) \qquad (2)$$

At constant temperature, the rate constant for a reaction is also constant therefore, from Eq. (1) and (2), we have

$$\frac{2.303}{50}\log\left(\frac{100}{40}\right) = \frac{2.303}{t_{93.6\%}}\log\left(\frac{100}{6.4}\right)$$

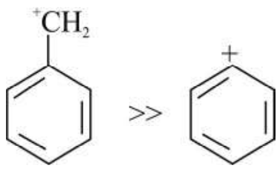
$$t_{93.6\%} = 83.8 \text{ min}$$

105. (2) Biuret test gives bluish violet colour due to the presence of - CO - NH - group.

106. (1) Water is amphoteric solvent. It can act both acids and bases.

107. (1) Those alkyl halides which form a stable carbocation shows reaction through S_N1

mechanism. Among the given alkyl haldies, benzyl chloride forms the most stable carbocation, due to the resonance, hence, it is most reactive towards S_N1 mechanism.



108. (4) The flame colours of metal ions are due to metal excess defect. These type of crystals are generally coloured. This is due to the presence of free electrons. These electrons get excited easily to higher energy levels by absorption of certain wave lengths from the visible light and therefore, the compounds appear coloured.

109. (4) Maltose

110. (2) Since, $(CH_3CH_2OCS_2K)$ potassium ethyl xanthate contain hydrocarbon, therefore, it is used in separation of ores which makes it the ore water repellant (hydrophobic).

111. (1) Change in entropy is dependent on temperature

$$\Delta S = \frac{q}{T}$$

$$\Delta S \propto \frac{1}{T}$$

ΔS inversely proportional to T

Therefore, if $T_1 > T_2$, then $\Delta S_1 < \Delta S_2$

112. (3) (i) Alcohol is first oxidised to acetaldehyde by chlorine.

$$[Cl_2 + H_2O \rightarrow 2HCl + O]$$

$$CH_3CH_2OH + O \rightarrow CH_3CHO + H_2O$$

(ii) Acetaldehyde then reacts with chlorine to form chloral.

$$CH_3CHO + 3Cl_2 \xrightarrow{\text{chlorination}} CCl_3CHO + 3HCl$$

(iii) Chloral, thus formed, is hydrolysed by calcium hydroxide.

$$CCl_3CHO + Ca(OH)_2 \rightarrow 2CHCl_3 + (HCOO)_2Ca$$

113. (2) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

$K_c = 0.1, K_p = K_c(RT)^{\Delta n}$

$\Delta n = 0, K_p = K_c = 0.1$.

114. (4) According to this law, the product of atomic mass and specific heat of a solid element is approximatley equal to 6.4.

115. (4) Normality of acid = molarity $\times$ basicity

i.e. 0.2 = molarity $\times$ 2

$\therefore$ Molarity = 0.2/2 = 0.1

116. (2) Sucrose is composed of α-D-glucopyranose unit and a β-D-fructofuranose unit. These units are joined by $\alpha,\beta-$ glucosidic linkage between C-1 of the glucose unit and C-2 of the fructose unit.

117. (1) Amylopectin is a water insoluble component of water. Amylose is a water soluble component of water.

118. (2) Since, Cu is more reactive than Ag, as it come earlier in electrochemical reactivity series, therefore, when $AgNO_3$ solution stirred with a copper spoon Cu can displace Ag from $AgNO_3$ solution stirred with a copper spoon Cu can displace Ag from $AgNO_3$ solution.

$$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

119. (4) Nucleotide contains nitrogenous bases like adenine, guanine, thymine, cytosine and uracil.

120. (3) A molecule called nucleoside is formed by condensing a molecule of the base with the appropriate pentose (i.e. base + sugar).

SUBJECT : MATHS

121. (3) $\frac{d}{dx}\left[\tan^{-1}\left(\frac{a-x}{1+ax}\right)\right]$

$\frac{d}{dx}\left[\tan^{-1}a-\tan^{-1}x\right]$

$=0-\frac{1}{1+x^2}$.

122. (2) $A_1=\int_0^{\pi/4}\cos x\,dx$

$=[\sin x]_0^{\pi/4}=\frac{1}{\sqrt{2}}-0=\frac{1}{\sqrt{2}}$

$A_2=\int_0^{\pi/4}\sin x dx=[-\cos x]_0^{\pi/4}$

$=-\left(\cos\frac{\pi}{4}-\cos 0\right)=1-\frac{1}{\sqrt{2}}$

required area $(A)=$ $(A)=|A_1-A_2|=\sqrt{2}-1$

123. (2) $\int\frac{dx}{x(x^7+1)}$

put $x^7=t;\ 7x^6\ dx=dt$

$\int\frac{dt}{7t(t+1)}=\frac{1}{7}\int\left(\frac{1}{t}-\frac{1}{t+1}\right)dt$

$=\frac{1}{7}(\log t-\log(t+1))+C$

$=\frac{1}{7}\log\left(\frac{x^7}{x^7+1}\right)+C$

124. (4)

Let $z=\sin\frac{\pi}{5}+i\left(1-\cos\frac{\pi}{5}\right)$

$\therefore Amp\,(z)=\tan^{-1}\left(\frac{1-\cos\frac{\pi}{5}}{\sin\frac{\pi}{5}}\right)$

$=\tan^{-1}\left(\frac{2\sin^2\frac{\pi}{10}}{2\sin\frac{\pi}{10}\cos\frac{\pi}{10}}\right)$

$=\tan^{-1}\left(\tan\frac{\pi}{10}\right)=\frac{\pi}{10}$

125. (3)

Projection of vector $\vec{a}$ and $\vec{b}$ is given by $\frac{\vec{a}.\vec{b}}{|\vec{b}|}$

i.e, $\vec{a}=2\hat{i}+\hat{j}-3\hat{k};\ \vec{b}=\hat{i}-2\hat{j}+\hat{k}$

$a.b=-3;|b|=\sqrt{6}\quad\therefore\frac{a.b}{|b|}=-\sqrt{\frac{3}{2}}$

126. (1)

Given that, $\cos\left(\sin^{-1}\frac{\pi}{3}+\cos^{-1}\frac{\pi}{3}\right)$

We know that $\sin^{-1}x+\cos^{-1}x=\frac{\pi}{2}$

$\cos\left(\sin^{-1}\frac{\pi}{3}+\cos^{-1}\frac{\pi}{3}\right)=\cos\left(\frac{\pi}{2}\right)=0$

127. (4)

Let $f(x)=|x|+\frac{|x|}{x}=f_1(x)+f_2(x)$

At $x=0$

$f_1(0)=0$

LHL$=\underset{h\to 0}{Lt}|x|=0,\quad R.H.L=\underset{h\to 0}{Lt}|x|=0$

$\therefore f_1(x)$ is continuous at $x=0$

Now consider $f_2(x)$ $[At\ x=0]$

$$LHL = \underset{x\to 0}{Lt}\frac{|x|}{x} \qquad [Put\ x = 0-h]$$

$$= \underset{h\to 0}{Lt}\frac{|0-h|}{0-h} = \underset{h\to 0}{Lt}-\frac{h}{h} = -1, \text{ similarly RHL=1}$$

$\therefore f_2$ is discontinuous at $x=0$

$\therefore f(x) = |x| + \frac{|x|}{x}$ is discontinuous at $x=0$

because $\frac{|x|}{x}$ is discontinuous there.

128. (2)

Given that,

$$(x) = \begin{cases} \frac{e^{1/x}-1}{e^{1/x}+1} & if\ x \neq 0 \\ 0 & if\ x=0 \end{cases}$$

Right hand limit is

$$\lim_{x\to 0} f(x) = \lim_{x\to 0}\left(\frac{e^{1/x}-1}{e^{1/x}+1}\right)$$

Dividing numerator and denominator by $e^{1/x}$, we get

$$= \lim_{x\to 0}\left(\frac{(e^{1/x}-1)/e^{1/x}}{(e^{1/x}+1)/e^{1/x}}\right) = \lim_{x\to 0}\left(\frac{1-e^{-1/x}}{1+e^{-1/x}}\right)$$

$$= \frac{1-0}{1+0} = 1$$

Therefore, $\lim_{x\to 0} f(x) = 1$

Left hand limit is

$$\lim_{x\to 0} f(x) = \lim_{x\to 0}\left(\frac{e^{-1/x}-1}{e^{-1/x}+1}\right) = \frac{0-1}{0+1} = -1$$

Therefore, $\lim_{x\to 0} = -1$

129. (4) $y = 2\sqrt{a}\sqrt{x}$

$$Area = \int_a^{4a} 2\sqrt{a}\,x^{1/2}dx = 2\times 2\sqrt{a}\left.\frac{(x)^{3/2}}{3}\right]_a^{4a}$$

$$= \frac{4\sqrt{a}}{3}.\left[(4a)^{3/2} - (a)^{3/2}\right]$$

$$= \frac{(4a)^{1/2}.(a)^{3/2}}{3}.\left[(2)^3 - 1\right] = \frac{4a^2}{3}[7] = \frac{28a^2}{3}$$

130. (4) The student can wear one pant and one shirt. The required number of ways in which he can wear the dress $= {}^5P_1 \times {}^8P_1 = 5\times 8 = 40$.

131. (3)

Given that, $A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

$$So, A^2 = A\cdot A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Therefore, $A^2 = I$

Then, $A^4 = A^2.A^2 = I.I$

132. (1) $\int_0^{2\pi}(\sin x + |\sin x|)$

$$= \int_0^{\pi}(\sin x + |\sin x|)dx + \int_{\pi}^{2\pi}(\sin x + |\sin x|)dx$$

$$= \int_0^{\pi} (\sin x + \sin x) dx + \int_{\pi}^{2\pi} (\sin x - \sin x) dx$$

$$= 2\int_0^{\pi} (\sin x dx) + 0$$

$$= 2[-\cos x]_0^{\pi} = -2(\cos \pi - \cos 0)$$

$$= -2(-1-1) = 4.$$

133. (2) $\int e^x \left(\frac{1+\sin x}{1+\cos x}\right) dx$

$$= \int e^x \left(\frac{1+2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}}\right) dx$$

$$= \int e^x \left(\frac{1}{2\cos^2\frac{x}{2}} + \frac{2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}}\right) dx$$

$$= \int e^x \left(\frac{1}{2}\sec^2\frac{x}{2} + \tan\frac{x}{2}\right) dx$$

$$\therefore \quad = \int e^x \left(f(x) + f'(x)\right) dx = e^x f(x) + c$$

$$\left[\text{where } f(x) = \tan\frac{x}{2} f'(x) = \frac{1}{2}\sec^2\frac{x}{2}\right]$$

$$e^x f(x) + C = e^x \tan\frac{x}{2} + C$$

134. (4)

Given equation of circle

$x^2 + y^2 + 4x + 6y + 13 = 0$

radius $= \sqrt{g^2 + f^2 - c} = \sqrt{4+9-13} = 0$

135. (4)

$$\lim_{x\to 0}\left[\frac{\sqrt{a+x}-\sqrt{a-x}}{x}\right]$$

$$= \lim_{x\to 0}\left[\frac{\left(\sqrt{a+x}-\sqrt{a-x}\right)\left(\sqrt{a+x}+\sqrt{a-x}\right)}{x\sqrt{a+x}+\sqrt{a-x}}\right]$$

$$= \lim_{x\to 0}\left[\frac{a+x-a+x}{x\left(\sqrt{a+x}+\sqrt{a-x}\right)}\right] = \frac{2}{2\sqrt{a}} = \frac{1}{\sqrt{a}}$$

136. (3) Given that,

$$f(x) = \begin{vmatrix} x^3 - x & a+x & b+x \\ x-a & x^2-x & c+x \\ x-b & x-c & 0 \end{vmatrix}$$

Then,

$$f(0) = \begin{vmatrix} 0 & a & b \\ -a & 0 & c \\ -b & -c & 0 \end{vmatrix}$$

It is skew symmetric determinant

$\therefore \quad f(0) = 0$

137. (2)

Given that, order of matrix A= 3 and $|A| = 5$

Now, $|A\,adj\,A| = |A|\,|adj A|$

We know that, $|adj\,A| = |A|^{n-1}$

where n is order of matrix A.

So, $|A\,adj\,A| = |A|\cdot|A|^{n-1} = 5\times 5^{3-1} = 5^3 = 125$

138. (3)

$$\left(\frac{1+x+x^2}{x}\right)\left(\frac{1+y+y^2}{y}\right) \qquad (1)$$

Let $f(x)=\dfrac{1+x+x^2}{x}, g(x)=\dfrac{1+y+y^2}{y}$

$f(x)=\dfrac{1}{x}+1+x$

w.k.t $A.M \geq G.M$

$$\frac{x+\frac{1}{x}}{2} \geq \sqrt{x-\frac{1}{x}}$$

$x+\dfrac{1}{x} \geq 2 \Rightarrow x+\dfrac{1}{x}+1 \geq 2+1=3$

$\therefore\ f(x) \geq 3$ similarly $\mathrm{g}(x) \geq 3$

from (1)

$f(x)\cdot g(x) \geq 3\cdot 3=9$

$\therefore\ \left(\dfrac{1+x+x^2}{x}\right)\left(\dfrac{1+y+y^2}{y}\right) \geq 9$

139. (1)

Surface area of cube is given by

$A=6a^2$

where, a is side of cube.

Increase in side of side is 5%.

$$\frac{da}{dt}=\frac{5a}{100}$$

Differentiating Eq. (1) with respect to t, we get

$$\frac{dA}{dt}=12a\frac{da}{dt}$$

So,

$$\frac{dA}{dt}=12a\cdot\frac{5a}{100}=\frac{60a^2}{100}$$

$$\Rightarrow \frac{dA}{dt}=\frac{10A}{100}$$

Therefore, increase in surface area is 10%.

140. (3) $\sin^{-1}\dfrac{x}{5}+\operatorname{cosec}^{-1}\dfrac{5}{4}=\dfrac{\pi}{2}$

Let $\operatorname{cosec}^{-1}\dfrac{5}{4}=A$

$\sin A=\dfrac{4}{5},\ \cos A=\dfrac{3}{5} \Rightarrow A=\cos^{-1}\dfrac{3}{5}$

$\therefore\ \sin^{-1}\dfrac{x}{5}+\cos^{-1}\dfrac{3}{5}=\dfrac{\pi}{2}$

w.r.t $\sin^{-1}x+\cos^{-1}x=\dfrac{\pi}{2}$ compare this formula

$x=3$.

141. (2) $pq-\sqrt{1-p^2}\sqrt{1-q^2}=-r$

$-\sqrt{1-p^2}\sqrt{1-q^2}=-r-pq$

$(1-p^2)(1-q^2)=(r+pq)^2$

$1-p^2-q^2+p^2q^2=r^2+p^2q^2+2pqr$

$-p^2-q^2-r^2=+2pqr-1$

$\Rightarrow p^2+q^2+r^2+2pqr=+1$

142. (1)

$$\tan 70^0=\tan\left(50^0+20^0\right)=\frac{\tan 50^0+\tan 20^0}{1-\tan 50^0\tan 20^0}$$

$\Rightarrow \tan 70^0-\left(\tan 70^0\tan 20^0\right)\tan 50^0$

$=\tan 50^0+\tan 20^0$

$\Rightarrow \tan 70^0-\cot 20^0\tan 20^0\tan 50^0$

$=\tan 50^0+\tan 20^0$

$\Rightarrow \tan 70^0-\tan 50^0=\tan 50^0+\tan 20^0$

$\Rightarrow \tan 70^0-\tan 20^0=2\tan 50^0$

$\therefore \dfrac{\tan 70^0-\tan 20^0}{\tan 50^0}=2$

143. (4)

Given that $\therefore \quad f(x)=\begin{cases}\dfrac{1-\cos kx}{x\sin x}, if\ x\neq 0\\ \dfrac{1}{2}, if\ x=0\end{cases}$

and $f(x)$ is continuous at $x=0,$ so,

$$\lim_{x\to 0} f(x)=f(0)$$

$$\lim_{x\to 0}\frac{1-\cos kx}{x\sin x}=\frac{1}{2}$$

$$\lim_{x\to 0}\frac{1-\cos ax}{x^2}=\frac{a^2}{2},\ \lim_{x\to 0}\frac{\sin x}{x}=1$$

$$\lim_{x\to 0}\frac{1-\cos kx}{x^2}\times\lim_{x\to 0}\frac{1}{\left(\dfrac{\sin x}{x}\right)}=\frac{1}{2}$$

$$\frac{k^2}{2}\cdot\frac{1}{(1)}=\frac{1}{2}\Rightarrow k^2=1$$

$$k=\pm 1$$

144. (1)

$$2X+\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}=\begin{bmatrix}3 & 8\\ 7 & 2\end{bmatrix}$$

$$2X=\begin{bmatrix}3 & 8\\ 7 & 2\end{bmatrix}-\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}=\begin{bmatrix}2 & 6\\ 4 & 2\end{bmatrix}\Rightarrow X=\begin{bmatrix}1 & 3\\ 2 & -1\end{bmatrix}$$

145. (3)

$$i.e.\quad \sin\theta.\frac{1}{\sqrt{2}}+\cos\theta.\frac{1}{\sqrt{2}}=\frac{1}{\sqrt{2}}$$

$$i.e,\quad \sin\left(\theta+\frac{\pi}{4}\right)=\sin\frac{\pi}{4};$$

$$\therefore \theta+\frac{\pi}{4}=n\pi+(-1)^n\frac{\pi}{4}$$

$$\theta=n\pi+(-1)^n\frac{\pi}{4}-\frac{\pi}{4};$$

$$\theta=n\pi+\left\{(-1)^n-1\right\}\frac{\pi}{4}$$

i.e. $\quad \theta=n\pi+\left\{(-1)^n-1\right\}\dfrac{\pi}{4}$

$n=0,\pm 1,\pm 2.....$

146. (1) We have $\sin^{-1}x+\sin^{-1}y=C$

Differentiating we get

$$\frac{dx}{\sqrt{1-x^2}}+\frac{dy}{\sqrt{1-y^2}}=0$$

i.e $i.e\sqrt{1-y^2}dx+\sqrt{1-x^2}dy=0$

147. (2)

Given two curves,

$$y^2=8x$$

$$\Rightarrow y=\sqrt{8x} \qquad (1)$$

$$\Rightarrow y=2x \qquad (2)$$

From Eqs. (1) and (2) we get point of intersection

$$(2x)^2=8x$$

$$\Rightarrow 4x^2=8x$$

$$\Rightarrow x=2,0$$

So, area of the region bounded by these two curves is

$$A=\int_0^2\left(\sqrt{8x}-2x\right)$$

$$=\sqrt{8}\int_0^2\sqrt{x}\,dx-2\int_0^2 x\,dx=\sqrt{8}\left(\frac{x^{3/2}}{3/2}\Big|_0^2\right)-2\left(\frac{x^2}{2}\Big|_0^2\right)$$

$$=\sqrt{8}\left(\frac{(2)^{3/2}-0}{3/2}\right)-2\left(\frac{(2^2)-0}{2}\right)$$

$$=2\sqrt{2}\left(\frac{2}{3}\right)\left(2\sqrt{2}\right)-4$$

$$=\frac{16}{3}-4=\frac{4}{3}\text{ square units}$$

148. (4)

$$\lim_{x\to 0}\frac{e^x-1}{x}=\frac{0}{0}$$

Indeterminate form using L'Hospital rule

$$\lim_{x\to 0}\frac{e^x}{1}=e^0=1$$

149. (2)

$$\int\frac{1+x^4}{1+x^6}dx=\int\frac{1+x^4+x^2-x^2}{\left(1+x^4-x^2\right)\left(1+x^2\right)}dx$$

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

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

$$=\int\frac{1}{\left(x^2+1\right)}dx+\int\frac{x^2}{\left(x^6+1\right)}dx$$

We know that,

$$\int\frac{1}{x^2+1}dx=\tan^{-1}x$$

$$=\tan^{-1}x+\int\frac{x^2}{\left(x^6+1\right)}dx$$

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

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

We know that, $\int\frac{3x^2}{\left(x^3\right)^2+1}=\tan^{-1}x^3$ *we get*

$$\int\frac{1+x^4}{1+x^6}dx=\tan^{-1}x+\frac{1}{3}\tan^{-1}x^3+C$$

150. (3)

$$\left(y-2\right)^2=16\left(x-1\right)$$

This is of the form $\left(y-\beta\right)^2=4a\left(x-\alpha\right)$

Where vertex of the parabola is at $\left(\alpha,\beta\right)$.

$\therefore$ Here, the vertex is at (1, 2)

151. (3) The given matrix is singular.

$$\begin{vmatrix}3 & -1+x & 2\\ 3 & -1 & x+2\\ x+3 & -1 & 2\end{vmatrix}=0$$

$$\begin{vmatrix}x+4 & -1+x & 2\\ x+4 & -1 & x+2\\ x+4 & -1 & 2\end{vmatrix}=0 \qquad C_{1'}=C_1+C_2+C_3$$

$$\Rightarrow(x+4)\begin{vmatrix}1 & -1+x & 2\\ 1 & -1 & x+2\\ 1 & -1 & 2\end{vmatrix}=0 \qquad \begin{array}{l}R_{2'}=R_2-R_1\\ R_{3'}=R_3-R_1\end{array}$$

$$\Rightarrow(x+4)\begin{vmatrix}1 & -1+x & 2\\ 0 & -x & x\\ 0 & -x & 0\end{vmatrix}=0$$

$\Rightarrow (x+4)\left[1\ \{0+x^2\}\ \right]=0$

$\therefore x=0,-4.$ But $x\in[-4,-1]$.

$\therefore x=0$ is extraneous. $\therefore x=-4$

$\therefore$ Number of values of $x=1$.

152. (1) Let $\vec{a}=x\hat{i}+y\hat{j}+z\hat{k}$ $\therefore \hat{a}.\hat{i}=x$

Similarly, $\vec{a}.\hat{j}=y$ and $\vec{a}.\hat{k}=z$

$\therefore \left(\vec{a}.\hat{i}\right)i+\left(\vec{a}.\hat{j}\right)+\left(\vec{a}.\hat{k}\right)\hat{k}$

$=x\hat{i}+y\hat{j}+z\hat{k}=\vec{a}$

153. (1)

$$z=\frac{1}{2}+\frac{i\sqrt{3}}{2}=\cos\frac{\pi}{3}+i\sin\frac{\pi}{3}=cis\frac{\pi}{3}$$

$$z^{\frac{1}{4}}=\left(cis\frac{\pi}{3}\right)^{\frac{1}{4}}=cis\frac{\pi}{12}$$

$\because$ w.k.t $(cis\theta)^n=cis\,n\theta$

154. (3)

$$T_p\ of\ AP=\frac{1}{q}\Rightarrow A+(p-1)D=\frac{1}{q}\quad ...(i)$$

$$T_q\ of\ AP=\frac{1}{p}\Rightarrow A+(q-1)D=\frac{1}{p}\quad ...(ii)$$

Subtracting, $D(p-1-q+1)=\frac{1}{q}-\frac{1}{p}$

or, $D(p-q)=\frac{p-q}{pq}$ $\therefore D=\frac{1}{pq}$

$D=\frac{1}{pq}$ substitute in (1)

$$A+(p-1)\frac{1}{pq}=\frac{1}{q}$$

$$A=\frac{1}{q}-\frac{p-1}{pq}=\frac{p-p+1}{pq}=\frac{1}{pq}$$

$$A=\frac{1}{pq}$$

pqth term = $a_{pq}=A+(pq-1)D$

$$=\frac{1}{pq}+(pq-1)\frac{1}{pq}=\frac{1+pq-1}{pq}$$

$=1$

155. (4) $9x^2+4y^2=36$

$\frac{x^2}{4}+\frac{y^2}{9}=1$ (equation of ellipse)

Remember area enclosed by ellipse is πab.

i.e., $\pi(2)(3)=6\pi$

156. (2) $\frac{\log x}{a-b}=\frac{\log y}{b-c}=\frac{\log z}{c-a}=t$

$\Rightarrow \log x=(a-b)t\Rightarrow \log y=(b-c)t$

$\Rightarrow \log z=(c-a)t\Rightarrow \log(xyz)=0\Rightarrow xyz=1$

157. (3)

A relation is reflexive, if $(a,b)\in R$ for every $a\in Set\,A$. A relation is symmetric, if $(a,b)\in R$ than $(b,a)\in R$. A relation is transistive, if $(a,b)\in R$ than $(b,a)\in R$ then $(a,c)\in R$. Given that, $S=\{1,2,3\}$ defined by relation $R=\{(1,1)\}$. Clearly R is not reflexive because for $2\in S$, $(2,2)\notin R$. So, relation R is a symmetric and transistive.

158. (3) We have $xy=c^2$

$\therefore y=\frac{c^2}{x}$ $\left[xy=c^2;x=\frac{c^2}{y}\right]$

$\therefore \frac{dy}{dx} = c^2\left(-\frac{1}{x^2}\right)$ Subnormal at any point is

$$SN = y\frac{dy}{dx} = y \times \left(\frac{-c^2}{x^2}\right) = \frac{-c^2 y}{\left(c^2/y\right)^2} = \frac{c^2}{c^4} \times y^3$$

$\therefore$ SN $\propto$ y^3

159. (1) $y = \tan^{-1}\left(\frac{\cos x - \sin x}{\cos x + \sin x}\right)$

$$y = \tan^{-1}\left[\frac{\cos x(1-\tan x)}{\cos x(1+\tan x)}\right] = \tan^{-1}\left(\frac{1-\tan x}{1+\tan x}\right)$$

$$= \tan^{-1}\left[\tan\left(\frac{\pi}{4} - x\right)\right]$$

$$= \frac{\pi}{4} - x \quad \therefore \ dy/dx = -1$$

160. (3) $\left(25x^2 - 150x + 225\right)$

$$+\left(9y^2 - 90y + 255\right) - 225 = 0$$

$$25\left(x^2 - 6x + 9\right) + 9\left(y^2 - 10y + 25\right) = 225$$

$$25\left(x-3\right)^2 + 9\left(x-5\right)^2 = 225$$

$$\frac{\left(x-3\right)^2}{9} + \frac{\left(x-5\right)^2}{25} = 1$$

$$e = \sqrt{1 - \frac{9}{25}} = \sqrt{\frac{25-9}{25}} = \frac{4}{5}$$

161. (2) $\left(a\hat{i} + 6\hat{j} - \hat{k}\right).\left(7\hat{i} - 3\hat{j} + 17\hat{k}\right) = 0$

for perpendicular vectors.

$\Rightarrow 7a - 18 - 17 = 0 \Rightarrow 7a = 35 \Rightarrow a = 5.$

162. (2) $f(x) = 2x^3 - 15x^2 + 36x + 4$

$f'(x) = 6x^2 - 30x + 36$

For maxima and minima.

$6x^2 - 30x + 36 = 0 \Rightarrow x = 3, 2$

$f''(x) = 12x - 30$

$f''(3) = +ve \rightarrow$ minimum;

$f''(2) = -ve \rightarrow$ maximum

163. (*) Given that, straight line

$$\frac{x-2}{3} = \frac{3-y}{-4} = \frac{z-4}{5} \Rightarrow \frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$$

and plane $2x - 2y + z = 5$.

We know that, sine of the angle between the line and plane is given by

$$\sin\theta = \left|\frac{\overline{b}.\overline{n}}{\left|\overline{b}\right|\left|\overline{n}\right|}\right|$$

Equation of line: $\overline{b} = 3\hat{i} + 4\hat{j} + 5\hat{k}$

Equation of plane: $\overline{n} = 2\hat{i} - 2\hat{j} + \hat{k}$

So,

$$\sin\theta = \left|\frac{\left(3\hat{i} + 4\hat{j} + 5\hat{k}\right).\left(2\hat{i} - 2\hat{j} + \hat{k}\right)}{\sqrt{(3)^2 + (-4)^2 + (5)^2}\ \sqrt{(2)^2 + (-2)^2 + (1)^2}}\right|$$

$$\Rightarrow \sin\theta = \left|\frac{(3X2) + (+4)(-2) + (5)(1)}{\sqrt{9+16+25}\ \sqrt{4+4+1}}\right|$$

$$\Rightarrow \sin\theta = \left|\frac{6-8+5}{\sqrt{50}\ \sqrt{9}}\right| = \frac{+3}{\sqrt{50}\ X3} = \frac{1}{\sqrt{50}}$$

Therefore, sine of angle between the line and plane is $\frac{1}{\sqrt{50}}$.

164. (3)

Last digit in 7^{300}

$7^1 = 7$, last digit =7

$7^2 = 49$, last digit $=9$

$7^3 = 49 \times 7$, last digit $= 3$

$7^4 = 49 \times 49$, last digit $=1$

$7^5 = 49 \times 49 \times 7$, last digit $=7$ ...

$\therefore \quad 7^{300} = (7^4)^{75}$

$\therefore$ Observation last digit is '1'.

165. (3) For the parabola $x^2 = 4ay.$,

the eqn. of tangent is $xx^1 = 2a\left(y + y^{'}\right)$

Here, $x^2 = -4y;$ $\quad\quad \therefore 4a = +4 \Rightarrow a = 1$

$x^{'} = -4, y^{'} = -4$.

$\therefore$ The required equation is $2x - y + 4 = 0$

166. (4) $\cos^{-1} x + \cos y^{-1} + \cos^{-1`} z = 3\pi$

Since $0 < \cos^{-1} x \le \pi,$ we have

$\cos^{-1} x = \pi, \cos^{-1} y = \pi, \cos^{-1} z = \pi$

$\therefore x = y = z = \cos \pi = -1$

$\therefore xy + yz + zx = (-1)(-1) + (-1)(-1) + (-1)(-1)$

$=3$

167. (2) $\sin\left(\frac{1}{2}\cos^{-1}\frac{4}{5}\right) = \sin\left(\frac{1}{2} \times (2\theta)\right)$

where $where\left(2\theta = \cos^{-1}\frac{4}{5} \therefore \cos 2\theta = \frac{4}{5}\right)$

$$\sin\theta = \sqrt{\frac{1-\cos 2\theta}{2}} = \sqrt{\frac{1-\frac{4}{5}}{2}} = \sqrt{\frac{1}{5\times 2}} = \frac{1}{\sqrt{10}}.$$

168. (1) Given that, angle made by line with $x - axis$ and $y - axis$ is $\frac{\pi}{3}$. We know that if a, b, c are angle made by line with x, y and $z - axis$ respectively. Then,

$\cos^2 a + \cos^2 b + \cos^2 c = 1$

We have $a = b = \frac{\pi}{3}$

So, $\cos^2 \frac{\pi}{3} + \cos^2 \frac{\pi}{3} + \cos^2 c = 1$

$\Rightarrow \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 + \cos^2 c = 1$

$\Rightarrow 2\left(\frac{1}{4}\right) + \cos^2 c = 1$

$\Rightarrow \cos^2 c = 1 - \frac{1}{2} = \frac{1}{2}$

$\Rightarrow \cos C = \frac{1}{\sqrt{2}}$

$\Rightarrow C = \cos^{-1}\frac{1}{\sqrt{2}} = \frac{\pi}{4}$

So, angle made by $z - axis$ is $\frac{\pi}{4}$

169. (2) $= \frac{1+2i}{1-(1-i)^2} = \frac{1+2i}{1-(1-1-2i)} = \frac{1+2i}{1+2i} = 1$

$\therefore$ $Modulus = 1;$ $\quad Argument = 0$

170. (3) $\left|\vec{a} \times \vec{b}\right| = 4 \Rightarrow \left|\vec{a}\right|\left|\vec{b}\right| \sin\theta = 4$ $\quad\quad$ (1)

$\left|\vec{a}.\vec{b}\right| = 2 \Rightarrow \left|\vec{a}\right|\left|\vec{b}\right| \cos\theta = 2$ $\quad\quad$ (2)

From (2), $\left|\vec{a}\right|^2 \left|\vec{b}\right|^2 \left(\cos^2\theta\right) = 4$

$\Rightarrow \left|\vec{a}\right|^2 \left|\vec{b}\right|^2 \left(1 - \sin^2\theta\right) = 4$

$\Rightarrow \left|\vec{a}\right|^2 \left|\vec{b}\right|^2 \left(1 - \frac{16}{\left|\vec{a}\right|^2\left|\vec{b}\right|^2}\right) = 4$

$$\Rightarrow |\vec{a}|^2 |\vec{b}|^2 - 16 = 4 \Rightarrow |\vec{a}|^2 |\vec{b}|^2 = 20$$

171. (4) Given that, events E_1 and E_2 of sample S and A is any event.

$$P_1(E_1) = P(E) = P(E_2) = \frac{1}{2}$$

$$P_1(E_2/A) = \frac{1}{2}$$

$$P_1(A/E_2) = \frac{2}{3}$$

According to Bayes theorem.

Continue

$$P(A/E_2) = \frac{P(E_2)P(E_2/A)}{P(E_1)P(E_1/A) + P(E_2)P(E_2/A)}$$

$$\frac{2}{3} = \frac{\frac{1}{2}\frac{1}{2}}{\frac{1}{2}P\left(\frac{E_1}{A}\right) + \frac{1}{2}\frac{1}{2}} = \frac{\frac{1}{2}\frac{1}{1}}{\frac{1}{2}\left(P\left(\frac{E_1}{A}\right) + \frac{1}{2}\right)}$$

$$P\left(\frac{E_1}{A}\right) + \frac{1}{2} = \frac{\frac{1}{2}}{\left(\frac{2}{3}\right)} = \frac{1}{2} \times \frac{3}{2} = \frac{3}{4}$$

$$P\left(\frac{E_1}{A}\right) = \frac{3}{4} - \frac{1}{2} = \frac{3-2}{4} = \frac{1}{4}$$

172. (2) When $x = 1, 3t^2 + 1 = 1$

$\therefore \quad 3t^2 = 0$ or $t = 0$

Continue $\frac{dy}{dt} = 3t^2, \frac{dx}{dt} = 6t$

$$\therefore \quad \frac{dy}{dx} = \frac{dy}{dt} / \frac{dx}{dt} = \frac{3t^2}{6t} = \frac{t}{2}$$

Slope of tangent $\left.\frac{dy}{dx}\right|_{t=0} = 0$

173. (4) Let $\vec{a} = 3\hat{i} - 2\hat{j} + 2\hat{k}$, $\vec{b} = 6\hat{i} + 4\hat{j} - 2\hat{k}$, $\vec{c} = 3\hat{i} - 2\hat{j} - 4\hat{k}$

$$\hat{b} X \hat{c} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 6 & 4 & -2 \\ 3 & -2 & -4 \end{vmatrix} = -20\hat{i} + 18\hat{j} - 24\hat{k}$$

$$\vec{a}.\left(\vec{b} X \vec{c}\right) = -60 - 36 - 48 = -144$$

174. (1) $\vec{a}$ and $\vec{b}$ are unit vectors.

$$\therefore |\vec{a}| = |\vec{b}| = 1$$

$\therefore |\vec{a} + \vec{b}| \neq 1, \ \therefore \vec{a} + \vec{b}$ is not a unit vector.

175. (3)

Given that, sum of n terms of A.P. is $S_n = n^2 + n.$

We know that, common difference = difference between two adjacent terms.

Let first term be a_1 and second term be a_2. Then common difference, $d = a_2 - a_1$.

Now, sum of first term $S = a_1$

$$\Rightarrow a_1 = (1)^2 + 1 = 2$$

And sum of first two term $= S_2 = a_1 + a_2$

$$\Rightarrow (2)^2 + 2 = a_1 + a_2$$

$$\Rightarrow a_2 = 4 + 2 - a_1 = 4 + 2 - 2 = 4$$

Therefore, $a_1 = 2$ and . $a_2 = 4$ Then, common difference . $d = a_2 - a_1 = 4 - 2 = 2$

176. (2) $\begin{vmatrix} 1 & a & b \\ 1 & c & a \\ 1 & b & c \end{vmatrix} = 0$

$\Rightarrow 1\left(c^2 - ab\right) - a(c-a) + b(b-c) = 0$

$\Rightarrow a^2 + b^2 + c^2 = ab + bc + ca$

$\Rightarrow 2a^2 + 2b^2 + 2c^2 - 2ab - 2bc - 2ca = 0$

$\Rightarrow \left(a^2 - 2ab + b^2\right) + \left(b^2 - 2bc + c^2\right) + \left(c^2 - ab + b^2\right)$
$=0$

$\Rightarrow (a - b^2) + \left(b - c\right)^2 + (c-a)^2 = 0$

$\Rightarrow a = b = c \quad \Rightarrow \quad A = B = C = 60^0$

$\therefore \sin^2 A + \sin^2 B + \sin^2 C = \left(\frac{\sqrt{3}}{2}\right)^2 + \left(\frac{\sqrt{3}}{2}\right)^2 + \left(\frac{\sqrt{3}}{2}\right)^2$

$= 3X\frac{3}{4} = \frac{9}{4}$

177. (2) $I_n = \int \left(\log x\right)^n dx$

$= \left(\log x\right)^n \cdot x - \int x.n \int \left(\log x\right)^{n-1} \cdot \frac{1}{x} dx$

$= x(\log x)^n - n\,I_{n-1}$

$\therefore I_n + n\,I_{n-1} = x(\log x)^n$

178. (1) For any point P on the ellipse have focus S and S'.

$SP + S'P = 2a \quad \therefore$ for $\frac{x^2}{25} + \frac{y^2}{16} = 1$

Sum of focal distance=2.5=10

179. (3) Equation of hyperbola is $\frac{x^2}{16} - \frac{y^2}{25} = 1$

eccentricity is: $\frac{b^2}{a^2} + 1 = e^2$ i.e. $\frac{25}{16} + 1 = e^2$

$\Rightarrow e^2 = \frac{41}{16} = e = \frac{\sqrt{41}}{4}$

180. (3) $1, \omega, \omega^2$ are cube roots of unity product

$= 1 \cdot \omega \cdot \omega^2$

$= \omega^3$

$= 1$