

Your Name

Student ID

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Professor's Name

- Turn off and stow away all cell phones, watches, pagers, music players, and other similar devices.
- This exam is closed book. You may use one $8.5'' \times 11''$ sheet of handwritten notes (both sides OK). Do not share notes.
- You can use only a Texas Instruments TI-30X IIS calculator. No other models are allowed.
- In order to receive credit, you must **show your work**. If you do not indicate the way in which you solved a problem, or if the work shown is incorrect or incomplete, you may get little or no credit for it, even if your answer is correct.
- You may use directly the integral formulas in the table below. You must **show your work in evaluating any other integrals**, even if they are on your sheet of notes.

Table of Integration Formulas Constants of integration have been omitted.

1. $\int x^n dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1)$	2. $\int \frac{1}{x} dx = \ln x $
3. $\int e^x dx = e^x$	4. $\int b^x dx = \frac{b^x}{\ln b}$
5. $\int \sin x dx = -\cos x$	6. $\int \cos x dx = \sin x$
7. $\int \sec^2 x dx = \tan x$	8. $\int \csc^2 x dx = -\cot x$
9. $\int \sec x \tan x dx = \sec x$	10. $\int \csc x \cot x dx = -\csc x$
11. $\int \sec x dx = \ln \sec x + \tan x $	12. $\int \csc x dx = \ln \csc x - \cot x $
13. $\int \tan x dx = \ln \sec x $	14. $\int \cot x dx = \ln \sin x $
17. $\int \frac{dx}{x^2 + a^2} = \frac{1}{a} \tan^{-1}\left(\frac{x}{a}\right)$	18. $\int \frac{dx}{\sqrt{a^2 - x^2}} = \sin^{-1}\left(\frac{x}{a}\right), \quad a > 0$

- Place a box around your answer to each question. Unless otherwise instructed, simplify your answers, but leave them in exact form (for example $\frac{\pi}{3}$ or $5\sqrt{3}$).
- All pages are double-sided except for this cover page, the last pages. You may use the blank pages for extra room but, if you want us to grade these spare pages, clearly **indicate in the problem area** that your work is on the back of the cover page or on the blank page(s) at the end of the exam.
- This exam has 9 problems on 9 pages. When the exam starts, check that your exam is complete. Good luck!

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1. (14 points) Evaluate the following integrals. Show your work. Simplify and box your answers.

(a) $\int \frac{1}{\sqrt{x^2 + 2x + 10}} dx$

(b) $\int \sqrt{x} e^{\sqrt{x}} dx$

2. (14 points) Evaluate the following integrals. Show all work. Simplify and box your answers.

(a) (5 points) $\int_0^{\pi/3} \frac{\sin(4x)}{\cos(2x)} dx$

(b) (9 points) $\int_1^{\infty} \frac{x-2}{x^3+x} dx$

3. (12 points) A train is traveling back and forth along a railway track, starting 4 miles south of King Street Station, heading north. We measure its velocity at t hours to be $v(t) = 60\sin(2\pi t)$ miles per hour.

(a) Where is the train in relation to King Street Station after 45 minutes?

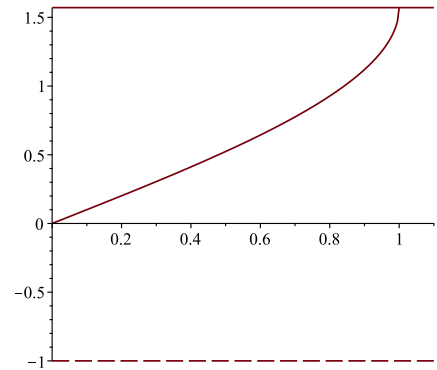
(b) How many miles did the train travel in one hour?

4. (10 points) Set up an integral for the length of the curve $y = 4 - x^2$ from $x = -2$ to $x = 2$, and then approximate that integral using the Trapezoidal Rule with $n = 4$ subintervals. You may leave your answer in simplified exact form, or as a decimal rounded to the nearest 2 decimal places.

5. (10 points) Let \mathcal{R} be the region in the first quadrant bounded by:

the lines $x = 0$, $y = \frac{\pi}{2}$ and the curve $y = \sin^{-1} x$.

Rotate \mathcal{R} about the line $y = -1$ to form a solid of revolution. What is the volume of this solid?



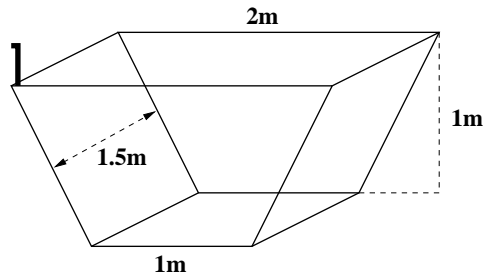
6. (10 points) A tank is completely filled with water. Recall that the density of water is 1000 kg/m^3 and the acceleration due to gravity is $g = 9.8 \text{ m/sec}^2$.

The front and the back of the tank are 1.5 m apart and have the shape of a trapezoid. The trapezoids have width at bottom of 1 m, at top 2 m, and height 1 m (see picture.)

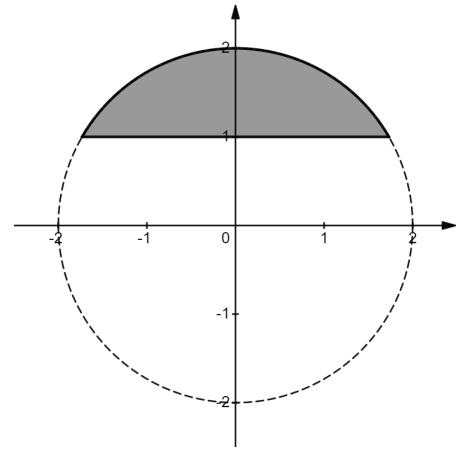
The outlet of the water tank is 0.25 m higher than the top of the tank.

Set up an integral for the work required to pump all the water out of the tank through the outlet.

SET UP ONLY. DO NOT EVALUATE THE INTEGRAL.



7. (10 points) Find the y -coordinate \bar{y} of the centroid of the region above the line $y = 1$ and below the curve $y = \sqrt{4 - x^2}$.



8. (10 points) Find the solution of the following initial value problem. Write your answer in explicit form, $y = f(x)$.

$$\frac{dy}{dx} = \frac{x}{y} \sqrt{(x^2 + 1)(y^2 + 1)}, \quad y(0) = \frac{3}{4}$$

9. (10 points) At time $t = 0$, a tank contains 100 gallons of pure gasoline.

A mixture whose volume is 30% ethanol and 70% gasoline is pumped into the tank at a rate of 2 gallons per minute. The solution is kept thoroughly mixed and drains from the tank at the same rate.

Calculate the number of gallons of ethanol in the tank after 25 minutes. Round your answer to two decimal places.

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