

# Sound

## Lesson about sound

DynaLearn level 2 | Version 1.0

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This lesson is about sound, specifically how the frequency and amplitude of the wave determine pitch and volume.	
<b>Given name</b>	
<b>Surname</b>	
<b>Class</b>	
<b>Date</b>	
<b>Comments by teacher</b>	

# 1. Introduction

## Lesson Objectives

- You can name the three factors that affect the pitch of the tone a string makes.
- You can explain what the frequency of a vibration is.
- You can explain the relationship between frequency and pitch.
- You can explain the relationship between the amplitude and the volume.

## Sound

Sound is caused by a source, travels through a medium, and is heard by a receiver (Figure 1).

- When you vibrate a string, there are three properties that affect its frequency:
- How thick the string is. The thicker the string, the lower the tone.
- How long the string is. The longer the string, the lower the tone.
- How tight the string is stretched. The lower the tension, the lower the tone.



Source: Guitar String



Medium: Air

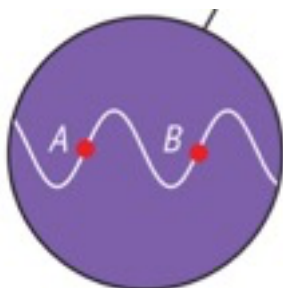


Receiver: Ear

**Figure 1.** The moving guitar string vibrates the air. The vibration travels through the air and is received by the ear as sound.

The number of vibrations per second is called the **frequency** (Figure 2). The frequency is measured in hertz (Hz). If the frequency is 128 Hz, the legs of the tuning fork move back and forth 128 times per second. *The higher the frequency, the higher the tone (**pitch**) you hear.* For example, a 440 Hz tuning fork will produce a higher pitch than a 128 Hz tuning fork.

The **volume** indicates how loud the sound is produced by the sound source (Figure 3). The volume is determined by the **amplitude**. The amplitude is the maximum deflection of the wave motion. *A greater amplitude, gives a louder sound.*



**Figure 2.** Full wave (between A and B).



**Figure 3.** Greater amplitude, gives a louder sound.

## 2. Starting DynaLearn

There are several ways to log in. Use one of the two options below. Then check whether the login was successful (see 'Let's check').


Via a code:


1. Go to DynaLearn (<https://create.dynalearn.nl/>).
2. Click on 'log in with code', at the bottom left.
3. Enter the project code and your (school) email address.
4. Copy the code from the confirmation email received from *dynalearn.nl* (see spam folder if needed) and fill in the other details.
5. Log in to DynaLearn.

By email invitation:



1. Copy the login details from the invitation email received from *dynalearn.nl*.
2. Go to DynaLearn (<https://create.dynalearn.nl/>).
3. Log in to DynaLearn.

### Let's check!

After logging in, you will automatically enter in the white workspace of the assignment. You can recognize it by the question mark on the right side of the screen . Is the question mark missing? Then first do the following:

- In DynaLearn, click . Click on 'Select template'.
- Choose 'Sound' and press 'Load'. You now see the model as shown in Figure 4.


Save model file and start:


1. Click on  top left. Change the name to 'Sound' and click 'Save'.
2. How do you proceed? Just follow the steps in this workbook. Note! You can't skip steps. Ask for help if you do not understand a certain step. The video function  in DynaLearn shows how a model ingredient can be created. The boxes contain a brief explanation about the model ingredient. Put a check mark  $\checkmark$  next to the step you completed. This way you keep track of where you are in the assignment.

### 3. Fill in the missing data

1. Read Box 1.

#### Box 1. Entity and quantity.

An entity  is usually a physical thing in a system (e.g., car, human).

A quantity  is a measurable property of an entity (e.g., temperature, length).

2. If the login was successful, you will see the model shown below (Figure 4). Some **entities** and **quantities** are already in the model. But the model is not finished yet. **Note:** If you do not see the details as shown in figure 4, then go back to the previous section under **Let's Check!**

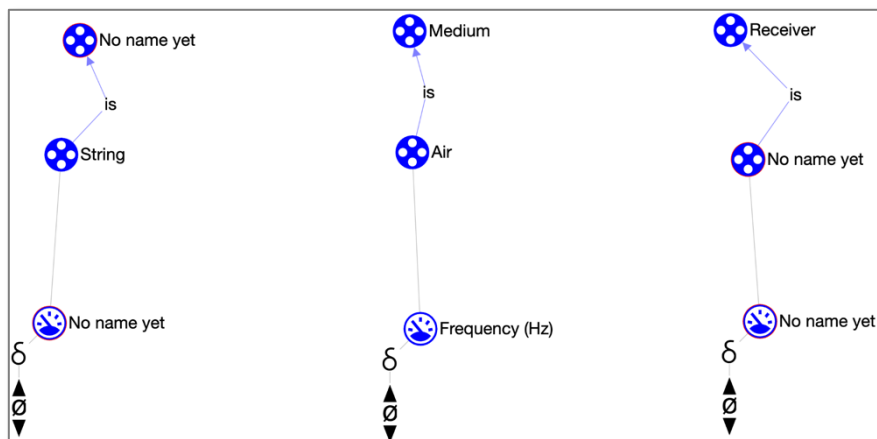










Figure 4. Initial situation when building the model.

3. Read Box 2.



#### Box 2. Help function.

If the question mark  or an ingredient in your model  turns red, then something is wrong. Click the question mark  for a hint. Then click on a number, for example , to see where the error is in your model. Only use the question mark if you can't figure it out yourself!

4. Give the **entities** with *no name yet*, the correct name (see  → ). Use the question mark for verification (Box 2).
5. Give the **quantities** with *no name yet*, the correct name (see  → ). Use the question mark for verification (Box 2).
6. Read Box 3.

#### Box 3. Cause-and-effect relationships.

In DynaLearn, there are two types of cause-and-effect relationships:

- Positive relationship : the quantities change in the same direction (if quantity 1 increases, then quantity 2 increases also)
- Negative relationship : the quantities change in opposite direction (if quantity 1 increases, then quantity 2 decreases. Or vice versa: if quantity 1 decreases, then quantity 2 increases)

7. One quantity is not yet connected to the other two quantities. Add the missing **cause-effect** relationship (see → ). Use the question mark for verification.
- Pay attention to the direction (from which quantity, to which other quantity?).
  - Is it a negative  $\ominus$  or a positive  $\oplus$  relationship?

Has the question mark turned grey in the meantime? If so, then you have done steps 1 to 3 correctly.

## 4. Running a simulation to check

You are now going to check the model with the help of a simulation.

1. Read Box 4.

### Box 4. Change of a quantity.

A quantity can change. This is indicated by The delta symbol ( $\delta$ ) is the mathematical sign for change (also known as the derivative). The down arrow (  $\Downarrow$ ) is decrease, the zero ( $\emptyset$ ) is constant and the up arrow (  $\Uparrow$ ) is increase.

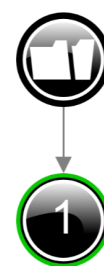
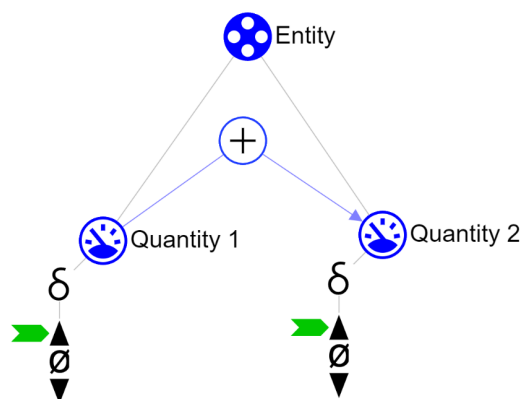
2. Set as **initial values** (see → ):

- The **quantity** of entity *String* increases:

3. Read Box 5.

### Box 5. Read the outcome of a simulation.




After starting a simulation (with ) , a window appears on the right in which the possible states of the system are indicated. There is one possible state in this example




You can click on the state to view the outcome. The state icon then gets a green circle. In the model, the change for this state is indicated by green arrows . The model shows that in state Quantity 1 increases and that therefore Quantity 2 also increases.

4. **Read** Box 6.

**Box 6.** Help function.

If the exclamation mark appears , something went wrong during the simulation. Click on the exclamation mark  for a hint. Then click on a number, for example , to locate the error in your model.







5. **Start** the simulation by selecting 

6. **Make** the sentence below correct (by crossing out 2 of the 3 options):




If the *thickness/tension/length* of a string increases, then the *frequency* of the vibration in the air will *decrease/remain the same/increase*. As a result, the *pitch* that the ear perceives will *decrease/remain the same/increase*.

## 5. Which quantities influence the frequency?

A string can vary in thickness, in length and in tension. In addition, the guitarist can hit the string harder or softer. Which of these quantities influence the frequency and thus the pitch of the sound?

1. **Add** the two missing **quantities** to **entity** *string* (see  → ). **Use** the question mark for verification.
2. Every **quantity** belonging to the *string* has a **cause-effect** relationship with the **quantity** *frequency* of the vibration of the air. **Add** the missing cause-effect relationships to the model (see  → ). **Use** the question mark for verification.
  - a. Pay attention to the direction (from which quantity, to which other quantity?).
  - b. Is it a negative  or a positive  relationship?

Check your model again by running a simulation.

3. **Set** as **initial values** (see  → ):
  - a. The *thickness* decreases.
  - b. The *voltage* remains the same.
  - c. The *length* increases.
4. **Run** the simulation . How many states are there? If all goes well, there are three possible outcomes. We call this **ambiguity**.







*Note: If you see a blue exclamation mark (on the right side of the screen?), please read [Box 6](#).*

5. **Make** the table below correct (by crossing out 2 of the 3 options for frequency and pitch). **Give** a brief explanation of each situation.

Results	Frequency	Pitch	Give your explanation
Situation 1	<i>decreases/stays</i> <i>the same/increases</i>	<i>decreases/stays</i> <i>the same/increases</i>	
Situation 2	<i>decreases/stays</i> <i>the same/increases</i>	<i>decreases/stays</i> <i>the same/increases</i>	
Situation 3	<i>decreases/stays</i> <i>the same/increases</i>	<i>decreases/stays</i> <i>the same/increases</i>	



## 6. What about the volume of the sound?

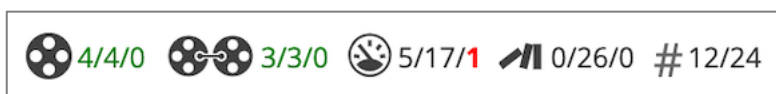
Until now, we discussed the characteristics of the string and how those characteristics determine the pitch of the sound. Now we are going to look at the volume: at the softness and loudness of the sound. The hitting of the guitarist is decisive here. Hitting stronger gives a larger amplitude of vibration in the air, and this is received by the ear as a louder sound.

- Add** the **quantities** *Hitting*, *Amplitude* and *Volume* to your model (see  → ).
  - Note: Which **entity** gets which **quantity**? **Use** the question mark for verification.
- The three new **quantities** are connected with two **cause-effect** relationships. **Add** these two missing cause-effect relationships to the model (see  → ). **Use** the question mark for verification.
  - Pay attention to the right direction (from which quantity, to which other quantity?).
  - Is it a negative  or a positive  relationship?
- Read** Box 7 to determine whether your model is complete.

### Box 7. Progress bar.

At the bottom of the screen is the *progress bar* (see example below).

Entity shows:  4/4/0, this means: 4 created, 4 needed, 0 error. For quantity it shows  : 5/17/1: this means: 5 made, 17 needed, 1 error. If all the numbers are **green**, that ingredient type is completed.



Check your model again by running a simulation.

4. **Set** as **initial values** (zie  → ):

- a. The *hitting* is increasing.
- b. The other quantities remain the same (*thickness, tension, and length*).

5. **Run** the simulation . How many states are there?

6. **Make** the table below correct. **Give** a brief explanation.

Results	Amplitude	Volume	Give your explanation
<i>Situation 1</i>	<i>decreases/stays the same/increases</i>	<i>decreases/stays the same/increases</i>	
?	?	?	
?	?	?	