Show all your work on the exam paper, legibly and in detail, to receive full credit. The use of a calculator or any other electronic device is prohibited. You may only use techniques discussed to date in class. You must simplify all answers unless you are explicitly instructed not to.

1. Evaluate the integrals:

   a. (12 pts) \( \int x^3 \ln x \, dx \)

   b. (12 points) \( \int x^2 \sin x \, dx \)
2a) (7 pts) Draw the region enclosed by the curves $y = x$, $y = 4x$, and $y = 2$. Be sure to give the coordinates of the intersection points of the curves.

2b) (6 pts) Write down the integral required to compute the area of the region enclosed by the curves of part a), as an integral with respect to "x". You will need to split it into two pieces. Do not evaluate the integrals.

2c) (6 pts) Write down the integral required to compute the area of the region enclosed by the curves of part a), as an integral with respect to "y".

2d) (5 pts) Evaluate the integral in part c)
3 (10 pts) Find the area of the region in the first quadrant enclosed by the curves $x = 0$, $y = 2$ and $y = \frac{1}{\sqrt{1 - x^2}}$. Treat it as an integral with respect to $x$. 

![Graph of the curves](image)
Note: For the problems on this page you do NOT have to evaluate the integrals and you do NOT have to algebraically simplify the integrands.

4a. (12 pts) Write down the definite integral that represents the volume of the solid that results when the region enclosed by the curves $y = \sqrt{x}, \ y = 0, \ and \ x = 9$ is revolved about the $x$-axis.

4b. (10 pts) Write down the definite integral that represents the volume of the solid that results when the region enclosed by the curves $y = \sqrt{x}, \ y = 0, \ and \ x = 9$ is revolved about the $y$-axis.
5) (10 pts) A spring exerts a force of 90 newtons when stretched 3 meters beyond its natural length. Find the integral that represents the work done in stretching the spring 5 meters beyond its natural length.
6) (10 pts) A cone-shaped reservoir is 20 ft in diameter across the top and 15 ft deep. If
the reservoir is filled to the top, write down the integral that represents the work done in
pumping all the water to the top of the reservoir. Use 62.4 lb/ft³ as the weight density of
water. Set up the relevant integral - **DO NOT EVALUATE THE INTEGRAL.**
Bonus Problem
(Make sure you are confident of your solutions with the earlier problems before attempting this one)

7a) (2 pts) Write down an integral with respect to $y$ which gives the area in problem 3).

7b) (3 pts) Evaluate the integral from 7a). You should get the same answer as in problem 3).
Space for additional work