Waves (Do the work on your own paper)

Frequency and Period: $f = \dfrac{1}{T}$

80.0 Hz	1. A wave passes every 0.0125 seconds. What is the frequency with which waves pass?
0.00382 s	2. Middle C is 261.6 Hz. What is its period?
10. Hz	3. What is the frequency of a wave that has a period of 0.10 seconds?
0.37 Hz	4. An earthquake wave has a period of 2.7 seconds. What is its frequency?

Velocity, Frequency, and Wavelength: $v = f\lambda$

5400 m/s	5. What is the velocity of an earthquake wave that has a frequency of 12 Hz, and a wavelength of 450 m?
2540 Hz	6. What is the frequency of a sound wave (v = 343 m/s) that is 0.135 m long?
3.28 m	7. What is the wavelength of a, 91.5×10^{6} Hz (91.5 MHz) radio wave? (v = c = 3.00×10^{8} m/s)
3.3 m/s	8. What is the velocity of ocean waves if they have a wavelength of 13.2 meters, and a frequency of 0.25 Hz?
2.6 Hz	9. What is the frequency that 16 m long boxcars pass a crossing when the train is going 42 m/s?
1.31 m	10. What is the wavelength of a sound wave with a frequency of 261.6 Hz? (v = 343 m/s)
7.14×10^{14} Hz	11. What is the frequency of a 420. nm ($420. \times 10^{-9}$ m) light wave? (v = c = 3.00×10^{8} m/s)

Velocity, Frequency, Period and Wavelength: $f = \dfrac{1}{T}$ $\quad v = f\lambda$ so $\quad v = \dfrac{\lambda}{T}$

72.5 m/s	12. What is the speed of a wave with a wavelength of 14.5 m, and a period of 0.20 s?
0.012 s	13. What is the period of a 4.2 m wavelength sound wave? (v = 343 m/s)
3.0×10^{8} m/s	14. What is the speed of a wave with a wavelength of 150 m, and a period of 0.50μs (0.50×10^{-6} s)?
3.33×10^{-10} s 3.0×10^{9} Hz (3.0 GHz)	15. What is the period of an electromagnetic wave with a wavelength of 0.10 m? (v = c = 3.00×10^{8} m/s) What is the frequency?

Doppler Effect (Do the work on your own paper)

Use **343 m/s** as the speed of sound.

Moving Source: $f' = f\left(\frac{v}{v \pm u_s}\right)$ Moving Observer: $f' = f\left(\frac{v \pm u_o}{v}\right)$

262.2 Hz	1. A car with a horn frequency of 240 Hz approaches you at 29 m/s. What frequency do you hear?
136.1 Hz	2. A person hums at 150 Hz while driving away from you at 35 m/s. What frequency do you hear?
344.6 Hz	3. Your dad is singing at 356 Hz, and you run away from him at 11 m/s. What frequency do you hear?
995.5 Hz	4. You are riding on a train going 45 m/s. As you approach a crossing, there is a bell with a frequency of 880 Hz. What frequency do you hear?
187.3 Hz	5. A salsa band is running away from you at 14 m/s. If you hear a pitch of 180 Hz, what frequency are they really playing?
390.6 Hz	6. You hear a pitch of 420 Hz as a car with a man standing on the roof playing a flugelhorn approaches you at 24 m/s. What frequency is the man really creating?
442.5 Hz	7. You are riding a rocket-propelled skateboard at 57 m/s toward a television playing a Lawrence Welk re-run. If you hear a pitch of 516 Hz, what is the real pitch the television is making?
92.7 Hz	8. You are in a motorboat going 21 m/s away from a foghorn. You hear it at a pitch of 87 Hz, so what pitch is it really creating?
10.8 m/s away	9. If you hear a frequency of 253 Hz as you listen to a middle C (261 Hz) being played on a piano that is on a flatbed train car, is the car going toward you or away, and how fast?
9.2 m/s toward	10. If a car 217 Hz car horn is heard at 223 Hz, is the car approaching you or receding from you, and what is its speed?
17.5 m/s away	11. You are riding in a train with a blindfold on, and you hear an 880 Hz crossing bell, but it appears to have a pitch of only 835 Hz. Are you moving toward or away from the bell, and how fast?
27.3 m/s toward	12. How fast and in what direction (away or toward) do you have to run relative to a concertmaster playing an A 440 Hz so that you hear it at 475 Hz?
388.4 Hz	13. You are driving at 27 m/s toward an oncoming driver on a highway. They are approaching you at 43 m/s. (a tad in excess of the speed limit) You honk at them with your 318 Hz horn to indicate your dissatisfaction with their driving habits. What frequency do they hear?
453.4 Hz	14. You are driving your Porsche at 57 m/s on the Autobahn and you come behind a Prius in the left lane going only 35 m/s. You honk your 421 Hz horn at them. What frequency do they hear?
94,900.3 Hz	15. A bat flying at 17 m/s is approaching a moth flying toward the bat at 7.0 m/s. If the bat generates an echolocation frequency of 82,500 Hz, what frequency does the bat hear reflected off the moth?

Standing Waves (Do the work on your own paper)

$$f = \frac{1}{T} \qquad v = f\lambda \qquad L = \frac{n\lambda}{4}$$

2.56 m

1. If this standing wave is 3.2 m long, what is the wavelength?

0.45 m
297.8 Hz

2. If this standing wave is 0.45 m long, what is the wavelength?
If the wave speed is 134 m/s, what is the frequency?

0.72 m
86.4 m/s

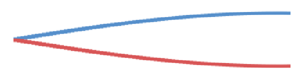
3. If this standing wave is 0.36 m long, what is the wavelength?
If the frequency is 120 Hz, what is the wave speed?

9.0 m

4. If this wavelength is 12 m long, how long is this standing wave?

0.525 m
163.3 Hz

5. If this wavelength is 2.1 m, how long is this standing wave?
If the wave speed is 343 m/s, what is the frequency?



0.90 m
93.6 m/s

6. If this wavelength is 1.8 m, how long is this standing wave?
If the frequency is 52 Hz, what is the wave speed?

0.34 m
1008.8 Hz
2017.6 Hz
3026.5 Hz

7. A pennywhistle is a both ends open pipe. If the standing wave in the pipe is 17 cm long, what is the wavelength and frequency of the fundamental mode of vibration, and what is the frequency of the next two modes of vibration? (Use 343 m/s as the waves speed)

0.66 m
290.4 m/s
880 Hz
1320 Hz

8. A violin has a 33 cm long string, and is tuned to A 440 Hz. (The fundamental frequency is 440 Hz, and it is a both ends fixed standing wave) What is the wavelength of the fundamental? What is the speed of waves along the string? What are the next two frequencies possible?

1.25 m
192 Hz
320 Hz

9. An organ pipe is being designed to make a fundamental tone of 64 Hz. If the speed of sound is 320 m/s inside the pipe, and the pipe is a one end open and one end closed pipe, what length should it be? What are the next two frequencies it can make?

0.423 m
0.634 m
930.7 Hz

10. A horn is a both ends open pipe. If the third harmonic has a frequency of 698 Hz, and sound has a speed of 295 m/s inside the pipe, what is the wavelength of the sound in the horn, and what is the length of the standing wave in the horn? What is the next higher frequency it can generate?

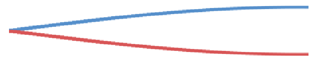
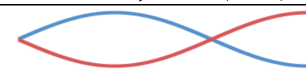
1492.3 Hz

11. A guitar has a wave speed of 485 m/s in its string, and a string length of 65 cm. What is the frequency of the fourth harmonic on this string?

0.329 m
1305 Hz

12. What length should a panpipe be (one end open, one end closed) if it is to create a fundamental tone of 261 Hz (middle C)? Use 343 m/s as the speed of sound in the pipe. What is the frequency of the third harmonic?

Calculate the missing quantity below. L is the length of the waveform (the picture), λ is the wavelength.

	a	**b**	**c**	**d**
B1	 L = 193 cm, λ = ? (386 cm)	 L = 5.76 m, λ = ? (23.0 m)	 λ = 24.0 cm, L = ? (36.0 cm)	 λ = 65.0 cm, L = ? (81.3 cm)
B2	 L = 215 cm, λ = ? (215 cm)	 L = 4.32 m, λ = ? (5.76 m)	 λ = 24.0 cm, L = ? (24.0 cm)	 λ = 2.70 m, L = ? (4.05 m)
B3	 L = 73.0 cm, λ = ? (58.4 cm)	 L = 3.82 m, λ = ? (2.55 m)	 λ = 93.5 cm, L = ? (187 cm)	 λ = 2.40 m, L = ? (2.40 m)
B4	 L = 16.1 cm, λ = ? (9.20 cm)	 L = 3.45 m, λ = ? (1.725 m)	 λ = 183 cm, L = ? (91.5 cm)	 λ = 1.80 m, L = ? (1.35 m)
B5	 L = 32.5 cm, λ = ? (14.4 cm)	 L = 5.31 m, λ = ? (2.12 m)	 λ = 63.0 cm, L = ? (158 cm)	 λ = 72.0 cm, L = ? (108 cm)

(These are just more practice problems if you are having a hard time with calculating L or λ)

More hard word problems without pictures:

13. Draw the third harmonic (The third lowest tone it can make.) of a both ends open pipe. If the speed of sound is 323 m/s, and the pipe is 57.5 cm long, what is the frequency of this harmonic? (843 Hz)
14. Draw the first harmonic (The lowest tone it can make.) of a tightly stretched string. If the string is 29.8 cm long, and the frequency of this harmonic is 322 Hz, what is the wave speed on the string? (192 m/s)
15. Draw the third possible harmonic (The third lowest tone it can make.) of a one end fixed, one end open pipe. If the pipe is 34.1 cm long, and this harmonic has a frequency of 1092 Hz, what is the speed of sound in the pipe? (298 m/s)
16. Draw the first harmonic (The lowest tone it can make.) of a both ends open pipe. If the speed of sound is 310. m/s, and the pipe is 42.1 cm long, what is the frequency of this harmonic? (368 Hz)
17. Draw the third harmonic (The third lowest tone it can make.) a guitar string. If this harmonic has a frequency of 864 Hz, and the string is 68 cm long, what is the speed of the waves in the string? (392 m/s)
18. What is the fifth harmonic (The fifth lowest tone it can make) of a 45.0 cm long panpipe? (one end fixed) if the fundamental is 180. Hz? (1620 Hz)

Waves Lab

Name____

You will need your Chromebook to read the directions on the website. Work in your quadpods, and submit a group lab.

A. Tension and velocity (Small spring, any open area/Chromebook)
Which is faster? (The high tension or the low)

B. Wavelength and frequency (Mondo spring in the front of the room/Chromebook)
What is the relationship between frequency and wavelength?

C. Wavelength and Wavespeed (Chromebook at your desk)
What is the relationship between wavespeed and wavelength? (As you increase wavespeed, what happens to the wavelength)

D. Reflections (Chromebook at your desk)
What happens to the pulses as the reflect off the Fixed ends? (Do they reflect upright or inverted?)

What happens to the pulses as the reflect off the loose (Free) end? (Do they reflect upright or inverted?)

E. Types of waves (Small Slinky - empty table, or floor)
In your own words, write a definition of a longitudinal wave, and a transverse wave

F. Superposition (In the hall with a long slinky)

☐ **- We certify that we completed the two tasks in the hall with the slinky and the cups**
In your own words, write a definition of the principle of superposition.

Standing Waves Lab

Name____

You will need your Chromebook to read the directions on the website. Work in your quadpods, and submit a group lab. Follow the directions on the lab site.

Both ends fixed

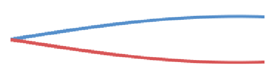
1. Click the play button to run the PHET
2. At the top click "Oscillate", "Fixed End", and at the bottom, set the amplitude to 0.16 cm, and the frequency to 0.41 Hz, the damping to "None" and the Tension to "High"
3. This is the fundamental frequency (f_o) of both ends fixed for this string. The standing waves (resonances) follow a pattern of $1f_o$, $2f_o$, $3f_o$ ...
4. See what happens when you change the frequency from 0.41 to 0.82 and 1.23 Hz (Hit "Restart" when you change the frequencies)

One end fixed:

1. At the top click "Oscillate", "**Loose End**", and at the bottom, set the amplitude to 0.16 cm, and the frequency to **0.21** Hz, the damping to "None" and the Tension to "High"
2. Hit "Restart" at the top
3. This is the fundamental frequency (f_o) of one end fixed for this string. The standing waves (resonances) follow a pattern of $1f_o$, $3f_o$, $5f_o$ ... so these will be **0.21** Hz, **0.63**Hz, and **1.05** Hz
4. See if you can get those resonances by changing the frequency. (Hit "Restart" every time you make a change)

Both ends free: (sorry - just watch that video)

Standing waves
Draw the first three modes of (The first mode is drawn for you...)

Both ends fixed:	**One End Fixed:**	**Both Ends Free:**
		

Mock Waves Test **Name** ___________________________

1. Basic Waves

A. What is the period of a wave with a frequency of 250 Hz? (0.0040 s)

B. What is the wavelength of a sound wave with a frequency of 440 Hz traveling at 343 m/s? (0.780 m)

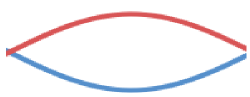
C. What is the frequency of a radio wave that is 50.0 m long? ($v = c = 3.00\text{x}10^8$ m/s) ($6.00\text{x}10^6$ Hz or 6.00 MHz)

2. Standing Waves:

A. Calculate the **wavelengths** below. The length given is the length of the waveform (The picture)

L = 445 cm

(356 cm)



L = 0.64 m

(1.28 m)

L = 1.48 m

(1.48 m)

B. If this <u>wavelength</u> is 24 cm long, how long is this <u>standing wave</u>?  (18 cm)

C. A guitar has strings that are 0.65 m long, and there is a wave speed of 245 m/s along its strings. What is the frequency of the third harmonic? (The third possible mode of resonance) (565.4 Hz)

3. Doppler (use 343 m/s as the speed of sound)

A. You fly 185 m/s toward a stationary tuba playing a frequency of 62.0 Hz. What frequency do you hear?
(95.4 Hz)

B. An ice cream truck with a frequency of 986 Hz is driving 21.0 m/s away from you. What frequency do you hear? (929 Hz)

C. A violinist rides a Segway toward you at 14.70 m/s. You hear a frequency of 1120. Hz, what frequency are they really playing? (1072 Hz)

Physics - Mock Spring Final!!! **Name** ___________________________

Page 1 - Kinematics and Projectile Motion

1. A car going 25 m/s goes 13.4 m. What time does it take? (0.536 s)

2. A train can accelerate at 0.150 m/s/s. What time will it take to reach its top speed of 24.0 m/s from rest? (160 s)

3. A giant lizard stops in 5.85 m in 1.15 s. What was its acceleration?(-8.85 m/s/s)

4-6: A ball rolls off the edge of a 15.0 m tall cliff with a purely horizontal velocity, and strikes the ground at a distance of 12.4 m from the base of the cliff.

4. What time was the ball in the air? (1.75 s)

5. What was the ball's horizontal velocity? (7.09 m/s)

6. Draw a picture of the final velocity of impact. Calculate the speed it is traveling, and find the angle below horizontal the velocity makes.
(speed = 18.6 m/s, 67.5^{o} below horiz.)

Page 2 - Forces

7. If there is a net force of 42.0 N on a 3.60 kg mass, what time would it cover 37.0 m from rest? (2.52 s)

8-9: A 1.60 kg mass hangs on a cord.
8. What does the tension need to be in the rope to accelerate the mass upwards at 3.56 m/s/s? (+21.4 N)

9. What is the acceleration of the mass if the tension in the rope is 19.3 N? (+2.26 m/s/s)

10. A 4.25 kg block of wood has a kinetic coefficient of friction of 0.120 and a static of 0.330 between it and the level floor. If the block is sliding to the right, and I exert a force of 7.80 N to the right, what is the acceleration of the block? (+0.659 m/s/s)

Page 3 - Work and Energy

11a. What speed must a 0.458 kg hammer go to have 60.0 J of kinetic energy? (16.2 m/s)

11b. What is the potential energy of a 2.60 kg clock weight that is 1.45 m above its lowest point? (36.9 J)

12. How much time does it take for a 450. Watt heater to produce 4580 J of heat? What heat will it put out in 32.0 s? (10.2 s, 14,400 J)

13. A sled dog has a power output of 310. W. In what time can it drag a 112 kg sled 95.0 m across a frozen lake where the coefficient of friction is 0.130? (43.8 s)

14. Mom gives 55.0 kg Tamara a push from rest on her massless sled for a distance of 7.20 m at the top of a 3.80 m tall hill. If she is going 11.0 m/s at the bottom of the hill, what force did Mom exert at the top to speed her up? (Neglect friction) (178 N)

Page 4 - Impulse and Momentum, Circular Motion

15. A rocket engine burns 12.0 grams of fuel (0.0120 kg) in 1.10 seconds with an exhaust velocity of 782 m/s. What it the thrust of this engine? (8.53 N)

16. A bullet going 481 m/s imbeds in a stationary block of wood. The bullet and block combo are going 5.27 m/s after the collision, and the combo has a mass of 12.1 kg (Bullet and block). What was the mass of the bullet? (0.133 kg)

17. Two football players strike each other head on. Player 1 has a mass of 119 kg and is running 6.20 m/s to the East, and player 2 has a mass of 102 kg is running 4.20 m/s to the West. What is their post-collision velocity if they stick together? (Speed and direction) (1.40 m/s East)

18. How fast can your 800 Kg car go around a corner with a radius of 13 m when the available centripetal force is 6500 N? (10.3 m/s)

19. There is a force of gravity of 3.40×10^{-9} N between a 5.00 kg mass and a wrecking ball whose centers are separated by 2.50 m. What is the mass of the wrecking ball? (63.7 kg)

20. A Rock-O-Plane has a radius of 5.64 m and a period of 6.25 s. What "g" force do they read at the top and the bottom of the ride? (0.418 "g"s, 1.582 "g"s)