A1 A spherical droplet of liquid evaporates at rate

$$\frac{dV}{dt} = -KA$$

where, V = volume (mm^3) of sphere

t = time (min)

K = evaporation rate (mm/min)

A = surface area (mm^2)

r = radius of sphere (mm)

Given: $t = 0$ to 10 min

step size $(\Delta t) = 0.25$ min

$K = 0.1$ mm/min

initial radius $(r_i) = 3$ mm

To Find:- Need to compute volume using Euler's method from $t=0$ to 10 min using step size of 0.25 min.

Solⁿ:- $V = \frac{4}{3}\pi r^3$ $\quad A = 4\pi r^2$

$$\Rightarrow \frac{dV}{dt} = -KA \quad \text{(Given)}$$

$$\Rightarrow \frac{d\left(\frac{4}{3}\pi r^3\right)}{dt} = -K(4\pi r^2)$$

$$\Rightarrow \frac{4}{3}\pi \times 3r^2 \frac{dr}{dt} = -K(4\pi r^2)$$

$$\Rightarrow \frac{dr}{dt} = -K$$

$$\Rightarrow \frac{dr}{dt} = -K \quad \text{——— (1)}$$

Apply Euler's method;

$$\frac{dr}{dt} = \lim_{\Delta t \to 0} \frac{r(t+\Delta t) - r(t)}{\Delta t} = \frac{r(t_{j+1}) - r(t_j)}{t_{j+1} - t_j} \quad \text{——— (2)}$$

Put (2) in (1)

$$\Rightarrow \frac{r(t_{j+1}) - r(t_j)}{t_{j+1} - t_j} = -K$$

$$\Rightarrow r(t_{j+1}) = r(t_j) - K(t_{j+1} - t_j) \; ;$$

$$\boxed{\begin{aligned} \text{step size} &= \Delta t \\ &= t_{j+1} - t_j \\ &= 0.25 \end{aligned}}$$

$$\Rightarrow \boxed{r(t_{j+1}) = r(t_j) - (0.1)(0.25)} \quad \text{——— (3)}$$

From above eq (3), we can get volume by

$$\boxed{V = \frac{4}{3}\pi r^3}$$

From the Python code, we get final radius = 2mm
initial radius = 3mm

$$\text{Average evaporation rate} = \frac{\text{final radius} - \text{initial radius}}{\text{Total time}}$$

$$= \frac{2\,\text{mm} - 3\,\text{mm}}{10\,\text{min}}$$

$$= -0.1\ \text{mm}/\text{min}$$

So the above computed average evaporation rate is equal to the given evaporation rate (K)
Hence verified.