PS-4 Solution

Nana Ama Darpaah

December 9, 2024

This is my GitHub link: Nana Ama's GitHub Link

1 Question 1

Th heat capacity of a solid at temperature T, as expressed by Debye's theory, is given by

$$C_v = 9V\rho k_B(T/\theta_D^3)\int_0^{\theta_D/T}(x^4\exp(x))/(exp(x)-1)^2dx \tag{1}$$

where V is the volume, ρ is the number density of atoms, k_B is Boltzmann's constant and θ_D is the Debye temperature.

At V = $1000cm^3$, $\rho = 6.022e28m^{-3}$ and $\theta_D = 428K$ at N = 50 sample points, the function cv(T) was created using Gaussian quadrature which yielded the heat capacity at a specific temperature.

A plot of heat capacity against temperature ranging from T = 5 K and T = 500 K was made using the function above. The result is as shown in Figure 1.

2 Question 2

Using

$$T = \sqrt{8m}\int_0^a dx/\sqrt{V(a)-V(x)} \tag{2}$$

Gaussian quadrature was used to evaluate the integral within the function using N = 20 points and a graph of the period against amplitude was plotted from a = 0 to a = 2. The graph is shown below.

It can be seen from the graph in Figure 2 that as amplitudes increase, the oscillator gets faster.

3 Question 3

For n = 0, 1, 2, 3 at x = -4 to x = 4, the graph of ψ_n against x yields the result in Figure 3

For n = 30 at x = -10 to x = 10, the graph of ψ_n against x yields The uncertainty was found to be 2.3452078737858177

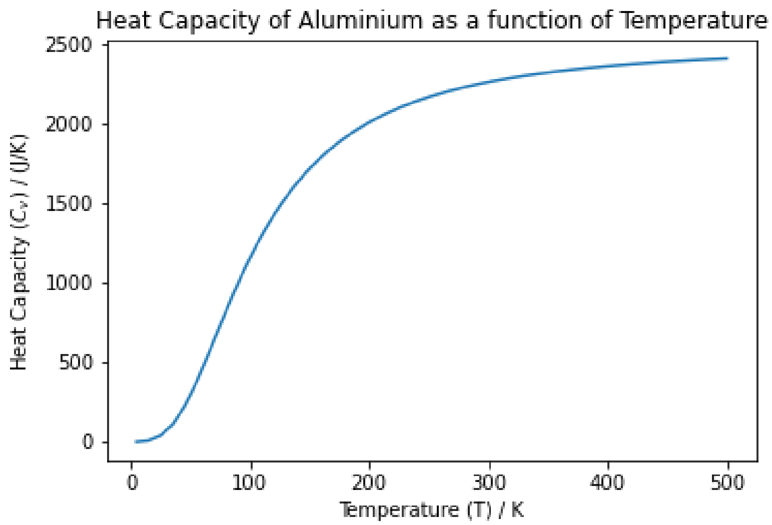

Figure 1: A graph of the heat capacity of aluminium against temperature

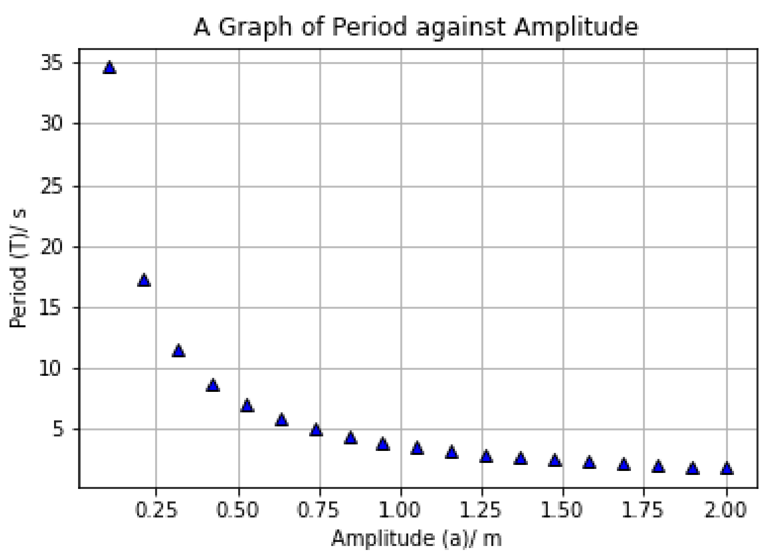

Figure 2: A graph of period against amplitude of an harmonic oscillator

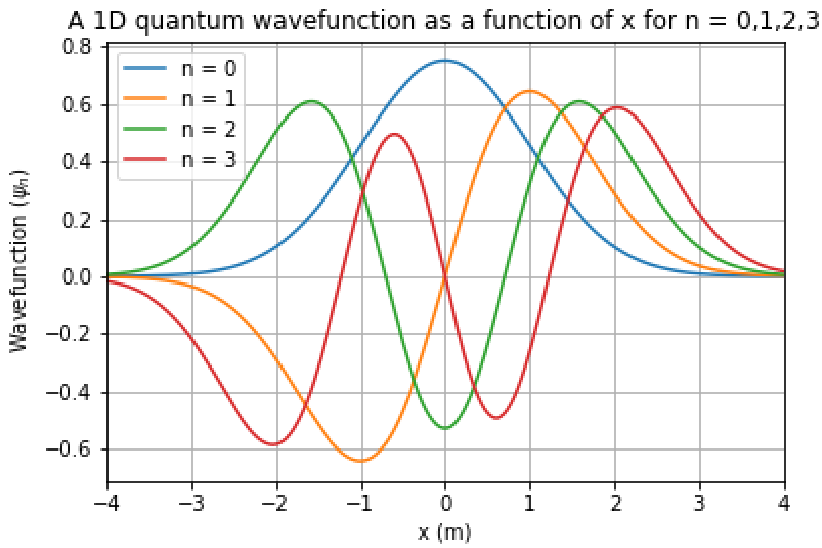

Figure 3: A graph of first 4 wavefunction plots of n against x

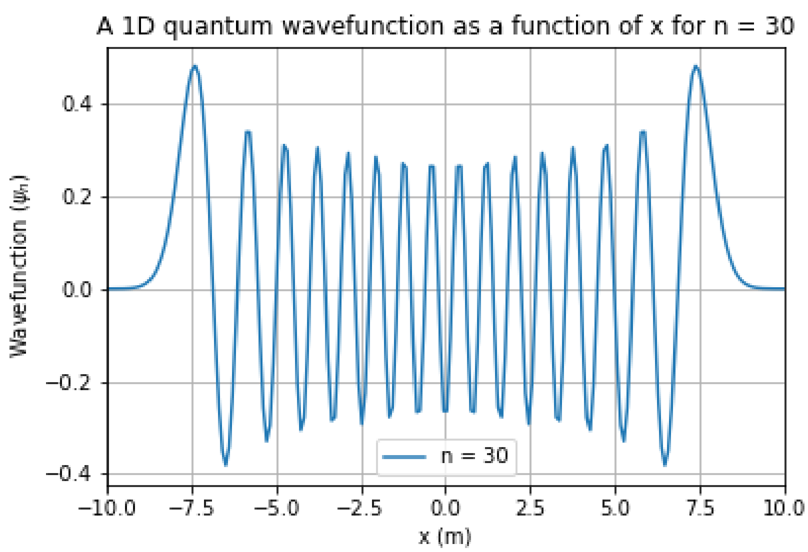

Figure 4: A plot of the wavefunction at n = 30 against x