A drug patch is a product used to deliver drugs via attachment to the skin. When the patch is attached (t=0), the drug begins to diffuses out of the patch into the skin/blood (1 dimensional flux in x direction).

As time progresses, the drug concentration inside the patch changes with respect to both x position and time.

The patch is 5 mm thick (x direction), with cross sectional area 1600 mm2 (z=40 mm).

z

patch

z

Skin/blood

X

X=0

X=5

Diffusion of the drug through the patch is modeled as j = -D A dC/dx, where

j = flux of drug (gm/hr)

C= drug concentration (gm/mm3)

A = cross sectional area (mm2)

D=diffusion constant (mm2/hr)

Solution

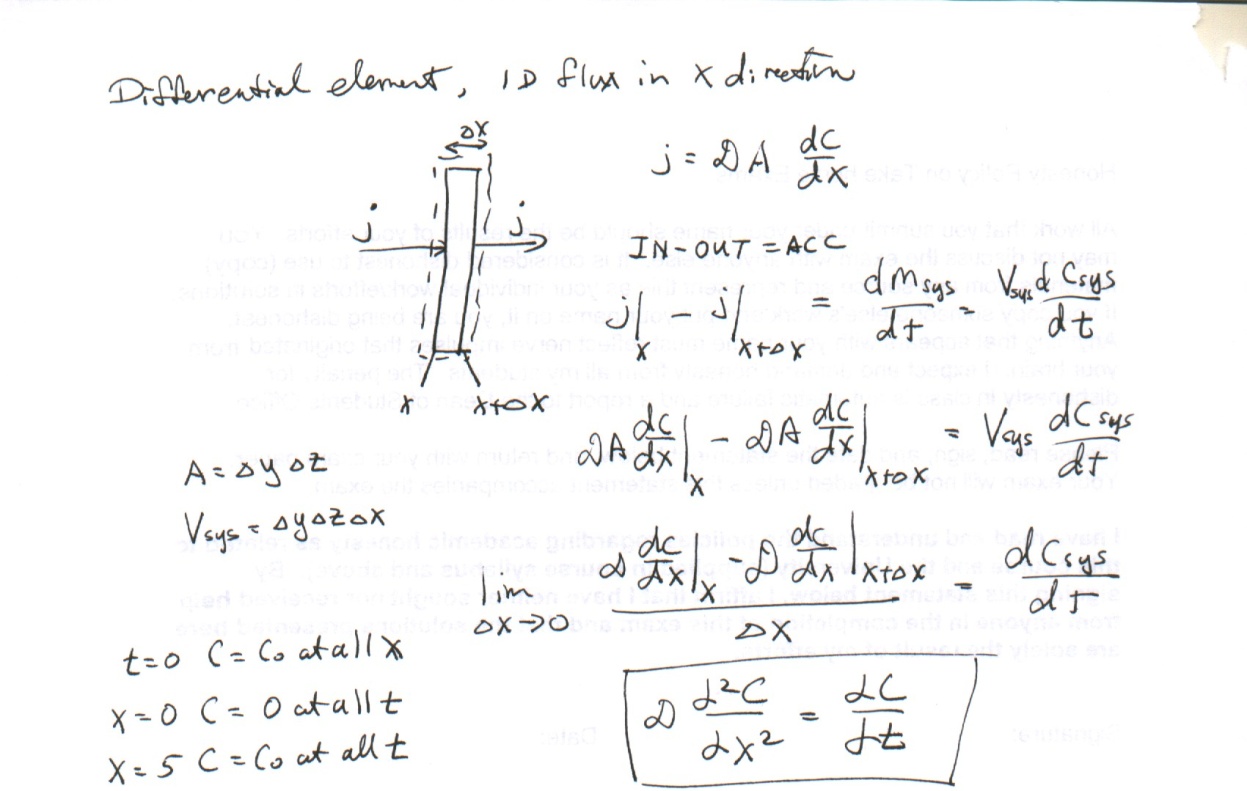
Thinking about what happens, initially, the patch has uniform concentration at time zero. As time progresses, the drug leaves the right side of the patch into the skin, so the drug concentration at that location starts to decrease. As time progresses, drug diffuses from the left side of the patch to the lower concentration at the right side of the patch, creating a changing gradient of concentration in the x direction.

Since there is a gradient in the patch, setting up the model requires using a differential size system so the system has a homogeneous concentration. see picture below. Note that drug flow into the system from the left side and out of system on the right side.

Once the system, boundaries, and flows are set up, then a component mass balance can be created.

In –out = accumulation

Flows are by diffusion, hence j=DAdC/dx at each side. Accumulation is simply the change in concentration in the system with time, i.e. VdCsys/dt. Analyzing the dimensions of each term shows them to be mass/time, which is consistent on both sides of the equal sign.



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