IG_0606 Additional Maths

Equations, Inequalities and Graphs. Notes

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IG-Maths 0606

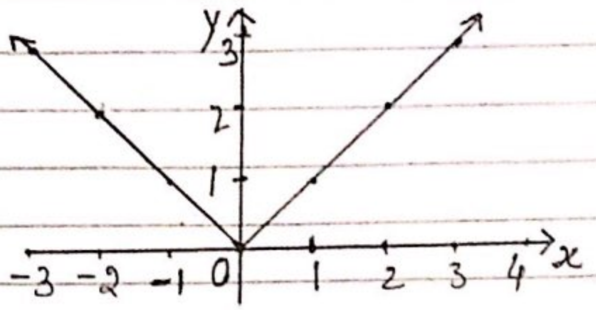
Equations, inequalities and graphs

§ Modulus Function:

Given $x \in R$

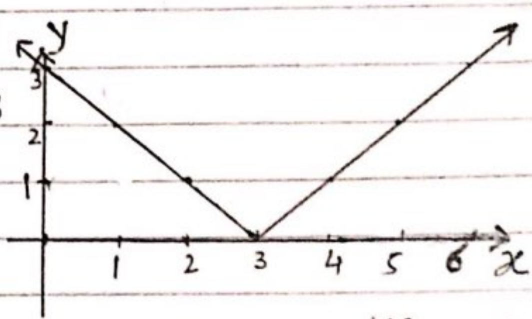
(i) $y = |x| = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{cases}$

x	-3	-2	-1	0	1	2	3
y	3	2	1	0	1	2	3



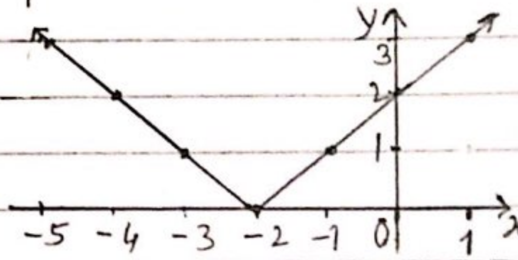
(ii) $y = |x-3| = \begin{cases} (x-3) & \text{if } x \geq 3 \\ -(x-3) \text{ or } (3-x) & \text{if } x < 3 \end{cases}$

x	0	1	2	3	4	5	6
y	3	2	1	0	1	2	3



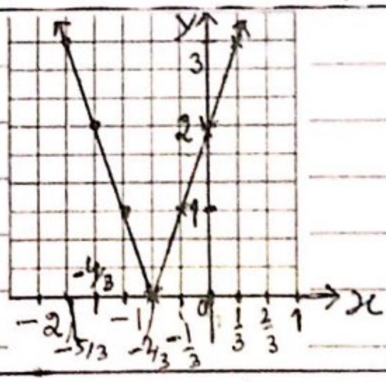
(iii) $y = |x+2| = \begin{cases} x+2, & x \geq -2 \\ -(x+2), & x < -2 \end{cases}$

x	-5	-4	-3	-2	-1	0	1
y	3	2	1	0	1	2	3



(iv) $y = |3x+2| = \begin{cases} 3x+2, & x \geq -2/3 \\ -(3x+2), & x < -2/3 \end{cases}$

x	$-5/3$	$-4/3$	-1	$-2/3$	$-1/3$	0	$1/3$	$2/3$
y	3	2	1	0	1	2	3	4



(v) $y = |x^2 - 5x + 4|$

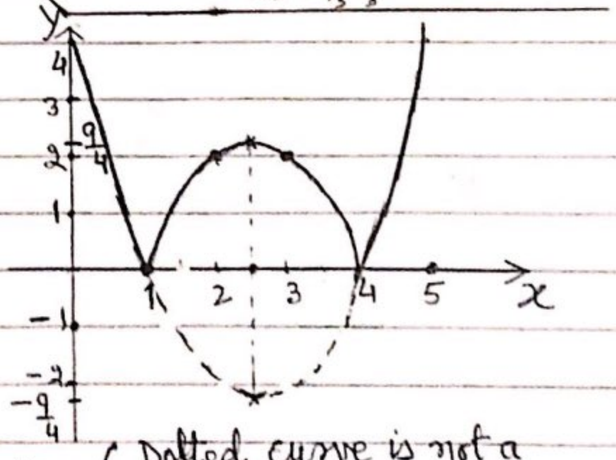
$= |(x-1)(x-4)|$

$= \begin{cases} (x-1)(x-4); & (x-1)(x-4) \geq 0 \\ -(x-1)(x-4); & (x-1)(x-4) < 0 \end{cases}$

$= \begin{cases} (x-1)(x-4); & x \leq 1 \text{ or } x \geq 4 \\ -(x-1)(x-4); & 1 \leq x \leq 4 \end{cases}$

(Apply solution of quad. inequation)

x	0	1	2	$\frac{5}{2}$	3	4	5
y	4	0	2	$9/4$	2	0	4



Note: (Dotted curve is not a part of graph)

§ Some Properties of Modulus functions:

(i) $|a \times b| = |a| \cdot |b|$ $\quad a, b \in R$

(ii) $\left|\frac{a}{b}\right| = \frac{|a|}{|b|}$

(iii) $|a-x| = |x-a|$

(iv) $|x| = |y| \Rightarrow x = y$ or $x = -y$

or $|x| = |y| \Rightarrow x^2 = y^2$

(v) $|x| = a \Rightarrow x = \pm a \quad : a > 0$

(vi) $|x| \leq a \Rightarrow -a \leq x \leq a \quad : a > 0$

(vii) $|x| \geq a \Rightarrow x \leq -a$ or $x \geq a : a > 0$

(viii) $|x-p| \leq a \Rightarrow p-a \leq x \leq p+a \quad ; a \geq 0$

(IX) $|x^2| = x^2 = |x|^2 \quad ; x \in R$

(X) $\sqrt{x^2} = |x| \quad ; x \in R$

XI $|x| > |a| \Leftrightarrow x^2 > a^2$

(XII) $|x| < |a| \Leftrightarrow x^2 < a^2$

(XIII) $|f(x)| = \begin{cases} f(x) ; & f(x) \geq 0 \\ -f(x) ; & f(x) < 0 \end{cases}$

Example 1. Solve the equation $|5-3x| = 10$ $\quad$ /M-17/22/Q1/...[3]

Solution: $|5-3x| = 10$

$\Rightarrow 5-3x = \pm 10$

$\Rightarrow 5-3x = 10$ or $5-3x = -10$

$\Rightarrow 3x = -5$ or $3x = 15$

$x = -5/3$ or $x = 5$ ✓

Alternate method.

$|5-3x| = 10$

$\Rightarrow (5-3x)^2 = 10^2$

$\Rightarrow 9x^2 - 30x + 25 = 100$

$\Rightarrow 9x^2 - 30x - 75 = 0$

$\Rightarrow 3x^2 - 10x - 25 = 0$

$\Rightarrow (x-5)(3x+5) = 0$

$\Rightarrow x = -5/3$ or 5 ✓

Example 2. Solve $|5x+3| = |1-3x|$ [S-17/22/Q1] --- [3]

Solution: $|5x+3| = |1-3x|$

$\Rightarrow 5x+3 = 1-3x$ or $5x+3 = -(1-3x)$

$\Rightarrow 8x = -2$ or $2x = -4$

$x = -2/8$ or $x = -2$

$\therefore x = -0.25$ or -2 ✓

Alternate method:

$|5x+3| = |1-3x|$

$\Rightarrow (5x+3)^2 = (1-3x)^2$

$\Rightarrow 25x^2 + 30x + 9 = 9x^2 - 6x + 1$

$\Rightarrow 16x^2 + 36x + 8 = 0$

$\Rightarrow 4x^2 + 9x + 2 = 0$

$\Rightarrow (4x+1)(x+2) = 0$

$\Rightarrow x = -\frac{1}{4}$ or -2

$\Rightarrow x = -0.25$ or -2 ✓

$\frac{2}{5}, -2$

Example 3. Solve. $2|x-1| = 3|x|$

Solution:

$2|x-1| = 3|x|$

$\Rightarrow 2(x-1) = 3x$ or $2(x-1) = -3x$

$\Rightarrow 2x-2 = 3x$ or $2x-2 = -3x$

$\Rightarrow x = -2$ or $x = 2/5$

Alternate method:

$2|x-1| = 3|x| \Rightarrow (2|x-1|)^2 = (3|x|)^2$ [$\because |x|^2 = x^2$

$\Rightarrow 4(x-1)^2 = 9x^2$

$\Rightarrow 4(x^2 - 2x + 1) = 9x^2$

$\Rightarrow 4x^2 - 8x + 4 = 9x^2$

$\Rightarrow 5x^2 + 8x - 4 = 0$

$\Rightarrow (x+2)(5x-2) = 0$

$\Rightarrow x = -2$ or $\frac{2}{5}$ ✓

Example 4 (i) On the axes, sketch the graph of $y = 2 - x$ and $y = |3+2x|$ ---[4]

(ii) Solve $|3+2x| = 2-x$ $\boxed{M\text{-}16/12/Q4}$ ---[3]

Solution $y = 2 - x$ ---(1)

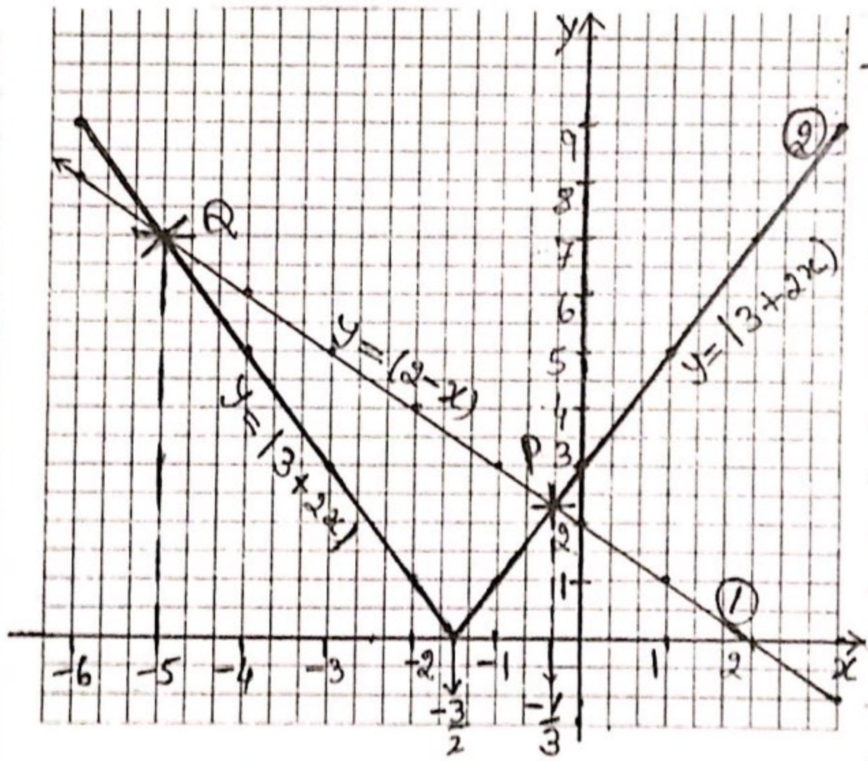
x	-5	-4	-3	-2	-1	0	1	2
y	7	6	5	4	3	2	1	0

and $y = |3+2x| = \begin{cases} 3+2x \;; & 3+2x \geq 0 \text{ or } x \geq -\frac{3}{2} \\ -(3+2x)\;; & x < -3/2 \end{cases}$ —(2)

x	-5	-4	-3	$-\frac{3}{2}$	-1	0	1	2	3
y	7	5	3	0	1	3	5	7	9

(ii) The two graphs (i) and (ii) intersect at $P\left(x=-\frac{1}{3}\right)$; $Q(x=5)$

$\therefore$ Required Solutions $x = -\frac{1}{3}; -5$



$x = -\frac{1}{3}$ or $x = -5$ ✓

(ii) Alternate method: To solve algebrically:

$|3+2x| = 2-x$

$\Rightarrow 3+2x = 2-x$ or $3+2x = -(2-x)$

$\Rightarrow 3x = -1$ or $x = 5$

$\Rightarrow x = -\frac{1}{3}$ or 5. ✓

Equations, inequations and graphs.

Example 5 (a) On the axes below, sketch the graph of $y=|2x+5|$ and the graph of $y=|2-x|$, stating the coordinates of the points where graph meets the coordinate axes. ....[4]

(b) (i) Solve $|2x+5|=|2-x|$ ---[1]

SP-20/01/Q5

(ii) Solve $|2x+5| \leqslant |2-x|$ ---[3]

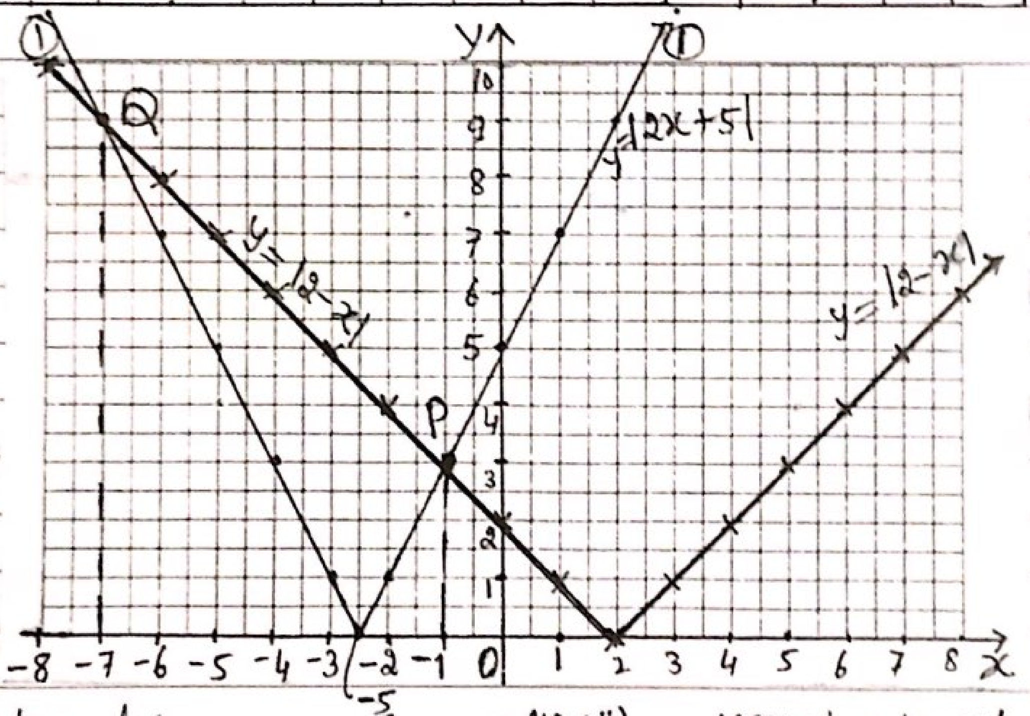
Solution:

$$y=|2x+5|=\begin{cases} 2x+5 ; & (2x+5)\geqslant 0 \text{ or } x \geqslant -\frac{5}{2} \\ -(2x+5) ; & x<-\frac{5}{2} \end{cases} \quad \text{—— (1)}$$

x	−8	−7	−6	−5	−4	−3	$-\frac{5}{2}$	−2	−1	0	1
y	+11	+9	+7	+5	+3	+1	0	1	+3	5	7

and $$y=|2-x|=\begin{cases} 2-x ; & 2-x\geqslant 0 \text{ or } x\leqslant 2 \\ x-2 ; & x>2 \end{cases} \quad \text{—— (2)}$$

x	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7
y	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5



graph (1) intersects the axes $\begin{cases} x\text{-axis } x=-2.5 \\ y\text{-axis } y=5 \end{cases}$

graph (2) intersects the axes $\begin{cases} x\text{-axis at } x=2 \\ y\text{-axis at } y=2 \end{cases}$

(b)(i) Two graphs intersect at $x=-1$ or -5
P or Q

(b)(ii) $|2x+5| \leqslant |2-x|$

Curve (1) is below curve (2) between P and Q

∴ Required Solution is

$-7 \leqslant x \leqslant -1$

Equations, inequations and graphs

Example 5(b) Alternate method: (Algebric method)

Solve: $|2x+5| \leq |2-x|$

$\Rightarrow (2x+5)^2 \leq (2-x)^2$ $\quad \because |x| \leq |y| \Rightarrow x^2 \leq y^2$

$\Rightarrow 4x^2+20x+25 \leq 4+x^2-4x$

$\Rightarrow 3x^2+24x+21 \leq 0$

$\Rightarrow x^2+8x+7 \leq 0$ —— ①

$\Rightarrow (x+7)(x+1) \leq 0$

Critical values are -1 and -7

$\therefore$ Solution is $-7 \leq x \leq -1$

$a < b$

$(x-a)(x-b) \leq 0$

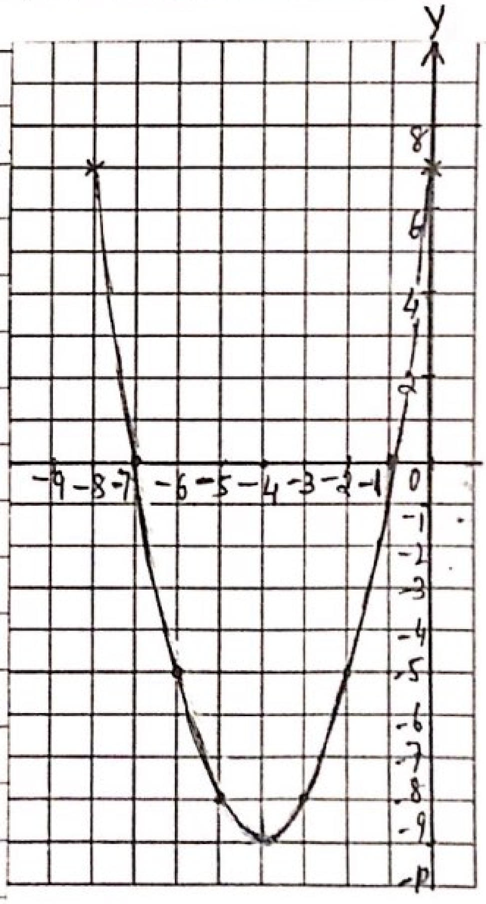
$\Rightarrow a \leq x \leq b$

Using Graphic method:

To Solve $x^2+8x+7 \leq 0$ —— ①

or $(x+7)(x+1) \leq 0$

x	-8	-7	-6	-5	-4	-3	-2	-1	0
y	7	0	-5	-8	-9	-8	-5	0	7



The graph is below x-axis when $-7 \leq x \leq -1$

$\therefore$ Solution of $x^2+8x+7 \leq 0$

when $-7 \leq x \leq -1$ ✓

Example 6. Solve the inequality: $|2x-5| > 3|2x+1|$

Solution: $|2x-5| > 3|2x+1|$

$\Rightarrow (2x-5)^2 > 3^2(2x+1)^2$

$\Rightarrow 4x^2-20x+25 > 9(4x^2+4x+1)$

$\Rightarrow 4x^2-20x+25 > 36x^2+36x+9$

$\Rightarrow 32x^2+56x-16 < 0$

$\Rightarrow 4x^2+7x-2 < 0$

$\Rightarrow (4x-1)(x+2) < 0$

$\Rightarrow -2 < x < \frac{1}{4}$ ✓

Alternate method: Graphically.

Draw the graph of $y = |2x-5|$ and $y = 3|2x+1|$ and solve

$|2x-5| = \begin{cases} 2x-5, & x \geq 5/2 \\ -(2x-5), & x < 5/2 \end{cases}$ — ①

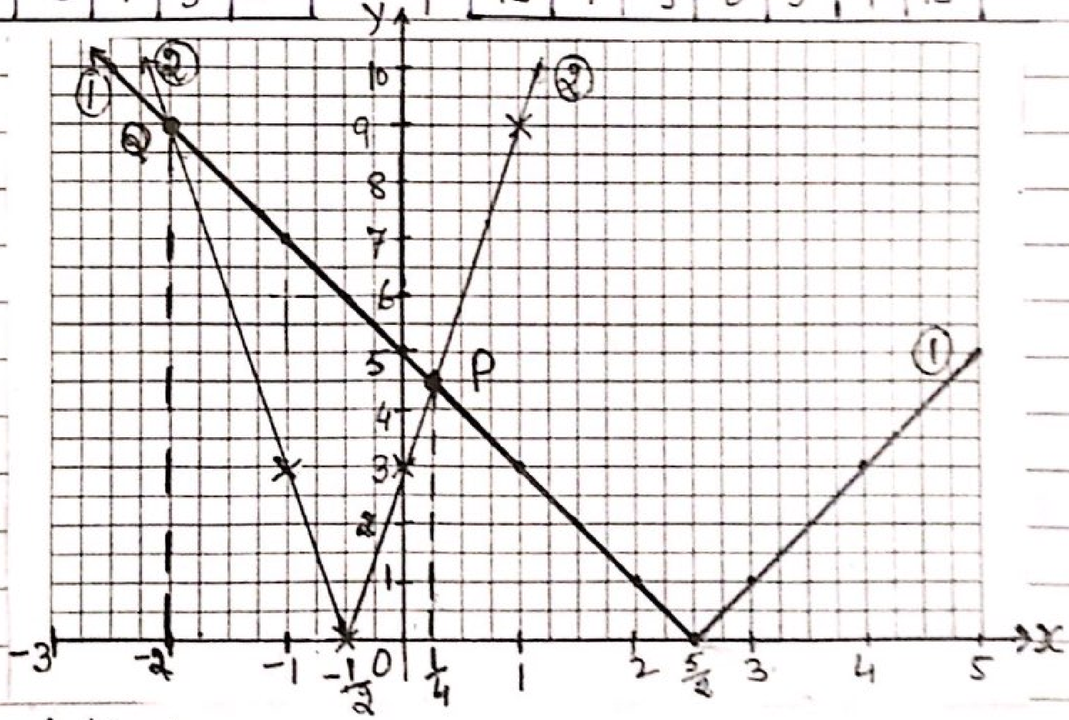
$3|2x+1| = \begin{cases} 3(2x+1), & x \geq -\frac{1}{2} \\ -3(2x+1), & x < -\frac{1}{2} \end{cases}$ — ②

x	0	1	2	5/2	3	4	5
y	5	3	1	0	1	3	5

−3	−2	−1	$-\frac{1}{2}$	0	1	2
15	9	3	0	3	9	15

Two graphs ① and ② intersect at $P(x=\frac{1}{4})$ and $Q(x=-2)$

Graph ② is below graph ① between -2 & $\frac{1}{4}$



∴ Required solution is:

$-2 < x < \frac{1}{4}$

Example 7: Solve: $|3x-2| < 5$

Solution:

$(\because |x| < 1 \Rightarrow -1 < x < 1)$

$|3x-2| < 5$

$\Rightarrow -5 < 3x-2 < 5$

$\Rightarrow -3 < 3x < 7$

$\Rightarrow -1 < x < \frac{7}{3}$ ✓

Alternate Method 1.

$|3x-2| < 5$

$\Rightarrow (3x-2)^2 < 5^2$

$(|x| < a \Rightarrow x^2 < a^2$, $a > 0)$

$\Rightarrow 9x^2 - 12x + 4 < 25$

$\Rightarrow 9x^2 - 12x - 21 < 0$

$\Rightarrow 3x^2 - 4x - 7 < 0$

$\Rightarrow (x+1)(3x-7) < 0$

$\Rightarrow -1 < x < \frac{7}{3}$ ✓ $\left[\because (x+1)(3x-7) = 0,\ x = -1 \text{ or } \frac{7}{3}\right]$

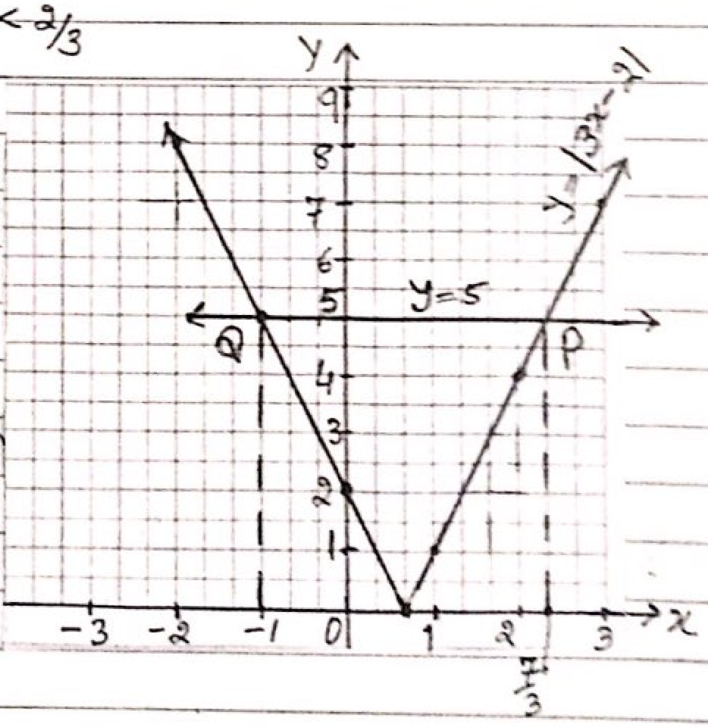
Alternate method 2:

Solving Graphically:

Consider $y = |3x-2|$ and $y = 5$

$$y = |3x-2| = \begin{cases} 3x-2 & ; x \geq \frac{2}{3} \\ -(3x-2) & ; x < \frac{2}{3} \end{cases}$$

x	-2	-1	0	2/3	1	2	3
y	8	5	2	0	1	4	7



graphs of $y = |3x-2|$ & $y = 5$

Intersect at $P\left(x = \frac{7}{3}\right)$ and $Q(x = -1)$

$y = |3x-2|$ is below $y = 5$ between $x = -1$ and $x = \frac{7}{3}$

$\therefore$ Required solution is

$-1 < x < \frac{7}{3}$ ✓

Example 8. Solve $|2x-5|>1$

Solution $|2x-5|>1$

$\Rightarrow 2x-5>1$ or $2x-5<-1$

$\Rightarrow 2x>6$ or $2x<4$

$\Rightarrow x>3$ or $x<2$ ✓

$\left[\because |x|>a \Rightarrow x>a \text{ or } x<-a\right]$ $a>0$

Alternate method 1. $|2x-5|>1$

$\Rightarrow (2x-5)^2>1^2$

$\left(\because |x|>a \Rightarrow x^2>a^2\right)$ $a>0$

$\Rightarrow 4x^2-20x+25>1$

$\Rightarrow 4x^2-20x+24>0$

$\Rightarrow x^2-5x+6>0$

$\Rightarrow (x-3)(x-2)>0$

$\Rightarrow x>3$ or $x<2$ ✓

$\left[\because (x-a)(x-b)>0 \Rightarrow x>a \text{ or } x<b\right]$ $a>b$

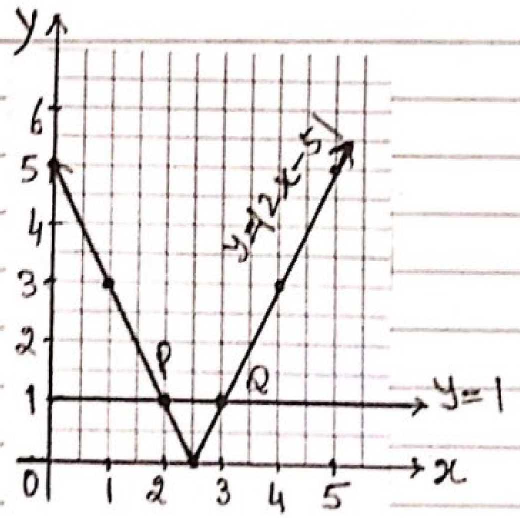
Alternate method 2:

Solve Graphically, Draw the graphs of $y=|2x-5|$ & $y=1$ and Solve $|2x-5|>1$

Consider $y=|2x-5|$ —— ① and $y=1$ —— ②

$$= \begin{cases} (2x-5) ; & x \geq \frac{5}{2} \\ -(2x-5) ; & x<5/2 \end{cases}$$

x	0	1	2	$\frac{5}{2}$	3	4	5
y	5	3	1	0	1	3	5



The graphs of ① and ② intersect at P ($x=2$) and Q ($x=3$).

Now graph ① is above graph ② for $x>3$ or $x<2$

$\therefore$ The required solution:

$x>3$ or $x<2$ ✓

Example 9: Solve $|x-2|+|1-x|=4$ — (1)

Solution:

$|x-2|+|1-x|=4$

or $|x-2| = 4-|1-x|$

$\therefore$ $x-2 = 4-|1-x|$ — (2) or $x-2 = |1-x|-4$ — (3)

$\Rightarrow |1-x| = 6-x$

$\Rightarrow 1-x = 6-x$ or $1-x = x-6$

$\Rightarrow 1 = 6$ ✗ or $2x = 7$

$x = \frac{7}{2}$ ✓

Check $x=\frac{7}{2}$ in (1)

$|\frac{7}{2}-2|+|1-\frac{7}{2}|=4$

$\frac{3}{2}+\frac{5}{2}=4$ True

$\therefore$ $x=\frac{7}{2}$ ✓ is one Solution.

$\Rightarrow |1-x| = 2+x$

$\Rightarrow 1-x = 2+x$ or $1-x = -(2+x)$

$\Rightarrow 2x = -1$ or $1=-2$ ✗

$\Rightarrow x = -\frac{1}{2}$ ✓

Check $x=-\frac{1}{2}$ in (1)

$|-\frac{1}{2}-2|+|1-(-\frac{1}{2})|=4$

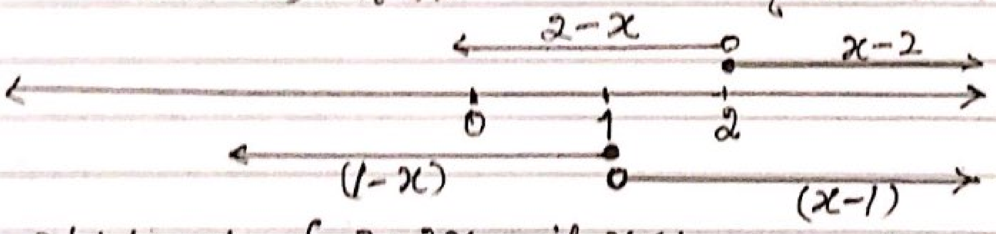
$\frac{5}{2}+\frac{3}{2}=4$ True

$\therefore$ $x=-\frac{1}{2}$ is also a Solu.

$\therefore$ Required Solution are. $x=\frac{7}{2}$ or $-\frac{1}{2}$ ✓

Alternate method 1. (Using Number line)

$$|x-2| = \begin{cases} x-2; & x \geq 2 \\ 2-x; & x<2 \end{cases} \quad \text{and} \quad |1-x| = \begin{cases} 1-x; & 1-x \geq 0 \text{ or } x \leq 1 \\ x-1; & x>1 \end{cases}$$



$$\therefore |x-2|+|1-x| = \begin{cases} 3-2x & \text{if } x \leq 1 \\ 1 & \text{if } 1<x<2 \\ 2x-3 & \text{if } x \geq 2 \end{cases}$$

Now Solution of (1) $3-2x=4$ or $2x-3=4$

$\Rightarrow$ $x=-\frac{1}{2}$ or $x=\frac{7}{2}$ ✓

both these values satisfy the given equation (1).

$\therefore$ Req. solution. $x=-\frac{1}{2}$ or $\frac{7}{2}$ ✓

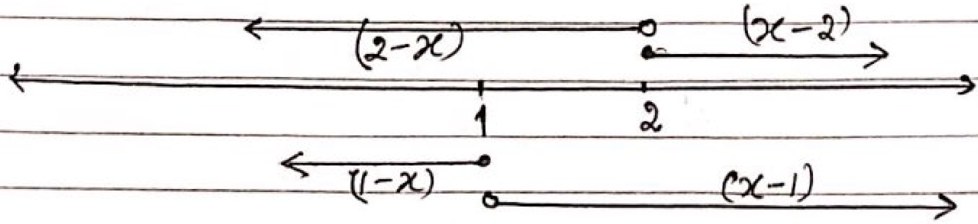
Example 9. Alter method 2. Solve $|x-2|+|1-x|=4$ —— ①

(i) Draw the graph of $y=|x-2|+|1-x|$ —— ②

and $y=4$ —— ③

(ii) Hence solve $|x-2|+|1-x|=4$

Solution (i) $|x-2| = \begin{cases} x-2 & \text{if } x\geq 2 \\ 2-x & \text{if } x<2 \end{cases}$ and $|1-x| = \begin{cases} 1-x & \text{if } 1-x\geq 0 \text{ or } x\leq 1 \\ x-1 & \text{if } x>1 \end{cases}$

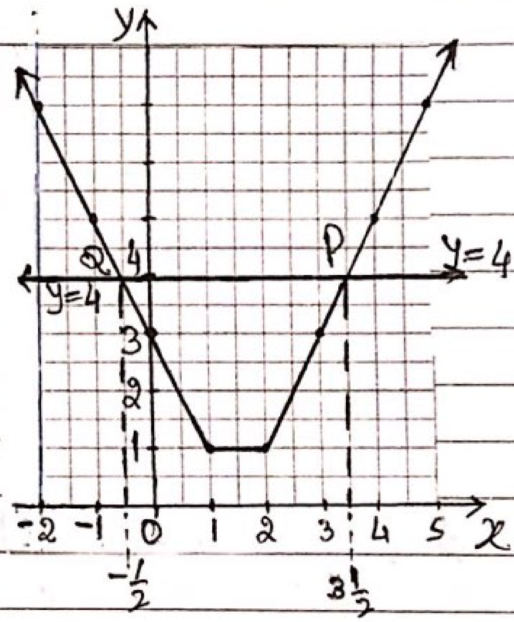


$\therefore \quad |x-2|+|1-x| = \begin{cases} 3-2x & \text{if } x\leq 1 \\ 1 & \text{if } 1<x<2 \\ 2x-3 & \text{if } x\geq 2 \end{cases}$

x	-2	-1	0	1	$3/2$	2	3	4	5
y	7	5	3	1	1	1	3	5	7

Graphs of ② & ③ intersect at $P\left(x=3\frac{1}{2}\right)$ and $Q\left(x=-\frac{1}{2}\right)$

$\therefore$ Required solution of equation ① is $x=-\frac{1}{2}$ or $\frac{7}{2}$



Equation, inequations and graphs.

§ Sketching graphs of cubic polynomials and their moduli. and solving the cubic inequalities graphically.

Example 10. (a) On the axes, sketch the graph of, $y = \frac{1}{5}(x-2)(x-4)(x+5)$, showing the coordinates of the points where the graph meets the coordinate axes. ---[2]

(b) Explain why your sketch in part (a) can be used to solve $(x-2)(x-4)(x+5) \leq 0$ ---[1]

(c) Hence solve, $(x-2)(x-4)(x+5) \leq 0$ --[1]

(d) Sketch the graph of $y = \left|\frac{1}{5}(x-2)(x-4)(x+5)\right|$ ---[2]

(e) Solve $(x-2)(x-4)(x+5) \geq 0$ $\boxed{SP-20/02/Q2}$ -[1]

Solution: $y = \frac{1}{5}(x-2)(x-4)(x+5)$

(a) has zero's at $x = 2, 4$ and -5 ✓

Curve intersects the x-axis at $(2,0)$, $(4,0)$ and $(-5,0)$.

Now when $x = 0$, $y = 8 \Rightarrow$ Curve intersect y-axis at $(0,8)$ ✓

x	$-\infty$	-6	-5	-3	-1	0	1	2	3	4	5
y	$-\infty$	-16	0	14	12	8	3.6	0	-1.6	0	6

when $x \to \infty$, $y \to \infty$

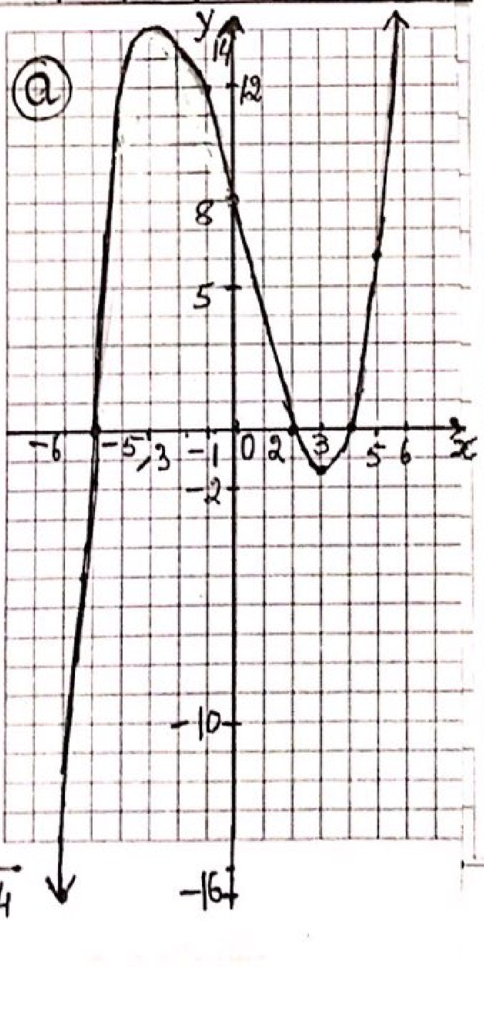
(b) As multiplying by 5 does not change the value of x.

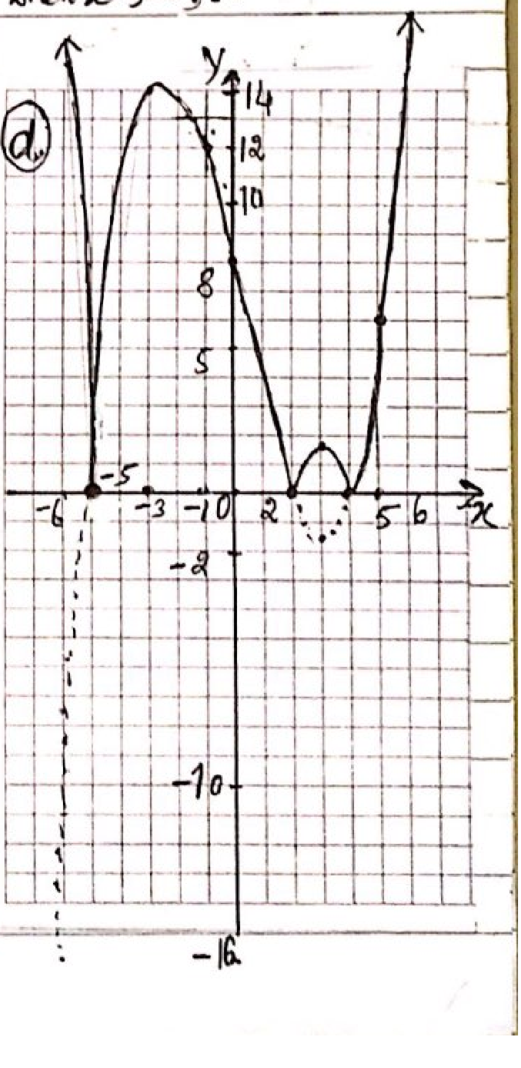
(c) $x \leq 5$ or $2 \leq x \leq 4$

(d) Graph of $\frac{1}{5}|---|$ is obtained by taking the reflection of graph below x-axis in x-axis above it.

Graph of $\frac{1}{5}|(x-2)(x-4)(x+5)|$ is given by (d)

(e) $-5 \leq x \leq 2$ or $x \geq 4$





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Equations, inequations and graphs

Example 11

(a) Sketch the graph of $y=(x-2)^2(x+1)$

(b) Sketch the graph of $y=|(x-2)^2(x+1)|$

(c) Solve $(x-2)^2(x+1)\geqslant 0$ (d) $(x-2)^2(x+1)\leqslant 0$

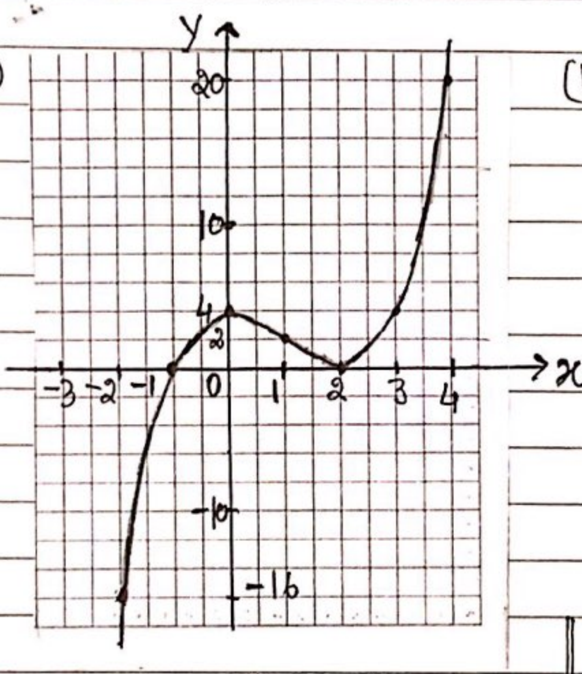
Solution (a) $y=(x-2)^2(x+1)$ ——— (1)

Intersects x-axis at $(2,0)$ and $(-1,0)$

Intersects y-axis at $(0,4)$

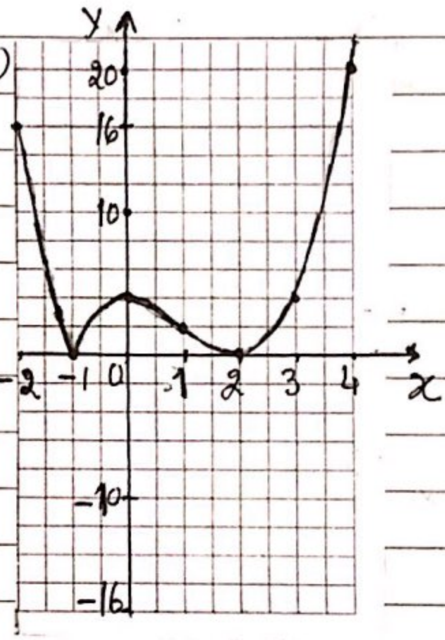
x	$x\to$	$-\infty$	-2	-1	0	1	2	3	4	$x\to+\infty$
y	$y\to$	$-\infty$	-16	0	4	2	0	4	20	$y\to+\infty$

(a)



$y=(x-2)^2(x+1)$

(b)



$y=|(x-2)^2(x+1)|$

(c) $x\geqslant -1$

(d) $x\leqslant -1$

Equations, inequations and graphs.

§ Solving a quadratic equation after using a substitution.

Example 12. Solve: $9x^4 - 29x^2 + 20 = 0$

or $9(x^2)^2 - 29x^2 + 20 = 0$

$9y^2 - 29y + 20 = 0$ Put $x^2 = y$

$9y^2 - 20y - 9y + 20 = 0$

$y(9y-20) - 1(9y-20) = 0$

$(9y-20)(y-1) = 0$

$y = \frac{20}{9}$ or $y = 1$

$y = \frac{20}{9} \Rightarrow x^2 = \frac{20}{9}$

$x = \pm\sqrt{\frac{20}{9}}$

$= \pm \frac{2\sqrt{5}}{3}$

or $y = 1 \Rightarrow x^2 = 1$

$\Rightarrow x = \pm 1$ ✓

$\therefore\ x = 1, -1, \frac{2\sqrt{5}}{3}, \frac{-2\sqrt{5}}{3}$

Example 13. Solve: $x^4 - 2x^2 - 8 = 0$

or $(x^2)^2 - 2x^2 - 8 = 0$ Put $y = x^2$

$y^2 - 2y - 8 = 0$

$y^2 - 4y + 2y - 8 = 0$

$y(y-4) + 2(y-4) = 0$

$(y-4)(y+2) = 0$

$y = 4$ or $y = -2$

or $x^2 = 4$

$x = \pm 2$ ✓

$x^2 = -2$ ✗ [$y = x^2$

square of real number is not negative.

$\therefore\ x = 2, -2$ ✓

Equations, inequations and graphs.

Example 14. Solve. $x^{2/3} + x^{1/3} - 2 = 0$

or $(x^{1/3})^2 + x^{1/3} - 2 = 0$ Put $x^{1/3} = y$

or $y^2 + y - 2 = 0$

$y^2 + 2y - y - 2 = 0$

$y(y+2) - 1(y+2) = 0$

$(y+2)(y-1) = 0$

$\therefore y = -2$ or $y = 1$ $[y = x^{1/3}$

$\Rightarrow x^{1/3} = -2$ or $x^{1/3} = 1$

$\Rightarrow x = (-2)^3$ or $x = 1^3$

$\therefore x = -8$ or 1 ✓

Example 15. Solve. $x - 5\sqrt{x} + 6 = 0$

or $(\sqrt{x})^2 - 5\sqrt{x} + 6 = 0$ Put $\sqrt{x} = y$

or $y^2 - 5y + 6 = 0$

or $y^2 - 3y - 2y + 6 = 0$

$y(y-3) - 2(y-3) = 0$

$(y-3)(y-2) = 0$

$\therefore y = 3$ or $y = 2$

$[\because y = \sqrt{x}$

$\sqrt{x} = 3$ or $\sqrt{x} = 2$

$\therefore x = 9$ or $x = 4$ ✓

Example 16.

Solve. $x - 4\sqrt{x} - 21 = 0$

or $(\sqrt{x})^2 - 4\sqrt{x} - 21 = 0$ Put $\sqrt{x} = y$

$y^2 - 4y - 21 = 0$

$y^2 - 7y + 3y - 21 = 0$

$y(y-7) + 3(y-7) = 0$

$(y-7)(y+3) = 0$

$\therefore y = 7$ or $y = -3$

$\therefore \sqrt{x} = 7$ or $\sqrt{x} = 3$

$\therefore \sqrt{x} = 7$ or $\sqrt{x} = -3$ ✗

$x = 7^2$ as $\sqrt{x} \geq 0$

$x = 49$ ✓

$\therefore x = 49$ ✓