Physics I: Lab 08
Orbits

In this lab you will use SageMath to numerically calculate the paths for several different kinds of orbital motion.

For simplicity, assume that for the given universe, planet, and unit system the product $GM_{planet} = 1$. Also assume that the given satellite has a mass of 1. Under these conditions the gravitational force is $F_g = 1/r^2$ and the requirement for circular motion is $F_c = v^2/r$. (Do not make these assumptions outside of this lab.)

Part 0

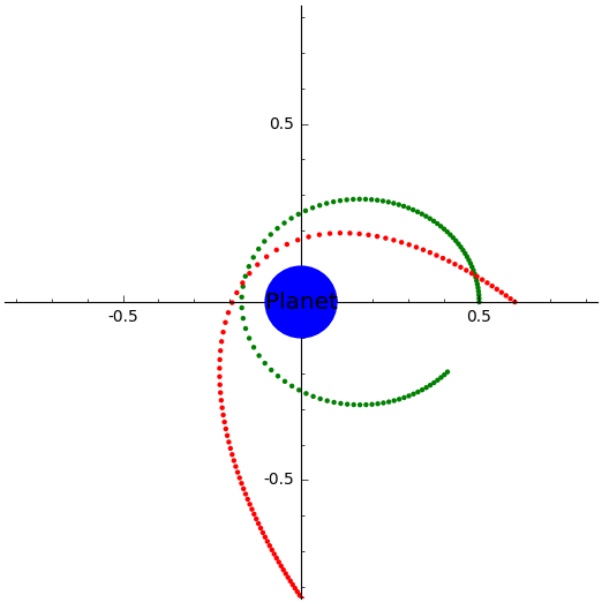
Copy the orbit_plot.sage script and run the following example:

```
radius = var("radius")

blue_circle = circle((0, 0), 0.1, color="blue", fill=True, zorder=100, figsize=[5.5, 5.5])
planet_label = text("Planet", (0, 0), color="black", fontsize="large", zorder=101)

plot1 = orbit_plot(0.5, 0.0, 1.0, 1.0/(radius*radius), 0.01, 1.0, "green")
plot2 = orbit_plot(0.6, -1.0, 0.9, 1.0/(radius*radius), 0.01, 1.0, "red")

g = Graphics()
g += blue_circle
g += planet_label
g += plot1
g += plot2
g.set_axes_range(-0.8, 0.8, -0.8, 0.8)
g.show()
```



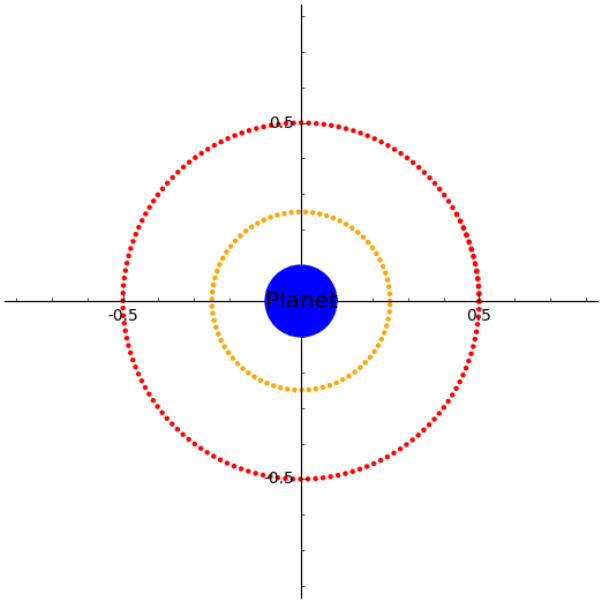
Make sure you understand what each argument of orbit_plot() means; Refer to the table below:

1. x_i of the satellite ($y_i = 0$ by default)
2. v_{xi} of the satellite
3. v_{yi} of the satellite
4. the gravitational force law, i.e. $F_g = 1/r^2$ (see above)
5. the time interval between data points, make this smaller for more detail
6. the path length at which the calculations stops, make this larger to see more of the path
7. the color of the data points

Adjust a few settings to see how they affect your resulting plot.

Part 1

Create two circular orbits of different radii. Record your initial values and a screenshot of your plot.

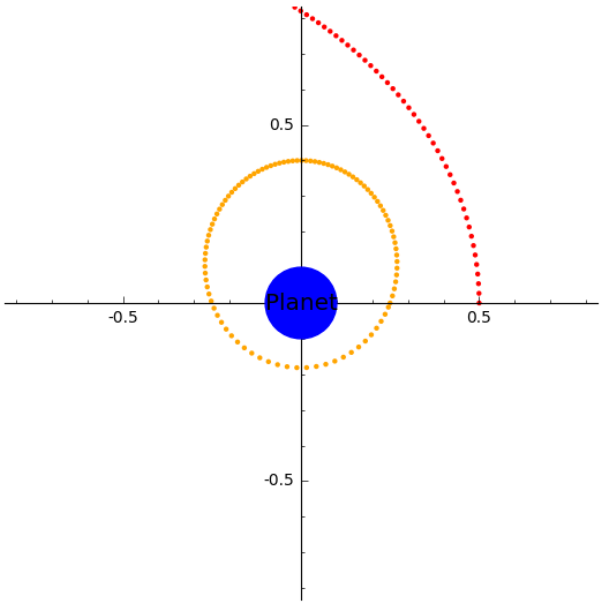


Part 2

a) Create an elliptical orbit by either

- making the velocity too large
- making the velocity too small
- making the velocity non-tangent to a circular path.

b) Create a case where the velocity is larger than the escape velocity.
Record your conditions and a screenshot of your plot.



Part 3

Design your own universe with a different gravitational force law. Experiment until you find an interesting result. Record your conditions and a screenshot of your plot.