Number Systems

CHAPTER 1

TRY YOURSELF SOLUTIONS

1. A rational number lying between $\frac{1}{3}$ and $\frac{1}{5}$

$= \left(\frac{1}{3}+\frac{1}{5}\right) \div 2 = \left(\frac{5+3}{15}\right) \times \frac{1}{2} = \frac{8}{15} \times \frac{1}{2} = \frac{4}{15}$

Thus, the required rational number between $\frac{1}{3}$ and $\frac{1}{5}$ is $\frac{4}{15}$ *i.e.*, $\frac{1}{3} > \frac{4}{15} > \frac{1}{5}$.

2. Let $x = 4$, $y = 5$ and $n = 5$

Since $x < y$

$\therefore \quad d = \frac{y-x}{n+1} = \frac{(5-4)}{(5+1)} = \frac{1}{6}$

Thus, five rational numbers between 4 and 5 are $(x + d)$, $(x + 2d)$, $(x + 3d)$, $(x + 4d)$ and $(x + 5d)$.

i.e., $\left(4+\frac{1}{6}\right), \left(4+\frac{2}{6}\right), \left(4+\frac{3}{6}\right), \left(4+\frac{4}{6}\right)$ and $\left(4+\frac{5}{6}\right)$

i.e., $\frac{25}{6}, \frac{26}{6}, \frac{27}{6}, \frac{28}{6}$ and $\frac{29}{6}$

i.e., $4 < \frac{25}{6} < \frac{26}{6} < \frac{27}{6} < \frac{28}{6} < \frac{29}{6} < 5.$

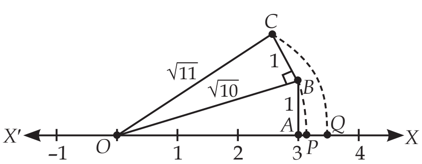
3. Here, $\frac{-1}{6} < \frac{-1}{7}$ or $\frac{-7}{42} < \frac{-6}{42}$ and $n = 3$.

Since, we need to find three rational numbers between $\frac{-7}{42}$ and $\frac{-6}{42}$, so multiply the numerator and denominator by $(3 + 1) = 4$ of $\frac{-7}{42}$ and $\frac{-6}{42}$ *i.e.*, $\frac{-7}{42} = \frac{-7 \times 4}{42 \times 4} = \frac{-28}{168}$ and $\frac{-6}{42} = \frac{-6 \times 4}{42 \times 4} = \frac{-24}{168}$

Thus, three rational number between $\frac{-1}{6}$ and $\frac{-1}{7}$ or $\frac{-7}{42}$ and $\frac{-6}{42}$ are $\frac{-25}{168}, \frac{-26}{168}$ and $\frac{-27}{168}$ such that $\frac{-6}{42} > \frac{-25}{168} > \frac{-26}{168} > \frac{-27}{168} > \frac{-7}{42}$.

4. Draw a number line $X'OX$ and let O be the origin. Take $OA = 3$ units and draw $AB = 1$ unit such that $AB \perp OA$. Join OB. We get,

$OB = \sqrt{OA^2 + AB^2} = \sqrt{3^2 + 1^2} = \sqrt{9+1} = \sqrt{10}$ units



With O as centre and radius $OB = \sqrt{10}$ units draw on arc which intersects OX at P. Then, $OP = OB = \sqrt{10}$ units

Thus, the point P represents $\sqrt{10}$ on the number line.

Now, draw $BC = 1$ unit such that $BC \perp OB$. Join OC. We get,

$OC = \sqrt{OB^2 + BC^2} = \sqrt{(\sqrt{10})^2 + 1^2} = \sqrt{11}$ units

With O as centre and radius $OC = \sqrt{11}$ units draw an arc which intersects OX at Q. Then, $OQ = OC = \sqrt{11}$ units

Thus, the point Q represents $\sqrt{11}$ on the number line.

5. Draw a number line $X'OX$ and let O be the origin. Take $OA = 2$ units and draw $AB = 1$ unit such that $AB \perp OA$. Join OB. We get,

$OB = \sqrt{OA^2 + AB^2} = \sqrt{2^2 + 1^2} = \sqrt{5}$ units

With O as centre and radius, $OB = \sqrt{5}$ units draw an arc which intersects OX at P.

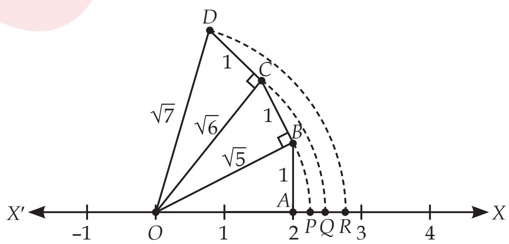
Then, $OP = OB = \sqrt{5}$ units

Thus, the point P represents $\sqrt{5}$ on the number line.

Now, draw $BC = 1$ unit such that $BC \perp OB$. Join OC.

We get, $OC = \sqrt{OB^2 + BC^2} = \sqrt{(\sqrt{5})^2 + 1^2}$

$= \sqrt{5+1} = \sqrt{6}$ units



With O as centre and radius $OC = \sqrt{6}$ units draw an arc which intersects OX at Q. Then, $OQ = OC = \sqrt{6}$ units.

Thus, the point Q represents $\sqrt{6}$ on the number line.

Now, draw $CD = 1$ unit such that $CD \perp OC$. Join OD.

We get, $OD = \sqrt{OC^2 + CD^2} = \sqrt{(\sqrt{6})^2 + 1^2} = \sqrt{7}$ units

With O as centre and radius $OD = \sqrt{7}$ units draw an arc which intersects OX at R. Then, $OR = OD = \sqrt{7}$ units

Thus, the point R represents $\sqrt{7}$ on the number line.

6. We have,

```
16 ) 35.0000 ( 2.1875
     -32
     ----
       30
      -16
      ----
       140
      -128
      -----
        120
       -112
       -----
          80
         -80
         ---
           0
```

$\therefore \quad \frac{35}{16} = 2.1875$

7. Let $x = 0.1\overline{63}$. Then,

$x = 0.1636363...$ ...(i)

Multiplying (i) by 10 and 1000, we get

$10x = 1.636363...$ ...(ii)

$1000x = 163.636363...$ ...(iii)

Subtracting (ii) and from (iii), we get

$(1000x - 10x) = (163.636363\ ...) - (1.636363\ ...)$

$\Rightarrow \quad 990x = 162 \;\Rightarrow\; x = \frac{162}{990} \Rightarrow x = \frac{9}{55}$

Thus, $0.1\overline{63} = \frac{9}{55}$

8. (i) $\frac{96}{300} = \frac{32}{100} = \frac{8}{25} = \frac{2^3}{5^2}$

Since, denominator of $\frac{96}{300}$ is of the form $2^m \times 5^n$. Thus, the given number is terminating decimal.

Verification : On dividing 96 by 300, we get

$$\begin{array}{r|l} 300 & 96.00 \; (0.32 \\ & -900 \\ \hline & \;\;600 \\ & -600 \\ \hline & \;\;\;\;0 \end{array}$$

$\frac{96}{300} = 0.32$ is terminating decimal.

(ii) $\frac{169}{91} = \frac{13}{7}$

Since, denominator of $\frac{169}{91}$ is not in the form of $2^m \times 5^n$.

Thus, the given number is non-terminating recurring decimal.

Verification : On dividing 13 by 7, we get

$$\begin{array}{r|l} 7 & 13.0000000 \; (1.8571428... \\ & -7 \\ \hline & \;\;60 \\ & -56 \\ \hline & \;\;\;40 \\ & \;-35 \\ \hline & \;\;\;\;50 \\ & \;\;-49 \\ \hline & \;\;\;\;\;10 \\ & \;\;\;\;-7 \\ \hline & \;\;\;\;\;\;30 \\ & \;\;\;\;-28 \\ \hline & \;\;\;\;\;\;\;20 \\ & \;\;\;\;\;-14 \\ \hline & \;\;\;\;\;\;\;\;60 \\ & \;\;\;\;\;\;-56 \\ \hline & \;\;\;\;\;\;\;\;\;4 \end{array}$$

$\therefore \quad \frac{13}{7} = 1.\overline{857142}$

9. We have, $8.0025 = \frac{80025}{10000} = \frac{80025 \div 25}{10000 \div 25} = \frac{3201}{400}$

10. (i) Let $x = 0.\overline{585}$. Then,

$x = 0.585585585\ ...$ ...(i)

Multiplying (i) by 1000, we get

$1000\,x = 585.585585\ ...$ ...(ii)

Subtracting (i) from (ii), we get

$1000x - x = (585.585585\ ...) - (0.585585585\ ...)$

$\Rightarrow \quad 999x = 585 \;\Rightarrow\; x = \frac{585}{999} \Rightarrow x = \frac{65}{111}$

Thus, $0.\overline{585} = \frac{65}{111}$

(ii) Let $x = 0.\overline{35}$. Then,

$x = 0.353535\ ...$ ...(i)

Multiplying (i) by 100, we get

$100x = 35.3535\ ...$ ...(ii)

Subtracting (i) from (ii), we get

$100x - x = (35.3535\ ...) - (0.3535\ ...)$

$\Rightarrow \quad 99x = 35 \;\Rightarrow\; x = \frac{35}{99}$

Thus, $0.\overline{35} = \frac{35}{99}$

11. Given numbers are 0.60 and 0.66. Thus, the required irrational numbers will lie between 0.60 and 0.66.

Also, the irrational numbers have non-terminating non-repeating decimals. Hence, the irrational numbers between 0.60 and 0.66 are 0.61010010001... and 0.62020020002... .

12. To find an irrational number, firstly we will divide 1 by 7 and 1 by 3.

Now,

$$\begin{array}{r|l} 7 & 1.000000 \; (0.142857... \\ & -7 \\ \hline & \;\;30 \\ & -28 \\ \hline & \;\;\;20 \\ & \;-14 \\ \hline & \;\;\;\;60 \\ & \;\;-56 \\ \hline & \;\;\;\;\;40 \\ & \;\;\;-35 \\ \hline & \;\;\;\;\;\;50 \\ & \;\;\;\;-49 \\ \hline & \;\;\;\;\;\;\;1 \end{array}$$

$\therefore \quad \frac{1}{7} = 0.142857... = 0.\overline{142857}$

Now,

$$\begin{array}{r|l} 3 & 1.00 \; (0.33... \\ & -9 \\ \hline & \;10 \\ & -9 \\ \hline & \;\;1 \end{array}$$

$\therefore \quad \frac{1}{3} = 0.333... = 0.\overline{3}$

Thus, the required irrational number will lie between $0.\overline{142857}$ and $0.\overline{3}$. Also, the irrational numbers have non-terminating non-repeating decimals. Hence, the required irrational number between 1/7 and 1/3 is 0.2101001000... .

13. To find irrational numbers, firstly we will divide 2 by 3 and 8 by 9.

Now, $3\overline{)2.000}(0.666\ldots$

$$\begin{array}{r} -18 \\ \hline 20 \\ -18 \\ \hline 20 \\ -18 \\ \hline 2 \end{array}$$

$\therefore \quad \frac{2}{3} = 0.666\ldots = 0.\overline{6}$

Now, $9\overline{)8.000}(0.888\ldots$

$$\begin{array}{r} -72 \\ \hline 80 \\ -72 \\ \hline 80 \\ -72 \\ \hline 8 \end{array}$$

$\therefore \quad \frac{8}{9} = 0.888\ldots = 0.\overline{8}$

Thus, the required irrational numbers will lie between $0.\overline{6}$ and $0.\overline{8}$. Also, the irrational numbers have non-terminating non-repeating decimals. Hence, the required irrational numbers between $\frac{2}{3}$ and $\frac{8}{9}$ are 0.6101001000... and 0.7101001000....

14. (i) We have, $\frac{8\sqrt{20}}{3\sqrt{20}} = \frac{8}{3}$, which is a rational number.

(ii) Here, 6 is a rational number and $\sqrt{3}$ is an irrational number. Since, we know that division of a rational number and an irrational number always gives an irrational number as quotient.

Hence, $\frac{6}{\sqrt{3}}$ is an irrational number.

(iii) We have, $(3+2\sqrt{7})-(-3+2\sqrt{7})$

$= 3+2\sqrt{7}+3-2\sqrt{7} = 6$, which is a rational number.

15. We have, $(2+\sqrt{3})+(2-\sqrt{3})$

$= 2+\sqrt{3}+2-\sqrt{3} = 4$

16. We have, $\left(2\sqrt{2}+5\sqrt{3}\right)+\left(\sqrt{2}-3\sqrt{3}\right)$

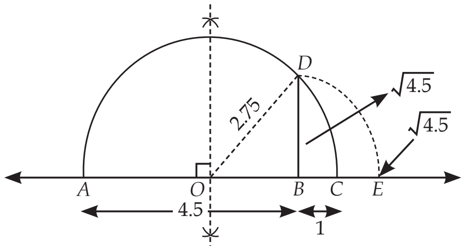
$= \left(2\sqrt{2}+\sqrt{2}\right)+\left(5\sqrt{3}-3\sqrt{3}\right)$

$= (2+1)\sqrt{2}+(5-3)\sqrt{3} = 3\sqrt{2}+2\sqrt{3}$

17. We have, $(9\sqrt{7}+72)\div(3\sqrt{7}+24)$

$= \frac{9(\sqrt{7}+8)}{3(\sqrt{7}+8)} = 3$

18. Draw a line segment, AB = 4.5 units and extend it to C such that BC = 1 unit and AC = 5.5 units. Mark O as mid-point of AC. Draw a semicircle with centre O and radius $OC = \frac{AC}{2}$ = 2.75 units. Draw $BD \perp AC$ and intersecting the semicircle at D.



In ΔOBD, $BD^2 = OD^2 - OB^2$

$\Rightarrow \quad BD^2 = (2.75)^2 - (1.75)^2 = (2.75 + 1.75)(2.75 - 1.75)$

$\Rightarrow \quad BD = \sqrt{4.5}$ units.

To represent $\sqrt{4.5}$ on the number line, let us treat the line BC as the number line, with B as zero, C as 1, and so on.

Draw an arc with centre B and radius $BD = \sqrt{4.5}$ units, which intersects the number line BC (produced) at E.

$BD = BE = \sqrt{4.5}$ units

$\therefore \quad E$ represents $\sqrt{4.5}$.

19. We have, $(5+\sqrt{7})(2+\sqrt{5})$

$= 5\times 2+5\times\sqrt{5}+\sqrt{7}\times 2+\sqrt{7}\times\sqrt{5}$

$= 10+5\sqrt{5}+2\sqrt{7}+\sqrt{7\times 5} = 10+5\sqrt{5}+2\sqrt{7}+\sqrt{35}$

$[\because \sqrt{x}\cdot\sqrt{y} = \sqrt{xy}]$

20. We have, $(\sqrt{11}-\sqrt{5})^2 = 11+5-2\sqrt{11\times 5}$

$\left[\because \left(\sqrt{x}-\sqrt{y}\right)^2 = x+y-2\sqrt{xy}\right]$

$= 16-2\sqrt{55}$

21. We have, $\left(9+\sqrt{\frac{3}{2}}\right)\left(9-\sqrt{\frac{3}{2}}\right)$

$= 81-\frac{3}{2} \quad \{\because (x+\sqrt{y})(x-\sqrt{y}) = x^2-y\}$

$= \frac{162-3}{2} = \frac{159}{2}$

22. Given, $x = 2\sqrt{5}+\sqrt{3}$ and $y = 2\sqrt{5}-\sqrt{3}$

$\therefore \quad x+y = 2\sqrt{5}+\sqrt{3}+2\sqrt{5}-\sqrt{3} = 4\sqrt{5}$

Now, $(x+y)^2 = x^2+y^2+2xy$

$\Rightarrow \quad x^2+y^2 = (x+y)^2 - 2xy$

$\Rightarrow \quad x^2+y^2 = (4\sqrt{5})^2 - 2\times(2\sqrt{5}+\sqrt{3})(2\sqrt{5}-\sqrt{3})$

$\Rightarrow \quad x^2+y^2 = 80-2[(2\sqrt{5})^2-(\sqrt{3})^2]$

$[\because (x-y)(x+y) = x^2-y^2]$

$\Rightarrow \quad x^2+y^2 = 80 - 2[20-3] = 80 - 2\times 17$

$\Rightarrow \quad x^2+y^2 = 80 - 34 = 46$

23. We have, $\frac{5}{\sqrt{3}-\sqrt{5}}$

$= \frac{5}{\sqrt{3}-\sqrt{5}}\times\frac{\sqrt{3}+\sqrt{5}}{\sqrt{3}+\sqrt{5}} = \frac{5(\sqrt{3}+\sqrt{5})}{(\sqrt{3})^2-(\sqrt{5})^2}$

$= \frac{5(\sqrt{3}+\sqrt{5})}{3-5} = -\frac{5}{2}(\sqrt{3}+\sqrt{5})$

24. We have, $\frac{5+2\sqrt{3}}{7+4\sqrt{3}}$

On rationalising, we get

$$\frac{(5+2\sqrt{3})}{(7+4\sqrt{3})}\times\frac{(7-4\sqrt{3})}{(7-4\sqrt{3})}=\frac{(5+2\sqrt{3})(7-4\sqrt{3})}{(7+4\sqrt{3})(7-4\sqrt{3})}$$

$$=\frac{35-20\sqrt{3}+14\sqrt{3}-2\sqrt{3}\times 4\sqrt{3}}{(7)^2-(4\sqrt{3})^2}$$

$$=\frac{35-6\sqrt{3}-24}{49-48}=\frac{11-6\sqrt{3}}{1}$$

$$\therefore\quad \frac{5+2\sqrt{3}}{7+4\sqrt{3}}=11-6\sqrt{3} \qquad \text{...(i)}$$

Given, $\frac{5+2\sqrt{3}}{7+4\sqrt{3}}=a+b\sqrt{3}$

$\Rightarrow\quad 11-6\sqrt{3}=a+b\sqrt{3}$ [Using (i)]

On comparing, we get

a = 11 and b = –6

25. Given, $x=(4-\sqrt{15})$

Squaring both sides, we get

$$x^2=(4-\sqrt{15})^2 \Rightarrow x^2=(4)^2+(\sqrt{15})^2-2\times 4\times\sqrt{15}$$

$\Rightarrow\quad x^2 = 16 + 15 - 8\sqrt{15}$

$\Rightarrow\quad x^2 = 31 - 8\sqrt{15}$ ...(i)

$$\therefore\quad \frac{1}{x^2}=\frac{1}{31-8\sqrt{15}}$$

On rationalising, we get

$$\frac{1}{x^2}=\frac{1}{31-8\sqrt{15}}\times\frac{31+8\sqrt{15}}{31+8\sqrt{15}}\Rightarrow\frac{1}{x^2}=\frac{31+8\sqrt{15}}{(31)^2-(8\sqrt{15})^2}$$

$$\Rightarrow\quad \frac{1}{x^2}=\frac{31+8\sqrt{15}}{961-960}=\frac{31+8\sqrt{15}}{1}=(31+8\sqrt{15}) \qquad \text{...(ii)}$$

Now, $x^2+\frac{1}{x^2}=(31-8\sqrt{15})+(31+8\sqrt{15})$

[Using (i) and (ii)]

$$\Rightarrow\quad x^2+\frac{1}{x^2}=31-8\sqrt{15}+31+8\sqrt{15}\ \Rightarrow\ x^2+\frac{1}{x^2}=62$$

26. We have, $x = 1 - \sqrt{2}$

$$\Rightarrow\quad \frac{1}{x}=\frac{1}{1-\sqrt{2}}$$

On rationalising, we get

$$\frac{1}{x}=\frac{1\times(1+\sqrt{2})}{(1-\sqrt{2})\times(1+\sqrt{2})}$$

$$\Rightarrow\quad \frac{1}{x}=\frac{1+\sqrt{2}}{(1)^2-(\sqrt{2})^2}=\frac{(1+\sqrt{2})}{1-2}=-(1+\sqrt{2})$$

(i) Now, $x+\frac{1}{x}=(1-\sqrt{2})-(1+\sqrt{2})$

$=1-\sqrt{2}-1-\sqrt{2}=-2\sqrt{2}$

(ii) Now, $x-\frac{1}{x}=(1-\sqrt{2})+(1+\sqrt{2})=2$

(iii) $\left(x+\frac{1}{x}\right)^2=(-2\sqrt{2})^2$ [Using part (i)]

$$\Rightarrow\quad x^2+\frac{1}{x^2}+2\times x\times\frac{1}{x}=8$$

$$\Rightarrow\quad x^2+\frac{1}{x^2}+2=8\ \Rightarrow\ x^2+\frac{1}{x^2}=6$$

27. We have, $\frac{(25)^{3/2}\times(243)^{3/5}}{(16)^{5/4}\times(8)^{4/3}}$

$$=\frac{(5^2)^{3/2}\times(3^5)^{3/5}}{(2^4)^{5/4}\times(2^3)^{4/3}}=\frac{5^{2\times\frac{3}{2}}\times 3^{5\times\frac{3}{5}}}{2^{4\times\frac{5}{4}}\times 2^{3\times\frac{4}{3}}} \qquad [\because (x^m)^n = x^{m\times n}]$$

$$=\frac{5^3\times 3^3}{2^5\times 2^4}=\frac{(5\times 3)^3}{2^{5+4}} \quad [\because x^m\times y^m=(x\times y)^m\ ;\ x^m\times x^n=x^{m+n}]$$

$$=\frac{(15)^3}{2^9}=(15)^3\times 2^{-9}$$

28. We have, L.H.S. = $\frac{2^{\frac{1}{2}}\times 3^{\frac{1}{3}}\times 4^{\frac{1}{4}}}{10^{\frac{-1}{5}}\times 5^{\frac{3}{5}}}\div\frac{3^{\frac{4}{3}}\times 5^{\frac{-7}{5}}}{4^{\frac{-3}{5}}\times 6}$

$$=\left[\frac{2^{\frac{1}{2}}\times 3^{\frac{1}{3}}\times(2^2)^{\frac{1}{4}}}{10^{\frac{-1}{5}}\times 5^{\frac{3}{5}}}\right]\div\left[\frac{3^{\frac{4}{3}}\times 5^{\frac{-7}{5}}}{(2^2)^{\frac{-3}{5}}\times(2\times 3)}\right]$$

$$=\left[\frac{2^{\frac{1}{2}}\times 3^{\frac{1}{3}}\times 2^{2\times\frac{1}{4}}}{(2\times 5)^{\frac{-1}{5}}\times 5^{\frac{3}{5}}}\right]\div\left[\frac{3^{\frac{4}{3}}\times 5^{\frac{-7}{5}}}{2^{\frac{-3}{5}\times 2}\times 2\times 3}\right] \qquad [\because (x^m)^n = x^{m\times n}]$$

$$=\left[\frac{2^{\frac{1}{2}+\frac{1}{2}}\times 3^{\frac{1}{3}}}{2^{\frac{-1}{5}}\times 5^{\frac{-1}{5}}\times 5^{\frac{3}{5}}}\right]\div\left[\frac{3^{\frac{4}{3}-1}\times 5^{\frac{-7}{5}}}{2^{\frac{-6}{5}+1}}\right] \qquad \left[\begin{array}{l}\because x^m\times x^n=x^{m+n}\\ x^m\div x^n=x^{m-n}\end{array}\right]$$

$$=\left[\frac{2^{1-\left(\frac{-1}{5}\right)}\times 3^{\frac{1}{3}}}{5^{\frac{-1}{5}+\frac{3}{5}}}\right]\div\left[\frac{3^{\frac{1}{3}}\times 5^{\frac{-7}{5}}}{2^{\frac{-1}{5}}}\right]=\left[\frac{2^{\frac{6}{5}}\times 3^{\frac{1}{3}}}{5^{\frac{2}{5}}}\right]\div\left[\frac{3^{\frac{1}{3}}\times 5^{\frac{-7}{5}}}{2^{\frac{-1}{5}}}\right]$$

$$=\frac{2^{\frac{6}{5}}\times 3^{\frac{1}{3}}}{5^{\frac{2}{5}}}\times\frac{2^{\frac{-1}{5}}}{3^{\frac{1}{3}}\times 5^{\frac{-7}{5}}}=\frac{2^{\frac{6}{5}-\frac{1}{5}}\times 3^{\frac{1}{3}-\frac{1}{3}}}{5^{\frac{2}{5}-\frac{7}{5}}}$$

$$=\frac{2^1\times 3^0}{5^{-1}}=2\times 5=10=\text{R.H.S.}$$

29. Given, $a - b = 0\ \Rightarrow\ \frac{2^{x-1}}{2^{x-2}}-\frac{2^{-x}}{2^{x+1}}=0$

$\Rightarrow\quad 2^{x-1-x+2} - 2^{-x-x-1} = 0$ $[\because x^m \div x^n = x^{m-n}]$

$\Rightarrow\quad 2^1 - 2^{-2x-1} = 0\ \Rightarrow\ 2^{-2x-1} = 2^1$

On comparing power of 2, we have

$\Rightarrow\quad -2x - 1 = 1 \Rightarrow x = -1$

30. We have, $\frac{6^{2/3}\times\sqrt[3]{6^7}}{\sqrt[3]{6^6}}$

$$=\frac{6^{2/3}\times(6^7)^{1/3}}{(6^6)^{1/3}}=\frac{6^{2/3}\times 6^{7\times 1/3}}{6^{6\times 1/3}} \qquad [\because (x^m)^n=x^{m\times n}]$$

$$= \frac{6^{2/3} \times 6^{7/3}}{6^2} = \frac{6^{\frac{2}{3}+\frac{7}{3}}}{6^2} \qquad [\because\ x^m \times x^n = x^{m+n}]$$

$$= \frac{6^3}{6^2} = 6^{3-2} \qquad \left[\because x^m \div x^n = x^{m-n}\right]$$

$= 6$

31. We have,

$$\text{L.H.S.} = \left(\frac{1}{x^{a-b}}\right)^{\frac{1}{(a-c)}} \cdot \left(\frac{1}{x^{b-c}}\right)^{\frac{1}{(b-a)}} \cdot \left(\frac{1}{x^{c-a}}\right)^{\frac{1}{(c-b)}}$$

$$= (x)^{\frac{1}{(a-b)} \times \frac{1}{(a-c)}} \cdot (x)^{\frac{1}{(b-c)} \times \frac{1}{(b-a)}} \cdot (x)^{\frac{1}{(c-a)} \times \frac{1}{(c-b)}}$$

$$[\because\ (x^m)^n = x^{m \times n}]$$

$$= (x)^{\frac{1}{-(a-b)(c-a)}} \cdot (x)^{\frac{1}{-(b-c)(a-b)}} \cdot (x)^{\frac{1}{-(c-a)(b-c)}}$$

$$= (x)^{\frac{1}{-(a-b)(c-a)} + \frac{1}{-(b-c)(a-b)} + \frac{1}{-(c-a)(b-c)}} \qquad [\because\ x^m \times x^n = x^{m+n}]$$

$$= (x)^{\frac{-(b-c)-(c-a)-(a-b)}{(a-b)(b-c)(c-a)}} = (x)^{\frac{-b+c-c+a-a+b}{(a-b)(b-c)(c-a)}} = x^0 = 1 \ [\because\ x^0 = 1]$$

$= \text{R.H.S.}$

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