Grade 10 ADV Physics

UNITED ARAB EMIRATES
MINISTRY OF EDUCATION

الإمارات العربية المتحدة
وزارة التربية والتعليم

EOT1 Sample Questions

2024/2025 Exam coverage

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MCQ Questions

1	Apply the equation ($T=2\pi\sqrt{(l/g)}$) to calculate the period of a simple pendulum for small-angle oscillations.	Student Book	P.(7-8)
		Q.(5-8 & 11)	P.8

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 planet with an unknown value of g, the period of a 0.75 m long pendulum is 1.8 s. What is g for this planet?

1	Apply the equation ($T=2\pi\sqrt{(l/g)}$) to calculate the period of a simple pendulum for small-angle oscillations.	Student Book	P.(7-8)
		Q.(5-8 & 11)	P.8

8. Periodic Motion Explain why a pendulum is an example of periodic motion.

11. Pendulum How must the length of a pendulum be changed to double its period? How must the length be changed to halve the period?

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	P.(4-6)
		Q.(1-4)	P.6

1. What is the spring constant of a spring that stretches 12 cm when an object weighing 24 N is hung from it?

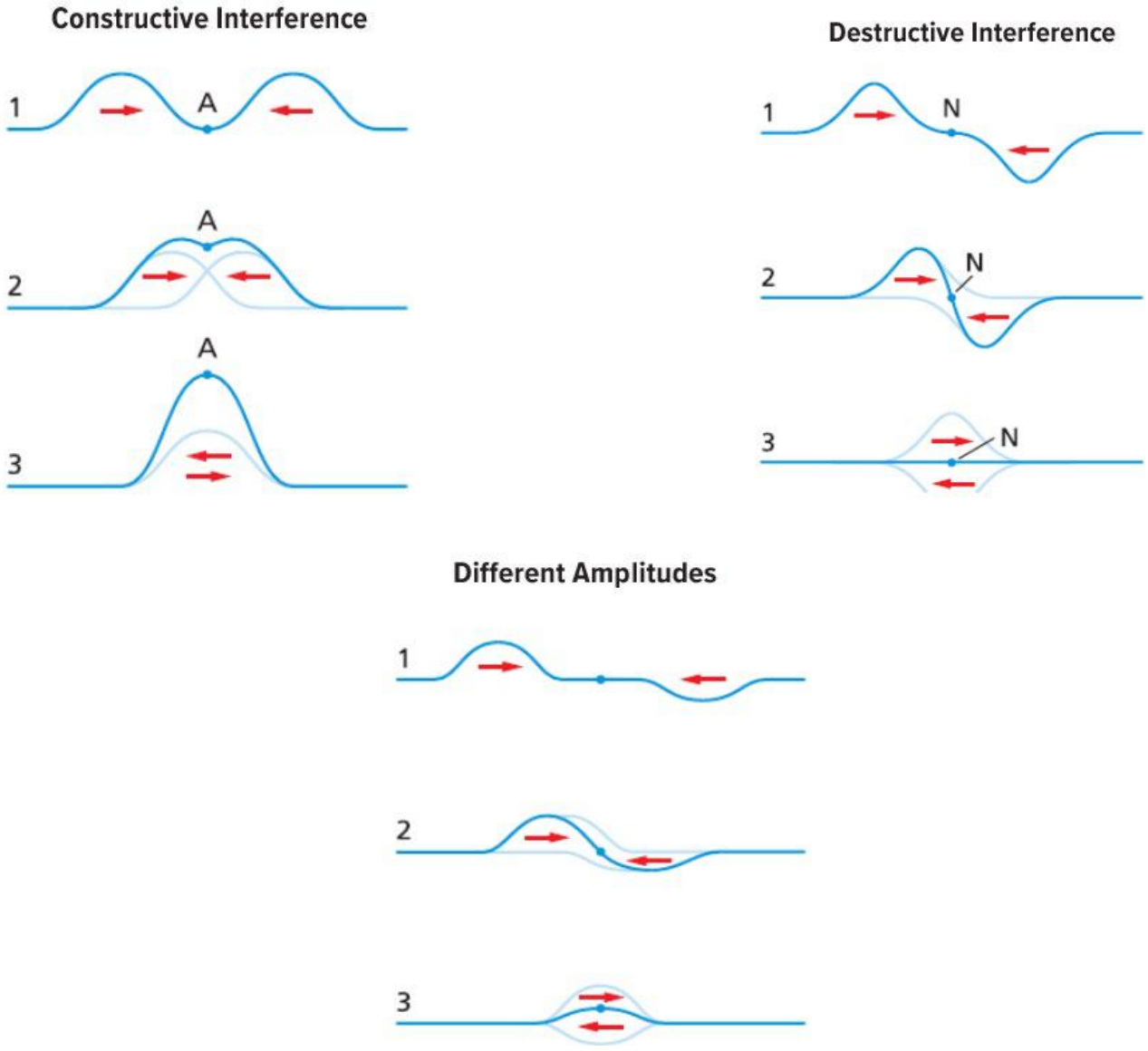
2. A spring with k = 144 N/m is compressed by 16.5 cm. What is the spring's elastic potential energy?

3. A spring has a spring constant of 56 N/m. How far will it stretch when a block weighing 18 N is hung from its end?

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?

3	Sketch snapshots for the superposition of two overlapping wave pulses (same wavelength) traveling in opposite directions showing the resultant wave.	Student Book	P.(16-17)
		Q.31	P.20

31. Superposition of Waves Sketch two wave pulses whose interference produces a pulse with an amplitude greater than either of the individual waves.



4	Differentiate between transverse, longitudinal, and surface waves and give examples.	Student Book	P.(9-10)
		Q.(25-27)	P.14

25. Transverse Waves Suppose you and your lab partner are asked to demonstrate that a transverse wave transports energy without transferring matter. How could you do it?

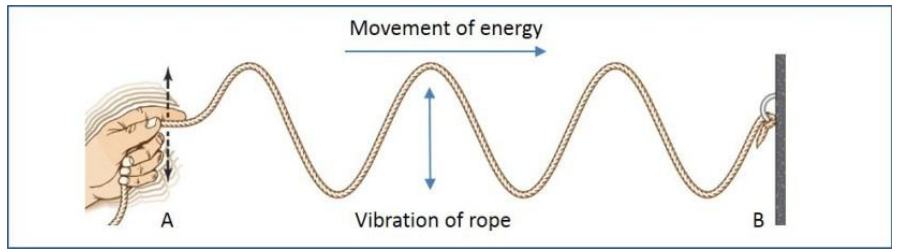
26. Wave Characteristics You are creating transverse waves on a rope by shaking your hand from side to side. Without changing the distance your hand moves, you begin to shake it faster and faster. What happens to the amplitude, wavelength, frequency, period, and velocity of the wave?

27. Longitudinal Waves Describe longitudinal waves. What types of mediums transmit longitudinal waves?

4	Differentiate between transverse, longitudinal, and surface waves and give examples.	Student Book	P.(9-10)
		Q.(25-27)	P.14

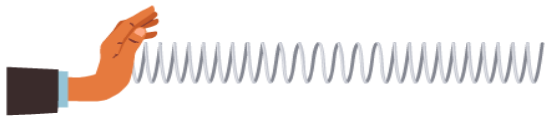
Transverse waves:

A wave that disturbs the particles in the medium perpendicular to the direction of the wave's travel



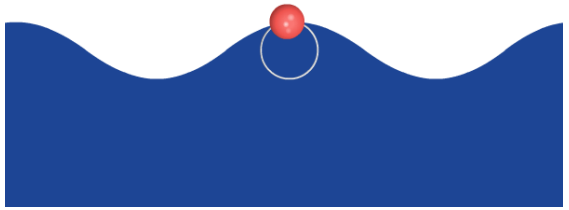
Longitudinal waves:

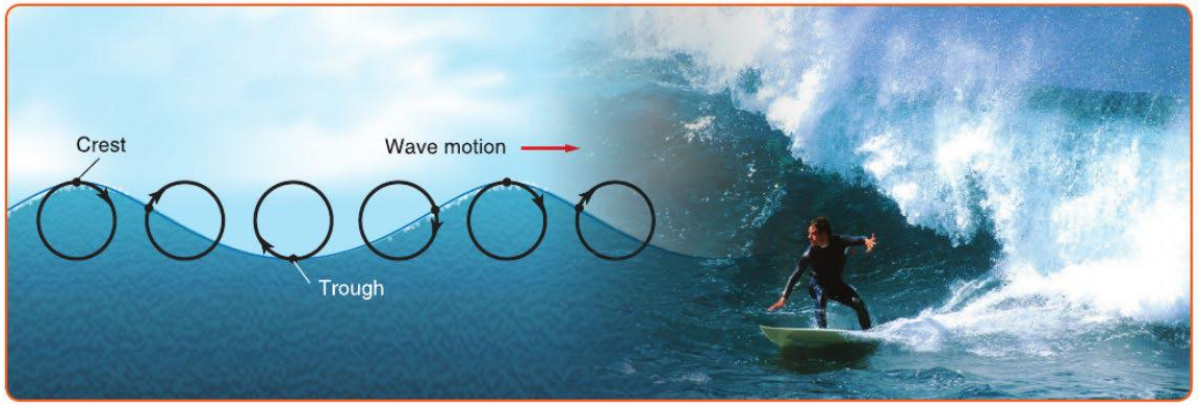
A wave where the disturbance is parallel to the direction of the wave's travel.



Surface waves:

The medium's particles follow a circular path that is at times parallel to the direction of travel and at other times perpendicular to the direction of wave travel.





5	Explore through an experiment, like using a number of musical instruments, the perception of sound depending on its different physical quantities like amplitude and frequency, and relate them to loudness and pitch.	Student Book	P. (29-30)
		Q.6	P.33

6. Wave Characteristics What physical characteristic of a sound wave should be changed to alter:

The pitch of the sound?

The loudness of the sound?

6	Describe the sound level and define the decibel (dB) as a unit of measuring sound level.	Student Book	P.(29-30)
		Figure 4	P.30

Perceiving Sound:

Sound level is a logarithmic scale of to measure sound intensities.

The unit of measurement for sound level is the **decibel (dB)**.

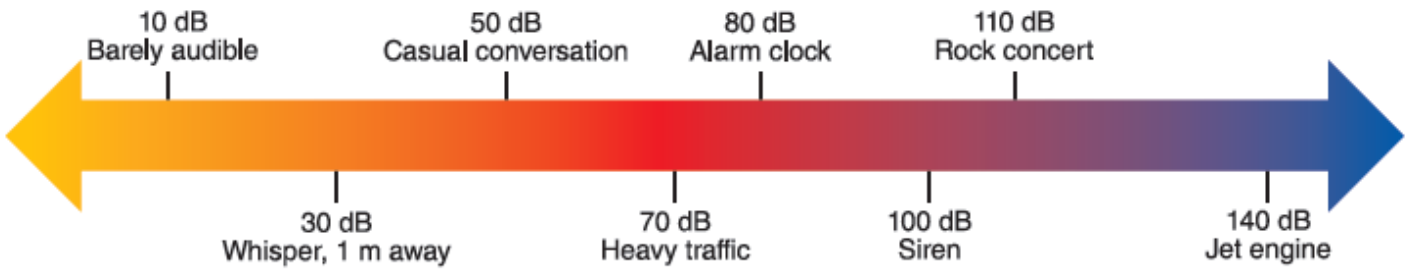
The sound level depends on the ratio of the intensity of a given sound wave to that of a most faintly heard sound. This faintest sound is measured at 0 dB.

A sound that is ten times more intense registers 20 dB. A sound that is another ten times more intense is 40 dB.

Most people perceive a 10-dB increase in sound level as about twice as loud as the original level.

How many times greater is the sound pressure level of a heavy traffic (70 dB) than a whisper (30 dB)?

10 *10 =100 times



This range of sound wave intensities can be illustrated on a **Decibel Scale**.

7	Explore the meaning of resonance and understand how musical instruments work.	student Book	P.(35-40)
		Q.(13-16)	P.40

13. A 440 Hz tuning fork is used with a resonating column to determine the velocity of sound in helium gas. If the spacing between resonances is 110 cm, what is the velocity of sound in helium gas?

14. The frequency of a tuning fork is unknown. A student uses an air column at 27°C and finds resonances spaced by 20.2 cm. What is the frequency of the tuning fork? Use the speed calculated in Example Problem 2 for the speed of sound in air at 27°C (347m/s).

7	Explore the meaning of resonance and understand how musical instruments work.	student Book	P.(35-40)
		Q.(13-16)	P.40

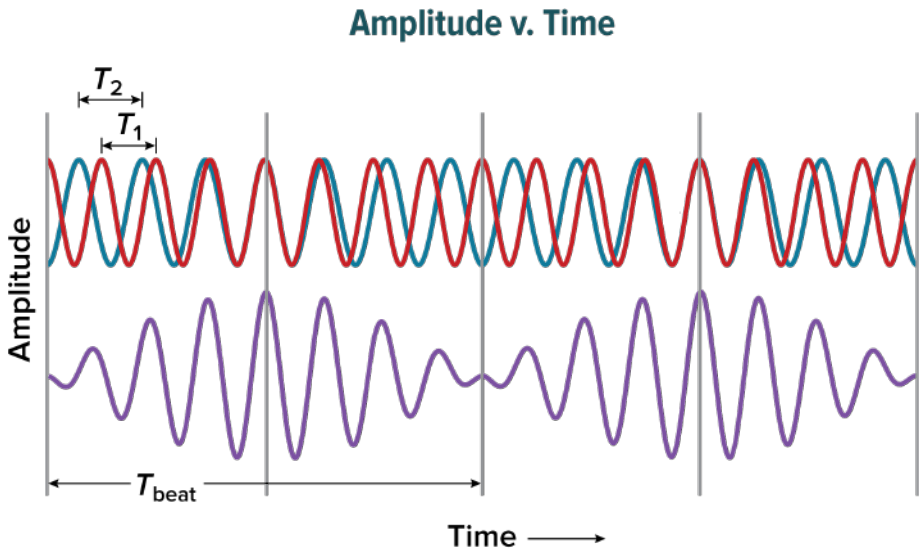
15. A 440 Hz tuning fork is held above a closed pipe. Find the spacing between the resonances when the air temperature is 20°C (v = 343m/s).

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.

Two frequencies that are nearly identical (When the ratio becomes nearly 1:1) interfere to produce oscillating high and low sound levels called a **beat.**



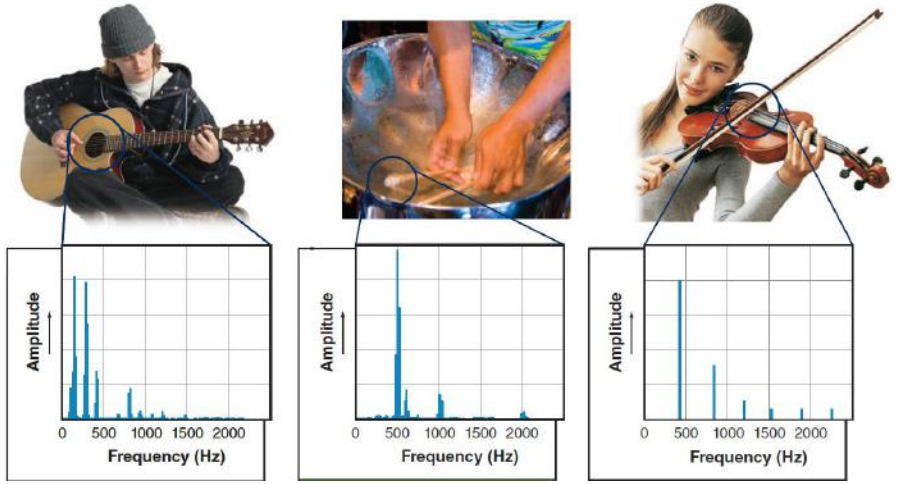
The frequency of a beat is the magnitude of difference between the frequencies of the two waves.

$$f_{beat} = |f_A - f_B|$$

When the difference is less than 7 Hz, the ear detects this as a pulsation of loudness.

22. Timbre Why do various instruments sound different even when they play the same note?

23. Beats A tuning fork produces three beats per second with a second, 392-Hz tuning fork. What is the frequency of the first tuning fork?



9	Distinguish between electrical conductors and insulators giving typical examples	Student Book	P. (53-54)
		Q. (2-4)	P.54

2. Charged Objects After you rub a comb on a wool sweater, you can use the comb to pick up small pieces of paper. Why does the comb lose this ability after a few minutes?

3. Types of Charge A pith ball is a small sphere made of a light material, such as plastic foam, that is often coated with a layer of graphite or aluminum paint. How could you determine whether a pith ball suspended from an insulating thread is neutral, charged positively, or charged negatively?

4. Charge Separation You can give a rubber rod a negative charge by rubbing the rod with wool. What happens to the charge of the wool? Why?

Conductors: A material that allows charges to move about easily.
If a conductor is charged, the excess charges move freely on its surface.
The best electrical conductors are metals (gold, iron, copper, aluminum).

Insulators: A material through which a charge will not move easily.
If an insulator is charged, the charges localized on same place.
Examples of electrical insulators are plastics, wood, rubber and glass.

10	Demonstrate an understanding that the work performed in moving a charged particle in an electric field can result in the particle gaining electric potential energy or kinetic energy or both.	Student Book	P. (74 - 75)
		Q.(43 - 52)	P. (74 - 75)

43. The electric field intensity between two large, charged parallel metal plates is 6000 N/C. The plates are 0.05 m apart. What is the electric potential difference between them?

44. A voltmeter reads 400 V across two charged, parallel plates that are 0.020 m apart. What is the magnitude of the electric field between them?

45. What electric potential difference is between two metal plates that are 0.200 m apart if the electric field between those plates is $2.5 \times 10^3 N/C$?

46. When you apply a potential difference of 125 V between two parallel plates, the field between them is $4.25 \times 10^3 N/C$. How far apart are the plates?

10	Demonstrate an understanding that the work performed in moving a charged particle in an electric field can result in the particle gaining electric potential energy or kinetic energy or both.	Student Book	P. (74 - 75)
		Q.(43 - 52)	P. (74 - 75)

47. CHALLENGE You apply a potential difference of 275 V between two parallel plates that are 0.35 cm apart. How large is the electric field between the plates?

48. What work is done on a 3.0 C charge when you move that charge through a 1.5 V electric potential difference?

49. What is the magnitude of the electric field between the two plates shown in **Figure 26**?

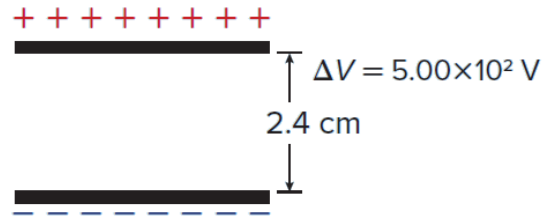


Figure 26

50. An electron in an old television picture tube passes through a potential difference of 18,000 V. How much work is done on the electron as it passes through that potential difference?

10	Demonstrate an understanding that the work performed in moving a charged particle in an electric field can result in the particle gaining electric potential energy or kinetic energy or both.	Student Book	P. (74 - 75)
		Q.(43 - 52)	P. (74 - 75)

51. The electric field in a particle accelerator has a magnitude of $4.5 \times 10^5 N/C$. How much work is done to move a proton 25 cm through that field?

52. CHALLENGE A 12 V car battery has $1.44 \times 10^6 C$ of usable charge on one plate when it is fully energized. How much work can this battery do before it needs to be energized again?

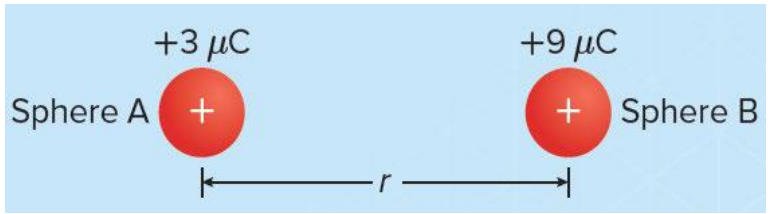
11	1. Use vector addition to calculate the net force on a charge due to other point charges. 2. Solve problems involving the electrostatic force acting on charged particles by making use of Coulomb's Law.	Student Book	P.(59-62)
		Q.(15-17, 22-23)	P.63

15. **Charge and Distance** What is Coulomb's law and how does it allow you to describe and predict the effects of electrostatic forces between distant objects?

16. **Force and Charge** How are electrostatic force and charge related? Describe the force when the charges are like charges and the force when the charges are opposite.

17. **Force and Distance** How are electrostatic force and distance related? How would the force change if the distance between two charges were tripled?

22. **Electrostatic Forces** Two charged spheres are held a distance *r* apart, as shown in **Figure 14.** Compare the force of sphere A on sphere B with the force of sphere B on sphere A.

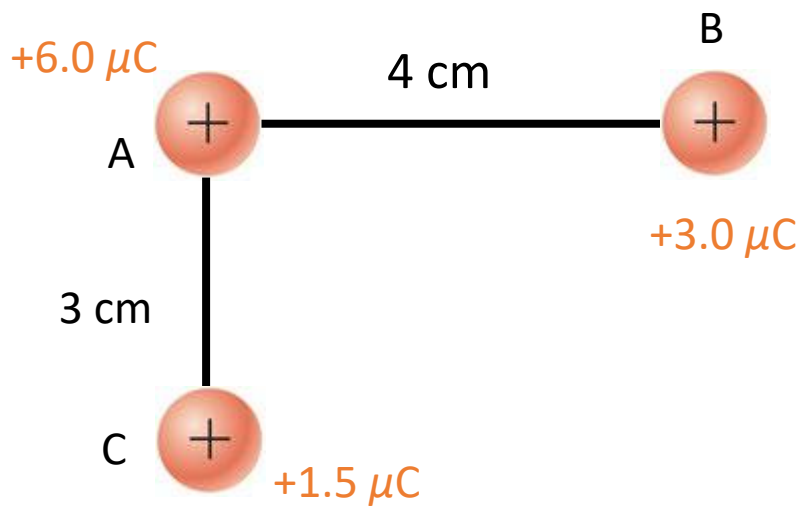


23. **Critical Thinking** Suppose you are testing Coulomb's law using a small, positively charged plastic sphere and a large, positively charged metal sphere. According to Coulomb's law, the force depends on $\frac{1}{r^2}$, where r is the distance between the centers of the spheres. As you bring the spheres close together, the force is smaller than expected from Coulomb's law. Explain.

9. A negative charge of $-2.0 \times 10^{-4} C$ and a positive charge of $8.0 \times 10^{-4} C$ are separated by 0.30 m. What is the force between the two charges?

10. A negative charge of $-6.0 \times 10^{-6} C$ exerts an attractive force of 65 N on a second charge that is 0.050 m away. What is the magnitude of the second charge?

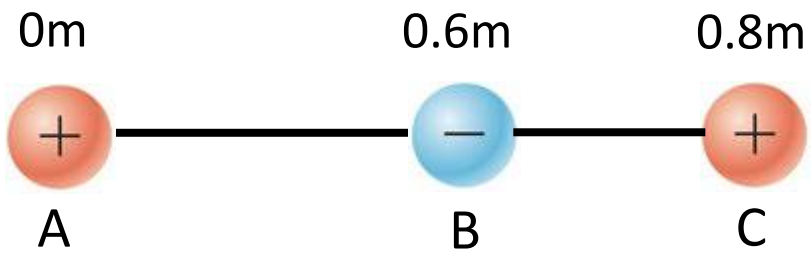
11. Suppose you replace the charge on B in Example Problem 1 with a charge of +3.00 μC. Diagram the new situation, and find the net force on A.



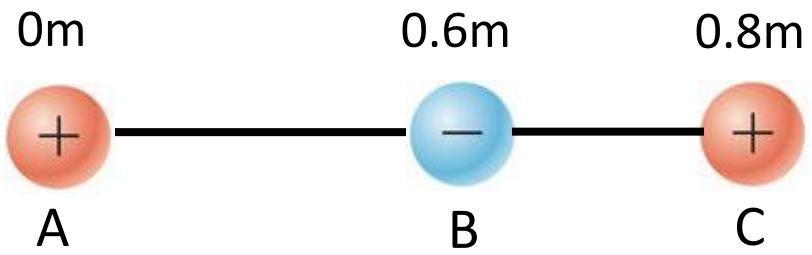
12	1. State and apply Coulomb's law to charges separated by finite distances. 2. Conduct an experiment to demonstrate charging of objects and the electrostatic force between charged objects.	Student Book	P.(59-62)
		Physics Challenge, Q.(9-17, 22-23)	P.(62-63)

12. Describe how the electrostatic force between two charges changes when the distance between those two charges is tripled.

13. Sphere A is located at the origin and has a charge of $+2.0 \times 10^{-6} C$. Sphere B is located at +0.60 m on the *x*-axis and has a charge of $-3.6 \times 10^{-6} C$. Sphere C is located at +0.80 m on the *x*-axis and has a charge of $+4.0 \times 10^{-6} C$. Determine the net force on sphere A.



14. CHALLENGE Determine the net force on sphere B in the previous problem.



13	1. Explain how electric charges are distributed on a spherical conductor, and the effect of this on both the electric field and the electric potential. 2. Explain the meaning of equipotential.	Student Book	P.78
		Figure 28; Q. 61	P.80

Conducting Sphere

On a conducting sphere, the charge is evenly distributed around the surface.

Conducting and hollow spheres

Charges spread far apart in a way that minimizes their potential energy.

Electric field is 0 inside the object

Hollow Sphere

The charges on the hollow sphere are entirely on the outer surface.

Irregular Surface

C

On an irregular conducting surface, the charges are closest together at sharp points.

The field lines are closer together, and the field is stronger.

61. A sphere is charged by a 12 V battery and suspended above Earth as shown in **Figure 31.** What is the net charge on the sphere?

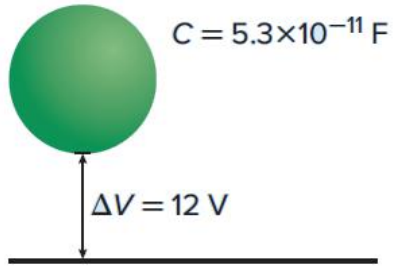


Figure 31

14	Describe Millikan's oil-drop experiment and explain how it confirms that charge exists in discrete amounts, which are integral multiples of the elementary charge.	Student Book	P.(76-77)
		Q.(53-56); Q.66	P.81

53. A drop is falling in a Millikan oil-drop apparatus with no electric field. What forces are acting on the oil drop, regardless of its acceleration? If the drop is falling at a constant velocity, describe the forces acting on it.

54. An oil drop weighs $1.9 \times 10^{-15} N$. You suspend it in an electric field of $6.0 \times 10^{3} N/C$. What is the net charge on the drop? How many excess electrons does it carry?

14	Describe Millikan's oil-drop experiment and explain how it confirms that charge exists in discrete amounts, which are integral multiples of the elementary charge.	Student Book	P.(76-77)
		Q.(53-56); Q.66	P.81

55. An oil drop carries one excess electron and weighs $6.4 \times 10^{-15} N$. What electric field strength do you need to suspend the drop, so it is motionless?

56. CHALLENGE You suspend a positively charged oil drop that weighs $1.2 \times 10^{-14} N$ between two parallel plates that are 0.64 cm apart. The potential difference between the plates is 240 V. What is the net charge on the drop? How many electrons is the drop missing?

14	Describe Millikan's oil-drop experiment and explain how it confirms that charge exists in discrete amounts, which are integral multiples of the elementary charge.	Student Book	P.(76-77)
		Q.(53-56); Q.66	P.81

66. **Millikan Experiment** When the net charge on an oil drop suspended in a Millikan apparatus is changed, the drop begins to fall. How should you adjust the potential difference between the conducting plates to bring the drop back into balance?

15	1. Define capacitance as the ratio of the net charge on one plate of a capacitor to the potential difference across the plates, and it is measured in Farads. 2. Apply the equation for capacitance to solve numerical problems.	Student Book	P.(79-81)
		Q.(57-62, 68)	P.(80-81)

57. A 27 μF capacitor has an electric potential difference of 45 V across it. What is the amount the net charge on the positively charged plate of the capacitor?

58. Suppose you connect both a 3.3 μF and a 6.8 μF capacitor across a 24 V electric potential difference. Which capacitor has the greater net charge on its positively charged plate, and what is its magnitude?

15	1. Define capacitance as the ratio of the net charge on one plate of a capacitor to the potential difference across the plates, and it is measured in Farads. 2. Apply the equation for capacitance to solve numerical problems.	Student Book	P.(79-81)
		Q.(57-62, 68)	P.(80-81)

59. You later find that the magnitude of net charge on each of the plates for each of the capacitors in the previous problem is $3.5 \times 10^{-4} C$. Which capacitor has the larger potential difference across it? What is that potential difference?

60. Suppose that you apply an electric potential difference of $6.0\ V$ across a $2.2\ \mu F$ capacitor. What does the magnitude of the net charge on one plate need to be to increase the electric potential difference to $15.0\ V$?

15	1. Define capacitance as the ratio of the net charge on one plate of a capacitor to the potential difference across the plates, and it is measured in Farads. 2. Apply the equation for capacitance to solve numerical problems.	Student Book	P.(79-81)
		Q.(57-62, 68)	P.(80-81)

61. A sphere is charged by a 12 V battery and suspended above Earth as shown in **Figure 31.** What is the net charge on the sphere?

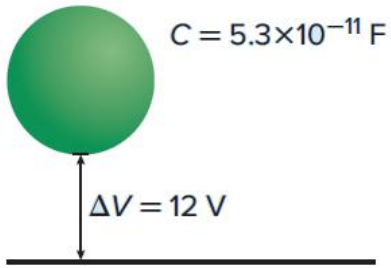


Figure 31

62. CHALLENGE You increase the potential difference across a capacitor from 12.0 V to 14.5 V. As a result, the magnitude of the net charge on each plate increases by $2.5 \times 10^{-5} C$. What is the capacitance of the capacitor?

15	1. Define capacitance as the ratio of the net charge on one plate of a capacitor to the potential difference across the plates, and it is measured in Farads. 2. Apply the equation for capacitance to solve numerical problems.	Student Book	P.(79-81)
		Q.(57-62, 68)	P.(80-81)

68. **Capacitance** What is the magnitude of net charge on each conductor plate of a 0.47-μF capacitor when a potential difference of 12 V is applied across that capacitor?

FRQ Questions

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

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 the 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?

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

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?

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

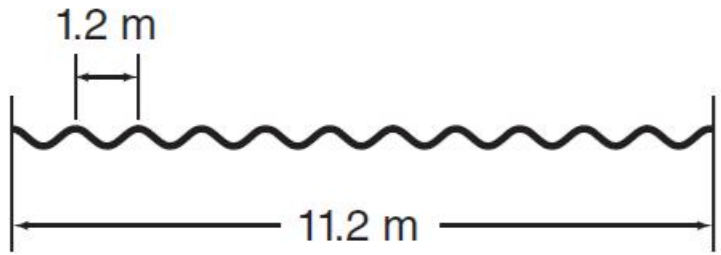
22. Describe the change in the wavelength of a wave when the period is reduced by one-half.

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?

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

25. Transverse Waves Suppose you and your lab partner are asked to demonstrate that a transverse wave transports energy without transferring matter. How could you do it?

10. The wave shown in the figure below travels 11.2 m to a wall and back again in 4 s. What is the wave's frequency?



Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

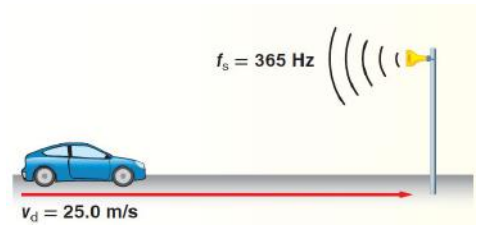
15. A 440 Hz tuning fork is held above a closed pipe. Find the spacing between the resonances when the air temperature is 20°C (v = 343m/s).

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

1. Repeat Example Problem 1, but with the car moving away from you. What frequency would you hear?

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)----->(away) you, what frequency would you hear? Assume that the temperature is 20°C (velocity of sound =343 m/s) .

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.



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		Q.15; Q.(1-12)	P.40

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.

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

5. CHALLENGE A trumpet plays middle C (262 Hz). How fast would it have to be moving to raise the pitch to C sharp (277 Hz)? Use 343 m/s as the speed of sound.

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

6. Wave Characteristics What physical characteristic of a sound wave should be changed to alter the pitch? The loudness?

7. Graph The eardrum moves back and forth in response to the pressure variations of a sound wave. Sketch a graph of the displacement of the eardrum versus time for two cycles of a 1.0-kHz tone and for two cycles of a 2.0-kHz tone.

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
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8. Effect of Medium List two characteristics of sound that are affected by the medium through which the sound passes and two characteristics that are not affected.

9. Decibel Scale How many times greater is the sound pressure level of a typical rock concert (110 dB) than a normal conversation (50 dB)?

10. Early Detection In the nineteenth century, people put their ears to a railroad track to get an early warning of an approaching train. Why did this work?

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
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11. Bats A bat emits short pulses of high-frequency sound and detects the echoes.

a- In what way would the echoes from large and small insects compare if they were the same distance from the bat?

b- In what way would the echo from an insect flying toward the bat differ from that of an insect flying away from the bat?

12. Critical Thinking Can a trooper using a radar detector at the side of the road determine the speed of a car at the instant the car passes the trooper? Explain.

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

24. A positive test charge of $5.0 \times 10^{-6} C$ is in an electric field that exerts a force of $2.0 \times 10^{-4} N$ on it. What is the magnitude of the electric field at the location of the test charge?

25. A negative charge of $2.0 \times 10^{-8} C$ experiences a force of 0.060 N to the right in an electric field. What are the field's magnitude and direction at that location?

26. A positive charge of $3.0 \times 10^{-7} C$ is located in a field of 27 N/C directed toward the south. What is the force acting on the charge?

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

27. Complete **Table 2.28.**

Table 2 Sample Data

Test Charge Strength (C)	Force Exerted on Test Charge (N)	Electric Field Intensity (N/C)
1.0×10^{-6}	0.30	
2.0×10^{-6}		3.3×10^{5}
	0.45	1.5×10^{5}

28. A negative test charge is placed in an electric field as shown in **Figure 17.** It experiences the force shown. What is the magnitude of the electric field at the location of the charge?

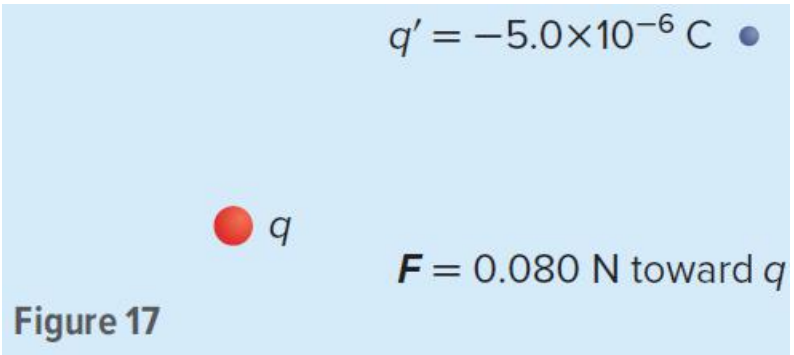


Figure 17

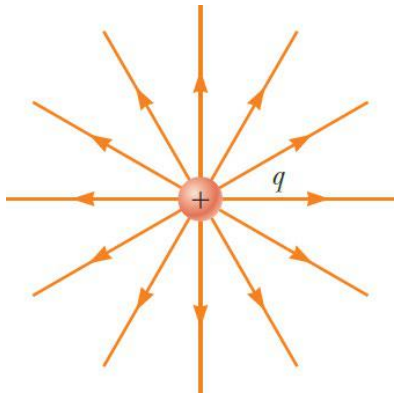
Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

29. CHALLENGE You are probing the electric field of a charge of unknown magnitude and sign. You first map the field with a $1.0 \times 10^{-6} C$ test charge, then map it with a $2.0 \times 10^{-6} C$ test charge.

a. Would you measure the same forces at the same place with the two test charges? Explain.

b. Would you find the same field strengths? Explain.

30. What is the magnitude of the electric field at a position that is 1.2 m from a 4.2×10^{-6} C point charge?



Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

31. What is the magnitude of the electric field at a distance twice as far from the point charge in the previous problem?

32. What is the electric field at a position that is 1.6 m east of a point charge of $+7.2 \times 10^{-6} C$?

33. The electric field that is 0.25 m from a small sphere is 450 N/C toward the sphere. What is the net charge on the sphere?

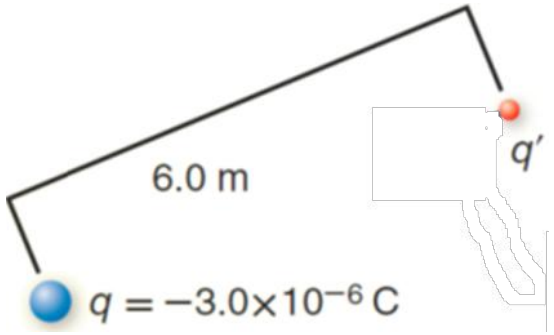
Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

34. How far from a point charge of $+2.4 \times 10^{-6} C$ must you place a test charge in order to measure a field magnitude of 360 N/C?

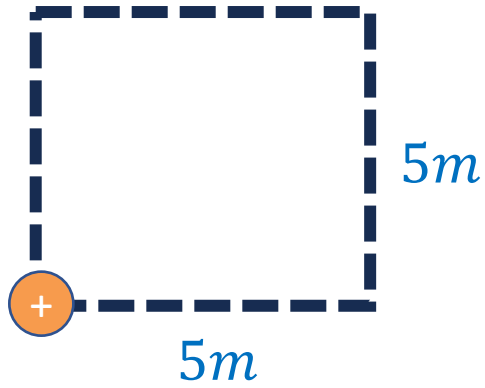
35. Explain why the strength of the electric field exerted on charge q' by the charged body q is independent of the charge on q'. *Hint: Use mathematics to prove your point*.

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

36. What is the magnitude of the electric field exerted on the test charge shown in the figure below?



37. CHALLENGE You place a small sphere with a net charge of $5.0 \times 10^{-6} C$ at one corner of a square that measures 5.0 m on each side. What is the magnitude of the electric field at the opposite corner of the square?



Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

2. Charged Objects After you rub a comb on a wool sweater, you can use the comb to pick up small pieces of paper. Why does the comb lose this ability after a few minutes?

3. Types of Charge A pith ball is a small sphere made of a light material, such as plastic foam, that is often coated with a layer of graphite or aluminum paint. How could you determine whether a pith ball suspended from an insulating thread is neutral, charged positively, or charged negatively?

4. Charge Separation You can give a rubber rod a negative charge by rubbing the rod with wool. What happens to the charge of the wool? Why?

5. Net Charge An apple contains approximately 10_{26} charged particles. Why don't two apples repel each other when they are brought together?

Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

6. Charging a Conductor Suppose you hang along metal rod from silk threads so that the rod is electrically isolated. You then touch a charged glass rod to one end of the metal rod. Describe the charges on the metal rod.

7. Charging by Friction You can charge a rubber rod negatively by rubbing it with wool. What happens when you rub a copper rod with wool?

18. **Charging by Induction** In an electroscope being charged by induction, what happens when the charging rod is moved away before the ground is removed from the knob?

19. **Electroscopes** Why do the leaves of a charged electroscope rise to a certain angle and no farther?

Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

20. **Attraction of Neutral Objects** What properties explain how both positively charged objects and negatively charged objects can attract neutral objects?

21. **Charging an Electroscope** How can you charge an electroscope positively using a positively charged rod? Using a negatively charged rod?

Previous Years Exam Questions

Whenever necessary, use the following physical formulas

Vibrations and Waves	*Sound*		*Electrostatics*
$F = -kx$	$f_d = f_s\left(\frac{v - v_d}{v - v_s}\right)$		$F = k\frac{q_1 q_2}{r^2}$
$PE_{spring} = -\frac{1}{2}kx^2$	Closed Pipe	$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$	$E = \frac{F_{on\,q'}}{q'}$
$T = 2\pi\sqrt{\frac{\ell}{g}}$	Closed Pipe	$f_3 = \frac{3v}{4L} = 3f_1$	$E = k\frac{q}{r^2}$
$f = \frac{1}{T}$	Open Pipe	$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$	
$\lambda = \frac{v}{f}$	Open Pipe	$f_2 = \frac{v}{L} = 2f_1$	
	Closed Pipe	$f_5 = \frac{5v}{4L} = 5f_1$	
	Open Pipe	$f_3 = \frac{3v}{2L} = 3f_1$	

Whenever necessary, use the following physical constants

$g = 9.81\ m/s^2$	$c = 3 \times 10^8\ m/s$	$k = 9 \times 10^9\ N.m^2/C^2$
$q_{elecrton} = -1.6 \times 10^{-19}\ C$	$q_{proton} = +1.6 \times 10^{-19}\ C$	

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

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?

$$v = \frac{d}{T} = \frac{515}{1.5} = 343\ m/s$$

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

$$T = \frac{1}{f} = \frac{1}{436} = 2.29 \times 10^{-3}\ s$$

c. What is its wavelength?

$$\lambda = \frac{v}{f} = \frac{343}{436} = 0.787\ m$$

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 the wave?

The wavelength, frequency, and speed of a wave are related by the following equation: $v = \lambda f$. The speed depends on the type of wave and the medium through which it is passing.

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?

$$v = \lambda f = (0.7)(3.6) = 2.45 m/s$$

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

The frequency decreases to two thirds of its original value.

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

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?

$$\lambda = \frac{v}{f} \quad = \frac{15}{6} = 2.5\ m$$

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?

$$T = \frac{t}{number\ of\ waves} \qquad = \frac{0.1}{5} = 0.02\ s$$

$$v = \frac{\lambda}{T} \quad = \frac{1.2}{0.02} = 0.6\ m/s$$

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?

$$v = \lambda f \qquad = (0.6)(20) = 12\ m/s$$

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

The frequency is one-half of its original value.

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

The wavelength is one-half of its original value

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 length.

Q1	1. Determine wave properties such as wavelength, period, frequency, amplitude, and speed using a graphical or a visual representation of a periodic mechanical wave. 2. Explain that transverse and longitudinal waves transfer energy without transferring matter during their propagation.	Student Book	P.(10-14); P.9
		Q.(14-23); Q.25	P.14

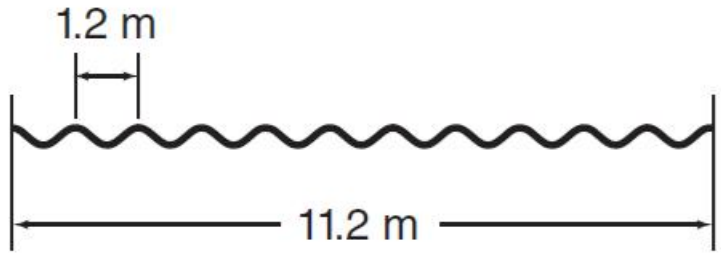
25. Transverse Waves Suppose you and your lab partner are asked to demonstrate that a transverse wave transports energy without transferring matter. How could you do it?

Loosely tie a piece of yarn somewhere near the middle of a rope.

With your partner holding one end of the rope, shake the other end up and down to create a transverse wave.

Note that while the wave moves down the rope, the yarn moves up and down but stays in the same place on the rope.

10. The wave shown in the figure below travels 11.2 m to a wall and back again in 4 s. What is the wave's frequency?



$$v = \frac{d}{t} = \frac{11.2}{2} = 5.6\ m/s$$

$$f = \frac{v}{\lambda} = \frac{5.6}{1.2} = 4.7\ Hz$$

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

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 (v = 343m/s).

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

$$\lambda = \frac{343}{440} = 0.78\ m$$

spacing between the resonances

$$\frac{\lambda}{2} = 0.39\ m$$

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

1. Repeat Example Problem 1, but with the car moving away from you. What frequency would you hear?

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)----->(away) you, what frequency would you hear? Assume that the temperature is 20°C (velocity of sound =343 m/s) .

Known
vd = 0
vs = +24.6 m/s
fs = 523 Hz
v = 343 m/s

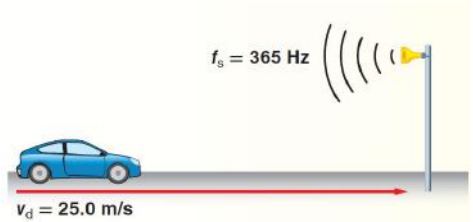
$$f_d = f_s \frac{v \pm v_d}{v \pm v_s}$$

$$f_d = (523)\frac{(343) - (0)}{(343) + (24.6)}$$

Unknown
fd = ?

$$f_d = 488\ Hz$$

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.



Known
vs = 0
vd = 25 m/s
fs = 365 Hz
v = 343 m/s

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

Unknown
fd = ?

$$f_d = (365)\frac{(343) + (25)}{(343) - (0)}$$

$$f_d = 391.6\ Hz$$

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

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.

Known
vs = -24.6
vd = +24.6 m/s
fs = 475 Hz
v = 343 m/s

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

$$f_d = (475)\frac{(343) + (24.6)}{(343) - (24.6)}$$

Unknown
fd = ?

$$f_d = 548.4\ Hz$$

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.

Known
vs = -9.2 m/s
vd = 0 m/s
fs = 657 Hz
v = 1482 m/s

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

$$f_d = (3.5)\frac{(1482) - (0)}{(1482) - (9.2)}$$

Unknown
fd = ?

$$f_d = 3.52\ MHz$$

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
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5. CHALLENGE A trumpet plays middle C (262 Hz). How fast would it have to be moving to raise the pitch to C sharp (277 Hz)? Use 343 m/s as the speed of sound.

Known
fs = 262 Hz
fd = 277 Hz
vd = 0
v = 343 m/s

Unknown
vs = ?

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

$$277 = (262)\frac{343}{343 - v_s}$$

$$\frac{277}{262} = \frac{343}{343 - v_s}$$

$$1.057 = \frac{343}{343 - v_s}$$

$$1.057(343 - v_s) = 343$$

$$(343 - v_s) = \frac{343}{1.057}$$

$$343 - v_s = \frac{343}{1.057}$$

$$343 - v_s = 324.5$$

$$-v_s = 324.5 - 343$$

$$-v_s = -18.5\ m/s$$

$$v_s = 18.5\ m/s$$

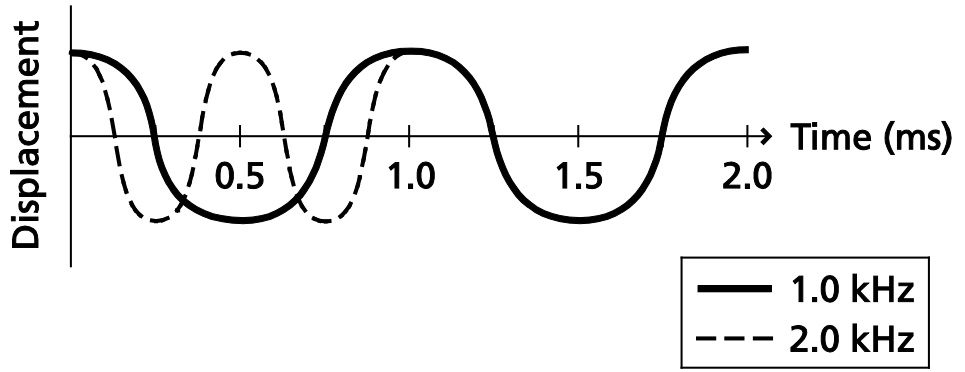
Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

6. Wave Characteristics What physical characteristic of a sound wave should be changed to alter the pitch? The loudness?

frequency; amplitude

7. Graph The eardrum moves back and forth in response to the pressure variations of a sound wave. Sketch a graph of the displacement of the eardrum versus time for two cycles of a 1.0-kHz tone and for two cycles of a 2.0-kHz tone.

The student's sketch should resemble a sine wave, with appropriate labels and with time increasing continuously and displacement varying between minimum and maximum values.



Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

8. Effect of Medium List two characteristics of sound that are affected by the medium through which the sound passes and two characteristics that are not affected.

Affected: speed and wavelength;

Unaffected: period and frequency

9. Decibel Scale How many times greater is the sound pressure level of a typical rock concert (110 dB) than a normal conversation (50 dB)?

The sound pressure level increases by a factor of 10 for every 20-dB increase in sound level.

Therefore, 60 dB corresponds to a 1000-fold increase in the sound pressure level.

10. Early Detection In the nineteenth century, people put their ears to a railroad track to get an early warning of an approaching train. Why did this work?

The velocity of sound is greater in solids than in gases.

Therefore, sound travels faster in steel rails than in air, and the rails help focus the sound, so it does not die out as quickly as in air.

Q2	1. Use the relation between resonance length and wavelength to solve problems for closed and open pipes. 2. Define sound pitch and relate it to the frequency of a sound wave. 3. Define resonance and list some examples and consequences. 4. Explain resonance in air columns and give examples on different instruments. 5. Apply the Doppler effect equation to calculate different frequencies and velocities.	Student Book	P.29; P.37; P8; P.(30-33)
		Q.15; Q.(1-12)	P.40

11. Bats A bat emits short pulses of high-frequency sound and detects the echoes.

a- In what way would the echoes from large and small insects compare if they were the same distance from the bat?

They would differ in intensity.

Larger insects would reflect more of the sound energy back to the bat.

b- In what way would the echo from an insect flying toward the bat differ from that of an insect flying away from the bat?

An insect flying toward the bat would return an echo of higher frequency.

An insect flying away from the bat would return an echo of lower frequency.

12. Critical Thinking Can a trooper using a radar detector at the side of the road determine the speed of a car at the instant the car passes the trooper? Explain.

No; the car must be approaching or receding from the detector for the Doppler effect to be observed.

Transverse motion produces no Doppler effect.

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

24. A positive test charge of $5.0 \times 10^{-6} C$ is in an electric field that exerts a force of $2.0 \times 10^{-4} N$ on it. What is the magnitude of the electric field at the location of the test charge?

$$E = \frac{F}{q} = \frac{2 \times 10^{-4}}{5 \times 10^{-6}} = 40 \text{ N/C}$$

25. A negative charge of $2.0 \times 10^{-8} C$ experiences a force of 0.060 N to the right in an electric field. What are the field's magnitude and direction at that location?

$$E = \frac{F}{q} = \frac{0.06}{2 \times 10^{-8}} = 3 \times 10^{6} \text{N/C}$$

26. A positive charge of $3.0 \times 10^{-7} C$ is located in a field of 27 N/C directed toward the south. What is the force acting on the charge?

$$\vec{F} = q_0 \vec{E}$$

$$\vec{F} = (3 \times 10^{-7}) \times (27) = 8.1 \times 10^{-6} \text{ N}$$

(south)

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

27. Complete **Table 2.28.**

Table 2 Sample Data

Test Charge Strength (C)	Force Exerted on Test Charge (N)	Electric Field Intensity (N/C)
1.0×10^{-6}	0.30	
2.0×10^{-6}		3.3×10^{5}
	0.45	1.5×10^{5}

Table 2 Sample Data		
Test Charge Strength (C)	**Force Exerted on Test Charge (N)**	**Electric Field Intensity (N/C)**
1.0×10^{-6}	**0.30**	**3.0×10^{5}**
2.0×10^{-6}	**0.65**	**3.3×10^{5}**
3.0×10^{-6}	**0.45**	**1.5×10^{5}**

28. A negative test charge is placed in an electric field as shown in **Figure 17.** It experiences the force shown. What is the magnitude of the electric field at the location of the charge?

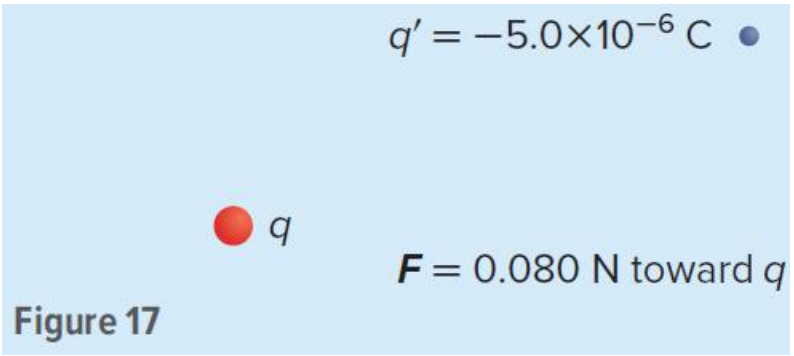


Figure 17

$$E = \frac{F}{q} = \frac{0.08}{5 \times 10^{-6}} = 1.6 \times 10^{-4}\text{N/C}$$

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

29. CHALLENGE You are probing the electric field of a charge of unknown magnitude and sign. You first map the field with a $1.0 \times 10^{-6} C$ test charge, then map it with a $2.0 \times 10^{-6} C$ test charge.

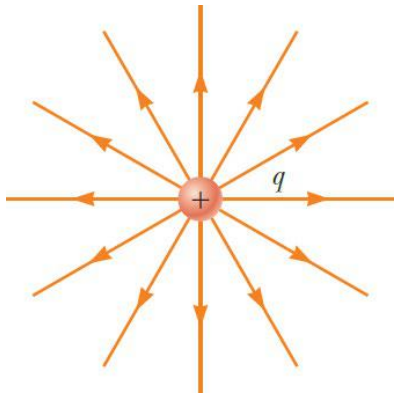
a. Would you measure the same forces at the same place with the two test charges? Explain.

No; the force on the 2.0 μC charge would be twice that on the 1.0 μC charge.

b. Would you find the same field strengths? Explain.

Yes; you would divide the force by the strength of the test charge, so the results would be the same.

30. What is the magnitude of the electric field at a position that is 1.2 m from a 4.2×10^{-6} C point charge?



$$E = \frac{kq}{r^2}$$

$$E = \frac{9 \times 10^9 (4.2 \times 10^{-6})}{(1.2)^2}$$

$E = 2.6 \times 10^4$ N/C outward

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

31. What is the magnitude of the electric field at a distance twice as far from the point charge in the previous problem?

Because the field strength varies as the square of the distance from the point charge, the new field strength will be one-fourth of the old field strength, or 6.5×10^3 N/C.

32. What is the electric field at a position that is 1.6 m east of a point charge of $+7.2 \times 10^{-6} C$?

$$E = k\frac{q}{r^2}$$

$$E = 9 \times 10^9 \frac{7.2 \times 10^{-6}}{(1.6)^2} = 2.5 \times 10^4 \text{ N/C}$$

The direction of the field is east (away from the positive point charge)

33. The electric field that is 0.25 m from a small sphere is 450 N/C toward the sphere. What is the net charge on the sphere?

$$E = k\frac{q}{r^2}$$

$$q = \frac{Er^2}{k} \qquad q = \frac{(450)(0.25)^2}{(9 \times 10^9)} = 3.1 \times 10^9 \text{ N/C}$$

The charge is negative, because the field is directed toward it.

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

34. How far from a point charge of $+2.4 \times 10^{-6} C$ must you place a test charge in order to measure a field magnitude of 360 N/C?

$$E = k\frac{q}{r^2}$$

$$r^2 = k\frac{q}{E}$$

$$r = \sqrt{k\frac{q}{E}}$$

$$r = \sqrt{(9 \times 10^9)\frac{(2.4 \times 10^{-6})}{360}} = 7.7\ m$$

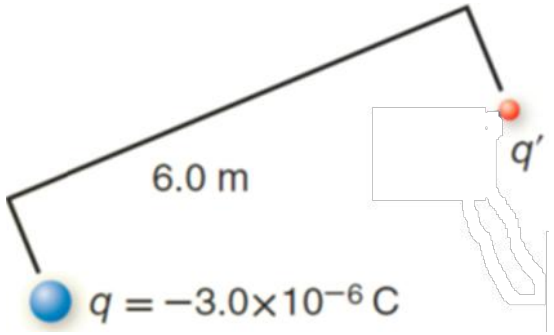
35. Explain why the strength of the electric field exerted on charge *q'* by the charged body *q* is independent of the charge on *q'*. *Hint: Use mathematics to prove your point*.

Because the strength of the test charge (q') and the force (F) are directly proportional, $F = k\frac{q\acute{q}}{r^2}$.

Therefore, the electric field, which is the ratio of the force to the test charge, is independent of q' ($\frac{F}{\acute{q}} = k\frac{q}{r^2}$), assuming that the distance between the charges does not change and the strength of the charged body does not change.

Q3	1. Describe the charge distribution on a solid conducting sphere, a hollow conducting sphere and an irregular conducting surface. 2. Calculate the electric field strength at a point close a single point charge / a conducting charged sphere.	Student Book	P.(65-67), P.78
		Q.(24 - 37)	P.(66-67)

36. What is the magnitude of the electric field exerted on the test charge shown in the figure below?



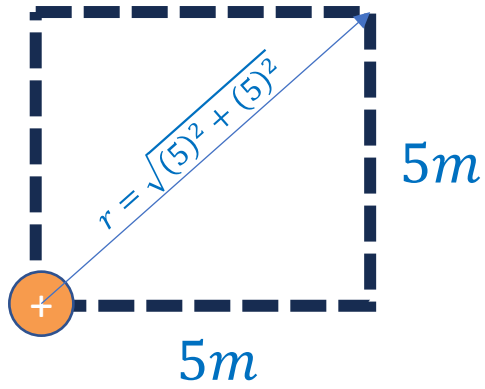
$$E = \frac{kq}{r^2}$$

$$E = \frac{9 \times 10^9 (3 \times 10^{-6})}{(6)^2}$$

$$E = 750 \text{ N/C} \quad \text{inward}$$

37. CHALLENGE You place a small sphere with a net charge of $5.0 \times 10^{-6} C$ at one corner of a square that measures 5.0 m on each side. What is the magnitude of the electric field at the opposite corner of the square?

$$r = \sqrt{(5)^2 + (5)^2} = 7.07$$



$$E = k\frac{q}{r^2}$$

$$E = 9 \times 10^9 \frac{(5 \times 10^{-6})}{(7.07)^2} = 900 \text{ N/C}$$

Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

2. Charged Objects After you rub a comb on a wool sweater, you can use the comb to pick up small pieces of paper. Why does the comb lose this ability after a few minutes?

The comb loses its negative charge to its surroundings and becomes neutral once again.

3. Types of Charge A pith ball is a small sphere made of a light material, such as plastic foam, that is often coated with a layer of graphite or aluminum paint. How could you determine whether a pith ball suspended from an insulating thread is neutral, charged positively, or charged negatively?

Bring an object of known charge, such as a negatively charged hard rubber rod, near the pith ball. If the pith ball is repelled, it has the same charge as the rod. if it is attracted, it may have the opposite charge or be neutral. To find out which, bring a positively charged glass rod near the pith ball. If they repel, the pith ball is positive; if they attract, the pith ball must be neutral.

4. Charge Separation You can give a rubber rod a negative charge by rubbing the rod with wool. What happens to the charge of the wool? Why?

The wool becomes positively charged because it gives up electrons to the rubber rod.

5. Net Charge An apple contains approximately 10_{26} charged particles. Why don't two apples repel each other when they are brought together?

An apple contains equal numbers of positive and negative charges, so it is neutral.

Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

6. Charging a Conductor Suppose you hang along metal rod from silk threads so that the rod is electrically isolated. You then touch a charged glass rod to one end of the metal rod. Describe the charges on the metal rod.

The glass rod attracts electrons off the metal rod, so the metal becomes positively charged.

The charge is distributed uniformly along the rod.

7. Charging by Friction You can charge a rubber rod negatively by rubbing it with wool. What happens when you rub a copper rod with wool?

Because the copper is a conductor, it remains neutral as long as it is in contact with your hand.

18. **Charging by Induction** In an electroscope being charged by induction, what happens when the charging rod is moved away before the ground is removed from the knob?

The electroscope remains neutral.

19. **Electroscopes** Why do the leaves of a charged electroscope rise to a certain angle and no farther?

As the leaves move farther apart, the electrostatic force between them decreases until it is balanced by the gravitational force pulling down on the leaves.

Q4	Demonstrate knowledge of electrostatic charge, differentiate materials based on their electrical conductivity, and describe the methods of electrical charging of objects.	Student Book	P.(52-58),
		Q.(2-7), Q.(18-21)	P.54; P.63

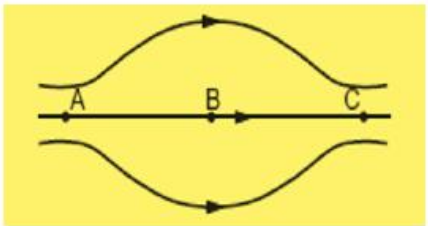
20. **Attraction of Neutral Objects** What properties explain how both positively charged objects and negatively charged objects can attract neutral objects?

Charge separation, caused by the attraction of opposite charges and the repulsion of like charges, moves the opposite charges in the neutral body closer to the charged object and the like charges farther away. The inverse relation between force and distance means that the nearer, opposite charges will attract more than the more distant, like charges will repel. The overall effect is attraction.

21. **Charging an Electroscope** How can you charge an electroscope positively using a positively charged rod? Using a negatively charged rod?

To charge positively, touch the rod to the electroscope.

To charge positively using a negatively charged rod, bring the rod near the electroscope. Ground the electroscope; remove the ground and then remove the rod.



الشكل يُمثِّل بعض من خطوط مجال كهربائي، تم تحديد 3 نقاط A, B, C لقياس شدة المجال الكهربائي عندها.

أي من العبارات الآتية صحيح؟

The Figure represents some electric field lines; Three points A, B, and C were selected to measure the electric field strength.

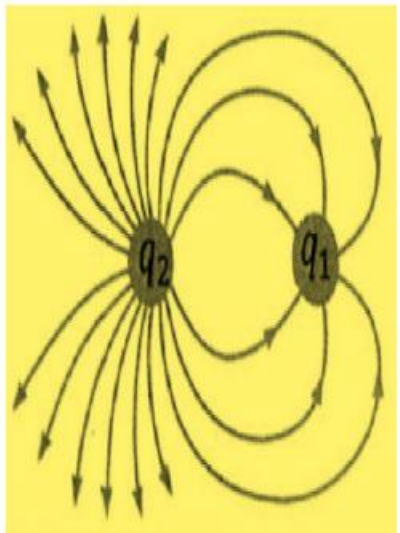
Which of the following statements is correct?

$E_A > E_B > E_C$

$E_A = E_C > E_B$

$E_A = E_C < E_B$

$E_A = E_B = E_C$



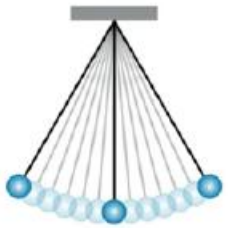
يظهر في الشكل خطوط المجال الكهربائي الناتج عن شحنتين (q_1, q_2)،

أي من العبارات التالية صحيحة؟

The Figure shows the electric field lines due to two charges (q_1, q_2).

Which one of the following statements is correct?

q_1 is negative, q_2 is positive; and $\|q_1\| < \|q_2\|$	q_1 سالبة، q_2 موجبة؛ $\|q_1\| < \|q_2\|$
q_1 is positive, q_2 is negative; and $\|q_1\| = \|q_2\|$	q_1 موجبة، q_2 سالبة؛ $\|q_1\| = \|q_2\|$
q_1 and q_2 are positive; and $q_1 < q_2$	q_1 و q_2 موجبتان؛ $q_1 < q_2$
q_1 and q_2 are negative; and $q_1 < q_2$	q_1 و q_2 سالبتان؛ $q_1 < q_2$



البندول البسيط يتأرجح بحركة تو افقية بسيطة، وعند دراسة حركته، أي الكميات الفيزيائية الآتية يعتمد عليها الزمن الدوري للبندول؟

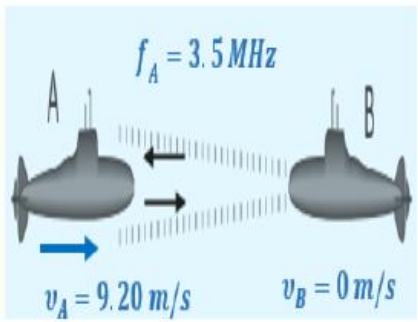
The simple pendulum swings in a simple harmonic motion. When studying its motion, which of the following physical quantities does the pendulum's period depend on?

Length of pendulum, material of the bob	طول البندول، المادة المصنوعة منه
Gravitational field (gravity), mass of bob	مجال الجاذبية، كتلة كرة البندول
Length of pendulum, gravitational field (gravity)	طول البندول، مجال الجاذبية
Mass of bob, shape of the bob	كتلة كرة البندول، شكل كرة البندول

أي الكميات الفيزيائية الآتية تقاس بوحدة الديسيبل (dB)؟

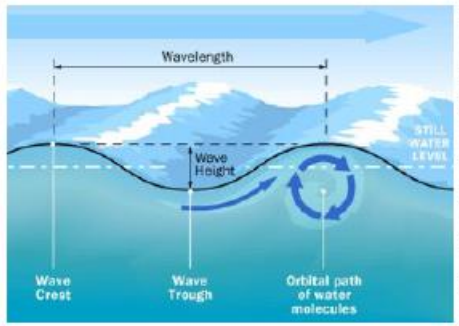
Which of the following physical quantities is measured in decibels (dB)?

Sound Pitch	حِدَّة الصوت
Sound Loudness	علو (جهارة) الصوت
Sound Level	مُستوى الصوت
Sound Amplitude	سعة الصوت



تتحرك الغواصة A بسرعة $9.20\,m/s$ باتجاه غواصة أخرى B في حالة السكون، تُصدر الغواصة A إشارة سونار بتردد مقداره $3.50\,MHz$، إذا علمت أن سرعة الصوت في الماء $1482\,m/s$. ما التردد الذي سترصده الغواصة الثانية (B)؟

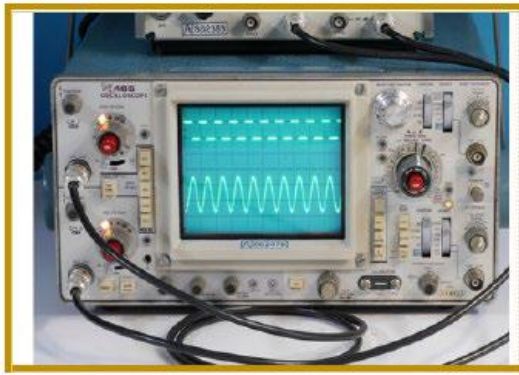
A submarine A is moving at $(9.20\,m/s)$ towards another submarine B, at rest. The Sub A sends out a sonar signal at $(3.50\,MHz)$. If you know the speed of sound in water is $(1482\,m/s)$. What



في هذا النوع من الموجات، تتبع جسيمات الوسط مسارًا دائريًا يكون في بعض الأحيان موازيًا وفي أحيان أخرى متعامدًا مع اتجاه انتقال الموجة، كما هو موضح في الشكل. ما اسم هذا النوع من الموجات؟

In this type of waves, the medium's particles follow a circular path that is at times parallel and at other times perpendicular to the direction of wave travel, as shown in the Figure. What is the name of this type of waves?

Primary waves	موجات أولية
Longitudinal waves	موجات طولية
Transverse waves	موجات مستعرضة
Surface waves	موجات سطحية

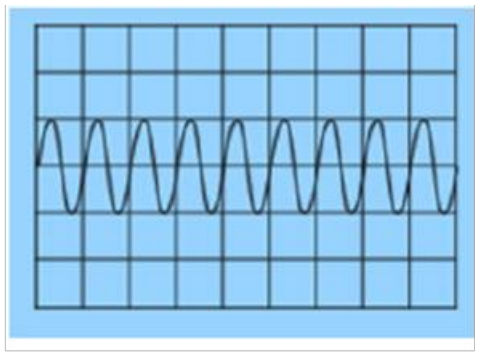


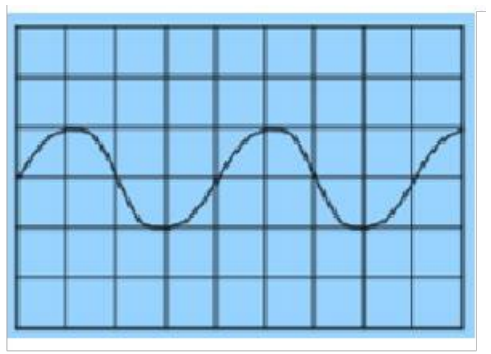
جهاز "راسم ذبذبات" يُبيّن موجات صوتية لأربعة من المصادر المختلفة.

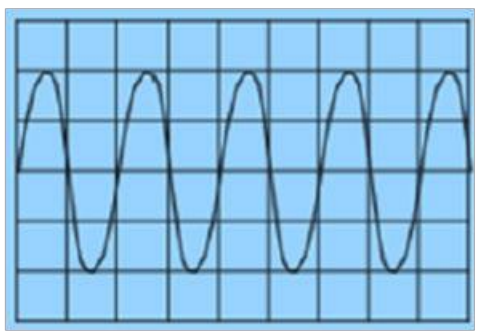
أي الرسوم البيانية الآتية لموجة لها أعلى حدة صوتية؟

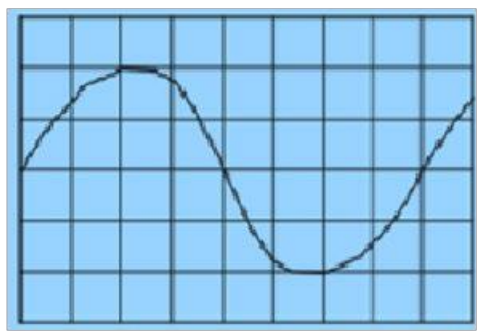
An oscilloscope displays four sound waves from different sources.

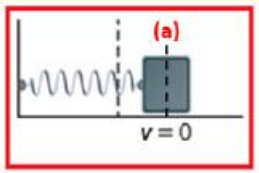
Which of the following graphs represents the wave with the highest pitch?

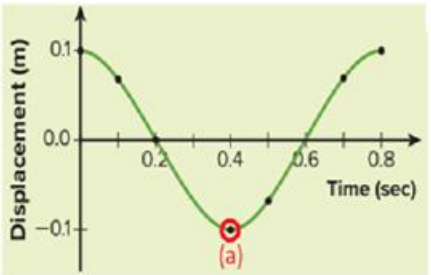






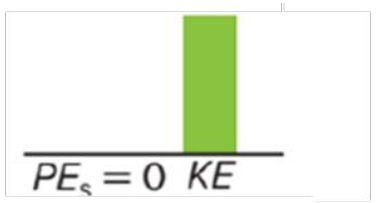


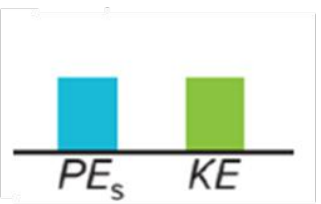


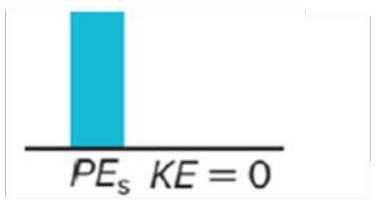


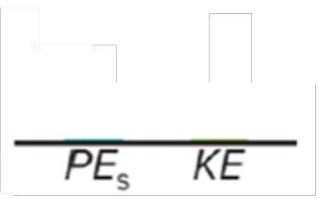
يتحرك نظام الكتلة-الزنبرك (النابض) حركة تو افقية بسيطة أفقية. إذا تحرك الجسم عند الزمن $t = 0$ من الوضعية المبينة في الشكل، بحيث كانت طاقته الكلية على شكل طاقة وضع مرونية. اعتماداً على الرسم البياني، ومبدأ حفظ الطاقة الميكانيكية. أي الرسومات الآتية تُعبّر عن الطاقة التي يمتلكها النظام عندما يكون موقع الجسم عند (a)؟

The mass-spring system moves in a simple, horizontal harmonic motion. If the body moves at time $t = 0$ from the position shown in the Figure, so that the total energy is elastic potential energy. Based on the graph and the principle of conservation of mechanical energy, which graph expresses the energy possessed by the system when the body position is at (a)?



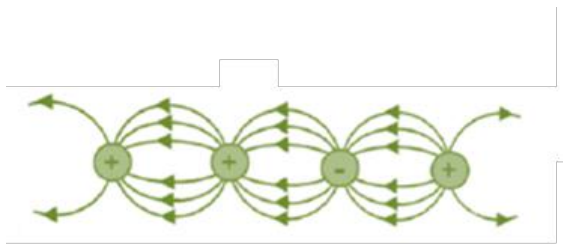


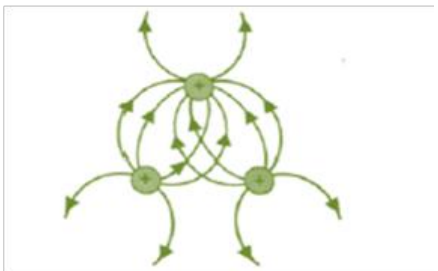


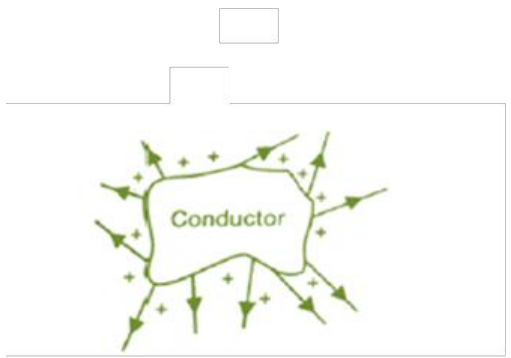


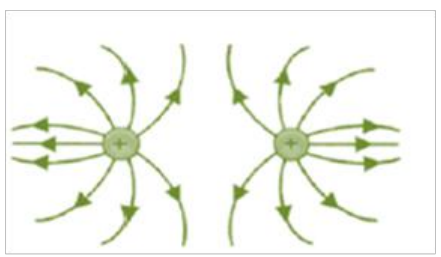
أي من المخططات الموضحة تُمثِّل خطوط المجال الكهربائي؟

Which of the diagrams shown represent the electric field lines?









أنبوب مفتوح من كلا الطرفين يتذبذب برنين تردده الأساسي $f_{(open)}$. عندما يتم تغطية أحد طرفي الأنبوب وجعله يتذبذب مرة أخرى، يكون تردد رنينه الأساسي $f_{(closed)}$. أي من العبارات التالية تصف العلاقة بين ترددي الرنين في الحالتين؟

A pipe open at both ends resonates at a fundamental frequency $f_{(open)}$. When one end is covered and the pipe is again made to resonate, the fundamental frequency is $f_{(closed)}$. Which of the following expressions describes

$f_{(closed)} = f_{(open)}$

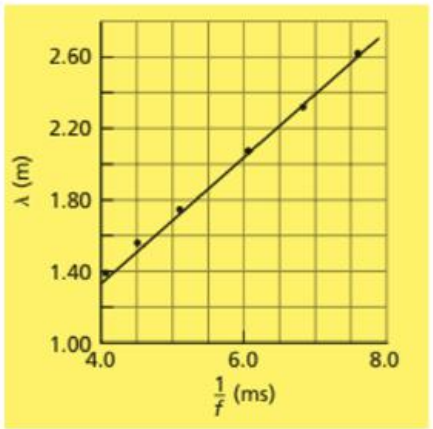
$f_{(closed)} = \frac{3}{2} f_{(open)}$

$f_{(closed)} = \frac{1}{2} f_{(open)}$

$f_{(closed)} = 2 f_{(open)}$

في مختبر بدرجة حرارة (20^0C) أجريت تجربة باستخدام شوكات رنانة ذات ترددات مختلفة. وفي التجربة تم قياس الأطوال الموجية (λ) لكل منها، وتم تمثيل العلاقة بين الطول الموجي ومعكوس (مقلوب) التردد $\left(\frac{1}{f}\right)$ كما هو موضح في الشكل.

ما الكمية التي يُمثِّلها ميل أفضل خط مستقيم في الرسم البياني؟



In a laboratory with a temperature of (20^0C), an experiment was conducted using tuning forks of different frequencies. In the experiment, the wavelength (λ) of each of them was measured, and the relationship between the wavelength and the inverse (reciprocal) of the frequency $\left(\frac{1}{f}\right)$ was plotted as shown in the Figure.

What physical quantity is represented by the slope of the line of best fit on the graph?

Sound Amplitude	سعة الصوت
Sound Speed	سرعة الصوت
Sound Intensity	شدة الصوت
Sound Power	قدرة الصوت

تحتوي حديقة *هيلي الترفيهية* في مدينة العين على رنان خارجي لأنابيب الأرغون المفتوحة، عندما ترتفع درجة حرارة الهواء، ماذا يحدث للتردد الأساسي للأنابيب المغلقة؟

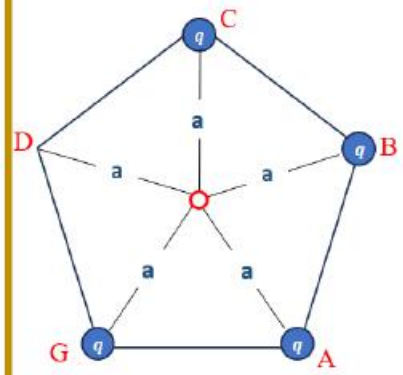
Hili Fun Park in Al-Ain city has an outer open organ pipe resonator. When the air temperature increases; What happened to the fundamental frequency of the closed pipes?

Goes up	ترتفع
Goes down	تنخفض
Stays the same	تبقى كما هي
Is impossible to determine	من المستحيل تحديد ذلك

دلك طالب ساق من الأبونيت بقطعة من الصوف، وبعد إتمام عملية الدلك، تم تقريب ساق الأبونيت من قطعة الصوف. كتب الطالب بعدها في كُراسة (دفتر) العلوم الملاحظات الآتية:

أنظر للملاحظات المدونة، واحكم أي منها صحيح بناءً على دراستك؟

A + B + C + D + E + F	B + E
B + C + E + F	B only



شكل خُماسي مُنتظم، وُضعت أربع شحنات مُتماثلة q على أربع رؤوس منه كما هو مُبيَّن في الشكل، إذا علمت أن المسافة بين كُل رأس ومركز الخماسي (O) يُساوي a.

ما هي شدة المجال الكهربائي في مركز الشكل الخماسي؟

A regular pentagonal shape, with four identical charges q placed on four vertices as shown in the Figure. If the distance between each vertex and the center of the pentagon (O) is equal to a,

What is the electric field strength at the center of the pentagon?

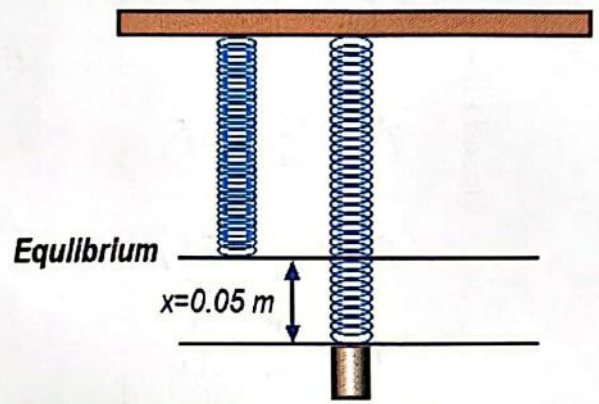
مُساعدة (تلميح): إذا كانت جميع رؤوس الشكل الخماسي تحتوي شحنات متماثلة (شحنة لكل رأس)؛ بالتناظر، سيكون محصلة شدة المجال الكهربائي في المركز (O) صفرًا $\sum \vec{E}_O = 0$.

Hint: If all the pentagon vertices are filled with identical charges (charge for each vertex); By symmetry, the net electric field strength at the center (O) will be zero $\sum \vec{E}_O = 0$.

$\vec{E}_O = \frac{Kq}{2a^2}$, along OD	$\vec{E}_O = \frac{Kq}{a^2}$, to right
$\vec{E}_O = \frac{Kq}{a^2}$, along OD	$\vec{E}_O = \frac{Kq}{2a^2}$, to right

A cylinder weighing $(70\ N)$ is suspended from a spring hook, causing the spring to extend $(0.05\ m)$ as shown in the Figure below.

تم تعليق أسطوانة وزنها $(70\ N)$ بخطاف زنبرك(نابض)، مما أدى إلى تمدد الزنبرك مسافة $(0.05\ m)$ كما هو مُوضح في الشكل أدناه:



A- What is magnitude and direction of the restoring / spring force acting on the cylinder-spring system?

A- ما مقدار واتجاه قوة الإرجاع / النابض المؤثرة في نظام الاسطوانة – النابض؟

B- What is the spring constant (k)?

B- ما مقدار ثابت المرونة (k) للنابض؟

C- What is the elastic potential energy of a spring PE_{spring}?

C- ما مقدار طاقة الوضع المرونية للنابض PE_{spring}؟

A- Two triangular wave pulses **A** and **B** are traveling toward each other on a stretched string, each pulse at speed $2.0\ cm/s$, as shown in the Figure (a), at $t = 0\ s$. Sketch accurately in Figure (b) the shape of the resulting wave at time $t = 2.0\ s$.

تتحرك موجتان مُثلثتان **A** و**B**، باتجاه بعضهما البعض على وتر مشدود، وسرعة كل نبضة $2.0\ cm/s$ ، كما هو مُوضّح في الشكل (a)، عند $t = 0\ s$. ارسم بدقة في الشكل (b) شكل الموجة الناتجة عند الزمن $t = 2.0\ s$.

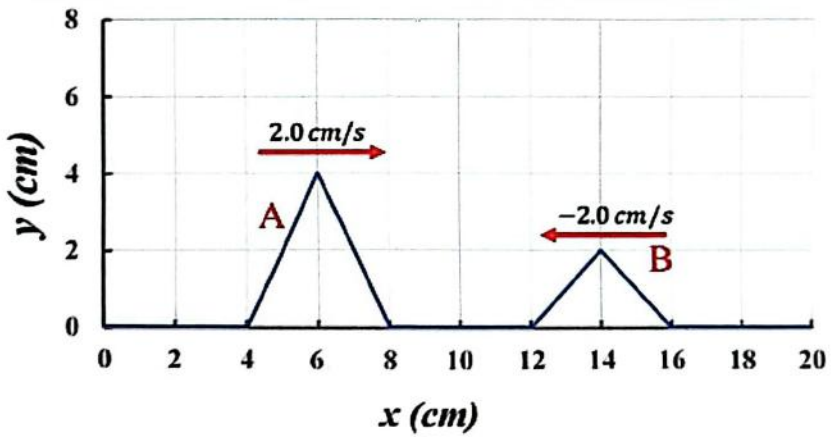


Figure (a) الشكل

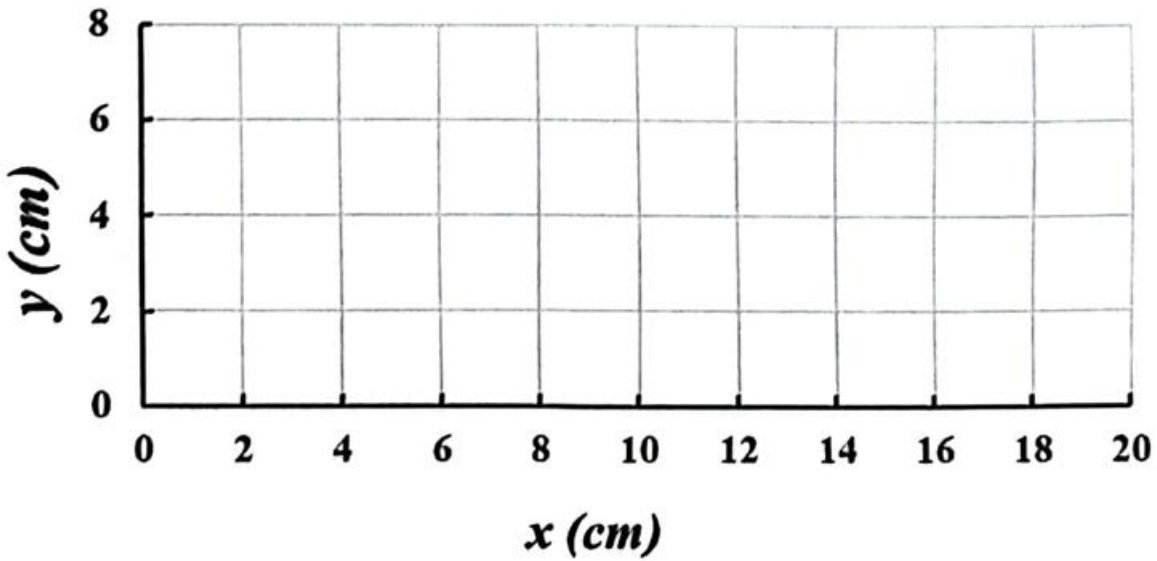


Figure (b) الشكل

B- Look at Figures (1) and (2) and then complete the table shown below.

B- أنظر للشكلين (1) و (2) ومن ثم اعمل على إكمال الجدول المبين أدناه.

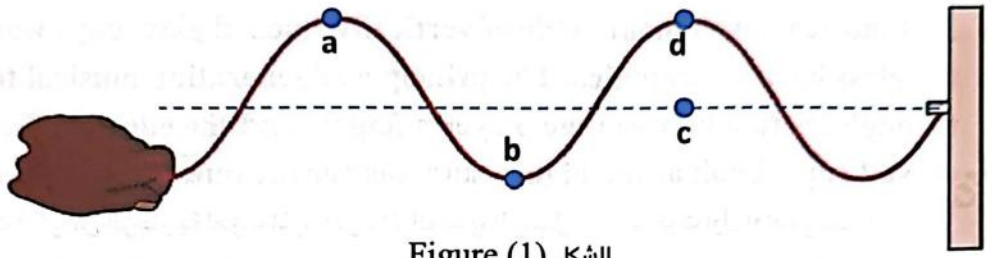


Figure (1) الشكل

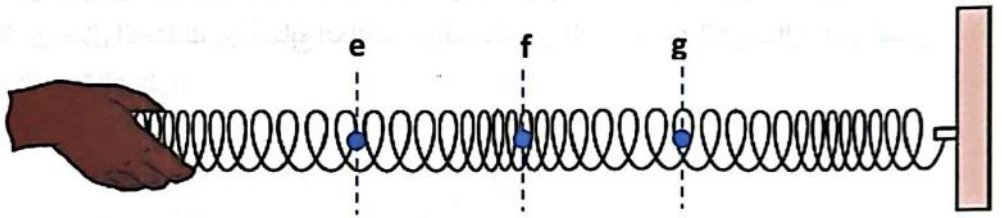


Figure (2) الشكل

Fill the blanks in the following table to:

- Determine the wave type (in first row).
- Identify each physical quantity (wave length, wave amplitude), using appropriate letters (a, b, …, g)- **example ef**…etc- as shown in the figure (in second and third rows).

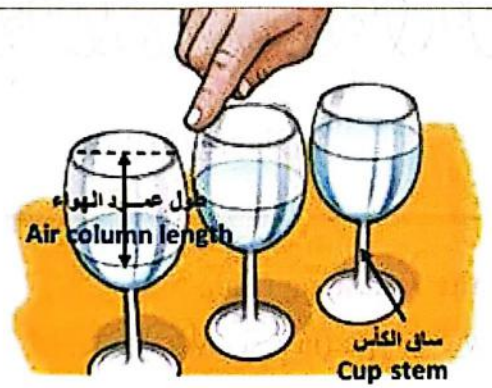
املأ الفراغات في الجدول التالي بما يلي:

- تحديد نوع الموجة (في الصف الأول).
- حدّد كل كمية فيزيائية (طول الموجة، سعة الموجة)، باستخدام الحروف المناسبة (a, b, …, g)– مثال ef ...إلخ – كما هو موضح في الشكل (في الصفين الثاني والثالث).

No. م.	Comparison item وجه المقارنة	Figure (1) الشكل (1)	Figure (2) الشكل (2)
1	Wave Type نوع الموجة	.....	.....
2	Wave Length طول الموجة	.....	.....
3	Wave Amplitude سعة الموجة	.....	XXXXXXXXXXXXXXXX

Glass cups have been used to play music since the Middle Ages. The first musical instrument made of vertically stacked glass cups was called the glass harp / harmonica. The principle of generating musical tones is through friction between the player's fingers and the edges of the crystal cups. Look at the Figure, and answer the questions that follow:

أستخدمت الكؤوس الزجاجية لعزف الموسيقى منذ العصور الوسطى، وقد سُمِّيت أول أداة موسيقية مصنوعة من الكؤوس الزجاجية المتراصة رأسيًا بالقيثارة / الهارمونيكا الزجاجية. يقوم مبدأ توليد النغمات الموسيقية من خلال الاحتكاك بين أصابع العازف وحواف الكؤوس المصنوعة من الكريستال، أنظر الشكل، وأجب عن الأسئلة التي تليه:



A. When taking a cup and trying to produce an audio tone for each of the following water levels (empty of water - one-third full of water - two-thirds full of water).

- What happens to the pitch of the sound when the water level in the cup increases? Justify your answer by using suitable formulas.

A. عند أخذ كأس، ومحاولة اصدار نغمة صوتية لكل من مستويات الماء في الكأس (فارغ من الماء – مملوء ثلثه بالماء – مملوء ثلثيه بالماء).

- ماذا يحدث لدرجة الصوت عند زيادة مُستوى الماء في الكأس؟ برّر اجابتك مُستخدماً العلاقات الرياضية.

_____

_____

_____

_____

- The length of the air column in the case of resonance is given by $\left(L = \frac{1}{4}n\lambda\right)$. In the Figure, would n be an odd or even number? Explain your answer.

- يتم إعطاء طول عمود الهواء في حالة الرنين بالعلاقة $\left(L = \frac{1}{4}n\lambda\right)$. في الشكل، هل n عدد فردي أم زوجي؟ وضّح إجابتك.

B. When two glasses are placed very close to each other, and you moved your finger along the rim of one cup to produce a tone, you noticed that the same tone is produced in the other cup.

What can this phenomenon be called? What is the condition for this phenomenon to occur?

B. عندما يتم وضع كأسين قريبين جدًا من بعضهما البعض، وقُمت بتحريك إصبعك على طول حافة أحد الكوبين لإصدار نغمة، لاحظت أنه يتم إنتاج نفس النغمة في الكوب الآخر.

ماذا يُمكن أن تُسمى هذه الظاهرة؟ وما هو الشرط لحدوث هذه الظاهرة؟

Two similarly and equally charged identical metal spheres A and B repel each other with a force $(2.0 \times 10^{-5}\ N)$, as shown in Figure (a). A third identical uncharged sphere C is touched to A and then placed at the mid-point between A and B, as shown in Figure (b). Answer the following (Show your work in details):

كُرتان معدنيتان A وB، مُتشابهتان وتحملان الشحنة نفسها، تتنافران بقوة $(2.0 \times 10^{-5}\ N)$، كما هو مُوضَّح في الشكل (a). تُقرب كُرة معدنية ثالثة مُطابقة لهما غير مشحونة C، من الكرة المعدنية A بحيث تلامسها، ثم يتم وضعها عند نقطة المنتصف بين A وB، كما هو موضح في الشكل (b)، أجب عما يلي (وضِّح الحل بالتفاصيل):

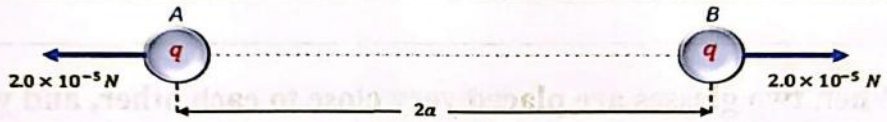


Figure (a)

Figure (b)

A- By using Figure (a); Find the ratio $\left(\frac{q^2}{a^2}\right)$, by using Coulomb's law.

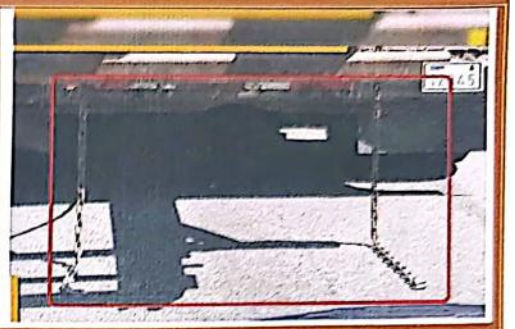
A- باستخدام الشكل (a)، أوجد النسبة $\left(\frac{q^2}{a^2}\right)$ باستخدام قانون كولوم.

B- What is the net electric force on sphere C in Figure (b), magnitude and direction? Hint: Use the answer from part A, in this part

B- ما القوة الكهربائية المحصلة المؤثرة على الكرة C في الشكل (b)، مقدارها و اتجاهها؟ تلميح: استخدم الإجابة من الجزء A في هذا الجزء

A- **Perhaps you have seen a gasoline truck trailing a metal chain beneath it.**
Explain this based on your knowledge about conductors and insulators.

A- ربما رأيت شاحنة نقل نفط تسير تحتها سلسلة معدنية،
اشرح ذلك بناءً على معرفتك بالموصلات والعوازل.



B- **The Doppler effect in water is observed in a ripple tank. The vibrating source is moving to the left, by using detectors of water waves at three locations A, B, and C as in the Figure below. Determine in which location(s) the value for each of the following physical quantities is greatest using in the Figure below:**

B- لوحظ تأثير دوبلر في الماء في حوض الموجات، مصدر الاهتزاز فيه يتحرك إلى اليسار، باستخدام أجهزة كشف موجات الماء في ثلاثة مواقع A وB وC كما في الشكل. مُستعيناً بالشكل أدناه، حدِّد أي موقع / مواقع تكون فيها القيمة أكبر ما يمكن لكل من الكميات الفيزيائية الآتية:

- Water wave speed (سرعة الموجة المائية): .....
- Water wavelength (طول الموجة المائية): .....
- Water wave frequency (تردد الموجة المائية): .....