This is a non-inverting amplifier with a gain of \( G = 1 + \frac{578}{121} = 478.7 \).
With such a large gain, it will saturate when \( V_i = \pm 10 V / G = \pm 0.021 \text{ V} \).

Times when \( |V_i| < 0.021 \text{ V} \), are
\[
T_1 = \pm \frac{0.1 - 0.021}{5 \text{ V/100 ms}} = \pm 1.580 \text{ ms}.
\]
\[
T_2 = \pm \frac{0.1 + 0.021}{5 \text{ V/100 ms}} = \pm 2.420 \text{ ms}.
\]

- Sketch \( V_o \).
- At what times does \( V_o \) reach \( \pm 10 \text{ V} \)?
- Does this circuit suffer from multiple transitions?

(Notes: voltage axis not to scale. The slope of the voltage may be approximated as 5 V/100 ms. Op amps are ideal)

- Sketch \( V_o \).
  1) From start to \(-2.420 \text{ ms}, V_o = -10 \text{ V}\)
  2) From \(-2.420 \text{ ms to } -1.580 \text{ ms}, V_o = \text{ transitions from } -10 \text{ V to } +10 \text{ V}\)
  3) From \(-1.580 \text{ ms to } 0 \text{ ms}, V_o = +10 \text{ V}\)
  4) From \(0 \text{ ms to } +1.580 \text{ ms}, V_o = -10 \text{ V}\)
  5) From \(+1.580 \text{ ms to } +2.420 \text{ ms}, V_o = \text{ transitions from } -10 \text{ V to } +10 \text{ V}\)
  6) From \(+2.420 \text{ ms to end}, V_o = +10 \text{ V}\)

- At what times does \( V_o \) reach \( \pm 10 \text{ V} \)?
  1) From start to \(-2.420 \text{ ms}, V_o = -10 \text{ V}\)
  3) From \(-1.580 \text{ ms to } 0 \text{ ms}, V_o = +10 \text{ V}\)
  4) From \(0 \text{ ms to } +1.580 \text{ ms}, V_o = -10 \text{ V}\)
  6) From \(+2.420 \text{ ms to end}, V_o = +10 \text{ V}\)

- Does this circuit suffer from multiple transitions?
  Yes
• Sketch $V_o$.

• At what times does $V_o$ reach $\pm 10$ V?

• Does this circuit suffer from multiple transitions?

(Notes: voltage axis not to scale. The slope of the voltage may be approximated as $5$ V/100 ms. Op amps are ideal)

Thresholds at $\pm \frac{1.93\, \text{k}\Omega}{564+1.93\, \text{k}\Omega} \times 10$ V = $\pm 0.034$ V.

Conditions:
1) If $V_i < V_+$ $\implies$ $V_o = +10$ V and $V_+ = +0.034$ V.
2) If $V_i > V_+$ $\implies$ $V_o = -10$ V and $V_+ = -0.034$ V.

• Sketch $V_o$.
  1) Initially, $V_o = +10$ and $V_+ = +0.034$ V
  2) when $V_i$ crosses $+0.034$ V, then $V_o = -10$ and $V_+ = -0.034$ V
  3) when $V_i$ crosses $-0.034$ V, then $V_o = +10$ and $V_+ = +0.034$ V
  4) when $V_i$ crosses $+0.034$ V, then $V_o = -10$ and $V_+ = -0.034$ V

• At what times does $V_o$ reach $\pm 10$ V?
  Transitions at $\pm \frac{0.1-0.034}{5\, \text{V/100 ms}} = \pm 1.32$ ms.
  1) Beginning until $-1.32$ ms $\implies$ $V_o = +10$ V.
  2) $-1.32$ ms until $0$ ms $\implies$ $V_o = -10$ V.
  3) $0$ ms until $+2.68$ ms $\implies$ $V_o = +10$ V.
  4) $+2.68$ ms until end $\implies$ $V_o = -10$ V.

• Does this circuit suffer from multiple transitions?
  Yes
This is a low pass filter with a gain of \( G = \frac{-305 \text{k}\Omega}{18.0 \text{k}\Omega} = -16.94 \).

With such a large gain, it will saturate when \( V_i = \pm 10 \text{ V} / G = \pm 0.590 \text{ V} \).

The time constant is \( \tau = 305 \text{k}\Omega \times 363 \text{nF} = 110.7 \text{ ms} \).

- Sketch \( V_o \) (this is difficult because of the exponential – indicate the main features of the curve)

- At what times does \( V_o \) reach \( \pm 10 \text{ V} \)?

- Does this circuit suffer from multiple transitions?

(Notes: voltage axis not to scale. The slope of the voltage may be approximated as 5 V/100 ms. Op amps are ideal)

\[ \begin{array}{c}
\text{Explanation: In the above case, the response is linear throughout the +/−0.1V transition of the input signal. The addition of the capacitor turns the circuit into a “lossy integrator”. Its step response would be an exponential with time constant \( RC = 110.7 \text{ ms} \). We don’t have exactly a step at the input; however, if the input transitions are short compared to the time constant we can approximate the output as an exponential (perhaps with a “bump” \( V_i \) briefly changes sign). assuming the input transitions are short compared to \( RC \), then \( V_o \) will NOT suffer from multiple transitions.} 
\end{array} \]