Programing Test

Problem

1. Write a short Python program to calculate how temperature at the end of a geothermal layer changes with time due to heat conduction and advection. Solve the simplified 1D heat-transport equation:

$$\frac{\partial T}{\partial t} + v\,\frac{\partial T}{\partial x} = \alpha\,\frac{\partial^2 T}{\partial x^2}$$

where

- $T(x,t)$= temperature (°C)
- v= flow velocity (m/s)
- α= thermal diffusivity (m^2/s)

2. Please document usage, using the given parameters as the example.

3. Please commit the program to a Git repo, such as GitHub, or whatever other source control mechanism you prefer. When you respond, provide the link to the code repo.

Parameters

Variable	Symbol	Value
Reservoir length,	L,	100 m
Number of grid points,	$n_{x,}$	21
Reservoir temperature,	T_0	200 °C
Injection temperature,	$T_{\text{inj,}}$	60 °C
Thermal diffusivity,	α,	9×10^{-7} m^2/s
Flow velocity,	v,	1.5×10^{-5} m/s
Time step, dt,		1 day = 86,400 s
Total time,		365 days

Boundary Conditions

- Left end: $T(0,t) = T_{\text{inj}}$ (fixed cold injection)
- Right end: zero gradient → $T(L,t) = T(L - \mathrm{d}x, t)$

Initial condition:

- Start: $T(x, 0) = T_0$

Tasks

Create arrays for x, T(x), and time.

Use a simple explicit update for each time step using the formula below:

*T_new[i] = T[i] + dt * (α * (T[i+1] - 2*T[i] + T[i-1]) / dx**2 - v*(T[i] - T[i-1]) / dx)*

where i is the number for the i_{th} grid point; dx is grid length, the same for each grid.

Apply the boundary conditions at each step.

After looping for 365 days, **plot outlet temperature vs. time**.