Exam I-Key

Physics 0082 September 24, 2013

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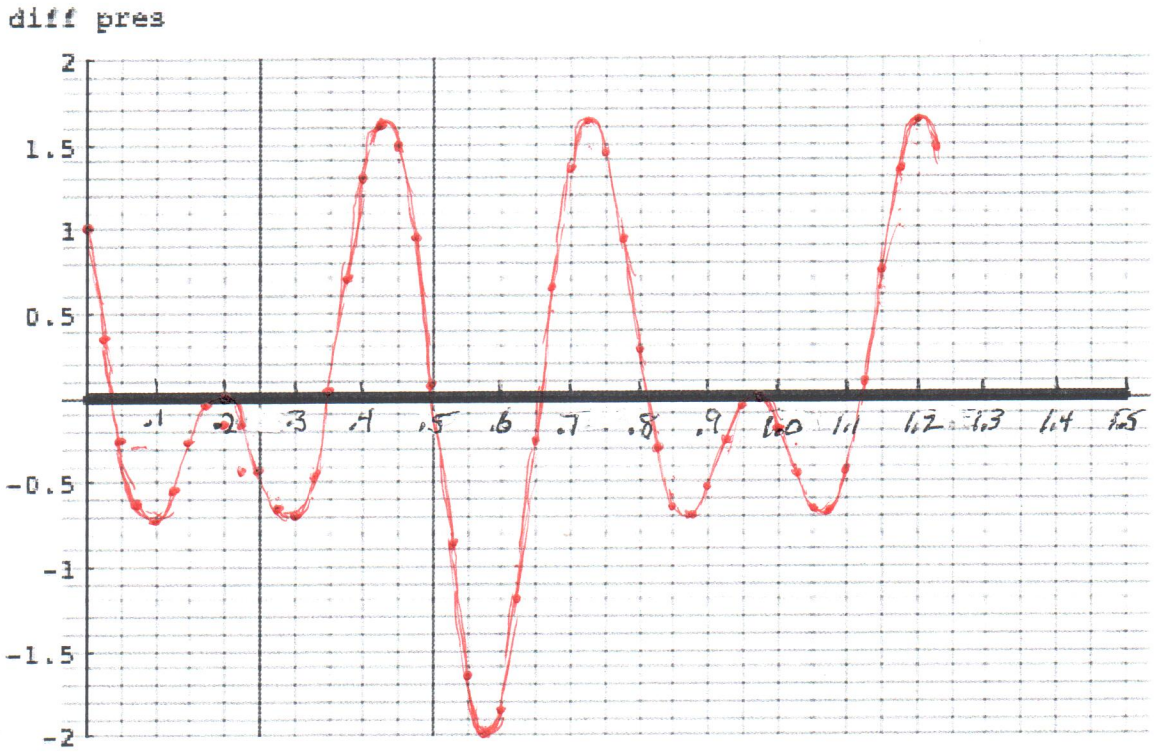
Instructions: Do the superposition of waves question on the graph paper provided with the exam. Answer the multiple-choice by circling the letter next to the correct answer. For the true false section, circle either True or False. The graphing question is worth 20pts and each multiple choice or true false question is worth 4 points for a total of 100pts.

Adding Waves

The table below gives the sinusoidal dependence of two waves, F_1 and F_2, as a function of the distance X from the sound source in meters. Add the two waves together by writing their numerical sum in the column R of the table. Then plot the **resultant wave** on the graph paper with your exam. Mark each point you plot with a **legible dot**. Then draw a smooth curve through your points so that the shape of the resultant wave is clear. The plot should show at least one full wavelength. You don't have to calculate or plot every point, but you must **include enough points** so that your smooth curve is **clearly defined** and **well drawn**.

Post Exam Comment by the Instructor. In making my own plot, I found it difficult to draw the resultant curve accurately without plotting all the points. Some of you tried to do this without plotting all the points and got into some trouble by guessing when you couldn't really tell what was happening. This is like a SUDOKU puzzle. You should never guess! I have put in all the addition in the table below. Some of you made mistakes here. Plotting more points should help identify mistakes of this sort. With this particular example, it is difficult to know where one the curves starts to repeat without plotting out to about $X = 0.9$. I have included my own effort at drawing the resultant complex wave.

X	F_1	F_2	R	X	F_1	F_2	R	X	F_1	F_2	R
0.	1.	0.	1.0	.500	-.27	.36	.09	1.0	-.85	.67	-.18
.025	.92	-.57	.35	.525	-.63	-.24	-.87	1.025	-.57	.13	-.44
.050	.69	-.94	-.25	.550	-.89	-.75	-1.64	1.050	-.20	-.46	-.66
.075	.34	-.97	-.63	.575	-1.00	-.99	-1.99	1.075	.20	-.87	-.67
.100	-.06	-.65	-.71	.600	-.95	-.88	-1.83	1.100	.57	-.99	-.42
.125	-.45	-.09	-.54	.625	-.74	-.45	-1.19	1.125	.85	-.74	.11
.150	-.76	.49	-.27	.650	-.41	.15	-.26	1.150	.99	-.22	.77
.175	-.96	.90	-.06	.675	-.02	.69	.67	1.175	.97	.38	1.35
.200	-.99	.99	0	.700	.38	.98	1.36	1.200	.79	.84	1.63
.225	-.87	.71	-.16	.725	.71	.92	1.63	1.225	.48	1.00	1.48
.250	-.60	.18	-.42	.750	.93	.53	1.46	1.250	.09	.80	.89
.275	-.24	-.41	-.65	.775	1.00	-.06	.94	1.275	-.31	.31	-.62
.300	.17	-.86	-.69	.800	.90	-.62	.28	1.300	-.66	-.29	-.95
.325	.54	-1.0	-.46	.825	.66	-.96	-.30	1.325	-.90	-.79	-1.69
.350	.83	-.78	.05	.850	.31	-.95	-.64	1.350	-1.00	-1.00	-2.0
.375	.98	-.27	.71	.875	-.09	-.60	-.69	1.375	-.93	-.85	-1.78
.400	.98	.33	1.31	.900	-.48	-.04	-.52	1.400	-.71	-.40	-1.11
.425	.81	.81	1.62	.925	-.79	.54	-.25	1.425	-.38	.20	-.18
.450	.51	1.0	1.51	.950	-.97	.93	-.04	1.450	.02	.73	.75
.475	.13	.83	.96	.975	-.99	.98	-.01	1.475	.41	.99	1.40
								1.500	.74	.90	1.64



✓ 20/20

In grading your curves, I matched them with my own. Significant discrepancies were penalized. Points were also taken off for not plotting at least one wavelength.

Multiple Choice (Circle the correct answer)

Post Exam Comment: I have indented the correct choice by 0.5 inches.

The following description applies to questions 1-7: A pressure wave is described by

$$\Delta p = \Delta p_0 \sin\left[\frac{2\pi}{\lambda}\left(x - vt\right)\right],$$

where positive x is in the direction of the traveling wave, v is the velocity of the wave, and λ is the wavelength. Figure 1 shows the time dependence t in seconds of the sound wave at a human ear located in space at $x = 0$. Figure 2 shows the spatial dependence x in meters at the fixed moment in time t = 0.

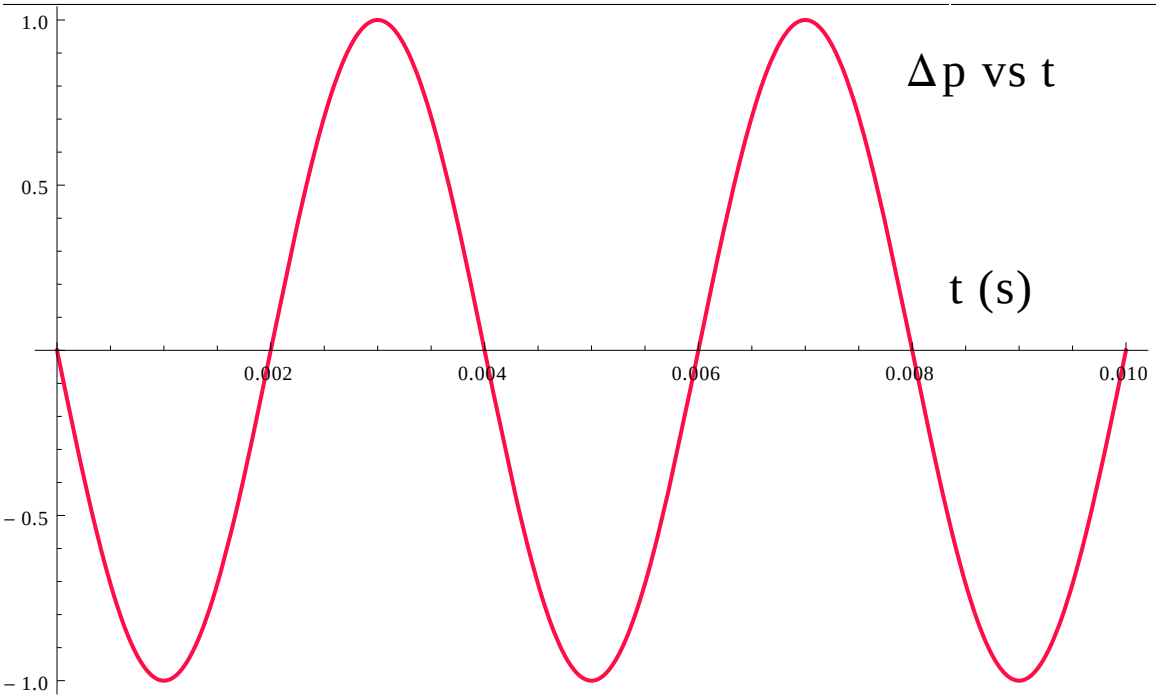


Fig. 1: This figure shows the time dependence t in seconds of the differential pressure wave describe above.

1. What is the period of the wave in seconds?

   (a) 0.001 s
   (b) 0.002 s
   (c) 0.004 s
   (d) 0.006 s
   (e) 0.008 s

2. What is the frequency of the wave in Hz?

   (a) 1000 Hz
   (b) 750 Hz
   (c) 500 Hz
   (d) 250 Hz
   (e) 167 Hz

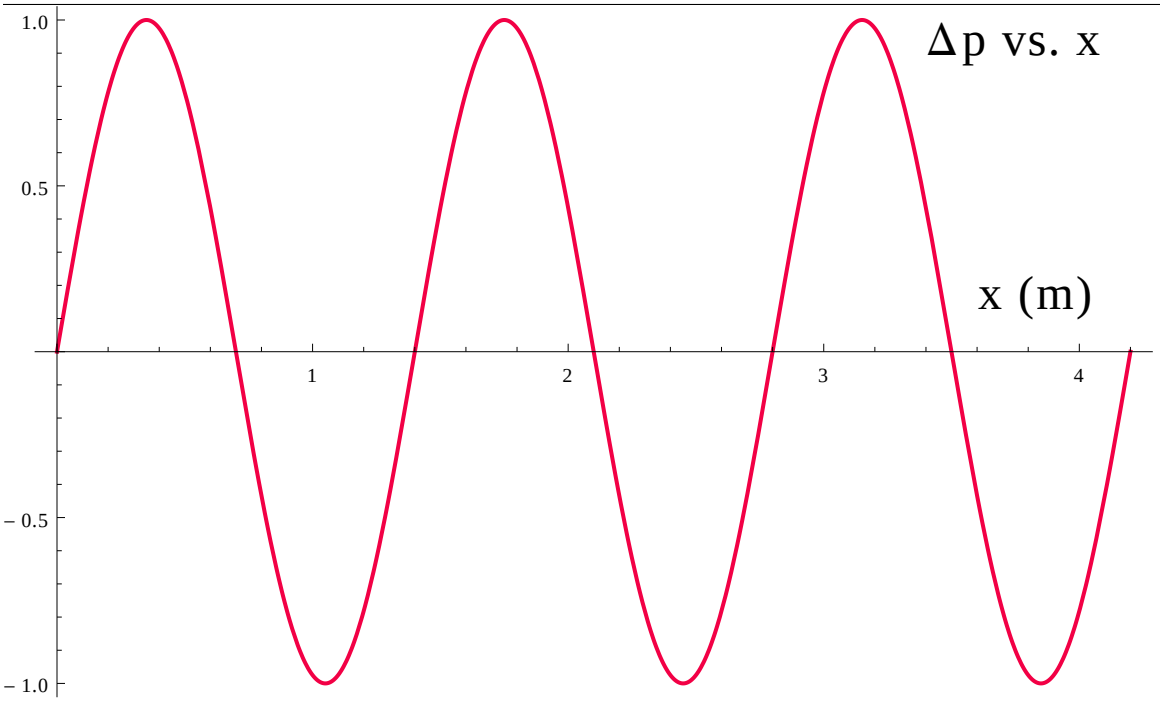


Fig. 2: This figure show the spatial dependence x in meters of the differential pressure wave describe above.

3. What is the wavelength in meters?

   (a) 0.30 m
   (b) 0.6 m
   (c) 1.0 m
   (d) 1.4 m
   (e) 2.8 m

4. What is the velocity v of the wave in m/s?

   (a) 300 m/s
   (b) 600 m/s
   (c) 250 m/s
   (d) 233 m/s
   (e) 350 m/s

5. What is the propagation constant k?

   (a) 18.0 m^{-1}
   (b) 8.98 m^{-1}
   (c) 4.49 m^{-1}
   (d) 2.99 m^{-1}
   (e) 2.24 m^{-1}

6. What is the angular frequency ω?

   (a) 1571 radians/s
   (b) 785 radians/s
   (c) 1178 radians/s
   (d) 6283 radians/s
   (e) none of the above

7. Assuming the independent variables x and t remain the same, how should the argument of the sine function be written if we use the parameters k and ω in place of λ and v.

   (a) $\Delta p = \Delta p_0 \sin[kx - \omega t]$
   (b) $\Delta p = \Delta p_0 \sin\left[\frac{x}{k} - \omega t\right]$
   (c) $\Delta p = \Delta p_0 \sin[kx + \omega t]$
   (d) $\Delta p = \Delta p_0 \sin\left[kx - \frac{t}{\omega}\right]$
   (e) $\Delta p = \Delta p_0 \sin\left[\frac{x}{k} - \frac{t}{\omega}\right]$

8. A complex tone composed of simple tones with frequencies 2f, 3f and 4f has a pitch characterized by the frequency

   (a) f
   (b) 2f
   (c) 3f
   (d) 4f
   (e) 6f

9. A sound source produces a certain sound-intensity level at a particular distance from the source. By how many decibels does the sound-intensity level diminish if we move to a point twice as far away?

   (a) 10 db
   (b) 6 db
   (c) 5 db
   (d) 3 db
   (e) 1 db

10. In question 9 if the near point has a loundness of 8 sones what is the loudness level LL in phons at the near point?

   (a) 30 phons
   (b) 45 phons
   (c) 50 phons
   (d) 60 phons
   (e) 70 phons

11. Adding to the information in questions 9 and 10, if we are told that the sound at the near point is at a frequency of 100 Hz, what is the sound-intensity level in db at the near point?

   (a) 57 db
   (b) 64 db
   (c) 66 db
   (d) 76 db
   (e) 80 db

True False Section (Circle the Correct Answer)

1. The period of a wave is the distance in space over which the wave pattern is spread before it repeats itself.

   (a) True
   (b) False

2. The period of a wave is equal to the reciprocal of the wavelength.

   (a) True
   (b) False

3. The frequency of a wave is the number of cycles it completes each second.

   (a) True

   (b) False

4. A simple tone can be represented by a sine wave.

   (a) True

   (b) False

5. A complex tone can be represented by a sum of sine waves of different frequencies.

   (a) True

   (b) False

6. Any periodic wave form no matter how complex can be regarded as the linear superposition of a harmonic series of sinusoidally varying waves whose frequencies are integer multiples of a fundamental frequency f, where f is equal to the reciprocal of the period of the complex wave.

   (a) True

   (b) False

7. Two sounds at different pitch are perceived by the human ear and brain as having equal loudness if they have an equal loudness level in phons.

   (a) True

   (b) False

8. Two sounds at different pitch are perceived by the human ear and brain as having equal loudness if they have the same sound-intensity level in decibels.

   (a) True

   (b) False

9. Two pure tones a musical fifth apart are the 3rd and 4th integer multiples of a fundamental frequency an octave below the lower pure tone.

   (a) True

   (b) False