15/02/2026

Set-2_Online

Aakash
Medical | IIT-JEE | Foundations

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MM : 180 AIATS For One Year JEE(Advanced)-2026 (XII Passed)_Test-4A_Paper-2_ONLINE **Time : 180 Min.**

PHYSICS

Section-I

1. (A,C)

2. (B,C)

3. (B,D)

4. (A,B,C)

5. (A,C,D)

6. (B,D)

Section-II

7. (10.10)

8. (00.40)

9. (01.00)

10. (40.00)

11. (00.00)

12. (00.50)

Section-III

13. (D)

14. (C)

15. (B)

16. (A)

Section-IV

17. (4)

18. (59)

19. (2)

CHEMISTRY

Section-I

20. (A,C,D)

21. (A,C,D)

22. (A,B,C,D)

23. (B,D)

24. (B,D)

25. (A,B,C)

Section-II

26. (00.13)

27. (01.04)

28. (01.44)

29. (05.55)

30. (02.00)

31. (09.00)

Section-III

32. (B)

33. (D)

34. (A)

35. (B)

Section-IV

36. (25)

37. (3)

38. (8)

MATHEMATICS

Section-I

39. (A,B,C)

40. (B,C,D)

41. (A,B,D)

42. (B,C)

43. (A,C)

44. (A,C)

Section-II

45. (01.00)

46. (10.00)

47. (61.00)

48. (04.00)

49. (02.00)

50. (00.00)

Section-III

51. (A)

52. (A)

53. (C)

54. (D)

Section-IV

55. (2)

56. (11)

57. (5)

Hints and Solutions

PHYSICS

Section-I

(1) **Answer :** (A,C)
Hint:
$\vec{I} = \Delta \vec{P}$, $\vec{J} = \Delta \vec{L}$
Solution:
$\vec{L}_f = 2L_0\hat{i} + L_0\hat{j} + 2L_0\hat{k}$
$\vec{P}_f = 2P_0\hat{i} + 3P_0\hat{j}$

(2) **Answer :** (B,C)
Hint:
R = N_1 × MSD + N_2 × CSD
Solution:
Zero error = $20 \times \frac{1}{100}$ = 0.20 mm
Actual reading = 20 + 20 CSD – 20 C.S.D
= 20 mm

(3) **Answer :** (B,D)
Hint:
Principle of homogeneity
Solution:
Principle of homogeneity
$\beta^2 = \frac{v^2}{n} = \frac{L^2 T^{-2}}{L}$
β = $L^{1/2}$ T^{-1}
$\alpha = \frac{L^{1/2} T^{-1} L}{M L^{-1} T^{-2}}$
M^{-1} $L^{5/2}$ T

(4) **Answer :** (A,B,C)
Hint:
Apply Ampere's Law
Solution:
$\oint B \cdot \vec{dl} = \mu_0 i_{enc}$

(5) **Answer :** (A,C,D)
Hint:
Potential energy and torque of magnetic dipole in magnetic field,
Solution:
τ = PE sin θ
U = –PE cos θ

(6) **Answer :** (B,D)
Hint:
$P = \sigma a T^4$
Solution:
$P \propto T_1^4 - T_2^4$
$P' \propto T_1^4 - T^4 = T^4 - T_2^4$
or $2P' \propto T_1^4 - T_2^4 \propto P$
$P' = \frac{P}{2}$
Also $\frac{P}{(P)^2} = \frac{(T_1^4 - T^4)}{T_1^4 - T_2^4}$
$\frac{T_1^4 - T_2^4}{2} = T^4$

Section-II

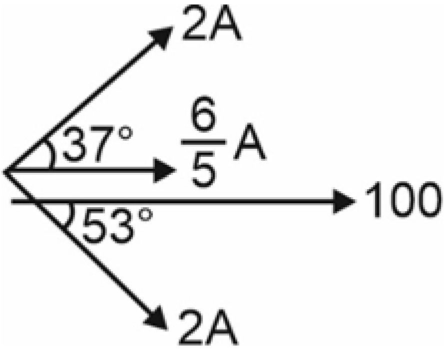
(7) **Answer :** 10.10

Hint:

Voltage across parallel elements remains same.

Solution:

$P = \sum L^2 R = (1.2)^2 \times \frac{250}{3} + 2^2\,(70) = 400\ \omega$



$i = \sqrt{\left(\frac{6}{5} + \frac{8}{5} + \frac{6}{5}\right)^2 + \left(2 \times \frac{1}{5}\right)^2}$

$= \sqrt{4^2 + \frac{4}{25}}$

$= \frac{2\sqrt{101}}{5}$

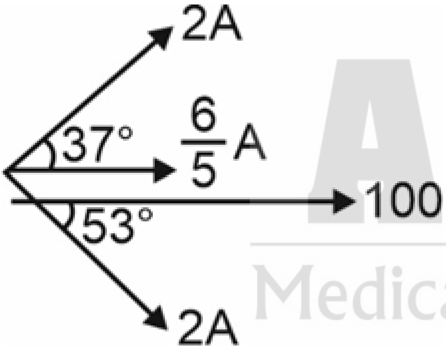
(8) **Answer :** 00.40

Hint:

Voltage across parallel elements remains same.

Solution:

$P = \sum L^2 R = (1.2)^2 \times \frac{250}{3} + 2^2\,(70) = 400\ \omega$



$i = \sqrt{\left(\frac{6}{5} + \frac{8}{5} + \frac{6}{5}\right)^2 + \left(2 \times \frac{1}{5}\right)^2}$

$= \sqrt{4^2 + \frac{4}{25}}$

$= \frac{2\sqrt{101}}{5}$

(9) **Answer :** 01.00

Hint:

$a^X = 0 \Rightarrow a = g$

also $t_1 + t_2 = T \Rightarrow <V> = 4\cos\theta$

Solution:

$v_y = u_y + a_y t$

$y = u_y t + \frac{1}{2} a_y t^2$

(10) **Answer :** 40.00

Hint:

$a^X = 0 \Rightarrow a = g$

also $t_1 + t_2 = T \Rightarrow <V> = 4\cos\theta$

Solution:

$v_y = u_y + a_y t$

$y = u_y t + \frac{1}{2} a_y t^2$

(11) **Answer :** 00.00
Hint:
$T = 2\pi\sqrt{\frac{1}{g_{eff}}}$
Solution:
$T = \pi\sqrt{\frac{4l\times 5}{10\times 4}} = 0.5$

(12) **Answer :** 00.50
Hint:
$T = 2\pi\sqrt{\frac{1}{g_{eff}}}$
Solution:
$T = \pi\sqrt{\frac{4l\times 5}{10\times 4}} = 0.5$

Section-III

(13) **Answer :** (D)
Hint:
$K = \frac{1}{2}mv^2$
Solution:
KE (g) = $\frac{h^2}{8mL^2}$

$P = \frac{h}{\lambda}$

$\lambda = \frac{2L}{n}$

$P = \frac{nh}{2L}$

$E_n = K = \frac{n^2h^2}{4L^2\,2m} = \frac{n^2h^2}{8mL^2}$

Energy of 1st excitation

$\Delta E = \frac{(4-1)h^2}{8mL^2} = \frac{3h^2}{8mL^2}$

(14) **Answer :** (C)
Hint:
$K = \frac{1}{2}mv^2$
Solution:
KE (g) = $\frac{h^2}{8mL^2}$

$P = \frac{h}{\lambda}$

$\lambda = \frac{2L}{n}$

$P = \frac{nh}{2L}$

$E_n = K = \frac{n^2h^2}{4L^2\,2m} = \frac{n^2h^2}{8mL^2}$

Energy of 1st excitation

$\Delta E = \frac{(4-1)h^2}{8mL^2} = \frac{3h^2}{8mL^2}$

(15) **Answer :** (B)
Hint:
Photoelectric equation and $\beta = \frac{\lambda D}{d}$
Solution:
$\beta = \frac{\lambda D}{d}$

= $\frac{6.6\times 10^{-34}}{8\times 10^{-31}\times 10^{6}} \times \frac{80}{1\times 10^{-4}}$

= $\frac{6.6}{8} \times 80 \times 10^{-34+31-6+4}$

= $\frac{6.6}{8} \times 8 \times 10^{-4}$

= 6.6×10^{-4}
= E = 2.5 eV
$\frac{1}{2}mv^2 = 2.5 \times 1.6 \times 10^{-19}$

$v^2 = \frac{8\times 10^{-19}}{8\times 10^{-31}}$

$v = 10^6$ m/s

$\lambda = \frac{6.6\times10^{-34}}{8\times10^{-31}\times10^6}$

(16) **Answer :** (A)

Hint:

Photoelectric equation and $\beta = \frac{\lambda D}{d}$

Solution:

$\beta = \frac{\lambda D}{d}$

$= \frac{6.6\times10^{-34}}{8\times10^{-31}\times10^6} \times \frac{80}{1\times10^{-4}}$

$= \frac{6.6}{8} \times 80 \times 10^{-34+31-6+4}$

$= \frac{6.6}{8} \times 8 \times 10^{-4}$

$= 6.6 \times 10^{-4}$

= E = 2.5 eV

$\frac{1}{2}mv^2 = 2.5 \times 1.6 \times 10^{-19}$

$v^2 = \frac{8\times10^{-19}}{8\times10^{-31}}$

$v = 10^6$ m/s

$\lambda = \frac{6.6\times10^{-34}}{8\times10^{-31}\times10^6}$

Section-IV

(17) **Answer :** 4

Hint:

At terminal velocity net force becomes zero.

Solution:

Fv = mg = 4N

(18) **Answer :** 59

Hint:

Doppler's effect in light.

Solution:

$\frac{\Delta\lambda}{\lambda} = \frac{v}{C}$

$\frac{1}{\lambda} = \frac{v}{C\Delta\lambda} = 10^6$

$T = \frac{2.9\times10^{-3}}{\lambda}$

$T = 2.9 \times 10^3$

10(N + M) = 10(2.9 + 3)

= 59

(19) **Answer :** 2

Hint:

$P = Fv$

Solution:

$F = \frac{20}{1000} \times 10 = 0.2\,\text{N}$

$P = 2$W

CHEMISTRY

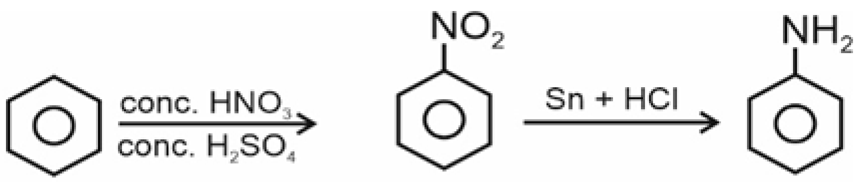
Section-I

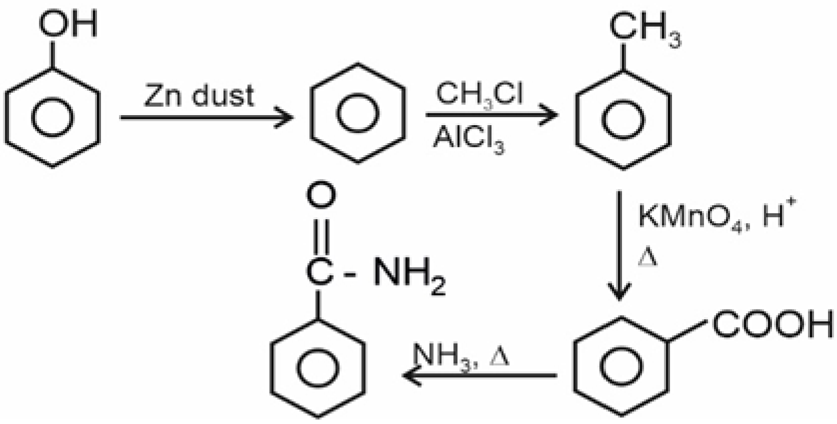
(20) **Answer :** (A,C,D)

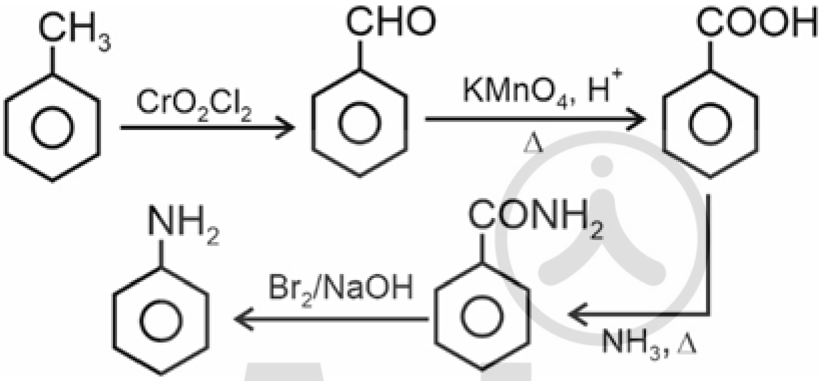
Hint:

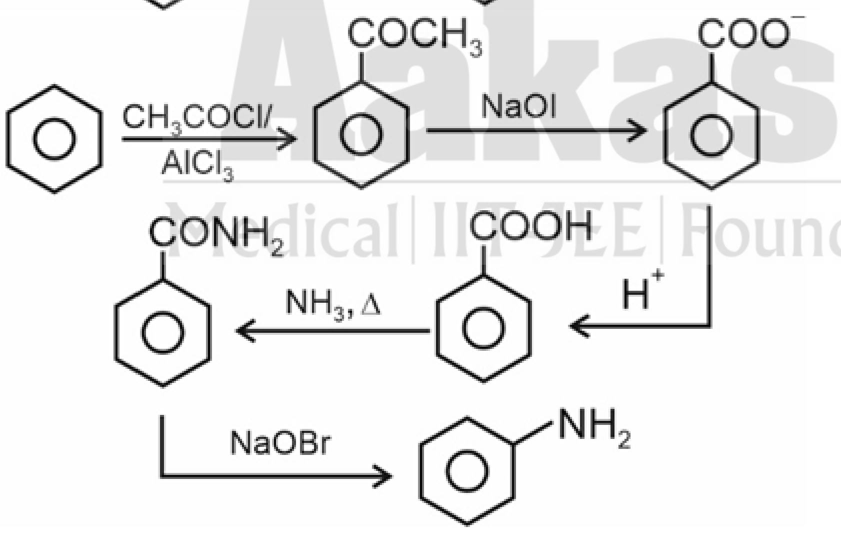
Toluene with chromyl chloride followed by hydrolysis produces benzaldehyde

Solution:

(A) 

(B) 

(C) 

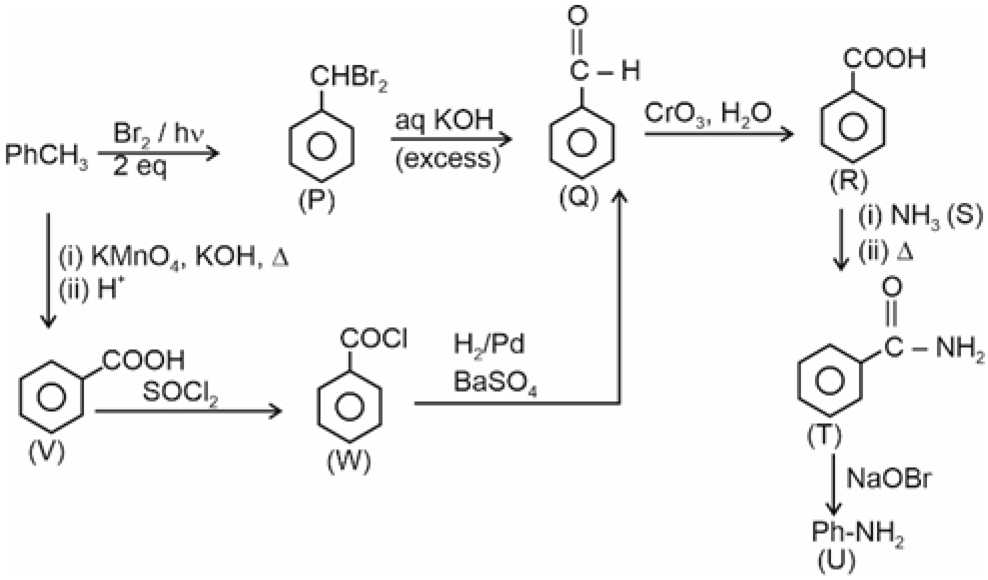
(D) 

(21) **Answer :** (A,C,D)

Hint:

1° Amide with NaOH + Br_2 (NaOBr) forms amine.

Solution:



(22) **Answer :** (A,B,C,D)

Hint:

Reaction follows 1st order kinetics.

Solution:

	2A	+	B ⟶ P
t = 0	4		2 –
t = 25s	4 – 2 × 1 = 2 mol		2 – 1 1 mol

rate = $-\frac{1}{2}\frac{d[A]}{dt} = \frac{-d[B]}{dt} = \frac{d[P]}{dt} = k[A]$

$\frac{-1}{2}\frac{d[A]}{dt} = k[A]$

$\frac{-d[A]}{dt} = 2k[A]$

Half life is t = 25 s

$2k = \frac{0.693}{25}$

$k = \frac{0.693}{50} = 1.386 \times 10^{-2} s^{-1}$

At 25 s

$-\frac{d[A]}{dt} = 2k[A]$

= 2 × 1.386 × 10^{-2} × 2

= 42 × 1.386 × 10^{-2} ms^{-1}

= 5.544 × 10^{-2} ms^{-1}

(23) **Answer :** (B,D)

Hint:

For the process to occur, E_{cell} must be positive.

Solution:

$Pt + Hg^{2+} \to Pt^{2+} + Hg$

E_{cell} = (– 1.19 + 0.854) – $\frac{0.0591}{2}\log\frac{10^{-3}}{10^{-1}}$

= – 0.336 + 0.0591

= – 0.276 V

$Pt^{2+} + Cu \to Pt + Cu^{2+}$

E_{cell} = $(-0.34 + 1.19) - \frac{0.0591}{2}\log 10^{-2}$

= 0.9091 V

$Hg + Cu^{2+} \to Hg^{2+} + Cu$

E_{cell} = $(-0.854 + 0.34) - \frac{0.0591}{2}\log 10^{-2}$

= – 0.514 + 0.0591

= – 0.4549 V

E_{cell} = $(+0.14 + 0.34) - \frac{0.0591}{2}\log 10^{-2}$

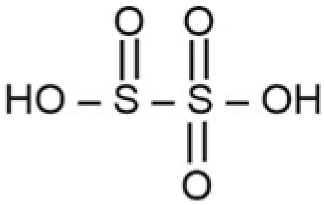
= 0.5391 V

(24) **Answer :** (B,D)

Hint:
With 4d and 5d series metal, all ligands behaves as SFL.
Solution:
$[Ni(CO)_4]$ = Tetrahedral
$[PtCl_4]^{2-}$ = Square planar
$[PdCl_4]^{2-}$ = Square planar
$[Co(CN)_4]^{2-}$ = Square planar
$[CoCl_4]^{2-}$ = Tetrahedral
MnO_4^- = Tetrahedral
$[Pt(NH_3)_2Cl_2]$ = Square planar
$[Ir(PPh_3)_2Cl(CO)]$ = Square planar

(25) **Answer :** (A,B,C)
Hint:
In $H_2S_2O_5$, S-O-S bond is not present.
Solution:

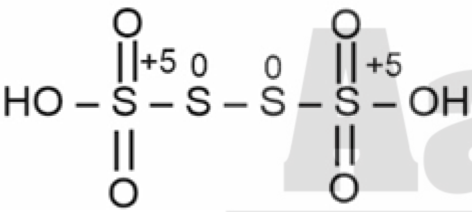
$H_2S_2O_5$



S = O bond = 3

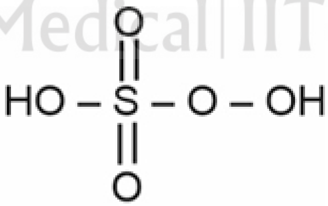
S – O – S bond = 0

$H_2S_4O_6$



Caro's acid :

H_2SO_5



basicity = 1

Section-II

(26) **Answer :** 00.13
Hint:
$\alpha = \frac{\Lambda_m^c}{\Lambda_m^\infty}$
Solution:
$\alpha_1 = \frac{\Lambda_m^c}{\Lambda_m^\infty} = \frac{y\times10^{-2}}{8\times10^2} = \frac{y}{8} = \alpha$
On dilution, molar conductance increases by 4 times
$\alpha_2 = \frac{4y\times10^2}{8\times10^2} = \frac{y}{2}$
$\alpha_2 = 4\alpha$
$HA \rightleftharpoons H^+ + A^-$
$C \quad 0 \quad 0$
$C - C\alpha \quad c\alpha \quad c\alpha$

$K_a = \frac{c\alpha^2}{1-\alpha}$

Since temperature is constant K_a will remain same.

$\frac{c_1\alpha_1^2}{1-\alpha_1} = \frac{c_2\alpha_2}{1-\alpha_2}$

$\frac{c\alpha^2}{1-\alpha} = \frac{\frac{c}{30}(4\alpha)^2}{1-4\alpha}$

$\frac{\alpha^2}{1-\alpha} = \frac{(4\alpha)^2}{30(1-4\alpha)}$

$\frac{\alpha^2}{1-\alpha} = \frac{16\alpha^2}{30(1-4\alpha)}$

$16(1-\alpha) = 30(1-4\alpha)$

$16 - 16\alpha = 30 - 120\alpha$

$104\alpha = 14$

$\alpha = 0.1346$

$\alpha = 0.13$

$\alpha = \frac{y}{8}$

$y = 8\alpha$

= 8 × 0.13

= 1.04

(27) **Answer :** 01.04

Hint:

$\alpha = \frac{\Lambda_m^c}{\Lambda_m^\infty}$

Solution:

$\alpha_1 = \frac{\Lambda_m^c}{\Lambda_m^\infty} = \frac{y\times10^{-2}}{8\times10^2} = \frac{y}{8} = \alpha$

On dilution, molar conductance increases by 4 times

$\alpha_2 = \frac{4y\times10^2}{8\times10^2} = \frac{y}{2}$

$\alpha_2 = 4\alpha$

HA	$\rightleftharpoons$	$\mathrm{H^+}+$	$\mathrm{A^-}$
C		0	0
$\mathrm{C-C\alpha}$		$\mathrm{c\alpha}$	$\mathrm{c\alpha}$

$K_a = \frac{c\alpha^2}{1-\alpha}$

Since temperature is constant K_a will remain same.

$\frac{c_1\alpha_1^2}{1-\alpha_1} = \frac{c_2\alpha_2}{1-\alpha_2}$

$\frac{c\alpha^2}{1-\alpha} = \frac{\frac{c}{30}(4\alpha)^2}{1-4\alpha}$

$\frac{\alpha^2}{1-\alpha} = \frac{(4\alpha)^2}{30(1-4\alpha)}$

$\frac{\alpha^2}{1-\alpha} = \frac{16\alpha^2}{30(1-4\alpha)}$

$16(1-\alpha) = 30(1-4\alpha)$

$16 - 16\alpha = 30 - 120\alpha$

$104\alpha = 14$

$\alpha = 0.1346$

$\alpha = 0.13$

$\alpha = \frac{y}{8}$

$y = 8\alpha$

= 8 × 0.13

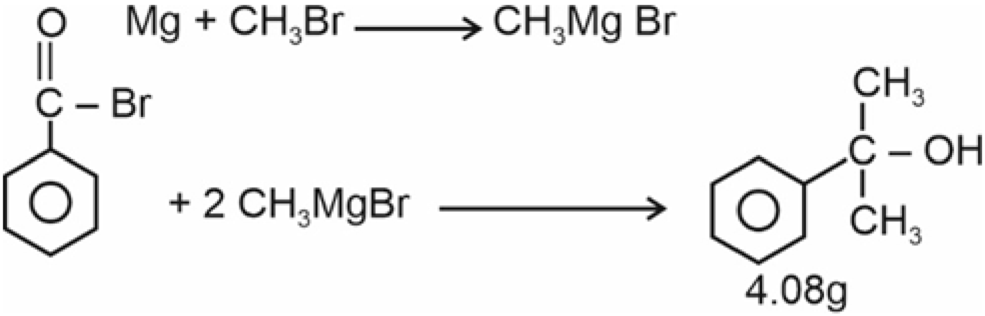
= 1.04

(28) **Answer :** 01.44

Hint:

RMgX is an organometallic compound.

Solution:



mole of organic compound

Produced = $\frac{4.08}{136} = 0.03$ mol

moles of CH_3MgBr = 0.06 mol

moles of Mg = 0.06 mol

mass of Mg = 0.06 × 24 = 1.44 g = x

mol of Benzoyl Bromide = 0.03 mol

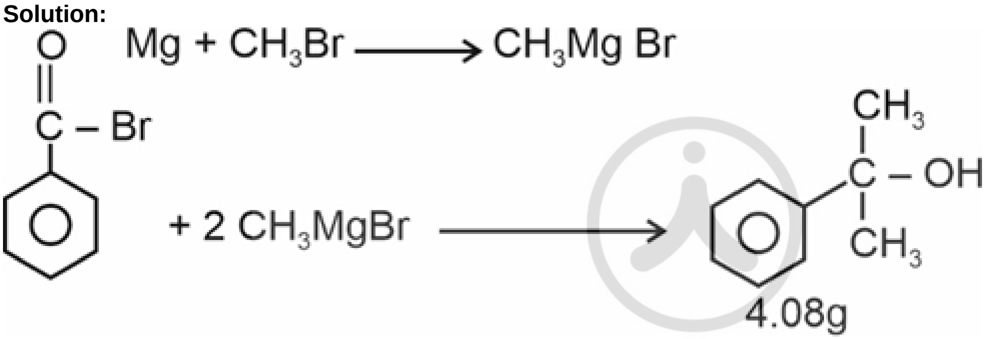
mass of benzoyl Bromide = 0.03×185 = 5.55 g = y

(29) **Answer :** 05.55

Hint:

RMgX is an organometallic compound.

Solution:



mole of organic compound

Produced = $\frac{4.08}{136} = 0.03$ mol

moles of CH_3MgBr = 0.06 mol

moles of Mg = 0.06 mol

mass of Mg = 0.06 × 24 = 1.44 g = x

mol of Benzoyl Bromide = 0.03 mol

mass of benzoyl Bromide = 0.03×185 = 5.55 g = y

(30) **Answer :** 02.00

Hint:

Sn reacts with HCl form $SnCl_2$.

Solution:

m_{eq} of Sn^{2+} = m_{eq} of $KMnO_4$

$x \times 10^{-2} \times 1000 \times 2 = 25 \times 0.015 \times 5 \times 10$

x × 10 = 9.375

2x = 1.875

moles of Sn^{2+} = 0.9375×10^{-2} mol

mass of Sn^{2+} = $0.9375 \times 10^{-2} \times 119$ g

= 1.115 g

% of $Sn = \frac{1.115}{11.9} \times 100 \approx 9.375\%$

= 9%

(31) **Answer :** 09.00

Hint:

Sn reacts with HCl form $SnCl_2$.

Solution:

m_{eq} of Sn^{2+} = m_{eq} of $KMnO_4$

$x \times 10^{-2} \times 1000 \times 2 = 25 \times 0.015 \times 5 \times 10$

x × 10 = 9.375

2x = 1.875

moles of Sn^{2+} = 0.9375×10^{-2} mol

mass of Sn^{2+} = $0.9375 \times 10^{-2} \times 119$ g

= 1.115 g

% of $Sn = \frac{1.115}{11.9} \times 100 \approx 9.375\%$

= 9%

Section-III

(32) **Answer :** (B)

Hint:

As % s-character increases bond dissociation energy increases

Solution:

$H{-}\underset{sp}{C} \equiv C - CH_3 \qquad H{-}CH = \underset{sp^2}{C}H - CH_3$

$(Ph)_2{-}CH^{\bullet}$ is more stable than $CH_3{-}\dot{C}H_2$

(33) **Answer :** (D)

Hint:

ΔH = BE(Reactants) – BE(Products)

Solution:

$CH_4 + Br_2 \rightarrow CH_3Br + HBr$

$\Delta H = 4 \times Be_{C-H} + BE_{Br-Br} - 3BE_{C-H}$

$-BE_{C-Br} - BE_{H-Br}$

ΔH = 4 × 105 + 46 – 3 × 105 – 71 – 87

= – 7 kcal

Initiation step

$Br - Br \rightarrow 2Br^{\bullet}$

ΔH = 46 kcal/mol (endo)

Propagation

$CH_4 + Br^{\bullet} \rightarrow CH_3^{\bullet} + H - Br$

(34) **Answer :** (A)

Hint:

Potassium ferrocyanide reacts with Fe^{3+} to form Ferric ferrocyanide.

Solution:

$K_4[Fe(CN)_6] + Fe^{3+} \rightarrow \underset{\text{Prussian blue ppt}}{Fe_4[Fe(CN)_6]_3}$

(35) **Answer :** (B)

Hint:

$Cu_2[Fe(CN)_6]$ is chocolate brown ppt.

Solution:

$K_4[Fe(CN)_6] + Cu^{2+} \rightarrow \underset{\text{Chololate brown ppt}}{Cu_2[Fe(CN)_6]}$

Section-IV

(36) **Answer :** 25

Hint:

For adiabatic process, q = 0

Solution:

I process is adiabatic as entropy is same

$W_1 = \Delta U$

$\Delta U = 250\,R - 1500\,R = -1250\,R = W_1$

In II process internal energy is constant, it means it is isothermal process

$W_2 = -2.303\, nRT \log \frac{V_3}{V_2}$

$= -nRT \ln \frac{V_3}{V_2}$

Given n = 1

$U = nC_VT$

$250R = C_VT$

$250R = \frac{5}{2}RT$

$T = \frac{500}{5} = 100\,K$

$W_1 = W_2$

$-1250R = -nRT \ln \frac{V_3}{V_2}$

$\frac{1250}{100} = \ln \frac{V_3}{V_2}$

$\ln \frac{V_3}{V_2} = 12.5$

(37) **Answer :** 3

Hint:

$\lambda = \frac{h}{p}$

Solution:

$p = \frac{h}{\lambda}$

$p = \frac{6.6\times10^{-34}}{589\times10^{-9}}$

p = 1.12 × 10^{-27} kg m s^{-1}

$p_{Na} = p$

$m_{Na}(\Delta V) = p$

$m_{Na} = \frac{23\times10^{-3}}{6\times10^{23}} = 3.83\times10^{-26}\ kg$

$\Delta v = \frac{1.12\times10^{-27}}{3.83\times10^{-26}}\ m\ s^{-1}$

$\Delta v = 0.0292\ m\ s^{-1}$

$\Delta v = 2.926\ cm\ s^{-1}$

(38) **Answer :** 8

Hint:

ClO_2^- and ClO_3^- is formed.

Solution:

$2ClO_2 + 2OH^- \rightarrow \overset{+3}{Cl}O_2^- + \overset{+5}{Cl}O_3^- + H_2O$

x + y = 3 + 5 = 8

MATHEMATICS

Section-I

(39) **Answer :** (A,B,C)

Hint:

$$\int_0^1 \frac{\sqrt{1-x}+\sqrt{x}}{1+\sqrt{2x}} f(x)dx$$

$$= \int_0^1 \frac{\sqrt{2x}-1}{\sqrt{x}-\sqrt{1-x}} f(x)dx$$

Solution:

$$\int_0^1 \frac{\sqrt{1-x}+\sqrt{x}}{1+\sqrt{2x}} f(x)dx$$

$$= \int_0^1 \frac{\sqrt{2x}-1}{\sqrt{x}-\sqrt{1-x}} f(x)dx$$

$$= \frac{1}{2}\int_0^1 \left(\frac{\sqrt{2x}-1}{\sqrt{x}-\sqrt{1-x}} f(x) + \frac{\sqrt{2(1-x)}-1}{\sqrt{1-x}-\sqrt{x}} f(1-x)\right)dx$$

$$= \frac{1}{2}\int_0^1 \frac{f(x)\sqrt{2}}{\sqrt{x}-\sqrt{1-x}}(\sqrt{x}-\sqrt{1-x})dx \left\{if\ f(1-x)=f(x)\right\}$$

$$= \frac{1}{\sqrt{2}}\int_0^1 f(x)dx.$$

(40) **Answer :** (B,C,D)

Hint:

$$[f(x)] = \begin{cases} 0\,; & x \neq 0 \\ 1\,; & x = 0 \end{cases}$$

Solution:

$\lim\limits_{x\to 2^+} f(f(x)) = 1$ and $\lim\limits_{x\to 2^-} f(f(x)) = 0$

$\lim\limits_{x\to 1} f(f(x)) = f(0) = 1$

$$[f(x)] = \begin{cases} 0\,; & x \neq 0 \\ 1\,; & x = 0 \end{cases}$$

$h'(x) = f(x + 1) - f(x) = 0$ at $x = \frac{-1}{2}$, where it attains maxima.

(41) **Answer :** (A,B,D)

Hint:

$|b| = |-b| = |\alpha\beta| = |\alpha|\,|\beta| < 1$

Solution:

Let α and β be the roots of $x^2 - ax - b = 0$

Then, $|\alpha| < 1$. Also

$|b| = |-b| = |\alpha\beta| = |\alpha||\beta| < 1$

∵ The roots α and β lie between –1 and 1 we have $f(-1) > 0$ and $f(1) > 0$.

Therefore $1 + a - b > 0$ and $1 - a - b > 0$

∴ $b - a < 1$ and $a + b < 1$

(42) **Answer :** (B,C)

Hint:

$$M = \left\{A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} :\ a,\ b,\ c,\ d\ \in R\right\}$$

$f : M \to R$ is given by $f(A) = |A|$

Solution:

$$M = \left\{A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} :\ a,\ b,\ c,\ d\ \in R\right\}$$

$f : M \to R$ is given by $f(A) = |A|$

Injectivity :

$$f\left(\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}\right) = \begin{vmatrix} 0 & 0 \\ 0 & 0 \end{vmatrix} = 0$$

and $f\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = \begin{vmatrix} 1 & 0 \\ 0 & 0 \end{vmatrix} = 0$

∴ f is not one-one

Surjectivity :

Let y be an element of the co-domain, such that

$$f(A) = -y,\ A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$\Rightarrow \begin{vmatrix} a & b \\ c & d \end{vmatrix} = y$$

$$\Rightarrow\ ad - bc = y\ \{a,\ b,\ c,\ d\ \in R\}$$

$$\Rightarrow\ A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \in M$$

⇒ f is onto.

(43) **Answer :** (A,C)

Hint:

$\frac{x}{y} + y = c$

Solution:

$xdy - y^2dy = ydx$

$ydx - xdy = -y^2dy$

$d\left(\frac{x}{y}\right) + dy = 0$

$\frac{x}{y} + y = c$

Passes through (4, 2)

⇒ $c = 4$

∴ $\frac{x}{y} + y = 4$

$x + y^2 = 4y$

$(y - 2)^2 = -(x - 4)$

Focus is $\left(4-\frac{1}{4},\ 2\right)=\left(\frac{+15}{4},\ 2\right)$

Equation of directrix is $x=\frac{17}{4}$

⇒ $4x - 17 = 0$

(44) **Answer :** (A,C)

Hint:

Area $=\int\limits_0^a (4x^3+6x)\,dx=4$

Solution:

Area $=\int\limits_0^a (4x^3+6x)\,dx=4$

$\left[x^4+3x^2\right]_0^a=4$

⇒ $a^4 + 3a^2 = 4$

⇒ $a^4 + 3a^2 - 4 = 0$

⇒ $(a^2 + 4)(a^2 - 1) = 0$

⇒ $a^2 = -4$ (Not possible)

Or

$a^2 = 1$

⇒ $a = \pm 1$

Section-II

(45) **Answer :** 01.00

Hint:

Let common difference be k.

$b = a + k$

$c = a + 2k$

$d = a + 3k$

Solution:

Let common difference be k.

$b = a + k$

$c = a + 2k$

$d = a + 3k$

Now, $d = a^2 + b^2 + c^2$

$a + 3k = a^2 + (a + k)^2 + (a + 2k)^2$

$a + 3k = a^2 + a^2 + k^2 + 2ak + a^2 + 4k^2 + 4ak$

$3a^2 + (6k - 1)a + (5k^2 - 3k) = 0$

$a=\frac{-(6k-1)\pm\sqrt{-24k^2+24k+1}}{6}$

For 'a' to be an integer, the discriminant must be a perfect square

If $k = 1$, then $-24(1)^2 + 24(1) + 1 = 1$, which is a perfect square

If $k = 1$, then $a=\frac{-5\pm1}{6}$

$\therefore\ a=-1\ Or\ \frac{-2}{3}$

$\therefore\ a=-1\ (a\in z)$

$\therefore$ $b = 0$, $c = 1$ and $d = 2$

Common difference = 1

$a + 2b + 3c + 4d = -1 + 0 + 3 + 8 = 10$

(46) **Answer :** 10.00

Hint:

Let common difference be k.

$b = a + k$

$c = a + 2k$

$d = a + 3k$

Solution:

Let common difference be k.

$b = a + k$

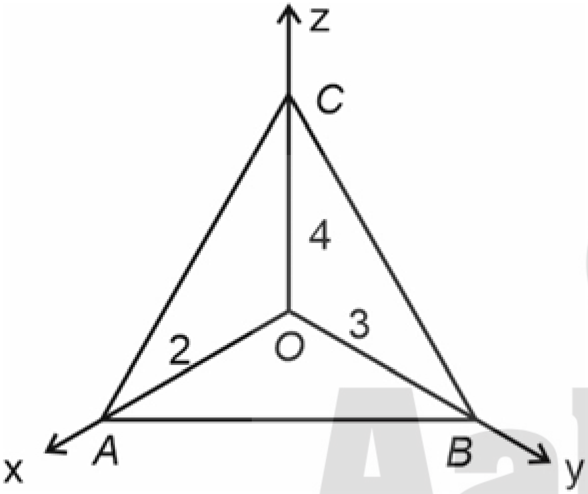
$c = a + 2k$

$d = a + 3k$

Now, $d = a^2 + b^2 + c^2$

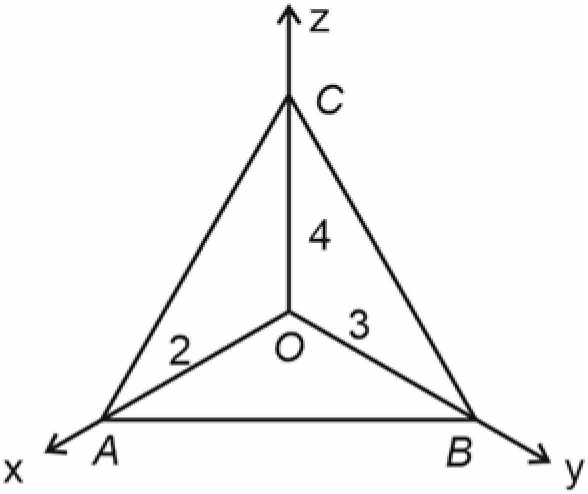
$a + 3k = a^2 + (a + k)^2 + (a + 2k)^2$
$a + 3k = a^2 + a^2 + k^2 + 2ak + a^2 + 4k^2 + 4ak$
$3a^2 + (6k - 1)a + (5k^2 - 3k) = 0$
$a = \frac{-(6k-1) \pm \sqrt{-24k^2+24k+1}}{6}$
For '*a*' to be an integer, the discriminant must be a perfect square
If $k = 1$, then $-24(1)^2 + 24(1) + 1 = 1$, which is a perfect square
If $k = 1$, then $a = \frac{-5 \pm 1}{6}$
$\therefore\ a = -1\ Or\ \frac{-2}{3}$
$\therefore\ a = -1\ (a \in z)$
$\therefore b = 0, c = 1$ and $d = 2$
Common difference = 1
$a + 2b + 3c + 4d = -1 + 0 + 3 + 8 = 10$

(47) **Answer :** 61.00
Hint:
Area of $\Delta OAB = \frac{1}{2}|a||b| = 3$
Solution:



Let $A(a, 0, 0)$, $B(0, b, 0)$, $C(0, 0, c)$
Area of $\Delta OAB = \frac{1}{2}|a||b| = 3$
$\Rightarrow\ |ab| = 6$
Area of $\Delta OBC = \frac{1}{2}|b||c| = 6$
$\Rightarrow\ |bc| = 12$
Area of $\Delta OCA = \frac{1}{2}|c||a| = 4$
$\Rightarrow\ |ca| = 8$
Now, $|ab||bc||ca| = 6 \times 12 \times 8$
$|a^2b^2c^2| = 576$
$|abc| = 24$
Now, $\frac{|abc|}{|bc|} = \frac{24}{12}$
$\Rightarrow |a| = 2$
Similarly, $|b| = 3$, $|c| = 4$
Area of ΔABC
$= \sqrt{ar(\Delta OAB) + ar(\Delta OBC) + ar(\Delta OCA)}$
$\lambda = \sqrt{3^2 + 6^2 + 4^2} = \sqrt{61}$
$\therefore \lambda^2 = 61$
Volume of tetrahedron
$OABC = \frac{1}{6}|abc| = \frac{1}{6} \times 24 = 4$

(48) **Answer :** 04.00
Hint:
Area of $\Delta OAB = \frac{1}{2}|a||b| = 3$
Solution:



Let $A(a, 0, 0)$, $B(0, b, 0)$, $C(0, 0, c)$

Area of $\Delta OAB = \frac{1}{2}|a||b| = 3$

$\Rightarrow |ab| = 6$

Area of $\Delta OBC = \frac{1}{2}|b||c| = 6$

$\Rightarrow |bc| = 12$

Area of $\Delta OCA = \frac{1}{2}|c||a| = 4$

$\Rightarrow |ca| = 8$

Now, $|ab||bc||ca| = 6 \times 12 \times 8$

$|a^2b^2c^2| = 576$

$|abc| = 24$

Now, $\frac{|abc|}{|bc|} = \frac{24}{12}$

$\Rightarrow |a| = 2$

Similarly, $|b| = 3$, $|c| = 4$

Area of ΔABC

$= \sqrt{ar(\Delta OAB) + ar(\Delta OBC) + ar(\Delta OCA)}$

$\lambda = \sqrt{3^2 + 6^2 + 4^2} = \sqrt{61}$

$\therefore \lambda^2 = 61$

Volume of tetrahedron

$OABC = \frac{1}{6}|abc| = \frac{1}{6} \times 24 = 4$

(49) **Answer :** 02.00

Hint:

Replace x by $\frac{x}{2}$

Solution:

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

Replace x by $\frac{x}{2}$

$f\left(\frac{x}{2}\right) - 2f\left(\frac{x}{4}\right) + f\left(\frac{x}{8}\right) = \left(\frac{x}{2}\right)^2$

Replace x by $\frac{x}{4}$

$f\left(\frac{x}{4}\right) - 2f\left(\frac{x}{8}\right) + f\left(\frac{x}{16}\right) = \left(\frac{x}{4}\right)^2$

Replace x by $\frac{x}{2^n}$

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

Adding and $n \to \infty$

$f(x) - f\left(\frac{x}{2}\right) = \frac{4x^2}{3}$ …(i)

Repeating same procedure to above (i)

We get $f(x) - f(0) = \frac{16x^2}{9}$

$f(x) - f(0) - x = 0$

$\Rightarrow \frac{16x^2}{9} - x = 0$

$\Rightarrow x = 0, \frac{9}{16}$

Number of solution = 2

$f'(x) = \frac{32x}{9}$

and
$f'(0) = 0$

(50) **Answer :** 00.00
Hint:
Replace *x* by $\frac{x}{2}$
Solution:
$f(x)-2f\left(\frac{x}{2}\right)+f\left(\frac{x}{4}\right)=x^2$
Replace *x* by $\frac{x}{2}$
$f\left(\frac{x}{2}\right)-2f\left(\frac{x}{4}\right)+f\left(\frac{x}{8}\right)=\left(\frac{x}{2}\right)^2$
Replace *x* by $\frac{x}{4}$
$f\left(\frac{x}{4}\right)-2f\left(\frac{x}{8}\right)+f\left(\frac{x}{16}\right)=\left(\frac{x}{4}\right)^2$
Replace *x* by $\frac{x}{2^n}$
$f\left(\frac{x}{2^n}\right)-2f\left(\frac{x}{2^{n+1}}\right)+f\left(\frac{x}{2^{n+2}}\right)=\left(\frac{x}{2^n}\right)^2$
Adding and $n \to \infty$
$f(x)-f\left(\frac{x}{2}\right)=\frac{4x^2}{3}$ …(i)
Repeating same procedure to above (i)
We get $f(x)-f(0)=\frac{16x^2}{9}$
$f(x) - f(0) - x = 0$
$\Rightarrow \frac{16x^2}{9}-x=0$
$\Rightarrow x=0,\ \frac{9}{16}$
Number of solution = 2
$f'(x)=\frac{32x}{9}$
and
$f'(0) = 0$

Section-III

(51) **Answer :** (A)
Hint:
Concept of combination
Solution:
When 1 all-rounder and 10 players from bowlers and batsman play number of ways $= {}^4C_1.{}^{14}C_{10}$
When 1 wicketkeeper and 10 players from bowlers and batsman play number of ways $= {}^2C_1.{}^{14}C_{10}$
When 1 all rounder 1 wicket keeper and 9 from batsman and bowlers play number of ways $= {}^4C_1.{}^2C_1.{}^{14}C_9$
When all 11 players play from bowlers and batsman then number of ways $= {}^{14}C_{11}$
∴ Total number of ways $= {}^4C_1.{}^{14}C_{10}+{}^2C_1.{}^{14}C_{10}+{}^4C_1.{}^2C_1.{}^{14}C_9+{}^{14}C_{11}$

(52) **Answer :** (A)
Hint:
Concept of combination
Solution:
If 2 batsmen don't want to play then the rest of 10 players can be selected from 17 other players number of ways $= {}^{17}C_{10}$
If the particular bowler doesn't play then number of ways $= {}^{19}C_{11}$
∴ Total number of ways $= {}^{17}C_{10}+{}^{19}C_{11}$

(53) **Answer :** (C)
Hint:
Let $y=x+\frac{1}{x}$
Solution:
$\left(x+\frac{1}{x}\right)^2+a\left(x+\frac{1}{x}\right)-b-2=0$
Let $y=x+\frac{1}{x}$
Range of $x+\frac{1}{x}$ is $(-\infty,\ -2]\cup[2,\ \infty)$
$y^2 + ay - b - 2 = 0$ have real roots
$\therefore\ D\geq 0$
$a^2+4(b+2)\geq 0\ \{\because\ a,\ b\ \geq 0\}$
Then, the maximum absolute value of the two roots is

$\frac{a+\sqrt{a^2+4(b+2)}}{2}$

We need this value to be at least 2. This is equivalent to $\sqrt{a^2+4(b+2)} \geq 4-a$

Squaring both sides, we get

$2a \geq 2-b$

This equation defines the region inside [0, 1] × [0, 1] that is occupied by S, from which we deduce that the desired area is $\frac{1}{4}$.

(54) **Answer :** (D)

Hint:

Let $y=x+\frac{1}{x}$

Solution:

$\left(x+\frac{1}{x}\right)^2+a\left(x+\frac{1}{x}\right)-b-2=0$

Let $y=x+\frac{1}{x}$

Range of $x+\frac{1}{x}$ is $(-\infty,\ -2]\cup[2,\ \infty)$

$y^2+ay-b-2=0$ have real roots

$\therefore\ D\geq 0$

$a^2+4(b+2)\geq 0\ \{\because\ a,\ b\ \geq 0\}$

Then, the maximum absolute value of the two roots is

$\frac{a+\sqrt{a^2+4(b+2)}}{2}$

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Squaring both sides, we get

$2a \geq 2-b$

This equation defines the region inside [0, 1] × [0, 1] that is occupied by S, from which we deduce that the desired area is $\frac{1}{4}$.

Section-IV

(55) **Answer :** 2

Hint:

Let $f(n)=\cos\frac{\pi}{n}\cos\frac{2\pi}{n}\cos\frac{3\pi}{n},\ n\in N$

Solution:

Let $f(n)=\cos\frac{\pi}{n}\cos\frac{2\pi}{n}\cos\frac{3\pi}{n},\ n\in N$

Clearly, $f(1)=1,\ f(2)=0,\ f(3)=\frac{1}{4},\ f(4)=0$

$f(5)=-\cos^2\frac{2\pi}{5}\cos\frac{\pi}{5}<0$

$f(6)=0,\ f(8)=\frac{1}{4}$

$f(7)=\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{3\pi}{7}$

$=-\left(\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{4\pi}{7}\right)$

$=\frac{-\sin\left(\frac{8\pi}{7}\right)}{8\sin\left(\frac{\pi}{7}\right)}=\frac{-\sin\left(\pi+\frac{\pi}{7}\right)}{8\sin\frac{\pi}{7}}=\frac{\sin\left(\frac{\pi}{7}\right)}{8\sin\left(\frac{\pi}{7}\right)}$

$=\frac{1}{8}$

for $n\geq 9,\ 0<\frac{\pi}{n},\ \frac{2\pi}{n},\frac{3\pi}{n}<\frac{\pi}{2}$ and since cos is a decreasing function $f(n)\geq f(9)>\cos^3\frac{3\pi}{9}=\frac{1}{8}>\frac{1}{n+1}$

(56) **Answer :** 11

Hint:

H_1 : Event that die shows up odd, $P(H_1)=\frac{1}{3}$

H_2 : Event that die shows up even, $P(H_2)=\frac{2}{3}$

Solution:

H_1 : Event that die shows up odd, $P(H_1)=\frac{1}{3}$

H_2 : Event that die shows up even, $P(H_2)=\frac{2}{3}$

S = {1, 2, 3, 4, 6, 8}

A = 2^{nd} roll show upto 2

If H_1 occurs then the focus become 2, 2, 6, 4, 6, 8

If H_2 occurs then the focus become 1, 1, 3, 2, 3, 4

Now, $P(A)=P(A\cap H_1)+P(A\cap H_2)$

$= P(H_1).\, P\left(\frac{A}{H_1}\right) + P(H_2).\, P\left(\frac{A}{H_2}\right)$

$= \frac{1}{3} \times \frac{2}{6} + \frac{2}{3} \times \frac{1}{6}$

$= \frac{2}{9}$

$\therefore$ $p + q = 11$

(57) Answer : 5

Hint:

Let $z_1 = x + iy,\ z_2 = y + ix$

Solution:

$z_1 z_2 = a + ib$

Let $z_1 = x + iy,\ z_2 = y + ix$

$x = 8\sin\theta + 7\cos\theta$

$y = \sin x + 4\cos\theta$

$z_1 z_2 = (xy - yx) + i(x^2 + y^2)$

$= i(x^2 + y^2) = a + ib$

$\Rightarrow\ a = 0,\ b = x^2 + y^2$

Now, $x^2 + y^2 = (8\sin\theta + 7\sin\theta)^2 + (\sin\theta + 4\cos\theta)^2$

$= 65\sin^2\theta + 65\cos^2\theta + 120\sin\theta\cos\theta$

$= 65 + 60\sin2\theta$

$\therefore\ z_1 z_2|_{\max} = 125$

$\therefore\ M^{1/3} = (125)^{1/3} = 5$