Name & Surname: _____ Class: _____ Date: _____

Waves: Amplitude and Energy

Use math to show how bigger waves carry more energy

About 30 minutes Level ★★★☆☆



Key words

amplitude: maximum distance a wave moves from its rest position

crest: highest point of a transverse wave

transverse wave: wave where particles move up and down while energy moves forward

energy: ability to do work, carried from place to place by a wave

trough: lowest point of a transverse wave

proportional: two values change together by a fixed math rule

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Explain and Compare

Use the math model to explain results and choose the best shake.

TASK A

/4

Answer in full sentences. Use amplitude and energy in your math and explanations.

1. **What is amplitude? How do you find it on a transverse wave diagram?**
   Amplitude is...

2. **Wave A has amplitude 2 cm. Wave B is the same type but has amplitude 6 cm. How many times more energy does Wave B carry? Show the math.**
   Energy ∝ amplitude², so...

3. **Explain why doubling amplitude gives four times the energy, using work done on the medium.**
   When the source moves farther...

4. **If you shake a slinky harder to add energy, what changes and what stays the same?**
   The amplitude...

TASK B

/8

Compare the three shakes for knocking over a cup with a rope wave. Think about energy and control.

Your group must knock over an empty paper cup 3 meters away using waves on a long rope. You can use one steady shake.

Gentle shake - 1-cm amplitude	**Medium shake - 2-cm amplitude**	**Strong shake - 4-cm amplitude**
Advantage	Advantage	Advantage
Disadvantage	Disadvantage	Disadvantage

Which is the most suitable? Justify your choice.

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Calculate Wave Energy

Finish the math table and match the key terms.

TASK C

/3

Fill the missing cells. Use the rule that energy grows as amplitude squared.

Amplitude	Energy compared to 1-cm wave
1 cm	1x (starting energy)
2 cm	
3 cm	
4 cm	

TASK D

Example done for you

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Match each science term to its meaning. Think about amplitude and energy.

1. amplitude
2. energy
3. crest
4. trough
5. proportional to the square
6. transverse wave

- ( ) highest point of a transverse wave
- ( ) lowest point of a transverse wave
- ( ) ability to do work, carried by a wave
- ( ) if one value doubles, the other grows 4 times
- ( ) wave where particles move up and down as energy moves forward
- (1) maximum displacement from the rest position

How did I do?

Circle a face for each line.

I can define amplitude and tell what it shows about a wave.	☹	😐	☺
I can use Energy ∝ amplitude squared to compare wave energy.	☹	😐	☺
I can explain why doubling amplitude gives four times the energy.	☹	😐	☺

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Answer sheet: Waves: Amplitude and Energy

Task A

1. Amplitude is the maximum displacement from the rest position. On a transverse wave diagram, measure from the middle rest line to the top of a crest or to the bottom of a trough.
2. Amplitude ratio is 6 ÷ 2 = 3. Energy ratio is 3^2 = 9. Wave B carries 9 times the energy of Wave A.
3. Moving the first coil farther from rest takes more work. The work stored is proportional to displacement squared, so 2 times the displacement needs 4 times the work, giving 4 times the wave energy.
4. The amplitude increases. The wavelength, frequency, and wave speed of that pulse stay the same.

Task B

Gentle shake - 1-cm amplitude: + Easy to control and safe to repeat.; – Carries little energy and may not push the cup over.

Medium shake - 2-cm amplitude: + Carries 4 times the energy of the gentle shake and is still easy to control.; – May still not push the cup over if more force is needed.

Strong shake - 4-cm amplitude: + Carries 16 times the energy of the gentle shake, most likely to move the cup.; – Harder to control, rope may slip or hit nearby desks.

Best choice is the strong 4-cm shake if space is clear and the group holds the rope safely, because energy $\propto$ amplitude^2, so 4^2 = 16 times the energy of the 1-cm wave, giving the clearest proof that larger amplitude means much more energy.

Task C

1 cm | 1x (starting energy)
2 cm | 4x
3 cm | 9x
4 cm | 16x

Task D

1. amplitude → maximum displacement from the rest position
2. energy → ability to do work, carried by a wave
3. crest → highest point of a transverse wave
4. trough → lowest point of a transverse wave
5. proportional to the square → if one value doubles, the other grows 4 times
6. transverse wave → wave where particles move up and down as energy moves forward

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