1. Integrate $\displaystyle\int \frac{\ln(x^{2/3})}{x}\, dx$.

2. Find the particular solution $y = f(x)$ which satisfies the separable differential equation $2y'\sqrt{x} = e^{\sqrt{x}-y}$ and $y(1) = 0$.

3. Let R be the region bounded by one arc of the secant curve $y = \sec x$, $-\frac{\pi}{2} < x < \frac{\pi}{2}$, and the line $y = \sqrt{2}$.

- **(i)** Find the area of R.
- **(ii)** Find the volume of the solid obtained by rotating R about the x-axis.

4. A certain spring is 2 meters long at rest, and it takes 10 N of force to compress the spring to 1.5 meters. Find the work needed to stretch the spring from 3 meters to 5 meters.

5. A certain population of bacteria triples every 21 days. How long does it take for the number of bacteria to double?

6. Find the length of the curve

$$y = \int_0^x \sqrt{\cos\ 2t}\, dt$$

from $x = 0$ to $x = \pi/4$.

7. Find the value of the definite integral $\displaystyle\int_0^{\pi/4} x^2 \sin(2x)\, dx$.

8. Which of the following statements are always true for functions f, g from $\mathbb{R}$ to $\mathbb{R}$? (Assume that f, g are eventually positive)

- **(I)** If f is a polynomial of degree n and g is a polynomial of degree m, and $n < m$, then $f = O(g)$.
- **(II)** If $f = O(g)$ and $g = O(f)$, then $\displaystyle\lim_{x\to\infty} \frac{f(x)}{g(x)} = 1$.
- **(III)** Suppose $f = O(x)$ and $g = O(x^2)$, then $f = O(g)$.

9. Which of the following sequences converge?

- **(I)** $a_n = \dfrac{(-1)^n}{n!}$,
- **(II)** $b_n = \cos\left(\dfrac{n\pi}{n+1}\right)$,
- **(III)** $c_n = \dfrac{e^n}{n^2}$.