Problem 1: Set up, BUT DO NOT EVALUATE, an integral which calculates the work required to empty the gigantic container of soda through the straw as pictured below. You may assume that the density if soda is 1,045 kg/m^3, and the acceleration due to gravity is 9.8 m/s^2. Show all steps leading to your answer and use appropriate units.

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Problem 2: Suppose the region bounded by the curves $y = \cos(x)$, $\frac{\pi}{2} \le x \le \frac{3\pi}{2}$, and $y = 0$ is rotated about the y-axis. Find the volume of the resulting solid.

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Problem 3: Calculate the integral.

$$\int_1^2 x^3 (\ln x)^2 \; dx$$

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(b) Find *and* *explain* the mistake in the following calculation. We will use integration by parts to calculate the following integral. Let $u = \frac{1}{x}$ and $dv = 1dx$. Then $du = -\frac{1}{x^2}$ and $v = x$. So we have

$$\int_0^1 \frac{1}{x}\, dx \;=\; x\left(\frac{1}{x}\right) - \int_0^1 -\frac{1}{x^2}(x)\, dx.$$

After simplifying we have

$$\int_0^1 \frac{1}{x}\, dx \;=\; 1 + \int_0^1 \frac{1}{x}\, dx.$$

Subtracting $\int_0^1 \frac{1}{x}\, dx$ from both sides we have

$$0 \;=\; 1.$$

Thus $0 = 1$.