Health Informatics, semester 1
Foundations of Science

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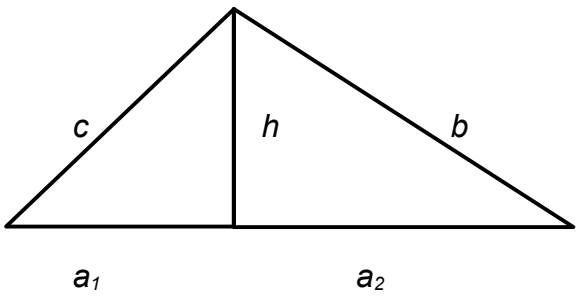
Homework for Unit 2:
Measurement and Classical Mechanics

Problem 3: Uncertainty propagation: Area and circumference of a triangle

Given is the following triangle:



You have measured the lengths a_1, a_2 and h. All have unknown variances σ_1^2, σ_2^2 and σ_h^2. Assume that uncertainties are uncorrelated and derive the general expressions for the expected value and the variance of

a) the triangle circumference and

b) the triangle area

as functions of a_1, a_2, h, σ_1^2, σ_2^2 and σ_h^2.

Problem 4: Transform to cylindrical coordinates

a) Transform between Cartesian coordinates *[x y z]* and cylindrical coordinates oriented along the z-axis.

b) Write down the Jacobian and calculate the Jacobian determinant for this transform.

c) Transform the volume element.

Problem 5: Converting units

a) Convert British speed limits (30, 60 and 70 miles per hour) into kilometers per hour.

b) An ice hockey rink has approximate dimensions 200 by 85 feet in North America and 60 by 30 meters in Europe. Neglect the rounded corners, google conversion formulas and calculate the areas of both rinks in acres.

c) A patient has a body temperature of 103°F. Convert to Celsius degrees. Should one worry?

Problem 6: Parabolic shot

A basket ball player is 2.02 m large and gets a free throw. The basket is mounted at height 3.05 m at a distance of 4.57 m away from the player. Assume that the player throws the ball right from his head position with speed 6.10 m/s and neglect any friction effects.

a) Calculate the trajectory of the ball depending on the angle with respect to the horizontal.

b) At which angle must the ball be thrown to optimally hit the basket?

Problem 7: Energy conservation

A lorry with mass 10 tons goes uphill at speed 80 km/h when it’s motor stops.

a) Neglect any friction effects to calculate how many meters it will continue to climb in altitude.

b) Assume that half of the energy is dissipated by friction effects and repeat the calculation.

c) How would the situation change, if the lorry’s speed was only 40 km/h?