1. Yes. The instant the SHO is at its center, the acceleration will be 0 as it is in equilibrium.
2. $m = 2kg$

   $k = 50\frac{N}{m}$

   $A = 0.04m$

   $v = \pm A\sqrt{\frac{k}{m}} = 0.2\frac{m}{s}$

   $2v = \pm (2A)\sqrt{\frac{k}{m}} = A\sqrt{\frac{k}{(\frac{1}{4}m)}} = 0.4\frac{m}{s}$

   Amplitude can be doubled, which means that you will need to push the block 8cm. Another way to double the velocity is to cut the mass by ¼ , which means you must make the block weigh $0.5kg$
3. You must use the stopwatch to get the period T

   $T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{L}{9.8}}$

   $L = 0.2482t^2$
4. A.

   Use Hooke's law and Newton's 2nd law:

   $F = -kx = \pm 10.2N$

   $a = \frac{F}{m} = \pm 2.55\frac{m}{s^2}$

   B.

   $E = \frac{1}{2}kA^2 = 0.306J$

   C.

   Fastest velocity will be at equilibrium point, therefore:

   $\frac{1}{2}mv^2 = \frac{1}{2}kA^2$

   $v = \pm 0.391\frac{m}{s}$

   D.

   The system's energy at any time can be represented by:

   $\frac{1}{2}kA^2 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$

   $v = \sqrt{\frac{A^2k - kx^2}{m}} = \pm 0.3387\frac{m}{s}$
5. A. Assuming A+ is right: 0, 4, 8

   B. Assuming A- is left: 2, 6

   C. Points 1, 3, 5, 7
6. At equilibrium, the block moves at $0.2\frac{m}{s}$ and can be represented by this equation:

   $E = \frac{1}{2}mv^2$

   Triple Energy:

   $3E = \frac{1}{2}m(\sqrt{3}v)^2$

   Velocity must be $0.346\frac{m}{s}$

7. A.

First calculate the frequency: $\frac{4.5}{0.8} = 5.625Hz$

Use frequency to calculate period: $T = \frac{1}{f} = 0.177$

$T = 2\pi\sqrt{\frac{m}{k}}$

$m = 0.1547kg$

B.

Get calculation from 7A: $T = 0.177$

C.

Get calculation from 7B: $f = 5.625Hz$

8. A.

Frequency: $0.16Hz$

Period: 6.25 seconds

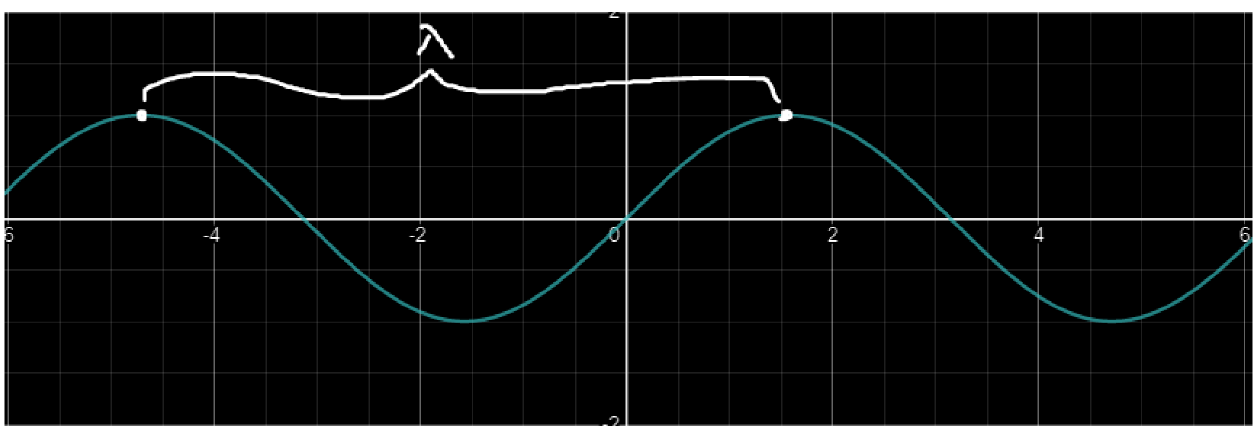
B.

When frequency increases, the period gets smaller. This means that the wave "refreshes" more, or the wavelength gets smaller.

When frequency decreases, the period gets greater, which means that the wave "refreshes" less. This means that the wavelength becomes greater

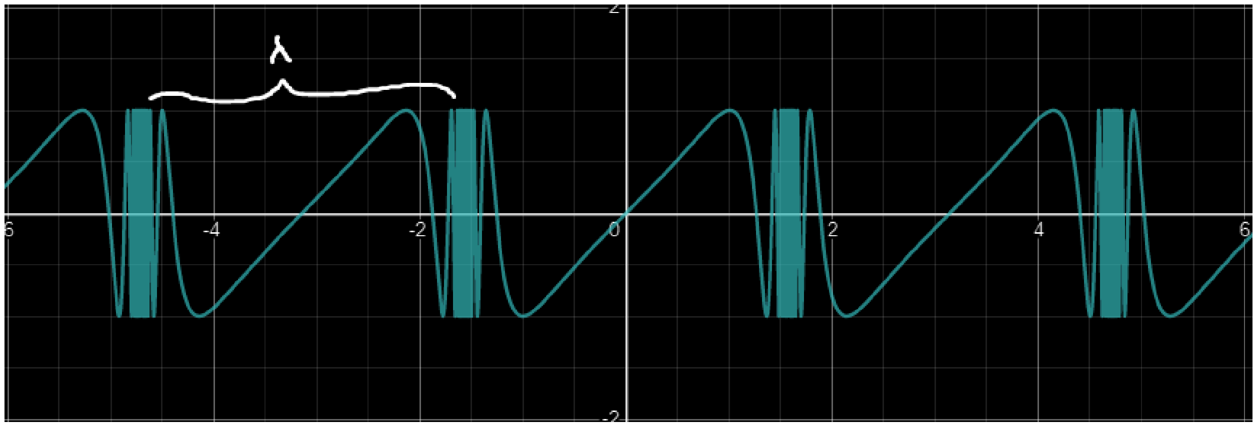
9. Around $6.2m$

10. Transversal:



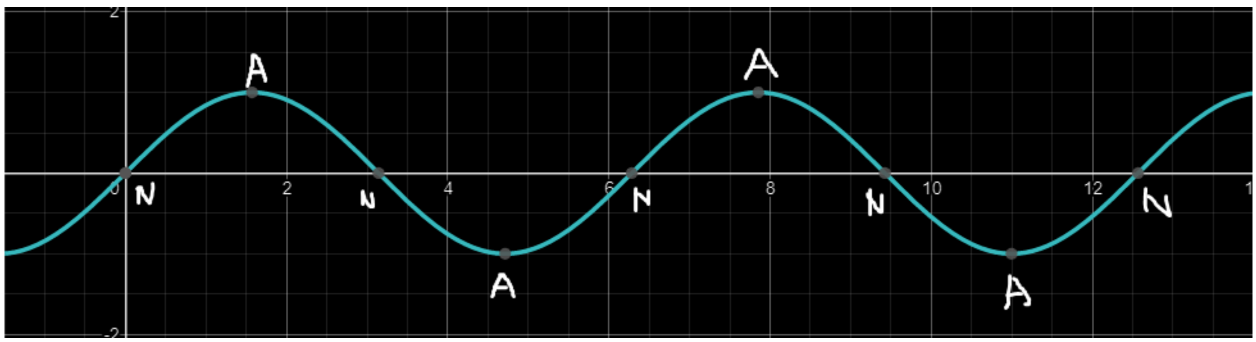
Equation: $f(x) = sin(x)$

Longitudinal:

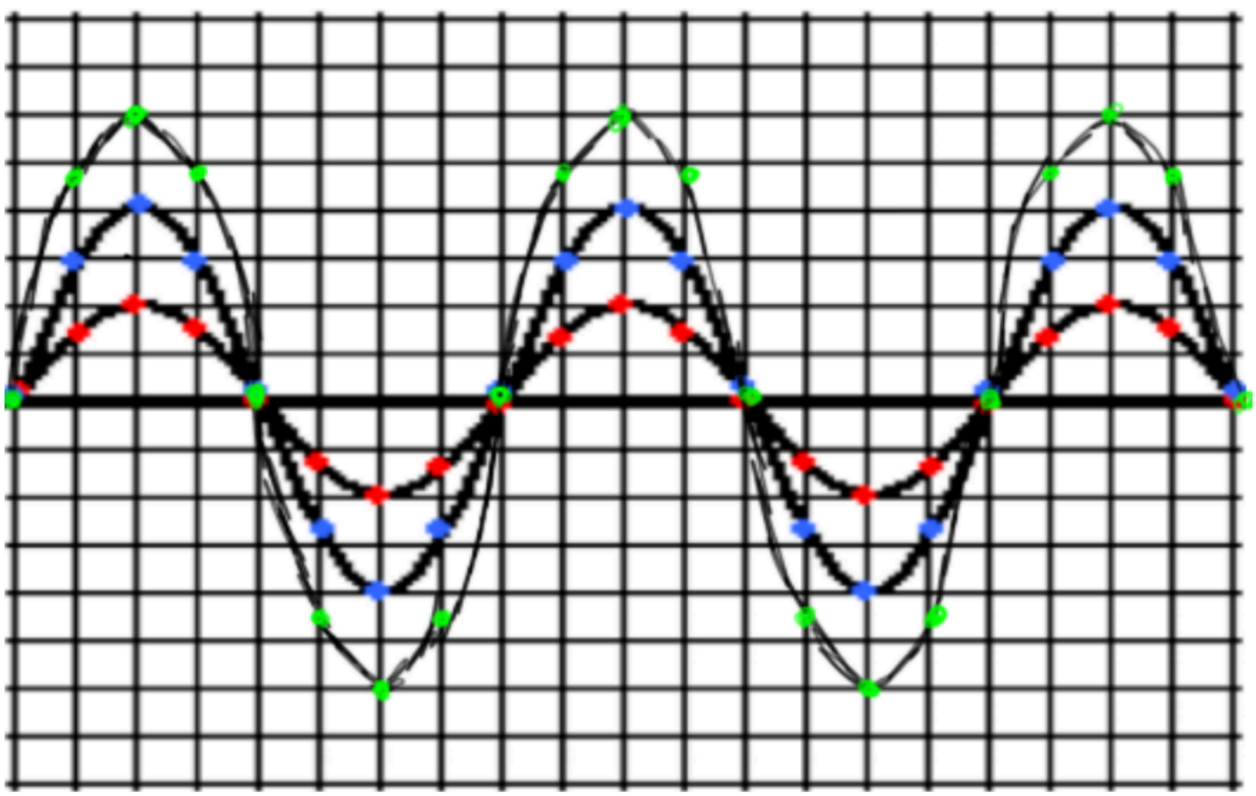


Equation: $sin(tan(x))$

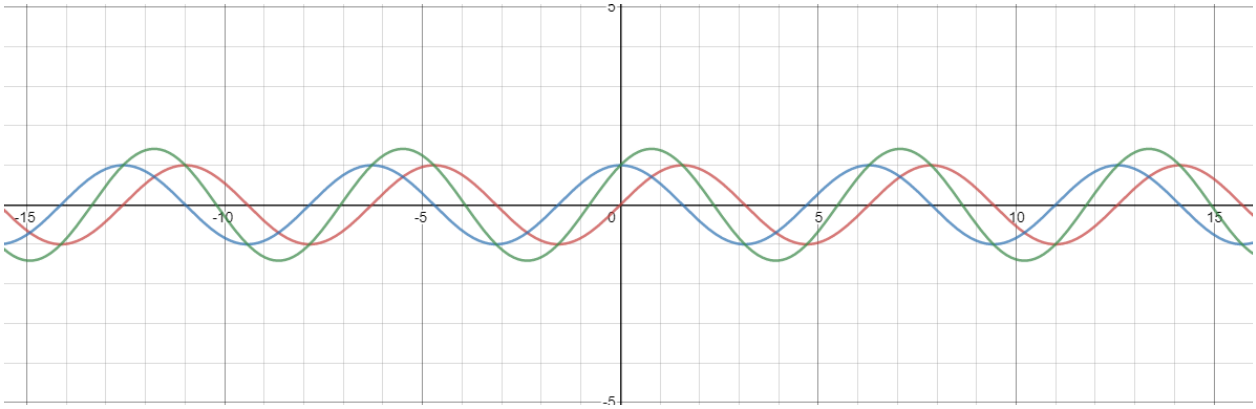
11. Equation: $sin(x)$



12. First Graph



Second Graph:



$sin(x) + cos(x)$ (Result): Green

$sin(x)$: Red

$cos(x)$: Blue

13. A.

    The longest harmonic standing wave will be the first harmonic standing wave.

    $L = \frac{\lambda}{2}$

    $\lambda = 6m$

    B.

    The second longest harmonic wave will be the second harmonic standing wave

    $L = \lambda = 3m$

    C.

    When a standing wave has 4 nodes, this means it is the third harmonic standing wave

    $f_n = \frac{nv}{2L}$

    $f_3 = \frac{3v}{2L} = 4Hz$

14. From the image provided, we can tell that b has a greater beat period. Period is inversely related to frequency, which means that if the frequency is greater, the period must be smaller. This means a is further apart
15. Whichever point is going the fastest towards the ball will have the greatest frequency. This means when it is heading towards the whistle and at point C, the whistle will have the greatest velocity
16. $350Hz \pm 4Hz = 346Hz,\ 354Hz$

    $355Hz \pm 9Hz = 346Hz,\ 364Hz$

    $346Hz$is seen in both
17. A.

    Using the equation $f_n = \frac{nv}{4L}$and assuming velocity is$343\frac{m}{s}$

    Fundamental Frequency:

    $f_1 = \frac{1\times343\frac{m}{s}}{4\times1.12m} = 76.5625Hz$

    Third Harmonic:

    $f_3 = \frac{3\times343\frac{m}{s}}{4\times1.12m} = 229.688Hz$

B.

Using the equation $f_n = \frac{nv}{2L}$ and assuming velocity is $343\frac{m}{s}$

Fundamental Frequency:

$f_1 = \frac{1 \times 343\frac{m}{s}}{2 \times 1.12m} = 153.125Hz$

Third Harmonic

$f_3 = \frac{3 \times 343\frac{m}{s}}{2 \times 1.12m} = 459.375Hz$

18. A.

Using the equation $f_1 = \frac{v}{2L}$

$330Hz = \frac{v}{2 \times 0.73m}$

$v = 481.8\frac{m}{s}$

Solve for d in the equation: $f_1 = \frac{v}{2(L-d)}$

$440Hz = \frac{481.8\frac{m}{s}}{2(0.73m-d)}$

$d = 0.1825m$

The non-vibrating length must be $0.1825m$ away from the other side

B.

$\lambda_1 = 2L$

$L = 0.73m - 0.1825m = 0.5475$

$\lambda_1 = 1.095m$

19. A. The apparent frequency is actually higher compared to the actual frequency because of the doppler effect.

B. The apparent frequency starts increasing compared to the original actual frequency