Part I. Wave Problems. Take into account significant figures.

1. A woman jogger runs 25 complete laps in 5.0 min. a) What is her lap period in seconds? b) What is her frequency in Hertz?

2. A child on a swing completes 20.0 cycles in 25.0 s. Calculate a) the frequency and b) the period of the swing.

3. A stroboscope is flashing so that the time interval between flashes is 1.18×10^{-2} s. Calculate the frequency of the strobe lights flashes.

4. Calculate the frequency, in Hz, and the period, in seconds, of a tuning fork that vibrates 2.4×10^4 times in 1.00 min.

5. Determine the frequency, in Hz, of each of the following:

   a) If 95 crests in a slinky pass a fixed point in 12.7 s.

   b) If the period of a tuning fork is 0.00462 s.

6. A swimmer notices that 30.0 waves strike a break water in 1.00 min. What is ther period of the waves in seconds?

7. Determine the frequency of each of the following:

   a) A basketball player who scores 36 points in 24 min.

   b) A roadrunner who escapes a coyote 27 times in 9 min.

   c) A fan that turns 170.0 times in 15.0 s.

8. Determine the period of each of the following:

   a) The pulse from a human heartbeat that is heard 24 times in 15 s.

   b) A tuning fork that vibrates 2048 times in 8.0 s.

   c) The Moon, which travels around the Earth 6.00 times in 163.8 days.

9. Calculate the frequency, in Hz, of each of the following periods:

   a) 5.0 s

   b) 0.80 s

   c) 2.50×10^{-2} s

   d) 0.40 min

10. Calculate the period, in seconds, of each of the following frequencies:

    a) 10.0 Hz

    b) 500.0 Hz

    c) 0.25 Hz

    d) 102.1 MHz

11. A source with a frequency of 25 Hz produces water waves that have a wavelength of 3.0 cm. What is the speed of the waves in cm/s? m/s?

12. An FM radio station broadcasts with a frequency of $f = 109.3$ MHz, the speed of the waves is 3.00×10^8 m/s a) What is the period of the radio waves? b) What is the wavelength of the radio waves?

13. A pebble thrown in water creates waves with a wavelength, λ, of 14 cm and a frequency of 3.5 Hz. a) What is the velocity of the waves? b) How long will it take the waves to reach a shore 5.2 m away?

14. A hiker shouts towards a cliff 846 m away. He hears his echo 4.75 s later. What is the speed of sound in air?

15. A wave in a rope travels at a speed of 2.5 m/s. If the wavelength is 1.3 m, what is the period of the wave?

16. A sound wave travels at 350.0 m/s. What is the wavelength of a sound with a frequency of 1.4×10^3 Hz?

17. The wavelength of a water wave is 8.0 m and its speed is 2.0 m/s. How many waves will pass a fixed point in the water in 1.00 min?

18. The tine of a tuning fork, when struck, has an amplitude of 0.13 cm. If the frequency of the tuning fork is 200 Hz, what total distance will the tine travel in 1.00 min?

19. Water waves with a wavelength of 6.0 m approach a lighthouse at 5.6 m/s. a) What is the frequency of the waves? b) What is the period of the waves?

20. Two people are fishing from small boats located 30 m apart. Waves pass through the water, and each person's boat bobs up and down 15 times in 1.0 min. At a time when one boat is on a crest, the other is in a trough, and there is one crest between the two boats. What is the speed of the waves in m/s?

21. The wavelength of a water wave is 3.7 m and its period is 1.5 s. Calculate:
    a) The speed of the wave.
    b) The time required for the wave to travel 100.0 m.
    c) The distance traveled by the wave in 1.00 min.

22. A boat at anchor is rocked by waves whose crests are 30.0 m apart and whose speed is 8.0 m/s. What is the interval of time between crests striking the boat?

23. A television station broadcasts with a frequency of 90.0 MHz. If the speed of the electromagnetic wave emitted by the station tower is 3.00×10^8 m/s, what is the wavelength of the waves?

24. What are the wavelengths in air of the lowest and the highest audible frequencies if the range of human hearing is 20.0 Hz to 20.0 kHz. Assume the speed of sound is 342 m/s.

25. A source vibrates a string with a frequency of 103.6 Hz. The wavelengths produced are 2.70 cm. If the frequency is reduced by a factor of four, then what is the speed and wavelengths of the waves if the tension remains the same?

26. Waves traveling on a piece of string encounter a second piece of string tied to the first. The original waves have a speed of 43.8 cm/s and a frequency of 7.35 Hz. In the second medium the waves have a speed of 17.2 cm/s.
    a) What is the frequency of the waves in the second medium?
    b) What is the wavelength of the waves in the second medium?
    c) What is the orientation of the transmitted wave, erect or inverted?
    d) What is the orientation of the reflected wave, erect or inverted?

27. A standing wave interference pattern is produced in a rope by a vibrator with a frequency of 28.0 Hz. a) If the wavelength is 25.5 cm, what is the distance between successive nodes? b) What is the velocity of the wave in m/s?

28. The distance between the second and fifth nodes in a standing wave is 93.0 cm. a) What is the wavelength of the waves? b) What is the velocity if the source has a frequency of 12.5 Hz?

29. A string is vibrated such that a standing wave is produced.

    a) What is the wavelength of a vibrating string if the distance between adjacent nodes is 8.5 cm?

    b) What is the velocity of the waves if the frequency of the source is 21 Hz?

30. Standing waves are produced in a string by two waves traveling in opposite directions at 6.0 m/s. The distance between the second and sixth node is 80.0 cm. Determine the wavelength and the frequency of the propagating waves.

31. A standing wave pattern in a string is observed to have eight antinodes (with a node at the beginning and end of the pattern). The distance between the second and seventh node is 12.5 cm. The speed of the waves is 2125 cm/s. What frequency must the string be vibrated at to observe three antinodes?

32. A standing wave pattern in a string is observed to have 12 antinodes (with a node at the beginning and end of the pattern). The distance between the third and nineth node is 46.1 cm. The speed of the waves is 1577 cm/s. What frequency must the string be vibrated at to observe six antinodes?

33. A standing wave pattern in a string is observed to have five antinodes (with a node at the beginning and end of the pattern). The distance between the first and fifth node is 33.6 cm. The speed of the waves is 7756 cm/s. What frequency must the string be vibrated at to observe two antinodes?

Part II. Sound Problems

34. What is the speed of sound on a hot summers day when the temperature is 35 °C?

35. What is the speed of sound on a cool 265 °K day?

36. What temperature, in °C, results in a speed of sound being $v = 376$ m/s?

37. What temperature, in °C, results in a speed of 1.2×10^3 km/h?

38. On a particular day the speed of sound is 321 m/s. Using the Kelvin temperature scale, What is the speed of sound if **a)** the temperature doubles. **b)** the temperature triples. **c)** the temperature drops by a factor of four.

39. What is the observed frequency of a 6.50×10^3 Hz source moving **a)** towards a stationary observer at 95.0 m/s? **b)** away from a stationary observer at 95.0 m/s? Take the speed of sound to be $v = 325$ m/s

40. A firetruck emitts a frequency of 7.85×10^3 Hz and travels at $v_s = 80.50$ km/h. A car is traveling at $v_o = 62.70$ km/h. The speed of sound is $v = 346.0$ m/s. What frequency is heard by the car's driver if **a)** the vehicles are approaching each other? **b)** the vehicles are receding from each other?

41. What is the speed of truck, in km/h, if the driver hears a frequency of a police car to be $f_o = 1.77 \times 10^4$ Hz? The police car is driving 139 km/h and its siren has a frequency of $f_s = 1.4 \times 10^4$ Hz. The speed of sound is 334 m/s.

42. The air temperature is 23 °C. What frequency will be heard by someone standing on a corner as a police car drives away at 135 km/h and emitts a frequency of 2.3×10^3 Hz?

43. A fighter plane is traveling at half the speed of sound and emitts a frequency of 614.0 Hz. A commercial aircraft is traveling at one-fifth the speed of sound. What frequency is detected by the commercial plane if **a)** the planes are approaching each other? **b)** the planes are receding from each other?

44. A stationary observer at an air show watches a fighter plane approach it at one-third the speed of sound. The plane emitts a sound frequency of 15 Hz. What is the wavelength of the sound detected by the observer if the air temperature is 27 °C?

45. Joe and Dave have nothing better to do with their time so they run towards each other yelling as they go. Joe can run at an impressive 250 m/s and Dave can run at a slow 95 m/s. Joe yells at 1.60×10^3 Hz and Dave shouts at 355 Hz. The air temperature is a cool 265 °K. **a)** What frequency does Joe hear Dave shout at? **b)** What frequecy does Dave hear Joe yell at?

46. How fast must a source be moving relative to a stationary observer such that the observer hears a frequency **a)** three times that of the source? **c)** one-fourth that of the source? Take the speed of sound to by 325 m/s.

47. What fraction of the speed of sound must a source by moving so that a stationary observer hears a frequecy four times greater than the source frequency?

48. What fraction of the speed of sound must a source by moving so that a stationary observer hears a frequency two-thirds that of the source?

49. Two fighter planes approach each other, one traveling North and the other traveling South. The North bound plane is traveling at two-fifths the speed of sound. The south bound plane detects a frequency three times that of the source. What fraction of the speed of sound is the South bound plane traveling?

50. A Saskatoon firetruck races towards a fire at 117 km/h while its sirens roars at 1.250×10^4 Hz. A stationary observer along the way hears a frequency of 1.395×10^4 Hz. What month is the fire occuring?

Part III. Wave Phenomena. Answer in complete sentences.

51. Suppose you and your lab partner were asked to measure the speed of a transverse wave in a giant slinky. How could you do it? List the equipment you would need.

52. You are creating waves in a rope by shaking your hand back and forth. Without changing the distance your hand moves, you begin to shake it faster and faster. What happens to the amplitude, frequency, period, and velocity of the wave?

53. If you pull on one end of a Slinky, does the pulse reach the other end instantaneously? What if you pull on a rope? Hit the end of a metal rod?

54. A pulse is sent along a spring. The spring is attached to a light thread that is tied to a wall. Sketch the problem, label the point where the spring and string are attached **A** and label the point where the string attaches to the wall point **B**. a) What happens when the pulse reaches point **A**? b) Is the pulse reflected from **A** erect of inverted? c) What happens when the transmitted pulse reaches **B**? d) Is the pulse reflected from **B** erect or inverted?

55. A long spring runs acros the floor of a room and out the door. A pulse is sent along the spring. After a few seconds, an inverted pulse returns. Is the spring attached to the wall in the next room or is it lying loose on the floor?

56. If you want to increase the wavelength of waves in a rope, should you shake it at a higher or lower frequency?

57. Rhonda sends a pulse along a rope. How does the position of a point on the rope, before the pulse comes compare to the position after the pulse has passed?

58. What is the difference between a pulse and a wave?

59. Suppose you produce a wave by shaking one end of a spring back and forth. How does the frequency of your hand compare to that of the wave?

60. Waves are sent along a spring of fixed length. a) Can the speed of the waves be changed? Explain. b) Can the frequency of a wave in the spring be changed? Explain.

61. What is the amplitude of a wave and what does it represent?

62. When a wave reaches the boundary of a new medium, part of the wave is reflected and part is transmitted. What determines the amount of reflection?

63. What happens to the spring at nodes of a standing wave?

64. You repeatedly dip your finger into a sink full of water to make circular waves. What happens to the wavelength as you move your finger faster?

65. When a stone is dropped into water, the resulting ripples spread farther and farther out, getting smaller and smaller in amplitude. Why does the amplitude eventually decrease to zero?

66. What happens when two billiard balls collide head on? How does this differ from two waves or pulses that collide head on?

67. You send a pulse down a string that is attached to a second string with unknown properties. The pulse returns to you inverted and with a smaller amplitude. Is the speed of the waves faster or slower in the second string? Explain your reasoning.

Physics 20 Waves Phenomena Mr. MacDonald 31/02/2007

Answer List

1. a) $T = 12\,\text{s}$
   b) $f = 0.083\,\text{Hz}$
2. a) $f = 0.800\,\text{Hz}$
   b) $T = 1.25\,\text{s}$
3. $f = 84.7\,\text{Hz}$
4. $f = 4.0 \times 10^2\,\text{Hz}$, $T = 2.5 \times 10^{-3}\,\text{s}$
5. a) 7.5 Hz
   b) 216 Hz
6. 2.00 s
7. a) 1.5 points/min
   b) 3 escapes/min
   c) 11.3 rotations/s
8. a) 0.63 s
   b) $3.9 \times 10^{-3}\,\text{s}$
   c) 27.3 days/lunar cycle
9. a) 0.20 Hz
   b) 1.2 Hz
   c) 40.0 Hz
   d) $4.2 \times 10^{-2}\,\text{Hz}$
10. a) 0.100 s
    b) $2.000 \times 10^{-3}\,\text{s}$
    c) 4.0 s
    d) $9.794 \times 10^{-9}\,\text{s}$
11. $v = 75\,\text{cm/s},\ 0.75\,\text{m/s}$
12. a) $T = 9.149 \times 10^{-9}\,\text{s}$
    b) $\lambda = 2.74\,\text{m}$
13. a) $v = 49\,\text{cm/s}$
    b) $t = 11\,\text{s}$
14. $v = 356\,\text{m/s}$
15. $T = 0.52\,\text{s}$
16. $\lambda = 0.25\,\text{m}$
17. 15 waves
18. 62 m
19. a) 0.93 Hz
    b) 1.1 s
20. 5.0 m/s
21. a) 2.5 m/s
    b) 41 s
    c) $1.5 \times 10^2\,\text{m}$
22. 3.8 s
23. 3.33 m
24. 17 m to $1.7 \times 10^{-2}\,\text{m}$
25. Speed remains the same. $v = 280.\,\text{cm/s}$ Wavelength becomes increased by a factor of four, $\lambda = 10.8\,\text{cm}$
26. a) 7.35 Hz
    b) 2.34 cm
    c) erect
    d) inverted
27. a) $\textit{node dist.} = 12.8\,\text{cm}$
    b) $v = 7.14\,\text{m/s}$
28. a) $\lambda = 62.0\,\text{cm}$
    b) $v = 775\,\text{cm/s}$
29. a) 17 cm
    b) 360 cm/s
30. $\lambda = 40.0\,\text{cm}$ and $f = 15\,\text{Hz}$
31. $f_3 = 159\,\text{Hz}$
32. $f_6 = 51.3\,\text{Hz}$
33. $f_2 = 185\,\text{Hz}$
34. $v = 352\,\text{m/s}$
35. $v = 326\,\text{m/s}$
36. $T = 73.8\,^\circ\text{C}$
37. $T = 3.8\,^\circ\text{C}$
38. **a)** $v = 454\,\text{m/s}$ **b)** $v = 556\,\text{m/s}$ **c)** $v = 161\,\text{m/s}$
39. **a)** $f_o = 9.185 \times 10^3\,\text{Hz}$ **b)** $f_o = 5158\,\text{Hz}$

40. **a)** $f_o = 8.813 \times 10^3$ Hz **b)** $f_o = 7.000 \times 10^3$ Hz
41. $v_o = 142$ km/h
42. $f_o = 2.0 \times 10^3$ Hz
43. **a)** $f_o = 1474$ Hz **b)** $f_o = 327$ Hz
44. $\lambda_o = 15$ m
45. **a)** $f = 889$ Hz **b)** $f = 8.86 \times 10^3$ Hz
46. **a)** 216 m/s approaching the observer. **b)** 975 m/s receding from the observer.
47. $\frac{v_s}{v} = \frac{3}{4}$
48. $\frac{v_s}{v} = \frac{1}{2}$
49. $\frac{v_o}{v} = \frac{4}{5}$
50. *Not going to make it that easy, check your answer with me.*
51. *short answer*
52. *short answer*
53. *short answer*
54. *short answer*
55. *short answer*
56. *Lower*
57. *Same position*
58. *short answer*
59. *Same frequency*
60. *short answer*
61. *The distance of maximum displacement fromt the equilibrium position. Represents the wave's energy*
62. *The difference in wave velocity of the new medium.*
63. *No motion*
64. *Wavelength get smaller*
65. *Short answer*
66. *short answer*
67. *Short answer*

Catalog List

1. 20P BA 1	2. 20P BA 5	3. 20P BA 7	4. 20P BA 8
5. 20P BA 20	6. 20P BA 22	7. 20P BA 23	8. 20P BA 24
9. 20P BA 25	10. 20P BA 26	11. 20P BA 9	12. 20P BA 2
13. 20P BA 3	14. 20P BA 4	15. 20P BA 10	16. 20P BA 12
17. 20P BA 29	18. 20P BA 28	19. 20P BA 35	20. 20P BA 38
21. 20P BA 39	22. 20P BA 41	23. 20P BA 44	24. 20P BA 46
25. 20P BA 48	26. 20P BA 49	27. 20P BA 16	28. 20P BA 17
29. 20P BA 52	30. 20P BA 57	31. 20P BA 58	32. 20P BA 59
33. 20P BA 60	34. 20P BA 61	35. 20P BA 62	36. 20P BA 63
37. 20P BA 64	38. 20P BA 65	39. 20P BA 66	40. 20P BA 67
41. 20P BA 68	42. 20P BA 69	43. 20P BA 70	44. 20P BA 71
45. 20P BA 72	46. 20P BA 73	47. 20P BA 74	48. 20P BA 75
49. 20P BA 76	50. 20P BA 77	51. 20P BB 1	52. 20P BB 2
53. 20P BB 3	54. 20P BB 6	55. 20P BB 7	56. 20P BB 8
57. 20P BB 10	58. 20P BB 11	59. 20P BB 13	60. 20P BB 14
61. 20P BB 15	62. 20P BB 16	63. 20P BB 19	64. 20P BB 21
65. 20P BB 37	66. 20P BB 39	67. 20P BB 40	