IIT – JEE: 2025 **TW TEST (MAIN)** **DATE: 10/12/23**

ANSWER KEY

RAY OPTICS

1.	(B)	2.	(C)	3.	(A)	4.	(C)	5.	(B)
6.	(D)	7.	(A)	8.	(D)	9.	(A)	10.	(B)
11.	(D)	12.	(C)	13.	(A)	14.	(B)	15.	(A)
16.	(A)	17.	(C)	18.	(A)	19.	(B)	20.	(C)
21.	(7)	22.	(6)	23.	(3)	24.	(3)	25.	(8)
26.	(0)	27.	(6)	28.	(49)	29.	(8)	30.	(96)

IUPAC NOMENCLATURE

31.	(C)	32.	(B)	33.	(A)	34.	(C)	35.	(A)
36.	(A)	37.	(B)	38.	(C)	39.	(D)	40.	(A)
41.	(B)	42.	(A)	43.	(D)	44.	(D)	45.	(A)
46.	(C)	47.	(A)	48.	(B)	49.	(B)	50.	(C)
51.	(4.00)	52.	(3.00)	53.	(4.00)	54.	(4.00)	55.	(4.00)
56.	(532.00)	57.	(5.00)	58.	(8.00)	59.	(8.00)	60.	(0.00)

PERMUTATIONS & COMBINATIONS

61.	(D)	62.	(C)	63.	(D)	64.	(C)	65.	(B)
66.	(D)	67.	(C)	68.	(C)	69.	(B)	70.	(C)
71.	(D)	72.	(C)	73.	(D)	74.	(A)	75.	(D)
76.	(C)	77.	(C)	78.	(A)	79.	(B)	80.	(B)
81.	(135)	82.	(1512)	83.	(1440)	84.	(126)	85.	(12)
86.	(3402)	87.	(672)	88.	(216)	89.	(13)	90.	(126)

TOPIC: RAY OPTICS

SOLUTIONS

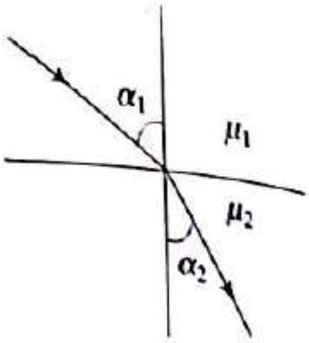
1. (B)

$\mu_1 \sin\alpha_1 = \mu_2 \sin\alpha_2$

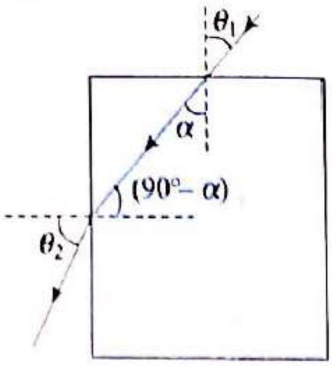
$\frac{c}{v_1}\sin\alpha_1 = \frac{c}{v_2}\sin\alpha_2$

$\frac{\sin\alpha_1}{f\lambda_1} = \frac{\sin\alpha_2}{f\lambda_2}$

$\lambda_2 = \frac{\sin\alpha_2}{\sin\alpha_1}\lambda_1$



2. (C)



As θ, increases, α also increases.

So, $(90^o - \alpha)$ decreases and hence θ, decreases.

3. (A)

$\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$

For a plane surface, $R = \infty$

$\therefore \quad \frac{\mu_1}{-u} + \frac{\mu_2}{v} = 0$

or $\quad \frac{\mu_2}{v} = \frac{\mu_1}{u}$ or $\frac{\mu}{v} = \frac{1}{u}$

or $\quad v = \mu_2 u$

Clearly, to the fish, the bird appears farther than its actual distance.

Again, $\frac{dv}{dt} = \mu\frac{du}{dt}$

or Apparent speed of bird = Refractive index $\times$ Actual speed of bird.

4. (C)

$$\sqrt{3}=\frac{\sin\left(\frac{60^\circ+\delta_m}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)}$$

$$\frac{\sqrt{3}}{2}=\sin\left(\frac{60^\circ+\delta_m}{2}\right)$$

$$\sin 60^\circ=\sin\left(\frac{60^\circ+\delta_m}{2}\right)$$

or $\frac{60^\circ+\delta_m}{2}=60^\circ$

or $\delta_m=60^\circ \Rightarrow i=\frac{A+\delta_m}{2}=\frac{60^\circ+60^\circ}{2}=60^\circ$

5. (B)

$$v_m=\frac{1}{2}c$$

$$\mu=\frac{c}{v_m}=\frac{c}{\frac{1}{2}c}=2 \text{ or } \frac{1}{\sin i_c}=2$$

or $\sin i_c=\frac{1}{2}$ or $i_c=30^\circ$

6. (D)

For convex mirror, $u+v=12\times 2=24\,\text{cm}$

(because for plane mirror, distance of object = distance of image)

Also, here for the convex mirror $u=20\,\text{cm}$, therefore v = 4 cm.

Hence, using $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

We find $f=5\,\text{cm}$

7. (A)

For a concave mirror, $u=-\frac{15}{2}\text{cm}$, $v=?$

$$f=-\frac{10}{2}\text{cm}=-5\text{ cm}$$

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-5}-\frac{1}{-15/2}=-\frac{1}{5}+\frac{2}{15}=\frac{-1}{15}$$

or $v=-15\,\text{cm}$

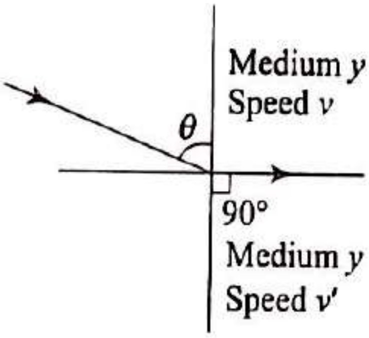
Clearly, the position of the final image is on the pole of the convex mirror.

8. (D)

Clearly, x is denser medium.

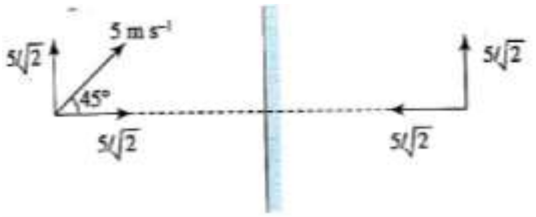
Now, $\frac{\sin\theta}{\sin 90^\circ} = \frac{1}{{}_Y\mu_X} = {}_X\mu_Y = \frac{v}{v'}$

or $v' = \frac{v}{\sin\theta}$



9. (A)

Speed of image w.r.t. mirror $= \sqrt{\left(\frac{5}{\sqrt{2}}\right)^2 + \left(\frac{5}{\sqrt{2}}\right)^2} = 5\,\text{ms}^{-1}$



10. (B)

$\frac{\sin 60^\circ}{\sin r_1} = \sqrt{3}$

or $\sin r_1 = \frac{\sin 60^\circ}{\sqrt{3}}$

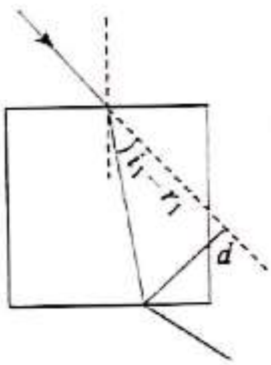
or $\sin r_1 = \frac{\sqrt{3}}{2} \times \frac{1}{\sqrt{3}} = \frac{1}{2}$

or $r_1 = 30^\circ$

Now, $\sin(i_1 - r_1) = \frac{d}{5}$

or $d = 5\sin(i_1 - r_1)$

or $d = 5\sin(60^\circ - 30^\circ) = 5\sin 30^\circ = \frac{5}{2}\text{cm}$



11. (D)

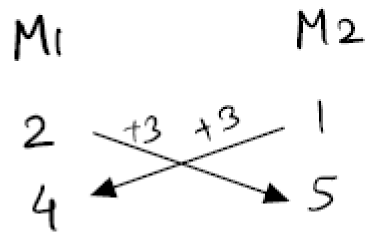
$S = 180 - 4$

$S_1 = 180 - (60) = 60^\circ$

$S_2 = 180 - 2(30) = 120^\circ$

$S_{net} = 60 + 120 = 180^\circ$

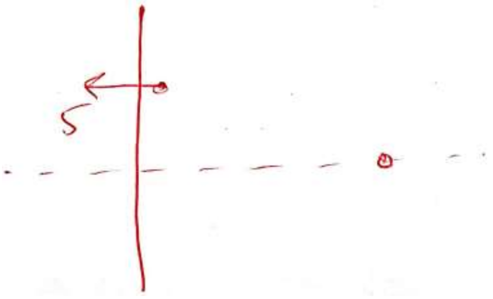
12. (C)



5 + 1 = 6

13. (A)

With the horizontal



$V_x = 10\cos 60° = 5$

Nothing to do with V_y

$V_{approved}$ = 10 m/s

14. (B)

Since image is inverted = concave.

15. (A)

One end will be at f.

$\frac{1}{v} + \frac{1}{-4} = \frac{-1}{f}$

$\Rightarrow \frac{1}{v} = \frac{1}{4} - \frac{1}{f}$

$v = \frac{uf}{f-u}$

$|v| = \frac{uf}{u-f}$

Distance $= \frac{uf}{u-f} - f = \frac{f^2}{u-f}$

16. (A)

Take 1st reflection from M_1

In plane mirror image will move towards left.

It will act object for concave mirror

$V = -\left(\frac{V^2}{a^2}\right)\frac{du}{dt}$

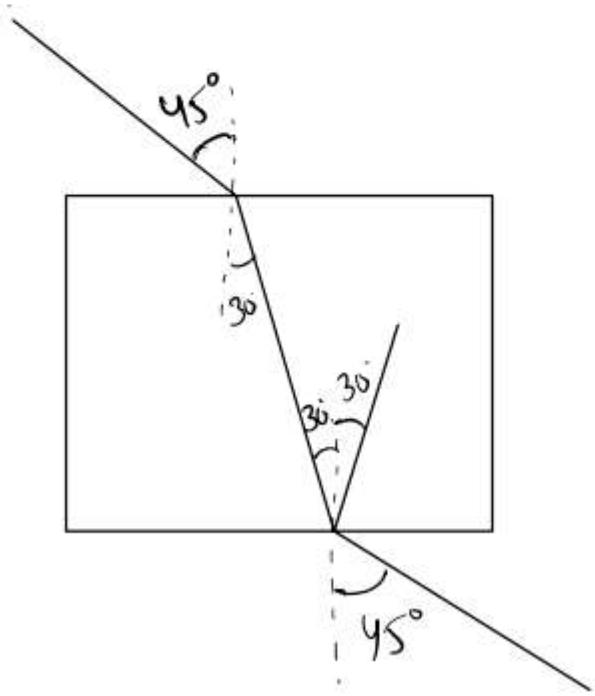
$\Rightarrow$ = Right

17. (C)

$\sqrt{2}\sin i = 1 \quad \Rightarrow\; i = 45°$

$1 \times \sin 4° = \sqrt{2}\sin r$

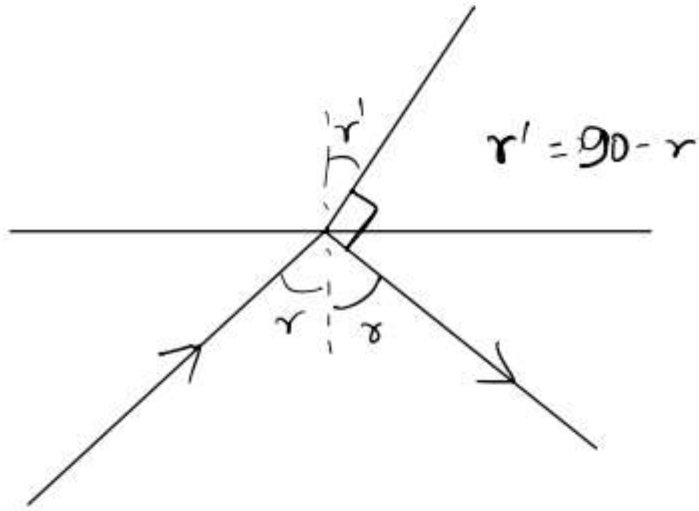
$\sin r = \frac{1}{2} \;\Rightarrow\; r = 30°$



$\Rightarrow$ Angle $= 180 - (45 + 30°) = 105°$

18. (A)

$i = r$ rectangle angle $= r'$



$\mu_1 \sin r = \mu_2 \cos r$

$\mu_2 = \mu_1 \tan r$

$\theta_C = \sin^{-1}\left(\frac{\mu_2}{\mu_1}\right)$

$\sin^{-1}(\tan r)$

19. (B)

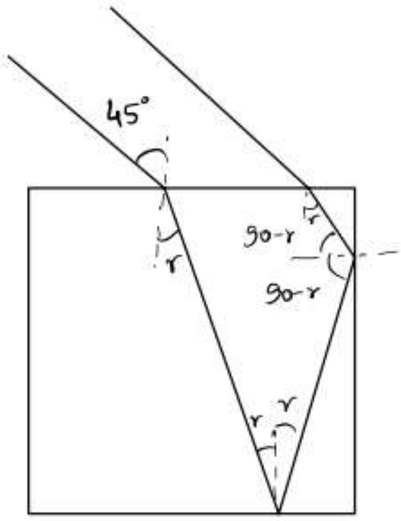
$\sqrt{3}\sin 30° = 1\sin r$

$r = 60°$

20. (C)

$1\sin 45° = 2\sin r$

$\sin r = \frac{1}{2\sqrt{2}} \Rightarrow r < 30°$



$\theta_C = \sin^{-1}\left(\frac{1}{2}\right) = 30°$

$\because 90 - r > \theta_C$

$\Rightarrow$ T / R will be plane

21. (7)

First reflection = 3

Second reflection = 3

Third reflection = 1

Total = 7

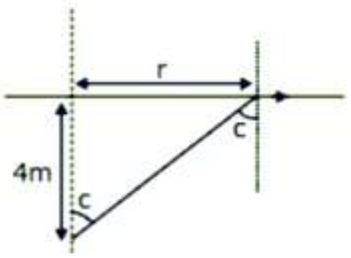
22. (6)

$\tan\theta = \left(\frac{r}{4}\right)$

$\sin^{-1}\left(\frac{3}{5}\right) = \theta \Rightarrow \theta = 37^{o}$

$\tan^{-1}\left(\frac{3}{4}\right) = \theta \Rightarrow \left(\frac{r}{4}\right) = \left(\frac{3}{4}\right)$

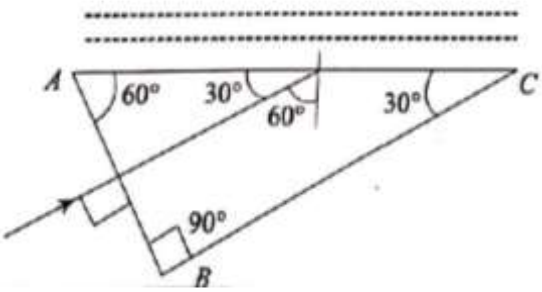
$\Rightarrow r = 3\,m$



23. (3)

Critical angle between glass and liquid.

$$\sin\theta_C = \frac{\mu}{(3/2)} = \frac{2\mu}{3}$$



Angle of incidence on $AC = 60^\circ$

For TIR, $i > \theta_C \Rightarrow \frac{2}{3}\mu$

$$\mu < \frac{3\sqrt{3}}{4} = \frac{I\sqrt{3}}{4} \text{ (given)}$$

So, $I = 3$

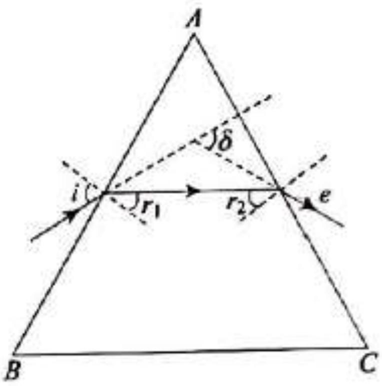
24. (3)

Given $i = 60^\circ$, $\delta = 30^\circ$ and $A = 30^\circ$.

We have $\delta = i + e - A$

From Eq. (i), we get $30^\circ = 60^\circ + e - 30^\circ$ or $e = 0$

So, r_2 is also zero, then $r_1 = A = 30^\circ$

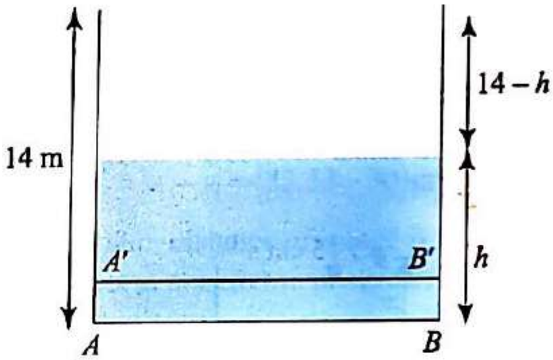


So, $\mu = \frac{\sin i}{\sin r_1} = \frac{\sin 60^\circ}{\sin 30^\circ} = \sqrt{3}$

Hence, the value of a = 3.

25. (8)

$A'B'$ is the apparent positon of bottom of container, at a distance h/μ from water surface.



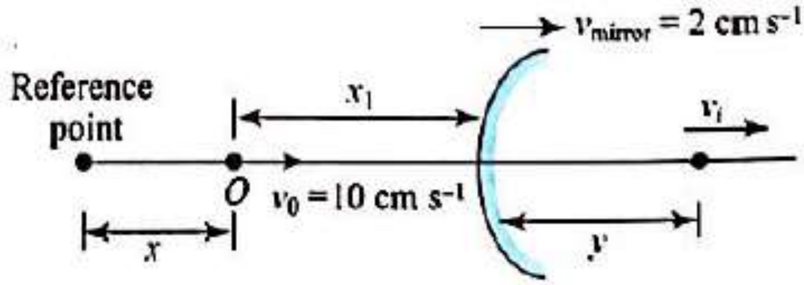
If the container seems to be half filled. Then

$$14-h=\frac{h}{\mu} \Rightarrow h=\frac{3h}{4} \Rightarrow h=8\,m$$

26. (0)

$$\frac{1}{y}+\frac{1}{-x}=\frac{1}{10} \qquad ...(i)$$

$$\frac{1}{y}-\frac{1}{10}=\frac{1}{10} \Rightarrow y=5\text{ cm}$$



$$\frac{dx}{dt}=10\,\text{cm s}^{-1},\ \frac{d(x+x_1)}{dt}=2\text{ cm s}^{-1}$$

$$\frac{dx_1}{dt}=-8\text{ cm s}^{-1}$$

$$\frac{dy}{dt}=v_i=2$$

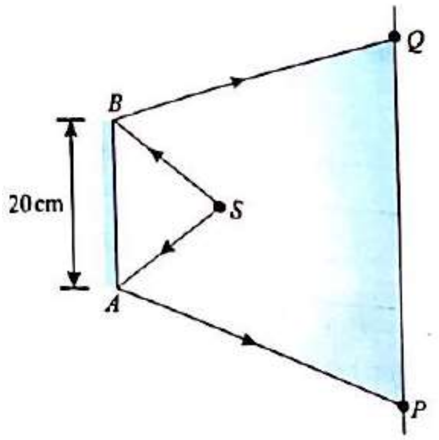
From (i): $\frac{dy}{dt}=\left(\frac{y}{x_2}\right)^2\frac{dx_1}{dt}$

$$\Rightarrow\ v_i-2=\left(\frac{5}{10}\right)^2(-8) \Rightarrow v_i=0$$

27. (6)

Insect can see the image of source *S* in the mirror, so far as it remains in field of view of image overlapping with the road.

Shaded portion is the field of view, which overlaps with the road up to length *PQ*.



By geometry we can see that, $PQ = 3AB = 60\,\text{cm}$

$$\therefore \quad t = \frac{\text{Distance}}{\text{Speed}} = \frac{60}{10} = 6\,\text{s}$$

28. (49)

29. (8)

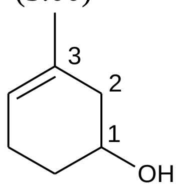
30. (96)

IIT – JEE: 2025 | **TW TEST (MAIN)** | **DATE: 10/12/23**

TOPIC: IUPAC & NOMENCLATURE

Answer & Solution

31. (C)
32. (B)
33. (A)
34. (C)
35. (A)
36. (A)
37. (B)
38. (C)
39. (D)
40. (A)
41. (B)
42. (A)
43. (D)
44. (D)
45. (A)
46. (C)
47. (A)
48. (B)
49. (B)
50. (C)
51. (4.00)
52. (3.00)



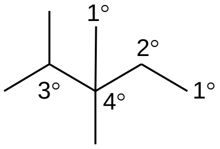
$\equiv$ 3-Methyl(3)

53. (4.00)

—OCH_3, —NO_2, —Br and NO

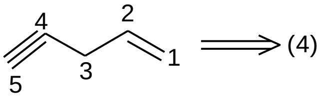
$\equiv$ (4)

54. (4.00)



$\equiv$ (4)

55. (4.00)



56. (532.00)
57. (5.00)
58. (8.00)
59. (8.00)
60. (0.00)

Answers & Solution

61. (D)
Direct formula

62. (C)
1, 3, 5, 7 $\rightarrow$ four digits
$\therefore$ number of numbers = 4! = 24
We have to find the sum of these 24 numbers suppose 7 is in the unit place, then the remaining three can be arranged as 3! = 6 ways.
Similarly, other digits can occupy the first place in 6 ways.
Hence, even due to unit place of all the 24 digits number = 6 (7 + 5 + 3 +1) units = 96 units.
Again suppose 7 is in the second place i.e., tens place and it will be so in 6 numbers.
Similarly, each digit will be in tens place of all the 24 numbers.
$= 6(7+5+3+1)\text{ tens} = 96 \times 10 \text{ units}$
Proceeding similarly for hundreds and thousands.
The sum $= 96(1+10+100+1000) = 96 \times 1111 = 106656$

63. (D)
$^{15+4-1}C_{4-1} = {}^{18}C_3$

64. (C)
Case 1 : Mr. B & Miss C are in committee and Mr. A is excluded
$\Rightarrow {}^4C_2 \times {}^4C_1 = 24$ ways
(Men) (Women)
Case 2 : Mr. B not there : ${}^5C_3 \times {}^5C_2 = 100$ ways
(Men) (Women)
Total ways = 24 + 100 = 124

65. (B)
$^{15}C_2 \times 2$

66. (D)

67. (C)
$^{n}C_2 \times 2 = 600 \Rightarrow n = 25$

68. (C)

$^{9}C_2 \times {}^{9}C_2$

69. (B)

$(5+1)(4+1)(6+1)-1$

70. (C)

$2^4 - 1$

71. (D)

Say B on right side of A
D or C will be right of B
This can be done in 2! Ways. Remaining three places can be filled in 3! ways
$= 2! \times 3! = 12$ ways.
Say C on right of A
B can be filled in 3 places. (B next should be D).
B immediately next is D
'A', 'C', 'B', 'D' are filled in 3 ways. Remaining two places in 2 ways.
Total = 6 ways
Total number = 12 + 6 = 18 ways.

72. (C)

Number of selections of 4 consonants out of 7 is $^{7}C_4$
Number of selections of 2 vowels from 4 is $^{4}C_2$
Arrangement of words in 6! ways
Desired words : $^{7}C_4 \times {}^{4}C_2 \times 6! = 151200$

73. (D)

$^{10}C_5 \cdot 5!$

74. (A)

$^{9}C_4 \times 1 \times (4)^5$

75. (D)

$(10)^4 - {}^{10}C_4 \cdot 4!$

76. (C)

EEQUU

Words starting with $E \to \frac{4!}{2!}$

Words starting with $QE \to \frac{3!}{2!}$

next word will be QUEEU $\to$ 1
and finally QUEUE $\to$ 1
Rank is 12 + 3 + 1 + 1 = 17^{th}

77. (C)

The distribution should be 2, 2, 2 and 3 to the youngest.

Now 3 toys for the youngest van be selected in $^9C_3$ ways, remaining 6 toys can be divided into three equal groups in $\frac{6!}{(2!)^3 3!}$ ways and can be distributed in 3! Ways.

Thus the required number of ways $= {}^9C_3 \frac{6!}{(2!)^3} = \frac{9!}{3!(2!)^3}$

78. (A)

$\frac{12!}{5!\cdot 3!\cdot 2!} \times {}^{13}C_3 \times 1$

79. (B)

For a number to be divisible by 5,5 or 0 should be at units place.

$\therefore$ Unit place can be filled by 2 ways

Remaining digits can be filled in $\frac{6!}{3!\times 2!}$ ways.

$\therefore$ Total ways $= \frac{2\times 6!}{3!2!}$

But these arrangements also include cases where 0 is at millions place and 5 at units place, which are undesirable cases

$\Rightarrow \frac{5!}{3!\times 2!}$ ways (undesirable)

subtract it from total ways.

$\therefore$ Desired ways $= 2\times \frac{6!}{3!\times 2!} - \frac{5!}{3!\times 2!} = 110$

80. (B)

To satisfy given condition first we have to arrange n men around the table

No. of ways to do so, $= (n-1)!$

Now, when these men are arranged and seated then there are n spaces between each men where we will arrange and seated n women

No. of ways to do so, $= {}^nC_n\,(n)!$

Hence, total number of ways will be (n – 1)! n!

81. (135)

$I_H \rightarrow$ Indian husband, $I_W \rightarrow$ Indian wife

$A_H \rightarrow$ American husband, $A_w \rightarrow$ American wife

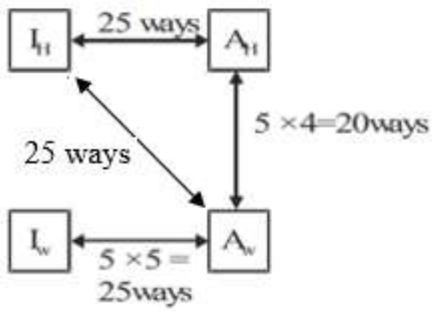
Case 1 : Hand shaking occuring between same nationals and same genders (M/F)

$I_H - I_H \rightarrow {}^5C_2 = 10$ ways

Similarly for $I_W - I_W$, $A_W - A_W$, $A_H - A_H$

Total ways 10 × 4 = 40.

Case 2 : All other possible hand shakes



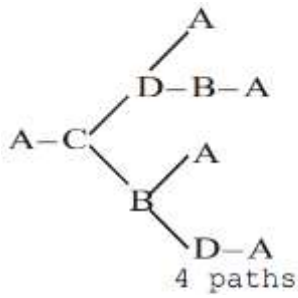
Hence total number of handshakes
= (25 × 3 + 40) + (20) = 135
Method – II
Total number of handshakes possible $^{20}C_2$
undesirable handshakes : $^{10}C_2 + {}^{10}C_1$
Hence, Desired ways = $^{20}C_2 - ({}^{10}C_2 + {}^{10}C_1)$

82. (1512)
2 gents can be selected from 9 gents in $^{9}C_2$ ways
2 ladies can be selected from 9 – 2 = 7 ladies in $^{7}C_2$ ways
$\therefore$ The number of required ways
$= {}^{9}C_2 \times {}^{7}C_2 \times 2$
= 1512 ways

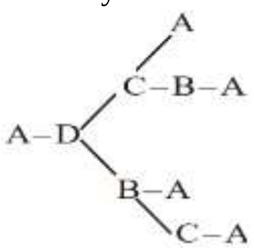
83. (1440)
EE & AA OR EA & EA

84. (126)
Maximum number of matches possible, if India win the series are 9 Out of these 9 matches we are required to choose 5 matches that India may win :
$\Rightarrow$ Total ways : $^{9}C_5$

85. (12)
Paths are shown as :-



Similarly if we start from A towards B we get another 4 paths.



Similarly if we start from A towards D Again 4 paths
$\therefore$ Total different paths = 4 × 3 = 12

II Method → $^3C_1 \times {}^2C_1 \times {}^2C_1 = 12$

86. (3402)

If number starts with 635

$\underline{6}\,\underline{3}\,\underline{5}$ _ _ _ _

(A) Let 9 be in the last position no. of ways of filling other 3 positions

$9 \times 9 \times 9 = 329$

(B) Let 9 be in other position except last

$\Rightarrow$ Last position can be 1, 3, 5, 7

$\Rightarrow$ no. of ways $= 4 \times 3 \times 9 \times 9 = 972$

Same case if number starts with 674, (A) & (B).

So, total ways $= 729 + 972 + 729 + 972$

$= 3402$

87. (672)

Total number of digits $= 3^7$

The 7-digit number has exactly two digits 2

Let's say the number

22cdefg, 2b2defg, 2bc2efg,..

Number of cases we can put exactly two digits (out of 7 digits) are 2 is

$6 + 5 + 4 + 3 + 2 + 1 = 21$ cases.

For each case, the remaining 5 digits can be either 1 or 3, so the number of ways for each case is

$2^5 = 32$ ways

$\therefore$ the number of favorable numbers is

$= 21 \times 32 = 672$ numbers

88. (216)

Sum of digits should be divisible by 3.

89. (13)

Make cases when all 5 boxes are filled by:

Case 1 : identical 5 red balls

$^5C_5 \rightarrow 1$ way

Case 2 : 4 identical red balls and 1 blue ball

$^5C_1 = 5$ ways

Case 3 : 3 red and 2 blue balls i.e. xRxRx

$\therefore\ {}^4C_2 = 6$ ways

Case 4 : 2 red and 3 blue balls i.e. xRxRx$\Rightarrow$ 3 gap s, 3 blue balls

$\Rightarrow {}^3C_3 = 1$ way

$\therefore$ Total number of ways are 1+5+6+1 = 13 ways

90. (126)

$^{4+6-1}C_{6-1} = {}^9C_5$