

**Spring 2021**  
**PHYS 377 Advanced Computational Physics**  
**HW # 1a**

**Problem 1:** A ball is dropped from a tower of height  $h$  with initial velocity zero. Write a program that asks the user to enter the height of the tower in meters and then calculates and prints the time the ball takes until it hits the ground, ignoring air resistance. Use your program to calculate the time for a ball dropped from a 100 m high tower.

**Problem 2:** Suppose the position of a point in two-dimensional space is given to us in polar coordinates  $r, \theta$ . We want to convert it to Cartesian coordinates  $x, y$ . Write a program to do this? The appropriate steps are: (1) Get the user to enter the values of  $r$  and  $\theta$  (2) Convert those values to cartesian coordinates using the standard formulas:  $x = r\cos\theta, y = r\sin\theta$  (3) Print out the results.

**Problem 3:** Suppose the position of a point in two-dimensional space is given to us in Cartesian coordinates  $x, y$ . We want to convert it to polar coordinates  $r, \theta$ . Write a program to do this? The appropriate steps are: (1) Get the user to enter the values of  $x$  and  $y$  (2) Convert those values to polar coordinates using the standard formulas:  $x = r\cos\theta, y = r\sin\theta$  (3) Print out the results.

**Problem 4:** Calculate the distance of a point in cylindrical coordinates to the origin. Print out the results.

**Problem 5:** There is a file on myCourses folder “Files and Data” called stm.txt, which contains a grid of values from scanning tunneling microscope measurements of the (111) surface of silicon. A scanning tunneling microscope (STM) is a device that measures the shape of a surface at the atomic level by tracking a sharp tip over the surface and measuring quantum tunneling current as a function of position. The end result is a grid of values that represent the height of the surface and the file stm.txt contains just such a grid of values. Write a program that reads the data contained in the file and makes a density plot of the values. Use the various options and variants you have learned about to make a picture that shows the structure of the silicon surface clearly.