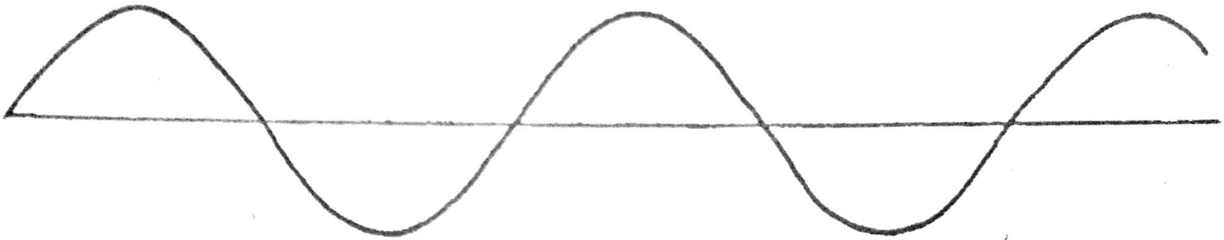
Name

Period Date

Concept-Development Practice Page 25-1

Vibrations and Waves

1. A sine curve that represents a transverse wave is drawn below. With a ruler, measure the wavelength and amplitude of the wave.



a. Wavelength = 7 cm

b. Amplitude = 1.5 cm

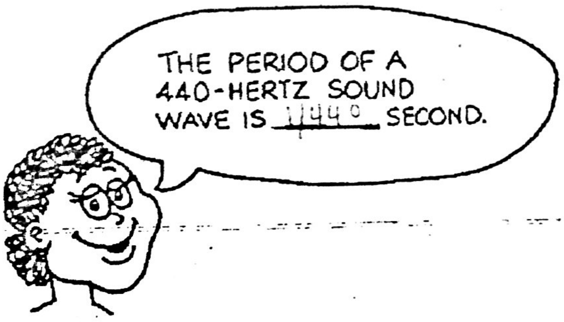
2. A kid on a playground swing makes a complete to-and-fro swing each 2 seconds. The frequency of swing is

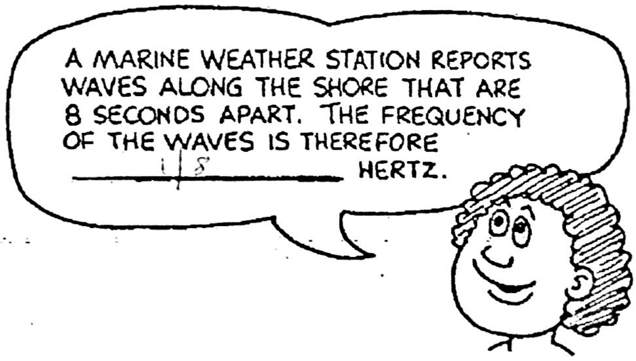
[✓ (0.5 hertz)] (1 hertz) (2 hertz)

and the period is

(0.5 second) (1 second) [✓ (2 seconds)]

3. *Complete the statements.*





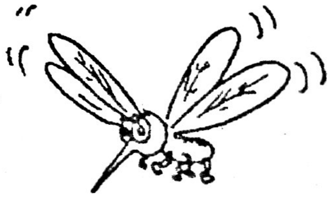
4. The annoying sound from a mosquito is produced when it beats its wings at the average rate of 600 wingbeats per second.

a. What is the frequency of the soundwaves?

600 HZ

b. What is the wavelength? (Assume the speed of sound is 340 m/s.)

0.57 m



Conceptual PHYSICS

5. A pitching machine goes haywire and pitches at 10 rounds per second. The speed of the balls is an incredible 300 m/s.

a. What is the distance in the air between the flying balls? 30

b. What happens to the distance between the balls if the rate of pitching is increased?

decreases

6. Consider a wave generator that produces 10 pulses per second. The speed of the waves is 300 cm/s.

a. What is the wavelength of the waves? 30 cm

b. What happens to the wavelength if the frequency of pulses is increased?

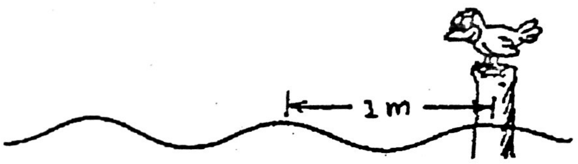
decreases

7. The bird at the right watches the waves. If the portion of a wave between two crests passes the pole each second, what is the speed of the wave?

1 m/s

What is its period?

1 s

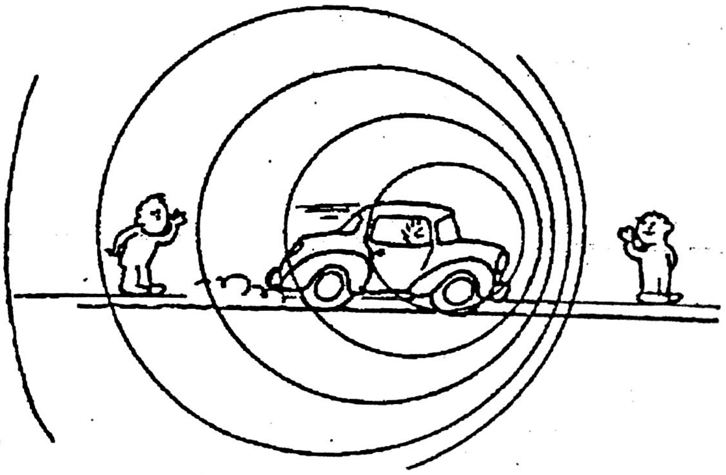


8. If the distance between crests in the above question was 1.5 meters, and two crests pass the pole each second, what would be the speed of the wave?

1.5 m/s

What would be its period?

1 s



9. When an automobile moves toward a listener, the sound of its horn seems relatively

(low pitched) (normal) [✓ (high pitched)]

and when moving away from the listener, its horn seems

[✓ (low pitched)] (normal) (high pitched)

10. The changed pitch of the Doppler effect is due to changes in

(wave speed) [✓ (wave frequency)]

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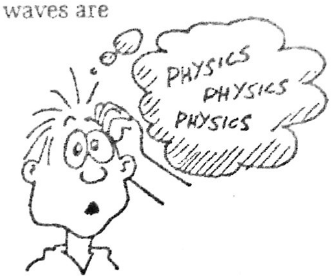
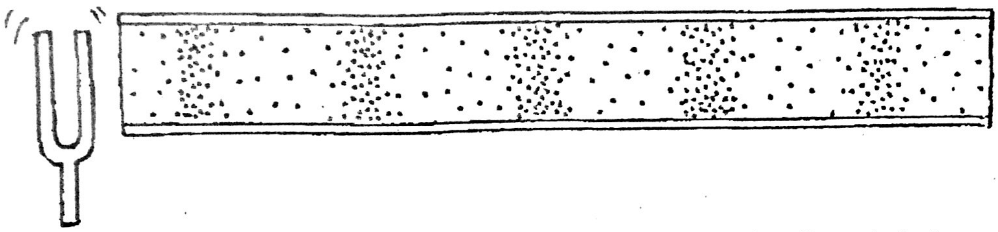
Sound

1. Two major classes of waves are *longitudinal* and *transverse*. Sound waves are
   [✓ (longitudinal)] (transverse)



2. The frequency of a sound signal refers to how frequently the vibrations occur. A high-frequency sound is heard at a high
   [✓ (pitch)] (wavelength) (speed)

3. The sketch below shows a snap shot of the compressions and rarefactions of the air in a tube as the sound moves toward the right. The dots represent molecules. With a ruler the wavelength of the sound wave is measured to be 2.5 cm.

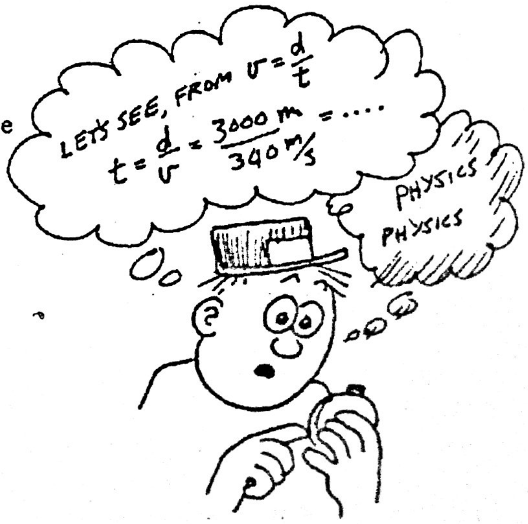


4. Compared to the wavelengths of high-pitched sounds, the wavelengths of low-pitched sounds are
   [✓ (long)] (short)

5. Suppose you set your watch by the sound of the noon whistle from a factory 3 km away.

   a. Compared to the correct time, your watch will be
      [✓ (behind)] (ahead)

   b. It will differ from the correct time by
      (3 seconds) (6 seconds) [✓ (9 seconds)]



conceptual PHYSICS

6. Sound waves travel fastest in

[✓ (solids)] (liquids) (gases)

(...same speed in each)

7. If the child's natural frequency of swinging is once each 4 seconds, for maximum amplitude the man should push at a rate of once each

(2 seconds) [✓ (4 seconds)] (8 seconds)

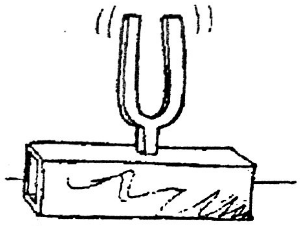
8. If the man in Question 7 pushes in the same direction twice as often, his pushes

(will) [✓ (will not)]

be effective because

(the swing will be pushed twice as often in the right direction)

[✓ (every other push will oppose the motion of the swing)]

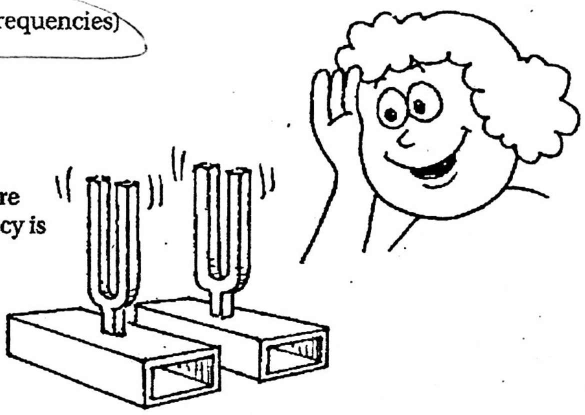


9. The frequency of the tuning fork is 440 hertz. It will NOT be forced into vibration by a sound of

(220 hertz) (440 hertz) [✓ (880 hertz)]

10. Beats are the result of the alternate cancellation and reinforcement of two sound waves of

(the same frequency) [✓ (slightly different frequencies)]



11. Two notes with frequencies of 66 and 70 Hz are sounded together. The resulting beat frequency is

[✓ (4 hertz)] (68 hertz) (136 hertz)

12. The accepted value for the speed of sound in air is 332 m/s at 0°C. The speed of sound in air increases 0.6 m/s for each Celsius degree above zero. Compute the speed of sound at the temperature of the room you are now in.

@22°C, V=345 m/s

conceptual PHYSICS

Wave Motion WS1

Solve: $\lambda = \frac{v}{f} = \frac{3.00 \times 10^8 \text{ m/s}}{99.5 \times 10^6 \text{ Hz}} = \mathbf{3.02\ m}$

Therefore, the distance from one point on the wave to the next identical point on the same wave is 3.02 m.

Example 2: In California, Clay is surfing on a wave that propels him toward the beach with a speed of 5.0 m/s. The wave crests are each 20. m apart. a) What is the frequency of the water wave? b) What is the period?

a. *Given:* $v = 5.0$ m/s
$\lambda = 20.$ m

Unknown: $f = ?$
Original equation: $v = \lambda f$

Solve: $f = \frac{v}{\lambda} = \frac{5.0\ m/s}{20.\ m} = \mathbf{0.25\ Hz}$

b. *Given:* $f = 0.25$ Hz

Unknown: $T = ?$
Original equation: $T = \frac{1}{f}$

Solve: $T = \frac{1}{f} = \frac{1}{0.25 \text{ Hz}} = \mathbf{4.0\ s}$

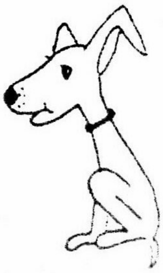
One crest comes along every 4.0 s.

Practice Exercises

Exercise 1: Harriet is told by her doctor that her heart rate is 70.0 beats per minute. If Harriet's average blood flow in the aorta during systole is 1.5×10^{-2} m/s, what is the wavelength of the waves of blood in Harriet's aorta, created by her beating heart?

Answer: 0.013 m

Exercise 2: Dogs are able to hear much higher frequencies than humans are capable of detecting. For this reason, dog whistles that are inaudible to the human ear can be heard easily by a dog. If a dog whistle has a frequency of 3.0×10^4 Hz, what is the wavelength of the sound emitted?



Answer: 0.011 m

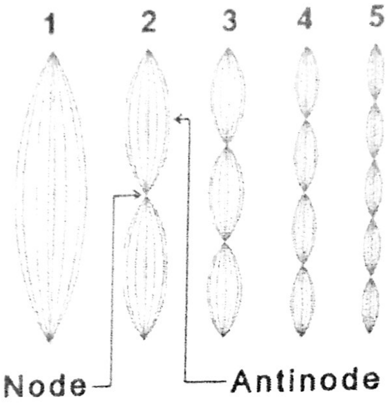
Name: ______________________ Date: ______________

Standing Waves

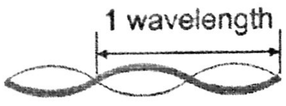
A wave that is confined in a space is called a **standing wave**. Standing waves on the vibrating strings of a guitar produce the sounds you hear. Standing waves are also present inside the chamber of a wind instrument.

A string that contains a standing wave is an oscillator. Like any oscillator, it has natural frequencies. The lowest natural frequency is called the **fundamental**. Other natural frequencies are called **harmonics**. The first five harmonics of a standing wave on a string are shown to the right.

There are two main parts of a standing wave. The **nodes** are the points where the string does not move at all. The **antinodes** are the places where the string moves with the greatest amplitude.



The wavelength of a standing wave can be found by measuring the length of two of the "bumps" on the string. The first harmonic only contains one bump, so the wavelength is twice the length of the individual bump.

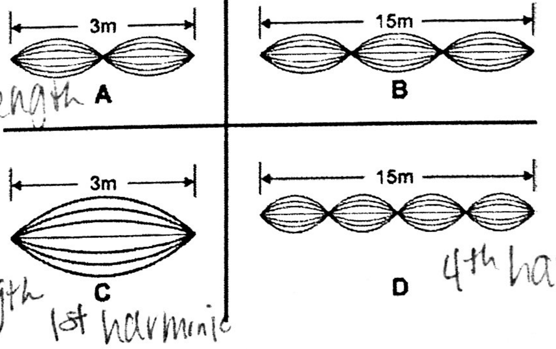


PRACTICE

1. Use the graphic below to answer these questions.
   a. Which harmonic is shown in each of the strings below?
   b. Label the nodes and antinodes on each of the standing waves shown below.
   c. How many wavelengths does each standing wave contain?
   d. Determine the wavelength of each standing wave.

2nd harmonic

3rd harmonic



λ=3m

1 wavelength

λ= 10m

3/2 wavelengths

λ= 6m

1/2 wavelength

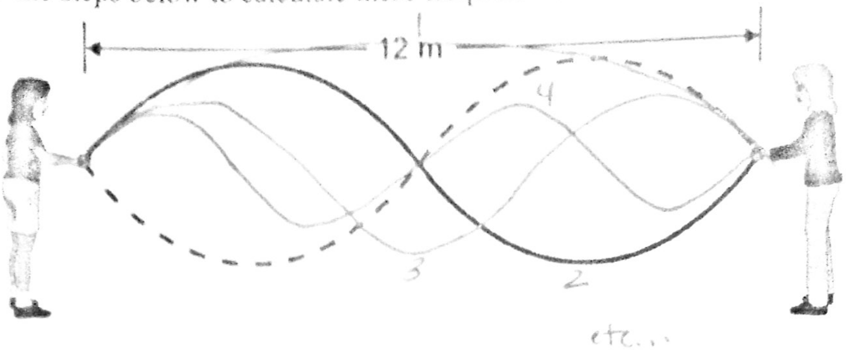
1st harmonic

λ= 7.5 m

2 wavelengths

4th harmonic

2. Two students want to use a 12-meter long rope to create standing waves. They first measure the speed at which a single wave pulse moves from one end of the rope to another and find that it is 36 m/sec. This information can be used to determine the frequency at which they must vibrate the rope to create each harmonic. Follow the steps below to calculate these frequencies.



a. Draw the standing wave patterns for the first six harmonics.

b. Determine the wavelength for each harmonic on the 12 meter rope. Record the values in the table below.

c. Use the equation for wave speed ($v = f\lambda$) to calculate each frequency.

all integer ✓ multiples of f_1

Harmonic	Speed (m/sec)	Wavelength (m)	Frequency (Hz)
1	36	24	1.5
2	36	12	3
3	36	8	4.5
4	36	6	6
5	36	4.8	7.5
6	36	4	9

d. What happens to the frequency as the wavelength increases? decreases

e. Suppose the students cut the rope in half. The speed of the wave on the rope only depends on the material from which the rope is made and its tension, so it will not change. Determine the wavelength and frequency for each harmonic on the 6 meter rope.

Harmonic	Speed (m/sec)	Wavelength (m)	Frequency (Hz)
1	36	12	3
2	36	6	6
3	36	4	9
4	36	3	12
5	36	2.4	15
6	36	2	18

f. What effect did using a shorter rope have on the wavelength and frequency?

$\downarrow \lambda$, $\uparrow f$

Wave Interference

Date:

READ

Interference occurs when two or more waves are at the same location at the same time. For example, the wind may create tiny ripples on top of larger waves in the ocean. The **superposition principle** states that the total vibration at any point is the sum of the vibrations produced by the individual waves.

Constructive interference is when waves combine to make a larger wave. Destructive interference is when waves combine to make a wave that is smaller than either of the individual waves. Noise cancelling headphones work by producing a sound wave that perfectly cancels the sounds in the room.

PRACTICE

This worksheet will allow you to find the sum of two waves with different wavelengths and amplitudes. The table below (and continued on the next page) lists the coordinates of points on the two waves.

1. Use coordinates on the table and the graph paper (see last page) to graph wave 1 and wave 2 individually. Connect each set of points with a smooth curve that looks like a wave. Then, answer questions 2 – 9.
2. What is the amplitude of wave 1? 4 blocks
3. What is the amplitude of wave 2? 2 blocks
4. What is the wavelength of wave 1? 32 blocks
5. What is the wavelength of wave 2? 4 blocks
6. How many wavelengths of wave 1 did you draw? 1 wave length
7. How many wavelength of wave 2 did you draw? 8 wavelengths
8. Use the superposition principle to find the wave that results from the interference of the two waves.
   a. To do this, simply add the heights of wave 1 and wave 2 at each point and record the values in the last column. The first four points are done for you.
   b. Then use the points in last column to graph the new wave. Connect the points with a smooth curve. You should see a pattern that combines the two original waves.
9. Describe the wave created by adding the two original waves. looks like 2nd wave but vibrates around 1st

x-axis (blocks)	Height of wave 1 (*y*-axis blocks)	Height of wave 2 (*y*-axis blocks)	Height of wave 1 + wave 2 (*y*-axis blocks)
0	0	0	0
1	0.8	2	2.8
2	1.5	0	1.5
3	2.2	-2	0.2
4	2.8	0	2.8

x-axis (blocks)	Height of wave 1 (*y*-axis blocks)	Height of wave 2 (*y*-axis blocks)	Height of wave 1 + wave 2 (*y*-axis blocks)
5	3.3	2	5,3
6	3.7	0	3,7
7	3.9	-2	1,9
8	4	0	4
9	3.9	2	5.9
10	3.7	0	3,7
11	3.3	-2	1,3
12	2.8	0	2,8
13	2.2	2	4,2
14	1.5	0	1,5
15	0.8	-2	-1,2
16	0	0	0
17	-0.8	2	-1,2
18	-1.5	0	-1,5
19	-2.2	-2	-4,2
20	-2.8	0	-2,8
21	-3.3	2	-1,3
22	-3.7	0	-3,7
23	-3.9	-2	-5,9
24	-4	0	-4
25	-3.9	2	-1.9
26	-3.7	0	-3,7
27	-3.3	-2	-5.3
28	-2.8	0	-2,8
29	-2.2	2	-0.2
30	-1.5	0	-1,5
31	-0.8	-2	-2,8
32	0	0	0

Name Samir Khan

1

7. What does it mean for waves to be in phase vs. out of phase?

in synch out of synch

8. What is interference? What is the difference between constructive and destructive interference?

2 waves interacting

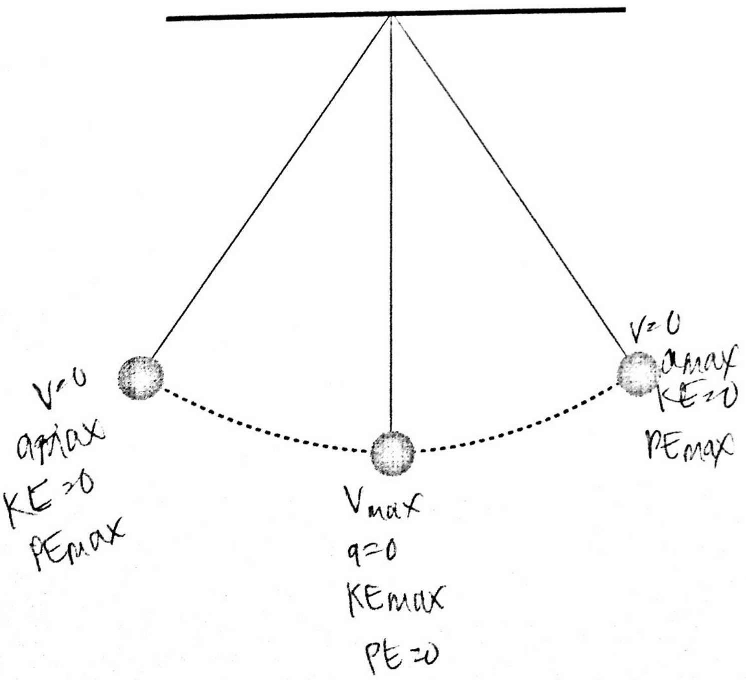
9. What is a standing wave?

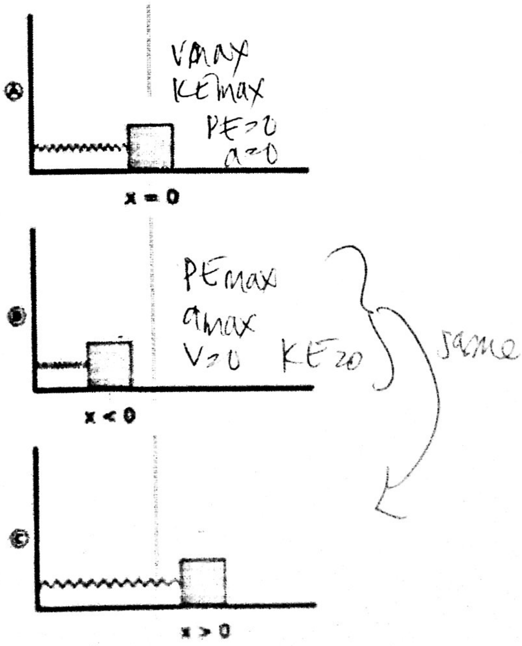
2 waves in opposite directions w/ same $A, \lambda,$ + f
interacting
causes nodes + antinodes

Review the Concepts: Simple Harmonic Motion

10. Simple harmonic motion is oscillatory motion under a restoring force proportional to the amount of displacement from equilibrium.

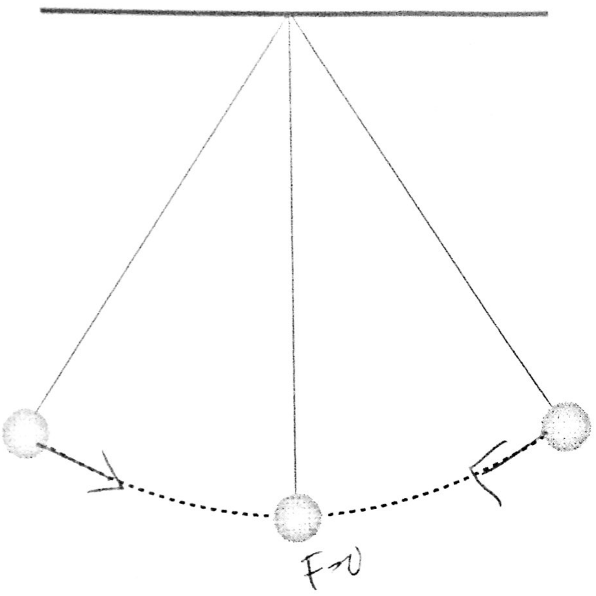
11. In the diagrams below, label the following: v_{max}, $v = 0$, a_{max}, $a = 0$, KE_{max}, $KE = 0$, PE_{max}, $PE = 0$





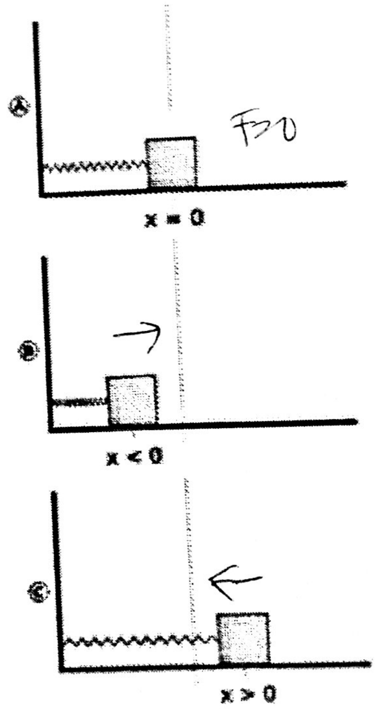
12. What is the restoring force on a simple pendulum? Draw arrows for the forces on the pendulum bob in the three positions below. Ignore air resistance and friction.

gravity



13. What is the restoring force on a mass-spring system? Draw arrows for the forces on the mass below. Ignore air resistance and friction.

spring force



14. What is the spring constant, *k*, a measure of?

stiffness of spring