Due: 30 September

1. Show that these two forms of the radial derivative in the spherical Laplacian are equivalent:

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\Phi}{\partial r}\right) = \frac{1}{r}\frac{\partial^2}{\partial r^2}(r\Phi)$$

2. If $\Phi = \dfrac{3z^2}{(x^2+y^2+z^2)^{3/2}}$, find the gradient $\vec{\nabla}\Phi$.

3. Show that $\dfrac{d}{dt}(v^2) = 2\vec{\boldsymbol{v}}\cdot\vec{\boldsymbol{a}}$. [The left-hand side contains the magnitude of the velocity (speed) squared; the right-hand side is a dot product between two vectors.]

4. Marion & Thornton 1.27

5. Marion & Thornton 1.34

6. (a) Show that the curl of the gradient of any scalar function vanishes.
   (b) Show that the divergence of the curl of any vector function vanishes.

7. Consider a point mass in free fall ($\vec{\boldsymbol{a}} = -g\hat{\jmath}$) with the following initial conditions: $\vec{\boldsymbol{v}}(0\ sec) = 50\ m/s\ \hat{\imath}$ and $\vec{\boldsymbol{x}}(1\ sec) = 20\ m\ \hat{\imath} + 100\ m\ \hat{\jmath}$. Find the displacement at 4 seconds, $\vec{\boldsymbol{x}}(4\ sec)$.