The circuit above is exposed to an input voltage $V_i$ as shown. Sketch the output, $V_o$. What value is $V_o$ at 19 ms? What value is $V_o$ at 38 ms?

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

- Sketch the output, $V_o$.
  
  At $t = 14$, $V_o = 29$. From 14 – 33, $V$ decreases exponentially toward 89. After 33, $V_o$ increases towards 29.

- What value is $V_o$ at 19 ms?
  
  $\tau = RC = 356 \times 24.1 = 8579.6 \mu s = 8.58 ms$
  
  At $t = 19$, $\Delta t = 5$.
  
  $V_o = 29 + (89 - 29)e^{-t/\tau} = 29 + 60e^{-5/8.58} = 62.50$

- What value is $V_o$ at 38 ms?
  
  First, figure out $V_o$ at $t = 33$.
  
  $\Delta t = 33 - 14 = 19$
  
  $V_o = 29 + (89 - 29)e^{-\Delta t/\tau} = 29 + 60e^{-19/8.58} = 35.55$
  
  Now, $V_o$ increases from 35.55 (not 29).
  
  At $t = 38$, $\Delta t = 5$.
  
  $V_o = 89 + (35.55 - 89)e^{-t/\tau} = 89 - 53.45e^{-5/8.58} = 59.16$
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