1. $V_{\text{rms}} = 0.13 \text{ mV} \left( \frac{R^2}{1 \text{ M\Omega}} \right) \left( \frac{1}{1 \text{ MHz}} \right) = 1.3 \text{ mV}$
   You see less than this on a scope, probably $V_{\text{obs}} \approx 0.2 \text{ mV}$

2. $X_c = \frac{1}{2\pi f_c}$; $f_c = \frac{1}{2\pi \text{ kHz}} = 120 \text{ kHz} = 120 \text{ kHz}$

3. $V_{\text{rms}} = 0.13 \text{ mV} \left( \frac{R^2}{1} \right)^{1/2} \left( \frac{1}{120} \right)^{1/2} = 0.01 \text{ mV}$
   You see more than this; other components are noisy too.

4. $V_{\text{rms}}^2 = 4kT R \Delta f = 4kT R \frac{1}{2\pi RC} = \frac{2}{\pi} \frac{kT}{C}$

5. $V = V_0 + V_{\text{noi}}$
   $\overline{V} = V_0 + \frac{1}{N} \sum_{i=1}^{N} V_{\text{noi}}$
   
   $\text{Standard Error of the Mean} = \frac{1}{\sqrt{N}} \text{ Standard Deviation of each Measurement}$
   $\overline{V}_{\text{rms}} = 10 \text{ mV} / \sqrt{N}$

6. $A_f$
   Random numbers add in quadrature:
   $V^2 = \frac{1}{N} \sum_{i=1}^{N} V_i^2$
   In Fourier space,
   $|V|^2 \sim \frac{1}{N} \sum_i A_i^2 \sim \int \Delta f A_i^2 \delta (\Delta f)$
   $\Rightarrow \overline{V}_{\text{rms}} \propto (\Delta f)^{1/2}$

7. $T = 0.01 \text{ sec}$
   $f_{\text{samp}} \approx 200.+6$
   $N_{\text{samp}} = 200+6$
   $\text{StDevMean} = \frac{\text{StDev}}{\sqrt{N}} = 7 \text{ mV}$
   $\text{Averaging for } T=0.01 \text{ sec is the same as filtering to } f \leq 100 \text{ kHz.}$
   $\text{[The } \Delta f \text{ difference has no significance here]}$
8. If you know $1200 < f_w < 1500$, this range can be aliased down to $0 < f_a < 200$, requiring $f_{\text{sample}} = 500$.

9. Digitization step $= \frac{20 \cdot V}{2^{16}(=64k)} = \frac{1}{3} mV \sim \text{StDeviation for each measurement}$

10. $f_{\text{sample}} = 44,100$

    $T = 0.01 \text{ sec}$

    $N_{\text{sample}} = 441$

    Noise = Sum of $N$ random components $\sim \sqrt{N \cdot \text{StDev}} \sim \sqrt{N} \cdot 20 \cdot V$

    Signal = Sum of $N$ wave components $\sim N \cdot 20 \cdot V$

    $\frac{\text{Signal}}{\text{Noise}} = \frac{N \cdot 2^{16}}{\sqrt{N}}$

    This is perhaps better thought of with the normalization

    $C_k = \frac{1}{N} \sum_{m=0}^{N-1} V_m e^{-2\pi i km/N}$

    Then $\text{max Signal} \sim 20 \cdot V$

    Noise $\sim \frac{1}{\sqrt{N}} \frac{20 \cdot V}{2^{16}}$

    Again, $\frac{S}{N} \sim \sqrt{N} \cdot 2^{16}$