85. (a) As the switch closes at $t = 0$, the current being zero in the inductor serves as an initial condition for the building-up of current in the circuit. Thus, at $t = 0$ any current through the battery is also that through the 20 Ω and 10 Ω resistors. Hence,

$$i = \frac{\mathcal{E}}{30\ \Omega} = 0.40\ \text{A}$$

which results in a voltage drop across the 10 Ω resistor equal to $(0.40)(10) = 4.0$ V. The inductor must have this same voltage across it $|\mathcal{E}_L|$, and we use (the absolute value of) Eq. 31-37:

$$\frac{di}{dt} = \frac{|\mathcal{E}_L|}{L} = \frac{4.0}{0.010} = 400\ \text{A/s}\ .$$

(b) Applying the loop rule to the outer loop, we have

$$\mathcal{E} - (0.50\ \text{A})(20\ \Omega) - |\mathcal{E}_L| = 0\ \ .$$

Therefore, $|\mathcal{E}_L| = 2.0$ V, and Eq. 31-37 leads to

$$\frac{di}{dt} = \frac{|\mathcal{E}_L|}{L} = \frac{2.0}{0.010} = 200\ \text{A/s}\ .$$

(c) As $t \to \infty$, the inductor has $\mathcal{E}_L = 0$ (since the current is no longer changing). Thus, the loop rule (for the outer loop) leads to

$$\mathcal{E} - i\,(20\ \Omega) - |\mathcal{E}_L| = 0 \quad\Longrightarrow\quad i = 0.60\ \text{A}\ .$$