Hong Kong Diploma of Secondary Education Examination

Physics – Compulsory part (必修部分)

Section A – Heat and Gases (熱和氣體)
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

Section B – Force and Motion (力和運動)
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

Section C – Wave Motion (波動)
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

Section D – Electricity and Magnetism (電和磁)
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

Section E – Radioactivity and Nuclear Energy (放射現象和核能)
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

Physics – Elective part (選修部分)

Elective 1 – Astronomy and Space Science (天文學和航天科學)
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恆星和宇宙)

Elective 2 – Atomic World (原子世界)
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

Elective 3 – Energy and Use of Energy (能量和能源的使用)
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

Elective 4 – Medical Physics (醫學物理學)
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)

WA6 : Sound

Part A : HKCE examination questions

1. **< HKCE 1981 Paper II - 20 >**

Which of the following statements is/are correct ?
(1) Sound waves cannot be diffracted.
(2) A louder sound travels faster in air.
(3) Sound travels faster in water than in air.

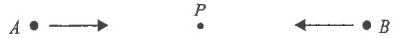
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

2. **< HKCE 1983 Paper II - 22 >**

An ultrasonic wave is sent from a ship to find the depth of the sea-bed. A signal is received 0.2 s later. Given that the speed of sound in sea water is 1500 m s^{-1}, what is the depth of the sea-bed ?

A. 75 m
B. 150 m
C. 300 m
D. 450 m

3. **< HKCE 1984 Paper II - 23 >**



Two sound waves of the same frequency are emitted from 2 sources *A* and *B* as shown in the diagram. What kind of interference will occur at the mid-point *P* when the 2 waves generated are (1) in phase; (2) anti-phase ?

	In phase	Anti-phase
A.	constructive	constructive
B.	constructive	destructive
C.	destructive	constructive
D.	cannot be determined	cannot be determined

4. **< HKCE 1985 Paper II - 21 >**

Which of the following are longitudinal waves ?
(1) sound waves transmitted through a solid
(2) sound waves transmitted through water
(3) waves in a vibrating string

A. (1) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

5. **< HKCE 1986 Paper II - 23 >**

Which of the following can be reflected and diffracted ?
(1) sound waves
(2) infra-red radiation
(3) X-rays

A. (1) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

6. **< HKCE 1986 Paper II - 27 >**

The depth of a lake can be found by the method of echo-sounding. The depth of a short pulse sent vertically down to the bottom of the lake was received after 0.6 s. Given that the speed of sound in water is 1440 m s^{-1}, the depth of the lake will be

A. 7.2 m.
B. 14.4 m.
C. 432 m.
D. 864 m.

7. **< HKCE 1987 Paper II - 14 >**

The wavelength and velocity of a sound in air are 25 cm and 340 m s^{-1} respectively. When this sound enters a medium, its wavelength becomes 75 cm. Find the velocity of the sound in the medium.

A. 113 m s^{-1}
B. 340 m s^{-1}
C. 1020 m s^{-1}
D. 1130 m s^{-1}

8. **< HKCE 1988 Paper II - 22 >**

A signal of sound is sent vertically downwards from a ship. Its echo reflected from the sea bed is detected by a microphone on the ship 0.4 s later. What is the depth of the sea if the speed of sound in the sea is known to be 1500 m s^{-1} ?

A. 150 m
B. 300 m
C. 600 m
D. 3000 m

9. **< HKCE 1988 Paper II - 25 >**

The range of sound that a boy can hear is from 30 Hz to 16500 Hz. If it is given that the speed of sound in air is 330 m s^{-1}, what is the shortest wavelength of sound in air that the boy can hear ?

A. 0.02 m
B. 0.09 m
C. 11.0 m
D. 50.0 m

10. **< HKCE 1989 Paper II - 24 >**

The wavelength and velocity of a sound in air are 25 cm and 330 m s^{-1} respectively. When this sound enters a medium, its wavelength becomes 75 cm. Find the velocity of the sound in the medium.

A. 165 m s^{-1}
B. 330 m s^{-1}
C. 660 m s^{-1}
D. 990 m s^{-1}

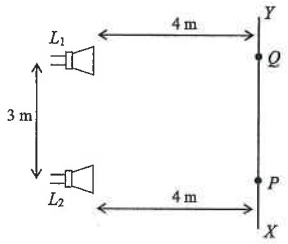
11. **< HKCE 1990 Paper II - 27 >**

Which of the following statements about sound is/are correct ?

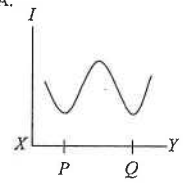
(1) Sound cannot travel through water.
(2) Loudness increases with the amplitude of the sound wave.
(3) Pitch increases with the wavelength of the sound wave.

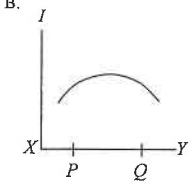
A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

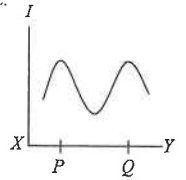
12. **< HKCE 1990 Paper II - 25 >**

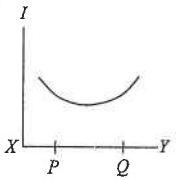


In the figure shown, the two loudspeakers L_1 and L_2 emit sound waves of wavelength 2 m. The waves emitted are exactly opposite in phase. Which of the following graphs best represents the variation of sound intensity I along the line XY ?

A.


B.


C.


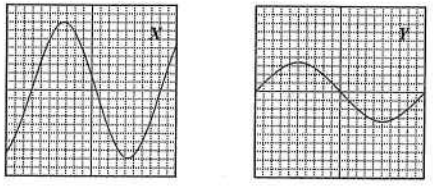
D.


13. **< HKCE 1990 Paper II - 28 >**

A bat emits sound waves of frequency 30 kHz and receives a reflected signal from an obstacle after 0.15 s. The speed of the sound in air is 340 m s^{-1}. How far is the obstacle away from the bat ?

A. 11.3 m
B. 25.5 m
C. 51.0 m
D. 88.2 m

14. **< HKCE 1991 Paper II - 27 >**



The diagrams above show the traces of two musical notes X and Y on an oscilloscope. Which of the following statements is/are true ?

(1) X has a higher pitch than Y.
(2) The loudness of X is greater than that of Y.
(3) X and Y are longitudinal waves.

A. (2) only
B. (1) & (2) only
C. (1) & (3) only
D. (1), (2) & (3)

15. **< HKCE 1991 Paper II - 26 >**

Which of the following is an application of ultrasonic in everyday life ?

A. Cooking
B. TV broadcasting
C. Camera autofocusing
D. Satellite telecommunication

16. **< HKCE 1992 Paper II - 23 >**

Which of the following is/are longitudinal waves ?

(1) Ultrasonic transmitted through air.
(2) Infrared transmitted through water.
(3) Gamma rays transmitted through outer space.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

17. **< HKCE 1993 Paper II - 27 >**

The frequencies of two musical notes X and Y are 256 Hz and 512 Hz respectively. If X and Y both have the same amplitude, which of the following statements is/are true ?

(1) Y has a higher pitch than X.
(2) The loudness of X is larger than that of Y.
(3) The wavelength of Y is longer than that of X.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

18. **< HKCE 1993 Paper II - 28 >**

Which of the following statements about ultrasonics is INCORRECT ?

A. Ultrasonics are longitudinal waves.
B. The frequency of ultrasonics is above 20 kHz.
C. Ultrasonics are deflected by a magnetic field.
D. Ultrasonics cannot travel through a vacuum.

19. **< HKCE 1994 Paper II - 23 >**

Which of the following is NOT an application of ultrasonics ?

A. Camera autofocusing
B. Satellite communication
C. Measurement of the depth of the sea-bed
D. Detection of cracks in railway tracks

20. **< HKCE 1995 Paper II - 25 >**

When a sound wave travels from air into water, its wavelength is increased by five times. If the speed of sound in air is 330 m s^{-1}, find the speed of the sound wave in water.

A. 66 m s^{-1}
B. 330 m s^{-1}
C. 1650 m s^{-1}
D. insufficient information

21. **< HKCE 1997 Paper II - 22 >**

Which of the following statements concerning microwaves and ultrasonic waves is/are correct ?

(1) Microwaves are electromagnetic waves while ultrasonic waves are not.
(2) Microwaves and ultrasonic waves travel with the same speed in air.
(3) Microwaves can be diffracted while ultrasonic waves cannot.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

22. **< HKCE 1998 Paper II - 28 >**

Which of the following statements about ultrasonic waves is correct ?

A. They are transverse waves.
B. They are electromagnetic waves.
C. They travel with a speed of 3×10 m s^{-1} in air.
D. They cannot travel through a vacuum.

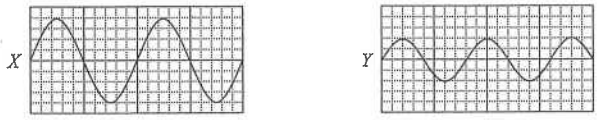
23. **< HKCE 1999 Paper II - 25 >**

Which of the following statements about light and sound is/are correct ?

(1) Both light and sound are transverse waves.
(2) Both light and sound travel faster in air than in water.
(3) Both light and sound can undergo refraction when travelling from one medium to another.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

24. **< HKCE 2000 Paper II - 28 >**



A microphone and a CRO are used to detect the sound emitted by two tuning forks X and Y in turn. The figures show the traces obtained, with the same setting of the CRO. Find the ratio of the frequency of the sounds emitted by X to that of Y.

A. 1 : 2
B. 2 : 1
C. 4 : 5
D. 5 : 4

25. **< HKCE 2001 Paper II - 24 >**

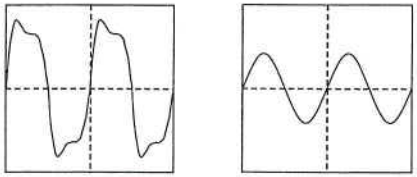
A sonar on a ship is used to find the depth of the sea. An ultrasonic wave pulse is sent downwards from the ship towards the sea bed. The pulse travels with a speed of 1500 m s^{-1} in sea water. If the reflected pulse is received after 0.16 s, find the depth of the sea.

A. 120 m
B. 240 m
C. 480 m
D. 4688 m

26. **< HKCE 2001 Paper II - 22 >**

Which of the following is **not** a transverse wave ?
A. radio waves
B. visible light
C. X-rays
D. ultrasonic waves

27. **< HKCE 2002 Paper II - 29 >**


Note *X* Note *Y*

The above figures show the CRO displays of two musical notes *X* and *Y*. The settings of the CRO for the two notes are identical. Which of the following statements are correct ?
(1) Notes *X* and *Y* are of different qualities.
(2) Note *X* is of a higher pitch than note *Y*.
(3) Note *X* is louder than note *Y*.
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

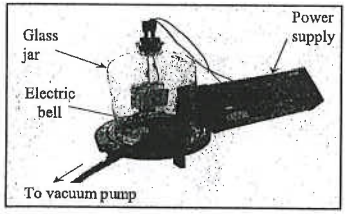
28. **< HKCE 2002 Paper II - 28 >**

The figure shows the image of a foetus (a baby not yet born) taken by a scanner. Which of the following waves should be used in the scanning process ?
A. infra-red
B. microwaves
C. ultrasonics
D. X-rays

29. **< HKCE 2003 Paper II - 29 >**

A ringing electric bell is placed inside a glass jar as shown. As air is pumped out of the jar, the sound will die away. Which of the following can explain this phenomenon ?

A. The hammer of the bell cannot vibrate in a vacuum.
B. Sound waves are internally reflected by the glass surface.
C. Sound waves cannot travel in a vacuum.
D. The frequency of sound waves in a vacuum exceeds the audible frequency range.



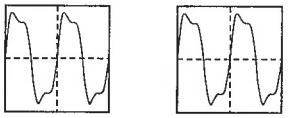
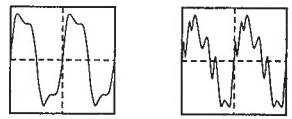
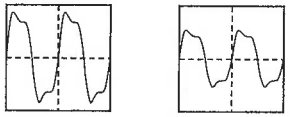
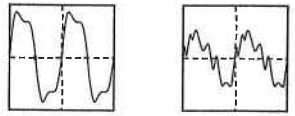
30. **< HKCE 2004 Paper II - 26 >**

Which of the following descriptions about microwaves and ultrasonic waves is correct ?
A. They can both travel in a vacuum.
B. They are both transverse waves.
C. They can both be deflected by magnetic fields.
D. They travel with different speeds in air.

31. **< HKCE 2005 Paper II - 38 >**

Two musical notes are produced by two different kinds of musical instruments. The two notes have the same pitch but different loudness. Which of the following combinations of notes satisfies the above description ?

Note : The settings of the CRO for displaying the notes are identical.

A. 
B. 
C. 
D. 

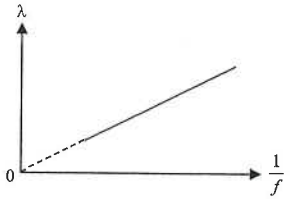
32. **< HKCE 2005 Paper II - 37 >**

Which of the following is a unit of sound intensity level ?
A. decibel
B. hertz
C. sievert
D. watt

33. **< HKCE 2005 Paper II - 13 >**

Which of the following statements about sound waves are correct ?
(1) Sound waves are longitudinal waves.
(2) Sound waves are electromagnetic waves.
(3) Sound waves cannot travel in a vacuum.
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

34. **< HKCE 2006 Paper II - 17 >**



A loudspeaker is connected to a signal generator to produce sound waves. The frequency *f* is varied and the corresponding wavelength λ is measured. The wavelength is plotted against the reciprocal of the frequency as shown above. Which of the following are correct deductions obtained from the graph ?
(1) The wavelength of the sound is inversely proportional to its frequency.
(2) The slope of the graph is equal to the speed of the sound.
(3) The speed of the sound depends on its frequency
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

35. **< HKCE 2006 Paper II - 34 >**

The following data show the frequencies and sound intensity levels of some musical notes produced by a piano.

Note	Frequency / Hz	Intensity level / dB
C	256	64
D	288	68
E	320	65
F	341	63

Which of the following statements is/are correct ?

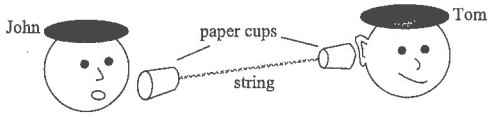
(1) The note F has the lowest pitch.

(2) The note D has the greatest loudness.

(3) The note C played on a guitar will sound differently from the same note produced by the piano.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

36. **< HKCE 2006 Paper II - 18 >**



John and Tom communicate with each other by using two paper cups connected with a string. Which of the following statements are correct ?

(1) The sound waves transmitted along the string are transverse waves.

(2) The speed of the sound waves along the string is faster than that in the air.

(3) When John whistles a note of 1000 Hz towards the paper cup, Tom will also hear a note of 1000 Hz.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

37. **< HKCE 2006 Paper II - 20 >**

Which of the following phenomena are due to the refraction of waves ?

(1) When water waves enter shallow water from deep water, the spacing between wavefronts decreases.

(2) A swimming pool appears shallower than it actually is.

(3) Mary can hear loud and soft sounds alternately when she walks across in front of two loudspeakers connected to a signal generator.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

38. **< HKCE 2006 Paper II - 33 >**

Flash lamps used by professional photographers can find object distances by using infrared waves so as to adjust the flash output. Which of the following is/are the reason(s) of using infrared waves instead of ultrasonic waves in such flash lamps ?

(1) Speed of infrared waves is much faster than that of ultrasonic waves making the time for finding object distances shorter.

(2) Objects to be photographed will usually emit infrared waves.

(3) The sound produced by ultrasonic waves makes photographers feel annoyed.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

39. **< HKCE 2007 Paper II - 36 >**

Which of the following descriptions about ultrasonic waves must be correct ?

A. In the same medium, the speed of the ultrasonic waves is higher than that of the audible sound waves.

B. In the same medium, the wavelength of the ultrasonic waves is longer than that of the audible sound waves.

C. In the same medium, the intensity of the ultrasonic waves is higher than that of the audible sound waves.

D. In the same medium, the frequency of the ultrasonic waves is higher than that of the audible sound waves.

40. **< HKCE 2007 Paper II - 37 >**

Two identical loudspeakers X and Y are connected in parallel to a signal generator. A microphone connected to a CRO detects a maximum when it is 0.2 m from X and 0.4 m from Y. It detects a minimum when it is 0.9 m from X and 0.4 m from Y. What is the possible wavelength of the sound wave ?

A. 0.1 m
B. 0.2 m
C. 0.4 m
D. 0.5 m

41. **< HKCE 2007 Paper II - 39 >**

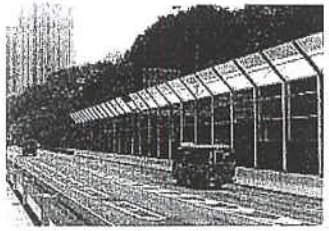
Noise barriers built along highways are used to block the noise generated by road traffic. Which of the following statements correctly explain how the noise barriers can block the noise ?

(1) The noise from vehicles is reflected.

(2) The noise is absorbed by the noise barriers.

(3) The noise is diffracted at the top edge of the noise barriers.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)



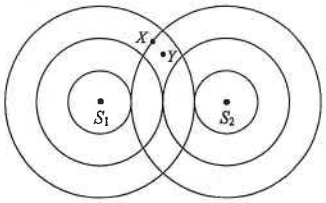
42. **< HKCE 2008 Paper II - 14 >**

A ship uses a sonar system to detect the depth of the sea. A sound wave signal of frequency 30000 Hz is sent vertically downward from the sea surface and the reflected signal is received 5 s later. Which of the following is correct ?
(The speed of sound wave in sea water is 1400 m s^{-1}.)

	Wavelength of the sound wave in sea water (m)	Depth of the sea (m)
A.	4.67×10^{-2}	3500
B.	4.67×10^{-2}	7000
C.	9.33×10^{-2}	3500
D.	9.33×10^{-2}	7000

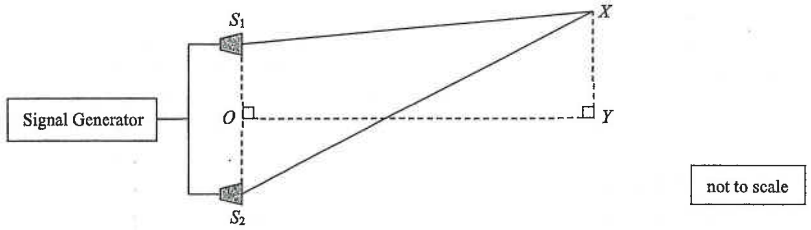
43. **< HKCE 2008 Paper II - 36 >**

In the figure, S_1 and S_2 are two identical loudspeakers connected in parallel to a signal generator. The circles represent the wavefronts of the sound wave produced. What are the changes to the loudness of the sound at X and Y if loudspeaker S_1 is turned off ?



	X	Y
A.	increases	increases
B.	decreases	decreases
C.	increases	decreases
D.	decreases	increases

44. **< HKCE 2009 Paper II - 35 >**



Sound waves of 660 Hz are produced from two identical loudspeakers S_1 and S_2 which are connected in parallel to a signal generator. The distances S_1X and S_2X are 2 m and 4 m respectively. O is the midpoint of S_1S_2. What kinds of interference occur at X and Y respectively ? Given that the speed of sound in air is 330 m s^{-1}

	X	Y
A.	constructive	constructive
B.	constructive	destructive
C.	destructive	constructive
D.	destructive	destructive

45. **< HKCE 2010 Paper II - 15 >**

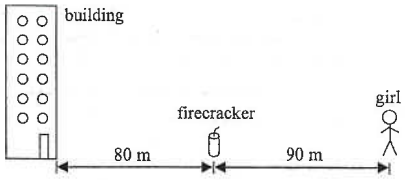
Which of the following statements about sound waves is **not** correct ?

A. Sound waves are longitudinal waves.
B. Sound waves diffract when travelling through a doorway.
C. Sound waves cannot pass through a vacuum.
D. All sound waves of frequencies above 20 Hz are audible.

46. **< HKCE 2010 Paper II - 12 >**

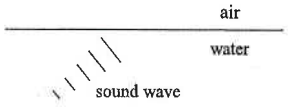
In the figure, a firecracker at a position 80 m away from a building explodes and produces a bang. A girl standing 90 m away from the firecracker hears two bangs. What is the time interval between the two bangs ?

Given : speed of sound in air = 340 m s^{-1}



A. 0.24 s
B. 0.26 s
C. 0.47 s
D. 0.50 s

47. **< HKCE 2010 Paper II - 39 >**

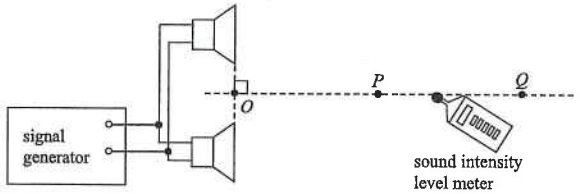


The figure shows a sound wave travelling in water. It is known that the sound waves travel faster in water than in air. After refraction, which of the following statements is/are correct ?

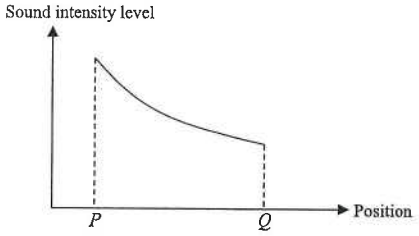
(1) The wavelength of the sound wave increases.
(2) The frequency of the sound wave remains unchanged.
(3) The sound wave bends away from the normal.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

48. **< HKCE 2010 Paper II - 40 >**



Two identical loudspeakers are connected in parallel to a signal generator, O is the midpoint between the loudspeakers. When a sound intensity level meter is moved from P to Q, the graph below shows the variation of the sound intensity level received with position.



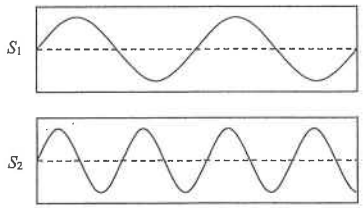
Which of the following statements is/are correct ?

(1) The sound intensity level at Q is smaller because the amplitude of the sound wave decreases as it is further away from the loudspeakers.
(2) Constructive interference occurs at point P while destructive interference occurs at point Q.
(3) The result of the experiment shows that sound is a wave.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

Part B : HKAL examination questions

49. < HKAL 1982 Paper I - 41 >



Two tuning forks F_1 and F_2 are hit respectively to give sound notes. Their waveforms are displayed on a CRO connected to a microphone. The traces S_1 and S_2 observed on the screen of the CRO are given by F_1 and F_2 respectively. The time base of the CRO remains the same in each case. Which of the following statements is/are correct ?

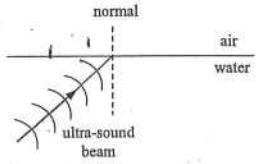
(1) The period of F_1 is greater than the period of F_2.

(2) The pitch of F_1 is greater than the pitch of F_2.

(3) The speed of sound from F_1 is greater than the speed of sound from F_2.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

50. < HKAL 1985 Paper I - 17 >



A beam of ultrasound is directed from water to air as shown in the above figure. Which of the following statements is true ?

A. The refracted beam leaving the surface will bend away from the normal.

B. The refracted beam will bend towards the normal.

C. The refracted beam will travel in the same direction as the incident beam.

D. Total internal reflection will occur.

51. < HKAL 1990 Paper I - 18 >

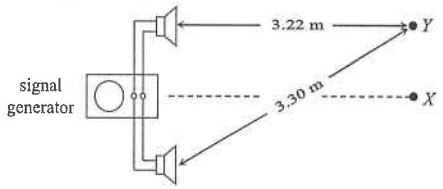
Which of the following represent the approximate noise levels

(1) in a quiet school library ?

(2) near the road with heavy traffic ?

	(1)	(2)
A.	30 dB	60 dB
B.	60 dB	90 dB
C.	30 dB	90 dB
D.	90 dB	60 dB

52. < HKAL 1992 Paper I - 22 >

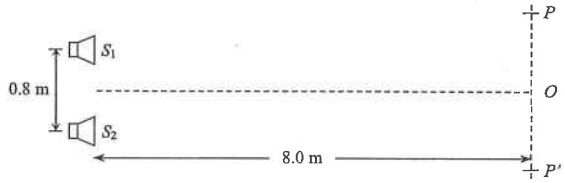


Two loudspeakers are connected to the same signal generator. A microphone placed at X detects a maximum sound intensity. When the microphone is moved upwards, maximum sound intensity is also detected at Y. Which of the following may give possible values of the wavelength of the sound emitted from the loudspeakers ?

(1) 0.04 m
(2) 0.08 m
(3) 0.16 m

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

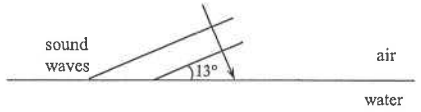
53. < HKAL 2008 Paper IIA - 11 >



Two loudspeakers S_1 and S_2 are connected to a signal generator to give out sound waves that are in phase. The separation between S_1 and S_2 is 0.8 m. A student moves a microphone along a line PP' 8.0 m away from the loudspeakers and parallel to S_1S_2. Loud sound is detected consecutively at P, O and P'. If PP' equals 2.0 m, estimate the wavelength of the sound produced by the loudspeakers.

A. 5 cm
B. 10 cm
C. 15 cm
D. 20 cm

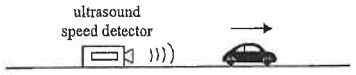
54. < HKAL 2010 Paper IIA - 15 >



Sound waves of frequency 1000 Hz travel from air to water as shown. If the incident wavefront makes an angle of 13° with the interface, find the angle of refraction and the wavelength of sound in water.
(Given : speed of sound in air and that in water are 340 m s^{-1} and 1500 m s^{-1} respectively.)

	angle of refraction	wavelength in water
A.	2.9°	7.7 cm
B.	2.9°	1.5 m
C.	83°	7.7 cm
D.	83°	1.5 m

55. **< HKAL 2011 Paper IIA - 12 >**



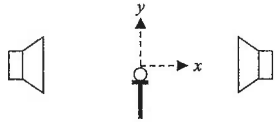
The above figure shows a speed detector used for measuring the speed of a toy car. The detector emits an ultrasound pulse P_1 towards the car, which is reflected back to the detector as pulse R_1 after 15 ms. Another pulse P_2 is emitted 0.5 s after P_1 is emitted and the reflected pulse R_2 is received 20 ms later.

Assume that the car is travelling directly away from the detector with uniform speed. Estimate its speed.

Given : speed of ultrasound in air = 340 m s^{-1}

A. 1.7 m s^{-1}
B. 2.1 m s^{-1}
C. 2.6 m s^{-1}
D. 3.4 m s^{-1}

56. **< HKAL 2011 Paper IIA - 11 >**

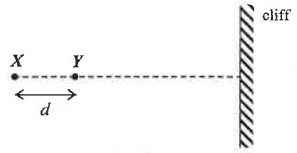


Two loudspeakers are connected to a signal generator and they gives out sound waves in anti-phase. A small microphone is placed midway between the two loudspeakers. The intensity of the sound detected by the microphone is close to zero. Which of the following changes can lead to a significant increase in the sound intensity detected ?

(1) Move the microphone along the x direction.
(2) Move the microphone along the y direction.
(3) Increase the frequency of the signal generator.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

57. **< HKAL 2013 Paper IIA - 16 >**



A boy claps his hands in front of a cliff at the position X as shown in the above figure. He hears the echo 0.8 s later. He then walks a distance d towards the cliff and claps again at the position Y. This time he hears the echo 0.6 s later. Find d if the speed of sound in air is 330 m s^{-1}.

A. 17 m
B. 33 m
C. 66 m
D. 132 m

Part C : Supplemental exercise

58. What is the approximate range of audible frequencies for a young adult ?

A. from 2 Hz to 2 000 Hz
B. from 20 Hz to 2 000 Hz
C. from 20 Hz to 20 000 Hz
D. from 200 Hz to 200 000 Hz

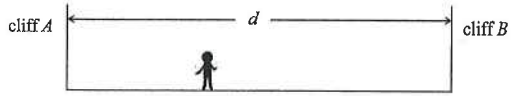
59. Which factors affect the quality of sound waves produced by a musical instrument ?

A. the amplitude of the sound waves
B. the frequency of the sound waves
C. the velocity of the sound waves
D. the waveform of the sound waves

60. Two boys both sing the same musical note "doh". However, the two notes can be distinguished to be sung by which boy since they have different

A. speed.
B. loudness.
C. pitch.
D. quality.

61.



Mary stands between two cliffs A and B as shown in the above figure. She claps her hands and hears the first echo after 1.2 s and the second echo after 1.8 s. If the speed of sound in air is 320 m s^{-1}, what is the distance d between the two cliffs ?

A. 192 m
B. 288 m
C. 480 m
D. 960 m

62. Peter sees a flash of lightning in the sky. After 6 s, he hears the bang of thunder. How far way is he from the thunderstorm ?
(Given : speed of light in air = 3×10^8 m s^{-1} ; speed of sound in air = 320 m s^{-1}.)

A. 960 m
B. 1920 m
C. 9×10^8 m
D. 18×10^8 m

63. Arrange the following in ascending order of frequency :

(1) the domestic mains voltage
(2) microwaves from a mobile phone
(3) a note of sound from a violin

A. (1) (2) (3)
B. (1) (3) (2)
C. (2) (1) (3)
D. (3) (2) (1)

Part D : HKDSE examination questions

64. **< HKDSE Sample Paper IA - 22 >**

Which of the following statements about sound waves is/are correct ?
(1) Sound waves are longitudinal waves.
(2) Sound waves are electromagnetic waves.
(3) Sound waves cannot travel in a vacuum.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

65. **< HKDSE 2012 Paper IA - 22 >**

The figure shows the waveforms of sound notes generated by a violin, a piano and a tuning fork. The scale is the same in time and intensity axes for all three waveforms.

(X)

(Y)

(Z)

Which of the following about the sound notes are correct ?
(1) They all have the same pitch.
(2) The qualities of sound of (Y) and (Z) are different.
(3) (X) is generated by the tuning fork.

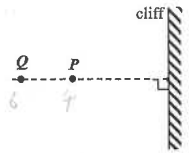
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (2) only
D. (1), (2) & (3)

66. **< HKDSE 2012 Paper IA - 23 >**

Which of the following about ultrasound is INCORRECT ?
A. Ultrasound is a longitudinal wave.
B. The frequency of ultrasound is greater than 20000 Hz.
C. In air, the speed of ultrasound is faster than the speed of audible sound.
D. In air, the diffraction effect of ultrasound is less prominent than that of audible sound.

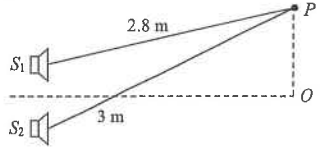
67. **< HKDSE 2013 Paper IA - 19 >**

Astronauts P and Q stand at 400 m and 600 m respectively from a vertical cliff on the surface of a planet. The figure shows the top view. P claps his hands once and Q hears two clapping sounds separated by 4 s. What is the speed of sound in the atmosphere of this planet ?



A. 100 m s^{-1}
B. 150 m s^{-1}
C. 200 m s^{-1}
D. 250 m s^{-1}

68. **< HKDSE 2014 Paper IA - 18 >**



S_1 and S_2 are two loudspeakers connected to a signal generator but the sound waves produced by them are in anti-phase. Point O is equidistant from the loudspeakers while point P is at the distances shown in the figure from the loudspeakers. What type of interference occurs at O and P if the wavelength of the sound waves is 10 cm ?

	O	*P*
A.	destructive	constructive
B.	constructive	constructive
C.	destructive	destructive
D.	constructive	destructive

69. **< HKDSE 2014 Paper IA - 17 >**

Figure (a) shows a car travelling with a uniform speed along a straight road away from a stationary ultrasound generator and detector at Y. When the car is 64 m from Y, the generator emits an ultrasound pulse towards the car.

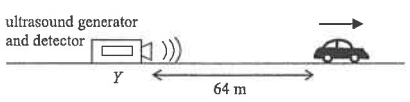


Figure (a)

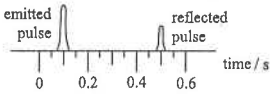


Figure (b)

The pulse is then reflected back to the detector at Y and displayed on a CRO as shown in Figure (b). Estimate the speed of the car. Given : speed of ultrasound in air is 340 m s^{-1}.

A. 16 m s^{-1}
B. 20 m s^{-1}
C. 24 m s^{-1}
D. 32 m s^{-1}

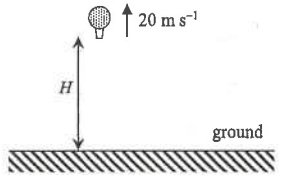
70. **< HKDSE 2014 Paper IA - 19 >**

Which of the following statements about sound waves is/are correct ?
(1) Sound waves are electromagnetic waves.
(2) Sound waves cannot travel in a vacuum.
(3) Sound waves cannot form stationary waves.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

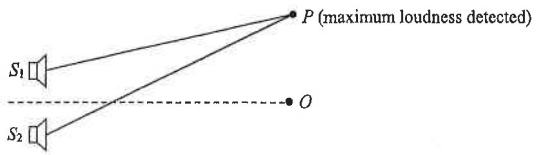
71. **< HKDSE 2015 Paper IA - 19 >**

A balloon is rising at a uniform speed of 20 m s^{-1}. When the balloon is at an altitude H as shown, it sends a sound signal towards the ground. After 5 s, the balloon receives the echo of the signal. Estimate H.
Given : speed of sound in air = 340 m s^{-1}.



A. 1600 m
B. 850 m
C. 800 m
D. 750 m

72. **< HKDSE 2016 Paper IA - 21 >**



Loudspeakers S_1 and S_2 connected to a signal generator emit sound waves which are in phase. Point O is equidistant from the loudspeakers while at point P maximum loudness is detected. The wavelength of the sound waves is λ. Which statement is INCORRECT ?

A. Both PS_1 and PS_2 must be integral multiples of wavelength λ.
B. The definite value of the path difference $PS_2 - PS_1$ cannot be determined from the information given.
C. At least one point of minimum loudness can be detected between O and P.
D. Minimum loudness will be detected at P if the sound waves from S_1 and S_2 are in antiphase.

73. **< HKDSE 2016 Paper IA - 23 >**

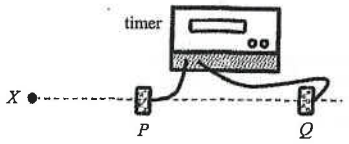
Which of the following are applications of ultrasound ?

(1) sterilizing drinking water
(2) detecting cracks in railway tracks
(3) breaking up kidney stones

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

74. **< HKDSE 2017 Paper IA - 15 >**

An experiment is set up to measure the speed of sound in air as shown. P and Q are two microphones connected to a timer. A sound is produced at X. The timer starts when P receives the sound, and stops when Q receives the sound. The timer shows the time taken for the sound to travel from P to Q. The distance PQ and the time shown can be used to calculate the speed of sound.



Which of the following statements is **INCORRECT** ?

A. X, P and Q must be along the same straight line.
B. The percentage error in the time measured will increase if the distance PQ is reduced.
C. The speed of sound determined should be independent of the distance between X and P.
D. The distance PQ must be equal to an integral multiple of wavelengths of the sound produced at X.

75. **< HKDSE 2017 Paper IA - 18 >**

Two musical notes of the same pitch and loudness are produced by two different musical instruments. They sound different to the human ears because they have different

A. amplitudes.
B. phases.
C. wave speeds.
D. waveforms.

76. **< HKDSE 2017 Paper IA - 21 >**

If the speed of sound in water is x and the speed of light in water is y, which of the following is correct ?

	speed of sound in air	**speed of light in air**
A.	$> x$	$> y$
B.	$> x$	$< y$
C.	$< x$	$> y$
D.	$< x$	$< y$

77. **< HKDSE 2018 Paper IA - 21 >**

Which of the following is **NOT** typical sound intensity level that occurs in daily life ?

A. 130 dB : when an airplane take-off
B. 110 dB : at a rock concert
C. 80 dB : having a normal conversation
D. 30 dB : inside a library

78. **< HKDSE 2018 Paper IA - 14 >**

Which of the following statements about waves is/are correct ?

(1) Longitudinal waves can transmit energy from one place to another but transverse waves cannot.
(2) Sound waves propagate faster in water than in air.
(3) Infra-red radiation is a kind of electromagnetic wave.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

79. <HKDSE 2019 Paper IA-21>

80. <HKDSE 2020 Paper IA-19>

Which of the following phenomena provides conclusive evidence that sound is a wave ?

(1) reflection of sound from a wall
(2) refraction of sound at the boundary between two media
(3) interference of sound

A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only

81. <HKDSE 2020 Paper IA-21>

Which of the following statements about ultrasound is/are correct ?

(1) Ultrasound has a shorter wavelength than audible sound.
(2) Ultrasound cannot be produced by vibrating objects.
(3) Ultrasound cannot be heard as it cannot travel through air.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

M.C. Answers

1. B	11. B	21. A	31. D	41. A	51. C
2. B	12. C	22. D	32. A	42. A	52. C
3. B	13. B	23. B	33. B	43. C	53. B
4. C	14. D	24. C	34. A	44. A	54. D
5. D	15. C	25. A	35. D	45. D	55. A
6. C	16. A	26. D	36. C	46. C	56. A
7. C	17. A	27. B	37. A	47. B	57. B
8. B	18. C	28. C	38. A	48. A	58. C
9. A	19. B	29. C	39. D	49. A	59. D
10. D	20. C	30. D	40. B	50. B	60. D
61. C	71. C	81. A			
62. B	72. A				
63. B	73. C				
64. D	74. D				
65. D	75. D				
66. C	76. C				
67. C	77. C				
68. C	78. D				
69. B	79. D				
70. A	80. B				

M.C. Solution

1. B

× (1) All waves, including sound waves, possess all the four phenomena, including diffraction.

× (2) Speed of sound is independent of its intensity or loudness, but depends on medium only.

✓ (3) Sound wave travels faster in liquid than in gas or air

2. B

$$d = \frac{v \cdot \Delta t}{2} = \frac{(1500)(0.2)}{2}$$

$$= 150 \text{ m}$$

3. B

As P is the mid-point, the path difference at P is zero.

If the two sources vibrate in phase, P would undergo constructive interference.

If the two sources vibrate out of phase (anti-phase), P would undergo destructive interference.

4. C

✓ (1) Sound waves in solid are longitudinal waves.

✓ (2) Sound waves in water are longitudinal waves.

× (3) Waves in vibrating string are transverse waves.

5. D

Since sound waves, infra-red radiation and X-rays are waves, they possess all the phenomena of waves.

Thus, all of them can be reflected and diffracted.

6. C

$$d = \frac{1}{2} v \Delta t = \frac{1}{2}(1440)(0.6) = 432 \text{ m}$$

7. C

There is no change in frequency when sound waves enter another medium.

By $v = f\lambda$ $\therefore$ $v \propto \lambda$

$$\therefore \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

$$\therefore \frac{(340)}{v_2} = \frac{(25)}{(75)} \qquad \therefore v_2 = 1020 \text{ m s}^{-1}$$

8. B

$$d = \frac{1}{2} v \Delta t = \frac{1}{2}(1500)(0.4) = 300 \text{ m}$$

9. A

By $v = f\lambda$, the greatest frequency gives the shortest wavelength.

$\therefore$ $(330) = (16500)\lambda$

$\therefore$ $\lambda = 0.02$ m

10. D

There is no change in frequency when sound enters another medium.

By $v = f\lambda$ $\therefore$ $v \propto \lambda$ (for constant frequency f)

$$\therefore \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} \qquad \therefore \frac{(330)}{v_2} = \frac{(25)}{(75)}$$

$\therefore$ $v_2 = 990 \text{ m s}^{-1}$

11. B

× (1) Sound wave can travel in any material medium, including water.

✓ (2) If the amplitude of sound increase, loudness increases.

× (3) If the wavelength increases, frequency decreases, thus pitch decreases.
Pitch should decrease with the wavelength.

12. C

For the two sources vibrating in **opposite** phase, type of interference is reverse :

(1) at the mid-point : $\Delta = 0\lambda$ $\therefore$ destructive interference occurs, intensity is minimum

(2) at Q : $\Delta = \sqrt{3^2+4^2} - 4 = 1\,\text{m} = \frac{1}{2}\lambda$ $\therefore$ constructive interference occurs, intensity is maximum

13. B

$d = \frac{1}{2} v \Delta t$

$= \frac{1}{2}(340)(0.15)$

$= 25.5\,\text{m}$

14. D

✓ (1) X has shorter period, thus it has higher frequency, therefore, X has higher pitch.

✓ (2) X has a greater amplitude, thus it has greater loudness

✓ (3) Both X and Y are musical notes, i.e. they are sound waves, thus they are longitudinal waves.

15. C

× A. Microwave oven cooking : microwaves

× B. TV broadcasting : radio waves

✓ C. Camera autofocusing : ultrasonic waves (OR infra-red radiation)

× D. Satellite telecommunication : microwaves

16. A

✓ (1) Ultrasonic waves are sound waves with frequency higher than 20000 Hz, they are longitudinal waves.

× (2) Infrared radiations are electromagnetic waves, they are transverse waves.

× (3) Gamma rays are electromagnetic waves, they are transverse waves.

17. A

✓ (1) Frequency of Y is higher than that of X, thus Y has a higher pitch.

× (2) As they have the same amplitude, they have the same intensity and thus same loudness.

× (3) By $v = f\lambda$, Y has the higher frequency, thus Y should have the shorter wavelength.

18. C

✓ A. Ultrasonics are sound waves with frequency higher than 20000 Hz, thus they are longitudinal waves.

✓ B. This is the definition of ultrasonics.

× C. Ultrasonics cannot be deflected by magnetic field.

✓ D. Sound wave requires a material medium to travel.

19. B

Satellite communication is an application of microwaves, not ultrasonics.

20. C

There is no change in frequency when sound enters another medium.

By $v = f\lambda$

$\therefore\ v \propto \lambda$

$\therefore\ v_{\text{water}} = 330 \times 5 = 1650\,\text{m s}^{-1}$

21. A

✓ (1) Ultrasonic waves are sound waves.

× (2) Ultrasonic waves are not electromagnetic waves, speed of ultrasonics is less than speed of microwaves.

× (3) Both are waves, thus both possess all wave phenomena, including diffraction.

22. D

× A. Ultrasonics are sound waves, thus they are longitudinal waves.

× B. Ultrasonics cannot travel in vacuum, they are not electromagnetic waves.

× C. Ultrasonics travel with the speed of sound, not the speed of light of $3 \times 10^8\,\text{m s}^{-1}$.

✓ D. Ultrasonics require a material medium to travel, they cannot travel in vacuum.

23. B

× (1) Sound is a longitudinal wave.

× (2) Sound travels faster in water than in air.

✓ (3) Both of them are waves, thus both possess all wave phenomena, including refraction.

24. C

For a certain interval of time displayed in the CRO,

X completes 2 cycles but Y completes 2.5 cycles.

$f_X : f_Y = 2 : 2.5 = 4 : 5$

25. A

$d = \frac{1}{2} c\, t = \frac{1}{2}(1500) \times (0.16) = 120\,\text{m}$

26. D

× A. Radio waves are electromagnetic waves, they are transverse in nature.

× B. Visible light is electromagnetic wave, it is transverse in nature.

× C. X-rays are electromagnetic waves, they are transverse in nature.

✓ D. Ultrasonics waves are longitudinal waves, they are NOT transverse waves.

27. B

✓ (1) Notes *X* and *Y* are of different qualities as they have different waveforms.

× (2) Notes *X* and *Y* have the same pitch as they have the same frequency (same period).

✓ (3) Note *X* has larger amplitude than note *Y*, so note *X* is louder than note *Y*.

28. C

Ultrasonics can be used to examine foetus without causing harmful effect

X-rays cannot be used since X-rays would cause harmful effect to the foetus.

29. C

Since sound waves cannot travel in a vacuum,

the sound cannot be heard after the air has been pumped out.

30. D

× A. Microwaves can travel in vacuum but ultrasonic waves cannot.

× B. Microwaves are transverse waves but ultrasonic waves are longitudinal waves.

× C. Both microwaves and ultrasonic waves cannot be deflected by magnetic fields.

✓ D. Speed of microwaves equals speed of light but speed of ultrasonic waves equal the speed of sound. Thus they have different speeds in air.

31. D

× A. The two waves have different loudness, thus they should have different amplitudes, not the same.

× B. The two waves have different loudness, thus they should have different amplitudes, not the same.

× C. The two waves are produced by different musical instruments, they should have different quality, thus they should have different waveforms, not the same.

✓ D. These two notes have different amplitudes, representing different loudness.
These two notes have different waveforms, representing different quality from different instruments.

32. A

✓ A. Decibel (dB) is a unit of sound intensity level.

× B. Hertz (Hz) is a unit of frequency.

× C. Sievert (Sv) is a unit of radiation dose.

× D. Watt (W) is a unit of power.

33. B

✓ (1) Sound waves are longitudinal waves, with particles vibrate along the direction of travel.

× (2) Sound waves are mechanical waves, not electromagnetic waves.

✓ (3) Sound waves need a material medium for travelling, they cannot travel in vacuum.

34. A

✓ (1) Since the graph is a straight line passes through the origin, λ and $\frac{1}{f}$ are proportional,

i.e. the wavelength is inversely proportional to the frequency.

✓ (2) The slope of the graph $= \frac{\lambda}{1/f} = f\lambda = v$.

× (3) Since the slope is constant, the speed is independent of the frequency *f*.

35. D

× (1) Pitch depends on the frequency.
As note C has the lowest frequency, note C should have the lowest pitch.

✓ (2) Intensity level gives the loudness of sound.
As note D has the greatest intensity level, note D has the greatest loudness.

✓ (3) Different musical instruments give out sounds of different quality, and they will sound differently.

36. C

× (1) The sound waves transmitted along the string should be longitudinal waves.

✓ (2) Speed of sound waves in solid is faster than that in the air.

✓ (3) Frequency would not change when the sound travels along the string.

37. A

✓ (1) Since the spacing between wavefronts is the wavelength, as wavelength decreases, speed decreases. When speed changes, refraction occurs.

✓ (2) The swimming pool appears shallower is due to apparent depth, which is due to refraction of light.

× (3) Alternate loud and soft sounds are due to interference, not refraction.

38. A

✓ (1) Speed of infrared waves is the speed of light which is much greater than the speed of sound waves.

× (2) The flash lamps would emit infrared waves and then detect the infrared waves reflected by the object.
The objects emit infrared waves or not would not affect the reflected infrared waves.

× (3) Ultrasonic waves cannot be heard by human ears, and thus no annoyance would be caused.

39. D

The definition of ultrasonic waves is sound waves with frequency higher than that of the audible sound waves,

or sound waves with frequency higher than 20 000 Hz.

Thus, ultrasound has frequency higher than that of audible sound.

40. B

At the point of maximum, path difference = 0.4 − 0.2 = 0.2 m = $n\lambda$

At the point of minimum, path difference = 0.9 − 0.4 = 0.5 m = $(m+\frac{1}{2})\lambda$

Suppose the wavelength is 0.2 m.

At the point of maximum, path difference = 0.2 m = (1) λ

At the point of minimum, path difference = 0.5 m = $(2\frac{1}{2})\lambda$

Since the wavelength 0.2 m satisfies the above conditions, this is the only possible wavelength among the four values.

41. A

✓ (1) The noise is reflected by the barrier and cannot transmit to the region behind the barriers.

✓ (2) The noise is absorbed at the lower part of the barriers to reduce the noise from spreading out.

× (3) If the noise is diffracted and spreads away, the noise cannot be blocked.

42. A

By $v = f\lambda$ $\therefore$ (1400) = (30000) λ $\therefore$ $\lambda = 4.67 \times 10^{-2}$ m

By $d = \frac{1}{2} v \Delta t = \frac{1}{2}(1400)(5) = 3500$ m

43. C

① X is a point under destructive interference since path difference at X is 0.5 λ. Loudness at X is minimum initially.
If S_1 is turned off, no destructive interference occurs, thus the loudness would increase.

② Y is a point under constructive interference since path difference at Y is 0 λ. Loudness at Y is maximum initially.
If S_1 is turned off, no constructive interference occurs, thus the loudness would decrease.

44. A

Wavelength of the sound wave :

By $v = f\lambda$ $\therefore$ (330) = (660) λ $\therefore$ $\lambda = 0.5$ m

Path difference at $X = 4 - 2 = 2$ m $= 4\lambda$ $\therefore$ Constructive interference occurs at X.

Path difference at $Y = 0$ m $= 0\lambda$ $\therefore$ Constructive interference occurs at Y.

45. D

Audible range of sound is from 20 Hz to 20000 Hz.

Sound waves above 20000 Hz are not audible.

46. C

The first bang is directly from the firecracker. $\therefore$ $t_1 = \frac{90}{340} = 0.265$ s

The second band is reflected from the building. $\therefore$ $t_2 = \frac{80+80+90}{340} = 0.735$ s

Time interval = 0.735 − 0.265 = 0.47 s

47. B

× (1) As the speed of sound wave in air is smaller, the wavelength of sound waves in air is shorter.

✓ (2) Frequency must be unchanged during refraction.

× (3) As the speed of sound waves in air is smaller, the refracted angle is smaller,
thus the sound waves should bend towards the normal.

48. A

✓ (1) Sound intensity decreases with distance.

× (2) As the path difference at Q is zero, Q has constructive interference.

× (3) This experiment only shows that the sound intensity decreases with distance.
To prove that sound is a wave, interference must be demonstrated.
Alternate loud and soft sound should be shown to demonstrate the phenomenon of interference.

49. A

✓ (1) S_1 takes a longer time to complete 1 cycle, thus the period of F_1 is greater.

× (2) As the period of F_1 is greater, the frequency of F_1 is smaller, thus the pitch of F_1 is lower.

× (3) Both are sound waves travelling in air, thus they should have the same speed.

50. B

When ultra-sound travels from water to air, it travels from a faster medium to a slower medium,

thus the refracted angle is smaller, the refracted beam bends towards the normal.

51. C

(i) In quiet school library, the sound level is very low, about 30 to 40 dB

(ii) Near a busy road with heavy traffic, the sound level is very high, about 90 to 100 dB

52. C

Path difference : $\Delta = 3.30 - 3.22 = 0.08$ m

✓ (1) If $\lambda = 0.04$ m, then $\Delta = 2\lambda$, thus constructive interference occurs.

✓ (2) If $\lambda = 0.08$ m, then $\Delta = 1\lambda$, thus constructive interference occurs.

× (3) If $\lambda = 0.16$ m, then $\Delta = 0.5\lambda$, thus destructive interference should occur.

53. B

$S_1P = \sqrt{(8)^2+(1-0.4)^2} = 8.022$ m

$S_2P = \sqrt{(8)^2+(1+0.4)^2} = 8.122$ m

Path difference at $P = 8.122 - 8.022 = 0.1$ m

Since P is at the first maximum from O, path difference at P is 1 λ.

$\therefore \lambda = 0.1$ m $= 10$ cm

54. D

By $\frac{\sin\theta_{air}}{\sin\theta_{water}} = \frac{v_{air}}{v_{water}}$ $\therefore \frac{\sin 13^\circ}{\sin\theta_{water}} = \frac{340}{1500}$ $\therefore \theta_{water} = 83^\circ$

By $v_{water} = f\lambda_{water}$

$\therefore (1500) = (1000)\lambda_{water}$

$\therefore \lambda_{water} = 1.5$ m

55. A

$d_1 = \frac{1}{2}vt_1 = \frac{1}{2}(340)(15\times10^{-3}) = 2.55$ m

$d_2 = \frac{1}{2}vt_2 = \frac{1}{2}(340)(20\times10^{-3}) = 3.4$ m

$v = \frac{\Delta d}{\Delta t} = \frac{3.4-2.55}{0.5} = 1.7$ m s^{-1}

56. A

✓ (1) Moving along the x direction would change the path difference, thus vary the type of interference.

× (2) Moving along the y direction would keep the path difference remain as zero, thus no variation.

× (3) As the path difference is zero, destructive interference occurs, no matter what the frequency is.

57. B

When the boy walks a distance d, the echo is heard with an extra time of $(0.8 - 0.6) = 0.2$ s

$d = \frac{1}{2}\times330\times0.2 = 33$ m

58. C

Audible frequencies for a normal young adult are in the range of 20 Hz to 20 000 Hz.

59. D

Quality is determined by the waveform of the sound waves.

60. D

We distinguish different sources of sound by observing the different quality of the sound notes.

61. C

The first echo is due to the reflection of sound at cliff A.

Distance between Mary and cliff A : $d_1 = \frac{1}{2}(320)\times(1.2) = 192$ m

The second echo is due to the reflection of sound at cliff B.

Distance between Mary and cliff B : $d_2 = \frac{1}{2}(320)\times(1.8) = 288$ m

Therefore, distance between the two cliffs :

$d = d_1 + d_2 = 192 + 288 = 480$ m

62. B

Since the speed of light is very great, the time taken for the lightning to be seen is negligible.

Distance travelled by the sound $= vt = (320)(6) = 1920$ m

63. B

(1) frequency of domestic main voltage = 50 Hz

(2) typical order of wavelength of microwaves $= 10^{-2}$ m $\therefore$ typical order of frequency $= \frac{(3\times10^8)}{(10^{-2})} \approx 10^{10}$ Hz

(3) Frequency of a sound note from a violin $\approx$ 1000 Hz

Ascending order of frequency : (1) (3) (2)

64. D

✓ (1) Sound waves are longitudinal waves, with particles vibrate along the direction of travel.

× (2) Sound waves are mechanical waves, not electromagnetic waves.

✓ (3) Sound waves need a material medium for travelling, they cannot travel in vacuum.

65. D

✓ (1) Since they all have the same number of cycles in the same time interval, they have the same frequency.

✓ (2) Since the waveforms of (Y) and (Z) are different, they have different qualities.

✓ (3) Tuning fork would give the pure sinusoidal waveform as shown in (X).

66. C

In air, the speed of ultrasound is the same as the speed of audible sound.

$\therefore$ C is INCORRECT.

67. C

The sound produced at P travels a distance of PQ towards Q and Q hears the first sound.

The sound produced at P travels towards the cliff and reflected to Q and Q hears the second sound.

The extra distance travelled by the second sound is two times the distance between P and the cliff.

Speed of sound : $v = \frac{2\times400}{4} = 200$ m s^{-1}

68. C

At O, the path difference is zero.

If the two waves emitted are in anti-phase, then destructive interference occurs at O.

At P, path difference $= 3 - 2.8 = 0.2$ m $= 20$ cm $= 2\lambda$

Since the two waves emitted are in anti-phase, thus destructive interference occurs at P.

69. B

The ultrasound is emitted at the time of 0.1 s and the reflected pulse is received at the time of 0.5 s.

The ultrasound pulse takes a time interval of 0.4 s to travel to the car and back to the detector.

Thus, the ultrasound pulse reaches the car after a time interval of 0.2 s.

At that instant, distance of the car from the generator $= vt = 340 \times 0.2 = 68$ m

Distance travelled by the car during this time interval of 0.2 s $= 68 - 64 = 4$ m

Speed of the car $= \frac{d}{t} = \frac{4}{0.2} = 20$ m s^{-1}

70. A

× (1) Sound waves are mechanical waves, not electromagnetic waves.

✓ (2) Sound waves need a material medium to travel, thus they cannot travel in vacuum.

× (3) All waves can form stationary waves, including sound waves.

71. C

By $d = vt$

$\therefore (H + H + 20 \times 5) = (340) \times (5)$ $\therefore H = 800$ m

72. A

× A. To give constructive interference, path difference $PS_2 - PS_1$ must be an integral multiples of λ.
However, PS_2 and PS_1 need not be integral multiples of λ, e.g. $\Delta = 2.5\lambda - 1.5\lambda = 1\lambda$.

✓ B. The path difference may be 1λ, 2λ, 3λ, …
The definite value cannot be determined.

✓ C. The path difference at P is at least equal to $1\ \lambda$.
Between O and P, there is a point that the path difference is $\frac{1}{2}\ \lambda$.
At this point, destructive interference occurs and minimum loudness is detected.

✓ D. If S_1 and S_2 are in antiphase, then the type of interference will be reversed,
thus, destructive interference will occur at P.

73. C

× (1) Ultrasound cannot sterilize drinking water, only ultraviolet radiation can sterilize drinking water.

✓ (2) Ultrasound can be used to detect cracks in railway or machines.

✓ (3) Ultrasound can be used to smash kidney stones, break them into smaller pieces.

74. D

✓ A. For sound travelling from X towards the right along a straight line,
P and Q should be along the same line.

✓ B. The speed of sound v is calculated by : $v = d / t$.
If the distance d is reduced, the percentage error of d will increase,
thus the percentage error of v will increase.

✓ C. If distance d increase, time t will also increase, the calculated value of v should be unchanged.

× D. The distance PQ can be any value, not necessary to be integral multiple of wavelength of sound.

75. D

Two musical notes having different waveforms can give different quality of sound,
and this can be distinguished as two different sounds by human ears.

76. C

Speed of sound in air is smaller than that in water, thus, speed of sound in air $< x$.

Speed of light in air is greater than that in water, thus, speed of light in air $> y$.

77. C

✓ A. When we are close to an airplane taking-off, the noise should exceed the threshold of pain.
Thus, 130 dB may be possible.

✓ B. At a rock concert, the noise may be very large and close to the threshold of pain.
Thus, 110 dB may be possible.

× C. Normal conversation between two persons should be around 60 dB.
Thus, 80 dB is **NOT** a typical level.

✓ D. Inside a library, it may be very quiet.
Thus, 30 dB may be possible.

78. D

× (1) Both longitudinal waves and transverse waves can transmit energy from one place to another.

✓ (2) Speed of sound waves in solid > speed of sound waves in liquid > speed of sound waves in air

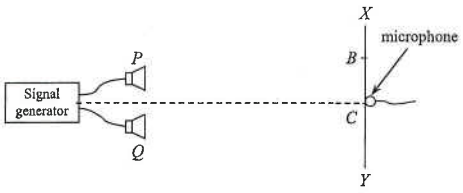
✓ (3) Infra-red radiation is a kind of electromagnetic wave, with wavelength longer than visible light.

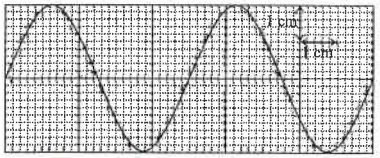
DSE Physics - Section C : Question PC - WA6 - Q / 01
WA6 : Sound

Part A : HKCE examination questions

1. **< HKCE 1988 Paper I - 5 >**

Two small loudspeakers P and Q emit sound wave of the same frequency and intensity. A microphone connected to a CRO is moved along the line YX as shown in the figure below. A trace on the screen is also shown in the figure.





(a) It is given that the time base setting is 0.1 ms cm^{-1}.

(i) What is the frequency of the sound ? (3 marks)

(ii) Is this frequency below, within or above audible range ? (1 mark)

(b) The amplitude of the trace shows a maximum when the microphone is at C (on the perpendicular bisector of PQ) and gradually decreases to a minimum at B.

(i) Explain briefly why this happens. (2 marks)

(ii) Write down an equation to show the relationship between the distance PB, QB and the wavelength λ. (2 marks)

(iii) If $PB = 3.04$ m and $QB = 3.12$ m, calculate the speed of sound in air. (3 marks)

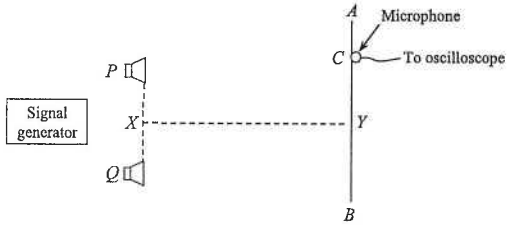
(iv) How would the distance CB be affected, when sound of a lower frequency is used ? (1 mark)

(c) If loudspeaker P is disconnected from the signal generator when the microphone is still at B, how would the period and amplitude of the trace be affected ? (2 marks)

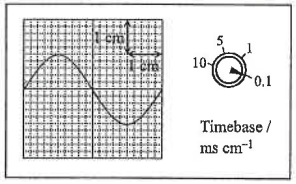
DSE Physics - Section C : Question PC - WA6 - Q / 02
WA6 : Sound

2. **< HKCE 1991 Paper I - 4 >**

The below figure shows the set-up to study the interference of sound. P, Q are two identical loudspeakers. $PC = 2.05$ m and $QC = 2.31$ m.



(a) Initially only P is connected to the signal generator and sound is emitted. A microphone connected to an oscilloscope is placed at point C. The below figure shows the trace on the oscilloscope. The speed of sound in air is 325 m s^{-1}. Find the frequency and wavelength of the sound. (5 marks)



(b) Now both P and Q are connected to the signal generator and they emit sound of the same frequency and intensity as in part (a). Interference is observed when the microphone is moved along AB.

(i) Is the interference of sound at C constructive or destructive ? Explain your answer. (3 marks)

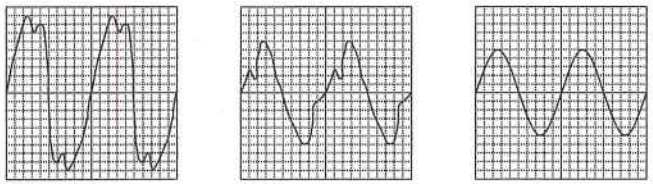
(ii) Compared with (a), how do the pitch and loudness of the sound at C change ? (2 marks)

(iii) The amplitude of the trace on the oscilloscope is not zero at the positions of destructive interference. Suggest two possible reasons. (2 marks)

(iv) A student says that alternate constructive and destructive interference will also be observed along XY. (X is the mid-point of PQ.) State whether his statement is true or false. Explain briefly. (3 marks)

3. **< HKCE 1996 Paper I - 4 >**

The figures below show the traces on a CRO of three notes produced by different musical instrument.
(Note : The settings of the CRO remain unchanged.)



Note *X* Note *Y* Note *Z*

(a) Which of the notes is produced by a tuning fork ? (1 mark)

(b) Compare the pitch and loudness of the three notes. Explain briefly. (4 marks)

4. **< HKCE 2000 Paper I - 9 >**

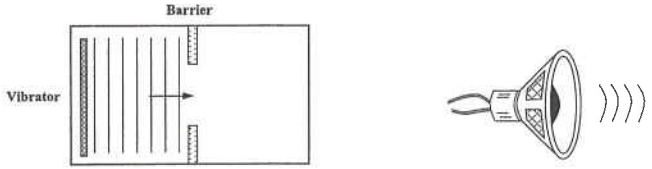


Figure 1

Figure 2

Figure 1 shows a vibrator producing straight water waves in a ripple tank. Figure 2 shows a loudspeaker which is emitting low-frequency sounds.

(a) You are given the following equipment :

a cork, a slinky spring, a candle and matches, a ruler.

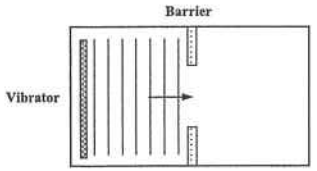
Select suitable equipment and describe

(i) a method to demonstrate that the water waves in Figure 1 are transverse, and (2 marks)

(ii) a method to demonstrate that the sound waves in Figure 2 are longitudinal. (2 marks)

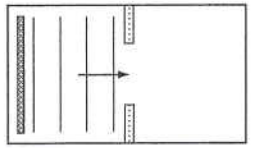
4. (b) A barrier with an opening is placed in the ripple tank as shown in Figure 1.

(i) In the figure below, draw the wave pattern formed on the other side of the barrier. Name this wave phenomenon. (3 marks)



(ii) The wavelength of the water waves is increased as shown in Figure 3.

Figure 3



(1) Suggest **two** methods which can be used to increase the wavelength of the water waves. (2 marks)

(2) On Figure 3, draw the wave pattern formed on the other side of the barrier. (2 marks)

(c)

Figure 4

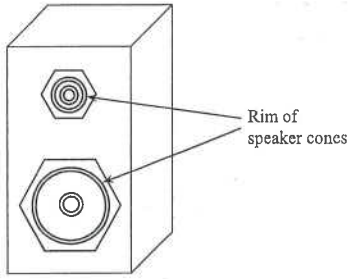


Figure 4 above shows a loudspeaker unit with two speaker cones, a big one and a small one. One speaker cone emits low-frequency sounds and the other emits high-frequency sounds. The sound waves generated by the speaker cones will bend around the rim of the cones in a way similar to water waves bending around corners of obstacles.

Which cone is more suitable for emitting high-frequency sounds ? Explain your answer. (3 marks)

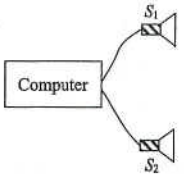
5. **< HKCE 2001 Paper I - 6 >**

Explain the following phenomena :

(a) In a thunderstorm, lightning is seen before thunder is heard. (1 mark)

(b) Sound waves can bend round a corner but light cannot. (2 marks)

6. **< HKCE 2002 Paper I - 5 >**



- P (Mary)
- Q (Susan)

Two identical loudspeakers S_1 and S_2 are connected to a computer. The set-up generates a sound of frequency 200 Hz. Mary and Susan stand at positions P and Q in front of the loudspeakers, where $PS_1 = 6.10$ m, $PS_2 = 8.65$ m and $QS_1 = QS_2$. The speed of sound in air is 340 m s^{-1}.

(a) Find the wavelength of the sound emitted by the loudspeakers. (2 marks)

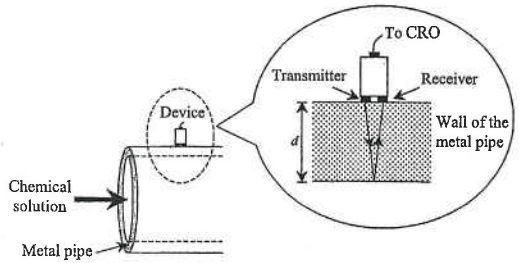
(b) (i) Find the path difference at P from S_1 and S_2. (1 mark)

(ii) Explain whether Mary will hear a loud or a soft sound. (2 marks)

(c) The set-up now generates sound of frequencies 200 Hz and 400 Hz alternately. Susan then predicts that constructive and destructive interference will occur alternately at Q. Explain whether Susan is correct or not. (2 marks)

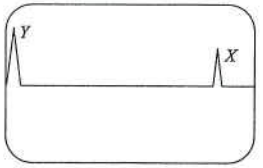
7. **< HKCE 2003 Paper I - 7 >**

Figure 1



In a factory, an engineer uses a device to monitor the thickness of the wall of a metal pipe used for conveying chemical solutions. The device consists of a transmitter and a receiver. During the test, the device is placed on the surface of the pipe. The transmitter emits an ultrasonic pulse of frequency 2×10^6 Hz. The pulse travels with a speed of 6×10^3 m s^{-1} inside the wall. The pulse is reflected from the other surface of the wall and is recorded by the receiver (see Figure 1). The device is connected to a CRO, which displays the transmitted and reflected pulses (see Figure 2).

Figure 2



(a) Find the wavelength of the pulse inside the wall. (2 marks)

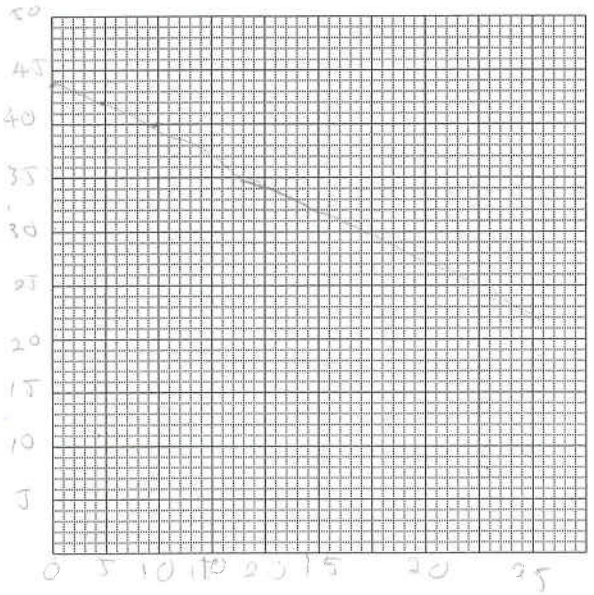
(b) Which of the two pulses in Figure 2 is the reflected pulse ? Explain your answer. (2 marks)

(c) The engineer conducts the test every five weeks and measure the total time of travel of the pulse inside the wall. The results are shown in the below table.

Time t / weeks	0	5	10	15	20	25
Total time of travel / 10^{-6} s	14.5	14.0	13.3	12.8	12.2	11.5
Thickness of the wall d / mm						

(i) Show that the thickness of the wall at time $t = 0$ is 43.5 mm. (2 marks)

7. (c) (ii) Plot a graph of the thickness of the wall d against time t on the graph below, with d ranging from 0 to 50 mm and t ranging from 0 to 40 weeks. (5 marks)



(iii) The pipe has to be replaced when the thickness of the wall drops to 30 mm. Using the graph in (c) (ii), estimate the time at which the pipe has to be replaced. (2 marks)

(d)

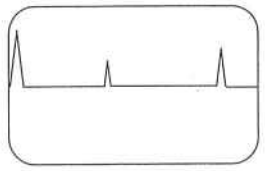
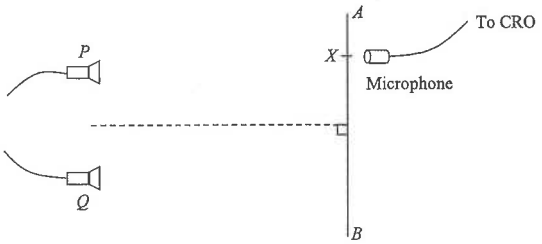


Figure 3

Figure 3 shows the CRO display of the test result on a certain day. The engineer points out that there may be a small crack in the wall of the pipe. Explain how the engineer arrives at such a conclusion. (2 marks)

8. **< HKCE 2003 Paper I - 5 >**



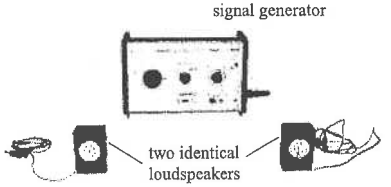
The Figure above shows two loudspeakers P and Q emitting sound waves which are of the same frequency and in phase. As a microphone is moved along the line AB, the amplitude of the trace displayed on the CRO is found to increase and decrease alternately.

(a) Name the wave phenomenon observed. (1 mark)

(b) The amplitude of the trace reaches a maximum when the microphone is placed at a point X, where $PX = 1.74$ m and $QX = 1.96$ m. A student says that one possible wavelength of the sound waves is 0.44 m. Explain whether the student is correct or not. (3 marks)

9. **< HKCE 2005 Paper I - 6 >**

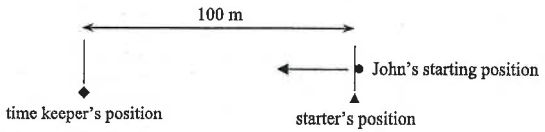
You are provided with the apparatus shown in the Figure below.



Describe how you should use the apparatus to conduct an experiment to demonstrate the interference of sound waves. You may use additional apparatus if necessary. (4 marks)

10. **< HKCE 2007 Paper I - 6 >**

John wants to find out the time he takes to run 100 metres. A starter at the starting point uses a horn to emit a sound signal of frequency 425 Hz to notify John to start running. A time keeper presses a stop watch to record the time when he hears the sound signal as shown in the figure below. Given that the speed of sound in air is 340 m s^{-1}.



(a) Find the wavelength of the sound signal emitted by the horn. (2 marks)

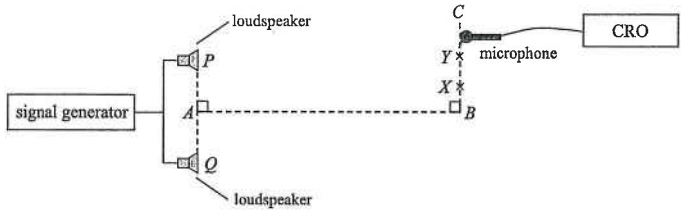
(b) (i) Find the time t taken by the sound signal to travel 100 metres. (1 mark)

(ii) As it takes time t for the sound signal to travel from the starter to the time keeper, David suggests the following ways to reduce the time delay t :

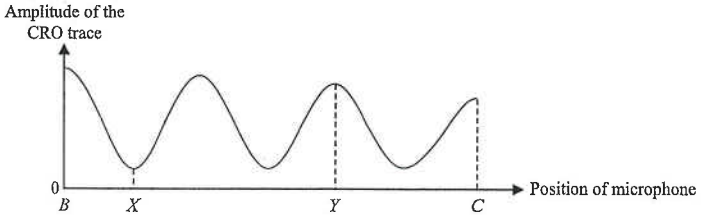
1. using a horn emitting sound of higher frequency;
2. lowering a flag instead of using a horn to notify the time keeper.

Explain whether each of the above suggestions will work. (4 marks)

11. **< HKCE 2007 Paper I - 10 >**



In the above Figure, two identical loudspeakers P and Q are connected to a signal generator. Position A is the midpoint of PQ. A microphone connected to a CRO is moved along BC to measure the loudness of the sound. The amplitude of the CRO trace increases as the loudness of the sound detected increases. The Figure below shows the result.



(a) (i) Explain why the loudness of the sound varies at different positions along BC. (2 marks)

(ii) State ONE reason why the amplitude of the CRO trace is NOT zero at position X. (1 mark)

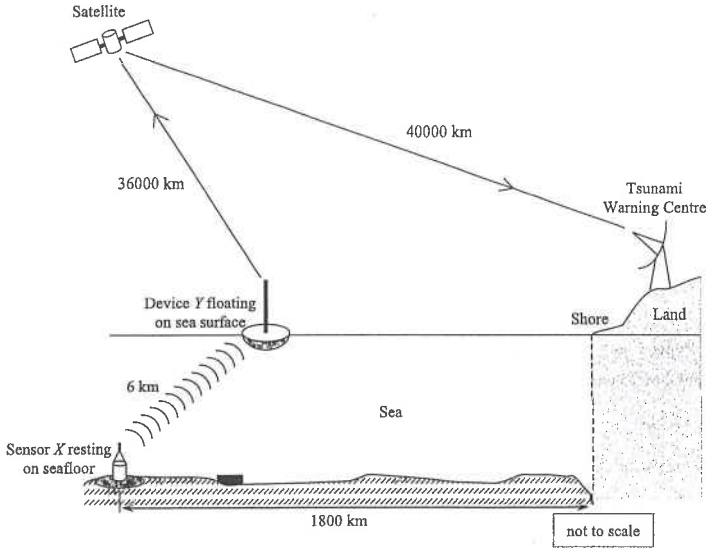
(b) If $PY = 5.10$ m and $QY = 5.78$ m, find

(i) the path difference at position Y from P and Q ; (1 mark)

(ii) the wavelength of the sound. (2 marks)

12. **< HKCE 2009 Paper I - 11 >**

A tsunami is a kind of large-scale water wave that is commonly generated by earthquakes. The Figure below shows a simplified tsunami detection system. Sensor *X* on the seafloor can detect earthquakes and tsunamis. When a tsunami is detected, an ultrasound signal will be sent from Sensor *X* to Device *Y* on the sea surface. Device *Y* will immediately transmit a microwave signal to a satellite and the satellite will send the microwave signal to the Tsunami Warning Centre on land.



(a) What is ultrasound ? (1 mark)

(b) Given :

Distance from the Sensor *X* to the shore = 1 800 km

Distance from Sensor *X* to Device *Y* = 6 km

Distance from Device *Y* to the satellite = 36 000 km

Distance from the satellite to the Tsunami Warning Centre = 40 000 km

Speed of ultrasound in water = 1 500 m s^{-1}

Speed of microwave = 3×10^8 m s^{-1}

Average speed of tsunami on the sea surface = 250 m s^{-1}

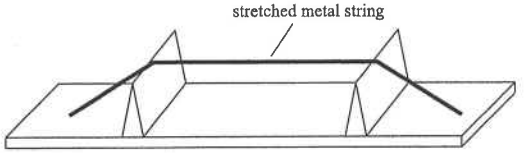
Can the Tsunami Warning Centre receive the signal one hour before the arrival of tsunami to the shore ? Show your calculations. (Assume that when a tsunami arrives at the water surface vertically above Sensor *X*, *X* sends a signal to Device *Y*.) (3 marks)

12. (c) Explain why ultrasound is not used to transmit signals from the satellite to the Tsunami Warning Centre. (1 mark)

(d) After receiving the signal from the satellite, the Tsunami Warning Centre will send a warning signal to the alarm stations in neighbouring cities. John suggests using ultrasound to transmit the warning signal, while Peter suggests using radio wave to transmit the warning signal. Explain which suggestion is more appropriate. (2 marks)

13. **< HKCE 2010 Paper I - 6 >**

The Figure below shows a metal string stretched over two wedges. Kathy plucks the string and a sound is heard.



(a) Describe how the sound is produced by the string. (3 marks)

(b) State one difference and one similarity in the **nature** of the wave on the string and the sound wave produced. (2 marks)

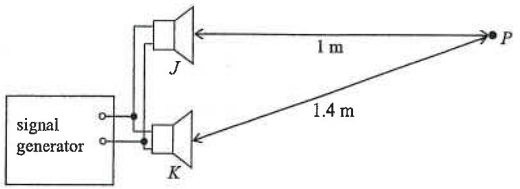
Difference :

Similarity :

14. **< HKCE 2011 Paper I - 8 >**

Two identical loudspeakers J and K are connected in parallel to a signal generator as shown in Figure (a). They are emitting sound waves of frequency 850 Hz. Point P is 1 m and 1.4 m away from J and K respectively.
Given : speed of sound = 340 m s^{-1}

Figure (a)

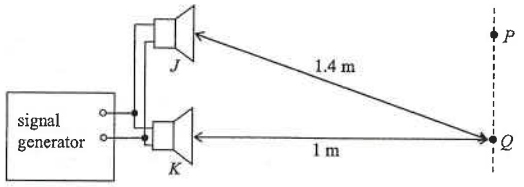


(a) Determine the wavelength of the sound produced. (2 marks)

(b) Determine the type of interference occurring at P. (3 marks)

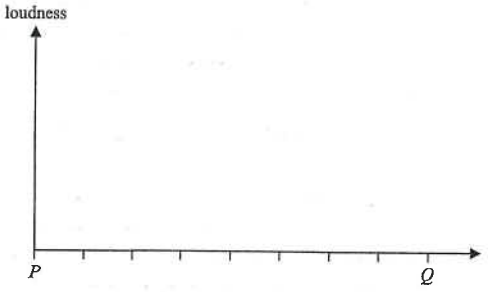
(c) Another point Q is 1.4 m and 1 m away from J and K respectively as shown in Figure (b). Mary walks along the straight line PQ.

Figure (b)



Sketch a graph in Figure (c) to show the variation of the loudness of the sound that Mary hears between P and Q. (2 marks)

Figure (c)

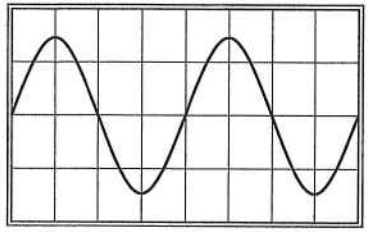


14. (d) Now loudspeaker K is disconnected and a microphone connected to a CRO is placed at P as shown in Figure (d). Loudspeaker J is emitting sound waves of frequency 850 Hz.

Figure (d)

The waveform of the sound received by the microphone is displayed on the CRO as shown in Figure (e).

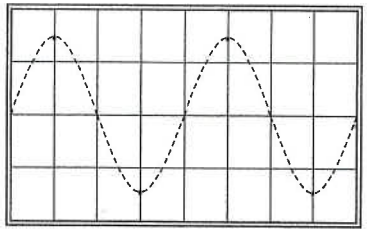
Figure (e)



The settings of the CRO remain unchanged.

(i) If the microphone is moved closer to loudspeaker J, describe the change of the waveform displayed on the CRO. (1 mark)

(ii) Now the microphone is returned to P and the sound emitted by loudspeaker J is changed to 425 Hz, sketch the waveform displayed on the CRO in the Figure below. (1 mark)



Part B : HKAL examination questions

15. **< HKAL 1984 Paper IIB - 3 >**

In the figure below, a signal generator G is connected to two loudspeakers L_1 and L_2 placed 3 m apart. The signal generator gives out a frequency of 680 Hz to the two loudspeakers that give out the sound waves in phase. The speed of the sound waves is 340 m s^{-1}.

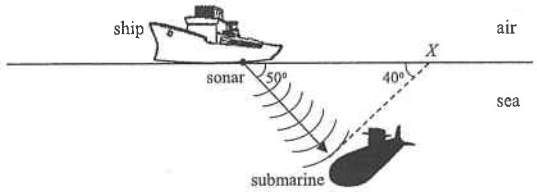
(a) A microphone is used to detect the sound intensity given out by the two loudspeakers.

(i) Describe the variation in the signal detected by the microphone when it moves along the line AB, which is the perpendicular bisector of L_1 L_2. (1 mark)

(ii) Describe the variation in the signal detected by the microphone when it moves slowly along line XY, which is parallel to L_1 L_2. (1 mark)

(b) Point Z in the above figure represents a point at which a minimum intensity sound is heard. When the loudspeaker L_2 is disconnected, explain the change of the intensity of the sound heard at Z. (2 marks)

16. **< HKAL 2004 Paper I - 3 >**



A ship equipped with a sonar system is used to detect objects in the sea. Ultrasound of frequency 25 kHz are sent towards the seabed. The ultrasound, which then propagate at an angle of 50° to the sea surface, are reflected from a submarine back to the ship after 0.15 s. (Given: speed of sound in air = 340 m s^{-1} ; speed of sound in sea water = 1500 m s^{-1})

(a) Find the wavelength of the ultrasound in sea water. (2 marks)

(b) Calculate the vertical distance of the submarine beneath the sea surface. (2 marks)

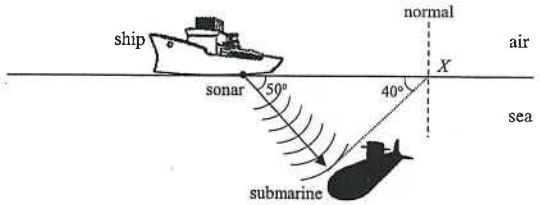
(c) Some of the ultrasound reflected by the submarine propagate along the dotted line and emerge into the air at X. Calculate the angle of refraction in air. (3 marks)

(d) Is it possible for the ultrasound, at certain angles of incidence, to undergo total internal reflection when it travels from sea water to the air ? Explain. (2 marks)

(e) Explain why radar using microwaves are not suitable for detecting objects in sea water. (1 mark)

Part C : HKDSE examination questions

17. < HKDSE Sample Paper IB - 10 >



The figure above shows a ship equipped with sonar. The sonar emits ultrasonic waves of frequency 25 kHz into the sea. The waves propagate at an angle of 50° to the surface of the sea and are reflected from a submarine back to the ship after 0.15 s.

Given : speed of sound in air = 340 m s^{-1}

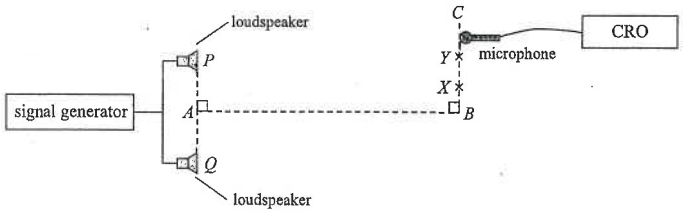
speed of sound in sea water = 1500 m s^{-1}

(a) Calculate the vertical distance of the submarine beneath the sea surface. (2 marks)

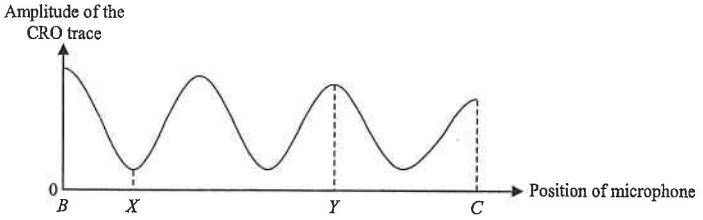
(b) Some of the reflected waves propagate along the dotted line and emerge into the air at *X*. Calculate the angle of refraction in air. (2 marks)

(c) Is it possible for ultrasonic waves, at certain angles of incidence, to undergo total internal reflection when they go from sea water to the air ? Explain. (2 marks)

18. < HKDSE Sample Paper IB - 6 >



The above Figure shows two identical loudspeakers *P* and *Q* connected to a signal generator. Position *A* is the mid-point of *PQ*. A microphone connected to a CRO is moved along *BC*. The amplitude of the CRO trace increases as the loudness of the sound detected increases. The Figure below shows how the amplitude of the CRO trace varies with the position of the microphone.

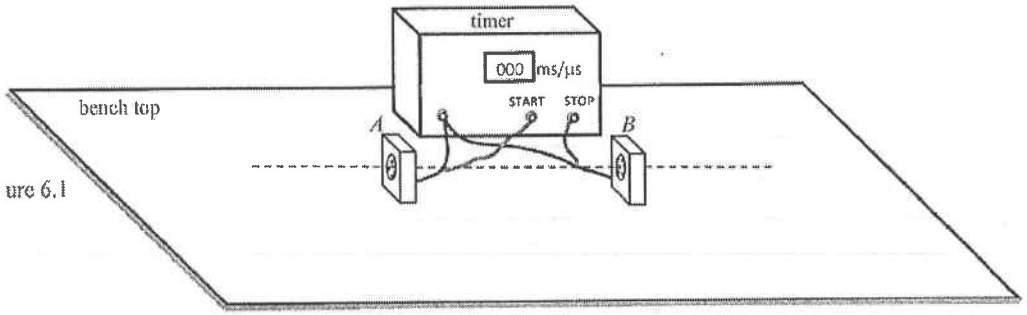


(a) (i) Explain why the loudness of the sound varies along *BC*. (2 marks)

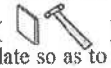
(ii) State **ONE** reason why the amplitude of the CRO trace is **NOT** zero at position *X*. (1 mark)

(b) If *PY* = 5.10 m and *QY* = 5.78 m, find the wavelength of the sound. (2 marks)

The set-up in Figure 6.1 is to find the speed of sound in air. Two identical microphones *A* and *B* are connected to a timer and placed on a bench top as shown. The timer can be triggered to 'start' and 'stop' timing using the respective microphones to feed signals to the START and STOP terminals of the timer.



ure 6.1

(a) You are given a hammer and a metal plate (). Use 'X' to indicate a suitable location on Figure 6.1 where the hammer should hit the plate so as to generate a sharp loud sound to be received by the microphones in this experiment. State an additional piece of apparatus needed and the measurements to be made in this experiment. (3 marks)

(b) The separation between *A* and *B* is set at 0.280 m. The experiment is repeated to obtain a few readings of the timer as follows:

801 μs, 838 μs, 539 μs, 821 μs

(i) Find the speed of sound in air. Show how you would treat the data obtained in the calculation.

(ii) Suggest one adjustment to the experimental setting so as to obtain a more accurate result.

(3 marks)

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

Question Solution

1. (a) (i) Period $T = 0.1 \times 5$ [1]
$= 0.5$ ms [1]
Frequency : $f = \frac{1}{T} = \frac{1}{0.5 \times 10^{-3}} = 2000$ Hz [1]

(ii) Within the audible range [1]

(b) (i) Constructive interference at C [1]
Destructive interference at B [1]

(ii) $QB - PB = \frac{1}{2}\lambda$ [2]

(iii) $\lambda = 2 \times (3.12 - 3.04) = 0.16$ m [1]
$v = f\lambda$ [1]
$= 2000 \times 0.16 = 320$ m s^{-1} [1]

(iv) larger [1]

(c) Period unchanged [1]
Amplitude increases [1]

2. (a) Period $= 4 \times 0.1 = 0.4$ ms [1]
Frequency $= \frac{1}{0.4 \times 10^{-3}} = 2500$ Hz [2]
Wavelength $\lambda = \frac{v}{f} = \frac{325}{2500} = 0.13$ m [2]

(b) (i) Path difference $= 2.31 - 2.05 = 0.26$ m $= 2\lambda$ [2]
$\therefore$ Constructive interference [1]

(ii) Pitch remains unchanged [1]
Loudness increases [1]

(iii) Any **TWO** of the following : [2]
- Noise from surrounding (OR background noise)
- Reflection of the loudspeaker's sound at the walls
- The intensities of the sound from P and Q reaching the microphone may not be equal.
- The microphone has finite size

2. (b) (iv) False [1]
The path difference along XY is always equal to zero.
The interference is always constructive along XY. [2]

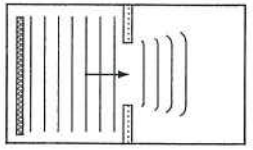
3. (a) Note Z [1]

(b) All of the notes X, Y and Z have the same pitch since they all have the same frequency. [2]
However, note X has the greatest loudness since note X has the greatest amplitude [1]
and note Z has the smallest loudness since note Z has the smallest amplitude. [1]

4. (a) (i) Place the cork in the ripple tank. [1]
The cork moves up and down. [1]

(ii) Place the candle which has been lighted up in front of the loudspeaker. [1]
The flame moves forward and backward. (**OR** The flame moves to and fro.) [1]

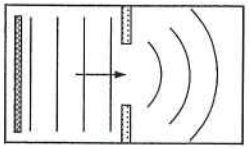
(b) (i)



< Correct shape > [1]
< Wavelength remains unchanged > [1]
The phenomenon is diffraction. [1]

(ii) (1) ① Increase the depth of the water in the ripple tank. [1]
② Decrease the frequency of the vibrator. [1]

(2)



< Correct shape > [1]
< Diffraction is larger than (b) (i) > [1]

(c) The smaller speaker cone is more suitable for emitting high-frequency sounds. [1]
Since the wavelength of high-frequency sounds is shorter, diffraction is less. [1]
Thus a smaller cone is used to increase its degree of diffraction. [1]

5. (a) The speed of light in air is much higher than that of sound. [1]

(b) The wavelength of light is much smaller than that of sound. [1]
Thus the degree of diffraction of light is much smaller. [1]

6. (a) $v = f\lambda$ [1]

$(340) = (200)\,\lambda \quad \therefore\ \lambda = 1.7$ m [1]

(b) (i) Path difference at $P = 8.65 - 6.10 = 2.55$ m [1]

(ii) Path difference at $P = \dfrac{2.55}{1.7}\lambda = 1.5\,\lambda$ [1]

Destructive interference occurs; so Mary will hear a soft sound. [1]

(c) Susan is incorrect. The path difference at Q from S_1 and S_2 is zero, [1]

constructive interference will always occur at Q. [1]

7. (a) By $v = f\lambda$

$\therefore\ (6 \times 10^3) = (2 \times 10^6)\,\lambda$ [1]

$\therefore\ \lambda = 3 \times 10^{-3}$ m [1]

(b) X is the reflected pulse [1]

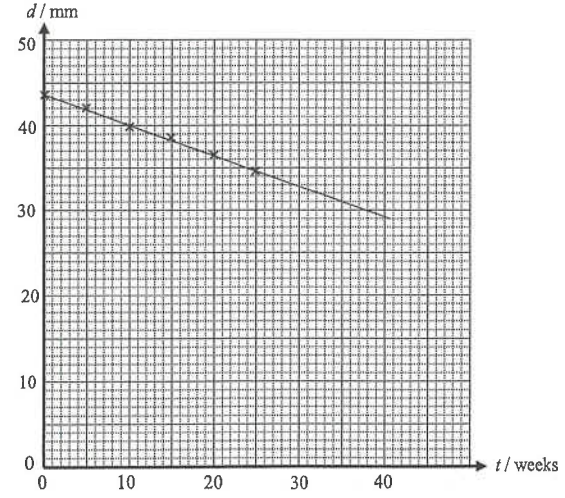
since the amplitude of the reflected pulse should be smaller. [1]

(c) (i) $d = \dfrac{v \cdot t}{2} = \dfrac{(6\times10^3)\cdot(14.5\times10^{-6})}{2}$ [1]

$= 0.0435$ m $= 43.5$ mm [1]

(ii)

Time t / weeks	0	5	10	15	20	25
Total time of travel / 10^{-6} s	14.5	14.0	13.3	12.8	12.2	11.5
Thickness of the wall d / mm	43.5	42.0	39.9	38.4	36.6	34.5



7. (c) (ii) < Two axes labelled > [1]

< Range of scale correct > [1]

< Points correctly plotted > [2]

< Straight line drawn > [1]

(iii) From the graph, d drops to 30 mm at $t = 37.5$ weeks [1]

Time at which the pipe has to be replaced = 37.5 weeks [1]

(d) Between the transmitted pulse and the pulse reflected from the wall, [1]

there is another pulse of smaller amplitude [1]

which should be reflected from the crack. [1]

8. (a) interference [1]

(b) Path difference at $X = 1.96 - 1.74$

$= 0.22$ m [1]

If the wavelength is 0.44 m, then the path difference is $\frac{1}{2}\lambda$ [1]

and thus the amplitude at X should be minimum but not maximum, so the student is not correct. [1]

9. Connect the two loudspeakers to the signal generator. [1]

Adjust the frequency of the signal generator to give a sound note that can be heard. [1]

Walking in front of the two loudspeakers, [1]

alternate loud and soft sound can be heard. [1]

< OR >

Connect the two loudspeakers to the signal generator. [1]

Adjust the frequency of the signal generator to give a suitable sound note. [1]

Connect a microphone to a CRO and move the microphone in front of the two loudspeakers, [1]

alternate maxima and minima can be observed on the CRO. [1]

10. (a) $v = f\lambda$ [1]

$(340) = (425)\,\lambda$

$\therefore\ \lambda = 0.8$ m [1]

(b) (i) $t = \dfrac{d}{v} = \dfrac{100}{340} = 0.294$ s [1]

(ii) 1. It does not work [1]

since the speed of sound is not affected by the frequency. [1]

2. It works [1]

since the speed of light is very high, time delay becomes negligible. [1]

11. (a) (i) Along *BC*, interference occurs. [1]

Constructive interference gives loud sound and destructive interference gives soft sound. [1]

(ii) Any **ONE** of the following : [1]

* There is background noise.
* Sound is reflected by the surrounding walls.
* *P* and *Q* do not have the same amplitude.
* The microphone is not a point receiver.

(b) (i) Path difference = 5.78 – 5.10 = 0.68 m [1]

(ii) $\Delta = 0.68 = 2\lambda$ [1]

$\lambda = 0.34$ m [1]

12. (a) Ultrasound is sound wave of frequency higher than 20 000 Hz. [1]

(b) Time for tsunami to reach the shore $= \frac{1800 \times 10^3}{250} = 7200$ s [1]

Time required for the travel of the signals $= \frac{6000}{1500} + \frac{76000 \times 10^3}{3 \times 10^8} = 4.25$ s [1]

Time left for announcing warning signal = 7200 – 4.25 = 7195.75 s > 1 h [1]

The system can meet the requirement.

(c) Ultrasound cannot travel in outer space. [1]

(d) The speed of radio wave is higher. [1]

Therefore, Peter's suggestion is more appropriate. [1]

13. (a) When the string vibrates up and down, [1]

the air nearby will be forced to move [1]

and the sound wave travels outwards. [1]

(b) Difference : (any **ONE**) [1]

* Wave on the string is transverse but sound wave is longitudinal.
* Wave on the string is stationary but sound wave is travelling.

Similarity : (any **ONE**) [1]

* Both waves are mechanical waves.
* Both waves need material medium for propagation.

14. (a) $v = f\lambda$ [1]

$\therefore$ (340) = (850) λ

$\therefore$ $\lambda = 0.4$ m [1]

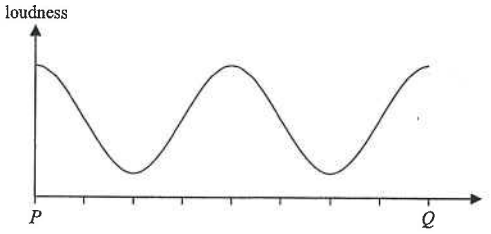
14. (b) Path difference at *P* = 1.4 – 1.0 [1]

= 0.4 m

= 1 λ [1]

Hence, constructive interference occurs at *P*. [1]

(c)

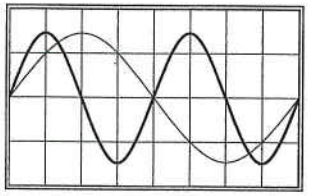


< maximum at *P* and *Q* > [1]

< all correct > [1]

(d) (i) The amplitude of the waveform will increase. [1]

(ii)



< same amplitude but with double period > [1]

15. (a) (i) Sound of maximum intensity is heard, and the intensity decreases along *AB*. [1]

(ii) Alternative maximum and minimum intensity is detected along *XY* [1]

(b) There is a minimum intensity sound at *Z* because destructive interference occurs there and the two waves arriving at *Z* exactly cancel. [1]

When L_2 is disconnected, no such cancellation occurs, as only one wave arrives.
Thus the intensity increases. [1]

16. (a) By $v = f\lambda$

$\therefore$ $(1500) = (25 \times 10^3)\lambda$ [1]

$\therefore$ $\lambda = 0.06$ m [1]

(b) Distance between the ship and the submarine $= \frac{1}{2} \times (1500) \times (0.15) = 112.5$ m [1]

Vertical distance = 112.5 × sin 50° = 86.2 m [1]

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WA6 : Sound

16. (c) The angle of incidence at $X = 50°$ [1]

$\therefore \frac{\sin 50°}{\sin r} = \frac{1500}{340}$ [1]

$\therefore r = 10°$ [1]

(d) No, the ultrasound refracts towards the normal [1]
since ultrasound travels faster in water than in air. [1]

(e) Microwaves would be absorbed by water effectively. [1]

17. (a) Vertical distance $= \frac{1}{2} \times (1500) \times (0.15) \times \sin 50°$ [1]

$= 86.2$ m [1]

(b) $\frac{\sin 50°}{\sin r} = \frac{1500}{340}$ [1]

$\therefore r = 10°$ [1]

(c) No, ultrasonic waves travel faster in sea water than in air, [1]
so they are refracted towards the normal and no total internal reflection is possible when they go from water to air. [1]

18. (a) (i) Along *BC*, interference occurs. [1]

Constructive interference gives loud sound and destructive interference gives soft sound. [1]

(ii) Any **ONE** of the following : [1]

- ✶ There is background noise.
- ✶ Sound is reflected by the surrounding walls.
- ✶ *P* and *Q* do not have the same amplitude.
- ✶ The microphone is not a point receiver.

(b) Path difference $= 2\lambda$

$\therefore 5.78 - 5.10 = 2\lambda$ [1]

$\therefore \lambda = 0.34$ m [1]

Hong Kong Diploma of Secondary Education Examination

Physics – Compulsory part (必修部分)

Section A – Heat and Gases (熱和氣體)
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

Section B – Force and Motion (力和運動)
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

Section C – Wave Motion (波動)
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

Section D – Electricity and Magnetism (電和磁)
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

Section E – Radioactivity and Nuclear Energy (放射現象和核能)
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

Physics – Elective part (選修部分)

Elective 1 – Astronomy and Space Science (天文學和航天科學)
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恒星和宇宙)

Elective 2 – Atomic World (原子世界)
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

Elective 3 – Energy and Use of Energy (能量和能源的使用)
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

Elective 4 – Medical Physics (醫學物理學)
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)