Problem 1.5 - Uncertainty Analysis, Case A

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$$\frac{p}{\rho_{Hg}\, g} \quad \mapsto \quad \begin{pmatrix} \rho_{Hg} & 13\,550 \pm 5 & \text{UniformD} \\ g & 9.80665 & \\ p & 101 \times 10^3 \pm 0.5 \times 10^3 & \text{UniformD} \end{pmatrix}$$

Evaluated Functional Relationship

```
?AnalysisEnvironment
```

$$y = \frac{x_3}{x_1\, x_2}$$

Variable		Uncertainty Interval	Distribution	$\lvert \partial f/\partial x_i \rvert$
x_1	ρ_{Hg}	$(1.3550 \pm 0.0005) \times 10^4$	Uniform	5.60947×10^{-5}
x_2	g	$9.80665 \times$ (exact) 10^0		7.7507×10^{-2}
x_3	p	$(1.010 \pm 0.005) \times 10^5$	Uniform	7.52558×10^{-6}

y	0.760083671666205	
y_{min}	0.756041898961835	= y - 0.00404177
y_{max}	0.764128428329774	= y + 0.00404476
ε_{max}	0.00404326413337472	= 0.532 %
$y \pm \varepsilon_{max}$	$(7.60 \pm 0.04) \times 10^{-1}$	$= 7.60(4) \times 10^{-1}$
u_c	0.00217847480928703	= 0.287 %
$y \pm u_c$	$(7.60 \pm 0.02) \times 10^{-1}$	$= 7.60(2) \times 10^{-1}$

Absolute Maximum Uncertainty

$$\varepsilon_{max} = \sum_{i=1}^{n} \lvert \partial_{x_i} f[x] \rvert\, \varepsilon_i ; \quad f[x] \pm \varepsilon_{max} \;\; // \; ?UCE$$

0.760083671666205 ± 0.00404326

∈ [0.75604; 0.764127]

≃ $(7.60 \pm 0.04) \times 10^{-1} = 7.60(4) \times 10^{-1}$

Combined Standard Uncertainty

$$u_c = \left(\sum_{i=1}^{n} (\partial_{x_i} f[x])^2\, u_i^2 \right)^{1/2} ; \quad f[x] \pm u_c \;\; // \; ?UCA$$

0.760083671666205 ± 0.00217847

∈ [0.757905; 0.762262]

≃ $(7.60 \pm 0.02) \times 10^{-1} = 7.60(2) \times 10^{-1}$

Monte Carlo Simulation

```
Block[ { data, trials = 10^6 },
  data = f @@ Table[RandomReal[fDist[i], {trials}], {i, 1, n}];
  Mean[data] ± StandardDeviation[data] ] // QUCA
```

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0.760084426837153 ± 0.0021794
 ∈ [0.757905; 0.762264]
 ≃ (7.60 ± 0.02) × 10^-1 = 7.60(2) × 10^-1
```