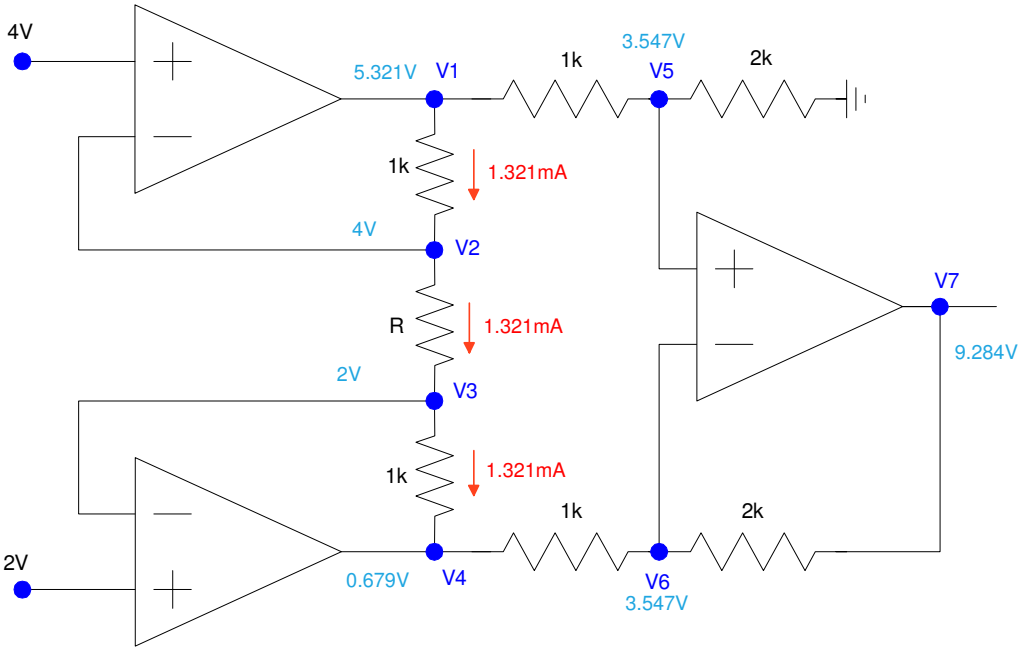
4) Determine the voltages V1..V7 for the following circuit.

- Assume ideal op-amps.
- Assume R = 1000 + 100*(your birth month) + (your birth day). For example, May 14th gives R = 1514.

V1	V2	V3	V4	V5	V6	V7
5.321V	**4V**	**2V**	**0.679V**	**3.547V**	**3.547V**	**9.294V**



With negative feedback, Vp = Vm

- V2 = 4V
- V3 = 2V
- V5 = V6

The current from V2 to V3 is

$$I = \left[\frac{4V-2V}{1514}\right] = 1.321mA$$

$$V_1 = V_2 + 1k \cdot I = 5.321V$$

$$V_4 = 2 - 1k \cdot I = 0.679V$$

$$V_5 = \left[\frac{2}{3}\right] V_1 = 3.547V$$

To find V7, two approaches

$$\left[\frac{V_6-V_4}{1k}\right] + \left[\frac{V_6-V_7}{2k}\right] = 0$$

or note that the last stage is an instrumentation amplifier with a gain of 2

$$V_7 = 2(V_1 - V_4)$$

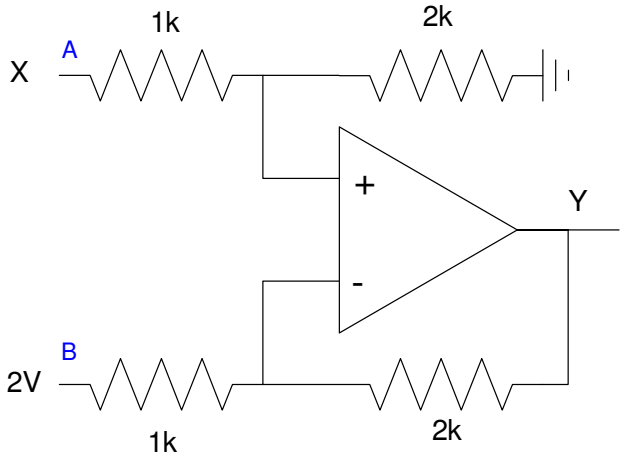
5) Design a circuit to implement

Y = 2X - 4

Many solutions. If you use an instrumentation amplifier, rewrite as

$$Y = 2(X - 2)$$

$$Y = \left[\frac{R_1}{R_2}\right](A - B)$$

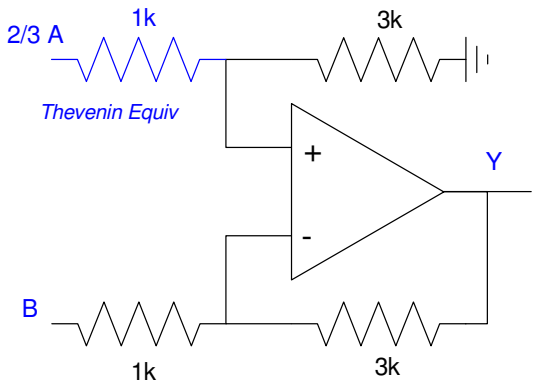


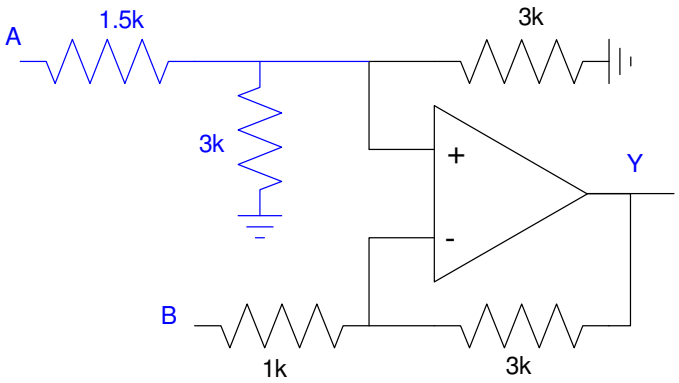
6) Design a circuit to implement

Y = 2A - 3B

There are many solutions. Using an instrumentation amplifier

$$Y = 3\left[\frac{2}{3}A - B\right]$$





Using inverting amlfiers