Assignment 1 – Hello Turtle!

Required Files

- `assignment1-template.py`

Part 1: Closed form calculations

The purpose of this part is to see if you can come up with Python expressions to evaluate a certain numerical answer. Unless otherwise stated, please **give the complete expression required to compute the numerical result**. **You may be penalized for only giving the final numerical result. In general, you should not use ready-made Python functions or packages unless it is stated otherwise.**

Quadratic equations [15 marks]

There are many kinds of equations to solve in algebra. One of the most common kind of equations are quadratic equations, which come in the form of $ax^2 + bx + c = 0$. In 628 AD, Brahmagupta explicitly described the general formula to be:

$$\mathrm{x} = \frac{-b \pm \sqrt{\mathrm{b}^2 - 4\mathrm{ac}}}{2\mathrm{a}}$$

Using Python, write out the expressions to get the roots of the equation $1010x^2 + 1009\mathrm{x} - 1008 = 0$, and assign them to variables `ans1` and `ans2`.

You may use the `sqrt` function from the `math` library to help you calculate square roots. The order of the roots does not matter.

*Coursemology note: You do not have to implement the function `checkAns`. Your answer on Coursemology should have two lines, each line being an assignment statement to the variables `ans1` and `ans2` respectively. E.g. two lines of "ans1 = x + y + z", "ans2 = 2*y + z"*

Snell's Law [15 marks]

In optics, refraction is a common phenomenon where light passes through two mediums of different refractive indexes. Snell's law is a formula used to describe the relationship between the incoming and outgoing angles of light, as well as the refractive indexes of the mediums.

The equation for Snell's Law is described as:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

where θ_1 is the incoming angle of incidence of light, θ_2 is the outgoing angle of refraction of light, n_1 is the refractive index of the first medium, and n_2 is the refractive index of the second medium.

Given the outgoing angle, $\theta_2 = 20^\circ$, the refractive index of the incoming medium, water ($n_1 = 1.33$) and the refractive index of the outgoing medium, diamond ($n_2 = 2.417$), write an expression to determine the incoming incidence angle IN DEGREES, and assign it to the variable `ans`.

Hint: What units does the `sin` function take in? The formula for converting degrees into radians is

$$\text{radians} = \text{degrees} \cdot \frac{\pi}{180^\circ}$$

You may use the `sin/asin` (also known as $\sin^{-1}$) functions as well as the `pi` constant from the `math` library.

Coursemology note: Your answer on Coursemology should just have one line, an assignment statement to the variable `ans`.

Part 2: Simple Turtle

You might have learnt some of the Python Turtle functions in lecture/tutorial. Here are a few questions to really test your understanding of how they work, and a very simple drawing to get you acquainted with drawing with Turtle!

Some of the functions covered are:

- `pd()`: Pen down. Any movements thereafter will be traced
- `pu()`: Pen up. Any movements thereafter will NOT be traced
- `forward(distance)`: Moves the turtle forward a number of units specified by distance
- `backward(distance)`: Moves the turtle backward a number of units specified by distance
- `right(degrees)`: Turns the turtle right by a certain number of degrees specified
- `left(degrees)`: Turns the turtle left by a certain number of degrees specified

(Note: the direction functions `forward`, `backward`, `right` and `left` all have shorthands, which are `fd`, `bk` (or `back`), `rt` and `lt` respectively. Use whichever function you prefer.)

Warmup

In the following sequences of function calls, try to imagine what will be drawn. Then, run the calls yourself on Python. Did it draw what you had expected? *(Note: This part is not graded and is only for your own practice. There is no need to copy your answers from this part to Coursemology)*

a)
```
forward(100)
backward(100)
forward(100)
backward(100)
```

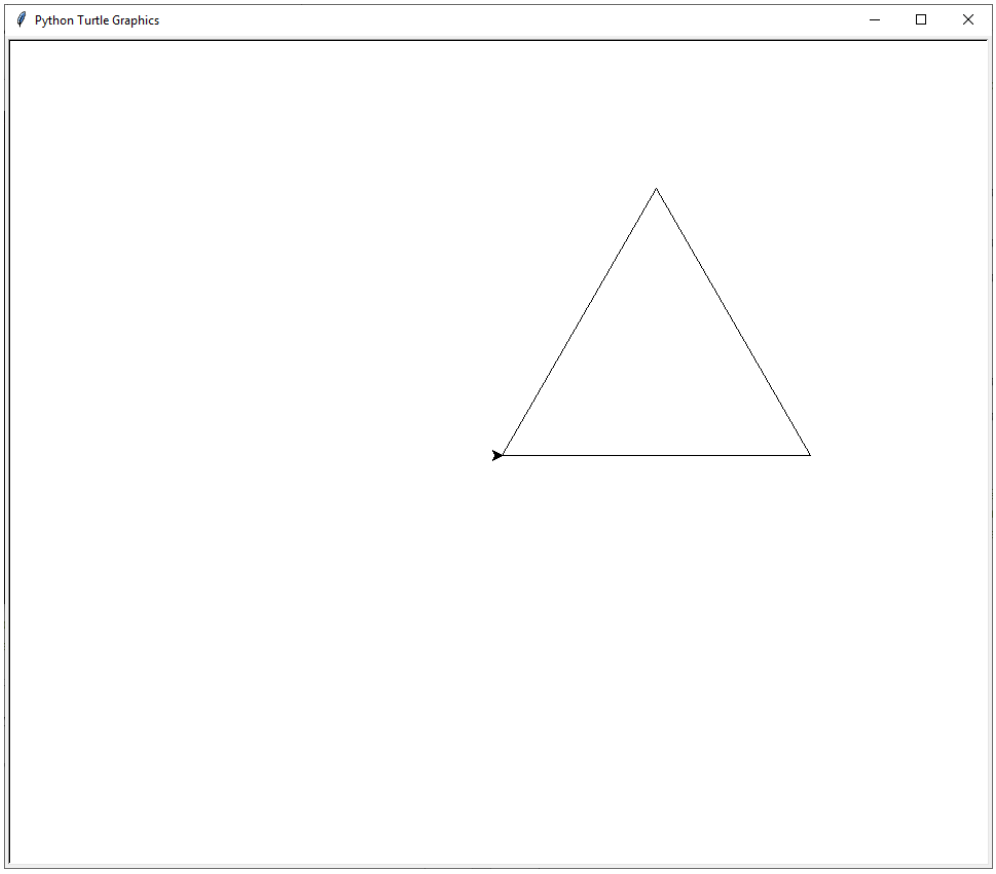
b)
```
backward(100)
pu()
left(90)
forward(100)
right(90)
forward(100)
```

c)
```
backward(100)
left(90)
forward(100)
right(90)
forward(100)
```

d)
```
right(90)
left(180)
right(315)
backward(100)
right(90)
backward(100)
```

Now you try! [20 marks]

With the functions that you have learnt so far, call a sequence of Turtle commands to draw an equilateral triangle with a distance of 300 units on each side, with the bottom of the triangle being parallel to the (imaginary) x-axis and the bottom left corner of the triangle corresponding to the starting point of Turtle. It should look something like this:



Coursemology note: Your answer on Coursemology should be a sequence of direction or movement functions, something like the following:

left(90)
right(90)
forward(100)
backward(100)