Processing of Time and Dimensions Data

Calculation of the Enclosed Volumes and Surface Areas

Measurement error of a calliper: $m(x) = 0{,}1\,\mathrm{mm}$

Measurement error of a micrometre: $m(x) = 0{,}01\,\mathrm{mm}$

$$u_{xB} = \frac{m(x)}{\sqrt{3}}$$

Sphere:

$$V = \frac{\pi d^3}{6} \qquad S = \pi d^2 \qquad u_{rd} = \frac{u_d}{d}$$

$$u_{rV} = 3u_{rd} \qquad u_{rS} = 2u_{rd}$$

$$u_V = u_{rV} V \qquad u_S = u_{rS} S$$

Measurement error of a calliper: $m\left(x\right)=0,1\mathrm{mm}$

Measurement error of a micrometre: $m\left(x\right)=0,01\mathrm{mm}$

$$u_{xB}=\frac{m\left(x\right)}{\sqrt{3}}$$

Cylinder:

$$V=\frac{\pi d^2 h}{4}$$

$$S=\frac{\pi d^2}{2}+\pi dh$$

$$u_{rd}=\frac{u_d}{d} \qquad u_{rh}=\frac{u_h}{h}$$

$$u_{rV}=\sqrt{4u_{rd}^2+u_{rh}^2}$$

$$u_S=\sqrt{\left(\frac{\partial S}{\partial d}\right)^2 u_d^2+\left(\frac{\partial S}{\partial h}\right)^2 u_h^2}=$$

$$=\pi\sqrt{\left(d+h\right)^2 u_d^2+d^2 u_h^2}$$

$$u_V=u_{rV}V$$

$$u_{rS}=\frac{u_S}{S}$$

Measurement error of a calliper: $m\left(x\right)=0{,}1\mathrm{mm}$

Measurement error of a micrometre: $m\left(x\right)=0{,}01\mathrm{mm}$

$$u_{xB}=\frac{m\left(x\right)}{\sqrt{3}}$$

Cuboid:

$$V=abc$$

$$S=2\left(ab+ac+bc\right)$$

$$u_{rV}=\sqrt{u_{ra}^2+u_{rb}^2+u_{rc}^2}$$

$$u_{ra}=\frac{u_a}{a}$$

$$u_{rc}=\frac{u_c}{c}$$

$$u_{rb}=\frac{u_b}{b}$$

$$u_V=u_{rV}V$$

$$u_S=\sqrt{\left(\frac{\partial S}{\partial a}\right)^2u_a^2+\left(\frac{\partial S}{\partial b}\right)^2u_b^2+\left(\frac{\partial S}{\partial c}\right)^2u_c^2}=$$

$$=2\sqrt{\left(b+c\right)^2u_a^2+\left(a+c\right)^2u_b^2+\left(a+b\right)^2u_c^2}$$

$$u_{rS}=\frac{u_S}{S}$$

Swing time τ of a pendulum

For our purpose, the period T was recorded.

$$T = 2\tau \qquad\qquad u_{r\tau} = \frac{u_\tau}{\tau} = \frac{u_T}{T} = u_{rT}$$

Human reaction time for single measurement: **0.5 s**

One period as a single measurement:

$$u_T = \frac{0,5}{\sqrt{3}}\,\mathrm{s} \qquad u_\tau = \frac{0,5}{2\sqrt{3}}\,\mathrm{s}$$

10 periods as a single measurement: $t = 10\,T = 20\,\tau$

$$u_t = \frac{0,5}{\sqrt{3}}\,\mathrm{s} \qquad u_T = \frac{0,5}{10\sqrt{3}}\,\mathrm{s} \qquad u_\tau = \frac{0,5}{20\sqrt{3}}\,\mathrm{s}$$

Repeated measurement of one period $t = T = 2\tau$

$$u_{r\tau} = \frac{u_\tau}{\tau} = \frac{u_T}{T} = u_{rT}$$

$$\overline{t} = \frac{\sum_{i=1}^{10} t_i}{10}$$

$$s_{\overline{t}} = u_{tA} = \sqrt{\frac{\sum_{i=1}^{10} \left(\overline{t} - t_i\right)^2}{10(10-1)}}$$

$$u_{\tau A} = \frac{u_{tA}}{2}$$

$$u_{\tau B} = \frac{u_{tB}}{2} = \frac{0{,}01}{2\sqrt{3}}\,\mathrm{s}$$

Stop-watch error

$$u_\tau = \sqrt{u_{\tau A}^2 + u_{\tau B}^2}$$

$$t = T = 2\tau \qquad u_{r\tau} = \frac{u_\tau}{\tau} = \frac{u_T}{T} = u_{rT}$$

Sequential measurement of one period (10 data points):

Linear regression: $y = ax$ $y = ax + b$

$$a = T \qquad \tau = \frac{a}{2} \qquad u_{\tau A} = \frac{u_{tA}}{2} = \frac{s_a}{2}$$

$$u_\tau = \sqrt{u_{\tau A}^2 + u_{\tau B}^2}$$

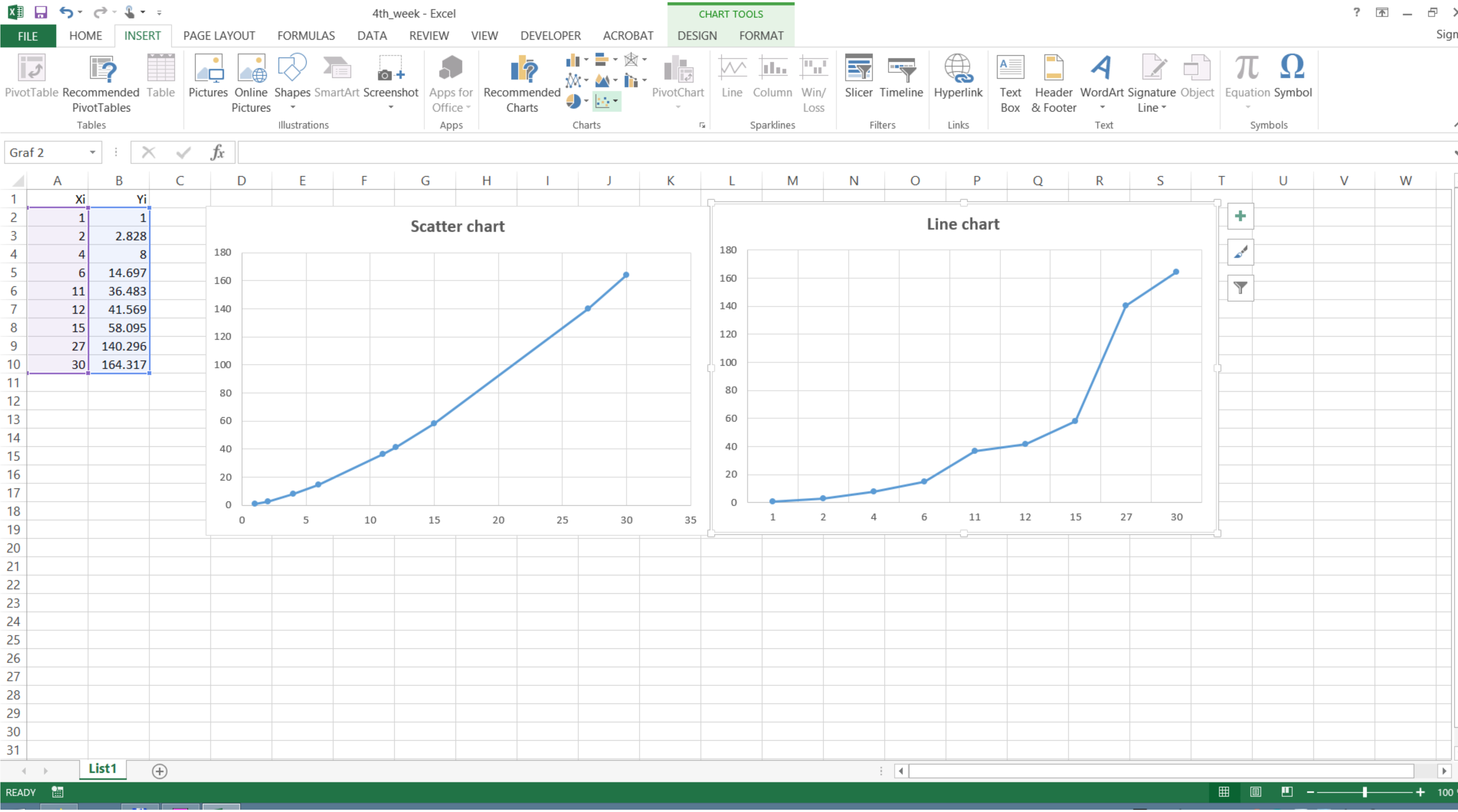
$$u_{\tau B} = \frac{u_{tB}}{2} = \frac{0,01}{2\sqrt{3}}\,\mathrm{s}$$

Sequential measurement of one period (computer controlled)

$$a = T \qquad \tau = \frac{a}{2} \qquad u_{\tau A} = \frac{u_{tA}}{2} = \frac{s_a}{2}$$

$$u_\tau = u_{\tau A}$$

$$u_{\tau B} = \frac{u_{tB}}{2} = 0$$


4th_week - Excel
Xi Yi
1 1
2 2.828
4 8
6 14.697
11 36.483
12 41.569
15 58.095
27 140.296
30 164.317
Scatter chart
Line chart
List1

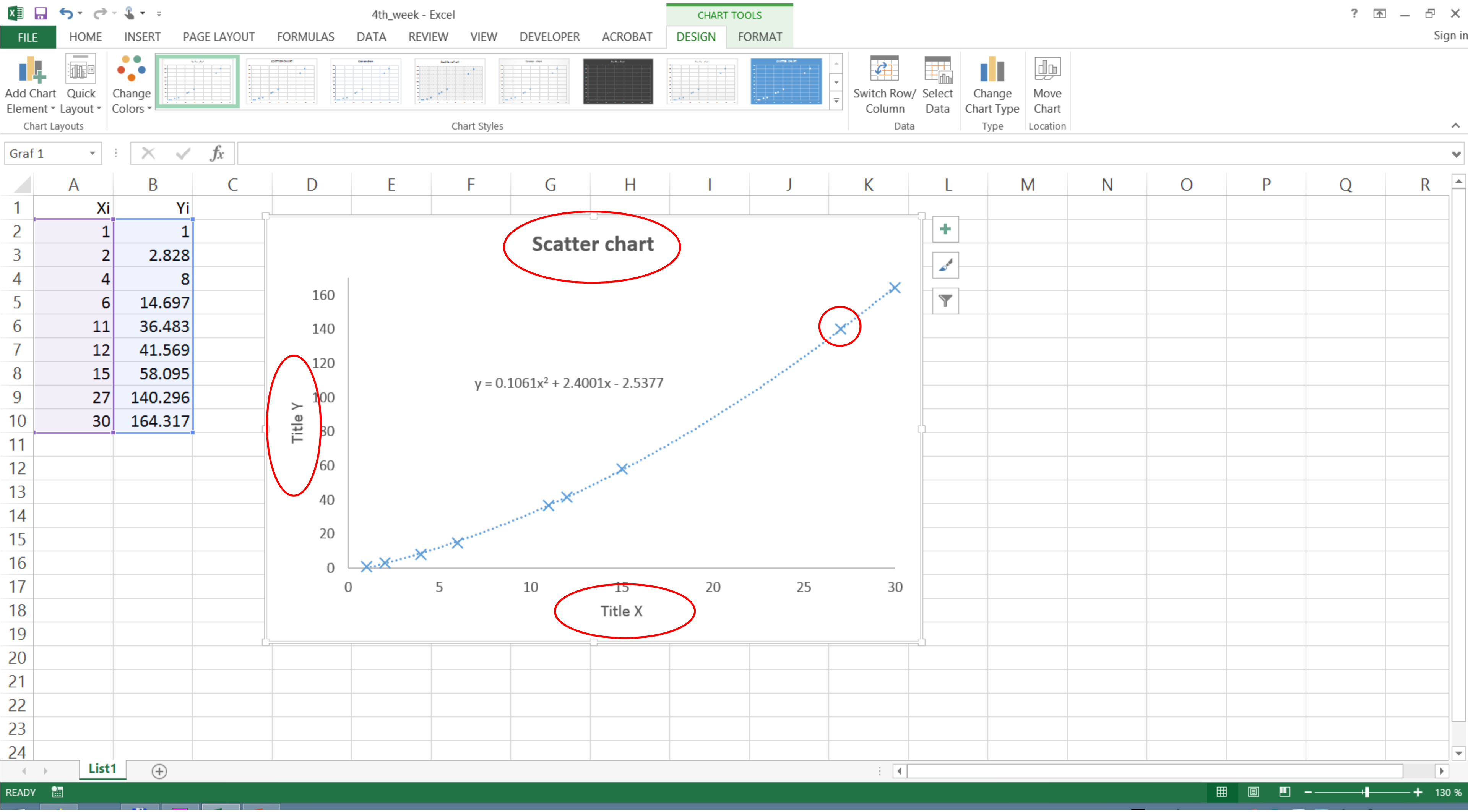

4th_week - Excel
CHART TOOLS
FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW DEVELOPER ACROBAT DESIGN FORMAT
Sign in
Add Chart Element
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Chart Layouts
Chart Styles
Switch Row/ Column
Select Data
Data
Change Chart Type
Type
Move Chart
Location
Graf 1
Xi Yi
1 1
2 2.828
4 8
6 14.697
11 36.483
12 41.569
15 58.095
27 140.296
30 164.317
Scatter chart
y = 0.1061x² + 2.4001x - 2.5377
Title Y
Title X
List1
READY
130 %