1. Find the area of the region included between the cardioids $r = a(1 + \cos\theta)$ and $r = a(1 - \cos\theta)$.

2. Find the area inside the circle $r = 2a\cos\theta$ and outside the circle $r = a$.

3. Find the value of the triple integral $\iiint_R xy\,dxdydz$ where R is the cylindrical solid $x^2 + y^2 \leq 1$ with $0 \leq z \leq 1$.

4. Use cylindrical coordinates to compute the integral $\iiint_D z(x^2 + y^2)^{-\frac{1}{2}} dxdydz$, where D is the solid bounded above by the plane $z = 2$ and below by the surface $2z = x^2 + y^2$.

5. Using the definition of average value of a function $f(x, y, z)$ over a solid region D as $\dfrac{1}{vol. \ of \ D} \iiint_D f(x, y, z)dv$, find the average value of the function $f(x, y, z) = x + y + z$ over the sphere $x^2 + y^2 + z^2 = 4$.

6. Find the volume bounded above by the sphere $x^2 + y^2 + z^2 = 32$ and below by the paraboloid $x^2 + y^2 = 4z$.

7. Find the volume of the tours generated by revolving the circle $x^2 + y^2 = 4$ about the line $x = 3$.

8. Find the volume bounded by the surfaces $z = 4 - x^2 - \dfrac{1}{4}y^2$ and $z = 3x^2 + \dfrac{y^2}{4}$.

9. Evaluate $\iiint z^2 dxdydz$ over the region common to the sphere $x^2 + y^2 + z^2 = a^2$ and the cylinder $x^2 + y^2 = ax$.

10. Find the centre of gravity of the area bounded by the parabola $y^2 = x$ and the line $x + y = 2$, treating the density as constant.

11. Find the mass of a plate in the shape of the curve $\left(\dfrac{x}{a}\right)^{\frac{2}{3}} + \left(\dfrac{y}{a}\right)^{\frac{2}{3}} = 1$, the density being given by $\rho = \mu xy$.

12. A solid body of constant density ρ is obtained by revolving the cardiod $r = a(1 + \cos\theta)$ about the initial line. Find its M.I. about a straight line through the pole and perpendicular to the initial line.

Answers: 1. $\dfrac{a^2}{2}(3\pi - 8)$; 2. $a^2\left(\dfrac{\pi}{3} + \dfrac{\sqrt{3}}{2}\right)$; 3. 0; 4. 8π; 5. 0; 6. $64\pi\left(4\sqrt{2} - \dfrac{7}{6}\right)$; 7. $24\pi^2$

; 8. $4\sqrt{2}\pi$; 9. $\dfrac{-2}{15}\pi a^5$; 10. $\left(\dfrac{8}{5}, -\dfrac{31}{54}\right)$; 11. $\dfrac{\mu a^2 b^2}{20}$; 12. $\dfrac{352}{105}\pi\rho a^5$.