PHY140Y

Spring Term – Week 3

January 20, 1999

1. Consider two suns of equal mass M orbiting each other at a radius R. Both stars are now rotating about each other.

   (a) Where is the centre of mass of this system?

   (b) What is the orbital period of this "binary" system?

2. We are going to investigate Gauss's Law.

   (a) Suppose we have a uniform field $F(\vec{r})$, meaning that this field is constant everywhere. Calculate the *flux* of this field through a square surface of areas A oriented at right angles to the field $\vec{F}$. Repeat this for the surface oriented with the normal to the surface perpendicular to the field vector. Note that we define the flux ϕ as the scalar quantity

   $$\phi = \int_S (F(\vec{x}) \cdot \hat{n}) dS, \tag{1}$$

   where $\hat{n}$ is the unit vector normal to the surface at each point $\vec{x}$ on the surface.

   (b) For the same field $\vec{F}$, calculate the flux of this field through a closed cubic surface. Orient the surface any way you want. Repeat this calculation for a sphere.

   (c) Now calculate the flux of the electric field generated by a point charge q through a sphere centred on the point charge at radius R. Show that this is independent of the radius of the sphere.