

15.3 This problem asks for a determination of the relaxation modulus of a viscoelastic material, which behavior is according to Equation 15.10--i.e.,

$$\sigma(t) = \sigma(0) \exp\left(-\frac{t}{\tau}\right)$$

We want to determine $\sigma(10)$, but it is first necessary to compute τ from the data provided in the problem statement. Thus, solving for τ from the above expression,

$$\tau = \frac{-t}{\ln\left[\frac{\sigma(t)}{\sigma(0)}\right]} = \frac{-30 \text{ s}}{\ln\left[\frac{0.5 \text{ MPa}}{3.5 \text{ MPa}}\right]} = 15.4 \text{ s}$$

Therefore,

$$\sigma(10) = (3.5 \text{ MPa}) \exp\left(-\frac{10 \text{ s}}{15.4 \text{ s}}\right) = 1.83 \text{ MPa}$$

Now, using Equation 15.1

$$E_r(10) = \frac{\sigma(10)}{\varepsilon_0} = \frac{1.83 \text{ MPa}}{0.5} = 3.66 \text{ MPa} \quad (522 \text{ psi})$$