Bigger Wiggle, Much More Energy

Teacher		**Class**	Grade 8
Subject	Science	**Topic**	Waves: amplitude and energy
Date		**Room**	
Lesson length	60 minutes	**Country**	United States

Students learn that wave energy grows as amplitude squared. They draw waves and calculate relative energy as 1, 4, 9.

Curriculum links

- Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

Learning objectives

- Students will measure amplitude as height from rest to crest or trough.
- Students will use Energy proportional to amplitude squared to predict energy changes.
- Students will compare low- and high-energy waves using diagrams and math.

Success criteria

- I can find amplitude on a wave diagram from the middle line.
- I can calculate relative energy as amplitude squared: 1, 4, 9.
- I can explain why doubling amplitude gives four times the energy.

What students already know

2-minute check: show a transverse wave sketch and ask a student to point to crest, trough, and rest position, then ask what a wave carries as it moves.

Key words

amplitude	farthest distance from the middle resting line to the top or bottom of a wave [12][13]
energy	what is carried by a wave that lets it push, move, or change things at the far end [12]
intensity	amount of power passing through each unit of surface area [17]
rest position	middle line where the medium sits when no wave is passing [12]

Materials

- Slides 1-7, 9-11
- Video clip 2 Amplitude-energy demo (0:00-0:47)
- Worksheet Task A (page 2) and Task C (page 3) - amplitude-energy table
- graph paper, pencils, rulers
- mini whiteboards and markers

Before the lesson

- Print Worksheet pages 2-3 for each student; Task C is the amplitude-energy table
- Print or provide graph paper, check pencils and rulers for pairs
- Load Slides 1-7, 9-11 and test Video clip 2 (0:00-0:47) with sound
- Draw a large wave on the board with a clear middle rest line, crest, and trough

Lesson outline

0–8 min **Starter** 8 min · Whole class

Surface ideas about waves and create a need to test how height links to energy.

YOU DO

1. Show Slide 1 title and Slide 2 objectives and read the I can find amplitude goal.
2. Ask the hook question and take predictions: doubling height doubles energy or more.
3. Show Slide 5 vote: loud clap vs soft clap, big rope shake vs small shake, bright lamp vs dim lamp.
4. Tally votes and link to a wave as an energy transport that moves energy without moving matter forward [12].

STUDENTS DO

1. Vote for which pair would best show an energy difference.
2. Turn and talk with a neighbor to predict what doubling height does to energy.
3. Share one prediction with the class.

Say: If I double the height of a wave, do I double the energy? Let's test it with squares, not guesses. Today we will model waves, measure height correctly, and use math to show how height tells us about energy.

Ask: What does a wave carry from one place to another? (Energy, not matter; particles mostly stay in place while energy moves forward [6] [12].) · If one wave is much taller than another, what do you predict about its energy? (The taller wave carries more energy; greater amplitude means more energy [13].)

Check understanding: Quick show of hands for double, quadruple, or same; if split, keep both ideas up to test in the lesson.

Support: Offer sentence frame: I think the taller wave has ___ energy because ___. **Stretch:** Ask a student to explain why a harder drum hit should make a taller sound wave.

Use: Slides 1-2, 5

8–20 min **Teaching** 12 min · Whole class

Model how to measure amplitude and how energy depends on amplitude squared.

YOU DO

1. Use Slide 3 to define amplitude as the maximum displacement from rest position [12] and as distance from rest to crest or trough [13].
2. Play Video clip 2 (0:00-0:47) to watch a small then large push make a small then large height.
3. Show Slide 4 big number: energy is proportional to the square of amplitude [17], so doubling amplitude quadruples energy [17].
4. Model the 1, 4, 9 pattern on the board with squares and Slide 6 prompts about what stays the same besides height.

STUDENTS DO

1. Label rest position, crest, trough, and amplitude on mini whiteboards.
2. Copy the 1, 4, 9 table and square each amplitude with the teacher.
3. Hold up boards showing amplitude as middle-to-crest distance.

Say: Amplitude is measured from the middle line, not top to bottom. Our simple model is energy equals amplitude squared. That is why a little extra height gives a lot extra energy. Putting more energy in changes height, not wavelength, frequency, or speed [12].

Worked example: Amplitude = 1 unit gives Energy = 1 squared = 1. Amplitude = 2 units gives Energy = 2 squared = 4. Amplitude = 3 units gives Energy = 3 squared = 9. So 1 to 2 doubles height but energy goes from 1 to 4, which is 4 times bigger [17].

Ask: Where do you place the ruler to measure amplitude? (From the middle rest line to a crest or to a trough, the maximum displacement [12] [13].) · If amplitude goes from 1 to 3, what happens to relative energy? (It goes from 1 to 9, so nine times the energy, because 3 squared is 9 [14][17].)

Check understanding: All hold up whiteboards with amplitude marked; reteach middle line if students show top-to-bottom.

Support: Give a center rest line on paper under the sketch so amplitude is clearly the distance from the middle line [13]. **Stretch:** Ask a student to predict the math if amplitude were 0.5 units and defend it with squaring.

Use: Slides 3-4, 6; Video clip 2 (0:00-0:47)

20–40 min **Main activity** 20 min · Pairs

Build and use the squared model to calculate relative wave energy from amplitude.

YOU DO

1. Show Slide 9 task: draw 3 waves, label amplitude from the middle line, calculate energy as amplitude squared.
2. Hand out graph paper and Worksheet Task C and model shading 1 by 1, 2 by 2, and 3 by 3 squares [14].
3. Set pairs to complete amplitudes 1, 2, and 3 units to find energies 1, 4, and 9 [17].
4. Circulate, check tables, and prompt pairs to rank waves and predict effect at the far end.

STUDENTS DO

1. Shade 1 by 1, 2 by 2, and 3 by 3 squares and count 1, 4, 9 energy units.
2. Fill Worksheet Task C missing cells using energy grows as amplitude squared.
3. Draw and label 3 waves, rank energy, and write the rule in words and numbers.

Say: In pairs, draw 3 waves with the same spacing but heights 1, 2, and 3. Label amplitude from the middle line. Shade the squares to prove the energy numbers, then rank which wave would hit hardest at the end.

Ask: Why does your shaded square for amplitude 2 hold 4 energy units? (Because energy is amplitude squared, and 2 squared is 4, so doubling quadruples energy [17].) · Which of your 3 waves would do the most work at the end and why? (The tallest one, because a high energy wave has high amplitude and hits harder [12].)

Check understanding: Scan Task C for 1, 4, 9; if errors, stop class and re-model 2 squared on graph paper.

Support: Let students shade 1 by 1, 2 by 2, and 3 by 3 squares on graph paper to see why squaring makes energy grow so fast [14].
Stretch: Predict the relative energy for amplitudes of 5 and 10 units and explain the pattern in a sentence.

Use: Slide 9; Worksheet Task C

40–52 min **Application** 12 min · Pairs

Apply the amplitude-energy model to explain low- versus high-energy waves.

YOU DO

1. Show Slide 7 chain: harder push on first coil gives farther motion from rest, bigger amplitude, much more energy [12].
2. Assign Worksheet Task A: answer in full sentences using amplitude and energy in math and explanations.
3. Remind students that waves move energy, not matter [12], and extra push changes amplitude, not speed [12].
4. Use Slide 10 mindmap to connect louder, brighter, and bigger to larger amplitude and more energy [13].

STUDENTS DO

1. Complete Worksheet Task A in full sentences using amplitude and energy.
2. Compare a small and large shake and state the energy math for each.
3. Correct one myth: waves do not carry matter across, they carry energy [12].

Say: Use your 1, 4, 9 math to explain real waves. A louder sound or brighter light at the same color means larger height and much more energy. Write in full sentences and include the numbers to prove it.

Ask: A student says a bigger wave must also travel faster. What does our model say? (More energy changes amplitude only, not wavelength, frequency, or speed [12].) · How would you prove a wave with amplitude 3 has 9 times the energy of amplitude 1? (Square both: 1 squared is 1 and 3 squared is 9, so tripling gives nine times [14][17].)

Check understanding: Collect two pair explanations and listen for amplitude and squared numbers; reteach with the square visual if missing.

Support: Provide word bank with amplitude, energy, rest position, and square to frame full sentences. **Stretch:** Ask a student to explain why a wave twice as tall could do much more than twice the damage, using four times energy [12][17].

Use: Slides 7, 10; Worksheet Task A

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52–60 min **Plenary** 8 min · Whole class

Check that students can measure amplitude and use squaring to predict energy.

YOU DO

1. Show Slide 11 quiz and cold-call answers for amplitude definition and doubling rule.
2. Ask students to self-rate the success criteria with thumbs up or sideways.
3. Collect Worksheet Tasks A and C and preview that frequency will be modeled next time.

STUDENTS DO

1. Answer quiz questions aloud and on paper as exit ticket.
2. Self-check I can statements and note one question they still have.
3. Hand in Tasks A and C with labeled diagrams.

Say: Let's lock it in. Amplitude is max distance from rest. Energy goes like amplitude squared. Show me you can use 1, 4, 9 without guessing.

Ask: What is amplitude? (Max displacement from rest position, middle line to crest or trough [12][13].) · Amplitude doubles from 1 to 2. What happens to energy? (It goes 4 times bigger, from 1 to 4, because energy goes as amplitude squared [17].)

Check understanding: Exit ticket on paper; if many miss squaring, start next lesson by re-shading 2 by 2 squares.

Support: Let students answer by pointing to their labeled diagram plus stating 2 squared equals 4. **Stretch:** Ask a student to state the amplitude needed for 16 times energy and explain with 4 squared.

Use: Slide 11

Common mistakes

Mistake	How to spot it	How to fix it
Thinking doubling amplitude doubles energy.	Student writes energy 2 when amplitude is 2.	Re-shade 2 by 2 squares to show 4 units and restate doubling quadruples because energy is amplitude squared [17].
Measuring amplitude from crest to trough instead of rest line.	Ruler spans full wave height on diagram.	Draw the middle rest line and measure rest to crest or trough only, the maximum displacement from rest [12][13].
Thinking waves carry matter forward across the ocean.	Student says water travels all the way to shore.	Show particles move mostly in place while the pattern moves forward; waves transport energy without transporting matter [6][12].

Support

- Use pre-drawn waves with a bold middle rest line and graph-paper squares for counting.

Stretch

- Calculate energy for amplitudes 5 and 10 and write why small height gains pack a big punch.

For the LSE or teaching assistant

Sit with pairs needing math support during Task C; prompt counting shaded squares and checking 1, 4, 9 before drawing.

Check for understanding

Question	Answer
What is amplitude and how do you find it on a diagram?	Max displacement from rest position; measure from middle line to crest or trough [12][13].
Amplitude triples from 1 to 3. What happens to energy?	It becomes nine times bigger, from 1 to 9 [14][17].
Wave A has amplitude 2 and Wave B has amplitude 4. How many times more energy does B carry? Show math.	Four times more: 4 squared is 16 and 2 squared is 4, and 16 divided by 4 is 4 [17].

Homework

Sketch two waves with same spacing but amplitudes 1 and 2, label amplitude, and show energy math 1 and 4.

Sources

1. Unit 3 · avon.k12.ct.us · https://www.avon.k12.ct.us/UserFiles/Servers/Server_158652/File/Departments/Teaching%20&%20Learning/District%20Curriculum/Science/Grade%208/Unit_03_Forces.pdf
2. Grade 8 Science Curriculum Pacing Guide · gcsd.k12.nj.us · https://gcsd.k12.nj.us/ourpages/auto/2025/6/4/46415968/Grade%208%20Science%20Curriculum%20Pacing%20Guide.pdf?rnd=1753277431198
3. 16.4 Energy and Power of a Wave - University Physics Volume 1 · pressbooks.online.ucf.edu · https://pressbooks.online.ucf.edu/osuniversityphysics/chapter/16-4-energy-and-power-of-a-wave/

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4. 16.4 Energy and Power of a Wave - General Physics Using Calculus I · pressbooks.online.ucf.edu · https://pressbooks.online.ucf.edu/phy2048tjb/chapter/16-4-energy-and-power-of-a-wave/
5. Acoustics: the study of sound waves - Stanford University · ccrma.stanford.edu · https://ccrma.stanford.edu/~jay/subpages/Lectures/Lecture1-Acoustics.pdf
6. Waves, Electromagnetic Radiation, and Sound - An Introduction to ... · openbooks.lib.msu.edu · https://openbooks.lib.msu.edu/isp201/chapter/waves/
7. Wave and Wave Properties | manoa.hawaii.edu/ExploringOurFluidEarth · manoa.hawaii.edu · https://www.manoa.hawaii.edu/exploringourfluidearth/physical/waves/wave-and-wave-properties
8. Amplitude & Intensity of Sound Waves - BU · cs.bu.edu · https://www.cs.bu.edu/fac/snyder/cs583/Literature%20and%20Resources/AmplitudeIntensitySoundWaves.pdf
9. Sound and noise - Sound waves, amplitude and frequency - 4th ... · bbc.co.uk · https://www.bbc.co.uk/bitesize/guides/z8rj4xs/revision/7
10. Waves KS3 | Y9 Science | Lesson Resources | Oak National Academy · thenational.academy · https://www.thenational.academy/teachers/programmes/science-secondary-ks3/units/waves/lessons
11. Sound Waves - BBC Bitesize · bbc.co.uk · https://www.bbc.co.uk/bitesize/articles/z38m7yc
12. Energy Transport and the Amplitude of a Wave · physicsclassroom.com · https://www.physicsclassroom.com/tutorial/vibrations-and-waves/properties-of-a-wave/energy-transport-and-the-amplitude-of-a-wave
13. wave - Students | Britannica Kids | Homework Help · kids.britannica.com · https://kids.britannica.com/students/article/wave/628468
14. What Does It Mean When a Wave's Amplitude Increases? · scienceinsights.org · https://scienceinsights.org/what-does-it-mean-when-a-waves-amplitude-increases/
15. Features of waves links to energy transfer guide for KS3 ... · bbc.co.uk · https://www.bbc.co.uk/bitesize/articles/zh28jsg
16. Wave Intensity - lipa.physics.oregonstate.edu · lipa.physics.oregonstate.edu · https://lipa.physics.oregonstate.edu/sec_intensity.html
17. Energy in Waves: Intensity - Introductory Physics for the Health and ... · openbooks.lib.msu.edu · https://openbooks.lib.msu.edu/collegephysics1/chapter/energy-in-waves-intensity-2/