	Representation		
	Rectangular	**Polar**	**Exponential**
z	$x+iy$	$r\cos\varphi + ir\sin\varphi$	$re^{i\varphi}$
z^*			
$zz^* = \lvert z\rvert^2$			
z^2			

1 Representations of Complex Numbers–Table

(1 pt each, 9 pts total) Fill out the table above that asks you to do several simple complex number calculations in rectangular, polar, and exponential representations.

2 Graphs of the Complex Conjugate

(2 pts each, 8 pts total)

For each of the following complex numbers, determine the complex conjugate, square, and norm. Then, plot and clearly label each z, z^*, and $|z|$ on an Argand diagram.

(a) $z_1 = 4i - 3$

(b) $z_2 = 5e^{-i\pi/3}$

(c) $z_3 = -8$

(d) In a few full sentences, explain the geometric meaning of the complex conjugate and norm.

3 Euler's Formula I

(2, 4 pts)

(a) Use Euler's formula $e^{i\phi} = \cos\phi + i\sin\phi$ and its complex conjugate to find formulas for $\sin\phi$ and $\cos\phi$. In your physics career, you will often need to read these formula "backwards," (i.e. notice one of these combinations of exponentials in a sea of other symbols and say, Ah ha! that is $\cos\phi$). So, pay attention to the result of the homework problem!

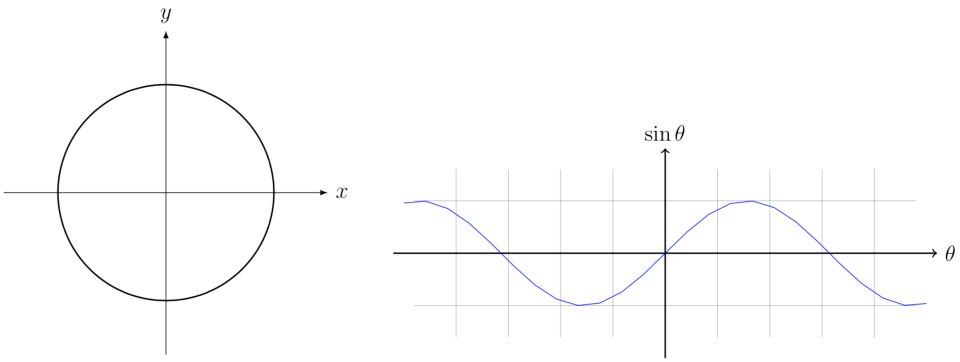
(b) Show that Euler's formula:

$$e^{i\phi} = \cos\phi + i\sin\phi$$

is true, by comparing the power series for the various terms.

4 Circle Trigonometry

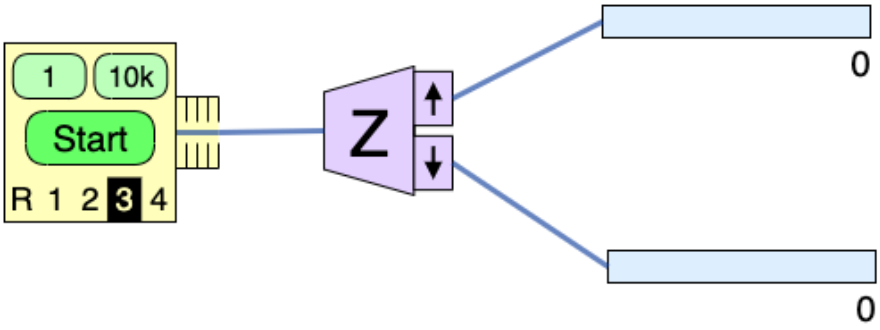
(4 pts) On the following diagrams, mark both θ and $\sin\theta$ for $\theta_1 = \frac{5\pi}{6}$ and $\theta_2 = \frac{7\pi}{6}$. Write one to three sentences about how these two representations are related to each other. (For example, see: this PHET)



5 Statistical Analysis of the Spins Sim

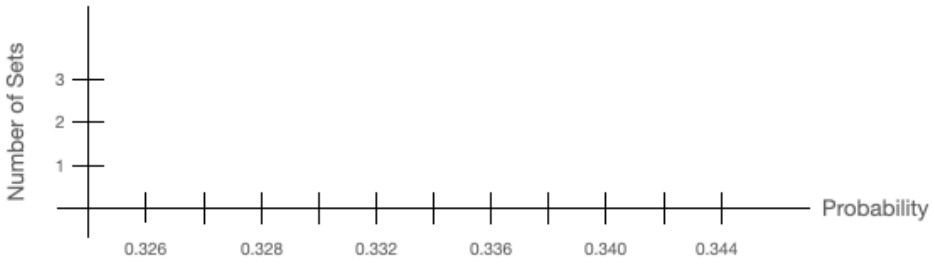
In the spins sim, the oven can be set to emit particles in a particular unknown prepared state (instead of in a random state).

- Set the oven to Unknown #3.
- Orient the analyzer in the z-direction.
- Perform 5 sets of 10,000 Stern-Gerlach experiments (10,000 particles are sent through a Stern-Gerlach Analyzer) and record the number of particles that end up in the top counter.
- For each set of experiments, calculate the probability that a single particle was measured to have $S_z = +\hbar/2$.



Do all of the following calculations by hand (you can use a calculator to help with the arithmetic).

(a) Plot a histogram of the probabilities you measured for each set. Use a bin size of 0.002 for the horizontal axis. (Choose appropriate values on the horizontal axis. You don't need to plot the full possible values 0-1. You may use a computer to make the histogram or you can sketch it by hand.)



(b) What is your best estimate of the probability that, when you measure S_z of a particle in the Unknown #3 state, you will get a result of $+\hbar/2$? Mark this value on your histogram.