Oscillations and Waves

1. A sound wave travels through air with a speed of 340 m/s.
   a. If the wavelength is 0.5 m, what is its wavenumber. 12.57 m^{-1}
   b. Using the relationship $\omega = \kappa v$, calculate the angular frequency 4273 rad/s
   c. What is the frequency of the wave? 680 Hz

2. Given the equation of a wave

$$x = 2400\, e^{i(1.14 \times 10^{7} z - 1.8 \times 10^{15} t + 0.8)}$$

   a. What is the wavelength? 5.51 nm
   b. What is the frequency? 2.86 x 10^{14} Hz
   c. What is the speed of the wave? 1.58 x 10^{8} m/s
   d. What is x when z = 6 x 10^{-5} and t = 9 x 10^{-14} s? 652
   e. Find at least two times when x = 1750 at the point z = 52.5 nm.
      i. You need the solution of the equation $\cos(1.14 \times 10^{7} z - 1.8 e^{15} t + 0.8) = 1750/2400 = 0.729$
      ii. There are multiple solutions equal to 0.754 rad + 2nπ, where n is any integer.
      iii. If n = 0 then t = 3.58 x 10^{-16} s
      iv. If n = 1 then t = -3.13 x 10^{-15} s
      v. If n = 2 then t = -6.62 x 10^{-15} s
      vi. If n = 3 then t = -1.01 x 10^{-14} s
      vii. If n = 4 then t = -1.36 x 10^{-14} s

3. Given three oscillators
   a. $x_1 = 5\, e^{i(200t)}$
   b. $x_2 = 8\, e^{i(200t+0.25)}$
   c. $x_3 = 4\, e^{i(200t+0.6)}$

   Find the amplitude and phase angle of the sum of these oscillators.

$$\begin{aligned} \sum x &= 5\, e^{i(200t)} + 8\, e^{i(200t+0.25)} + 4\, e^{i(200t+0.6)} \\ &= e^{i(200t)} (5 + 8\, e^{i0.25} + 4\, e^{i0.6}) \\ &= e^{i(200t)} (16.05 + 4.24i) \\ &= e^{i(200t)} (16.6\, e^{i0.258+2n\pi}) \end{aligned}$$

   Amplitude = 16.6
   Phase = 0.258 + 2nπ rad = 14.8° + n360°