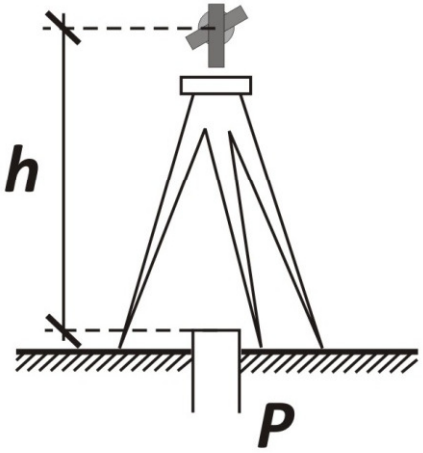
Surveying I. (BSc)

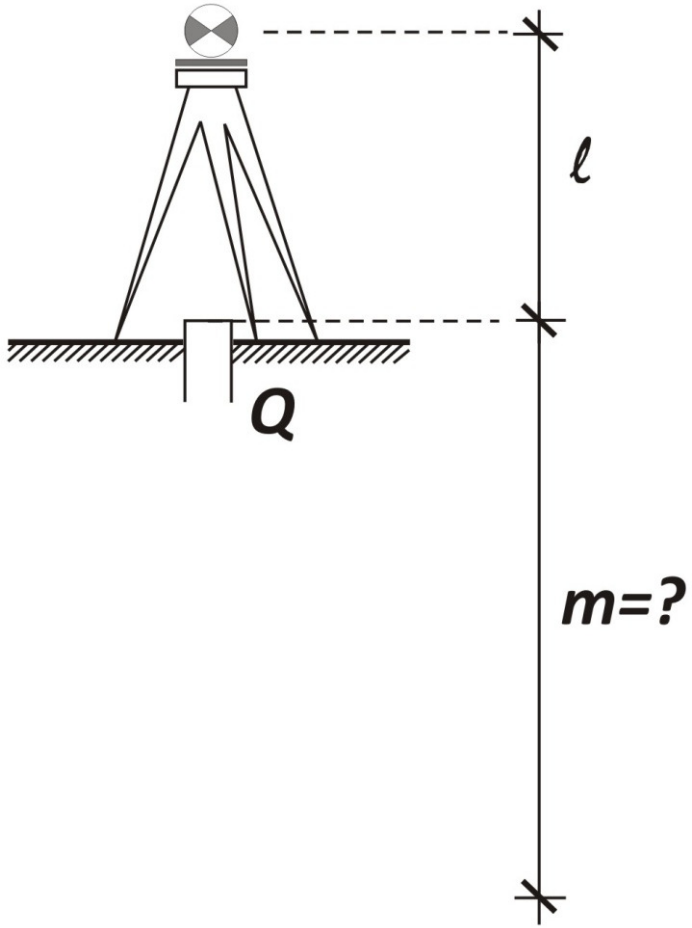
Trigonometric heighting. Distance measurements, corrections and reductions

How could the height of skyscrapers be measured?

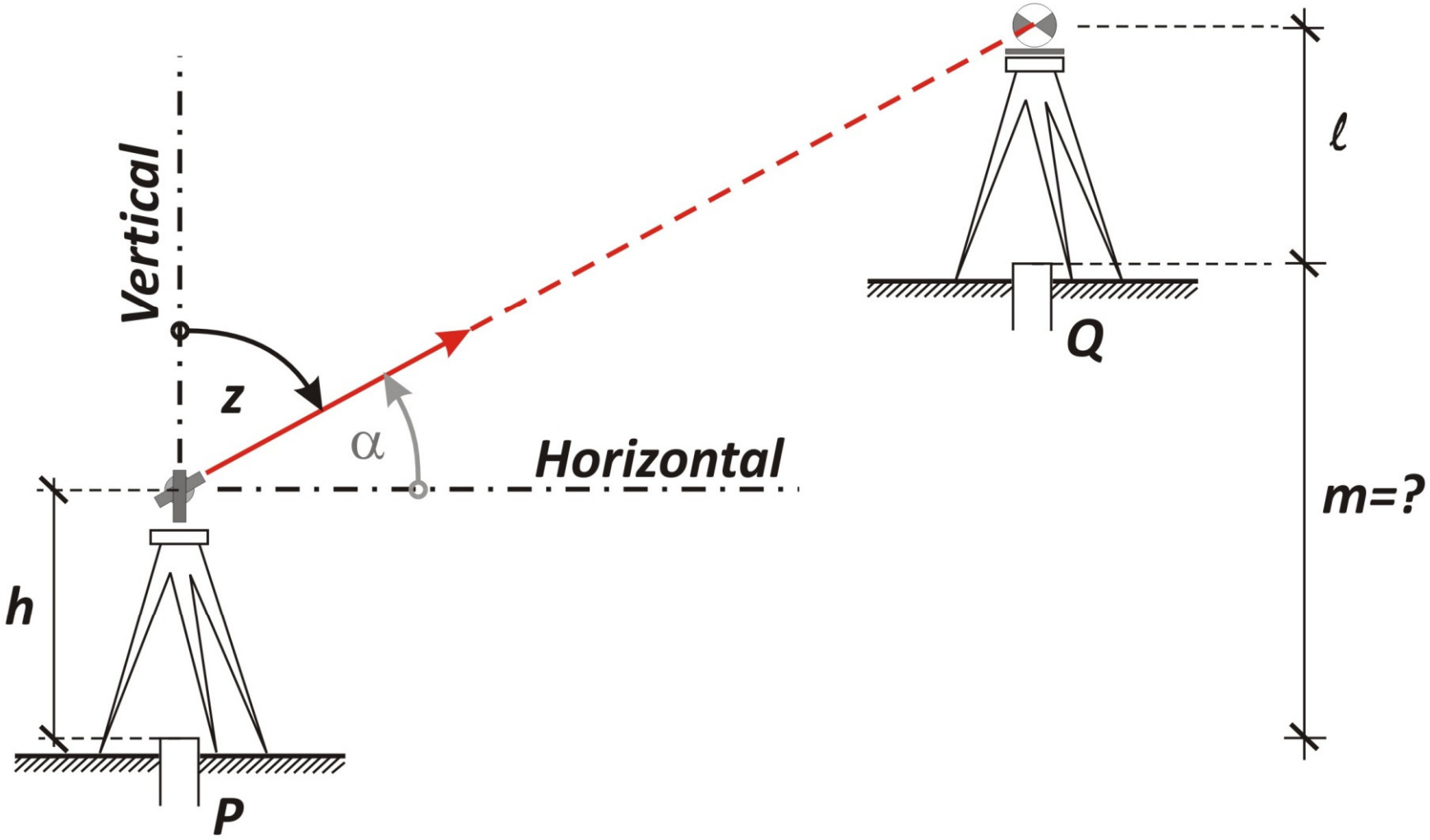
The principle of trigonometric heighting

The principle of trigonometric heighting





The principle of trigonometric heighting



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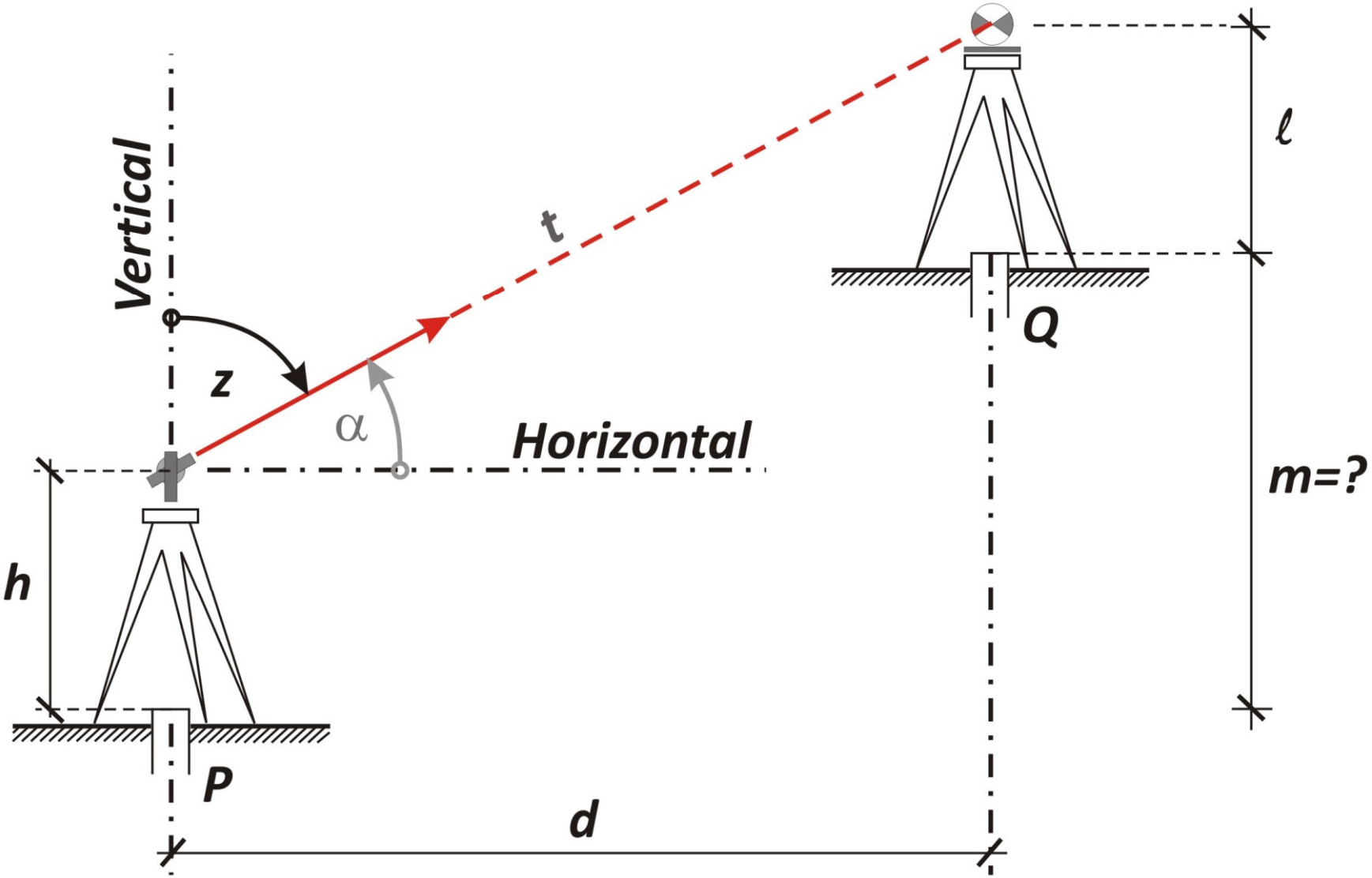

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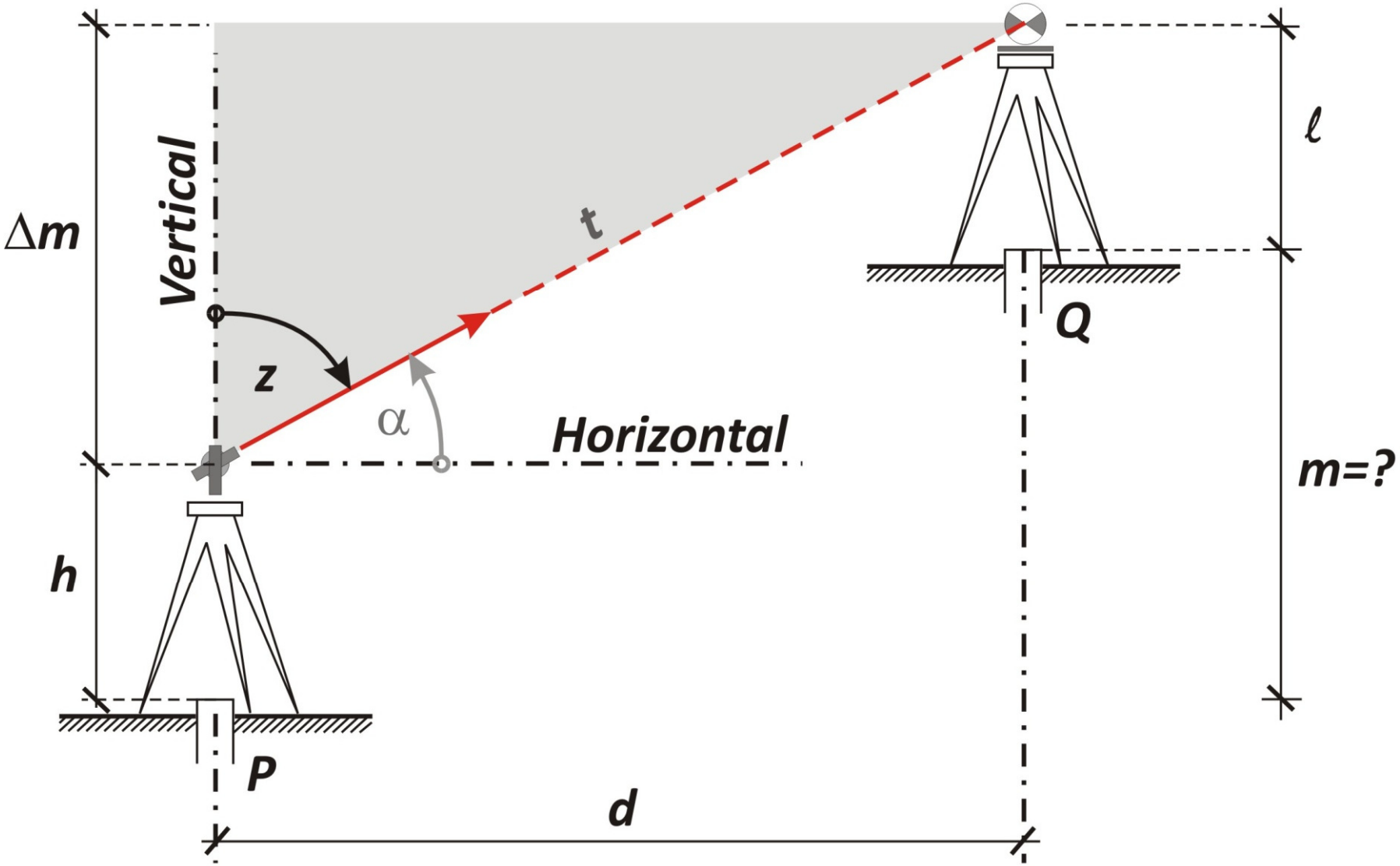
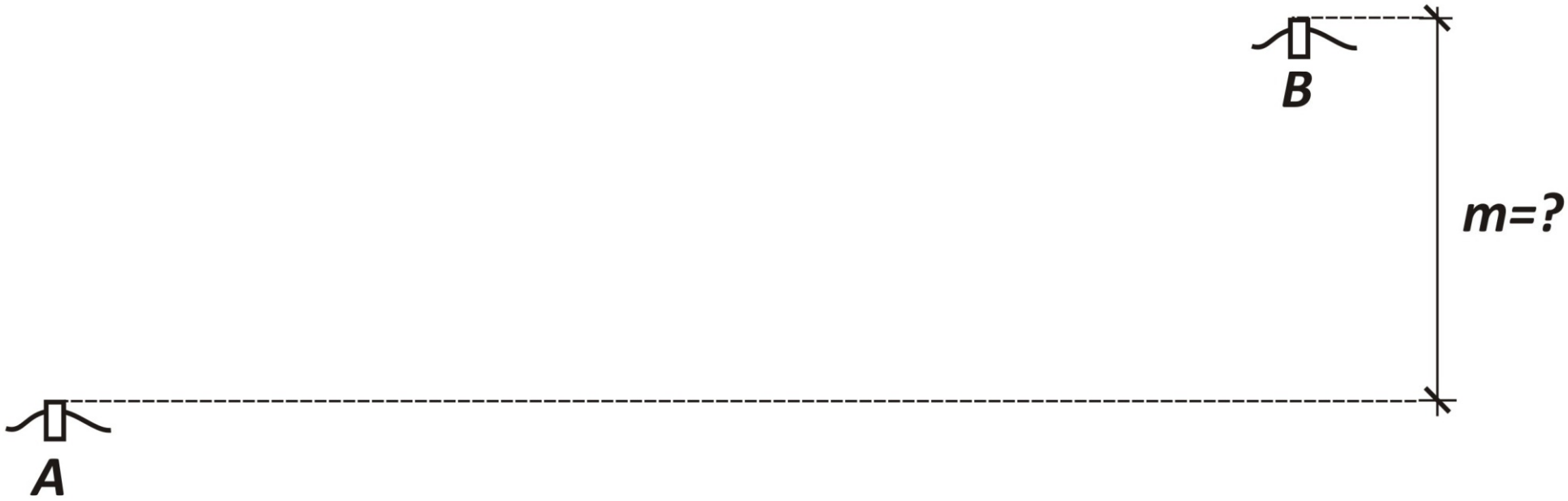


$$m = h + \Delta m - \ell = h - \ell + d \cot z$$

Trigonometric levelling



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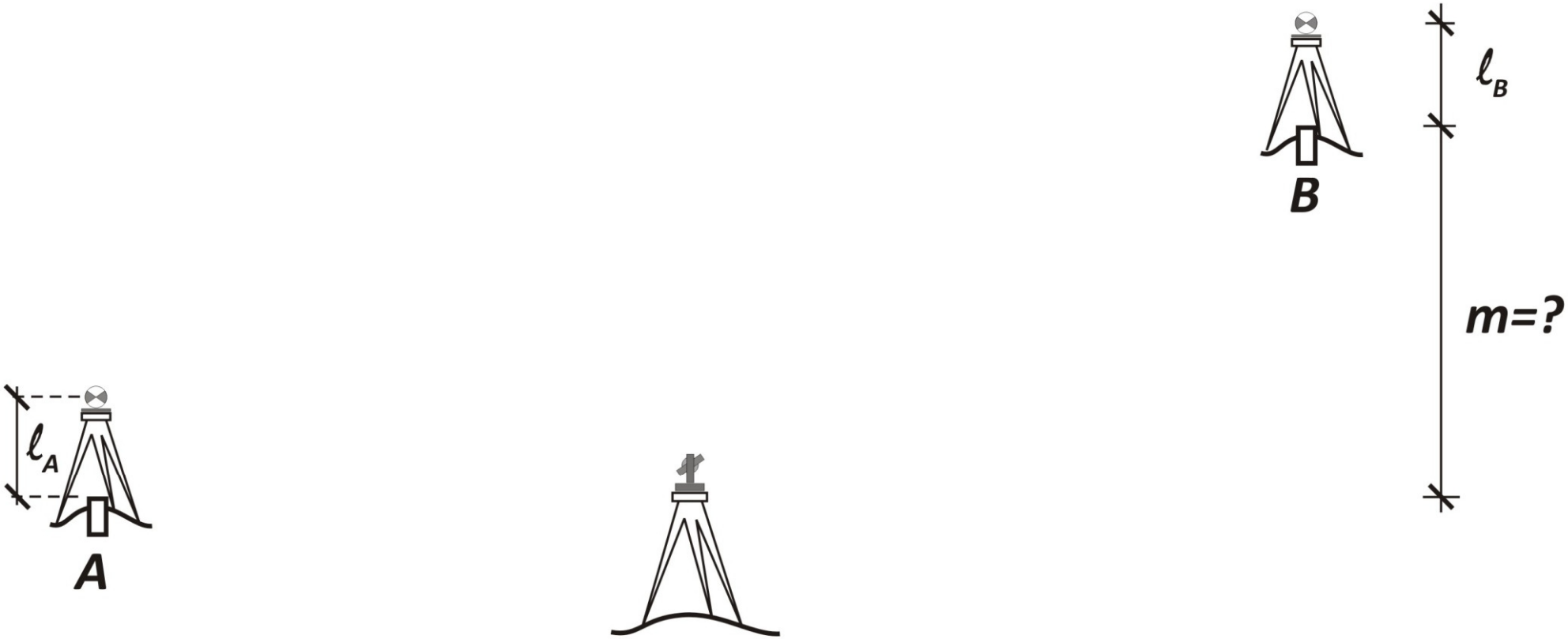
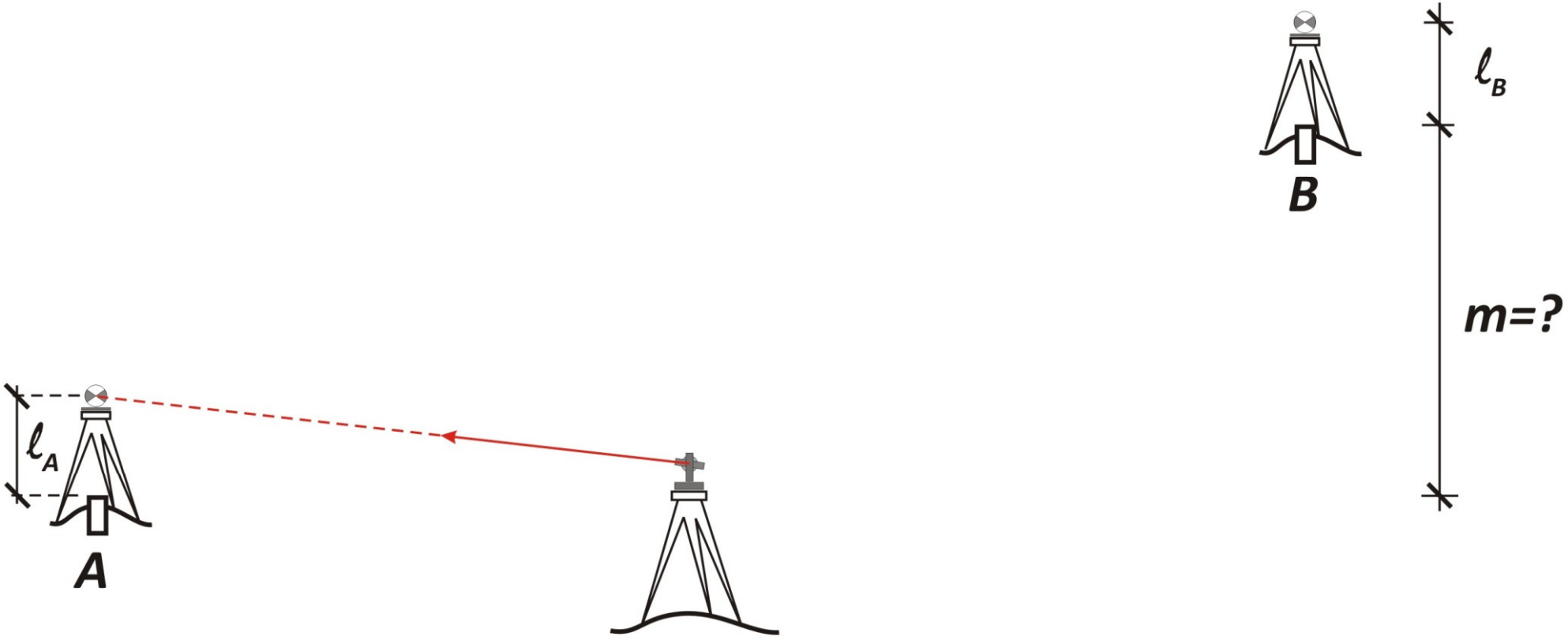
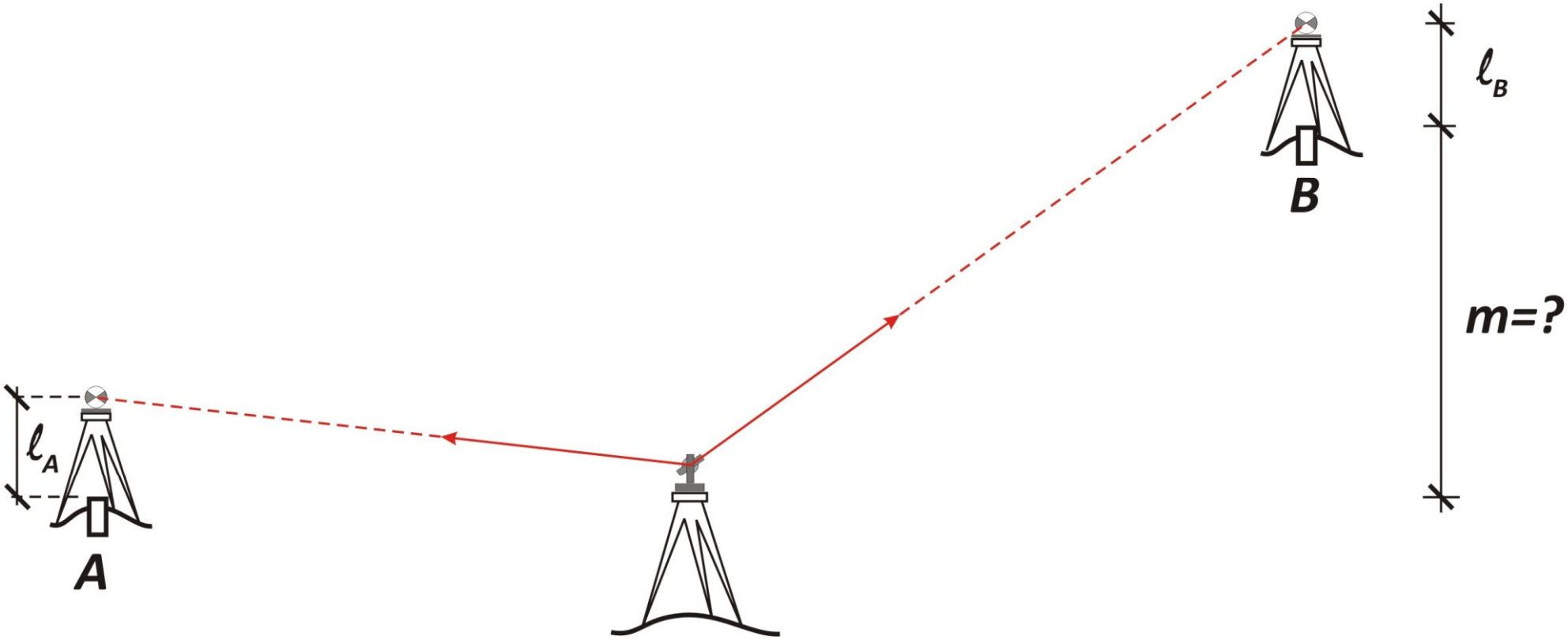


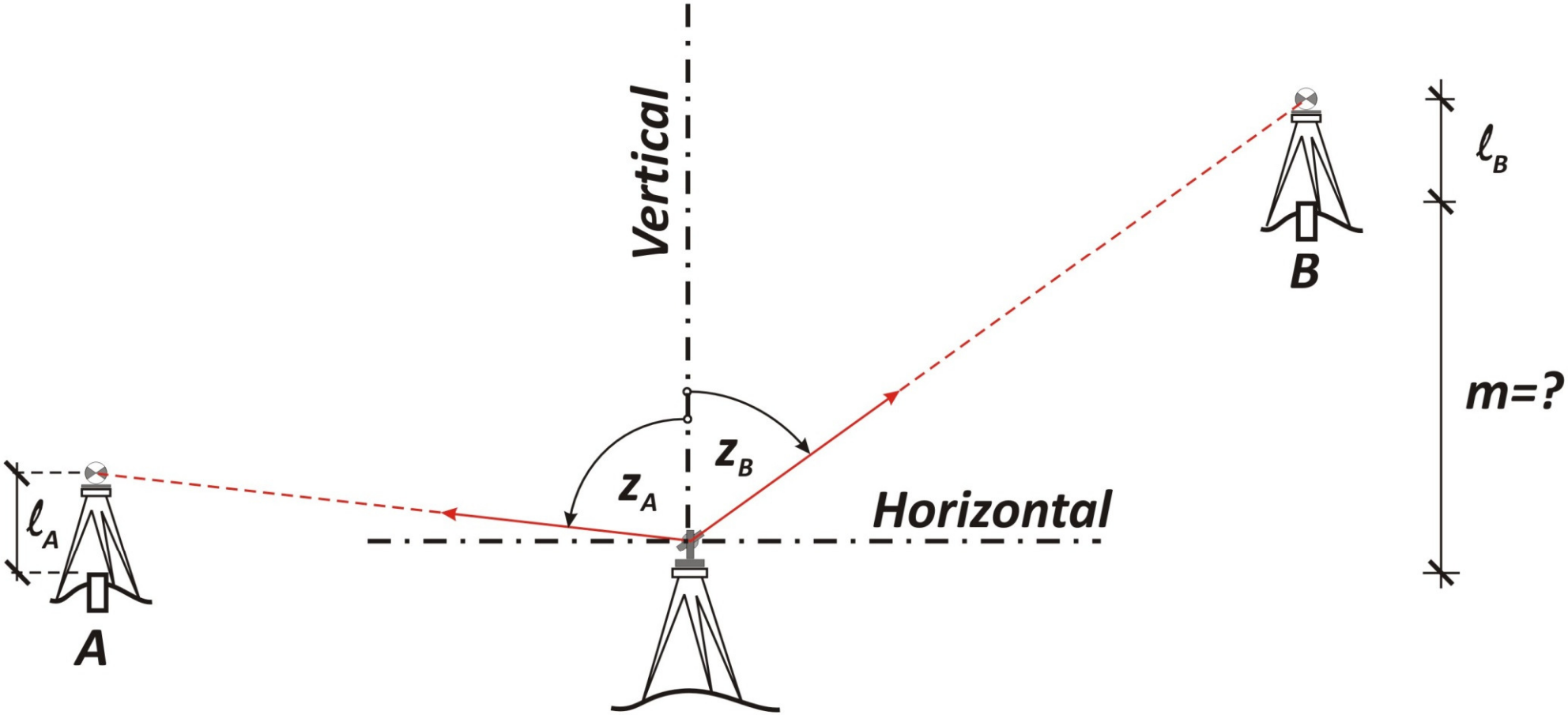
Trigonometric levelling



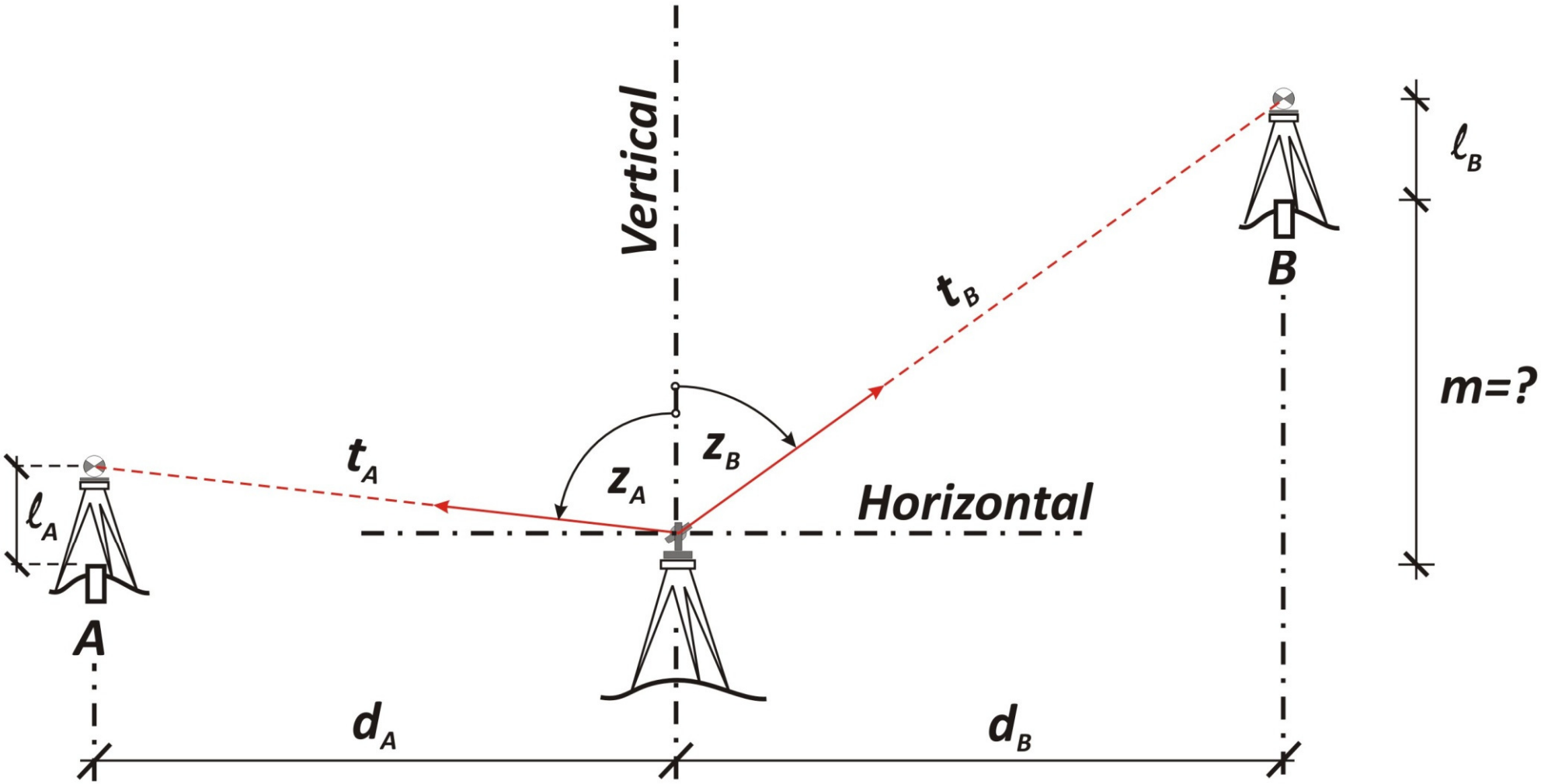
Trigonometric levelling



Trigonometric levelling

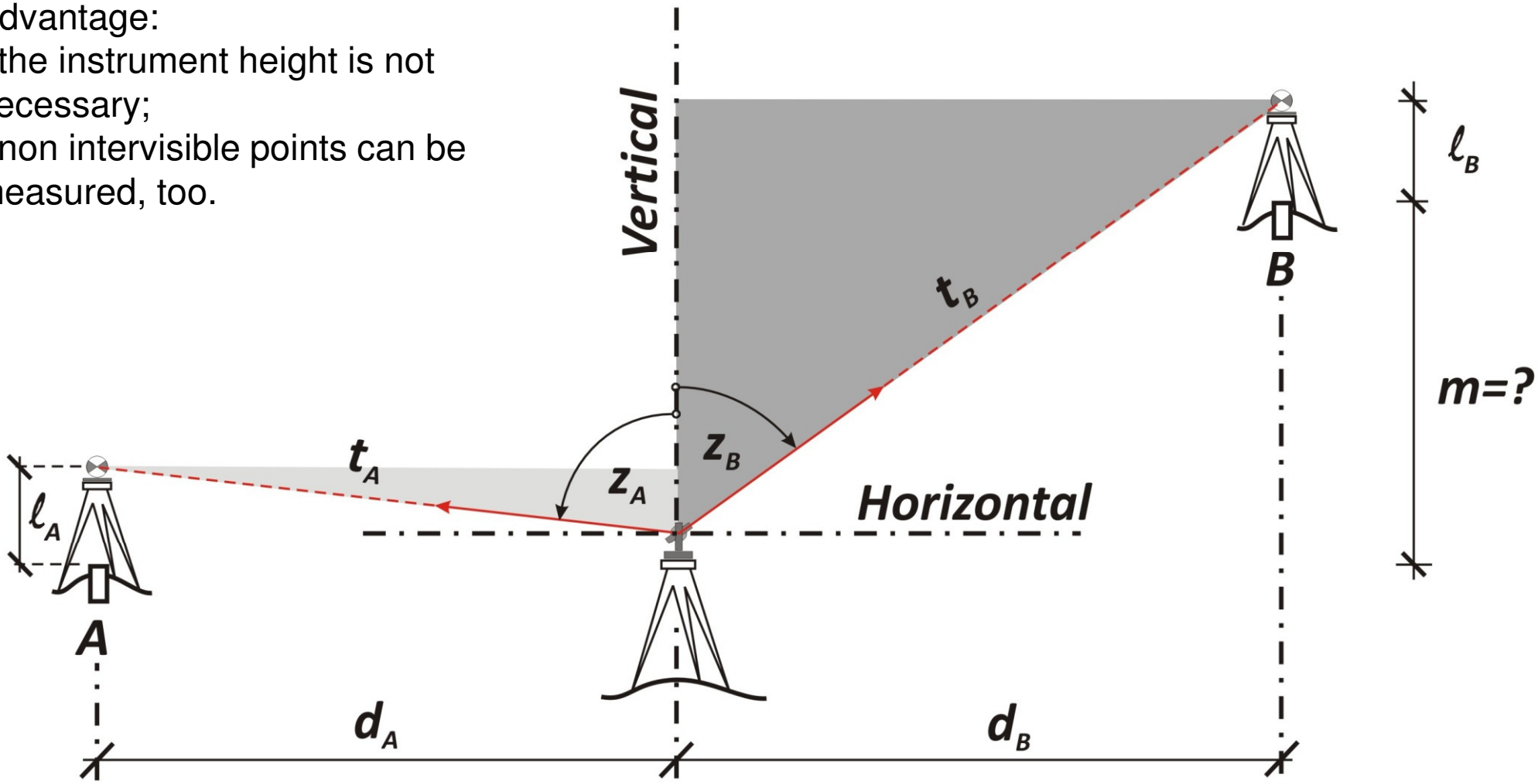


Trigonometric levelling



Trigonometric levelling

Advantage:
• the instrument height is not necessary;
• non intervisible points can be measured, too.



$$m = \left(d_B \cot z_B - \ell_B\right) - \left(d_A \cot z_A - \ell_A\right) =$$
$$= \left(t_B \cos z_B - \ell_B\right) - \left(t_A \cos z_A - \ell_A\right)$$

Trigonometric heighting

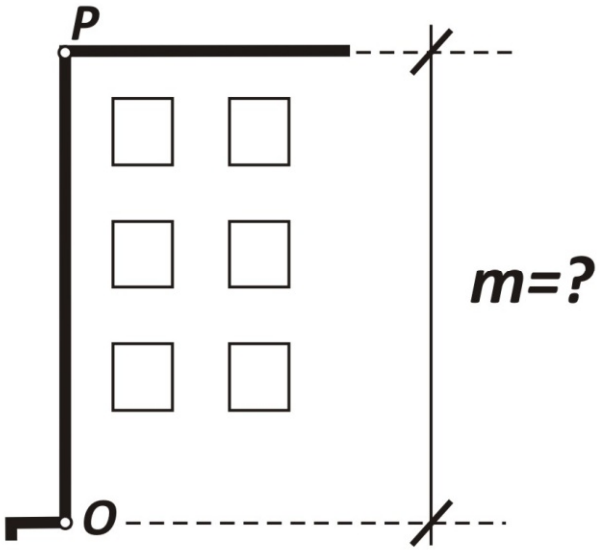
Advantages compared to optical levelling:

- **A large elevation difference can be measured over short distances;**
- **The elevation difference of distant points can be measured (mountain peaks);**
- **The elevation of inaccessible points can be measured (towers, chimneys, etc.)**

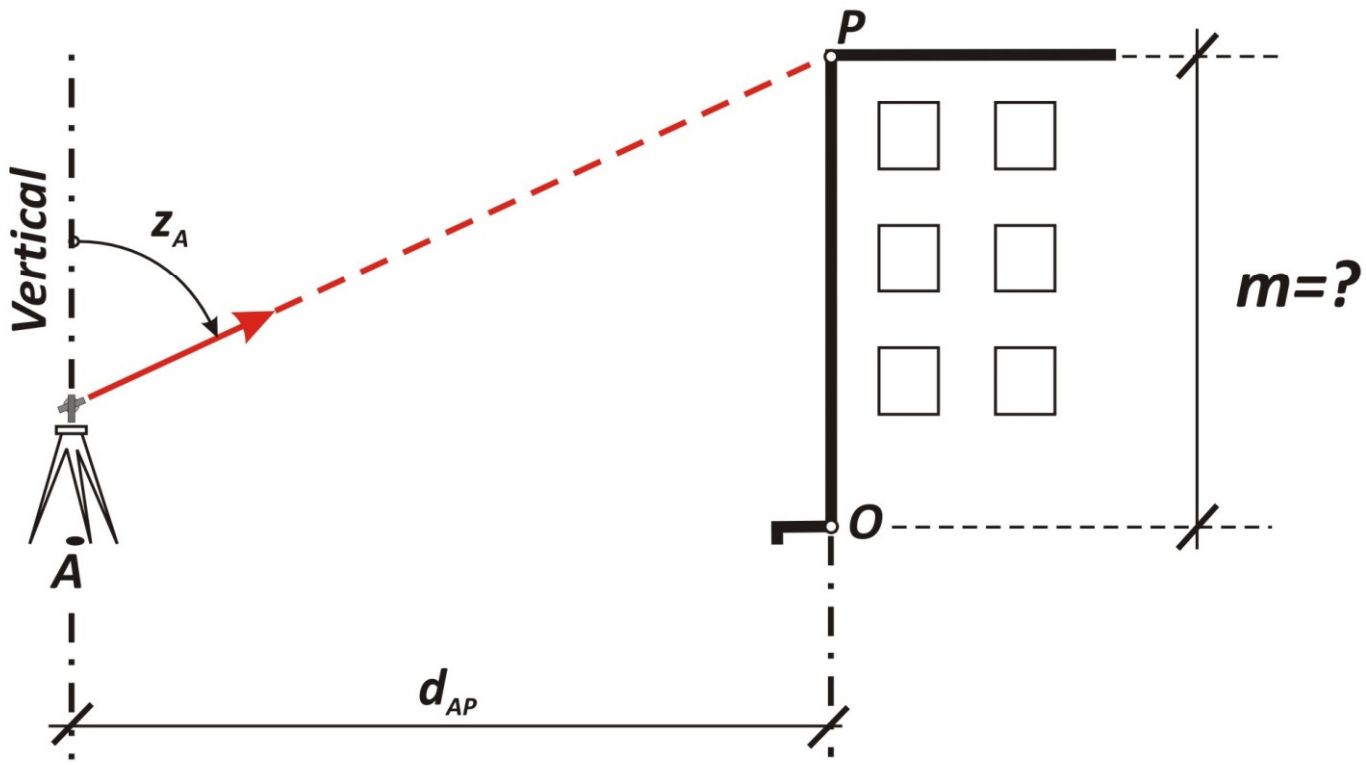
Disadvantages compared to optical levelling:

- **The accuracy of the measured elevation difference is usually lower.**
- **The distance between the points must be known (or measured) in order to compute the elevation difference**

The determination of the heights of buildings



The determination of the heights of buildings



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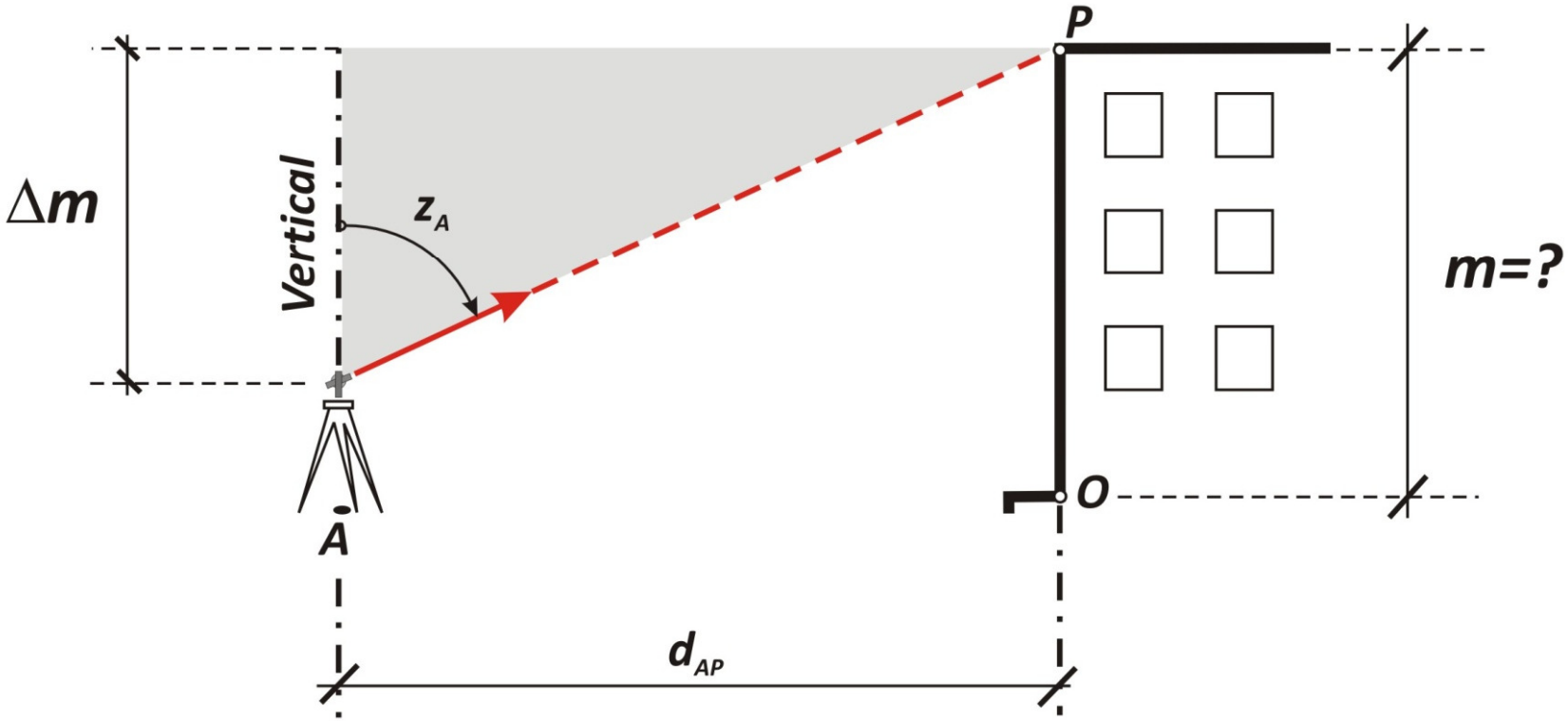
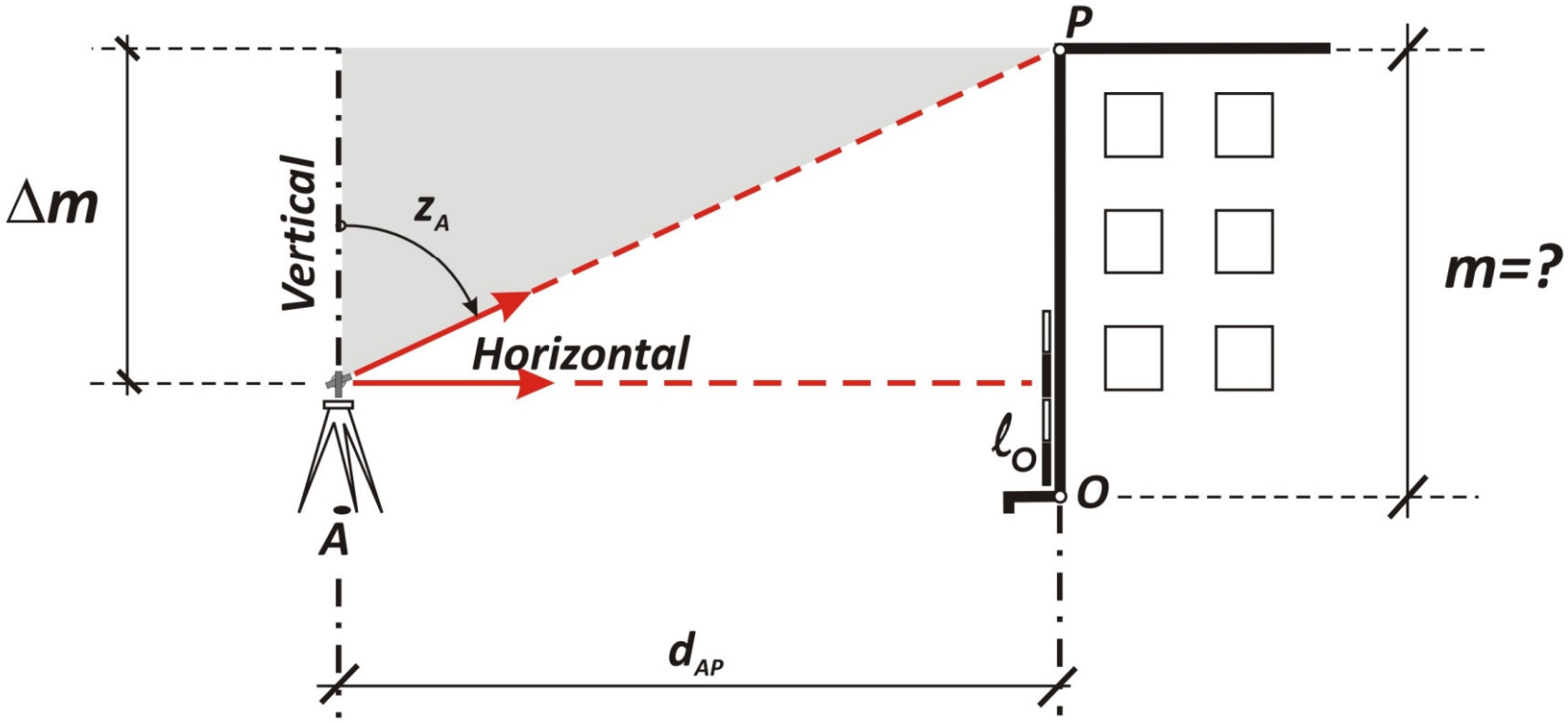


The determination of the heights of buildings



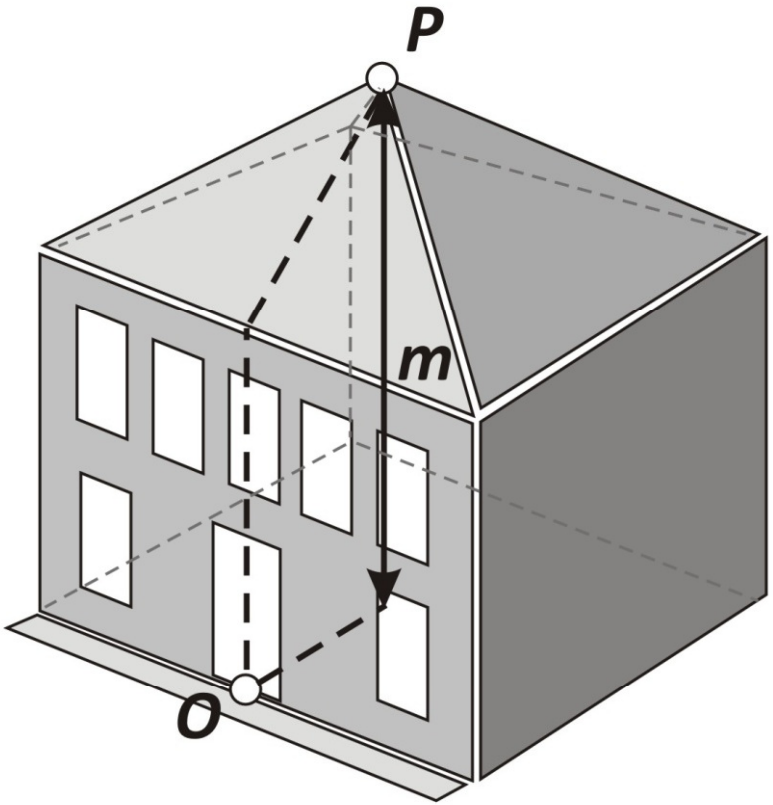
The horizontal distance is observable, therefore:

$$\Delta m = d_{AP} \cot z_A$$

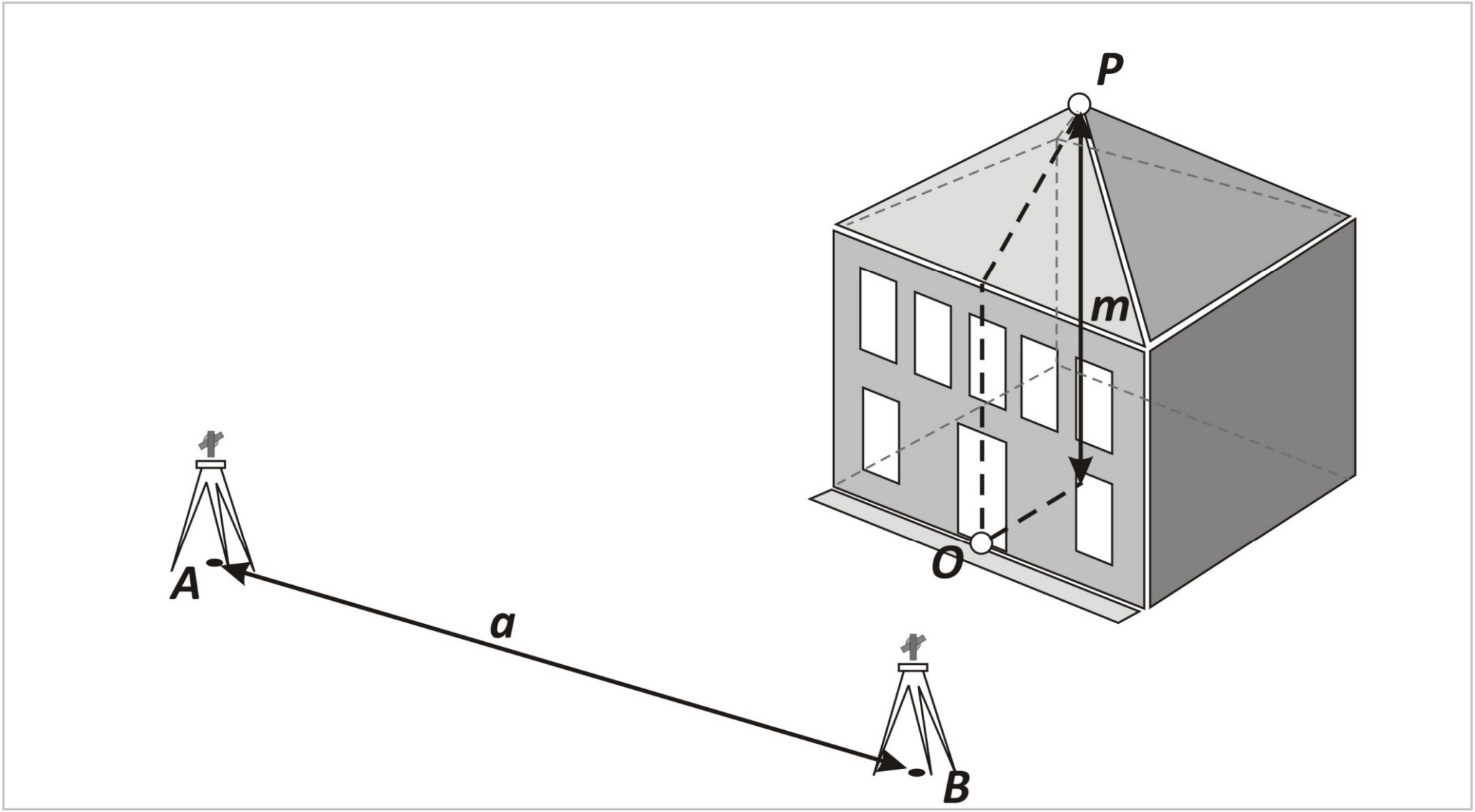
$$m = l_O + d_{AP} \cot z_A$$

Determination of the height of buildings

The distance is not observable.



Determination of the height of buildings



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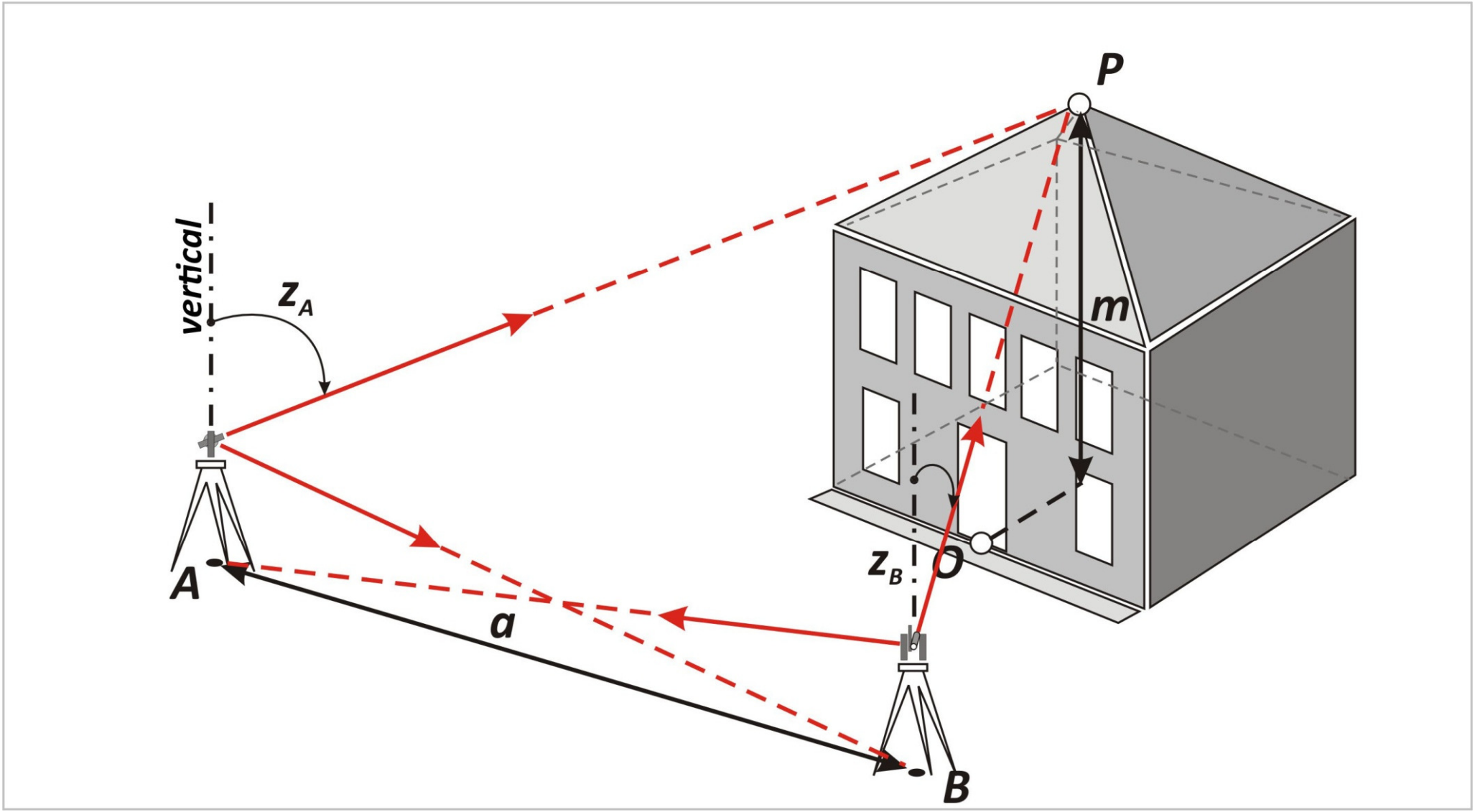

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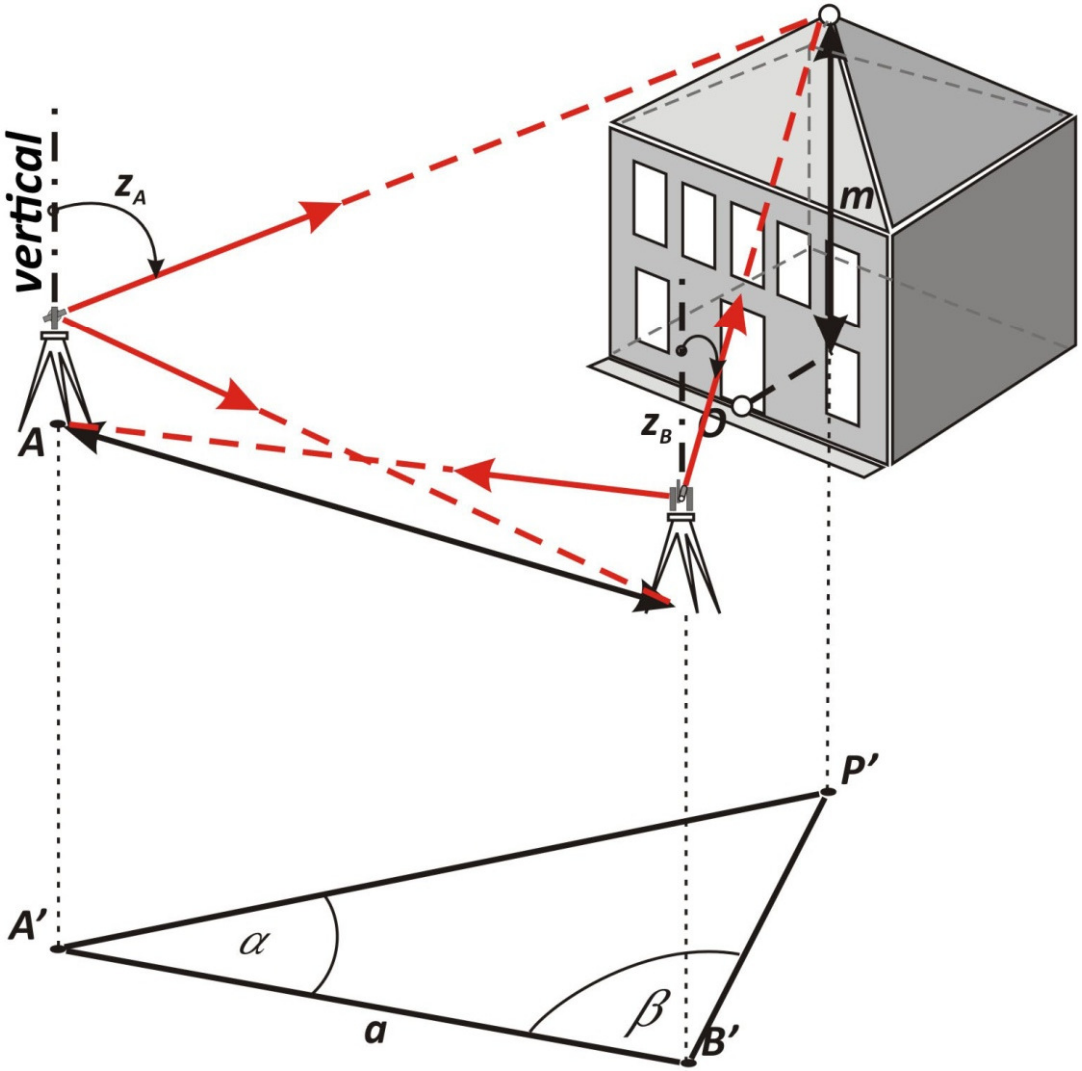

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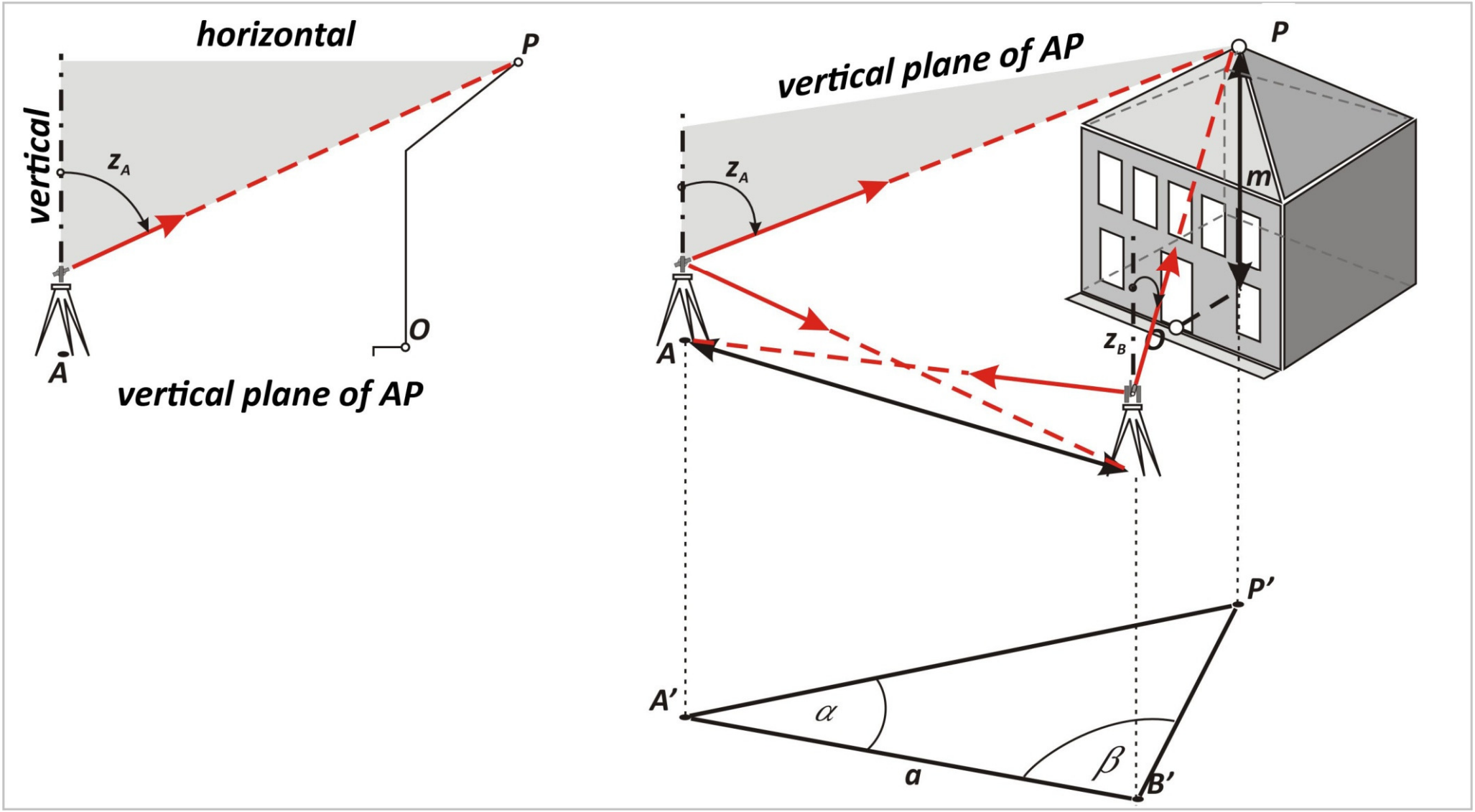

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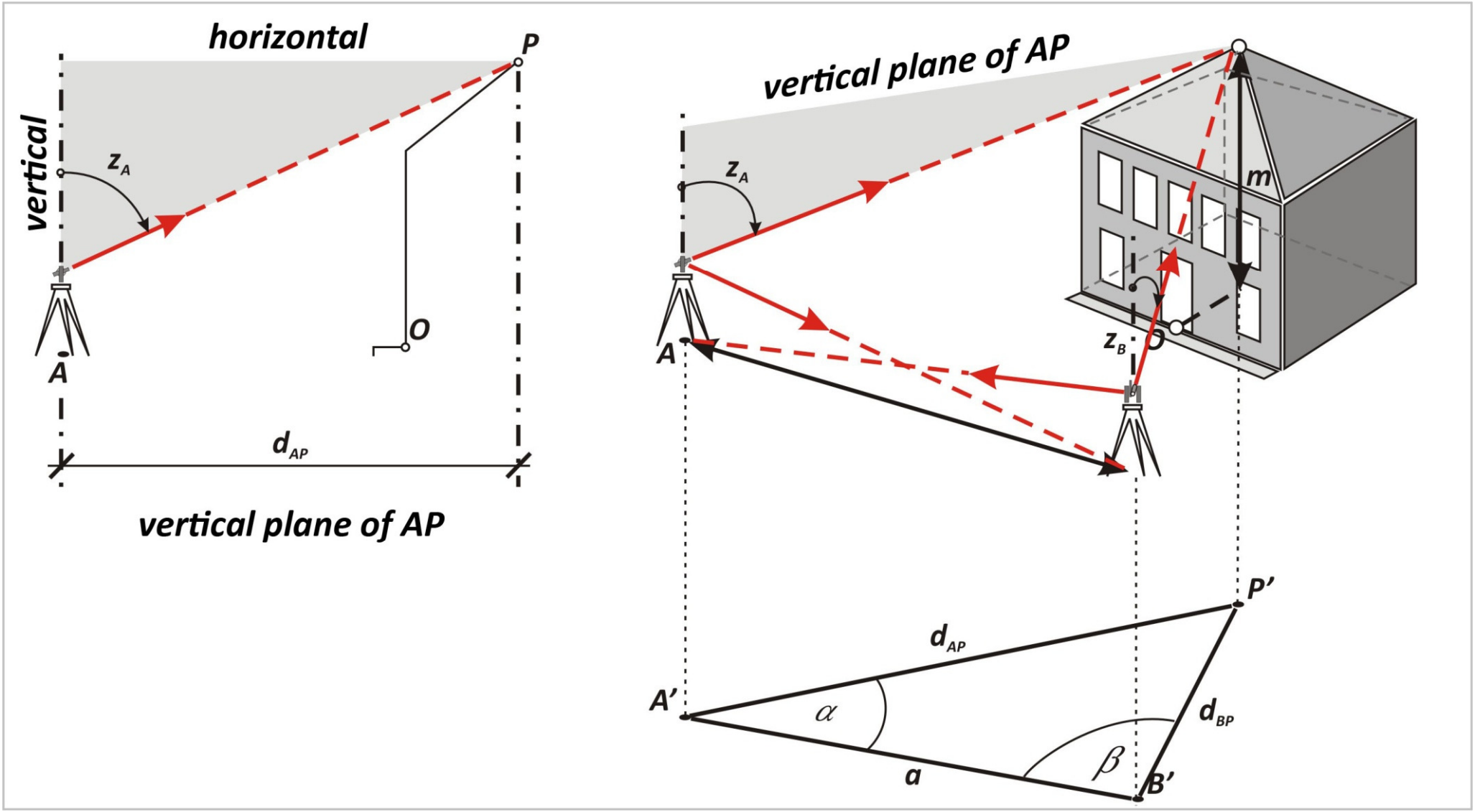

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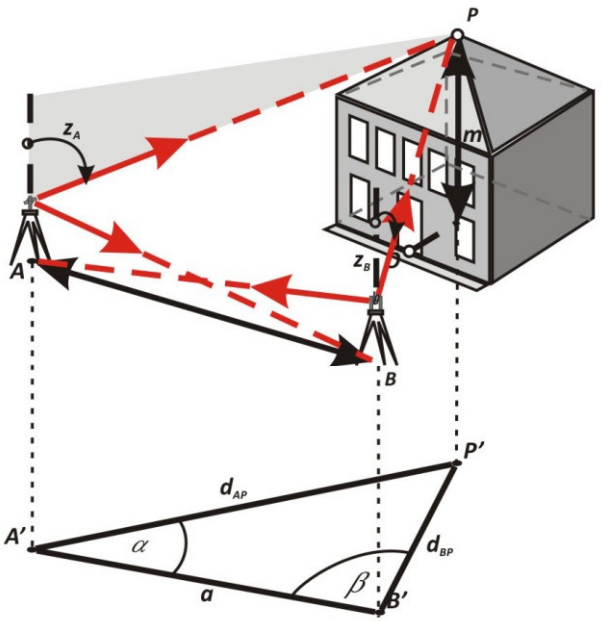
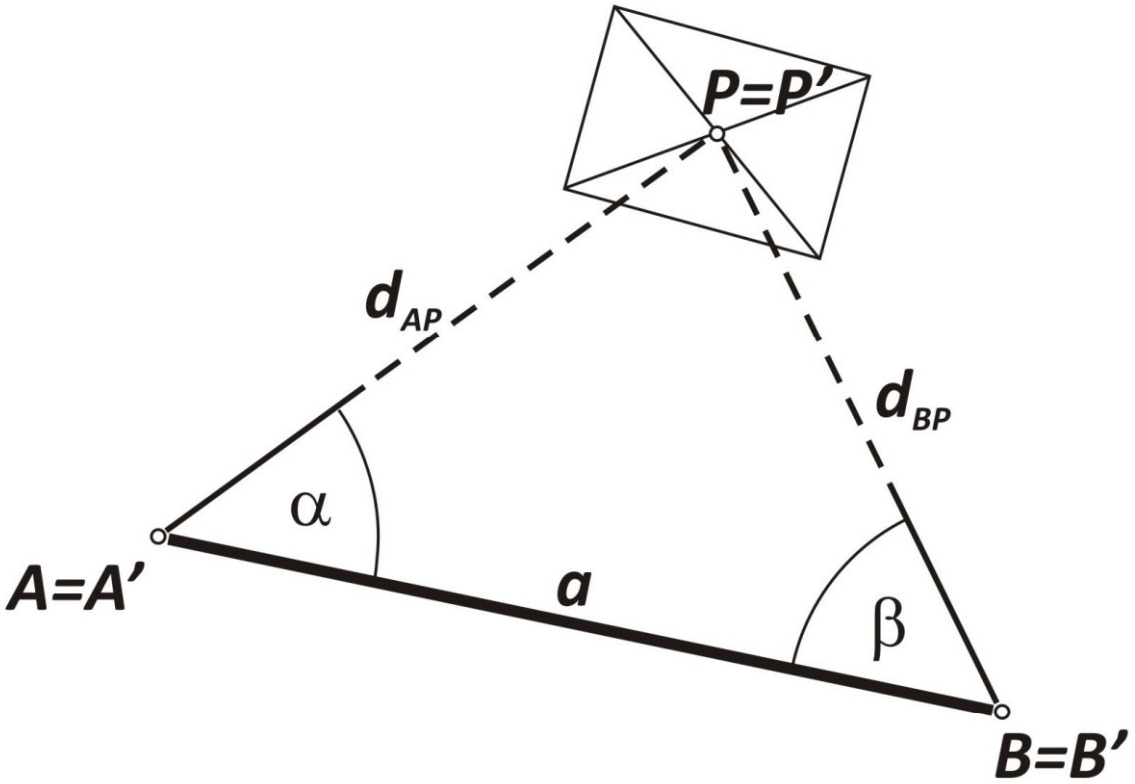


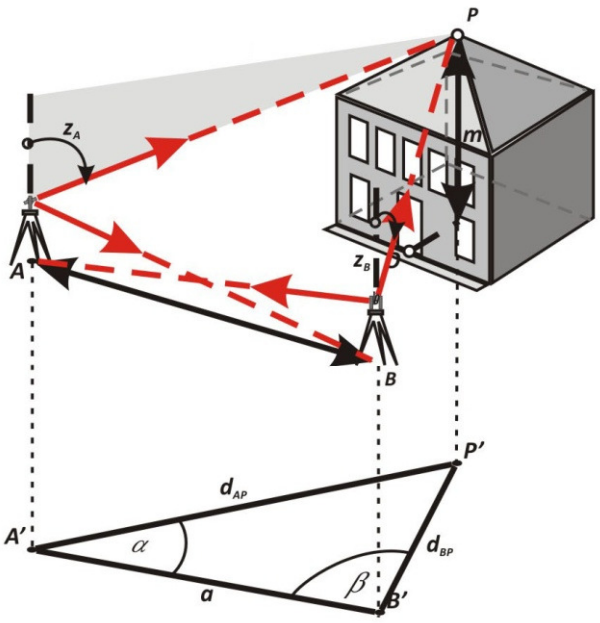


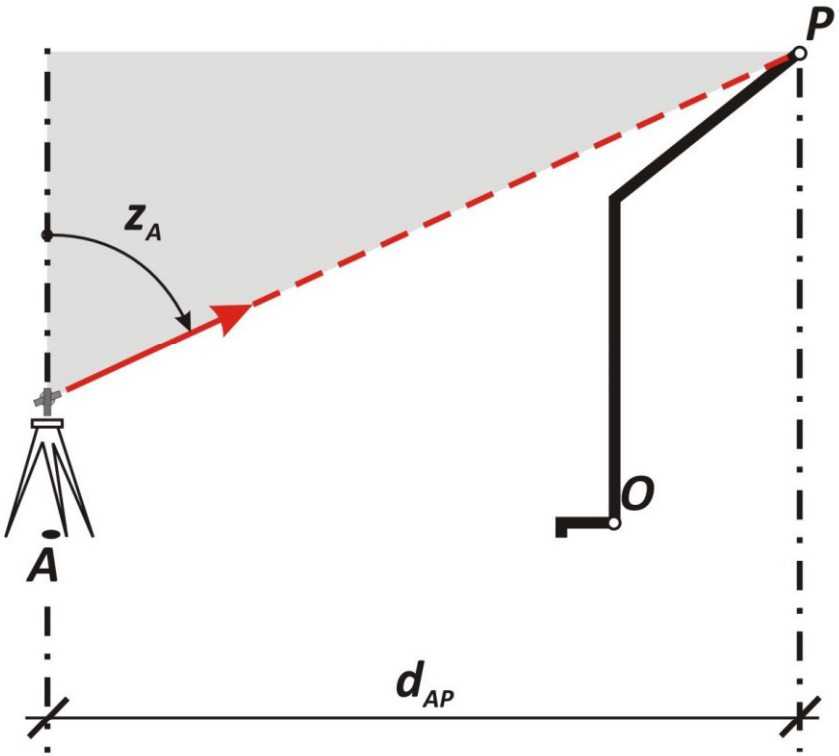
Using the sine-theorem:

$$\frac{d_{AP}}{\sin\beta} = \frac{a}{\sin(180-\alpha-\beta)} \Rightarrow d_{AP} = a\frac{\sin\beta}{\sin(\alpha+\beta)}$$

$$\frac{d_{BP}}{\sin\alpha} = \frac{a}{\sin(180-\alpha-\beta)} \Rightarrow d_{BP} = a\frac{\sin\alpha}{\sin(\alpha+\beta)}$$

Determination of the height of buildings





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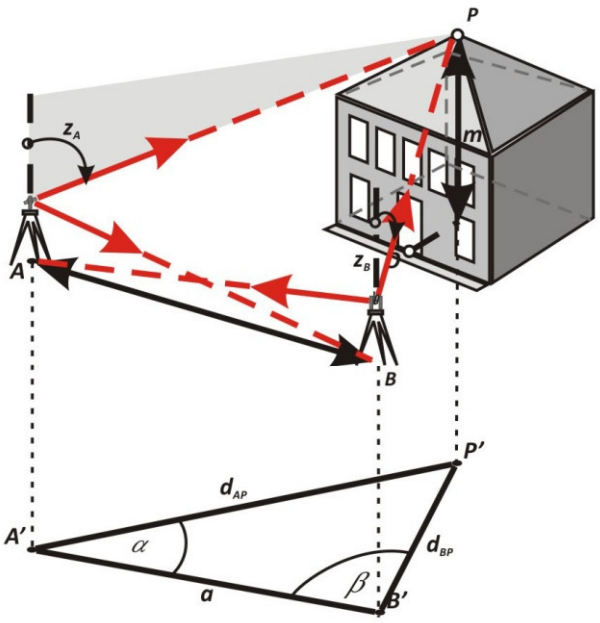
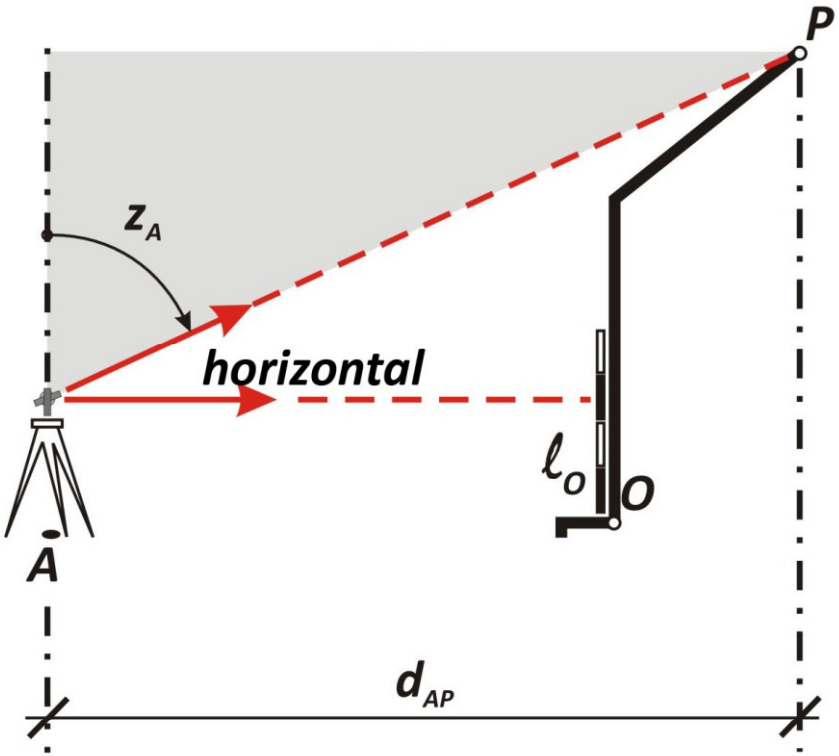
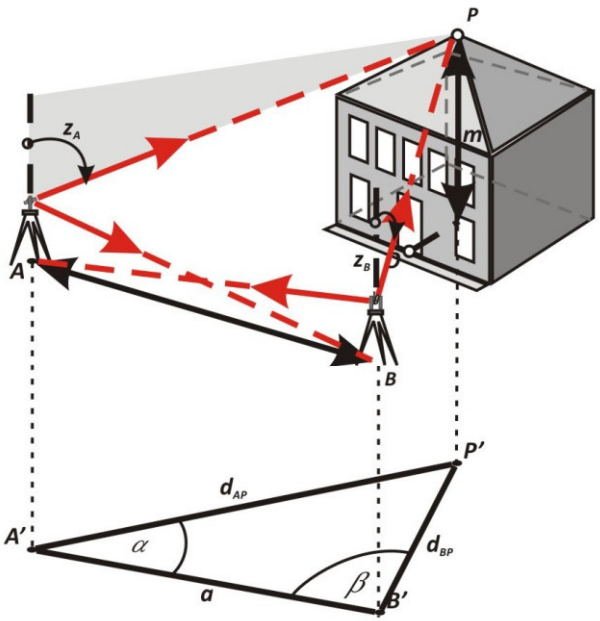
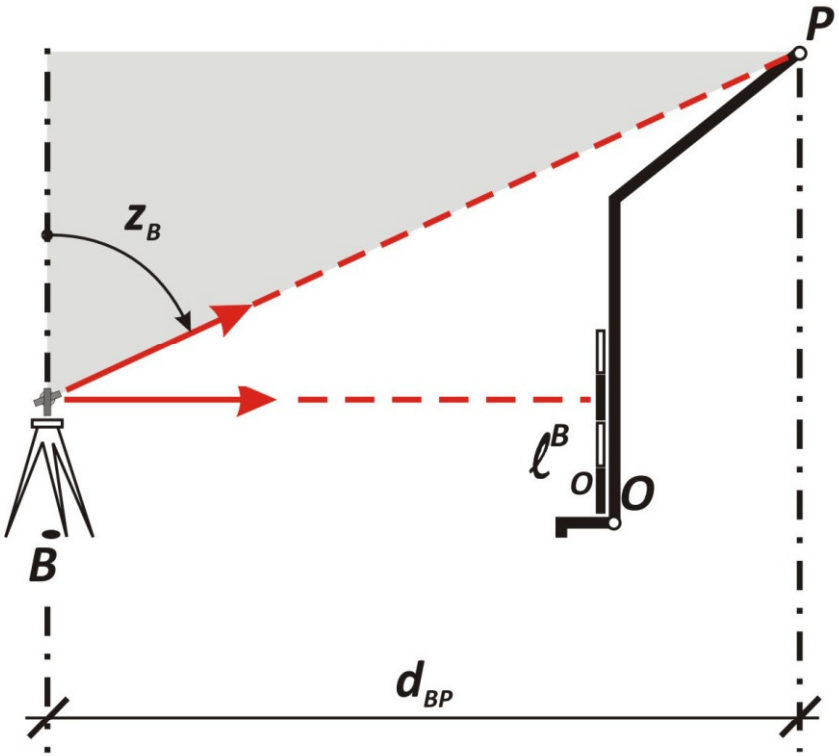




$$m^A = l_O + d_{AP} \cot z_A$$

Determination of the height of buildings





Using the observations in pont B:

$$m^B = l_O^B + d_{BP} \cot z_B$$

$$m = \frac{\left(m^A + m^B\right)}{2}$$