1. From the Nernst equation as it applies to the pH electrode, Equation (4), calculate the difference in pH corresponding to a difference in voltage of 0.1 mV (0.0001 V) at 20°C.

\[
E = E^0 - \frac{RT}{F} \ln [H^+] = E^0 + \left(\frac{2.303 \times RT}{F}\right) \text{pH} \quad \text{(Equation 4)}
\]

Assuming that \(E^0\) does not change with temperature, at 20°C (293 K)

\[
\Delta E = 0.0581 \Delta \text{pH} \quad \text{(1-2)}
\]

\[
\Delta \text{pH} = \frac{0.0001}{0.0581} = 0.00172 \text{ units} \quad \text{(1-3)}
\]

Alternatively

\[
E_1 = E^0 + 0.0581 \text{pH}_1 \quad \text{(1-4)}
\]

Let

\[
E_2 = E_1 \pm 0.0001 = E^0 + 0.0581 \text{pH}_2 \quad \text{(1-5)}
\]

\[
0.0581 \times (\text{pH}_2 - \text{pH}_1) = \pm 0.0001 \quad \text{(1-6)}
\]

\[
\Delta \text{pH} = \frac{\pm 0.0001}{0.0581} = \pm 0.00172 \text{ units} \quad \text{(1-7)}
\]

The precision of voltmeter will be ~ ±0.002 pH units if the voltmeter precision is 0.1 mV.