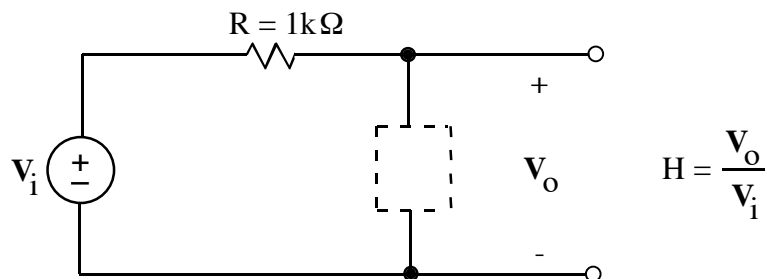**EX:** Choose one R, one L, or one C to go in the box to make the circuit a high-pass filter with a cutoff frequency $\omega_c = 10^5$ r/s. Give the value of the element you chose.

ANS: L = 10 mH

SOL'N: The output of the filter is given by the voltage divider formula, rearranged to express the transfer function H(ω):

$$H(j\omega) \equiv \frac{\mathbf{V}_o}{\mathbf{V}_i} = \frac{z}{R+z} \qquad \text{where z is impedance in box}$$

For high-pass, we want $|H(j\omega)| = 0$ for $\omega = 0$. So we want $z = 0$ at $\omega = 0$.

∴ Choose L so $z = j\omega L$ and $H(j\omega)\big|_{\omega=0} = \frac{0}{R} = 0$.

The resulting transfer function is

$$H(j\omega) = \frac{j\omega L}{R + j\omega L}.$$

ω_C is ω where denom R = ωL, i.e. Re[denom] = Im[denom].

$$\therefore \ \omega_C = \frac{R}{L} \Rightarrow L = \frac{R}{\omega_C} = \frac{1\,k}{100\,k} = 10\,mH$$