PS4

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https://github.com/PSH-hub24/phys-ga2000

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1 Q1

Fig 1 shows the heat capacity from 5K to 500K. Fig 2 shows the plot with different choices of N. But the curves mostly overlap with each other even after decreasing the linewidth, so it is hard to tell the difference.

2 Q2

Since $E = V(a)$, rearranging we have

$$\frac{dx}{dt} = \sqrt{\frac{2(V(a) - V(x))}{m}}. \tag{1}$$

Separate dx and dt, then integrate over a quarter of the period T (0 to $T/4$ w.r.t t, 0 to a w.r.t x), we have

$$\frac{T}{4} = \int_0^a \sqrt{\frac{m}{2(V(a) - V(x))}} dx \tag{2}$$

which give

$$T = \sqrt{8m} \int_0^a \frac{dx}{\sqrt{V(a) - V(x)}}. \tag{3}$$

Fig 3 shows the plot of period for part b. The result makes sense because the potential is $V(x) = x^4$. It leaves some order of x in the denominator of the definite integral of x, which gives a inversely proportional relationship between T and amplitude.

3 Q3

Fig 4 shows the wavefunctions for $n = 0, 1, 2, 3$. Fig 5 plots $n = 30$. Fig 6 calculates the rms position for part c and part d.

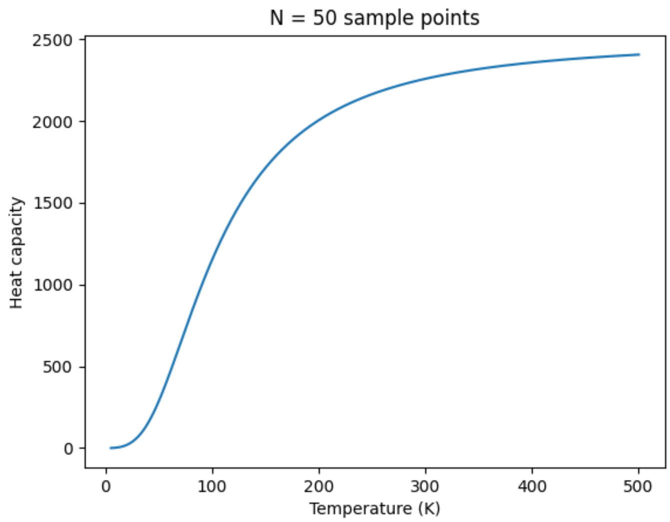

Figure 1: The plot for Q1 part b.

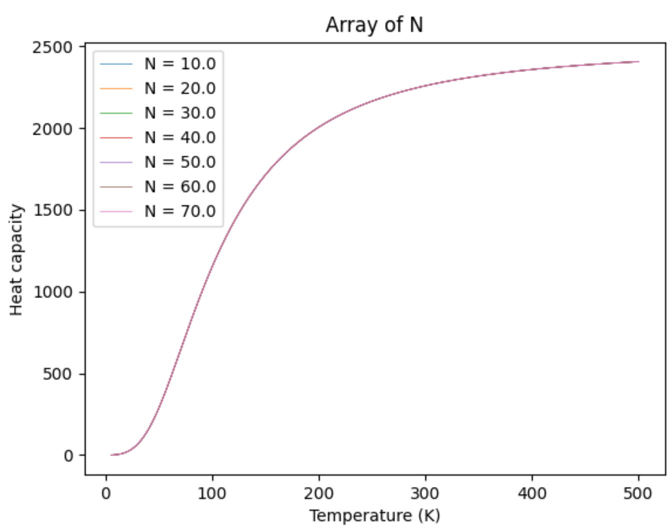

Figure 2: Q1 part c, different choices of N.

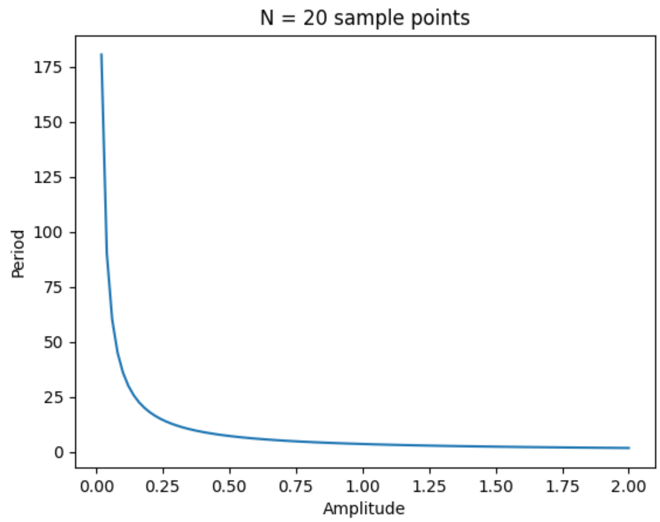

Figure 3: Q2 part b, the period for amplitudes ranging from 0 to 2.

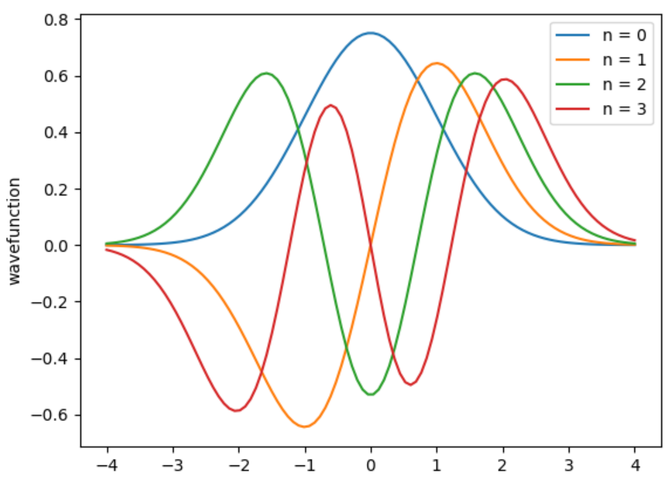

Figure 4: Q3 part a, the wavefunctions for $n = 0, 1, 2, 3$.

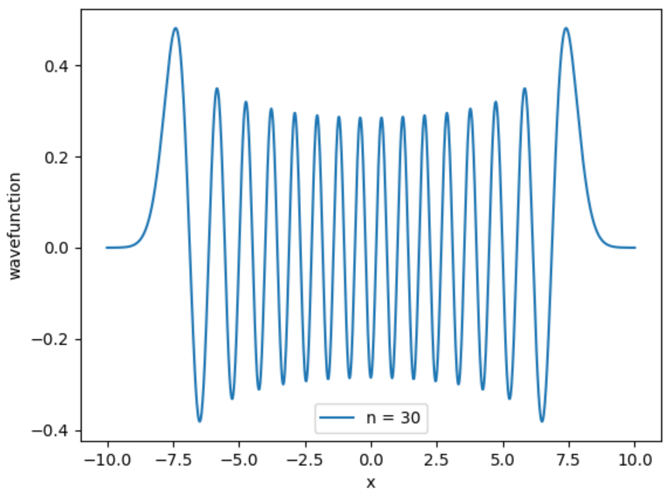

Figure 5: Q3 part b, $n = 30$.

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part c: The rms of the particle for n = 5 is 2.3452078797796547.
part d answer: 2.3452078799117135
[Finished in 2.1s]
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Figure 6: Q3 part c and d, the rms position calculated using the previous program (part c) and Gauss-Hermite quadrature (part d).