**PHYS 101 Lab 1**

**Measurement and Uncertainty in Scientific Experiments**

***Worksheet***

*Complete the worksheet individually and upload a pdf document in Drexel Learn.*

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*Show all work and calculations! You may use additional sheets.*

1. Significant Figures
   1. Suppose you are measuring the mass of a pendulum bob on an electronic mass balance. The mass balance reads “10.4 g”. How many significant figures does this reading have?

10.4 has 3 significant digits. Each 1, 0, and 4 are significant.

* 1. What is the relative uncertainty of this measurement, expressed as a percent error? (Recall that the precision of an electronic instrument is usually equal to the smallest difference it can detect, 0.1 g in this case)

(δx/x)\*100 = (0.1/10.4)\*100 = 0.96153846 = 0.962%

* 1. Suppose you measure the mass with a more precise electronic mass balance, that can measure mass with a precision of 0.01 g. If the mass balance reads “10.40 g”, how many significant digits are there? Write this value so that the number of significant digits is not ambiguous.

10.40 has 4 significant digits. That number in scientific notation is 1.040 x 10^1

1. Propagation of Uncertainty

You are asked to measure the volume of a spherical object. Knowing that the volume, *V*, is related to the radius, *R*, by , you measure the radius to be 2.2 cm ± 0.1 cm.

* 1. Convert the measurement of the radius to meters and express the radius in scientific notation.

2.2 cm \* (1 m / 100 cm) = 0.022 m

Expressed in scientific notation 0.022 m becomes 2.2 \* 10^(-2) m.

* 1. Calculate the volume of the sphere (in cubic meters) using the measured radius and determine the maximum relative uncertainty.

V = (4/3)\*pi\*(0.022)^3 = 0.00004460223 m^3 = 4.460223 \* 10^(-5) m^3

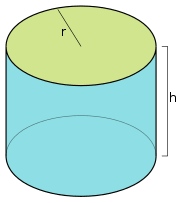
Δf(x) = ∂f/∂x\*Δx = (3\*(4/3)\*pi\*R^2) \* 0.1 = 0.4\*pi\*R^2

ΔV(R) = 0.4\*pi\*R^2

ΔV(0.022) = 0.00060821233 m^3 = 0.0006 m^3

V = 0.00004460223 m^3 ± 0.0006 m^3

* 1. You now calculate the volume of a cylindrical object. The height is measured to be *h* = 5.2 cm ± 0.05 cm and the radius is measured to be *r* = 2.5 cm ± 0.05 cm. Calculate the volume, *V*, the maximum absolute uncertainty, Δ*V*, and the maximum relative uncertainty, Δ*V* / *V*. Note:



V = pi\*R^2\*h = 102.10 cm^3

ΔV(R, h) = ∂V/∂R \*ΔR + ∂V/∂h \* Δh

ΔR = 0.05

∂V/∂R = 2\*pi\*h\*R

Δh = 0.05

∂V/∂h = pi\*R^2

ΔV(R, h) = 2\*pi\*h\*R \* ΔR + pi\*R^2 \* Δh

ΔV(2.5, 5.2) = 2\*pi\*5.2\*2.5\*0.05 + pi\*(2.5)^2\*0.05 = 5.07 cm^3

V = (102.10 ± 5.07) cm^3