(15) 1. Use a triple integral in **spherical coordinates** to calculate the **volume** of the 3D-region which is between the spheres 
\[ x^2 + y^2 + z^2 = 1 \] and \[ x^2 + y^2 + z^2 = 9 \] and above the cone 
\[ z = (x^2 + y^2)^{\frac{1}{2}}, \]
(10) 2. Find the **surface area** of that part of the surface \( z = 1 + y^4 \) which lies above the region of the xy-plane that is bounded by 

\[ x = 96y^5, \quad x = 0, \quad \text{and} \quad y = 1. \]
3. A mass distribution occupies the 3D-region which is bounded by the surfaces $y = x$, $y = x^2$, $z = 1$, and $z = 2 + x$.

The mass density function is $\delta = 12 x^2$ units of mass/unit volume.

Calculate the total mass.
(15) 4. A mass distribution occupies the 3D-region which is enclosed by the surfaces \( z = x^2 + y^2 \) and \( z = 2 - x^2 - y^2 \). The mass density function is \( \delta = z \) units of mass/unit volume. Calculate the total mass.
5. The force field $\mathbf{F} = y \mathbf{i} + xy \mathbf{j}$ acts on an object as it moves in the xy-plane. Calculate the work done by $\mathbf{F}$ as the object moves from $(0,0)$ to $(1,4)$ by moving first along $x = y^2$ from $(0,0)$ to $(1,1)$ and then along the vertical line segment from $(1,1)$ to $(1,4)$. 
(15) 6. Use Green's theorem to calculate the work done by \( F = y \, i + xy \, j \) as it acts on an object which moves once around the circle \( x^2 + y^2 = 9 \) in the counterclockwise direction.
7. Show that the force field

\[ F = \left( 2x + \ln(1 + y^2) \right) i + \left( 2xy \left( \frac{1}{1 + y^2} \right) + 1 \right) j \]

is conservative in the entire xy-plane by finding a potential function for it. Now use this potential function to calculate the work done by \( F \) as it acts on an object which moves from \((x,y) = (2,0)\) to \((x,y) = (4,3)\).