9.3: Particle in a Gravitational Field

The Unhindered Quantized Bouncing Particle

- Integration limit: $z_{max} = 3$
- Mass: $m = 2$
- Acceleration due to gravity: $g = 1$

The first 10 roots of the Airy function are as follows:

a_1 = 2.33810	a_2 = 4.08794	a_3 = 5.52055	a_4 = 6.78670	a_5 = 7.94413
a_6 = 8.02265	a_7 = 10.04017	a_8 = 11.00852	a_9 = 11.93601	a_{10} = 12.82877

Calculate energy analytically by selecting the appropriate Airy function root:

$$\text{i} = 1 \quad \text{E} = \frac{mg^2}{2}^{\frac{1}{3}} a_1 \quad \text{E} = 2.338$$

Generate the associated wavefunction numerically: Potential energy: $V(z) = mgz$

Given $\frac{-1}{2 \cdot m} \frac{d^2}{dz^2} \psi(z) + V(z)\psi(z) \equiv E\psi(z)$

$$\psi(0.0) = 0.0$$

$$\psi'(0.0) = 0.1$$

Given, $\psi = Odesolve(z, z_{max})$

Normalize wavefunction: $\psi(z) = \frac{\psi(z)}{\sqrt{\int_0^{zmax} \psi(z)^2 dz}}$