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Q.1. Starting and Ending position of the line are $(1,1)$ and $(8,5)$. Find intermediate points. [Bresenham's line Algo].

→ Given, $x_1 = 1$; $y_1 = 1$

$x_2 = 8$; $y_2 = 5$

$\Delta x = x_2 - x_1 = 8 \times\!\!\!\!\!\diagdown\ \ 8 - 1 = 7$

$\Delta y = y_2 - y_1 = 5 - 1 = 4$.

$P_k = 2\Delta y - \Delta x = 2*4 - 7 = 1$

As $P_k > 0$, case - II satisfied.

So, when $P_k \leq 1$,

$P_{k+1} = P_k + 2\Delta y - 2\Delta x = 1 + (2*4) - (2*7) = -5$

$x_{k+1} = x_k + 1 = 1 + 1 = 2$

$y_{k+1} = y_k + 1 = 1 + 1 = 2.$; $(2,2)$

when $P_k = -5 < 0$; case - I is satisfied.

$P_{k+1} = P_k + 2\Delta y = -5 + (2*4) = +3$

$x_{k+1} = x_k + 1 = 2 + 1 = 3$

$y_{k+1} = y_k = 2$; i.e., $(3,2)$

when, $P_k = 3 > 0$, case - II

$P_{k+1} = P_k + 2\Delta y - 2\Delta x = 3 + 8 - 14 = -3$

$x_{k+1} = x_k + 1 = 3 + 1 = 4$

$y_{k+1} = y_k + 1 = 2 + 1 = 3$; $(4,3)$.

Similarly for other values,

when, $P_k = -3$; $P_{k+1} = -3 + 8 = 5$; $x_{k+1} = 5$; $y_{k+1} = 3$; $(5,3)$

when, $P_k = 5$; $P_{k+1} = 5 + 8 - 14 = -1$; $x_{k+1} = 6$; $y_{k+1} = 4$; $(6,4)$

when, $P_k = -1$; $P_{k+1} = -1 + 8 = 7$; $x_{k+1} = 7$; $y_{k+1} = 4$; $(7,4)$

Lastly, $P_k = 7$; $P_{k+1} = 7 + 8 - 14 = 1$; $x_{k+1} = 8$; $y_{k+1} = 5$; $(8,5)$

This is the end point

Therefore, intermediate coordinates are :

$(2,2), (3,2), (4,3), (5,3), (6,4)$ and $(7,4)$

Q.2. Calculate the points between the starting coordinates $(9, 18)$ and ending coordinates $(14, 22)$.

→ Given, $x_1 = 9$; $y_1 = 18$

$x_2 = 14$; $y_2 = 22$

$\Delta x = x_2 - x_1 = 14 - 9 = 5$

$\Delta y = y_2 - y_1 = 22 - 18 = 4$

$P_k = 2\Delta y - \Delta x = 2 * 4 - 5 = 3$

As, $P_k > 0$; Case - II is satisfied.

So, when $P_k = 3$,

$P_{k+1} = P_k + 2\Delta y - 2\Delta x = 3 + (2 * 4) - (2 * 5) = 1$

$x_{k+1} = x_k + 1 = 9 + 1 = 10$

$y_{k+1} = 18 + 1 = 19$

i.e, $(10, 19)$

Again, when, $P_k = 1 > 0$; Case - II

$P_{k+1} = P_k + 2\Delta y - 2\Delta x = 1 + (2 * 4) - (2 * 5) = -1$

$x_{k+1} = x_k + 1 = 10 + 1 = 11$

$y_{k+1} = y_k + 1 = 19 + 1 = 20$

i.e., $(11, 20)$

when, $P_k = -1 < 0$; Case - I is satisfied.

$P_{k+1} = P_k + (2\Delta y) = -1 + (2 * 4) = 7$

$x_{k+1} = x_k + 1 = 11 + 1 = 12$

$y_{k+1} = y_k = 20$

i.e, $(12, 20)$

following this for $P_k = 7 > 0$; case - II,

$P_{k+1} = 7 + 8 - 10 = 5$

$x_{k+1} = 13$; $y_{k+1} = 21$

Lastly, for $P_k = 5 > 0$; which is end point,

$x_{k+1} = 14$; $y_{k+1} = 22$.

∴ Intermediate Points = $(10, 19), (11, 20), (12, 20)$ and, $(13, 21)$

Q.3. Calculate two points between the starting coordinates $(20,10)$ and ending coordinates $(30,18)$.

→ $x_0 = 20$; $x_n = 30$; $y_0 = 10$; $y_n = 18$.

$\Delta x = 30 - 20 = 10$; $\Delta y = 18 - 10 = 8$

$P_0 = 2\Delta y - \Delta x = 2*8 - 10 = 6$

$P_0 = 6 > 0$; $P_1 = P_0 + 2\Delta y - 2\Delta x = 6 + 16 - 20 = 2$

$x_1 = x_0 + 1 = 21$; $y_1 = y_0 + 1 = 11$; $(21, 11)$

$P_1 = 2 > 0$; $P_2 = P_1 + 2\Delta y - 2\Delta x = 2 + 16 - 20 = -2$

$x_2 = x_1 + 1 = 22$; $y_2 = y_1 + 1 = 12$; $(22, 12)$

$P_2 = -2 < 0$; $P_3 = P_2 + 2\Delta y = -2 + 16 = 14$

$x_3 = x_2 + 1 = 23$; $y_3 = y_2 = 12$; $(23, 12)$

Similarly,

when, $P_3 = 14 > 0$; $P_4 = 14 + 16 - 20 = 10$

$x_4 = 24$; $y_4 = 13$; $(24, 13)$

for, $P_4 = 10 > 0$; $P_5 = 10 + 16 - 20 = 6$

$x_5 = 25$; $y_5 = 14$; $(25, 14)$

for, $P_5 = 6 > 0$; $P_6 = 2$; $x_6 = 26$; $y_6 = 15$; $(26, 15)$

for, $P_6 = 2 > 0$; $P_7 = -2$; $x_7 = 27$; $y_7 = 16$; $(27, 16)$

for, $P_7 = -2 < 0$; $P_8 = 14$; $x_8 = 28$; $y_8 = 16$; $(28, 16)$

for, $P_8 = 14 > 0$; $P_9 = 10$; $x_9 = 29$; $y_9 = 17$; $(29, 17)$

Lastly, $P_9 = 10 > 0$; End Point; $x_{10} = 30$; $y_{10} = 18$; $(30, 18)$

Therefore, the intermediate coordinates are:-
$(21, 11)$, $(22, 12)$, $(23, 12)$, $(24, 13)$, $(25, 14)$, $(26, 15)$, $(27, 16)$, $(28, 16)$ and $(29, 17)$.
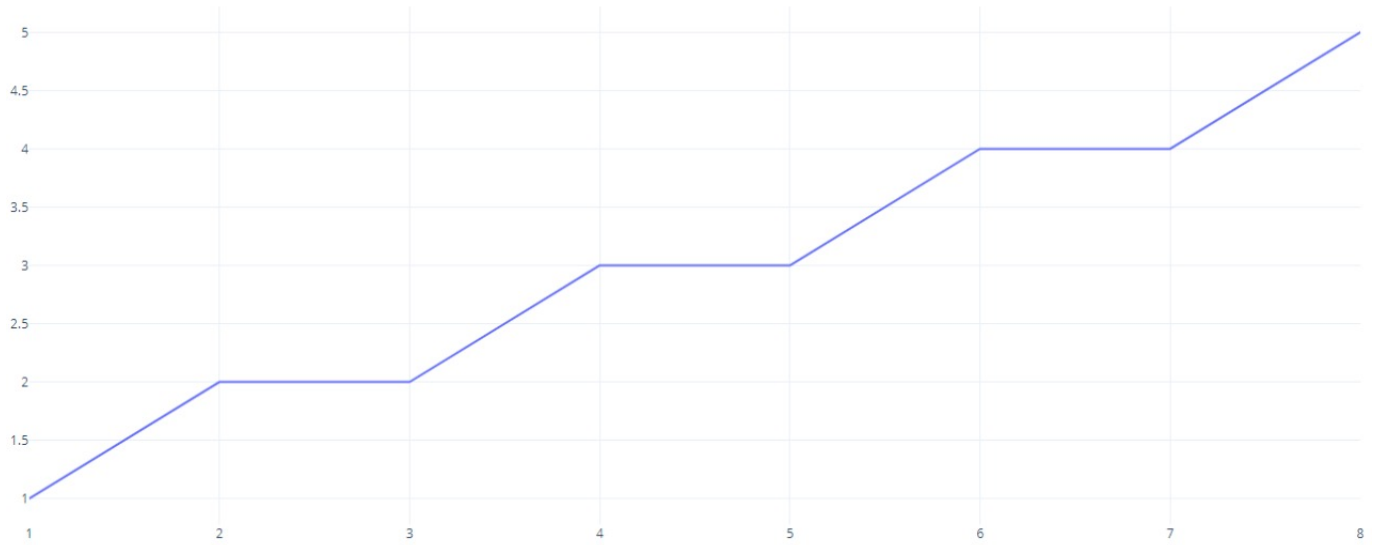
Figure: Graph for Q.1. Coordinates: (1, 1), (2, 2), (3, 2), (4, 3), (5, 3), (6, 4), (7, 4) and (8, 5)

Figure: Graph for Q.2. Coordinates: (9, 18), (10, 19), (11, 20), (12, 20), (13, 21) and (14, 22)
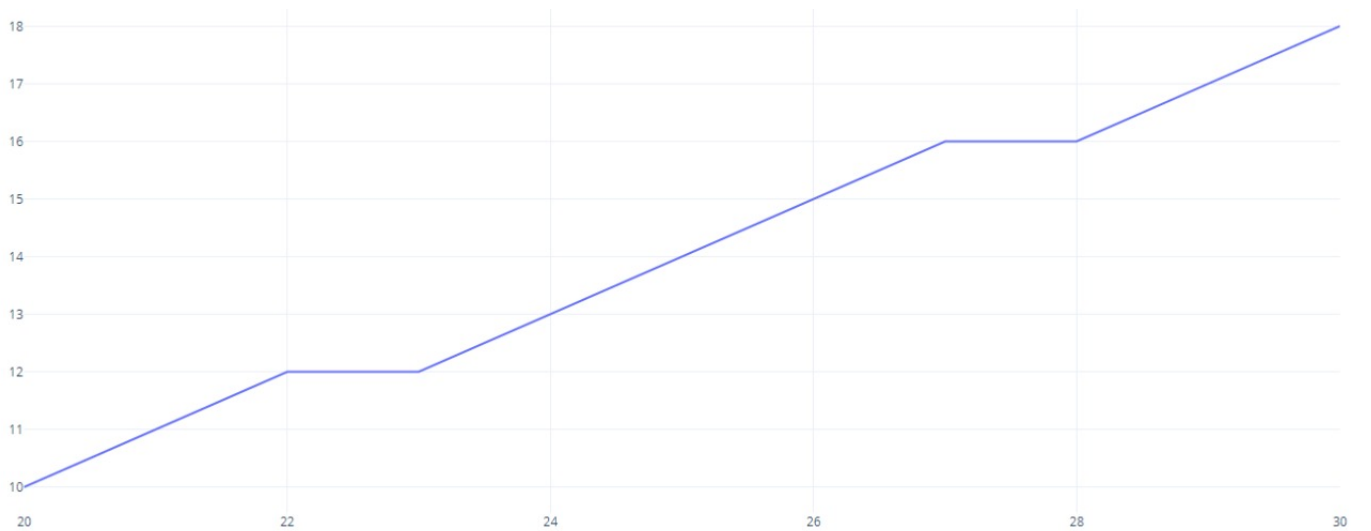

Figure: Graph for Q.3. Coordinates: (20, 10), (21, 11), (22, 12), (23, 12), (24, 13), (25, 14), (26, 15), (27, 16), (28, 16), (29, 17) and (30, 18)