The computation of U is now immediate:

$$U = \frac{1}{2}\int_{\text{sphere}} d^3\vec{r}\,\rho_0\left[\frac{1}{2}\frac{4\pi}{3}G\rho_0 r^2 - \frac{3}{2}\frac{4\pi}{3}G\rho_0 R^2\right]$$

$$= \frac{1}{2}\,4\pi\,\frac{1}{2}\frac{4\pi}{3}G\rho_0^2\int_0^R r^2\,dr\,\left[r^2 - 3R^2\right]$$

$$= \frac{1}{2}\,4\pi\,\frac{1}{2}\frac{4\pi}{3}G\rho_0^2\left\{\frac{r^5}{5} - 3\frac{R^2 r^3}{3}\right\}\Big|_0^R$$

$$= \frac{1}{2}\,4\pi\,\frac{1}{2}\frac{4\pi}{3}G\rho_0^2\left(-\frac{4}{5}\right)R^5$$

$$= \frac{1}{2}\cdot\frac{1}{2}\cdot 3\left\{\left(\frac{4\pi}{3}\right)^2\rho_0^2 R^6\right\}\frac{G}{R}\left(-\frac{4}{5}\right)$$

$$\boxed{U = -\frac{3}{5}\frac{M^2 G}{R}}$$

b) $\langle 2T_{cm}\rangle = -\langle U\rangle$. Argument the same as in problem DCM 1.18, part a

c) $\langle 2T_{cm}\rangle = 3Nk\tau$ and part (a) $\Rightarrow$

$$\boxed{\tau = \frac{M^2 G}{5RNk} = \frac{mMG}{5kR}} \quad \text{with } m = \frac{M}{N}$$