Instructions: Please, write your name and section number both on your blue book and on the question-sheet, and submit the question-sheet with your work. You may use left pages of the blue book for scratches and right pages for clean versions. You don’t have to write solutions to the problems in the given order, but a solution to each problem should start on its own page and the problem number should be clearly marked. Write all solutions clearly and show all your work. No calculator, no notes, no book and no other aid will be allowed. Each problem is out of 20 points.

Problem 1. Two cars stop on red side-by-side at a traffic light. They start moving on green at the same time \((t = 0)\). Car 1 travels at a speed given by \(v_1(t) = \frac{1}{2}t\) feet per minute, and Car 2 travels at a speed given by \(v_2(t) = \frac{1}{4}t^2\) feet per minute.

(a) At what time do the two cars travel at the same speed?
(b) At what time are the two cars side-by-side again?

Problem 2. Consider the area of the region bounded by \(y = \sqrt{x - 2}, x = 6\) and the \(x\)-axis. (Do not simplify the answer, just write down the sum of numbers, square roots are OK).

(a) Approximate this area by using midpoint method with \(n = 4\).
Is this approximation an overestimate or an underestimate? Explain your answer.
(b) Approximate this area by using Trapezoidal method with \(n = 4\).
Is this approximation an overestimate or an underestimate? Explain your answer.

Problem 3. Find the following improper integral. (If it converges, then find the value and if it diverges to infinity, write so. Either way, justify your answer fully.)

\[
\int_{e}^{\infty} \frac{1}{x(\ln x)^3} \, dx
\]

Problem 4. Find the area of the region bounded by \(x + y^2 - 6 = 0\) and \(x - y = 0\). (Sketch the region first.)

Problem 5. Find the volume of the solid by revolution by revolving the region bounded by \(y = \frac{1}{2}x^2, y = x\) with respect to \(y = -1\). (Sketch the plane region and a typical cross-section (washer). State the inner and outer radius of the washer. You don’t need to sketch the solid)

Problem 6. Find the arc length of the curve parametrized as \(x = -t + e^t\) and \(y = 1 + 4e^{\frac{t}{2}}\) from \(t = 0\) to \(t = 1\).