EQUATIONS:

$$f = \frac{1}{T} \qquad i = \frac{\Delta q}{\Delta t} \qquad V_{a,b} = iR$$

$$\beta = 10\text{dB}\left(\log \frac{I}{I_0}\right) \qquad I_0 = 1 \times 10^{-12}\ \text{W/m}^2 \qquad \text{speed of sound in air} \approx 340\ \text{m/s}$$

$$v = \frac{\lambda}{T} \qquad v = f\lambda \qquad f_{obs} = f_{emitted}\left(\frac{v_{sound} \pm v_{obs}}{v_{sound} \mp v_{source}}\right)$$

$$F = q\mathbb{E} \qquad EPE = U = qV \qquad \mathbb{E} = \frac{\Delta V}{\Delta x}$$

$$F = k\frac{q_1 q_2}{r^2} \qquad U = k\frac{q_1 q_2}{r}$$

CONSTANTS:

Atomic mass unit: $u = 1.66 \times 10^{-27}$ kg

elementary electric charge $e = 1.6 \times 10^{-19}$ C

electrostatic constant $k = 9.0 \times 10^{9}$ N·m^2/C^2

1. T/F Sound waves are longitudinal waves.
2. T/F Sound travels through a vacuum.
3. T/F Light travels much faster than sound.
4. T/F Musical "pitch" means about the same thing as "frequency."
5. T/F The range of human hearing is 200 Hz to 2000 Hz.
6. What is the approximate speed of sound in air?
7. What kind of wave is sound? What other kinds of waves are there? Give examples.
8. What is the wavelength of 300 Hz sound in air?
9. A pipe of length L closed at one end and open at the other is resonating at its fundamental frequency. Which statement is correct?
   (a) The wavelength is 4L and there is a node at the pipe's open end.
   (b) The wavelength is 4L and there is an antinode at the pipe's open end.
   (c) The wavelength is 2L and there is an antinode at the pipe's open end.
   (d) The wavelength is 2L and there is a node at the pipe's open end.
   (e) The wavelength is L and there is an antinode at the pipe's open end.
10. You hear two flutes sounding the same note, A (440 Hz)–almost. You hear two beats per second. What does that tell you?
11. The fundamental frequency of a organ pipe, which is open at one end and closed at the other, is f_1. How many nodes are present in a standing wave of frequency $9f_1$ in this pipe? (Include nodes at the ends of the pipe, if any.)
    (a) 3
    (b) 4
    (c) 5
    (d) 6
    (e) 10
12. What causes the Doppler Effect and how does it affect what you hear?
13. A block attached to the lower end of a vertical spring oscillates up and down. If the force exerted by the spring is described by Hooke's Law, then the period of the oscillation of the block depends on which of the following?
    I. Mass of the block
    II. Amplitude of the oscillation
    III. Force constant of the spring
    (a) I only
    (b) II only
    (c) III only
    (d) I and II only
    (e) I and III only
14. If the mass of a simple pendulum is doubled but its length remains constant, its period is multiplied by a factor of
    (a) $\frac{1}{2}$
    (b) $\frac{1}{\sqrt{2}}$
    (c) 1
    (d) $\sqrt{2}$
    (e) 2
15. When a mass is attached to a spring, the period of oscillation is approximately 2.0 seconds. When the mass attached to the spring is doubled, the period of oscillation is most nearly
    (a) 0.5 s
    (b) 1.0 s
    (c) 1.4 s
    (d) 2.0 s
    (e) 2.8 s
16. What is Hooke's Law? What is "k" in Hooke's Law? What kind of graph would help you find k?
17. Where in SHM is the net force greatest? Least?
18. If an SHO oscillates right and left, when it is left of equilibrium point, in which direction is F_{net}? In which direction is a?
19. Which of the following is true for a system consisting of a mass oscillating on the end of an ideal spring?
    (a) The kinetic and potential energies are equal at all times.
    (b) The kinetic and potential energies are both constant.
    (c) The maximum potential energy is achieved when the mass passes through its equilibrium position.
    (d) The maximum kinetic energy and maximum potential energy are equal, but occur at different times.
    (e) The maximum kinetic energy occurs at maximum displacement of the mass from its equilibrium position.

20. How does doubling the amplitude of a simple harmonic oscillator affect its period? Its frequency? Its total energy?

21. How does a bigger spring constant affect the period of oscillation for a SHO, all other things being equal?

22. Which one of the following would increase the period of a SHO by a factor of four?

    (a) Replace the spring with one that has a force constant that is 16 times greater.
    (b) Replace the spring with one that has a force constant that is 2 times greater.
    (c) Replace the object with one having 2 times the mass.
    (d) Replace the object with one having 4 times the mass.
    (e) Replace the object with one having 16 times the mass.

23. You hear two flutes sounding the same note, A (440 Hz) –almost. You hear two beats per second. What does that tell you?

24. In the Doppler effect for sound waves, factors that affect the frequency that the observer hears include which of the following?
    i. The speed of the source
    ii. The speed of the observer
    iii. The loudness of the source

    (a) i only
    (b) iii only
    (c) i and ii only
    (d) ii and iii only
    (e) i, ii, and iii

25. Sound in air can best be described as which of the following types of waves?

    (a) Longitudinal
    (b) Transverse
    (c) Torsional
    (d) Electromagnetic
    (e) Polarized

26. Two strings are adjusted to vibrate at exactly 200 Hz. The tension in one string is increased slightly. Afterward, three beats per second are heard when the strings vibrate at the same time. What is the new frequency of the string that was tightened?

    (a) 194 Hz
    (b) 197 Hz
    (c) 203 Hz
    (d) 206 Hz
    (e) None of these.

27. The fundamental frequency of a guitar string is f_1. How many nodes are present in a standing wave of frequency $4f_1$ in this string? (Include nodes at the ends of the string, if any.)

    (a) 3
    (b) 4
    (c) 5
    (d) 6
    (e) 10

28. From a noise on your left you hear a sound wave of sound level 50 dB. At the same time from a source to your right you hear a second wave with the same 50 dB sound level. What is the sound level of the combined sound waves?

    (a) 95 dB
    (b) 87 dB
    (c) 73 dB
    (d) 64 dB
    (e) 53 dB

29. What is a shock wave, and how can one be made?

Two parallel metal plates are separated by 0.050 m. A power supply maintains a 1000 V difference in potential between these two plates. An oil drop of mass 6.4×10^{-16} kg is suspended and motionless between these two plates as shown.

30. What must be the amount of electric charge q possessed by the drop?

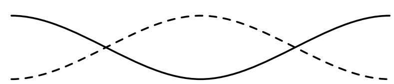
    (a) 2×10^{-9} C
    (b) 1.6×10^{-19} C
    (c) 1.6×10^{-18} C
    (d) 3.2×10^{-19} C
    (e) 6.4×10^{-16} C

31. Suppose a cosmic ray shoots past the oil drop, resulting in the oil drop picking up one more electron than before, thus changing its charge. What will happen to the motion of the oil drop?

(a) It will begin to rise.
(b) It will begin to descend.
(c) It will remain motionless.
(d) Its subsequent motion cannot be determined from the information given.

32. Six waves crash on a beach in a minute.
    (a) What is the period of these waves?
    (b) What is the frequency of these waves?

33. The time needed to complete one full cycle of a periodic process is called the
    (a) amplitude.
    (b) wavelength.
    (c) frequency.
    (d) period.



The standing wave diagram above represents air movement in one pipe in a pipe organ.

34. In which kind of pipe would this standing wave occur?
    (a) a pipe that is open on both ends
    (b) a pipe that is closed on both ends
    (c) a pipe that is open on one end and closed on the other
    (d) It makes no difference if its ends are open or closed.

35. How many wavelengths are there in the standing wave shown?
    (a) $\frac{1}{2}$
    (b) 1
    (c) $1\frac{1}{2}$
    (d) 2
    (e) $2\frac{1}{2}$

36. What are the points of minimum motion in a standing wave called?
    (a) nodes
    (b) antinodes
    (c) crests
    (d) troughs

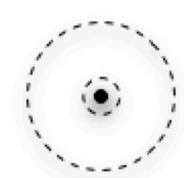
37. How does the strength of the electric field of a charged particle change if you move from Point 1 at distance D from the particle to Point 2 at distance 2D?

38. If an object is attracted to a negatively charged ebonite rod, we can be sure that the electric charge of that object is
    (a) neutral.
    (b) negative.
    (c) positive.
    (d) either neutral or positive.

39. A balloon becomes negatively charged when rubbed by wool because
    (a) the balloon gains electrons from the wool.
    (b) the balloon loses electrons to the wool.
    (c) the balloon gains protons from the wool.
    (d) the balloon loses protons to the wool.

40. An electroscope is touched by a positively charged piece of plexiglass. A "click" is heard. Therefore we can conclude that the electroscope
    (a) gains protons and loses electrons.
    (b) gains protons.
    (c) gains more protons than electrons.
    (d) loses electrons.

41. A negatively charged ebonite rod is first brought near the knob on top of a neutral electroscope without touching it. No spark occurs. Then it is taken away. Which statement best describes what happens in the electroscope?
    (a) Some electrons move from the aluminum leaf and lower shaft to the knob.
    (b) Some electrons move from the knob to the leaf and the lower shaft.
    (c) Some electrons first move from the knob to the leaf and lower shaft, and then they return to the knob.
    (d) Some electrons first move from the leaf and lower shaft to the knob, and then they return to the leaf and lower shaft.



42. In Neils Bohr's model of the hydrogen atom an electron can jump from the lowest orbit to the second orbit, increasing its distance from the proton by a factor of four. By what factor does its attractive force for the proton change?

   (a) one-half
   (b) two
   (c) one-fourth
   (d) four
   (e) one-sixteenth

43. One leaf blower 10 m away produces an intensity of 1×10^{-5} W/m^2.

(a) What is the intensity of the sound produced by two such leaf blowers 10 m away?

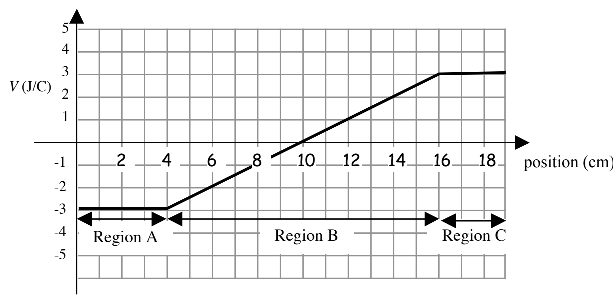
(b) What is the sound level of just one leaf blower 10 m away?

(c) What is the sound level in dB of two leaf blowers 10 m away?

44. Sketch the standing wave diagrams for the first three possible harmonics in a tube that is open to the air on one end and closed on the other. If this tube is 1 m long, find the wavelengths for each of these harmonics. Also find the frequencies of all three harmonics. The speed of sound is about 340 m/s.

45. A truck is moving along at 96 km/hr. (Change this to m/s!) It is sounding its horn, which has a frequency of 400 Hz. It is driving away from Taylor, but toward Pat. What frequency does Taylor hear? How about Pat?

46. Determine the strength of the electric field in each of the three regions indicated in the graph below.



47. Find the force felt by each of two electrons that are 1×10^{-10} m apart.

48. Three charged particles are placed at the following positions on the $x-$axis: 2 μC at $x = 0$, -3 μC at $x = 40$ cm, and -5 μC at $x = 120$ cm.

(a) Find the net force exerted on the -3 μC particle.

(b) Find the net force exerted on the -5 μC particle.

49. Americium-241 is the radioactive isotope that is used in most smoke detectors. One gram of ${}^{241}_{95}$Am is more than enough to supply over 3 million smoke detectors. As you can see, there is very little ${}^{241}_{95}$Am in a smoke detector. The radioactive decay of ${}^{241}_{95}$Am is ${}^{241}_{95}\text{Am} \rightarrow {}^{4}_{2}\text{ He} + {}^{237}_{93}\text{ Np}$. The helium nucleus that is emitted by americium is called an "alpha particle." The alpha particle (two protons and two neutrons) leaves the americium nucleus and is then repelled away from the remaining neptunium nucleus. The neptunium nucleus has very little recoil due to its relatively large mass.

The alpha particle begins its journey of repulsion from a distance of 4.14×10^{-14} m from the center of the neptunium nucleus.

(a) What is the electric potential due to the ${}^{237}_{93}$Np nucleus at this distance of 4.14×10^{-14} m?

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(b) How much potential energy will this system possess when the alpha particle is 4.14×10^{-14} m from the center of the ${}^{237}_{93}$Np nucleus?

(c) What will be the electric potential energy in this system when the alpha particle is very far away from the neptunium nucleus?

(d) How much kinetic energy will the alpha particle acquire due to this repulsion by the time it is very far away (aka "infinity") from the neptunium nucleus?

(e) What speed will the alpha particle have when it is very far away from the neptunium nucleus?

(f) How much force does the alpha particle experience due to the neptunium nucleus at its initial