First Name: _____ Last Name: _____

Student-No: _____ Section: _____

Grade:

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Short answer question

1. $\boxed{\text{2 marks}}$ Each part is worth 1 mark. Please write your answers in the boxes. Only answers in the boxes will be marked.

   For both parts of this question, let R be the region enclosed by the x-axis and the parabola $y = x^2 - 1$, where all units of length are metres (m). Imagine a water-filled container whose bowl-shaped interior is formed by rotating R about the y-axis. (You may take the density of water to be equal to $\rho = 1000\,\mathrm{kg/m^3}$, and acceleration due to gravity to be equal to $g = 9.8\,\mathrm{m/s^2}$. You do not have to include units in your final answers.)

   (a) Halfway down the container, the horizontal cross-section is a circular disk of water of radius $\frac{1}{\sqrt{2}}$ metres and thickness dy metres. What is the work done to pump this small disk of water out of a spout at the top of the container?

   Answer:

   (b) Write down, but *do not evaluate*, the integral describing the total work done to empty out the container by pumping the water out of a spout at the top.

   Answer:

Long answer question—you must show your work

2. $\boxed{\text{4 marks}}$ Determine whether the area under the curve $y = \dfrac{\sqrt{x}+1}{x^2 - \frac{1}{2}}$, above the x-axis, and to the right of $x = 1$ is finite or infinite.

Long answer question—you must show your work

3. $\boxed{\text{4 marks}}$ Find the solution to the differential equation $\dfrac{dy}{dx} = 9\sqrt{xy}$ whose graph intersects the point $(1, 4)$, expressed in the form $y = f(x)$.

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