Error Calculation

→ *All results must be written in the standard form (a ± Δa) with both the value and the error properly rounded!*

1. A distance of 15.4 cm is measured with a meter stick to a precision of 1 mm. Calculate the relative error.
2. The mass of an electron is to be measured to a precision of 2 ‰. Calculate the allowed absolute error.
3. A quantity a is measured to a precision of 1 %. Determine the relative errors of a^2 and $\sqrt{a}$.
4. Calculate the density of a cube with edge length (3.2 ± 0.1) cm and mass (88.21 ± 0.35) g. What material is it made of?
5. A carriage covers a distance of 3.29 m in 1.08 s. The absolute error of time measurement is 0.03 s, that of distance measurement 4 cm. Calculate the speed of the carriage.
6. The radius of a sphere is (5.34 ± 0.12) cm. Calculate the volume of the sphere.
7. A spherical object has a volume of (783.0 ± 1.8) cm^3. Calculate its radius.
8. Using the worst case method, determine the error bounds of $\cos(\omega \cdot t)$ for t = (4.32 ± 0.02) s and ω = (7.18 ± 0.01) s^{-1}.
9. In an experiment, the air resistance on a moving object is measured at different speeds. The absolute errors are 0.04 m/s for the speed and 1.0 mN for the force. Decide if air resistance really varies proportionally to the square of speed. Proceed as follows: Draw an appropriate diagram from the values displayed in the table below (with error bars), fit the function expected by the hypothesis, and discuss the result.

v [m/s]	1	2	2.5	3	3.5
F_L [mN]	8.0	33.9	48.7	72.3	99.8

Solutions: 1. 0.6 %; 2. $1.8 \cdot 10^{-31}$ kg 3. 2 %, 0.5 %; 4. (2.7 ± 0.3) g/cm^3; 5. (3.0 ± 0.1) m/s; 6. (640 ± 40) cm^3; 7. (5.718 ± 0.004) cm; 8. 0.92 ± 0.09