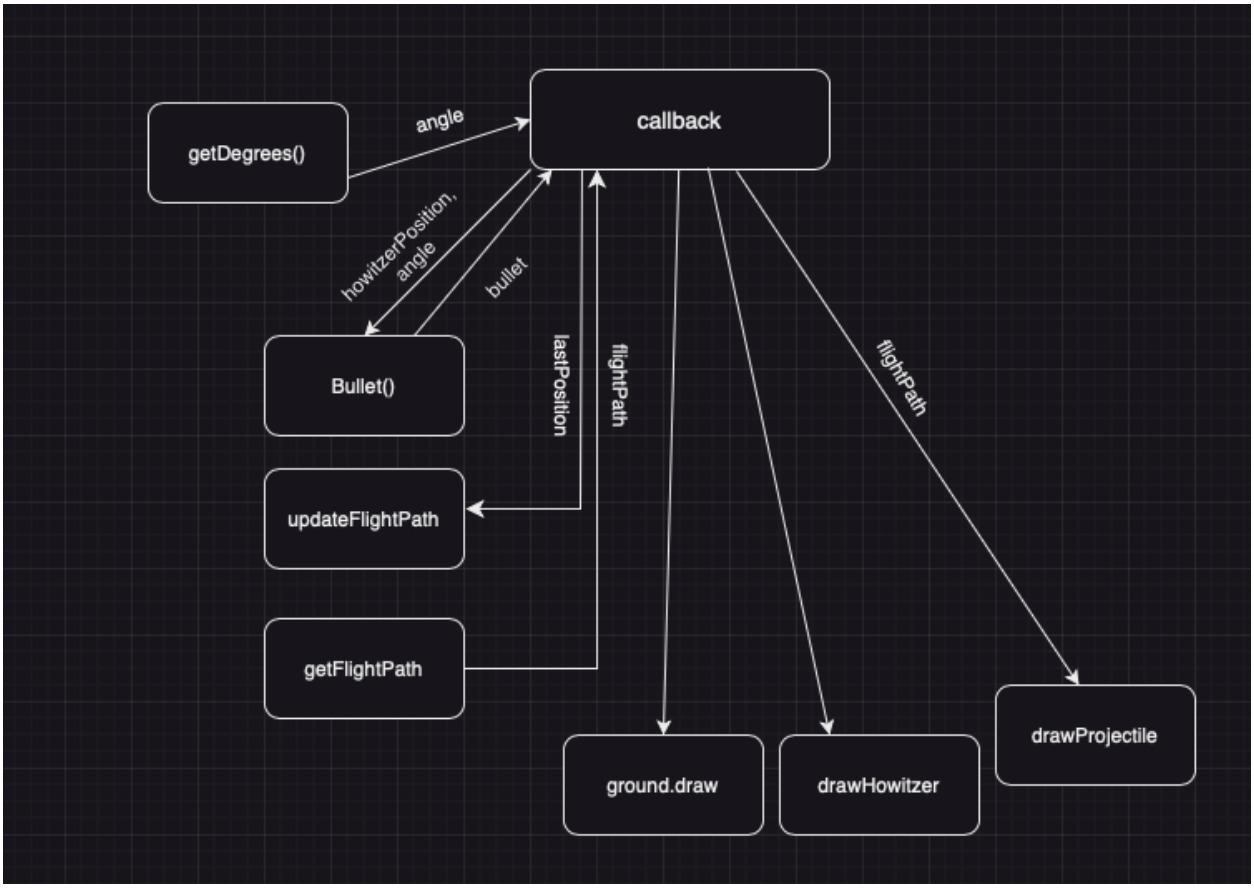
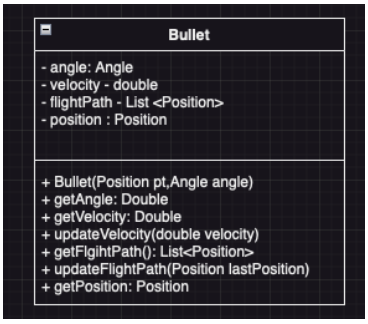
Structure Chart



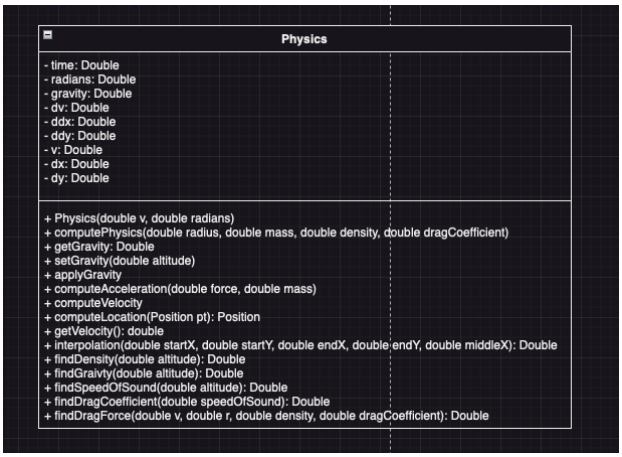
Class Diagrams:

Bullet Class:



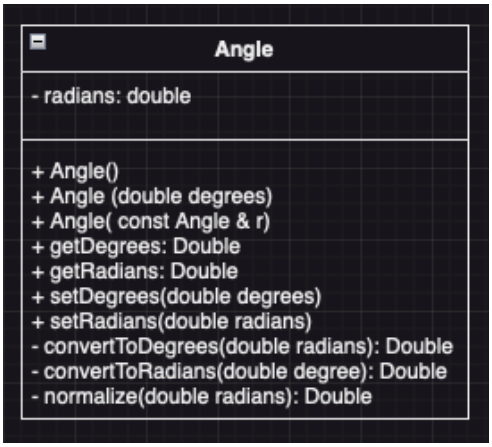
Fidelity: This class can be considered complete. It covers all required information for the projectile used in this program.
Robustness: This class has yet to be used or tested. So, it has a fragile level of robustness
Convenience: This class is easy to use and implement into a program to represent a bullet or projectile. Thus, it has seamless convenience.

Physics Class:



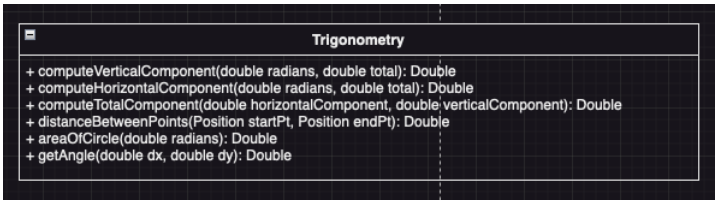
Fidelity: This class also covers all required states/attributes required for the physics of our program. Thus, it is complete in fidelity.
Robustness: This class has been tested and used already, but not formally and fully tested, so it has a tested level of robustness
Convenience: This class does require an understanding of physics to use in its fulness, but it does make working with numbers and the physics of our program a lot simpler. Thus, it has an easy level of convenience.

Angle Class:



Fidelity: This class is quite simple, but does cover all needed states for our angle, though it does use radians for both radians and degrees in angle measures. As such, this class can be considered complete in fidelity.
Robustness: This class has been tested and used, but has not been formally tested fully. Thus, it has a tested level of robustness
Convenience: This class is simple and easy to use to represent an angle in any program. It has a seamless level of convenience.

Trigonometry Class



Fidelity: This class fulfills all required functions. It has a complete level of fidelity.
Robustness: This class has been tested, but not entirely. Thus it has a tested level of robustness
Convenience: This class again, fulfills all required functions and is clear and easy to use. Thus, it has seamless convenience.

Pseudocode:

```
void setRo(double altitude)
    IF altitudeToDensityMap.find(altitude) != altitudeToDensityMap.end()
        ro <- altitudeToDensityMap[altitude]
    ELSE
        ro <- interpolation(altitude, altitudeToDensityMap)



void setGravity(double altitude)
    IF altitudeToGravityMap.find(altitude) != altitudeToGravityMap.end()
        gravity <- altitudeToGravityMap[altitude]
    ELSE
        gravity <- interpolation(altitude, altitudeToGravityMap)




void setSpeedOfSound(double altitude)
    IF altitudeToSoundMap.find(altitude) != altitudeToSoundMap.end()
        speedOfSound <- altitudeToSoundMap[altitude]
    ELSE
        speedOfSound <- interpolation(altitude, altitudeToSoundMap)



void setMach()
    mach <- v / speedOfSound



void setC()
    IF machToCMap.find(mach) != machToCMap.end()
```

```
        c <- machToCMap[mach]
    ELSE
        c <- interpolation(mach, machToCMap)



void setDrag()
    dragForce <- 0.5 * c * ro * v * v * area



void setAcceleration()
    acceleration <- dragForce / mass



void setDdx()
    ddx <- -sin(radians) * acceleration


void setDdy()
    ddy <- -gravity -cos(radians) * acceleration


double interpolation(double inputMiddle, map<double, double> m)

    it <- m.begin()

    WHILE it != m.end()
        IF it.key > inputMiddle

            inputEnd <- it.key
            outputEnd <- it.value
            it--
            inputBegin <- it.key
            outputBegin <- it.value
            BREAK

        it++

    IF it == m.end()
        it--;
        return it->second;

    RETURN outputBegin + (inputMiddle - inputBegin) * (outputEnd -
outputBegin) / (inputEnd - inputBegin)
```

Test Cases

Testing Constructor
We need to make sure that the start conditions are calculated correctly based on altitude and angle.
We have a display() method that will print to the screen the values of some of our private variables. The calculations have been configured such that the time interval between frames is set to one second, for simplicity. This helps verify the results when comparing them to the Whiteboard demo provided last week, which is the first test case.
NOTE: each output is calculated using a setter function!!! This means in addition to testing the Constructor, these test cases are testing 11 additional setter functions.

Test Name	Input	Output
Whiteboard demo	Altitude: 0, angle: 30	dx: 413.5 dy: 716.203 ro: 1.225 gravity: 9.807 speed of sound: 340 mach: 2.43235 c: 0.25954 drag: 2048.6 acceleration: 43.8673 ddx: -21.9336 ddy: -47.7972
Altitude in data tables	Altitude: 1000, angle 30	dx: 413.5 dy: 716.203 ro: 1.112 gravity: 9.804 speed of sound: 336 mach: 2.46131 c: 0.257565 drag: 1845.48 acceleration: 39.5178 ddx: -19.7589 ddy: -44.0274
Interpolation needed	Altittude: 1500, angle 30	dx: 413.5 dy: 716.203 ro: 1.0595 gravity: 9.8025 speed of sound: 334 mach: 2.47605 c: 0.25656 drag: 1751.49 acceleration: 37.5052 ddx: -18.7526 ddy: -42.2829
Input zeros	Altitude: 0, angle: 0	dx: 0

		dy: 827 ro: 1.225 gravity: 9.807 speed of sound: 340 mach: 2.43235 c: 0.25954 drag: 2048.6 acceleration: 43.8673 ddx: -0 ddy: -53.6743
Max Altitude	Altitude: 80,000, angle: 30	dx: 413.5 dy: 716.203 ro: 1.85e-05 gravity: 9.73 speed of sound: 324 mach: 2.55247 c: 0.25135 drag: 0.0299618 acceleration: 0.00064158 ddx: -0.00032079 ddy: -9.73056
Side Shot	Altitude: 0, angle: 90	dx: 827 dy: 0 ro: 1.225 gravity: 9.807 speed of sound: 340 mach: 2.43235 c: 0.25954 drag: 2048.6 acceleration: 43.8673 ddx: -43.8673 ddy: -9.807