هيكل الفيزياء physics

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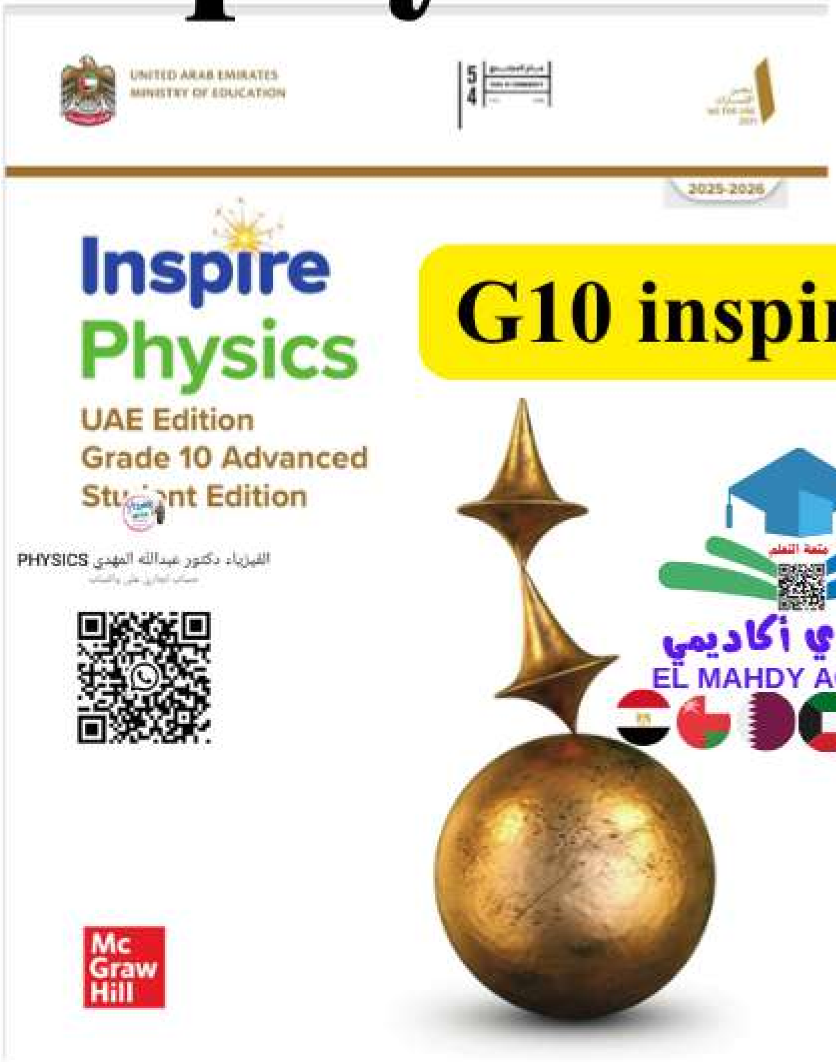

G10 inspire

PHYSICS 2025 2026 exam

المهدي أكاديمي
EL MAHDY ACADEMY

عام المجتمع
YEAR OF COMMUNITY
UAE

Academic Year العام الدراسي	$2K^{25}/2K^{26}$
Term/الفصل	①
Subject الموضوع	Physics (INSPIRE)
Grade الصف	10
Stream. المسار	Advanced المتقدم

المناهج الإماراتية المدرسة الإماراتية

تابعنا على

FOLLOW

دكتور اعداد وتطوير مناهج ومعلم بالتعليم

عزيزي الطالب/ عزيزتي الطالبة

نحن لا نجمع الهيكل في أسئلة فقط ولكن نقوم بالشرح الجزئيات المطلوبة في الهيكل ثم نقوم بجمع الأسئلة عليها من الكتاب

الجزء الأول والشرح على اليوتيوب

لحجز الأجزاء الأخرى تواصل معنا

1	Define periodic motion and quantities associated with periodic motion like period and amplitude. Describe the characteristics of simple harmonic motion.		3

Periodic motion · Amplitude · period (T) · Frequency · Simple harmonic motion

Periodic motion

Motion that repeats in a regular cycle, such as the bobbing of a mass on a spring or the swaying of a pendulum

Period 0r periodic Time (T)

: The time required for one full cycle of the motion

$$T = \frac{\text{Total Time t}}{\text{Number of Cycles n}}$$

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الدكتور
عبدالله المهدي

Frequency f

The number of cycles that a body makes in one second.

$$f = \frac{\text{Number of cycles}}{\text{Total time}}$$

Unit of Measurement: oscillation/second or cycle/second or vibration/second

All are equivalent to Hertz HZ or $\frac{1}{\text{second}}$ or S^{-1}

The Relationship between Frequency and Period:

Each is the reciprocal of the other

$$(\text{Period})T = \frac{1}{f}$$

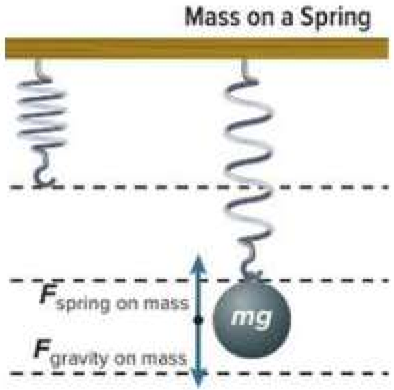
$$(\text{Frequency})f = \frac{1}{T}$$

Example: A body makes 360 oscillations, waves, or cycles in one minute. Calculate its period and frequency.

$$T = \frac{\text{Total time}}{\text{Number of cycles}} = \frac{60}{360} = \frac{1}{6}\ s$$

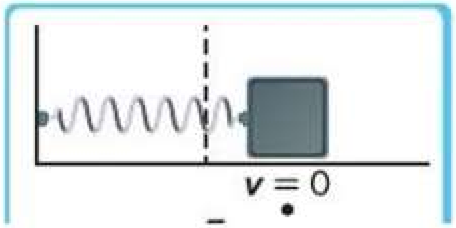
$$f = \frac{\text{Number of cycles}}{\text{Total time}} = \frac{360}{60} = 6\ \text{Hz}$$

$$(\text{Period})T = \frac{1}{f} = \frac{1}{6}$$



Amplitude: The maximum distance the object moves from its equilibrium position.

units cm or meter



Simple harmonic motion: A type of periodic motion where the force acting to restore an object to its equilibrium position is directly proportional to the object's displacement.

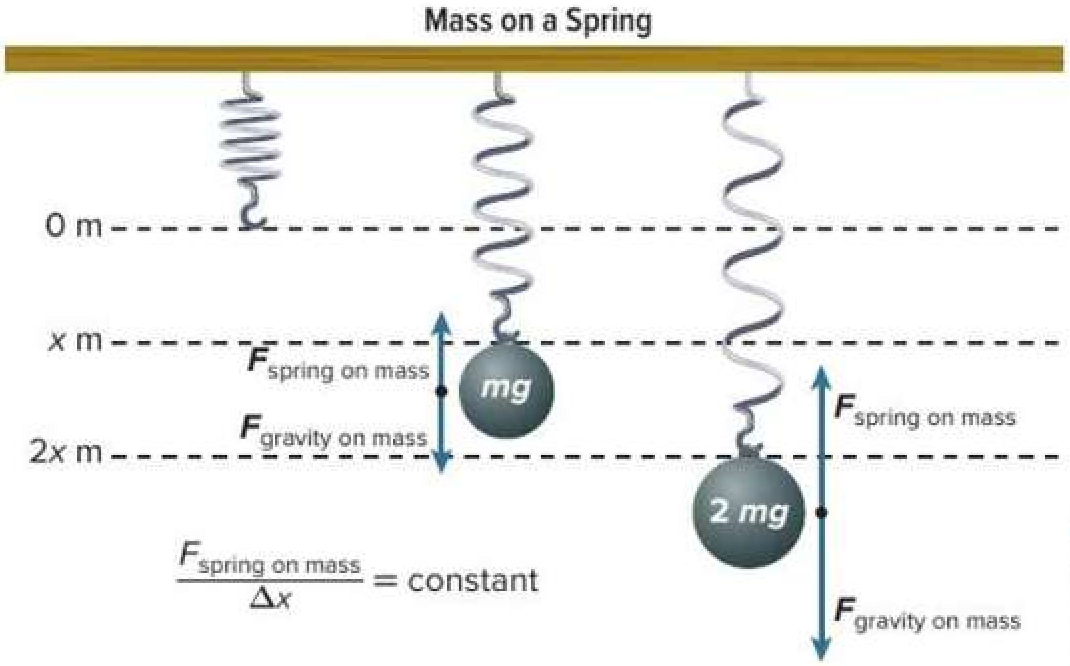


Figure 1 The force exerted on the mass by the spring is directly proportional to the mass's displacement.

Determine *the displacement if the mass is 0.5 mg.*

Characteristics of Harmonic Motion:

1-The restoring force is directly proportional to the displacement and always works to return the object to the equilibrium position.

2-Objects oscillate around an equilibrium point.

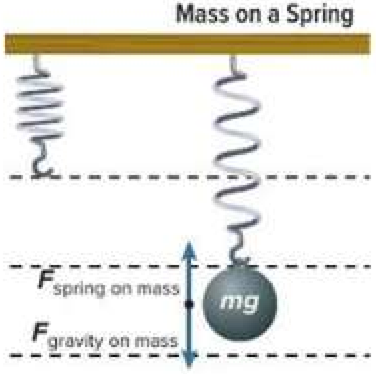
3-It can be described using a sine or cosine function.

2	Apply Hooke's law to calculate the force exerted by a spring, the spring constant, or the distance by which a spring is stretched or compressed.	Student Book Example Problem 1 Practice Problem Q. (3)	4 6 6

Hooke's Law

The magnitude of the force exerted by a spring is equal to the spring constant times the distance the spring is stretched or compressed from its equilibrium position.

$$F = -kx$$



The constant **k** has the same units as the slope, newtons/meter (N/m).

The negative sign in Hooke's law indicates that the force is in the direction opposite the stretch or compression direction. The force exerted by the spring on the mass is always directed toward the spring's equilibrium position.

Table 1 Force Magnitude-Stretch Distance in a Spring

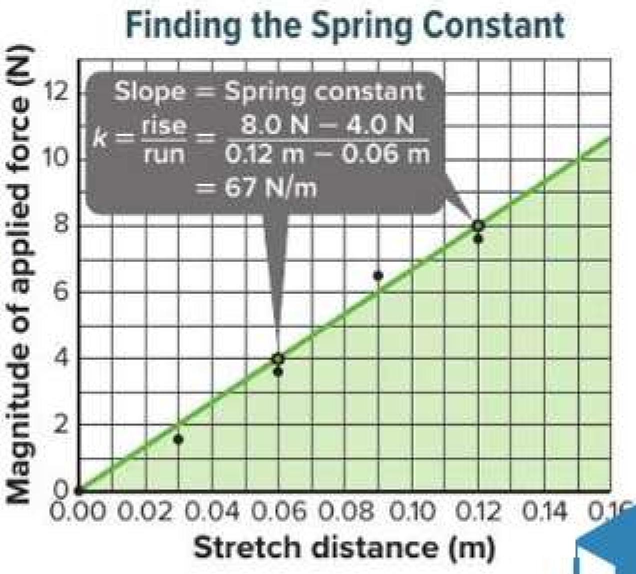
Stretch Distance (m)	Magnitude of Force Exerted by Spring (N)
0.0	0.0
0.030	1.9
0.060	3.7
0.090	6.3
0.12	7.8

Figure 2 The spring constant can be determined from the slope of the force magnitude-stretch distance graph. The area under the curve is equal to the potential energy stored in the spring.

Potential Energy in a Spring

The potential energy in a spring is equal to one-half times the product of the spring constant and the square of the displacement.

$$PE_{spring} = -\frac{1}{2}kx^2$$



PE calculated from the area under the curve between (F & X)

Important note

Potential energy is directly proportional to the square of the elongation. X^2

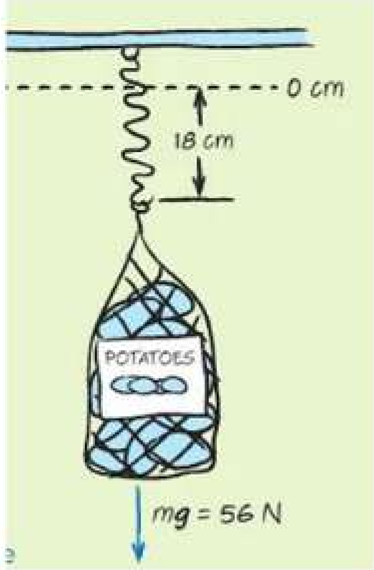
- If the elongation doubles, the potential energy increases four times.
- If the elongation increases 3 times, the potential energy increases ....
- If the potential energy doubles, it is likely that the elongation has increased to .... (Think, don't rush).
- You have two springs, one with an elongation of 5 cm and the second with an elongation of 10 cm, the ratio between their potential energies is ....

EXAMPLE Problem 1

THE SPRING CONSTANT AND THE ENERGY OF A SPRING A spring stretches by 18 cm when a bag of potatoes weighing 56 N is suspended from its end.

a. Determine the spring constant.

b. How much elastic potential energy does the stretched spring have?



3. A spring has a spring constant of 56 N/m. How far will a block weighing 18 N stretch it?

$$F = kx$$

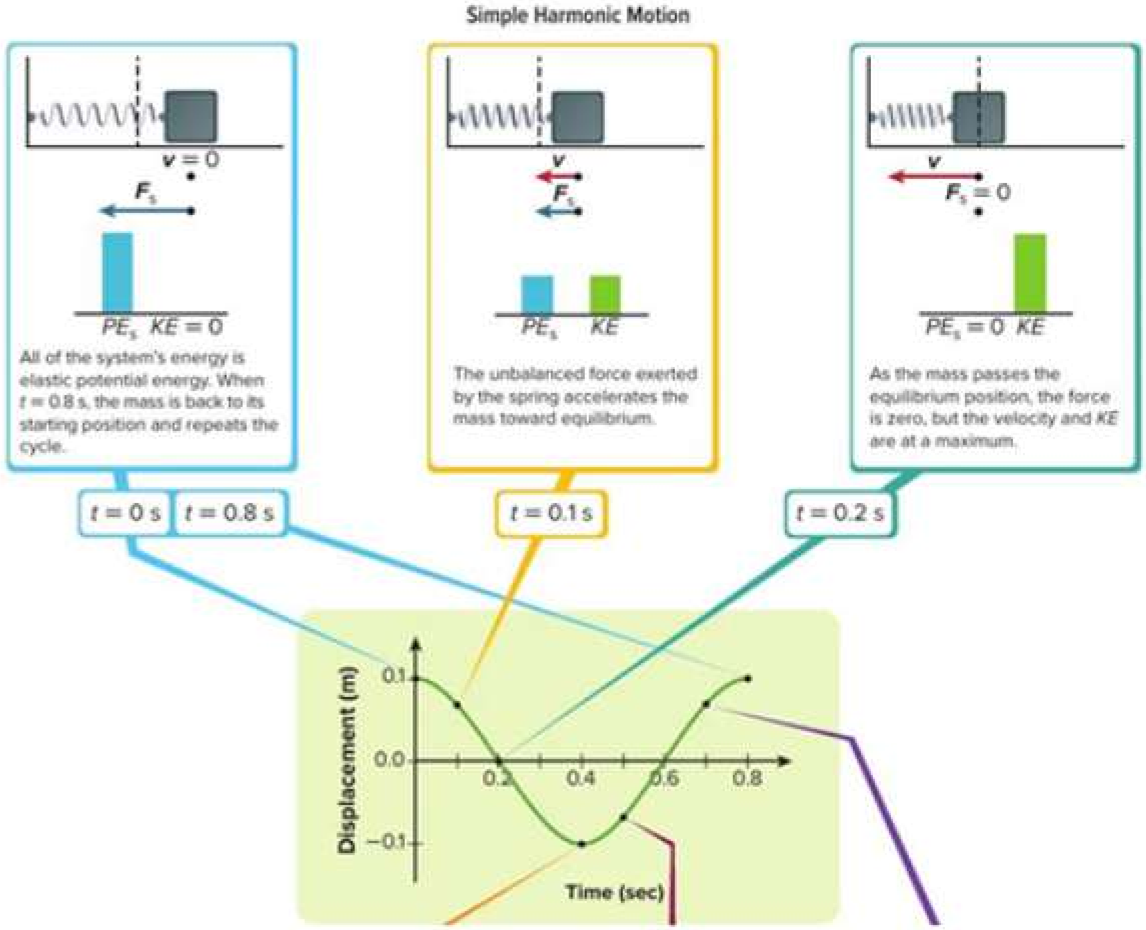
3	Apply the law of conservation of energy for both a horizontal oscillating mass – spring system and simple pendulum to relate the total energy of each system at one instant to the total energy at another instant.	Student Book Check Your Progress Q. (9)	5 8

The law of conservation of energy states that the total mechanical energy (E) of a system is constant,

$$E = KE + PE$$

$$KE = \frac{1}{2}mv^2$$

$$PE = \frac{1}{2}kx^2$$



what happen to

PE, KE, V , restoring force

اتبع الشرح مع الدكتور

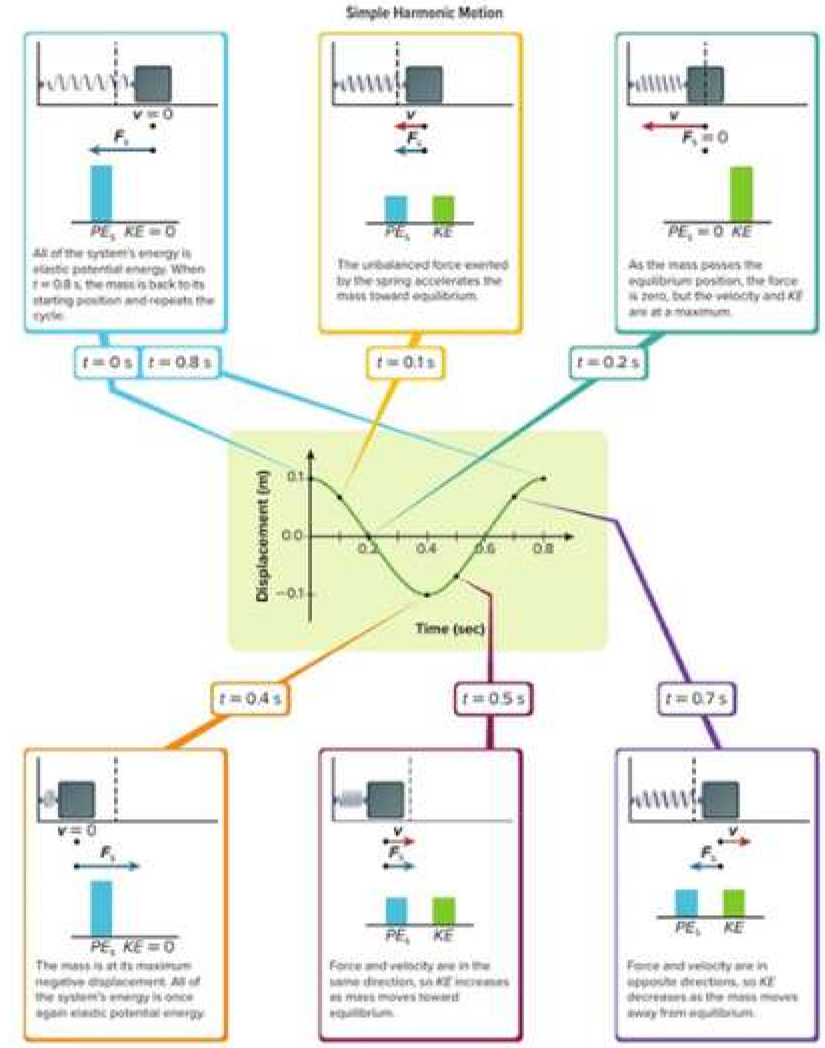


Figure 3 The total mechanical energy of the system is constant throughout the oscillation.

Explain *How can Hooke's law and the concept of conservation of energy be used to predict and describe the behavior of a system such as this?*

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At any position maximum or minmum

PE, KE, V , restoring force

9. **Energy of a Spring** The springs shown in **Figure 5** are identical. Contrast the potential energies of the bottom two springs.

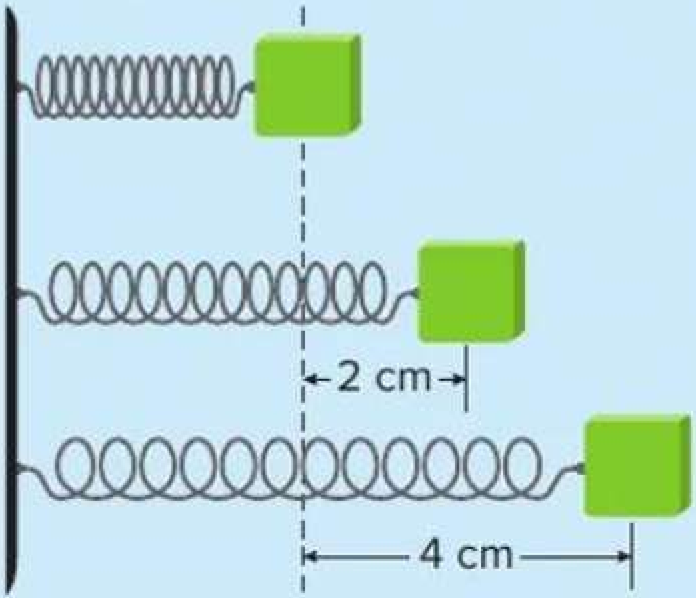


Figure 5

What is the ratio in PE? and why this answer?

4	Determine what affects the period of a simple pendulum.	Student Book Get It	7 7

Period of a Pendulum

The period of a pendulum is equal to 2π times the square root of the length of the pendulum divided by the gravitational field.

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

Notice that the period depends only on the length of the pendulum and the gravitational field, not on the mass of the bob or the amplitude of oscillation. One practical use of the pendulum is to measure g, which can vary slightly at different locations on Earth.

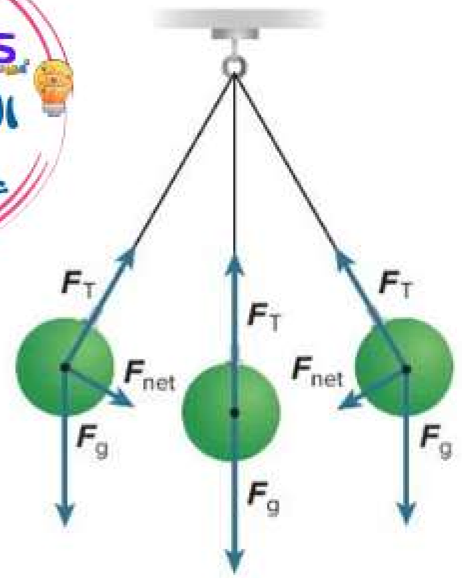


Figure 4 The pendulum's motion is an example of simple harmonic motion because the restoring force is directly proportional to the displacement from equilibrium.

Get It?

Compare the period of a very massive pendulum, like the one shown at the beginning of the module, with the period of a pendulum with the same length but a tiny mass.

1-If the pendulum's length increases 4 times, then the pendulum's periodic time.............

2-If the pendulum's length is doubled, then the pendulum's periodic time ....

3-If gravity increases 4 times, then the pendulum's periodic time ....

4-A pendulum whose periodic time was calculated on Earth is then taken to the moon. Its periodic time will (increase - decrease - remain the same)

5-The ratio between the periodic time of a pendulum with mass 20g and a pendulum with mass 80g, both having the same length and in the same location, is (less than - greater than - equal to) one.

5	Differentiate between transverse, longitudinal, and surface waves and give examples.	Student Book	9 →10

Transverse Waves

The particles in the medium move perpendicular to the direction of the wave's travel.

An example shown is shaking a rope up and down to create a wave that travels horizontally, Sea Wave

Longitudinal Waves

The particles in the medium move parallel to the direction of the wave's travel.

An example shown is squeezing and releasing a coiled spring to create a wave that travels in the same direction as the disturbance.
Sound waves are also an example of longitudinal waves.

Surface Waves

Particles in a surface wave move in a circular path, which is both parallel and perpendicular to the direction of wave motion. The circular motion is disrupted when the wave reaches the shore, causing it to break.

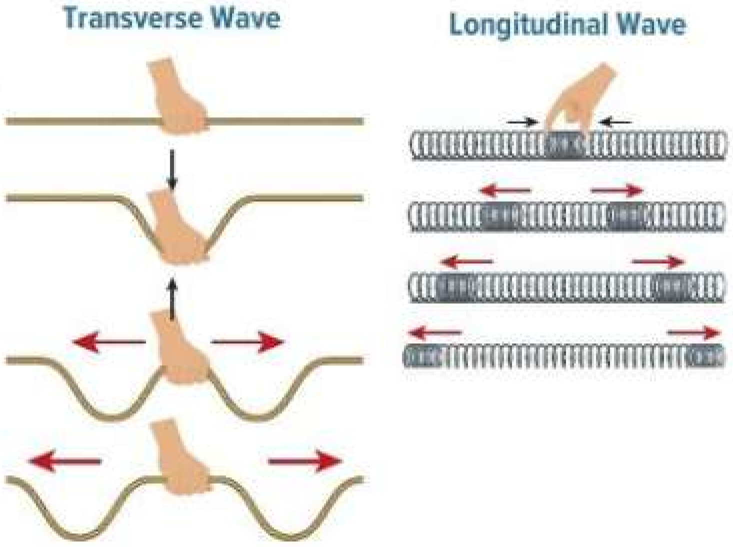


Figure 6 Shaking a rope up and down produces transverse wave pulses traveling in both directions. Squeezing and releasing the coils of a spring produces longitudinal wave pulses in both directions.
Explain *the difference between transverse and longitudinal waves.*

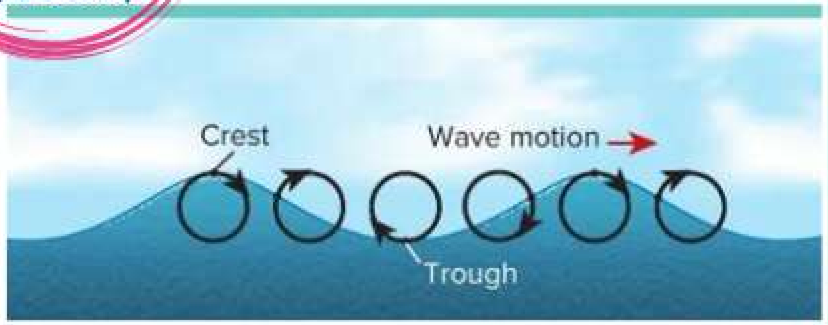


Figure 7 Surface waves in water cause movement both parallel and perpendicular to the direction of wave motion. When these waves interact with the shore, the regular, circular motion is disrupted and the waves break on the beach.

6	Describe wave properties like amplitude, energy of a wave, wavelength, speed, phase, period and frequency.	Student Book	10 →11

Amplitude

The maximum displacement or distance of a wave from its equilibrium position. It is always a positive value. The text uses the example of shaking a rope to show how the force of the shake affects the amplitude.

Energy of a wave

The energy a wave transfers is related to its amplitude. Waves with a greater amplitude transfer more energy. the energy transferred is proportional to the square of the amplitude, meaning doubling the amplitude increases the energy transfer by a factor of four.

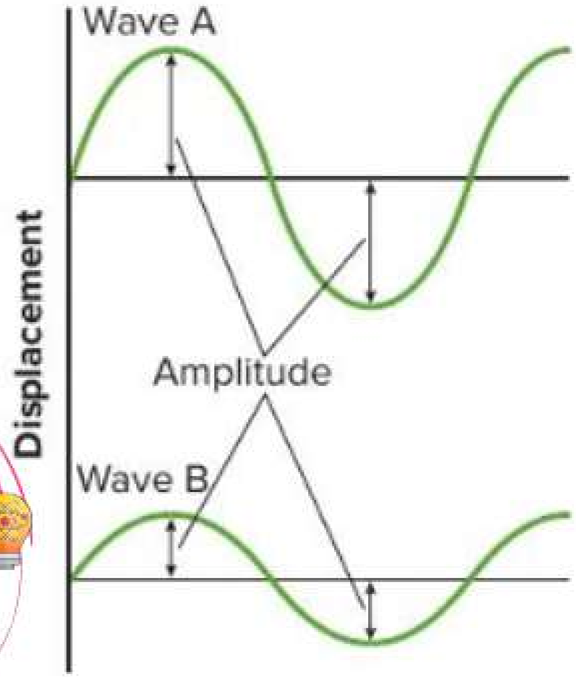
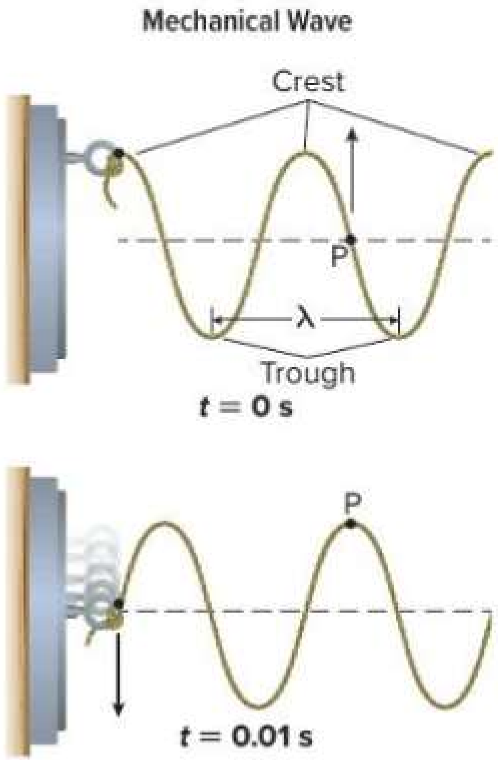


Figure 8 A wave's amplitude is measured from the equilibrium position to the highest or lowest point on the wave.

Wavelength λ

The shortest distance between repeating points on a wave.
The high points of a transverse wave are called crests, and the low points are called troughs in transverse,
longitudinal compressions and rarefactions,



Speed and velocity

The speed of a wave is determined by the displacement of a crest or compression divided by the time interval

$$v = \frac{\Delta d}{\Delta t} \qquad v = \lambda f$$

mechanical waves, speed depends on the medium and not on amplitude, frequency, or wavelength.

the speed depends on two main factors:

1-The medium through which the waves are traveling. 2-The type of wave. The temperature of the medium also affects wave speed, as demonstrated by sound waves traveling faster in warm, dry air compared to cool, dry air.

Get It?

Summarize how changing a wave's amplitude, frequency, or wavelength affects the wave's speed.

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Phase

Two points on a wave are "in phase" if they are separated by one or more full wavelengths and have the same displacement and velocity.
Points with opposite displacements and velocities are "180° out of phase." The phase difference between two particles in a wave can range from 0° to 360°.

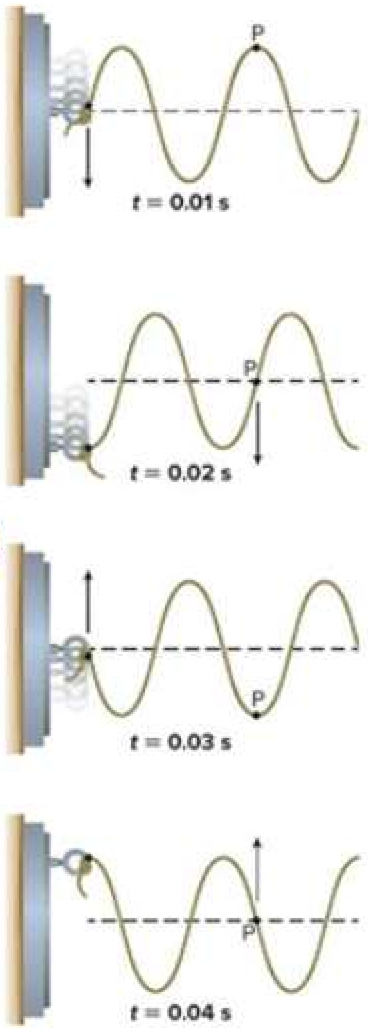

Figure 9 A mechanical oscillator moves the left end of the rope up and down, completing the cycle in 0.04 s.

The period T is the time it takes for a periodic wave to complete one full cycle

8	Calculate the frequency of a wave from its period and vice-versa $(f=\frac{1}{T})$.	Student Book Practice Problem (21,22,23)	12 14

Frequency of a Wave

The frequency of a wave is equal to the reciprocal of the period.

$$f = \frac{1}{T}$$

Both the period and the frequency of a wave depend only on the wave's source. They do not depend on the wave's speed or the medium.

Wavelength

The wavelength of a wave is equal to the velocity divided by the frequency.

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{L}{n}$$

21. How does the frequency of a wave change when the period of the wave is doubled?

when the period of the wave is doubled, the frequency is halved.
The frequency (f) and the period (T) of a wave are inversely proportional to each other.

22. Describe the change in the wavelength of a wave when the period is reduced by one-half.

the new wavelength is one-half of the original wavelength

Why

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23. If the speed of a wave increases to 1.5 times its original speed while the frequency remains constant, how does the wavelength change?

The wavelength increases to 1.5 times its original value.

9	❖ Describe the behaviour of mechanical waves at boundaries (reflection and refraction). ❖ Describe that a mechanical wave is inverted if reflected from a fixed end and remains upright if reflected from a free end.	Student Book	15 →16

Wave speed: The speed of a mechanical wave depends on the properties of the medium it travels through, such as the tension and mass per unit length of a spring. It does not depend on the wave's amplitude or frequency

Incident and reflected waves: When a wave pulse, called the "incident wave," strikes a boundary between two mediums, part of its energy is reflected back as a "reflected wave.

Wave at a Boundary

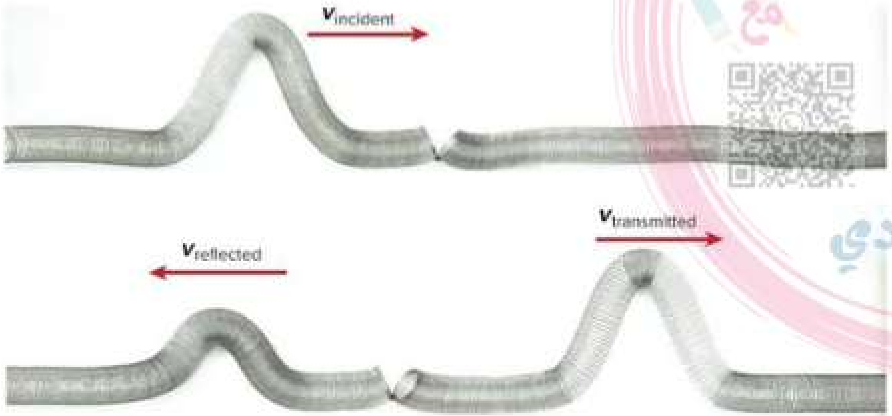


Figure 12 When the wave pulse meets the boundary between the two springs, a transmitted wave pulse and a reflected wave form.

Compare *the energy of the incident wave to the energy of the reflected wave.*

Reflected wave orientation: The reflected wave can be either upright or inverted. If the wave travels into a medium where its speed is greater (e.g., a stiffer spring), the reflected wave will be inverted.

When a wave pulse encounters a rigid boundary, the following occurs:

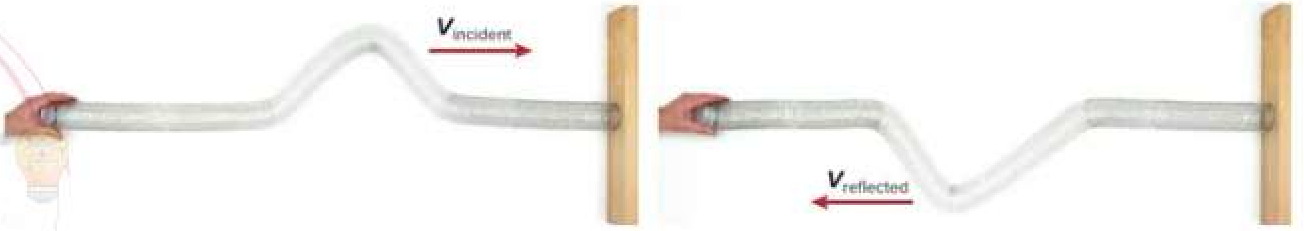


Figure 13 When a wave encounters a rigid boundary, the reflected wave is inverted. Note that the amplitude is not affected by the rigid boundary.

- The wave's energy is reflected back.
- The reflected pulse has almost the same amplitude as the incident wave.
- Almost all of the wave's energy is reflected, with very little being transmitted.
- The reflected pulse is inverted.

- The reason for inversion: When a wave reaches a fixed barrier (a fixed point), it exerts a force on the barrier. In return, the barrier exerts a reaction force on the wave that is equal in magnitude and opposite in direction. This opposing force causes the wave to invert, meaning its phase changes by 180° or π radians

السبب في الانقلاب : عند وصول الموجة إلى حاجز ثابت (نقطة ثابتة)، فإنها تؤثر بقوة على الحاجز، وبالمقابل، يؤثر الحاجز بقوة رد فعل مساوية في المقدار ومعاكسة في الاتجاه على الموجة. هذه القوة المعاكسة تتسبب في انقلاب الموجة، أي تغير تغير طورها بمقدار $180°$ أو π راديان.

Reflection from a free end:

When a wave reaches a free end, there is no opposing force from the barrier. Therefore, the wave continues its motion and reflects without inverting, meaning its phase remains the same

الانعكاس عند طرف حر : عند وصول الموجة إلى طرف حر، لا توجد قوة معاكسة من الحاجز. لذلك، تستمر الموجة في حركتها وتنعكس دون أن تنقلب، أي يبقى طورها كما هو

لا تقلق الدكتور يوضحها في الشرح

70. عندما تعبر موجة حدًّا فاصلًا بين حبل رفيع وحبل سميك كما هو موضّح في **الشكل 23**، يتغيّر طولها الموجي وسرعتها ولا يتغيّر ترددها. اشرح لماذا يبقى التردد ثابتًا.

الشكل 23

- التردد (f) هو عدد الاهتزازات الكاملة التي يصنعها مصدر الموجة في الثانية الواحدة. بما أن مصدر الموجة هو نفسه (الاهتزاز الأولي للحبل)، فإن عدد الاهتزازات في الثانية لا يتغير عند انتقال الموجة من حبل إلى آخر. لذلك، يبقى التردد ثابتًا.

71. ما وجه الاختلاف بين نبضة موجة منعكسة من جدار ثابت والنبضة الساقطة؟

- النبضة المنعكسة من جدار ثابت تكون معكوسة (مقلوبة) بالنسبة للنبضة الساقطة. أي إذا كانت النبضة الساقطة في الاتجاه العلوي، فإن النبضة المنعكسة تكون في الاتجاه السفلي. وذلك لأن الجدار الثابت يطبق قوة معاكسة على الحبل، مما يسبب انعكاس النبضة في الاتجاه المعاكس.

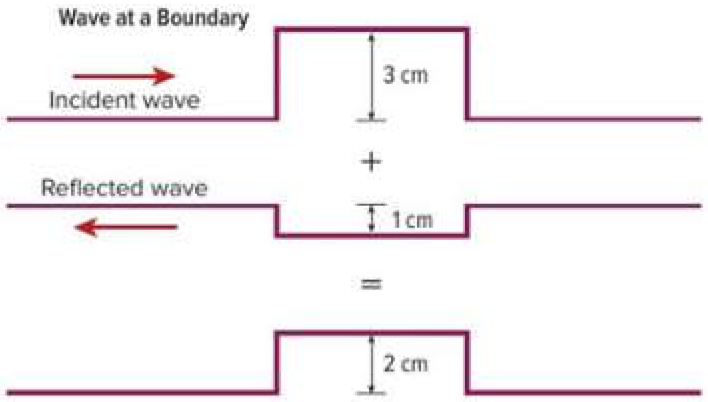
تغير طورها بمقدار $180°$ أو π راديان.

10	State and apply the principle of superposition to show that two overlapping waves add algebraically to give a resultant (or net) wave.	Student Book	16 → 17

Principle of Superposition: **This principle states that when two or more waves exist in the same medium at the same time, the resulting displacement of the medium is the algebraic sum of the displacements caused by each individual wave.**

Combination of Waves: The individual waves combine to form a new wave.

Amplitude Change: The new wave can have a lesser or greater amplitude, depending on whether the individual waves cancel, add, or subtract from each other.



Interference: The result of the superposition of two or more waves is called interference.

Figure 14 Waves add algebraically during superposition.

Constructive Interference

Occurs when wave displacements are in the same direction. The resulting wave has a greater amplitude than the individual waves. A point with the largest displacement is called an **antinode**. The resultant pulse is the algebraic sum of the two pulses

Destructive Interference:

Occurs when waves with equal but opposite displacements superimpose. The displacement at the point where the pulses meet is zero. A point that does not move is called **a node.**

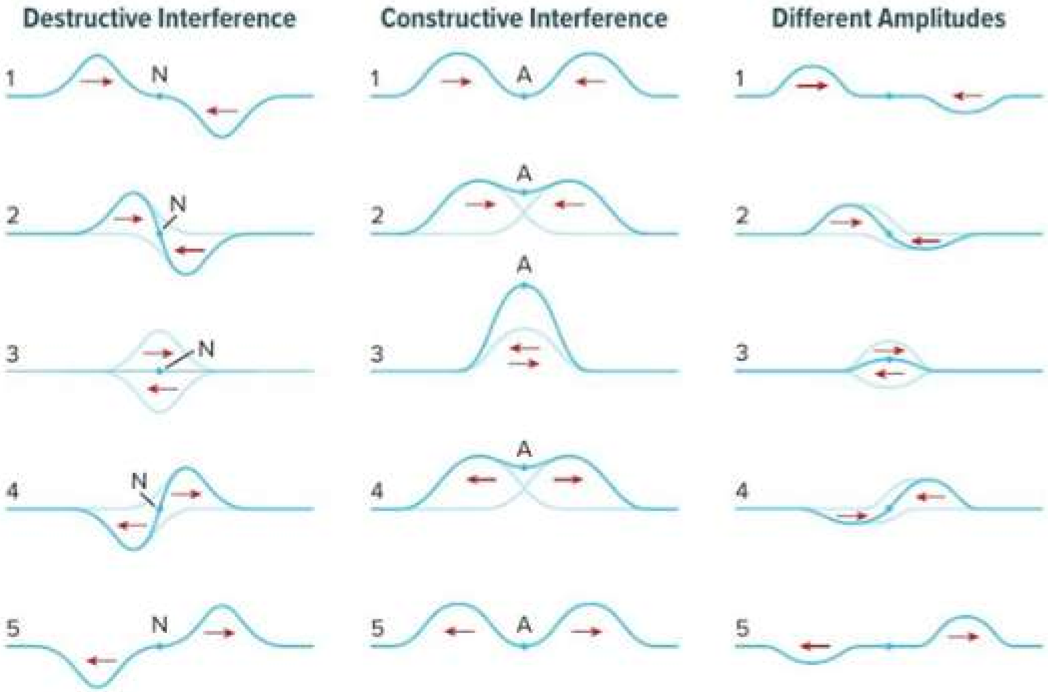


Figure 15 When waves add algebraically, the resulting combined waves can be quite different from the individual waves. **Summarize** *how waves behave during and after superposition.*

Get It?

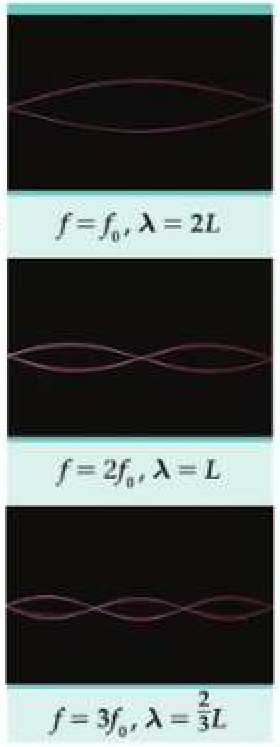
Compare the wave medium's displacement at a node and at an antinode.

A node is a point in a standing wave where the displacement is zero. This occurs due to destructive interference between two waves of equal amplitude.

An antinode is a point in a standing wave where the displacement is at its maximum. This occurs due to constructive interference, where waves combine to form a pulse with an amplitude greater than the individual waves.

11	❖ Describe the formation of standing waves on a string. ❖ Define nodes and antinodes and describe how they are formed.	Student Book	18

- A wave traveling along a rope attached to a fixed point is reflected and inverted at that point.
- When the reflected wave returns to the hand, it is inverted again and travels back down the rope.
- As a result, the displacement of the wave leaving the hand a second time is in the same direction as the first time.



A standing wave is a large-amplitude oscillation resulting from mechanical resonance. This occurs when the period of vibration matches the time it takes for a wave to travel to a fixed point and back.

Standing waves are formed by the interference of waves traveling in opposite directions.

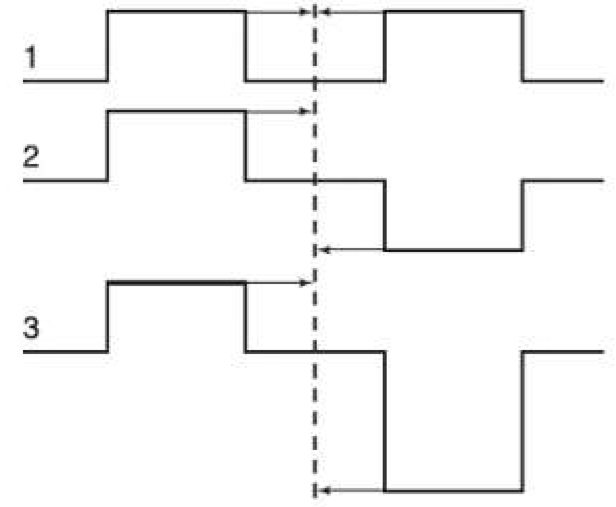
The key features of a standing wave are nodes (points of no displacement, such as the ends of a rope) and antinodes (points of maximum displacement, such as the middle of a rope).

Increasing the frequency of vibration produces more nodes and antinodes, causing the wave to vibrate in multiple segments.

Figure 16 Interference produces standing waves only at certain frequencies.

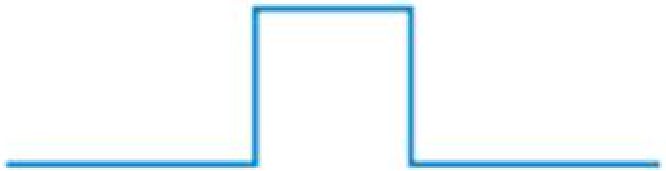
Predict *the wavelength if the frequency is four times the lowest frequency.*

76. مثّل بالرسم نتيجة كل حالة من الحالات الثلاث (1و2و3) الموضّحة في **الشكل 24**. عندما يقع مركزا النبضتين المتقاربتين على الخط المنقط بحيث تتداخل النبضتان تمامًا.



الشكل 24

76. 1. تتضاعف السعة.



2. تلغي السعات بعضها بعضًا.

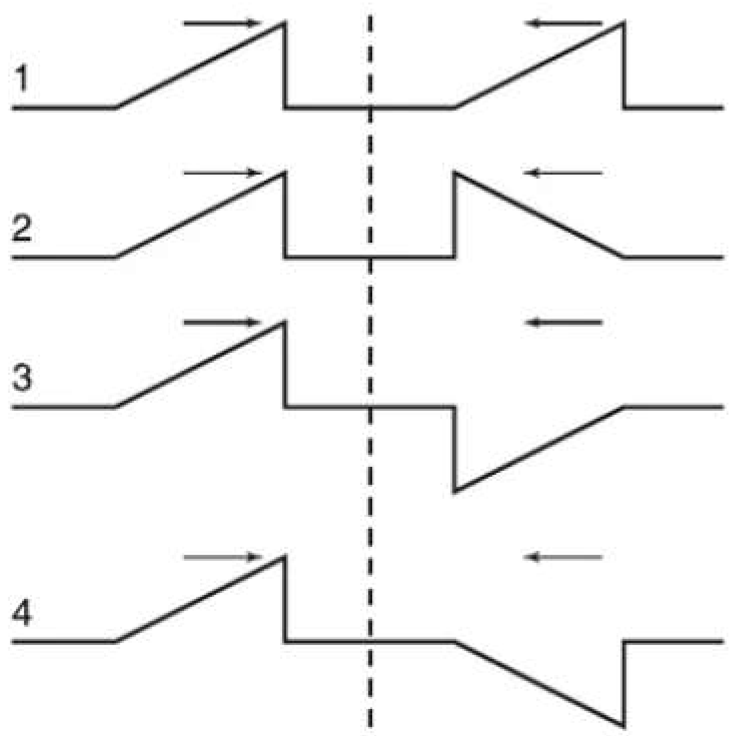
3. إذا كانت سعة النبضة الأولى تساوي نصف سعة النبضة الثانية، فستساوي النبضة الناتجة سعة النبضة الثانية.

الحالة 1: نبضة واحدة بسعة مضاعفة.

الحالة 2: خط مستقيم (صفر) في منطقة التداخل، ثم نبضة واحدة بعد المنطقة.

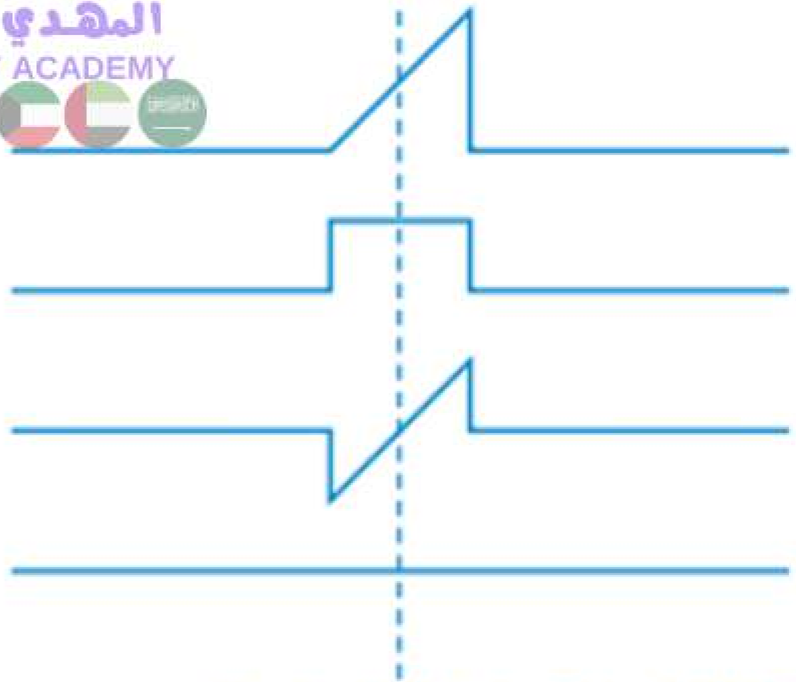
الحالة 3: نبضة واحدة ذات شكل مركب يتكون من الجزء الأول من النبضة الأولى والجزء الأخير من النبضة الثانية.

97. مثّل بالرسم نتيجة كل من الحالات الأربع الموضّحة في **الشكل 26**، عندما يقع مركزا كل من النبضتين على الخط المنقط بحيث تتداخل النبضتان تمامًا.



الشكل 26

.97



الحالة 1: تتداخل النبضتان بشكل بناء، مما ينتج عنه نبضة واحدة بسعة مضاعفة.

الحالة 2: تتداخل النبضتان بشكل هدام، مما ينتج عنه خط مستقيم (إزاحة صفرية).

الحالة 3: تتداخل النبضتان بشكل بناء في بعض الأجزاء وهدام في أجزاء أخرى، مما ينتج عنه نبضة واحدة ذات شكل مختلف.

الحالة 4: تتداخل النبضتان بشكل هدام، مما ينتج عنه خط مستقيم (إزاحة صفرية).

34. **الموجات المستقرة** ما العلاقة بين عدد العقد وعدد البطون في موجة مستقرة في زنبرك مثبت من الطرفين؟

عدد البطون أقل من عدد العقد بواحد. $(N_{nodes} = N_{antinodes} + 1)$

في الموجة المستقرة في زنبرك مثبت من الطرفين، تكون نهايتا الزنبرك دائمًا عقدًا (نقاط سكون). بينما تتشكل البطون (نقاط الاهتزاز القصوى) بين هذه العقد. لذلك، فإن عدد البطون يكون دائمًا أقل من عدد العقد بواحد.

72. صِف حركة جسيمات وسط يقع عند عُقد موجات مستقرة.

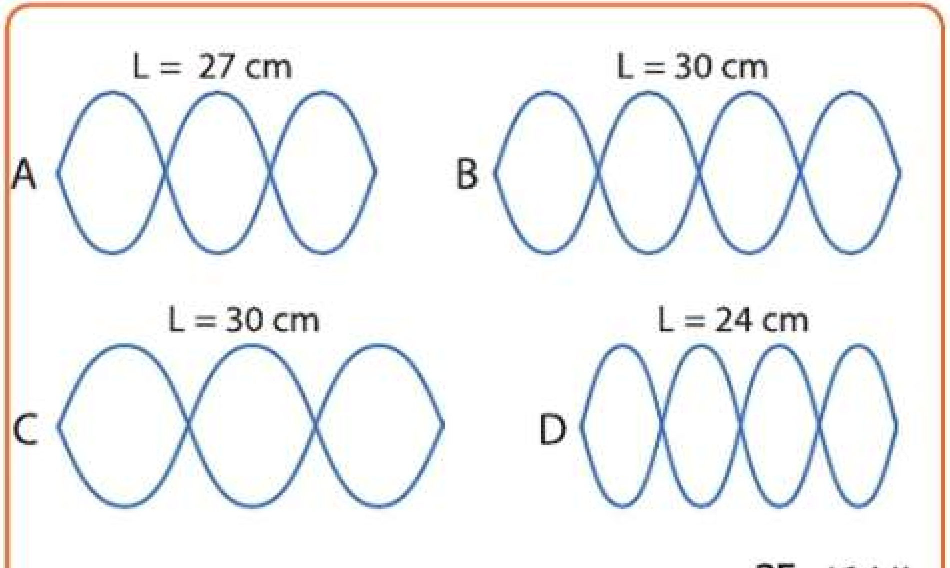
لا تهتز جسيمات الوسط الواقعة عند عقد الموجات المستقرة، وتبقى في موضعها الأصلي

74. اذا اهتز وتر مشكلًا أربعة أقسام. ستستطيع لمس بعض النقاط عليه من دون أن تحدث اضطرابًا في حركته. ما عدد هذه النقاط؟

5 نقاط

عندما يهتز وتر مشكلاً أربعة أقسام، فإن النقاط التي يمكن لمسها دون إحداث اضطراب في حركته هي العقد. عدد العقد في وتر يهتز في نمط موجي معين يساوي عدد الأقسام زائد واحد. لذلك، إذا كان عدد الأقسام 4، فإن عدد العقد هو (4+1=5) نقاط.

78. تنشأ موجات مستقرة في الأوتار الأربعة الموضّحة في **الشكل 25**. إنّ كتلة كل الأوتار هي نفسها لكل وحدة طول وتتأثر جميعها بقوة الشد نفسها.
إذا كانت أطوال الأوتار (L) معلومة. رتّب ترددات الموجات من الأكبر إلى الأصغر.



الشكل 25

78. يكون تردد أكبر طول موجي أقل ما يكون لأنّ سرعات الموجة واحدة. الأطوال الموجية هي A: 18 cm. B: 15 cm. C: 20 cm. D: 12 cm. إذًا ترتيب التردد هو D > B > A > C.

التردد الأساسي لموجة مستقرة في وتر معطى بالمعادلة:

$$f = \frac{v}{2L}$$

التردد يتناسب عكسيًا مع طول الوتر ($f \propto \frac{1}{L}$). هذ

هذا يعني أن الوتر الأقصر سيكون له تردد أعلى، والوتر الأطول سيكون له تردد أقل.

لكل وتر، نلاحظ عدد القطاعات (البطون) في الموجة المستقرة:

الوتر A: يحتوي على 4 بطون.

الوتر B: يحتوي على 3 بطون.

الوتر C: يحتوي على 2 بطن.

الوتر D: يحتوي على 5 بطون.

يمكن حساب التردد التوافقي (f_n) باستخدام عدد البطون (n) وطول الوتر (L) كالتالي:

$$f_n = n\frac{v}{2L}$$

سنستخدم العلاقة $f_n \propto \frac{n}{L}$ لترتيب الترددات.

- للشكل A: $n = 4$ و $L = 27$ سم. القيمة النسبية للتردد هي $\frac{4}{27} \approx 0.148$
- للشكل B: $n = 3$ و $L = 30$ سم. القيمة النسبية للتردد هي $\frac{3}{30} = 0.1$
- للشكل C: $n = 2$ و $L = 30$ سم. القيمة النسبية للتردد هي $\frac{2}{30} \approx 0.067$
- للشكل D: $n = 5$ و $L = 24$ سم. القيمة النسبية للتردد هي $\frac{5}{24} \approx 0.208$

بترتيب القيم النسبية من الأكبر إلى الأصغر:

$$0.208 > 0.148 > 0.1 > 0.067$$

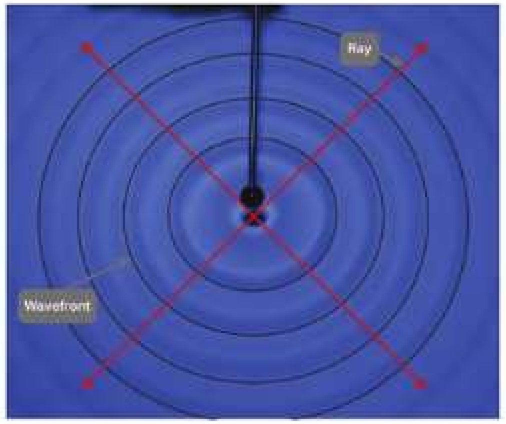
12	❖ Describe the representation of waves in two-dimensions. ❖ Use a ripple tank to model wave behaviour in two dimensions (such as reflection and refraction of waves traveling on the surface of water).	Student Book	18 →20

Waves on the surface of water are two-dimensional waves.

When a stone is dropped into water

A wavefront is a line that represents the crest of a two-dimensional wave, often shown as a series of concentric circles spreading out from a source.

Figure 17 Waves spread out in a circular pattern from the oscillating source.



A ray is a line drawn at a right angle to the wavefront that shows the direction of the wave's motion

A ray is a line drawn at a right angle to the wavefront that shows the direction of the wave's motion

Wavelength: The distance from one wavefront circle to the next is the wavelength.

Creating Waves two-dimensional

A ripple tank, which is a shallow tank with a thin layer of water, is used to investigate two-dimensional waves. A mechanical oscillator generates waves with straight wavefronts, and a lamp creates shadows of the wave crests.

reflection wave a rigid barrier. incidence angle is the angle between the incident ray and the normal, and the angle of reflection is the angle between the reflected ray and the normal.

The law of reflection states that the angle of incidence is equal to the angle of reflection $(\theta_i = \theta_r)$.

The normal is a line perpendicular to the boundary.

The angle of incidence is the angle between the incident ray and the normal.

The angle of reflection is the angle between the reflected ray and the normal.

The law of reflection states that the angle of incidence equals the angle of reflection, and this law applies to different types of waves

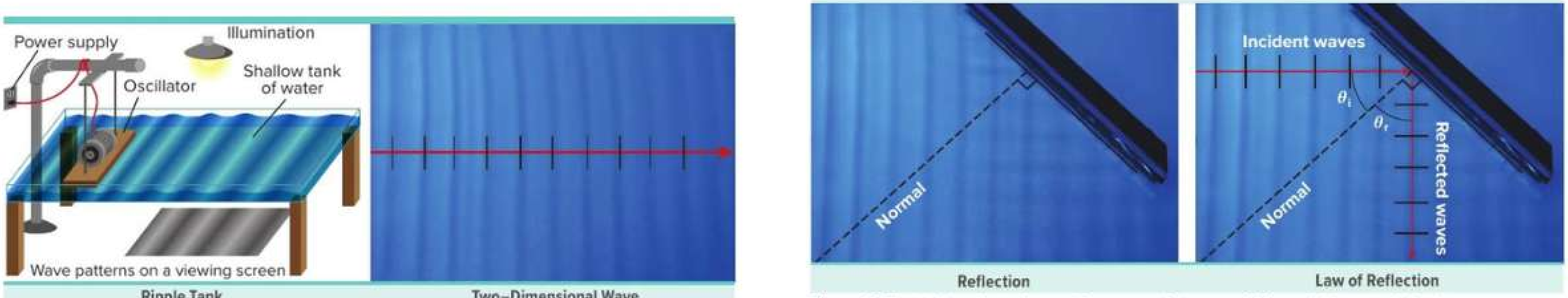


Figure 18 The ripple tank produces uniform waves that are useful for modeling wave behavior.

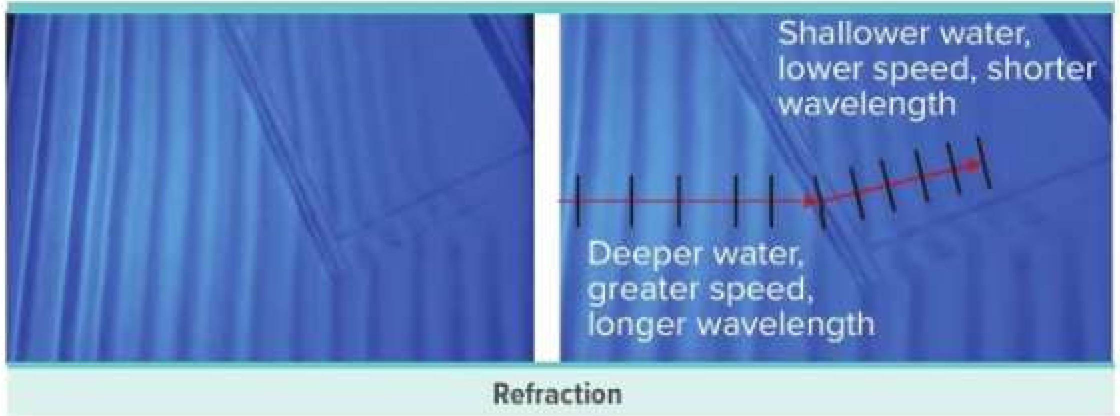


Figure 19 Waves in the ripple tank change direction as they enter shallower water.

Describe *how the wavelength changes as the wave travels into the shallow water.*

Refraction: The change in the direction of waves as they pass from one medium to another, which is caused by a change in wave speed.

Wave Properties: When waves travel from a deeper to a shallower medium, their speed decreases, and their wavelength becomes shorter, while their frequency remains the same

انكسار الموجات: يحدث عندما تنتقل الموجات من وسط إلى آخر، مثل انتقالها من الماء العميق إلى الماء الضحل. يؤدي هذا الانتقال إلى انخفاض سرعتها وتغيير اتجاهها.

Reflection and Refraction: When waves encounter a boundary between two mediums, part of the wave is refracted (passes through) and part is reflected (bounces back).

Examples: Examples of reflection and refraction include echoes from sound waves and rainbows from light waves

What happens when waves travel from one medium to another

(frequency - period - speed - wavelength - amplitude)

لا تقلق الدكتور يوضحها في الشرح

What happens when the wavelength changes the same medium؟ Speed - Frequency - Law

لا تقلق الدكتور يوضحها في الشرح

13	Explain that the speed of sound varies with different mediums and temperatures.	Student Book	27 → 28

A sound wave is a pressure oscillation transmitted through matter, caused by a vibrating source that produces regular variations in air pressure.

Wave Type: Sound is a **longitudinal wave**, meaning the motion of the particles is **parallel** to the direction of the wave's motion.

Frequency: The number of pressure oscillations per second.

Wavelength: The distance between successive high or low-pressure regions.

the speed of sound is greater in solids and liquids than in gases.

Speed of Sound: The speed of sound depends on the medium and, in air, is affected by temperature. At room temperature (20 C) and sea level, the speed of sound is 343 m/s.

The speed increases by approximately 0.6 m/s for every (1C degree) increase in air temperature.

$$v = 331 + 0.6T$$

where v is the speed of sound in m/s and T is the temperature in degrees Celsius

14	❖ Define sound pitch and relate it to the frequency of a sound wave. ❖ Define loudness and relate it to the amplitude of a sound wave.	Student Book	29

Pitch: is the highness or lowness of a sound, which is determined by the frequency of the sound wave.

fr the human ear can typically hear sounds between 20 Hz and 16,000 Hz.

Loudness: Loudness is the intensity of a sound as perceived by the ear, which is primarily determined by the amplitude of the pressure wave

Sound intensity is measured on a logarithmic scale called the sound level, with the unit being the decibel (dB).

14	❖ Define sound pitch and relate it to the frequency of a sound wave. ❖ Define loudness and relate it to the amplitude of a sound wave.	Student Book	29

Feature	Pitch	Loudness
Physical Characteristic	Frequency of vibration	Amplitude of the pressure wav
Description	The highness or lowness of a sound.	The intensity of a sound as perceived by the ear.
Measurement	Given a name on the musical scale (e.g., middle C).	Measured on a logarithmic sca decibels (dB).

Get It?

Identify What characteristic of waves is pitch most closely linked to?

Get It?

Compare How much more intense is a sound that registers 80 dB than one of 40 dB?

15	❖ Define the Doppler Effect. ❖ Explain the Doppler Effect of sound.	Student Book	30 →31

The Doppler effect is the change in the frequency of sound caused by the movement of the sound source, the detector, or both. A common example is the change in pitch of a fast car as it passes by, with the pitch being higher as it approaches and lower as it moves away.

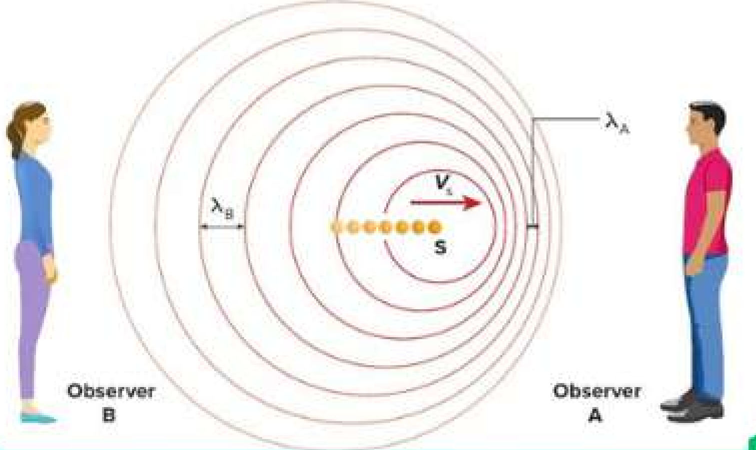
Doppler Effect

The frequency perceived by a detector is equal to the velocity of the detector relative to the velocity of the wave, divided by the velocity of the source relative to the the velocity of the wave, multiplied by the wave's frequency.

$$f_d = f_s \frac{v - v_d}{v - v_s}$$

Figure 6 As a sound producing source moves toward observer A, the wavelength is shortened to λ_A. As the source moves away from observer B, the wavelength is lengthened to λ_B.

Describe *What is the relative difference in the frequency of the detected sound for each observer?*



Moving Sound Source: When a sound source moves toward an observer, the sound waves are compressed, leading to a shorter wavelength and a higher detected frequency. When the source moves away, the waves are stretched, resulting in a longer wavelength and a lower detected frequency.

Moving Detector: A similar effect occurs if the detector is moving and the source is stationary. If the detector moves toward the source, it encounters more wave crests per second, and a higher frequency is detected. If the detector moves away from the source, it encounters fewer crests, and a lower frequency is detected.

Get It?

Compare the wavelength and frequency heard by an observer in front of the moving fire engine at the beginning of the module with the wavelength and frequency heard by an observer behind the fire engine.

16	Define nodes and antinodes and discuss pressure and displacements at these points in case of open and closed pipes.	Student Book	36 →37

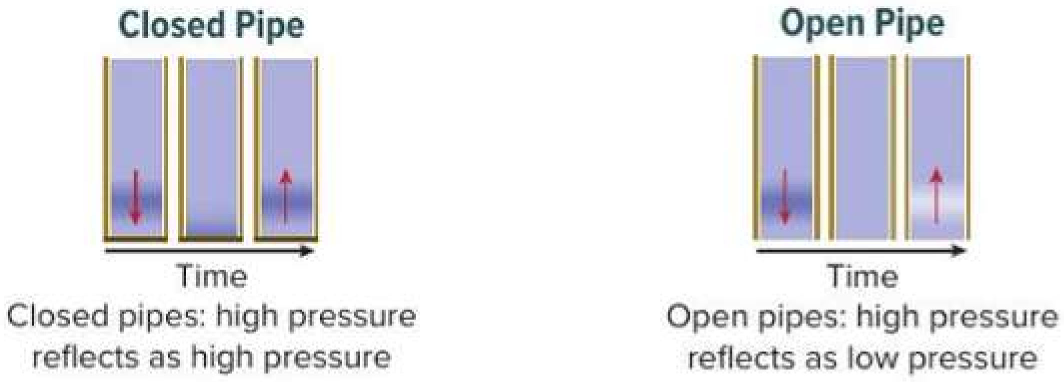


Figure 11 In closed pipes, the sound wave reflects off the closed end. High-pressure waves reflect as high pressure. In open pipes, the sound wave reflects off an open end. High-pressure waves are reflected as low pressure.

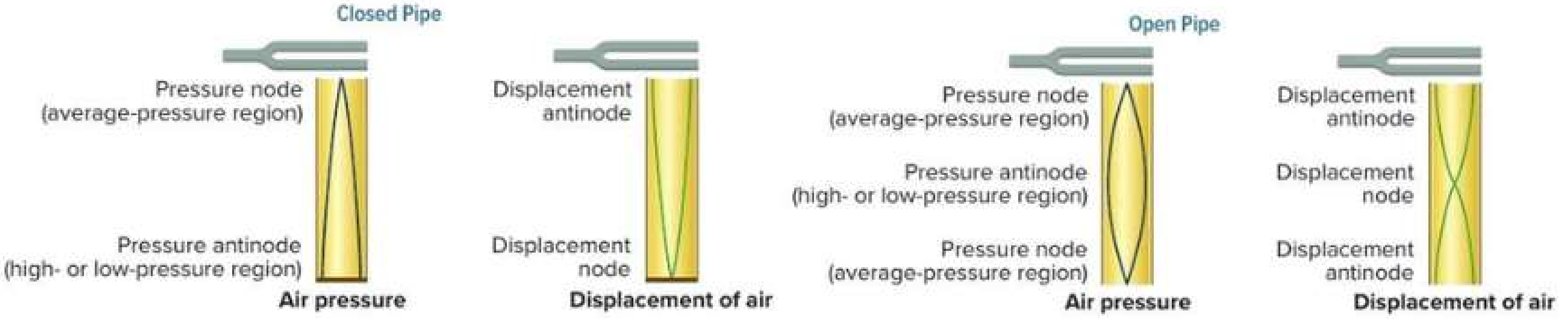


Figure 12 Standing waves in pipes can be represented by sine waves.

Identify *Which are the areas of mean atmospheric pressure in the air pressure graphs?*

Node: A node is the stationary point where two equal wave pulses meet and are in the same location.

Antinode: An antinode is the place of largest displacement when two wave pulses meet.

Definition of resonance: Resonance increases the amplitude of a vibration by repeatedly applying a small external force at the natural frequency of the air column.

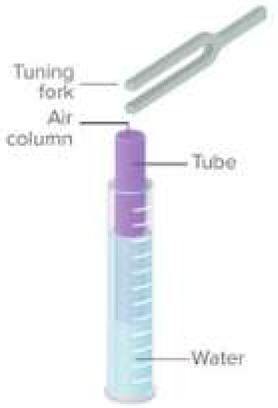


Figure 10 As the tube is raised or lowered, the length of the air column changes, which causes the sound's volume to change.

Pitch control: The length of the air column determines the frequencies that will resonate, and changing its length varies the pitch of the instrument.

Role of the mouthpiece and air column: The mouthpiece creates a mixture of frequencies, while the resonating air column amplifies a specific frequency, turning noise into music.

The sound is at its loudest when the air column is in resonance with the tuning fork, as the resonating air column intensifies the sound.

17	❖ Use the relation between resonance length and wave-length to solve problems for closed and open pipes. ❖ Explain resonance on strings and identify the relations between wavelength, frequency, and the string length.	Student Book Get It	36 →39 38

Closed Pipe

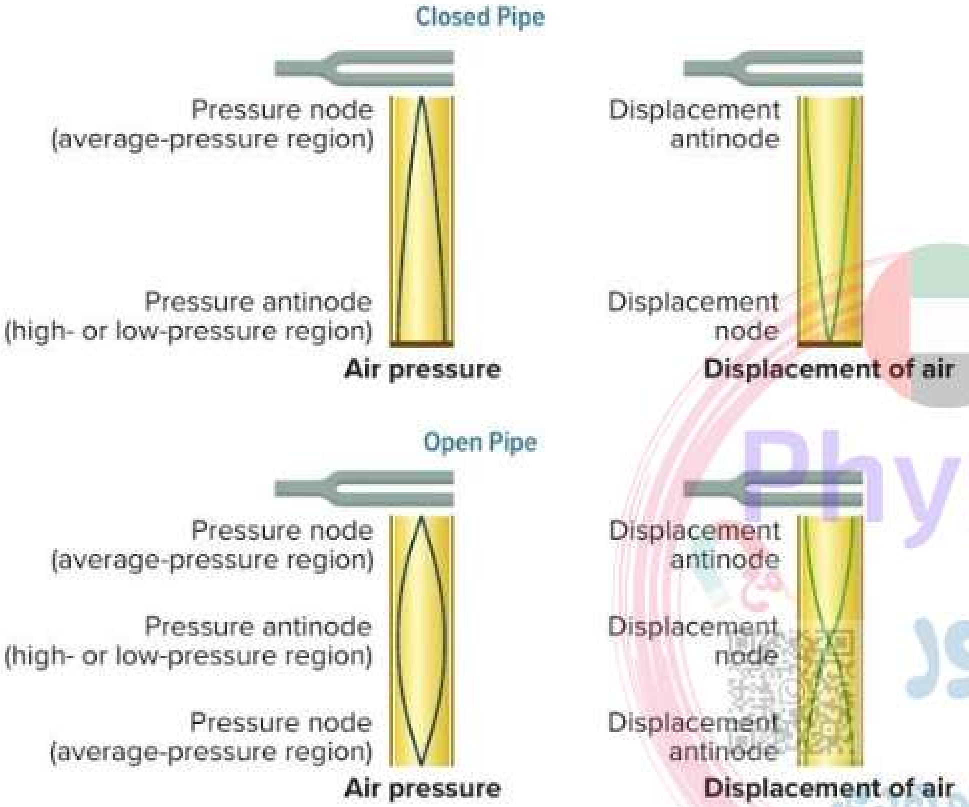


Figure 12 Standing waves in pipes can be represented by sine waves.

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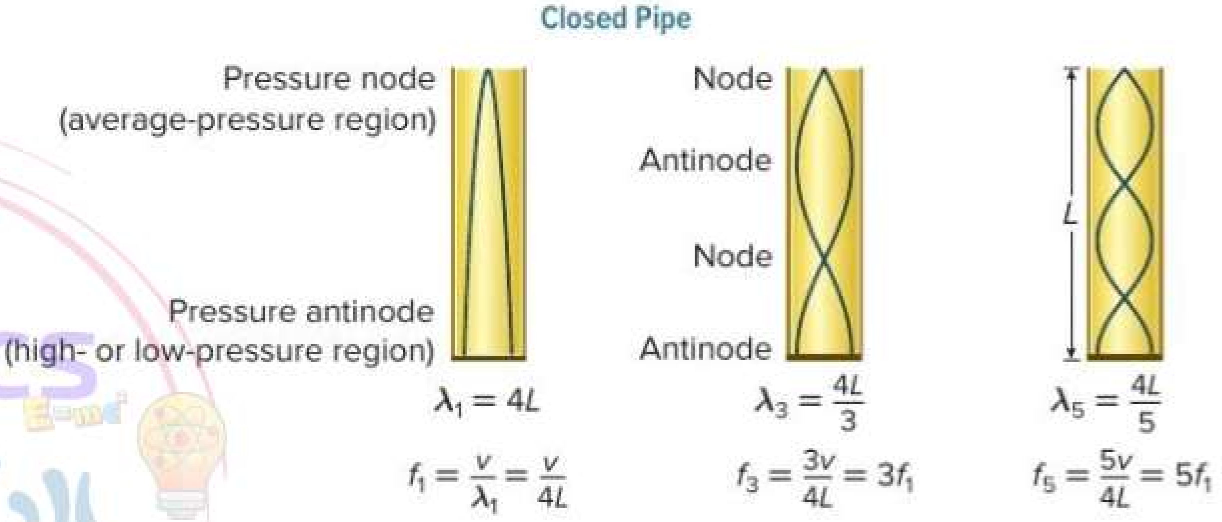


Figure 13 A closed pipe resonates when its length is an odd number of quarter wavelengths.

Open Pipe

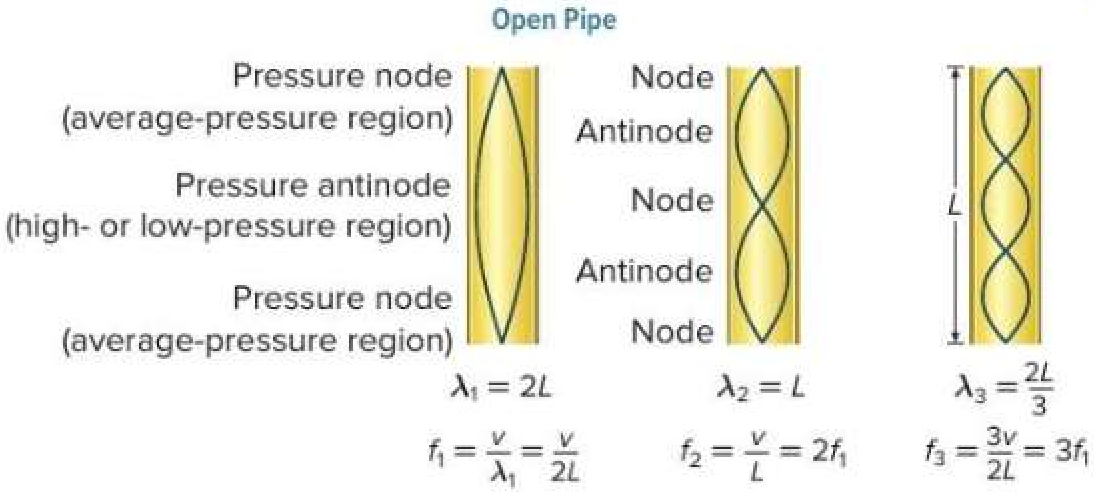


Figure 14 An open pipe resonates when its length is an even number of quarter wavelengths.

Explain *How does the length at which an open pipe resonates differ from the length at which a closed pipe resonates?*

Get It?

Predict A tuning fork plays a sound that has a wavelength of 0.78 m. A pipe that is 0.39 m long resonates with the tuning fork. Is the pipe open or closed? Explain your reasoning.

Wave speed and tuning: The speed of a wave on a string depends on its tension and mass per unit length. Increasing the tension makes the wave travel faster, which raises the frequency of the standing waves, allowing instruments to be tuned.

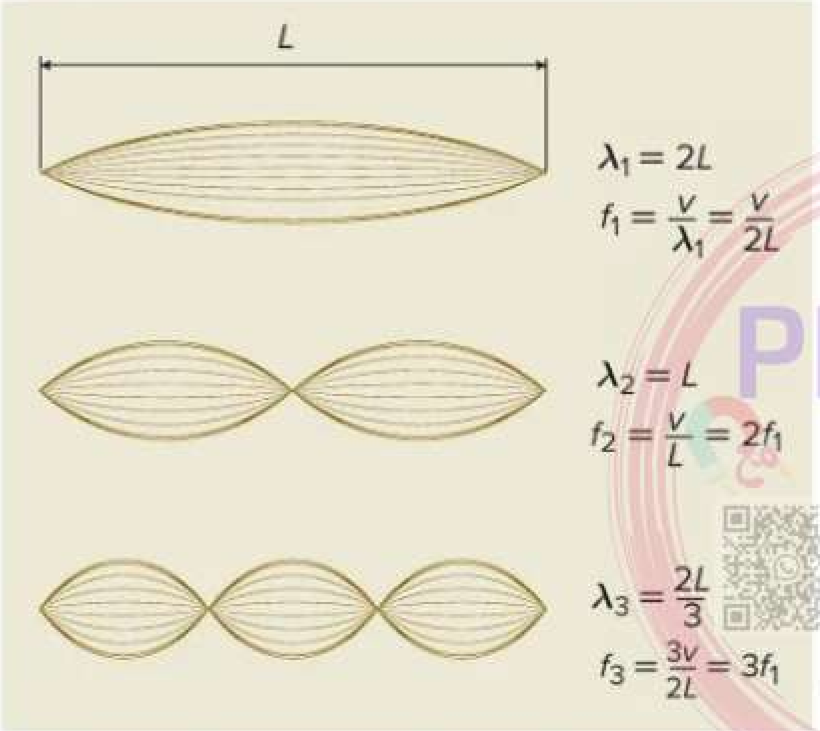
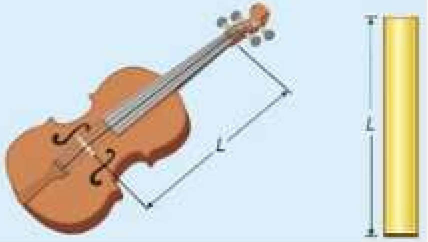


Figure 16 A string resonates with standing waves when its length is a whole number of half wavelengths.

1. Determine the tension, F_T, in a violin string of mass m and length L that will play the fundamental note at the same frequency as a closed pipe also of length L. Express your answer in terms of m, L, and the speed of sound in air, v. The equation for the speed of a wave on a string is $v_{string} = \sqrt{\frac{F_T}{\mu}}$, where F_T is the tension in the string and μ is the mass per unit length of the string.
2. What is the tension in a string of mass 1.0 g and 40.0 cm long that plays the same note as a closed pipe of the same length?



Get It?

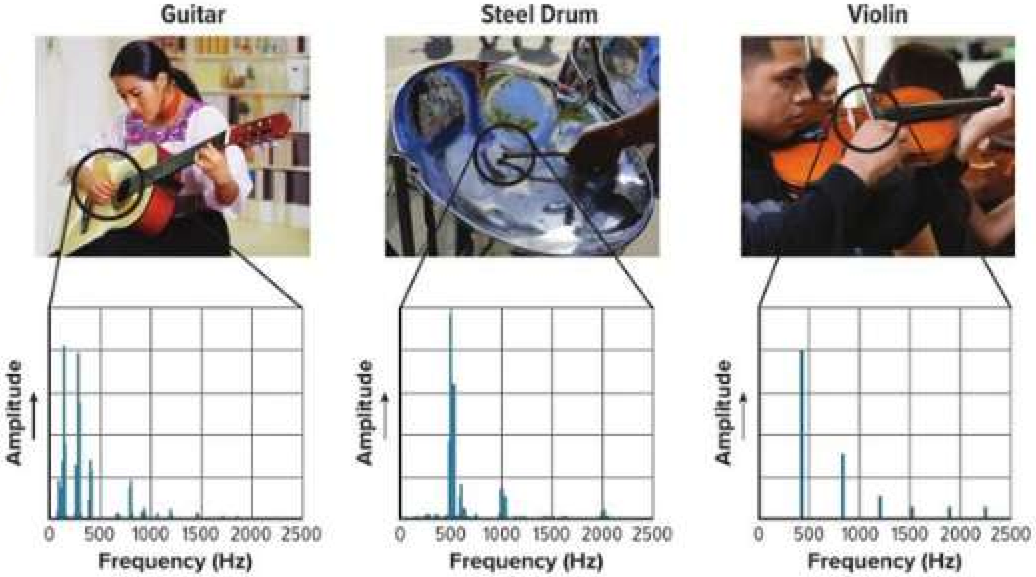
Describe the relationship between the tension of a string and the speed of a wave as it travels along the string.

19	❖ Define timbre in music as the difference between sound waves of different instruments. ❖ Define the fundamental frequency and harmonics and their relation with the timbre of a musical instrument.	Student Book	41

A clarinet's air column acts as a closed pipe, producing a complex sound wave. The lowest resonant frequency for a closed pipe of length (L) is called the fundamental, with the formula $f_1 = \frac{v}{4L}$.

Higher frequencies that are whole-number multiples of the fundamental frequency are called harmonics. For a closed pipe, these are odd multiples like $3f_1$ and $5f_1$.

The unique timbre of a clarinet is created by the addition of these harmonics.



ure 18 A guitar, a steel drum, and a violin produce characteristic sound spectra. Each spectrum is unique, as is timbre of the instrument.

Some instruments, such as a flute, act as open-pipe resonators. Their fundamental frequency, which is also the first harmonic, is $f_1 = \frac{v}{2L}$ with subsequent harmonics at $2f_1$, $3f_1$, $4f_1$, and so on. Different combinations of these harmonics give each instrument its own unique timbre. Each harmonic on the instrument can have a different amplitude as well. A graph of the amplitude of a wave versus its frequency is called a sound spectrum. The spectra of three instruments are shown in **Figure 18.**

Get It?
Explain the relationship between the fundamental and the harmonics of a musical instrument.

20	❖ Define a beat as oscillating high and low sound levels produced from the interference of two sound waves of nearly identical frequencies. ❖ Calculate the frequency of a beat as the magnitude of the difference between the frequencies of the two waves	Student Book	43

Octave: Two notes with a frequency ratio of **1:2** are an octave apart. The fundamental and its harmonics are related by octaves

Other Intervals:

A "major third" has a frequency ratio of **4:5**.

A "fourth" has a frequency ratio of **3:4**.

A "fifth" has a frequency ratio of **2:3**.

توضح الصورة الفواصل الموسيقية والأوتار بناء على نسب التردد:

- **أوكتاف (Octave):** نوتتان بنسبة تردد 1:2 تفصل بينهما مسافة أوكتاف. النوتة الأساسية وتوافقياتها مرتبطة بالأوكتافات.
- **فواصل أخرى:**
  - لـ "ثالث كبير" (major third) نسبة تردد 4:5.
  - لـ "رابع" (fourth) نسبة تردد 3:4.
  - لـ "خامس" (fifth) نسبة تردد 2:3.
- **وتر كبير (Major Chord):** الوتر الكبير، الذي يتكون من نغمات "دو" و "مي" و "صول"، له نسبة تردد 4:5:6. يعتبر هذا الوتر متناسقًا وقد تم الاعتراف به على أنه "الأعذب" في الموسيقى الغربية لأكثر من 2500 عام.

Beats

You have seen that consonance is defined in terms of the ratio of frequencies. When the ratio becomes nearly 1:1, the frequencies become very close. Two frequencies that are nearly identical interfere to produce oscillating high and low sound levels called a **beat.** This phenomenon is illustrated in **Figure 19.** The frequency of a beat is the magnitude of difference between the frequencies of the two waves, $f_{beat} = |f_A - f_B|$. When the difference is less than 7 Hz, the ear detects this as a pulsation of loudness. Musical instruments often are tuned by sounding one against another and adjusting the frequency of one until the beat disappears.

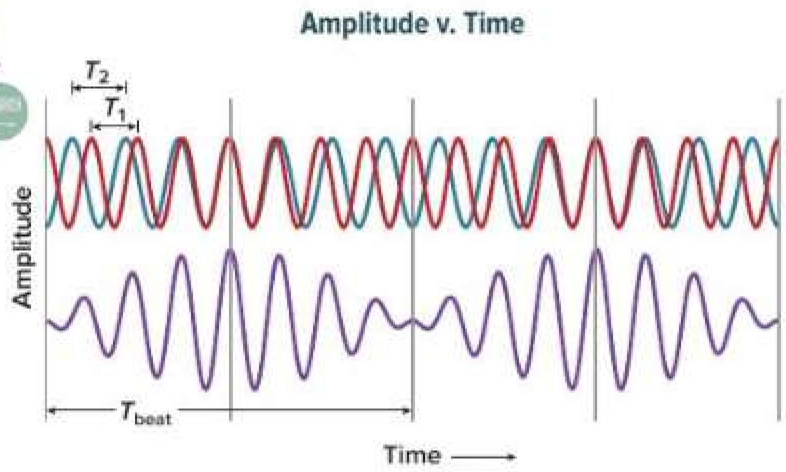


Figure 19 Beats occur as a result of the superposition of two sound waves of slightly different frequencies.

الأسئلة المقالية

21	1 PART	↳ Describe the characteristics of simple harmonic motion. ↳ Describe simple harmonic motion (mass – spring oscillator and a simple pendulum) at maximum displacement and at equilibrium positions in terms of velocity, acceleration, restoring force, and kinetic and potential energy.	Student Book Figure 1	3 3
	2 PART	↳ Describe the energy transformations between potential energy and kinetic energy for both a horizontal oscillating (mass – spring) system and a simple pendulum.	Student Book	5

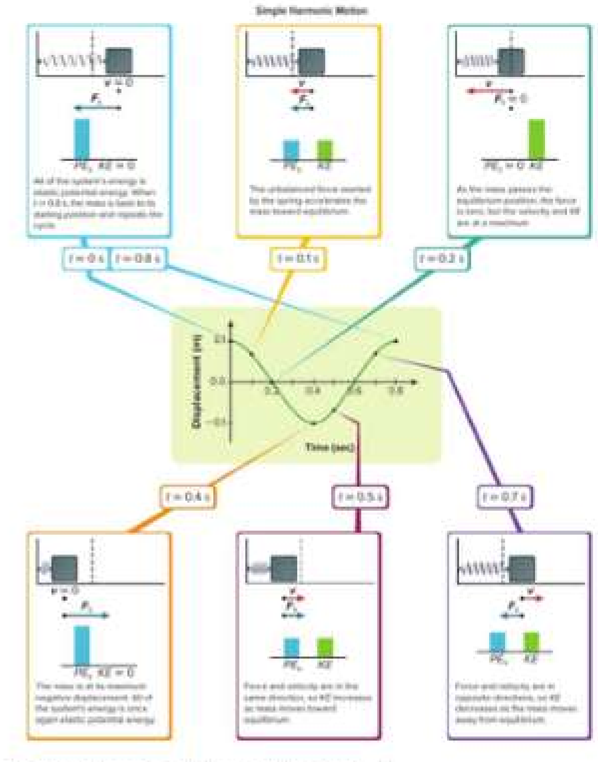


Figure 3 The total mechanical energy of the system is constant throughout the oscillation.

Explain How can Hooke's law and the concept of conservation of energy be used to predict and describe the behavior of a system such as this?

تم شرحهم سابقا

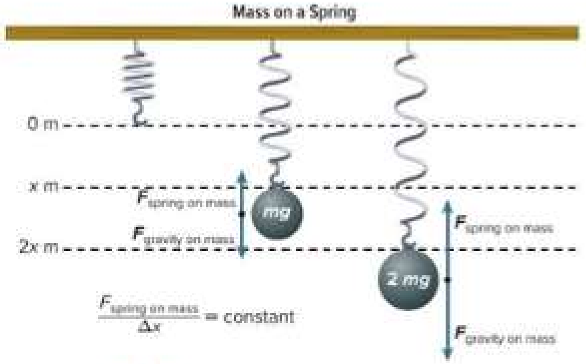


Figure 1 The force exerted on the mass by the spring is directly proportional to the mass's displacement.

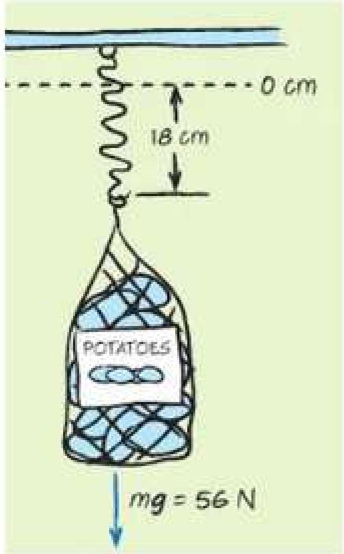
Determine *the displacement if the mass is 0.5 mg.*

22	1 PART	↳ Calculate the potential energy stored in a spring graphically from the area under a force vs extension graph. ↳ Calculate the spring constant graphically from the slope of force vs extension graph.	Student Book Example, Problem 1 Practice Problem Q.(1,2)	4 6 6
	2 PART	↳ Describe the motion of an oscillating simple pendulum. ↳ Apply the equation ($T = 2\pi\sqrt{\frac{l}{g}}$) to calculate the period of a simple pendulum for small-angle oscillations.	Student Book Example, Problem 2 Practice Problem Q.(6,7)	7 8 8

THE SPRING CONSTANT AND THE ENERGY OF A SPRING A spring stretches by 18 cm when a bag of potatoes weighing 56 N is suspended from its end.

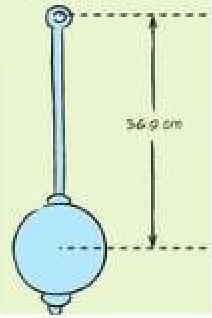
a. Determine the spring constant.

b. How much elastic potential energy does the stretched spring have?



1. What is the spring constant of a spring that stretches 12 cm when an object weighing 24 N is hung from it?
2. What is the elastic potential energy of a spring with $k = 144$ N/m that is compressed by 16.5 cm?
3. A spring has a spring constant of 56 N/m. How far will a block weighing 18 N stretch it?
4. **CHALLENGE** A spring has a spring constant of 256 N/m. How far must it be stretched to give it an elastic potential energy of 48 J?

FINDING *g* USING A PENDULUM A pendulum with a length of 36.9 cm has a period of 1.22 s. What is the gravitational field at the pendulum's location?



5. What is the period on Earth of a pendulum with a length of 1.0 m?

6. How long must a pendulum be on the Moon, where $g = 1.6$ N/kg, to have a period of 2.0 s?

7. **CHALLENGE** On a certain planet, the period of a 0.75-m-long pendulum is 1.8 s. What is g for this planet?

23	1 PART	↳ Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. ↳ Apply the relation ($v = \lambda f$) to calculate the speed, wavelength, or frequency of a wave.	Student Book Example, Problem 3 Practice Problem Q.(14,20)	12 13 14

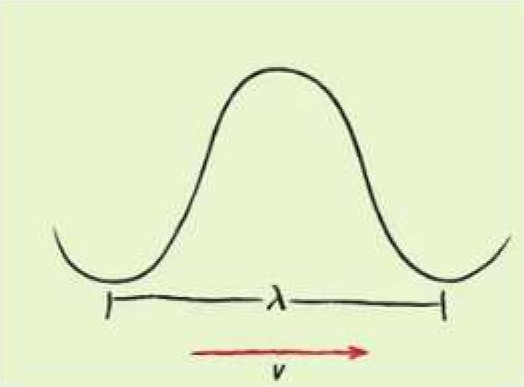
CHARACTERISTICS OF A WAVE A sound wave has a frequency of 192 Hz and travels the length of a football field, 91.4 m, in 0.271 s.

a. What is the speed of the wave?

b. What is the wavelength of the wave?

c. What is the period of the wave?

d. If the frequency were changed to 442 Hz, what would be the new wavelength and period?



14. A sound wave produced by a clock chime is heard 515 m away 1.50 s later.

  a. Based on these measurements, what is the speed of sound in air?

  b. The sound wave has a frequency of 436 Hz. What is the period of the wave?

  c. What is its wavelength?

15. How are the wavelength, frequency, and speed of a wave related? How do they depend on the medium through which the wave is passing and the type of wave?

16. What is the speed of a periodic wave disturbance that has a frequency of 3.50 Hz and a wavelength of 0.700 m?

17. How does increasing the wavelength by 50 percent affect the frequency of a wave on a rope?

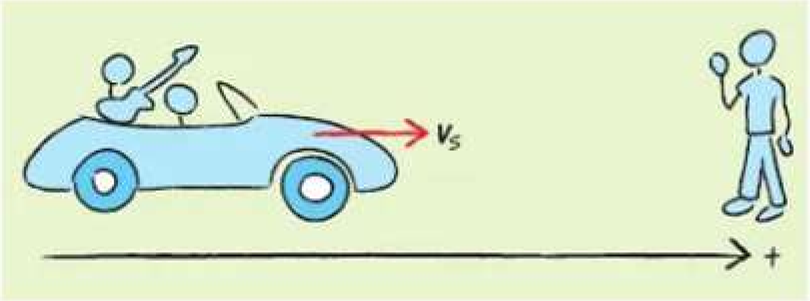
18. The speed of a transverse wave in a string is 15.0 m/s. If a source produces a disturbance that has a frequency of 6.00 Hz, what is its wavelength?

19. Five wavelengths are generated every 0.100 s in a tank of water. What is the speed of the wave if the wavelength of the surface wave is 1.20 cm?

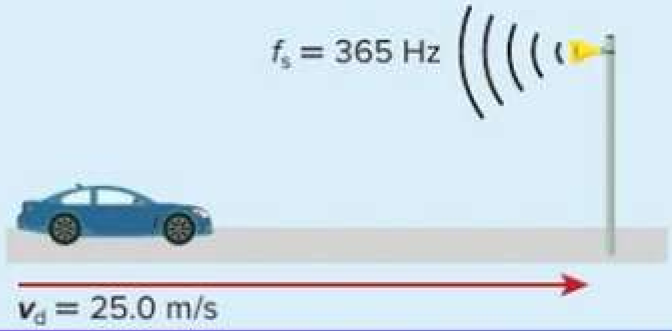
20. A periodic longitudinal wave that has a frequency of 20.0 Hz travels along a coiled spring toy. If the distance between successive compressions is 0.600 m, what is the speed of the wave?

2 PART	Apply the Doppler effect equation ($f_d = f_s[\frac{\vartheta - \vartheta_d}{\vartheta - \vartheta_d}]$) to calculate different frequencies and velocities.	Student Book Example, Problem 1 Practice Problem Q.(2.3.4)	30 → 31 32 32

THE DOPPLER EFFECT A guitar player sounds C above middle C (523 Hz) while traveling in a convertible at 24.6 m/s. If the car is coming toward you, what frequency would you hear? Assume that the temperature is 20°C.



2. You are in an automobile, like the one in **Figure 7,** traveling toward a pole-mounted warning siren. If the siren's frequency is 365 Hz, what frequency do you hear? Use 343 m/s as the speed of sound.



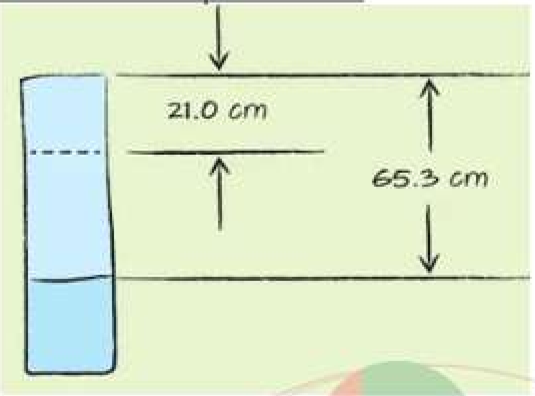
2 PART	Apply the Doppler effect equation ($f_d = f_s[\frac{v - v_d}{v - v_d}]$) to calculate different frequencies and velocities.	Student Book Example, Problem 1 Practice Problem Q.(2,3,4)	30 → 31 32 32

3. You are in an automobile traveling at 55 mph (24.6 m/s). A second automobile is moving toward you at the same speed. Its horn is sounding at 475 Hz. What frequency do you hear? Use 343 m/s as the speed of sound.

4. A submarine is moving toward another submarine at 9.20 m/s. It emits a 3.50-MHz ultrasound. What frequency would the second sub, at rest, detect? The speed of sound in water at the depth the submarines are moving is 1482 m/s.

1 PART	Use the relation between resonance length and wave-length to solve problems for closed and open pipes.	Student Book Example, Problem 2 Practice Problem Q.(15,16)	36 →37 40 40

FINDING THE SPEED OF SOUND USING RESONANCE When a tuning fork with a frequency of 392 Hz is used with a closed-pipe resonator, the loudest sound is heard when the column is 21.0 cm and 65.3 cm long. What is the speed of sound in this case? Is the temperature warmer or cooler than normal room temperature, which is 20°C? Explain your answer.



15. A 440-Hz tuning fork is held above a closed pipe. Find the spacing between the resonances when the air temperature is 20°C.

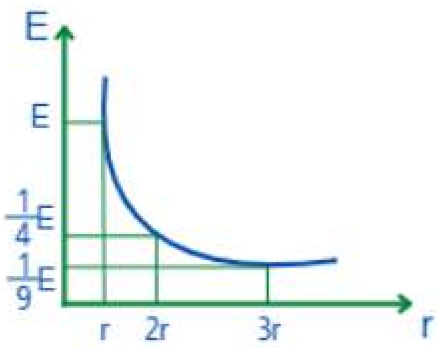
16. **CHALLENGE** A bugle can be thought of as an open pipe. If a bugle were straightened out, it would be 2.65-m long.

a. If the speed of sound is 343 m/s, find the lowest frequency that is resonant for a bugle (ignoring end corrections).

b. Find the next two resonant frequencies for the bugle.

2 PART	Apply the equation for illuminance of a point source to numerical problems.	Student Book	55
		Example, Problem 1	56
		Practice Problem Q.(3,5,6)	56

Luminous flux With the ray model of light, a source that is brighter produces more light rays than a less bright source. Imagine again a single lightbulb sending rays in nearly all directions. How could you capture all the light it emits? You would need to construct a surface that completely encloses the bulb, as in **Figure 5**. The rate at which the bulb, a luminous source, produces light energy is called the **luminous flux** (P) and is measured in lumens (lm). The total amount of light that strikes the surface in a given unit of time depends only on the luminous flux of the source.



$$E = \frac{P}{4\pi r^2}$$

$$I = E r2 \qquad I = \frac{P}{4\pi}$$

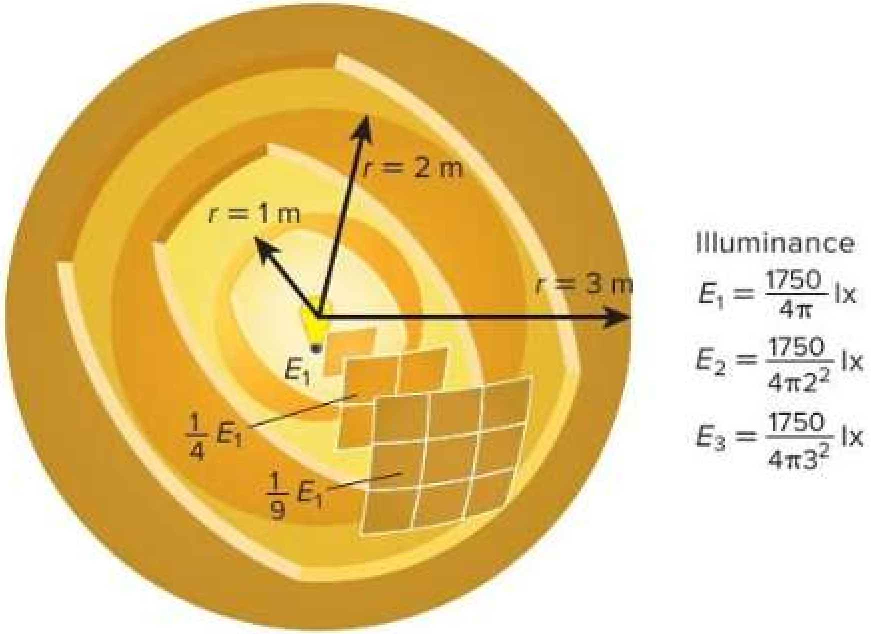
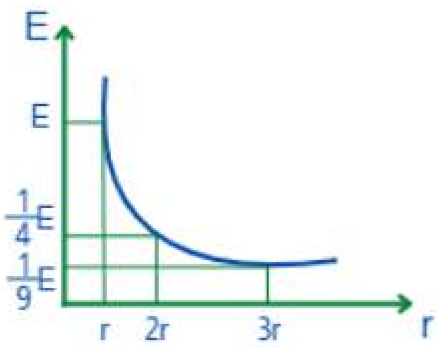


Figure 6 Illuminance (E) is the quantity of light that strikes a surface. As the distance from the luminous source (r) increases, E decreases. E depends on the inverse of r squared.

2 PART	Apply the equation for illuminance of a point source to numerical problems.	Student Book Example, Problem 1 Practice Problem Q.(3,5,6)	55 56 56

Luminous flux With the ray model of light, a source that is brighter produces more light rays than a less bright source. Imagine again a single lightbulb sending rays in nearly all directions. How could you capture all the light it emits? You would need to construct a surface that completely encloses the bulb, as in **Figure 5**. The rate at which the bulb, a luminous source, produces light energy is called the **luminous flux** (P) and is measured in lumens (lm). The total amount of light that strikes the surface in a given unit of time depends only on the luminous flux of the source.



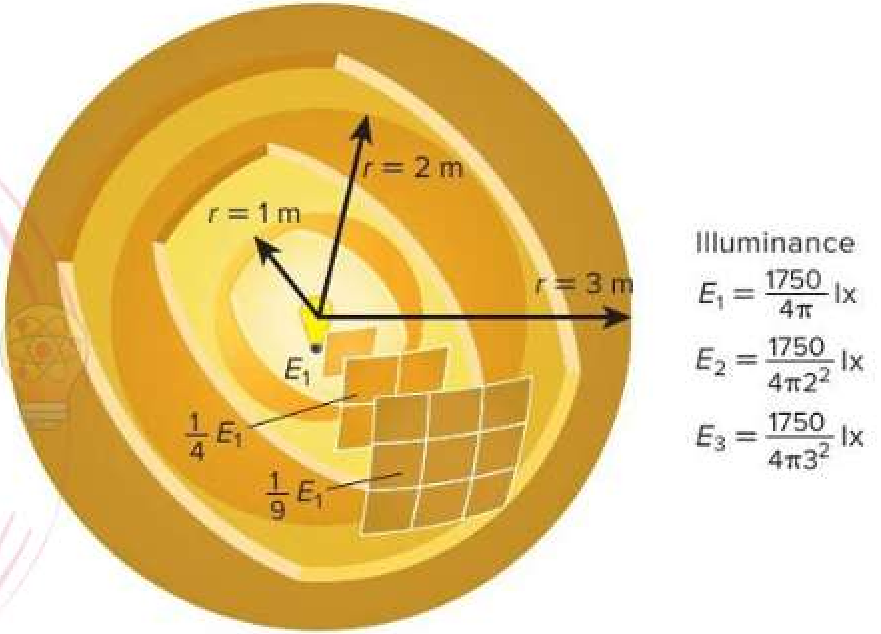
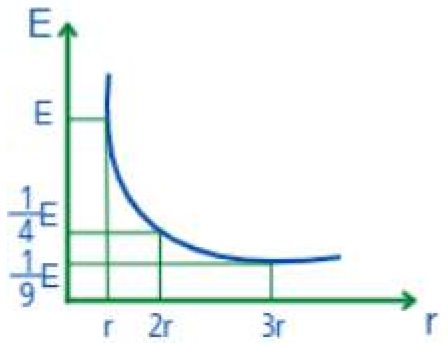


Figure 6 Illuminance (E) is the quantity of light that strikes a surface. As the distance from the luminous source (r) increases, E decreases. E depends on the

Get It?

Define *illuminance*, and state the units that are used for illuminance.

Iluminance Once you know the quantity of light being emitted by a luminous source, you can determine the amount of illumination the source provides to an object, such as a book. The luminous flux falling on a given surface area at any instant is called **illuminance** (*E*). It is measured in lux (lx), which is equivalent to lumens per square meter (lm/m^2). In this module, we assume, for simplification, that all light sources are point sources.



$$E = \frac{P}{4\pi r^2}$$

$I = E r2$ $\qquad$ $I = \dfrac{P}{4\pi}$

Luminous intensity Some luminous sources are specified in candelas (cd). A candela is not a measure of luminous flux but of luminous intensity. The luminous intensity of a point source is the luminous flux that falls on 1 m^2 of the inside of a 1-m-radius sphere, so luminous intensity is luminous flux divided by 4π. A bulb with 1750 lm of flux has an intensity of $\frac{1750 \text{ lm}}{4\pi} = 139$ cd.

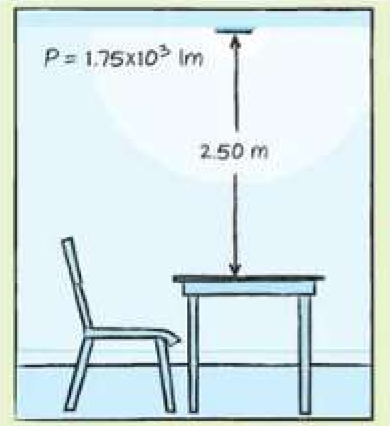
Get It?

Describe what luminous intensity is a measure of and what its relationship is to illuminance.

لا تقلق الدكتور يوضحها في الشرح

لا تقلق الدكتور يلخص القوانين ويشرح العلاقة بينهم في هذه الورقة

ILLUMINATION OF A SURFACE What is the illuminance on your desktop if it is lit by a 1750-lm lamp that is 2.50 m above your desk?



3. A 64-cd point source of light is 3.0 m away from a painting. What is the illumination on the painting in lux?

5. What is the illumination on a surface that is 3.0 m below a 150-W incandescent lamp that emits a luminous flux of 2275 lm?

6. A public school law requires a minimum illuminance of 160 lx at the surface of each student's desk. An architect's specifications call for classroom lights to be located 2.0 m above the desks. What is the minimum luminous flux that the lights must produce?

عزيزي الطالب/ عزيزتي الطالبة

نحن لا نجمع الهيكل في أسئلة فقط ولكن نقوم بالشرح الجزئيات المطلوبة في الهيكل ثم نقوم بجمع الأسئلة عليها من الكتاب

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