```
import turtle
import math


class SolarSystem:
    def __init__(self, width, height):
        self.thesun = None
        self.planets = []
        self.ssturtle = turtle.Turtle()
        self.ssturtle.hideturtle()
        self.ssscreen = turtle.Screen()
        self.ssscreen.setworldcoordinates(-
width / 2.0,-height / 2.0, width / 2.0,
height / 2.0)
        self.ssscreen.tracer(50)

    def addPlanet(self, aplanet):
        self.planets.append(aplanet)

    def addSun(self, asun):
```

```
        self.thesun = asun

    def showPlanets(self):
        for aplanet in self.planets:
            print(aplanet)

    def freeze(self):
        self.ssscreen.exitonclick()

    def movePlanets(self):
        G = .1
        dt = .001

        for p in self.planets:
            p.moveTo(p.getXPos() + dt *
p.getXVel(), p.getYPos() + dt * p.getYVel())

            rx = self.thesun.getXPos()-
p.getXPos()
            ry = self.thesun.getYPos()-
```

```
p.getYPos()
        r = math.sqrt(rx ** 2 + ry ** 2)

        accx = G * self.thesun.getMass() *
rx / r ** 3
        accy = G * self.thesun.getMass() *
ry / r ** 3

        p.setXVel(p.getXVel() + dt * accx)

        p.setYVel(p.getYVel() + dt * accy)


class Sun:
    def __init__(self, iname, irad, im,
itemp):
        self.name = iname
        self.radius = irad
        self.mass = im
        self.temp = itemp
```

```
        self.x = 0
        self.y = 0

        self.sturtle = turtle.Turtle()
        self.sturtle.shape("circle")
        self.sturtle.color("yellow")

    def getName(self):
        return self.name

    def getRadius(self):
        return self.radius

    def getMass(self):
        return self.mass

    def getTemperature(self):
        return self.temp

    def getVolume(self):
```

```
    v = 4.0 / 3 * math.pi * self.radius ** 3
    return v

def getSurfaceArea(self):
    sa = 4.0 * math.pi * self.radius ** 2
    return sa

def getDensity(self):
    d = self.mass / self.getVolume()
    return d

def setName(self, newname):
    self.name = newname

def __str__(self):
    return self.name

def getXPos(self):
    return self.x
```

```
    def getYPos(self):
        return self.y


class Planet:

    def __init__(self, iname, irad, im, idist,
ivx, ivy, ic):
        self.name = iname
        self.radius = irad
        self.mass = im
        self.distance = idist
        self.x = idist
        self.y = 0
        self.velx = ivx
        self.vely = ivy
        self.color = ic

        self.pturtle = turtle.Turtle()
        self.pturtle.up()
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        self.pturtle.color(self.color)
        self.pturtle.shape("circle")
        self.pturtle.goto(self.x, self.y)
        self.pturtle.down()

    def getName(self):
        return self.name

    def getRadius(self):
        return self.radius

    def getMass(self):
        return self.mass

    def getDistance(self):
        return self.distance

    def getVolume(self):
        v = 4.0 / 3 * math.pi * self.radius ** 3
        return v
```

```
def getSurfaceArea(self):
    sa = 4.0 * math.pi * self.radius ** 2
    return sa

def getDensity(self):
    d = self.mass / self.getVolume()
    return d

def setName(self, newname):
    self.name = newname

def show(self):
    print(self.name)

def __str__(self):
    return self.name

def moveTo(self, newx, newy):
    self.x = newx
```

```
        self.y = newy
        self.pturtle.goto(newx, newy)

    def getXPos(self):
        return self.x

    def getYPos(self):
        return self.y

    def getXVel(self):
        return self.velx

    def getYVel(self):
        return self.vely

    def setXVel(self, newvx):
        self.velx = newvx

    def setYVel(self, newvy):
        self.vely = newvy
```

```
def createSSandAnimate():
    ss = SolarSystem(2, 2)

    sun = Sun("SUN", 5000, 10, 5800)
    ss.addSun(sun)

    m = Planet("MERCURY", 19.5, 1000,
.25, 0, 2, "blue")
    ss.addPlanet(m)

    m = Planet("EARTH", 47.5, 5000, 0.3, 0,
2.0, "green")
    ss.addPlanet(m)

    m = Planet("MARS", 50, 9000, 0.5, 0,
1.63, "red")
    ss.addPlanet(m)
```

```
    m = Planet("JUPITER", 100, 49000, 0.7,
0, 1, "black")
    ss.addPlanet(m)

    m = Planet("Pluto", 1, 500, 0.9, 0, .5,
"orange")
    ss.addPlanet(m)

    m = Planet("Asteroid", 1, 500, 1.0, 0,
.75, "cyan")
    ss.addPlanet(m)

    def movePlanets(self):
        G = .1
        dt = .001

        for p in self.planets:
            p.moveTo(p.getXPos() + dt *
p.getXVel(), p.getYPos() + dt * p.getYVel())
```

```
            rx = self.thesun.getXPos()-
p.getXPos()
            ry = self.thesun.getYPos()-
p.getYPos()
            r = math.sqrt(rx ** 2 + ry ** 2)

            accx = G * self.thesun.getMass() *
rx / r ** 3
            accy = G * self.thesun.getMass() *
ry / r ** 3

            p.setXVel(p.getXVel() + dt * accx)

            p.setYVel(p.getYVel() + dt * accy)


class Sun:
    def __init__(self, iname, irad, im,
itemp):
        self.name = iname
```

```
        self.radius = irad
        self.mass = im
        self.temp = itemp
        self.x = 0
        self.y = 0

        self.sturtle = turtle.Turtle()
        self.sturtle.shape("circle")
        self.sturtle.color("yellow")

    def getName(self):
        return self.name

    def getRadius(self):
        return self.radius

    def getMass(self):
        return self.mass

    def getTemperature(self):
```

```
    return self.temp

def getVolume(self):
    v = 4.0 / 3 * math.pi * self.radius ** 3
    return v

def getSurfaceArea(self):
    sa = 4.0 * math.pi * self.radius ** 2
    return sa

def getDensity(self):
    d = self.mass / self.getVolume()
    return d

def setName(self, newname):
    self.name = newname

def __str__(self):
    return self.name
```

```
    def getXPos(self):
        return self.x

    def getYPos(self):
        return self.y


class Planet:

    def __init__(self, iname, irad, im, idist,
ivx, ivy, ic):
        self.name = iname
        self.radius = irad
        self.mass = im
        self.distance = idist
        self.x = idist
        self.y = 0
        self.velx = ivx
        self.vely = ivy
        self.color = ic
```

```
        self.pturtle = turtle.Turtle()
        self.pturtle.up()
        self.pturtle.color(self.color)
        self.pturtle.shape("circle")
        self.pturtle.goto(self.x, self.y)
        self.pturtle.down()

    def getName(self):
        return self.name

    def getRadius(self):
        return self.radius

    def getMass(self):
        return self.mass

    def getDistance(self):
        return self.distance
```

```
def getVolume(self):
    v = 4.0 / 3 * math.pi * self.radius ** 3
    return v

def getSurfaceArea(self):
    sa = 4.0 * math.pi * self.radius ** 2
    return sa

def getDensity(self):
    d = self.mass / self.getVolume()
    return d

def setName(self, newname):
    self.name = newname

def show(self):
    print(self.name)

def __str__(self):
    return self.name
```

```
def moveTo(self, newx, newy):
    self.x = newx
    self.y = newy
    self.pturtle.goto(newx, newy)

def getXPos(self):
    return self.x

def getYPos(self):
    return self.y

def getXVel(self):
    return self.velx

def getYVel(self):
    return self.vely

def setXVel(self, newvx):
    self.velx = newvx
```

```
    def setYVel(self, newvy):
        self.vely = newvy


def createSSandAnimate():
    ss = SolarSystem(2, 2)

    sun = Sun("SUN", 5000, 10, 5800)
    ss.addSun(sun)

    m = Planet("MERCURY", 19.5, 1000,
.25, 0, 2, "blue")
    ss.addPlanet(m)

    m = Planet("EARTH", 47.5, 5000, 0.3, 0,
2.0, "green")
    ss.addPlanet(m)

    m = Planet("MARS", 50, 9000, 0.5, 0,
```

```
1.63, "red")
    ss.addPlanet(m)

    m = Planet("JUPITER", 100, 49000, 0.7,
0, 1, "black")
    ss.addPlanet(m)

    m = Planet("Pluto", 1, 500, 0.9, 0, .5,
"orange")
    ss.addPlanet(m)

    m = Planet("Asteroid", 1, 500, 1.0, 0,
.75, "cyan")
    ss.addPlanet(m)

    numTimePeriods = 20000
    for amove in range(numTimePeriods):
        ss.movePlanets()
    ss.freeze()
createSSandAnimate()
```