PHY 321, FEB 10, HINTS HW4

$$V(r) = -\gamma \frac{1}{r}$$

$$\gamma = G \cdot M_1 M_2 \qquad \gamma = \frac{q_1 q_2}{4\pi\varepsilon_0}$$

$$r = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

$$\vec{F}(\vec{r}) = -\vec{\nabla} V(\vec{r})$$

$$= -\gamma \left(\frac{\partial}{\partial x} \vec{i} + \frac{\partial}{\partial y} \vec{j} + \frac{\partial}{\partial z} \vec{k} \right) \frac{1}{r}$$

$$\frac{1}{r} = \frac{1}{\sqrt{x^2 + y^2 + z^2}}$$

$$\frac{\partial}{\partial x} \left[\frac{1}{\sqrt{x^2 + y^2 + z^2}} \right] = \frac{2x}{2(x^2 + y^2 + z^2)^{3/2}}$$

$$= \frac{x}{r^3}$$

$$\frac{\partial}{\partial y} \left[\frac{1}{r} \right] = \frac{y}{r^3}$$

$$\frac{\partial}{\partial z} \left[\frac{1}{r} \right] = \frac{z}{r^3}$$

$$\vec{F}(\vec{r}) = -\gamma \frac{x\vec{i} + y\vec{j} + z\vec{k}}{r^3}$$

$$= -\gamma \frac{\vec{r}}{r^3}$$

$$= -\gamma \frac{1}{r^2} \hat{\vec{r}}$$

$$\hat{\vec{r}} = \frac{\vec{r}}{r}$$

$$\nabla \times \vec{F} = \left(\frac{\partial}{\partial y} F_z - \frac{\partial}{\partial z} F_y\right)\vec{i}$$

$$+ \left(\frac{\partial}{\partial z} F_x - \frac{\partial}{\partial x} F_z\right)\vec{j}$$

$$+ \left(\frac{\partial}{\partial x} F_y - \frac{\partial}{\partial y} F_x\right)\vec{k}$$

$$\frac{\partial}{\partial y} F_z = -\gamma \frac{\partial}{\partial y}\left[\frac{z}{(x^2+y^2+z^2)^{3/2}}\right]$$

$$= -\gamma \frac{3}{2} \frac{2y\ z}{(x^2+y^2+z^2)^{5/2}}$$

$$= -\gamma\, 3 \frac{y \cdot z}{(x^2+y^2+z^2)^{5/2}}$$

$$\frac{\partial}{\partial z} F_y = -\gamma \frac{\partial}{\partial z}\left[\frac{y}{(x^2+y^2+z^2)^{3/2}}\right]$$

$$= -\gamma \cdot 3 \, \frac{y \cdot z}{(x^2+y^2+z^2)^{5/2}}$$

$$\frac{\partial}{\partial y} F_z - \frac{\partial}{\partial z} F_y = 0$$