The circuit above is exposed to the an input voltage $V_i$ as shown. Sketch the output, $V_o$. What value is $V_o$ at 23 ms? What value is $V_o$ at 34 ms?

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

- Sketch the output, $V_o$.
  
  At $t = 18$, $V_o = 20$. From $18 - 29$, $V$ decreases exponentially toward 84. After 29, $V_o$ increases towards 20.

- What value is $V_o$ at 23 ms?
  
  \[ \tau = RC = 419 \times 21.6 = 9050.4 \mu s = 9.05 \text{ ms} \]
  
  At $t = 23$, $\Delta t = 5$.
  
  \[ V_o = 20 + (84 - 20)e^{-t/\tau} = 20 + 64e^{-5/9.05} = 56.83 \]

- What value is $V_o$ at 34 ms?
  
  First, figure out $V_o$ at $t = 29$.
  
  $\Delta t = 29 - 18 = 11$
  
  \[ V_o = 20 + (84 - 20)e^{-\Delta t/\tau} = 20 + 64e^{-11/9.05} = 38.98 \]
  
  Now, $V_o$ increases from 38.98 (not 20).
  
  At $t = 34$, $\Delta t = 5$.
  
  \[ V_o = 84 + (38.98 - 84)e^{-t/\tau} = 84 - 45.02e^{-5/9.05} = 58.09 \]
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