The circuit above is exposed to the input voltage $V_i$ as shown. Sketch the output, $V_o$. What value is $V_o$ at 18 ms? What value is $V_o$ at 35 ms?

Solution (all times in ms, voltages in $\mu$V):

- Sketch the output, $V_o$.
  At $t = 13$, $V_o = 22$. From $13 - 30$, $V$ decreases exponentially toward 96. After 30, $V_o$ increases towards 22.

- What value is $V_o$ at 18 ms?
  \[ \tau = RC = 482 \times 28.1 = 13544.2 \mu s = 13.54 \text{ ms} \]
  At $t = 18$, $\Delta t = 5$.
  \[ V_o = 22 + (96 - 22)e^{-\Delta t/\tau} = 22 + 74e^{-5/13.54} = 73.15 \]

- What value is $V_o$ at 35 ms?
  First, figure out $V_o$ at $t = 30$.
  $\Delta t = 30 - 13 = 17$
  \[ V_o = 22 + (96 - 22)e^{-\Delta t/\tau} = 22 + 74e^{-17/13.54} = 43.08 \]
  Now, $V_o$ increases from 43.08 (not 22).
  At $t = 35$, $\Delta t = 5$.
  \[ V_o = 96 + (43.08 - 96)e^{-\Delta t/\tau} = 96 - 52.92e^{-5/13.54} = 59.42 \]
Briefly (≤50 words) answer the following:

- What is the difference between a microshock and a macroshock?
- When electrodes are placed on the skin are you concerned with macroshock or microshock?
- Define the term “let-go current”.
- Why is the “let-go current” higher (on average) for a subject with higher mass?

For definitions, see in class notes from Sep 13 on “electrical safety”
The optoisolator above has an isolation voltage of 5 kV. Unfortunately, the user spills coffee on the circuit which connects the power line (120 V) to terminal D, while terminal C is at ground. The terminals A and B are connected to a circuit which is connected to the patient. **Sketch where the current does (and doesn’t) flow? Explain what protection the optoisolator offers.**

For definitions, see in class notes from Sep 18 on optoisolators