Time: 50 minutes.

Books, notes, calculators, cell phones, electronic memory devices, and electronic communication devices are NOT allowed.

Justify your answers and show all your work. If you need more space on a question, use the back of the page which preceeds that question. Unless otherwise indicated, simplification of answers is not required.
Marks

[5] 1. Evaluate $\int_0^1 x \arctan x \, dx$

[6] 2. Evaluate $\int x^2 \sqrt{9 - x^2}$. 
3. Find the limit of the sequence or show that it is divergent.

\[ a_n = \frac{n^n}{n!} \]

4. Evaluate \( \int \tan^2 x \sec x \, dx \).
5. Evaluate $\int \frac{2x^2 - 10x + 13}{x^2 - 6x + 9} \, dx$. 

6. Find the sum of the series or show that it is divergent.

$$\sum_{n=1}^{\infty} \ln \left( \frac{n^2}{n^2 + 2n + 1} \right)$$
7. Evaluate the integral or show that it is divergent.

\[ \int_{1}^{\infty} \frac{x + 1}{x^2 + 2x} \]

8. Use Simpson’s Rule with \( n = 6 \) to approximate \( \int_{0}^{3} \frac{1}{1 + y^3} \, dy \).
9. Find the centroid of the region bounded by the curves $y = e^x$, $y = e^{-x}$, $x = 0$, and $x = 1$. 
10. A tank contains 2000 L of water with 30 kg of dissolved sodium fluoride (NaF). Pure water enters the tank at a rate of 20 L/min. The solution is kept thoroughly mixed and drains from the tank at the same rate. How much sodium fluoride is in the tank after 2 hours?