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Answer

$$\frac{T_{i,j+1} - T_{i,j}}{\Delta t} = C \times \left[ \frac{T_{i+1,j} - 2T_{i,j} + T_{i-1,j}}{(\Delta x)^2} \right]$$

Where  $C = 2.2 \text{ cm}^2/\text{hr}$ Making  $T_{i,j+1} - T_{i,j}$  the subject of formula and substitutingfor  $C = 2.2 \text{ cm}^2/\text{hr}$ 

$$T_{i,j+1} - T_{i,j} = \frac{C \Delta t}{(\Delta x)^2} \times [T_{i+1,j} - 2T_{i,j} + T_{i-1,j}] \quad \text{--- (1)}$$

Where  $\frac{C \Delta t}{(\Delta x)^2} = r$ Taking  $C = 2.2 \text{ cm}^2/\text{hr}$ ,  $\Delta t = 0.02 \text{ hr}$ ,  $\Delta x = 0.3 \text{ cm}$ 

$$r = \frac{2.2 (0.02)}{(0.3)^2} = 0.4889$$

$$r = 0.49$$

Substituting for  $r$  into (1)

$$\begin{aligned} T_{i,j+1} - T_{i,j} &= 0.49 [T_{i+1,j} - 2T_{i,j} + T_{i-1,j}] \\ &= 0.49 T_{i+1,j} - 0.98 T_{i,j} + T_{i,j} + 0.49 T_{i-1,j} \\ &= 0.49 T_{i+1,j} + 0.02 T_{i,j} + 0.49 T_{i-1,j} \end{aligned}$$

OR

$$T_{i,j+1} = 0.49 T_{i+1,j} + (1 - 2 \times 0.49) T_{i,j} + 0.49 T_{i-1,j}$$

for  $t_0 = 0 \text{ hr}$ ,  $T(x, 0) = 3x^2$ ① When  $x = 0 \text{ cm}$ 

$$T(0, 0) = x_0 = 3 \times (0)^2 = 0 \text{ cm}$$

② Where  $x = 0.3 \text{ cm}$ 

$$T(0.3, 0) = x_1 = 3 \times (0.3)^2 = 0.27 \text{ cm}$$

③ Where  $x = 0.6 \text{ cm}$ 

$$T(0.6, 0) = x_2 = 3 \times (0.6)^2 = 1.08 \text{ cm}$$



(4) When  $x = 0.9 \text{ cm}$

$$T(0.9, 0) = x_3 = 3 \times (0.9)^2 = 2.43 \text{ cm}$$

(5) Where  $x = 1.2 \text{ cm}$

$$T(1.2, 0) = x_4 = 3 \times (1.2)^2 = 4.32 \text{ cm}$$

(6) Where  $x = 1.5 \text{ cm}$

$$T(1.5, 0) = x_5 = 3 \times (1.5)^2 = 6.75 \text{ cm}$$

(7) Where  $x = 1.8 \text{ cm}$

$$T(1.8, 0) = x_6 = 3 \times (1.8)^2 = 9.72 \text{ cm}$$

(8) Where  $x = 2.1 \text{ cm}$

$$T(2.1, 0) = x_7 = 3 \times (2.1)^2 = 13.23 \text{ cm}$$

(9) Where  $x = 2.4$

$$T(2.4, 0) = x_8 = 3 \times (2.4)^2 = 17.28 \text{ cm}$$

(10) Where  $x = 2.7 \text{ cm}$

$$T(2.7, 0) = x_9 = 3 \times (2.7)^2 = 21.87 \text{ cm}$$

(11) Where  $x = 3.0$

$$T(3.0, 0) = x_{10} = 3 \times (3.0)^2 = 27 \text{ cm}$$

(12) Where  $x = 3.3 \text{ cm}$

$$T(3.3, 0) = x_{11} = 3 \times (3.3)^2 = 32.67 \text{ cm}$$

(13) Where  $x = 3.6 \text{ cm}$

$$T(3.6, 0) = x_{12} = 3 \times (3.6)^2 = 38.88 \text{ cm}$$

(14) Where  $x = 3.9 \text{ cm}$

$$T(3.9, 0) = x_{13} = 3 \times (3.9)^2 = 45.63 \text{ cm}$$

(15) Where  $x = 4.2 \text{ cm}$

$$T(4.2, 0) = x_{14} = 3 \times (4.2)^2 = 52.92 \text{ cm}$$

(16) Where  $x = 4.5 \text{ cm}$

$$T(4.5, 0) = x_{15} = 3 \times (4.5)^2 = 60.75 \text{ cm}$$

(17) Where  $x = 4.8 \text{ cm}$

$$T(4.8, 0) = x_{16} = 3 \times (4.8)^2 = 69.12 \text{ cm}$$

(18) Where  $x = 5.1 \text{ cm}$

$$T(5.1, 0) = x_{17} = 3 \times (5.1)^2 = 78.03 \text{ cm}$$

(19) Where  $x = 5.4 \text{ cm}$

$$T(5.4, 0) = x_{18} = 3 \times (5.4)^2 = 87.48 \text{ cm}$$



20 Where  $x = 5.7 \text{ cm}$

$$T(5.7, 0) = x_{1,0} = 3 \times (5.7)^2 = 97.47 \text{ cm}$$

21 Where  $x = 6.0 \text{ cm}$

$$T(6.0, 0) = x_{2,0} = 3 \times (6.0)^2 = 108 \text{ cm}$$

For second row

$$\begin{aligned} T_{i,j+1} &= 0.49 T_{i+1,j} + (1 - 2 \times 0.49) T_{i,j} + 0.49 T_{i-1,j} \\ &= 0.49 T_{i+1,j} + 0.02 T_{i,j} + 0.49 T_{i-1,j} \end{aligned}$$

Where  $i = 1, j = 0$

$$\begin{aligned} T_{1,0} &= 0.49 T_{2,0} + 0.02 T_{1,0} + 0.49 T_{0,0} \\ &= 0.49 \times (1.08) + 0.02(0.27) + 0.49(0) \\ &= 0.5436 \end{aligned}$$

Where  $i = 2, j = 0$

$$\begin{aligned} T_{2,0} &= 0.49 T_{3,0} + 0.02 T_{2,0} + 0.49 T_{1,0} \\ &= 0.49(2.43) + 0.02(1.08) + 0.49(0.27) \\ &= 1.3446 \end{aligned}$$

Where  $i = 3, j = 0$

$$\begin{aligned} T_{3,0} &= 0.49 T_{4,0} + 0.02 T_{3,0} + 0.49 T_{2,0} \\ &= 0.49(4.32) + 0.02(2.43) + 0.49(1.08) \\ &= 2.6946 \end{aligned}$$

Where  $i = 4, j = 0$

$$\begin{aligned} T_{4,0} &= 0.49 T_{5,0} + 0.02 T_{4,0} + 0.49 T_{3,0} \\ &= 0.49(6.75) + 0.02(4.32) + 0.49(2.43) \\ &= 4.5846 \end{aligned}$$

Where  $i = 5, j = 0$

$$\begin{aligned} T_{5,0} &= 0.49 T_{6,0} + 0.02 T_{5,0} + 0.49 T_{4,0} \\ &= 0.49(9.72) + 0.02(6.75) + 0.49(4.32) \\ &= 7.0146 \end{aligned}$$

Where  $i = 6, j = 0$

$$\begin{aligned} T_{6,0} &= 0.49 T_{7,0} + 0.02 T_{6,0} + 0.49 T_{5,0} \\ &= 0.49(13.23) + 0.02(9.72) + 0.49(7.0146) \\ &= 13.4946 \end{aligned}$$



Where

$$\text{Where } i = 8, j = 0$$

$$\begin{aligned} T_{8,1} &= 0.49T_{9,0} + 0.02T_{8,0} + 0.49T_{7,0} \\ &= 0.49(21.87) + 0.02(17.28) + 0.49(13.23) \\ &= 17.5446 \end{aligned}$$

$$\begin{aligned} T_{9,1} &= 0.49T_{10,0} + 0.02T_{9,0} + 0.49T_{8,0} \\ &= 0.49(27) + 0.02(21.87) + 0.49(17.28) \\ &= 22.1346 \end{aligned}$$

$$\begin{aligned} T_{10,1} &= 0.49T_{11,0} + 0.02T_{10,0} + 0.49T_{9,0} \\ &= 0.49(32.67) + 0.02(27) + 0.49(21.87) \\ &= 27.2646 \end{aligned}$$

$$\begin{aligned} T_{11,1} &= 0.49T_{12,0} + 0.02T_{11,0} + 0.49T_{10,0} \\ &= 0.49(38.88) + 0.02(32.67) + 0.49(27) \\ &= 32.9346 \end{aligned}$$

$$\begin{aligned} T_{12,1} &= 0.49T_{13,0} + 0.02T_{12,0} + 0.49T_{11,0} \\ &= 0.49(45.63) + 0.02(38.88) + 0.49(32.67) \\ &= 39.1446 \end{aligned}$$

$$\begin{aligned} T_{13,1} &= 0.49T_{14,0} + 0.02T_{13,0} + 0.49T_{12,0} \\ &= 0.49(52.92) + 0.02(45.63) + 0.49(38.88) \\ &= 45.8946 \end{aligned}$$

$$\begin{aligned} T_{14,1} &= 0.49T_{15,0} + 0.02T_{14,0} + 0.49T_{13,0} \\ &= 0.49(60.75) + 0.02(52.92) + 0.49(45.63) \\ &= 53.1846 \end{aligned}$$

$$\begin{aligned} T_{15,1} &= 0.49T_{16,0} + 0.02T_{15,0} + 0.49T_{14,0} \\ &= 0.49(69.12) + 0.02(60.75) + 0.49(52.92) \\ &= 61.0146 \end{aligned}$$

$$\begin{aligned} T_{16,1} &= 0.49T_{17,0} + 0.02T_{16,0} + 0.49T_{15,0} \\ &= 0.49(78.05) + 0.02(69.12) + 0.49(60.75) \\ &= 69.3846 \end{aligned}$$

$$\begin{aligned} T_{17,1} &= 0.49T_{18,0} + 0.02T_{17,0} + 0.49T_{16,0} \\ &= 0.49(87.48) + 0.02(78.03) + 0.49(69.12) \end{aligned}$$

$$\begin{aligned} T_{18} &= 0.49T_{19,0} + 0.02T_{18,0} + 0.49T_{17,0} \\ &= 0.49(97.47) + 0.02(87.48) + 0.49(78.03) \end{aligned}$$



$$T_{18} = 87.7446$$

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$$\begin{aligned} T_{19} &= 0.49_{20,0} + 0.02T_{19,0} + 0.49_{18,0} \\ &= 0.49(108) + 0.02(97.47) + 0.49(87.48) \\ &= 97.7346 \end{aligned}$$

i	x	j	0	1
0	0	$x_0$	0	0.02
1	0.3	$x_1$	0.27	0
2	0.8	$x_2$	1.08	0.53216
3	0.9	$x_3$	2.43	1.346
4	1.2	$x_4$	4.32	2.69
5	1.5	$x_5$	6.75	4.5
6	1.8	$x_6$	9.72	7.02
7	2.1	$x_7$	13.23	9.95
8	2.4	$x_8$	17.2	13.49
9	2.7	$x_9$	21.87	17.54
10	3.0	$x_{10}$	27	22.13
11	3.3	$x_{11}$	32.67	27.26
12	3.6	$x_{12}$	38.88	32.93
13	3.9	$x_{13}$	45.63	39.14
14	4.2	$x_{14}$	52.92	45.89
15	4.5	$x_{15}$	60.75	53.18
16	4.8	$x_{16}$	69.12	61.07
17	5.1	$x_{17}$	78.03	69.38
18	5.4	$x_{18}$	87.48	78.29
19	5.7	$x_{19}$	97.49	97.734
20	6.0	$x_{20}$	108	108