53. (a) The inductor prevents a fast build-up of the current through it, so immediately after the switch is closed, the current in the inductor is zero. It follows that

$$i_1 = i_2 = \frac{\mathcal{E}}{R_1 + R_2} = \frac{100\,\mathrm{V}}{10.0\,\Omega + 20.0\,\Omega} = 3.33\ \mathrm{A}\ .$$

(b) After a suitably long time, the current reaches steady state. Then, the emf across the inductor is zero, and we may imagine it replaced by a wire. The current in R_3 is $i_1 - i_2$. Kirchhoff's loop rule gives

$$\mathcal{E} - i_1 R_1 - i_2 R_2 = 0 \quad \text{and} \quad \mathcal{E} - i_1 R_1 - (i_1 - i_2) R_3 = 0\ .$$

We solve these simultaneously for i_1 and i_2. The results are

$$\begin{aligned} i_1 &= \frac{\mathcal{E}\,(R_2 + R_3)}{R_1 R_2 + R_1 R_3 + R_2 R_3} \\ &= \frac{(100\,\mathrm{V})(20.0\,\Omega + 30.0\,\Omega)}{(10.0\,\Omega)(20.0\,\Omega) + (10.0\,\Omega)(30.0\,\Omega) + (20.0\,\Omega)(30.0\,\Omega)} \\ &= 4.55\ \mathrm{A}\ , \end{aligned}$$

and

$$\begin{aligned} i_2 &= \frac{\mathcal{E} R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} \\ &= \frac{(100\,\mathrm{V})(30.0\,\Omega)}{(10.0\,\Omega)(20.0\,\Omega) + (10.0\,\Omega)(30.0\,\Omega) + (20.0\,\Omega)(30.0\,\Omega)} \\ &= 2.73\ \mathrm{A}\ . \end{aligned}$$

(c) The left-hand branch is now broken. We take the current (immediately) as zero in that branch when the switch is opened (that is, $i_1 = 0$). The current in R_3 changes less rapidly because there is an inductor in its branch. In fact, immediately after the switch is opened it has the same value that it had before the switch was opened. That value is $4.55\,\mathrm{A} - 2.73\,\mathrm{A} = 1.82\,\mathrm{A}$. The current in R_2 is the same as that in R_3 ($1.82\,\mathrm{A}$).

(d) There are no longer any sources of emf in the circuit, so all currents eventually drop to zero.