12. The radius of a cylindrical column of liquid is decreasing at the rate of 0.02 m s\(^{-1}\), while the height is increasing at the rate of 0.01 m s\(^{-1}\).

Find the rate of change of the volume when the radius is 0.6 metres and the height is 2 metres.

*[Recall that the volume of a cylinder is given by \( V = \pi r^2 h \).]*

### Answer

\[
\frac{dr}{dt} = -0.02; \quad \frac{dh}{dt} = 0.01
\]

\[
V = \pi r^2 h
\]

\[
\frac{dV}{dt} = \pi \left(2r \frac{dr}{dt}\right) h + \pi r^2 \frac{dh}{dt}
\]

\[
= \pi \left(2 \times 0.6 \times (-0.02) \times 2 + 0.36 \times 0.01\right)
\]

\[
= \pi (-0.048 + 0.0036)
\]

\[
= -0.0444\pi \approx -0.14
\]

The rate of change in the volume is 
\(-0.0444\pi \text{ m}^3 \text{ s}^{-1}\).