

# Representing Complex Numbers Visually using Vpython

```
In [ ]: from vpython import *
        from numpy import *
        from vpython import rate
```

```
In [ ]: canvas()
        i=1j                                     # Let's use 'i' for "imaginary"
        a = arrow(color=color.red)               # red is a nice color
        z = 2*exp(i*pi/4.0)
        b = 0.01
        c = exp(i*b)
        count=0

        def SetArrowFromCN( cn, a):
            """
            SetArrowWithCN takes a complex number 'cn' and an arrow object 'a'.
            It sets the 'x' and 'y' components of the arrow's axis to the real
            and imaginary parts of the given complex number.
            """
            a.axis.x = cn.real
            a.axis.y = cn.imag

        SetArrowFromCN(z, a)
```

```
In [ ]: z.real
```

```
In [ ]: b = 0
        while b < 628:
            mags = abs(z)
            SetArrowFromCN(z, a)
            rate(100)
            p = arctan(z.imag/z.real)
            print(z, mags, p)
            z = z * c
            b = b + 1
```

## Questions

1.

There is hardly any change in the magnitude of the complex number, cn, because it is multiplied by a phase of magnitude 1.

2.

From the animation, the vector moves in an anticlockwise direction, we can picture how the phase changes by using the quadrant graph. It is positive above the x-axis and negative below the x-axis.

3.

A full cycle can be modelled as the circumference of a circle of radius 1. I divided  $2\pi$  by the pure phase. This gave the approximate number of iterations in order to complete a full cycle. We should also notice that the phase angle returns somewhere close to its starting point after one full cycle.

4.

Using Euler's formula:

$$\begin{aligned} e^{i\theta} &= \cos(\theta) + i\sin(\theta) \\ e^{i0.01} &= \cos(0.01) + i\sin(0.01) \\ c &\approx 1 + 0.01i \end{aligned}$$

We know that the cartesian form of z is:

$$z = 1.414 + 1.414i$$

TO confirm the cartesian number has the same effect as the phase, after multiplying c by z once, we should get:

$$z * c = 1.4 + 1.428i$$

or a phasor of magnitude 2 and phase angle of 0.795 as read from the second line of printed z's.

$$\begin{aligned} z * c &= (1.414 + 1.414i)(1 + 0.01i) = 1.414 + (0.01414 + 1.414)i - 0.01414 \\ z * c &= 1.414 + 1.428i \end{aligned}$$

Phase angle =

$$\tan^{-1}\left(\frac{1.428}{1.414}\right) = 0.79$$

```
In [ ]:
```