5. (8 points) A potter has a fixed volume of clay in the form of a cylinder. As he rolls the clay, the length of the cylinder, \( L \), increases, while the radius, \( r \), decreases. If the length of the cylinder is increasing at a constant rate of 0.2 cm per second, find the rate at which the radius is changing when the radius is 1.5 cm and the length is 4 cm.

[Recall that the volume of a cylinder of radius \( r \) and length \( L \) is \( \pi r^2 L \).]

Differentiating the formula for the volume, we find

\[
\frac{dV}{dt} = \pi 2r \frac{dr}{dt} L + \pi r^2 \frac{dL}{dt}.
\]

Although the shape of the clay is changing, the volume is not, so \( \frac{dV}{dt} = 0 \). Combining these two statements,

\[
\pi 2r \frac{dr}{dt} L + \pi r^2 \frac{dL}{dt} = 0
\]

whence

\[
\frac{dr}{dt} = -\frac{r \frac{dL}{dt}}{2L}.
\]

Plugging in the given values \( L = 4 \), \( r = 1.5 \), \( \frac{dL}{dt} = 0.2 \) we deduce

\[
\frac{dr}{dt} = -0.0375 \text{ cm/s}.
\]