1 Problem 1

The approximate error leaves neglects errors of $\mathcal{O}\left(h^3\right)$ or higher in approximating the true error so it will be off. The approx error is 0.026633333333333137 and the real error is 0.02666000000000572

2 Problem 2

2.1 a

$$
\begin{aligned}
E &= \frac{m}{2}\frac{dq}{dt}^2 + V(q) \\
\frac{2}{m}\left(E - V(q)\right) &= \frac{dq}{dt}^2 \\
dt &= \sqrt{\frac{m}{2}}\frac{dq}{\sqrt{E - V(q)}} \\
t\Big|_0^{t=T/4} &= \int_0^a \sqrt{\frac{m}{2}}\frac{dq}{\sqrt{E - V(q)}} \\
\frac{T}{4} &= \int_0^a \sqrt{\frac{m}{2}}\frac{dq}{\sqrt{E - V(q)}} \\
T &= \sqrt{8m}\int_0^a \frac{dq}{\sqrt{E - V(q)}}
\end{aligned}
$$

2.2 b

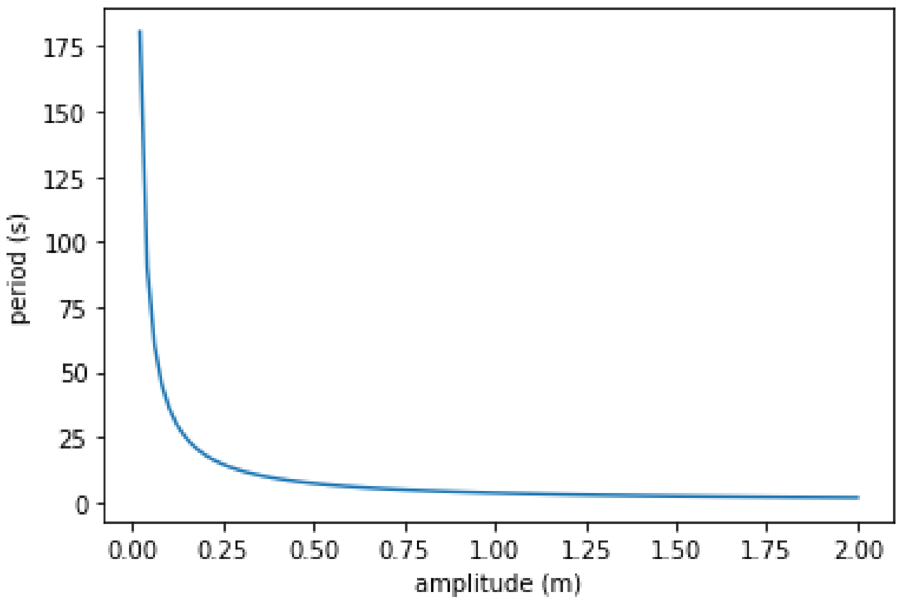

Figure 1: Period of Oscillator against amplitude

2.3 c

As $a \to 0$, the physical situation becomes a particle at rest in equilibrium. This particle wont move thus an infinite period. For potential that goes as x^n the integral can be approximated as $\approx \frac{a}{\sqrt{a^n}}$. Thus for $n < 2$, the period increases as a grows, vice versa for $n > 2$. At $n = 2$, we expect a constant period for any initial amplitude, which is what we see for a simple harmonic oscillator.

3 Problem 3

Notice for this problem $\left[\sqrt{\frac{m\omega}{\hbar}}\right] = \frac{1}{L}$ is unitless. Therefor, distance is unitless. Amplitude needs unit such that when square and integrated over distance, it gives a unitless probability. Therefor amplitude is also unitless here. For Hermite-Gaussian quadrature to perfectly determine the rms distance of a wave function of energy n, it needs $2n + 2$ points, $2n$ for the n^2 of the wave-function square amplitude, plus 2 from the x^2 term.

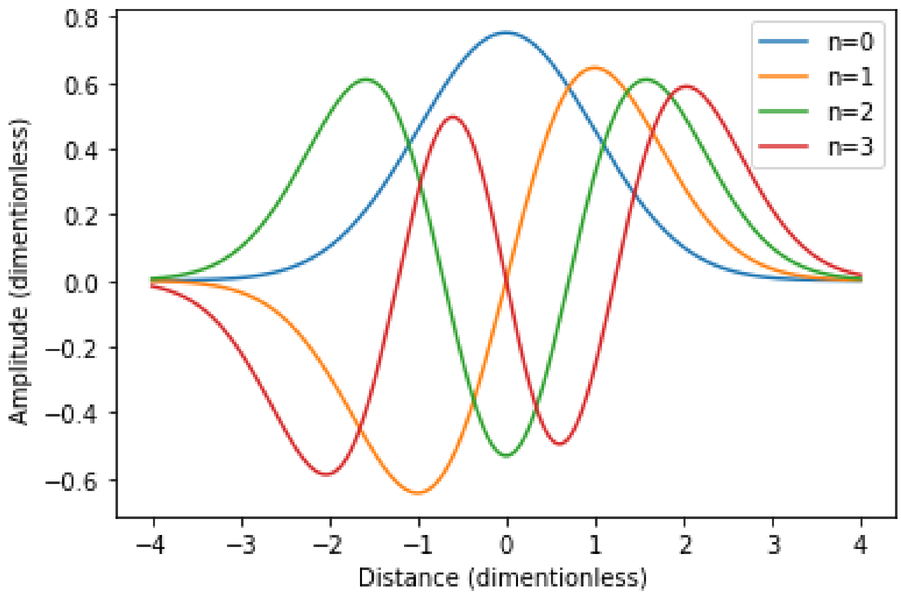

Figure 2: $|0\rangle$,$|1\rangle$,$|2\rangle$,$|3\rangle$

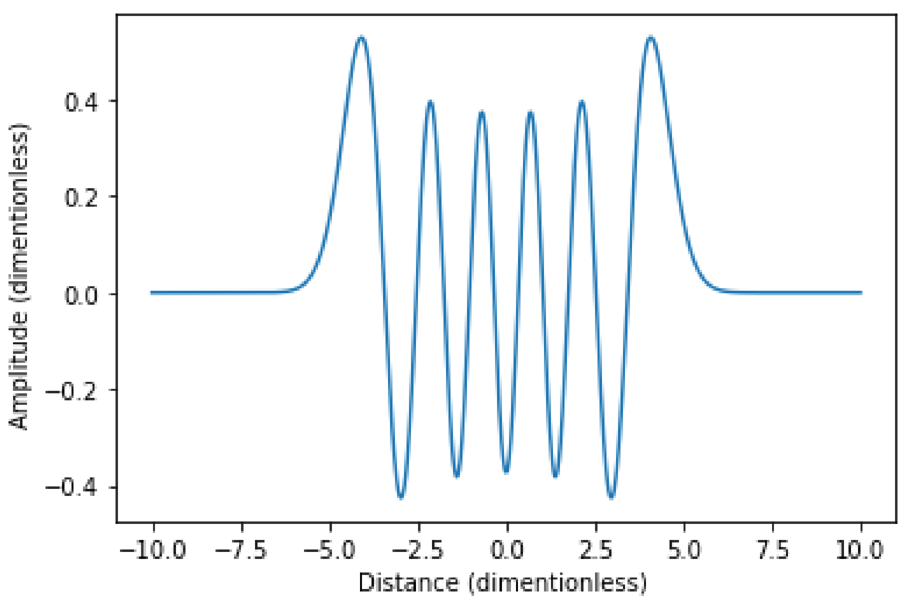

Figure 3: $|10\rangle$