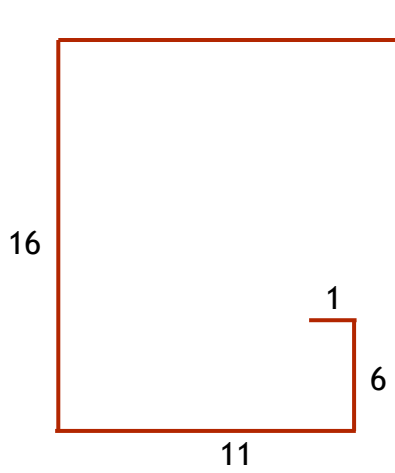
Drawing a Spiral

1. Draw Spiral Problem. 01-24-drawSpiral.py




```
def drawSpiral_1(t, maxSide):
    '''Small to big'''
    for sideLen in range(1, maxSide + 1, 5):
        t.forward(sideLen)
        t.right(90)
```

Why `maxSide + 1`?

So last value can be maxSide

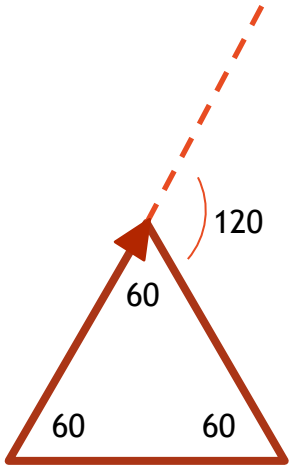
Drawing a Circle (Manually)

1. Draw Circle Problem. 01-25-drawCircle.py
   a. Draw a circle **of a given Radius**

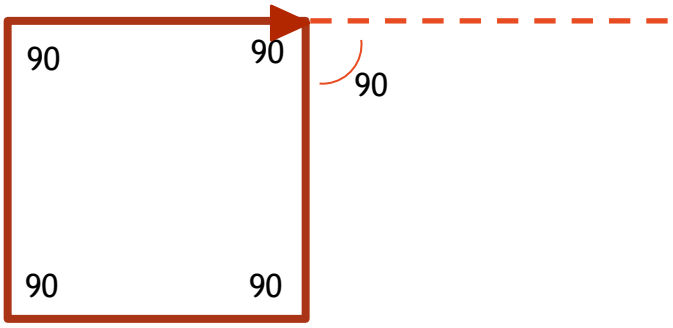
2. Reduce the Circle Problem to Drawing a Regular Polygon
   a. Draw an n-sided polygon where each side has the same length

   b. Inputs for Regular Polygon Problem:
      i. Number of sides, n
      ii. Length of each side, sideLen
      iii. The turtle to do the drawing

3. Calculate the **angle** the turtle must turn



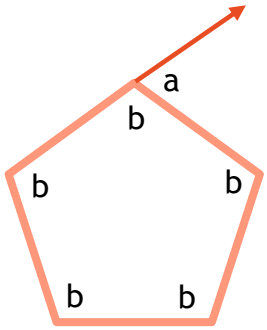
n = 3 → angle = 120°



n = 4 → angle = 90°

Want a general formula for any n

4. For an n-regular Polygon



Sum of interior angles: $angle\ sum = 180(n-2)$

All interior angles are the same (b)

So

$$b = \frac{180(n-2)}{n}$$

Now find angle a

$$a = 180 - b$$

$$= 180 - \frac{180(n-2)}{n}$$

$$= 180\left(1 - \frac{n-2}{n}\right)$$

$$= 180\left(\frac{n}{n} - \frac{n-2}{n}\right)$$

$$= 180\left(\frac{n-(n-2)}{n}\right)$$

$$= 180\left(\frac{n-n+2}{n}\right)$$

$$= 180\left(\frac{2}{n}\right)$$

$$= \frac{360}{n}$$

$$a = \frac{360}{n}$$

5. Back to original problem – Draw Circle of **Given Radius**
   a. Draw a polygon instead of a circle
   b. Select angle and side length for the given radius

   c. **Key Insight: Sum of polygon sides ≈ Circumference of Circle**

$$Sum\ of\ sides = numSides \times sideLength \approx Circumference = 2\pi r$$

$$numSides \times sideLen \approx 2\pi r$$

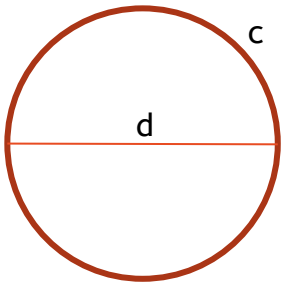
$$sideLength \approx \frac{2\pi r}{numSides}$$

   d. Given the **radius** and **number of Sides**
      i. calculate sideLength and call drawPolygon

   e. How many sides should we use?
      i. 360 Too slow
      ii. 3 Doesn't look like a circle
      iii. 30 Is pretty good

Chapter 2, Miller 3rd ed, πthon: Estimating Pi

What is π



c = circumference
d = diameter

$$\pi = \frac{c}{d}$$
$$\Rightarrow c = \pi d$$
$$\Rightarrow c = 2\pi r$$

π is irrational – It never ends and never repeats

So, we use approximations of π

```
22/7      355/113
```

We're going to look at better approximations of π

But first, the math module

math module

Constants

```
math.pi
math.tau →     2π
math.e
math.inf x = 10.0 THEN  9 times: x *= x  →    math.inf
math.nan math.inf / math.inf  →  math.nan
```