FREE CLASSROOM RESOURCE

BeatTiming: Tempo, Delay & Sample Timing Lab

A calculation-first music-technology lesson with a printable student worksheet and complete answer key.

AUDIENCE	TIME	FORMAT
Grades 8-12 and introductory college	30-45 minutes	Individual work or pairs

ESSENTIAL QUESTION

How can rhythmic notation be translated into exact milliseconds and digital-audio samples?

Learning objectives

1. Calculate straight, dotted, and triplet note durations from BPM with at least 80% accuracy.
2. Apply calculated note values to tempo-synchronized delay settings and explain the rhythmic relationship.
3. Calculate audio duration or sample-frame count from sample rate with at least 80% accuracy.

Prerequisites and materials

Students should understand BPM, common note divisions, multiplication, division, and basic fractions. Provide the worksheet, a basic calculator, and an internet-connected device for BeatTiming verification. A DAW, audio example, and headphones are optional. Students calculate first and verify second; no account or student-identifying information is required.

Accuracy conventions

BPM represents quarter-note beats. A dotted note is 3/2 the straight value; a triplet note is 2/3 the matching straight value. One sample frame contains one sample value for each channel; channel count changes storage size, not playback duration. Keep full precision and round only the final millisecond value to 0.01 ms when needed.

Lesson sequence

TIME	ACTIVITY
0-5 min	Hook: Compare pulses at 60 and 120 BPM. Ask what happens to the time between beats when BPM doubles.
5-12 min	Model: Introduce Q = 60,000 / BPM. At 120 BPM, derive quarter = 500 ms, eighth = 250 ms, dotted eighth = 375 ms, and eighth triplet = 166.67 ms. Introduce sample duration = frames / sample rate.
12-25 min	Rhythm practice: Students complete Questions 1-6, showing formulas and units.
25-32 min	Delay application: Complete Questions 7-9 and verify with BeatTiming. Discuss why synchronized delays fit the musical grid.
32-38 min	Digital audio: Complete Questions 10-12.
38-45 min	Review and extension: Correct one error, explain it, then optionally test one value in a DAW.

Assessment: Objective 1 requires 5 of Questions 1-6 correct; Objectives 2 and 3 require 2 correct answers in their sections. Require formulas, units, and reasonable rounding. For a 30-minute version, assign Questions 1-5, 7, 8, 10, and 12. Accessible HTML: beattiming.com/music-teacher-resources. Print pages 2-3 for students; pages 4-5 contain the teacher answer key.

STUDENT COPY

Tempo, Delay & Sample Timing Worksheet

Name: _____ Date: _____

FORMULA BOX

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Q = 60,000 / BPM milliseconds
Half = 2Q | Quarter = Q | Eighth = Q/2 | Sixteenth = Q/4
Dotted version = straight value x 3/2 | Triplet version = straight value x 2/3
Duration in seconds = sample frames / sample rate
Sample frames = sample rate x duration in seconds
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Show your calculation and include units. Keep full precision until the final step. For repeating values, give a fraction and a decimal rounded to 0.01 ms.

Rhythm and tempo

1. A song is at 120 BPM. How long is one quarter note?

2. At 100 BPM, calculate (a) one straight eighth note and (b) one straight sixteenth note.

3. At 128 BPM, how long is one straight eighth note?

4. At 128 BPM, how long is one dotted eighth note?

5. At 128 BPM, how long is one eighth-note triplet?

6. At 90 BPM, calculate (a) a straight quarter, (b) a dotted quarter, and (c) a quarter-note triplet. Put the three values in order from shortest to longest.

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Worksheet continued

Delay timing

7. A producer wants each delay repeat to occur three-quarters of a beat after the original sound. What dotted-eighth delay time should be entered at 120 BPM?

8. At 96 BPM, a stereo delay uses a dotted eighth on the left and an eighth-note triplet on the right. Calculate both delays. Which channel repeats first?

9. A quarter-note delay is set to exactly 480 ms. What is the project tempo?

Sample duration

10. A clip contains 44,100 sample frames at 44.1 kHz. How long is the clip?

11. A clip contains 96,000 sample frames at 48 kHz. How long is the clip?

12. A four-bar loop is in 4/4 at 120 BPM and uses a 48 kHz sample rate. (a) What is its duration? (b) How many sample frames does it contain? (c) How many sample values are in each channel?

Reflection

Why might a tempo-synchronized delay sound more rhythmically connected to a track than an arbitrary millisecond value?

Verify your calculations after completing them: BeatTiming.com/music-teacher-resources

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Answer Key: Questions 1-6

1. 60,000 / 120 = 500 ms.
2. At 100 BPM, Q = 600 ms. Eighth = 600 / 2 = 300 ms. Sixteenth = 600 / 4 = 150 ms.
3. At 128 BPM, Q = 468.75 ms. Eighth = 468.75 / 2 = 234.375 ms.
4. 234.375 x 3/2 = 351.5625 ms.
5. 234.375 x 2/3 = 156.25 ms.
6. At 90 BPM: straight quarter = 2000/3 ms = 666.67 ms; dotted quarter = 1000 ms; quarter triplet = 4000/9 ms = 444.44 ms. Shortest to longest: quarter triplet, straight quarter, dotted quarter.

Common misconception

An eighth-note triplet is one third of a quarter-note beat, or two thirds of a straight eighth note. It is not two thirds of a quarter note.

Differentiation and accessibility

Provide the formula box and the 120 BPM example for support. Permit calculator use, partner work, and verbal explanations. Do not require headphones; provide written descriptions for audio demonstrations. Advanced students can explore compound meter, reverse-BPM calculation, stereo PCM storage, or compare exact values with a DAW's rounded display.

Independent verification

Students can verify rhythm calculations with the BPM-to-milliseconds and delay calculators. The public accuracy page documents formulas, rounding, limits, and repeatable release testing.

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Answer Key: Questions 7-12

7. At 120 BPM, Q = 500 ms. Dotted eighth = 500 x 1/2 x 3/2 = 375 ms.

8. At 96 BPM, Q = 625 ms. Left dotted eighth = 625 x 1/2 x 3/2 = 468.75 ms. Right eighth triplet = 625 x 1/2 x 2/3 = 625/3 ms = 208.33 ms. The right channel repeats first.

9. 60,000 / 480 = 125 BPM.

10. 44,100 / 44,100 = 1 second.

11. 96,000 / 48,000 = 2 seconds.

12. Four bars of 4/4 contain 16 quarter-note beats. Duration = 16 x 60 / 120 = 8 seconds. Frames = 48,000 x 8 = 384,000 sample frames, containing 384,000 sample values in each channel.

Reflection model

A synchronized delay repeats on a subdivision of the song's beat, so its echoes reinforce the rhythmic grid. An arbitrary delay may fall between subdivisions and sound less connected, although creative off-grid timing can be intentional.

Reuse and attribution

AI-assisted development disclosure

This resource was created with generative-AI assistance for organization, wording, and candidate practice problems. Every numerical answer was recalculated from the stated formulas and checked by automated tests before publication. BeatTiming publishes the final resource and recommends that teachers review it for their classroom context. Students are not required to use AI.