The circuit above is exposed to the input voltage $V_i$ as shown. Sketch the output, $V_o$. What value is $V_o$ at 20 ms? What value is $V_o$ at 39 ms?

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

- Sketch the output, $V_o$.
  
  At $t = 15$, $V_o = 12$. From 15 – 34, $V$ decreases exponentially toward 89. After 34, $V_o$ increases towards 12.

- What value is $V_o$ at 20 ms?
  
  $\tau = RC = 434 \times 20.3 = 8810.2 \mu s = 8.81$ ms
  
  At $t = 20$, $\Delta t = 5$.
  
  $V_o = 12 + (89 - 12)e^{-t/\tau} = 12 + 77e^{-5/8.81} = 55.65$

- What value is $V_o$ at 39 ms?
  
  First, figure out $V_o$ at $t = 34$.
  
  $\Delta t = 34 - 15 = 19$
  
  $V_o = 12 + (89 - 12)e^{-\Delta t/\tau} = 12 + 77e^{-19/8.81} = 20.91$
  
  Now, $V_o$ increases from 20.91 (not 12).
  
  At $t = 39$, $\Delta t = 5$.
  
  $V_o = 89 + (20.91 - 89)e^{-t/\tau} = 89 - 68.09e^{-5/8.81} = 50.40$
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, while using the circuit outside, lightening strikes, applying 500 kV to terminal C, while terminal D 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