Physics Experiment Result Report

User 000

December 7, 2021

1 Section 1. Result for d:

The mean for d is:

$$\bar{d} = \frac{1}{6}\sum_{i=1}^{6} d_i = 7.9213\ mm$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(d_i - 7.9213)^2}{6-1}} = 0.0025\ mm$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0.0025}{\sqrt{6}} = 0.0026\ (mm)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.005\ mm$$

The compound uncertainty is:

$$u(d) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0026^2 + 0.005^2} = 0.0056\ (mm)$$

By the ceiling principle, the final compound uncertainty for d is:

$$u(d) = 0.006\ mm$$

And the final result for d is:

$$d = (7.921 \pm 0.006)\ mm\ (P = 0.955)$$

2 Section 2. Result for e:

The mean for e is:

$$\bar{e} = \frac{1}{6}\sum_{i=1}^{6} e_i = 5.9857\ mm$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(e_i - 5.9857)^2}{6-1}} = 0.0036\ mm$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0.0036}{\sqrt{6}} = 0.0038\ (mm)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.005\ mm$$

The compound uncertainty is:

$$u(e) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0038^2 + 0.005^2} = 0.0063\ (mm)$$

By the ceiling principle, the final compound uncertainty for e is:

$$u(e) = 0.007\ mm$$

And the final result for e is:

$$e = (5.986 \pm 0.007)\ mm\ (P = 0.955)$$

3 Section 3. Result for o:

The mean for o is:

$$\bar{o} = \frac{1}{6}\sum_{i=1}^{6} o_i = 5.8602\ mm$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(o_i - 5.8602)^2}{6-1}} = 0.0017\ mm$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0.0017}{\sqrt{6}} = 0.0018\ (mm)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.005\ mm$$

The compound uncertainty is:

$$u(o) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0018^2 + 0.005^2} = 0.0053\ (mm)$$

By the ceiling principle, the final compound uncertainty for o is:

$$u(o) = 0.006\ mm$$

And the final result for o is:

$$o = (5.860 \pm 0.006)\ mm\ (P = 0.955)$$

4 Section 4. Result for g:

The mean for g is:

$$\bar{g} = \frac{1}{6}\sum_{i=1}^{6} g_i = 5.8548\ mm$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(g_i - 5.8548)^2}{6-1}} = 0.0026\ mm$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0.0026}{\sqrt{6}} = 0.0027\ (mm)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.005\ mm$$

The compound uncertainty is:

$$u(g) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0027^2 + 0.005^2} = 0.0057\ (mm)$$

By the ceiling principle, the final compound uncertainty for g is:

$$u(g) = 0.006\ mm$$

And the final result for g is:

$$g = (5.855 \pm 0.006)\ mm\ (P = 0.955)$$

5 Section 5. Result for L:

The mean for L is:

$$\bar{L} = \frac{1}{6}\sum_{i=1}^{6} L_i = 159.0\ mm$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(L_i - 159.0)^2}{6-1}} = 0\ mm$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0}{\sqrt{6}} = 0.0000\ (mm)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.2\ mm$$

The compound uncertainty is:

$$u(L) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0000^2 + 0.2^2} = 0.20\ (mm)$$

By the ceiling principle, the final compound uncertainty for L is:

$$u(L) = 0.2\ mm$$

And the final result for L is:

$$L = (159.0 \pm 0.2)\ mm\ (P = 0.955)$$

6 Section 6. Result for m:

The mean for m is:

$$\bar{m} = \frac{1}{6}\sum_{i=1}^{6} m_i = 33.72\ g$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{6}(m_i - 33.72)^2}{6-1}} = 0\ g$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{2.56 \times 0}{\sqrt{6}} = 0.0000\ (g)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.01\ g$$

The compound uncertainty is:

$$u(m) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0000^2 + 0.01^2} = 0.010\ (g)$$

By the ceiling principle, the final compound uncertainty for m is:

$$u(m) = 0.01\ g$$

And the final result for m is:

$$m = (33.72 \pm 0.01)\ g\ (P = 0.955)$$

7 Section 7. Result for f:

The mean for f is:

$$\bar{f} = \frac{1}{4}\sum_{i=1}^{4} f_i = 1051.4\ Hz$$

The sigma (kick off all layouts) is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{4}(f_i - 1051.4)^2}{4-1}} = 0\ Hz$$

The type A uncertainty is:

$$u_A = t_p \cdot \frac{\sigma}{\sqrt{n}} = \frac{3.18 \times 0}{\sqrt{4}} = 0.0\ (Hz)$$

The type B uncertainty is:

$$u_B = \Delta_I = NoFunction = 0.1\ Hz$$

The compound uncertainty is:

$$u(f) = \sqrt{u_A^2 + u_B^2} = \sqrt{0.0^2 + 0.1^2} = 0.10\ (Hz)$$

By the ceiling principle, the final compound uncertainty for f is:

$$u(f) = 0.1\ Hz$$

And the final result for f is:

$$f = (1051.4 \pm 0.1)\ Hz\ (P = 0.955)$$

8 Section 8

The compound mean is:

$$\bar{E} = \frac{1.6067 L^3 f^2 m}{g^4} = 204880875512\ (Pa)$$

The relative compound uncertainty is:

$$E_E = \frac{u(E)}{\bar{E}} = \sqrt{\left(\frac{\partial \ln E}{\partial m}\right)^2 \cdot u^2(m) + \left(\frac{\partial \ln E}{\partial f}\right)^2 \cdot u^2(f) + \left(\frac{\partial \ln E}{\partial g}\right)^2 \cdot u^2(g) + \left(\frac{\partial \ln E}{\partial L}\right)^2 \cdot u^2(L)} = 0.005$$

The absolut compound uncertainty is:

$$u(E) = \bar{E} \cdot E_E = 204880875512 \times 0.0056 = 1147332903\ (Pa)$$

The final result is:

$$E = (204880875512 \pm 1147332903)\ Pa\ (P = 0.955)$$