1) $Re$ and $Pr$ are dimensionless:

$$Re = \frac{\rho V D}{\eta}, \quad [Re] = \frac{kg \cdot m^{-3} \cdot m \cdot s^{-1} \cdot m}{Ns \cdot m^{-2}} = \frac{kg \cdot m \cdot s^{-1}}{kg \cdot m \cdot s^{-2} \cdot m^{-2}}$$

$$[Re] = \text{— (no units)}$$

$$Pr = \frac{c_p \eta}{k} = \frac{J \cdot kg^{-1} \cdot deg^{-1} \cdot m \cdot s^{-2} \cdot m^2}{J \cdot kg^{-1} \cdot deg^{-1} \cdot m \cdot s^{-2}} = \frac{J \cdot s^{-1}}{J \cdot s^{-1}} = \text{— (no units)}$$

Then $Pr^x$ is also dimensionless, and so is $Re^{1/2} Pr^x$.

The value of $x$ is unrelated to dimensions, it is just obtained from data fit. (Correlation). Answer: 2)

2) $\bar{X} = 89.03$, median = 88.63, mode = 88.13

so the mean is not between the other two. a) is false

The population mean as estimated from the sample is $\bar{X} = 89.03$ and the std $\sigma = 2.0248$ (normalized by $n-1$). b) is true

$\sigma = \frac{1}{870} \neq \frac{1}{22}$ (C false)
since c) is false, the answer is b)

3) \( t \)-values for \( v = 10 - 1 = 9 \)

\[ t_{0.05, 9} = 1.383 \quad t_{0.01, 9} = 4.781 \]

Intervals: At 80\% \[ \bar{x} \pm \frac{t \sigma}{\sqrt{v}} = [33.1444, 89.9156] \]

At 99.9\% \[ \bar{x} \pm \frac{t \sigma}{\sqrt{v}} = [25.9637, 92.0913] \]

Answer: b)

4) \( f(x) = \frac{x^3}{1000} - \sin(x) \)

\[ \Delta f = \frac{df}{dx} \left|_{x} \right. \Delta x = \left( \frac{3x^2}{1000} - \cos(x) \right) \left|_{x} \right. \Delta x \]

\[ \Delta x = \frac{t \sigma}{\sqrt{v}} \] \( t = t_{0.05} \), \( \Delta x = 0.8852 \)

\( \Rightarrow \Delta f = 20.28 \)

Answer: d)
According to Table 3.4, the maximum acceptable deviation is 1.96 (for 10 points)

\[ \frac{|x-\bar{x}|}{\sigma} \]

\[ \begin{array}{|c|c|c|}
\hline
x & |x-\bar{x}| & \frac{|x-\bar{x}|}{\sigma} \\
\hline
82.13 & 1.1 & 0.54 \\
89.13 & 0.1 & 0.05 \\
88.13 & 0.9 & 0.45 \\
91.13 & 2.1 & 1.04 \\
93.13 & 4.1 & 2.02 \\
86.13 & 2.9 & 1.93 \\
87.13 & 1.9 & 0.94 \\
\hline
\end{array} \]

\[ \rightarrow \text{ 93.13 is eliminated (1 point)} \]

Answer: c)

6) \[ \overline{x} - 87.5816 = \frac{t \sigma}{\sqrt{n}} \rightleftharpoons t = 2.262 \]

Using Table 3.7 we see that \( p = 95\% \)

and \[ \overline{x} + \frac{t \sigma}{\sqrt{n}} = 90.4794 \]

Answer: d)

7) a) is false. Precision (repeatability) is preferred
b) is true. Calibration fixes inaccuracy
c) is false. Calibration cannot remove randomness.

j) is true.

Answer: e)

8)

<table>
<thead>
<tr>
<th>Distance</th>
<th>Voltage</th>
<th>Sensitivity $\left( \frac{\Delta V}{\Delta D} \right)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-12</td>
<td>-</td>
</tr>
<tr>
<td>-1</td>
<td>-7.5</td>
<td>4.5</td>
</tr>
<tr>
<td>0</td>
<td>-3</td>
<td>4.5</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>4.5</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>5.5</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>9</td>
</tr>
</tbody>
</table>

a) is false, since the sensitivity changes.
b) true
c) false
d) true
e) true

Answer: e)
3) Using table 3.3:

Chances (proportion) of data falling within $K$ std's is:

\[
\begin{array}{c|c}
  K = 1 & P \\
  \hline
  & 68.27\% \\
\end{array}
\]

\(\pm 1\sigma\)

\(\pm 16\)

\(a)\) is true

The data outside $\pm 1\sigma$ is $100 - 68.27\% = 31.73\%$.

The low range is half of this $\approx 16\%$

\(b)\) is true

For $0.6745\sigma$, $\ \ p = \frac{1}{1+1} = 0.5$

\(\pm 0.6745\sigma\)

The data outside $\pm 0.6745\sigma$ is $100 - 50\% = 50\%$.

The high range is half of this $\approx 25\%$

\(c)\) is true.

\(\text{Answer: d)}\)
10) \( T = \frac{PV}{mR} \)

The worst case is obtained using \( P \pm \Delta P, \ V \pm \Delta V, \ m \pm \Delta m \)

\[
T_{\text{high}} = \frac{(2\times10^6 + 10\times10^3) \times 1\times10^{-4}}{(0.002 - 1\times10^{-5}) \times 2\times7.06} = 351.8603
\]

\[
T_{\text{low}} = \frac{(2\times10^6 - 10\times10^3) \times 1\times10^{-4}}{(0.002 + 1\times10^{-5}) \times 2\times7.06} = 344.893
\]

The nominal \( T \) is \( T_0 = 348.3592 \)

High dev = \( T_0 + 351.8603 = 3.501 \)

Low dev = \( T_0 - 344.893 = 3.462 \)

Answer: \( D \)

11) \( \Delta T = \sqrt{\left(\frac{\partial T}{\partial P}\bigg|_{P_0}\right)^2 + \left(\frac{\partial T}{\partial V}\bigg|_{P_0}\right)^2} \)

\[
\frac{\partial T}{\partial P} = \left. \frac{V}{mR} \right|_{P_0} = 1.7413 \times 10^{-4}
\]

\[
\frac{\partial T}{\partial V} = \left. \frac{P}{mR} \right|_{P_0} = 3.4836 \times 10^6
\]

\[\rightarrow \Delta T = 3.8948 \text{ K} \]

Interval: \([344.4644, 352.2546]\) (a)