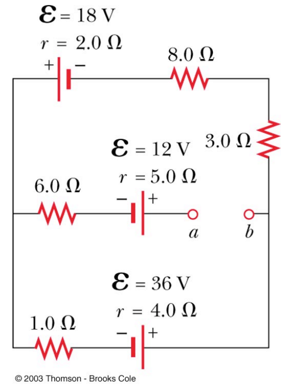
28. (a) Determine the potential difference ΔV_{ab} for the circuit in Figure P18.28. Note that each battery has an internal resistance as indicated in the figure. (b) If points a and b are connected by a 7.0-Ω resistor, what is the current through this resistor?



18.28 (a) Since there is not a continuous path in the center branch, no current exists in that part of the circuit. Then, applying Kirchhoff's loop rule to the outer perimeter gives

$$+18\text{ V}+36\text{ V}-\left[(1.0+4.0+3.0+8.0+2.0)\,\Omega\right]I=0$$

or $I=\dfrac{54\text{ V}}{18\,\Omega}=3.0\text{ A}$

Now, start at point b and go around the lower loop to point a, recording changes in potential to obtain

$$V_a-V_b=-36\text{ V}+(4.0\,\Omega+1.0\,\Omega)(3.0\text{ A})+(6.0\,\Omega+5.0\,\Omega)(0)+12\text{ V}=-9.0\text{ V},$$

or $|\Delta V|_{ab}=$ $\boxed{9.0\text{ V with point } b \text{ at a higher potential than } a}$

(b) Assume currents as shown in the modified circuit. Applying Kirchhoff's loop rule to the upper loop gives

$$-(11)I+12\text{ V}-(7.0)I-(13)I_1+18\text{ V}=0$$

or $18I+13I_1=30\text{ A}$ (1)

For the lower loop, the loop rule yields

$$-(5.0)(I_1-I)+36\text{ V}+(7.0)I-12\text{ V}+(11)I=0,$$

or $23I-5I_1=-24\text{ A}$. (2)

Solving equations (1) and (2) simultaneously gives $I_1=2.9\text{ A}$, and

$$I=-0.42\text{ A}$$

Thus, the current in the 7.0-Ω resistor is $\boxed{0.42\text{ A flowing from } b \text{ to } a}$.