Question #73250

A hole (diameter 5+-0,1 mm) is drilled into a cube (edge 20+- 0,2 mm). Calculate the volume of the body and its cumulative error.

Answer:

The volume of the body equals to

$$V = V_c - V_h = a^3 - a \cdot \frac{\pi d^2}{4},$$

where V_a and V_b – volume of a cube and a hole, a – edge of a cube, d – diameter of a hole.

The cumulative error of volume of the body we should use equals to:

$$\Delta V = \sqrt{\left(V_c \frac{\Delta a \sqrt{3}}{a}\right)^2 + V_h^2 \left[\left(\frac{\Delta a}{a}\right)^2 + 2\left(\frac{\Delta d}{d}\right)^2\right]},$$

where Δa and Δd – errors in measurements of a and d.

So, the volume of the body is

$$V = 20^3 - 20 \cdot \frac{\pi 5^2}{4} = 8000 - 19{,}63 = 7980{,}37 \; mm^2.$$

And its cumulative error is

$$\Delta V = \sqrt{\left(8000 \cdot \frac{0{,}2 \cdot \sqrt{3}}{20}\right)^2 + 19{,}63^2 \left[\left(\frac{0{,}2}{20}\right)^2 + 2\left(\frac{0{,}1}{5}\right)^2\right]} = 138{,}56 \; mm^2.$$

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