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 (普遍氣體定律)
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)

DSE Physics - Section C : M.C. PC - WA2 - M / 01
WA2 : Wave Phenomena

Part A : HKCE examination questions

1. **< HKCE 1982 Paper II - 12 >**

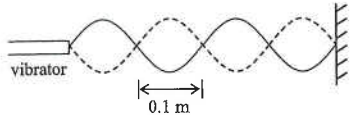
A train of water waves is travelling from a deep water region to a shallow water region. Which of the following properties of the water waves will be changed ?

(1) wavelength
(2) frequency
(3) velocity

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

2. **< HKCE 1982 Paper II - 13 >**

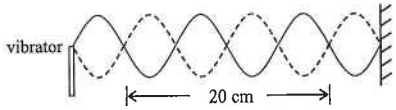
A stationary wave is obtained by attaching one end of a string to a 50 Hz vibrator as shown in the diagram. The velocity of the waves propagated in the string is



A. 0.1 m s^{-1}
B. 0.2 m s^{-1}
C. 5 m s^{-1}
D. 10 m s^{-1}

3. **< HKCE 1983 Paper II - 23 >**

A stationary wave is set up along a string by a vibrator as shown in the diagram. If the frequency of the vibrator is 5 Hz, what is the velocity of the wave set up in the string ?



A. 25 cm s^{-1}
B. 50 cm s^{-1}
C. 75 cm s^{-1}
D. 100 cm s^{-1}

4. **< HKCE 1984 Paper II - 22 >**

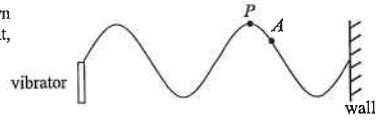
In a ripple tank experiment, a series of plane water waves are sent through a narrow slit. Which of the following will have changed when the water waves emerge from the slits ?

(1) wave speed
(2) wave pattern
(3) frequency

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

5. **< HKCE 1985 Paper II - 25 >**

A stationary wave is produced in a string by a vertical vibrator as shown in the diagram. If P is at the crest of an antinode at a certain instant, what is the direction of motion of the point A at that instant ?



A. upwards
B. downwards
C. to the right
D. momentarily at rest

6. **< HKCE 1986 Paper II - 24 >**

Straight waves in a ripple tank are observed using a hand stroboscope with a single slit. The maximum frequency of rotation of the stroboscope where a stationary pattern can be observed is 2 revolutions per second. The distance between the first crest and the eleventh crest is found to be 0.2 m. What is the speed of the wave ?

A. $\frac{0.2}{11}$ m s^{-1} B. $\frac{0.2}{10}$ m s^{-1}

C. $\frac{0.4}{11}$ m s^{-1} D. $\frac{0.4}{10}$ m s^{-1}

7. **< HKCE 1987 Paper II - 12 >**

The figure shows a stationary water wave at its maximum vibration. What is the direction of the motion of a particle P at this instant ?

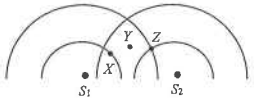
A. towards the right
B. upwards
C. downwards
D. momentarily at rest

8. **< HKCE 1988 Paper II - 24 >**

In a ripple tank, when water waves pass through a narrow gap in a barrier, what happens to its frequency and wavelength ?

	Frequency	Wavelength
A.	increases	decreases
B.	decreases	increases
C.	decreases	remains unchanged
D.	remains unchanged	remains unchanged

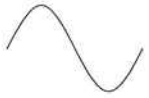
9. **< HKCE 1989 Paper II - 25 >**



The figure above shows the wave pattern in a ripple tank from coherent point sources S_1 and S_2. What kind of interference occurs at X, Y and Z ?

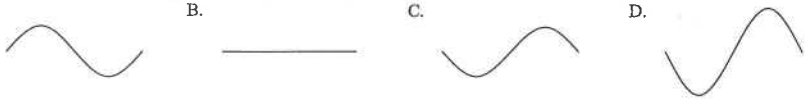
	X	Y	Z
A.	destructive	constructive	constructive
B.	no interference	constructive	constructive
C.	no interference	destructive	no interference
D.	no interference	destructive	constructive

10. **< HKCE 1989 Paper II - 26 >**



A stationary wave is formed in a string. The above diagram shows the string at the instant of maximum displacement. What will be the shape of the wave pattern one quarter of a period later ?

A. B. C. D.



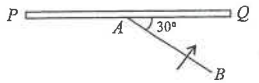
11. **< HKCE 1990 Paper II - 26 >**

In a ripple tank experiment, a series of plane water waves passes through a narrow slit. Which of the following properties of the waves will remain unchanged ?

(1) speed
(2) direction of travel
(3) frequency

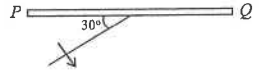
A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

12. **< HKCE 1990 Paper II - 23 >**



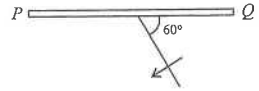
A straight pulse AB is travelling towards a straight barrier PQ in a ripple tank as shown above. Which of the following figures best shows the reflected pulse ?

A.



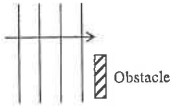
B.

C.



D.

13. **< HKCE 1991 Paper II - 24 >**

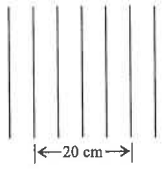


A series of water waves, generated in water of uniform depth, is travelling towards an obstacle as shown above. Which of the following diagrams best shows the wave pattern after passing the obstacle ?

A. B. C. D.

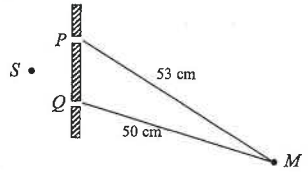
14. **< HKCE 1992 Paper II - 24 >**

In a ripple tank experiment, the pattern of plane water waves is frozen by using a stroboscopic lamp flashing at a frequency of 50 Hz as shown in the above diagram. If the frequency of the vibrator is 50 Hz, find the wavelength and speed of the waves.



	Wavelength	Speed
A.	4 cm	2 m s^{-1}
B.	4 cm	12.5 m s^{-1}
C.	5 cm	2.5 m s^{-1}
D.	5 cm	10 m s^{-1}

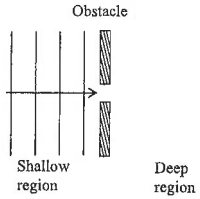
15. < HKCE 1992 Paper II - 25 >



In a double-slit experiment, a source S sends waves towards two slits P and Q, which are equidistant from S. The distances of a point M from P and Q are 53 cm and 50 cm respectively. If constructive interference occurs at M, the possible wavelength of the waves is

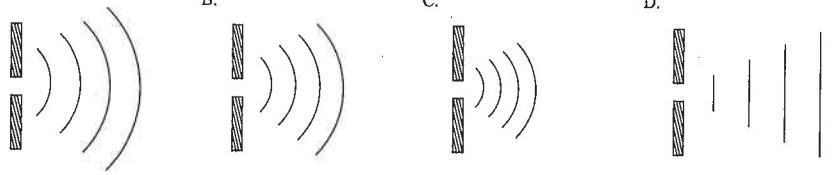
A. 1 cm.
B. 2 cm.
C. 4 cm.
D. 6 cm.

16. < HKCE 1992 Paper II - 26 >

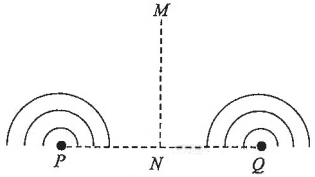


The figure above shows a series of plane water waves travelling in a shallow region of water. The waves pass through a small slit to a deep region of water. Which of the following diagrams shows the wave pattern in the deep region ?

A. B. C. D.



17. < HKCE 1993 Paper II - 25 >

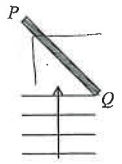


Two vibrators P and Q are set to vibrate in phase in a ripple tank. MN is the perpendicular bisector of PQ as shown above. Which of the following statements is/are true ?

(1) Constructive interference occurs along MN.
(2) Destructive interference occurs along PQ.
(3) A crest is always formed at M.

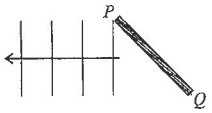
A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

18. < HKCE 1993 Paper II - 23 >

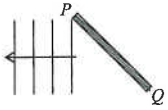


Plane water waves travel towards a straight barrier PQ as shown in the figure above. Which of the following diagrams best shows the reflected waves ?

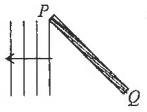
A.



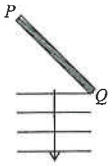
B.



C.



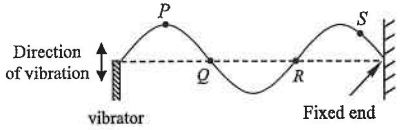
D.



19. < HKCE 1994 Paper II - 20 >

A vibrator generates a stationary wave on a string. The diagram shows the string at an instant of maximum displacement. Which of the following statement is correct ?

A. Particle P is moving towards the right.
B. Particle Q is moving upwards.
C. Particle R always remains at rest.
D. All particles in the string move with the same amplitude.



20. < HKCE 1996 Paper II - 25 >

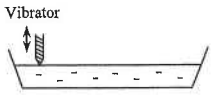


Figure (a)

Figure (b)

A vibrator generates continuous plane waves in a ripple tank (see Figure (a)). Figure (b) shows the wave pattern observed.

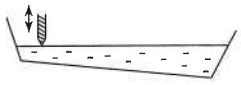
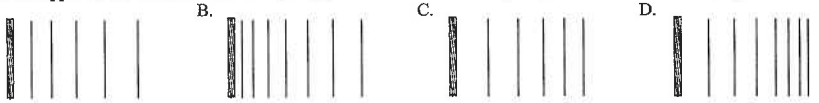


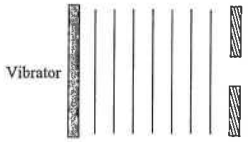
Figure (c)

Now the ripple tank is tilted as shown in Figure (c). Which of the following diagrams best shows the wave pattern observed ?

A. B. C. D.



21. < HKCE 1997 Paper II - 25 >

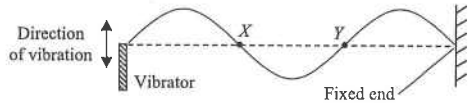


A vibrator generates continuous plane waves in a ripple tank. The waves undergo diffraction when they pass through a slit. Which of the following can increase the degree of diffraction of the waves ?

(1) Increasing the width the slit
(2) Placing the vibrator closer to the silt
(3) Increasing the wavelength of the water waves

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

Questions 22 and 23 : A vibrator generates a stationary wave on a string. The diagram below shows the string at a certain instant.



22. < HKCE 1997 Paper II - 23 >

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

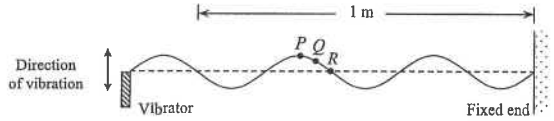
A. The distance between *X* and *Y* is equal to half the wavelength of the stationary wave.
B. All particles between *X* and *Y* on the string vibrate in the same direction.
C. All particles between *X* and *Y* on the string vibrate with the same frequency.
D. All particles between *X* and *Y* on the string vibrate with the same amplitude.

23. < HKCE 1997 Paper II - 24 >

The vibrating string also sets the neighbouring air into vibration. Which of the following statements about the waves on the string and those in air must be correct ?

A. They are both stationary.
B. They have the same speed.
C. They have the same wavelength.
D. They have the same frequency.

24. < HKCE 1998 Paper II - 27 >



A vibrator generates a stationary wave on a string. The above diagram shows the string at the instant of maximum displacement. Which of the following statements is **incorrect** ?

A. Particles *P* and *Q* move with the same amplitude.
B. The motions of particles *P* and *Q* are in phase.
C. Particle *Q* is momentarily at rest at this instant.
D. The wavelength of the stationary wave is 0.4 m.

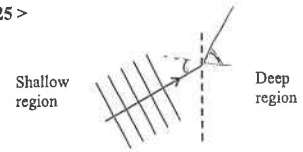
25. < HKCE 1998 Paper II - 26 >

A series of plane water waves travel towards an obstacle in a ripple tank. When the waves pass the obstacle, they bend around the corners of the obstacle. Which of the following statements is/are correct ?

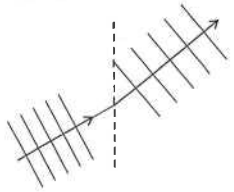
(1) The phenomenon is called diffraction.
(2) The speed of the waves remains unchanged as they bend round the corners.
(3) The degree of bending of the waves depends on the size of the obstacle relative to the wavelength of the waves.

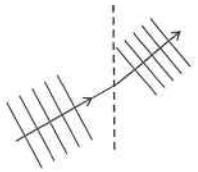
A. (1) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

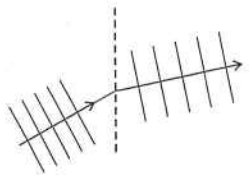
26. < HKCE 1998 Paper II - 25 >

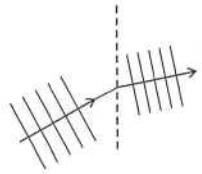


The diagram above shows a series of plane water waves travelling from a shallow region to a deep region of water. Which of the following diagrams best shows the wave pattern in the deep region ?

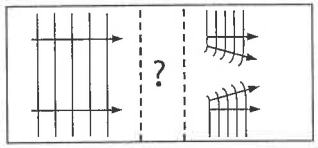
A.


B.


C.


D.


27. < HKCE 1999 Paper II - 22 >



A series of straight water waves travels towards the right in a ripple tank as shown above. In order to obtain the waves as shown in the right hand side, what kinds of phenomenon have the straight waves undergone ?

A. reflection only
B. refraction only
C. diffraction only
D. refraction and diffraction only

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

A plane water wave travels from a deep region to a shallow region of water. If the wavelength, frequency and speed of the wave in the deep region are λ_1, f_1 and v_1 respectively, while the corresponding values in the shallow region are λ_2, f_2 and v_2 respectively. Which of the following relations is/are correct ?

(1) $\lambda_1 > \lambda_2$
(2) $v_1 > v_2$
(3) $f_1 > f_2$

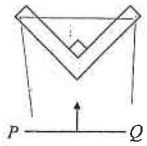
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

29. **< HKCE 2000 Paper II - 26 >**

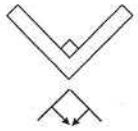
A water wave of frequency 30 Hz travels in a deep region of water. When the wave enters a shallow region, its wavelength is reduced to one-third of its original value. Find the frequency of the water wave in the shallow region.

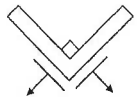
A. **30 Hz**
B. 60 Hz
C. 90 Hz
D. It cannot be determined since the speed of the water wave is not given.

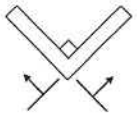
30. **< HKCE 2000 Paper II - 27 >**

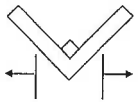


A straight pulse PQ travels towards a V-shaped barrier in a ripple tank as shown above. Which of the following diagrams best shows the reflected pulse(s) ?

A.


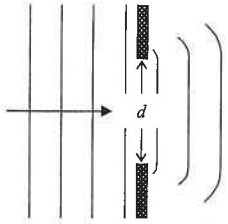
B.


C.


D.


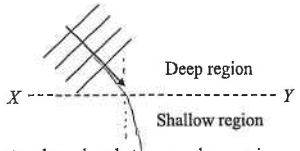
31. **< HKCE 2001 Paper II - 26 >**

Water waves of wavelength λ are diffracted as they pass through a gap of width d as shown in the figure above. Which of the following changes would produce the most significant diffraction effect ?

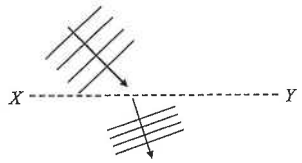


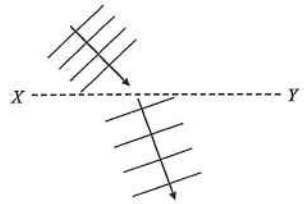
	λ	d
A.	remains unchanged	halved
B.	remains unchanged	doubled
C.	halved	halved
D.	halved	doubled

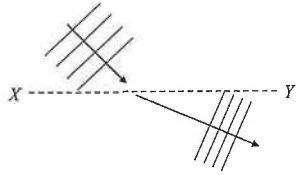
32. **< HKCE 2001 Paper II - 25 >**

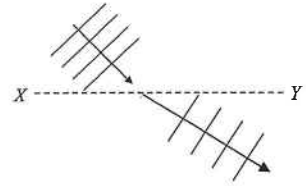


In the above diagram, XY represents a boundary between a deep region and a shallow region of water in a ripple tank. A series of straight water waves in the deep region travels towards XY. Which of the following diagrams best shows the wave pattern in the shallow region ?

A.


B.


C.


D.


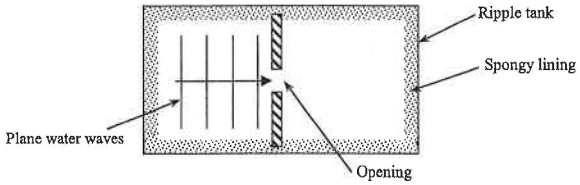
33. **< HKCE 2002 Paper II - 24 >**

In a ripple tank experiment, a series of water waver travels towards a barrier. Which of the following quantities would remain unchanged after the waves are reflected by the barrier ?

(1) **wavelength**
(2) **frequency**
(3) **speed**

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

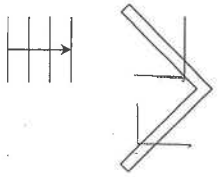
34. **< HKCE 2002 Paper II - 26 >**



Which of the following phenomena would be observed when the water waves pass through the opening in the above set-up ?

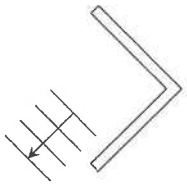
A. reflection
B. refraction
C. diffraction
D. interference

35. < HKCE 2003 Paper II - 27 >

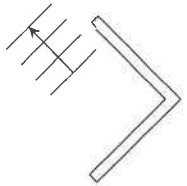


Plane water waves travels towards an L-shaped barrier in a ripple tank as shown above. Which of the following diagrams best shows the reflected wave pattern ?

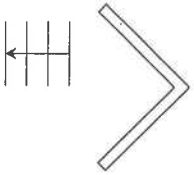
A.



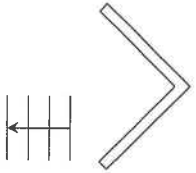
B.



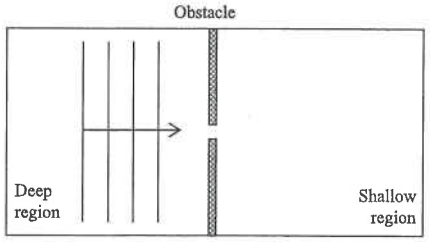
C.



D.



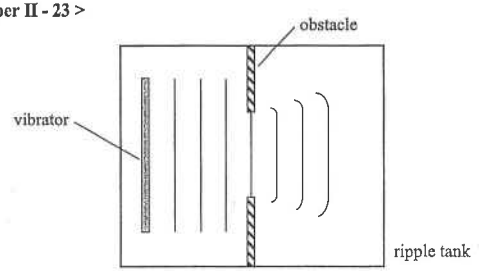
36. < HKCE 2003 Paper II - 28 >



Plane water waves travel from a deep region to a shallow region of water through a narrow gap as shown above. Which of the following properties of the waves remains unchanged ?

A. direction of travel
B. speed
C. wavelength
D. frequency

37. < HKCE 2004 Paper II - 23 >

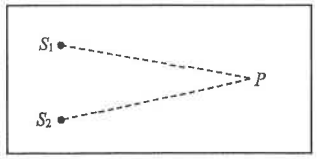


A student uses the above set-up to study the diffraction of water waves. Which of the following changes can make the diffraction effect more significant ?

(1) reducing the width of the gap between the obstacles
(2) increasing the frequency of the vibrator
(3) adding more water to the ripple tank

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

38. < HKCE 2004 Paper II - 25 >

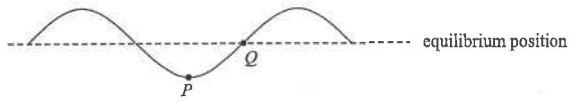


Two dippers S_1 and S_2 are connected to the same vibrator and produce identical waves in a ripple tank. P is a point such that $S_1P - S_2P = \lambda$, where λ is the wavelength of the water waves generated. Which of the following statements is/are correct ?

(1) Constructive interference occurs at P.
(2) A crest is always formed at P.
(3) If the wavelength of the waves generated by the dippers is doubled, destructive interference will occur at P.

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

39. < HKCE 2004 Paper II - 21 >



The figure shows the waveform of a transverse stationary wave at a certain instant. If particle P is at its lowest position at this instant, what will be the instantaneous motion of particles P and Q after a quarter of a period ?

	P	Q
A.	moving upwards	at rest
B.	moving upwards	moving upwards
C.	at rest	at rest
D.	at rest	moving upwards

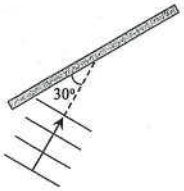
40. **< HKCE 2005 Paper II - 36 >**

An interference pattern is formed by two coherent point sources of water waves. Which of the following variations can change the positions of constructive interference ?

(1) changing the amplitude of the waves
(2) changing the wavelength of the waves
(3) changing the separation between the point sources

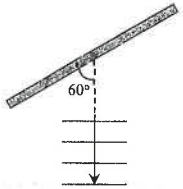
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

41. **< HKCE 2005 Paper II - 14 >**

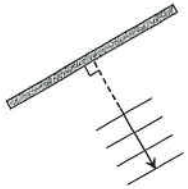


Straight water waves travel towards a barrier as shown above. Which of the following diagrams best shows the reflected wave pattern ?

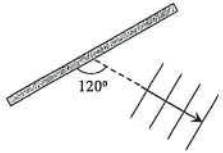
A.



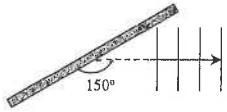
B.



C.



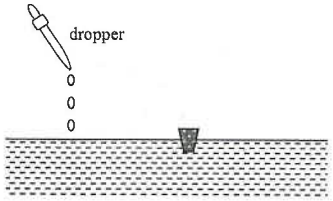
D.



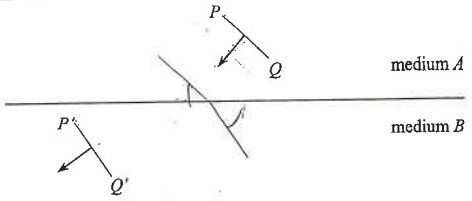
42. **< HKCE 2005 Paper II - 15 >**

A cork floats in water and a dropper is used to produce circular waves as shown in the diagram. Which of the following describes the motion of the cork when the waves pass through it ?

A. moves towards the dropper
B. moves away from the dropper
C. vibrates vertically about its original position
D. moves away from the dropper and vibrates vertically at the same time



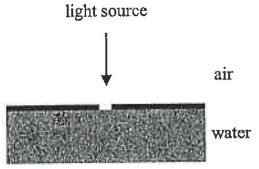
43. **< HKCE 2006 Paper II - 15 >**



A series of plane waves travel from medium *A* into medium *B*. The figure above shows the positions, *PQ* and *P'Q'*, of a wavefront before and after entering the medium *B*. What would happen to the speed and the wavelength of the wave when it travels from medium *A* to medium *B* ?

	Speed	Wavelength
A.	increases	increases
B.	increases	remains unchanged
C.	decreases	decreases
D.	decreases	remains unchanged

44. **< HKCE 2007 Paper II - 16 >**

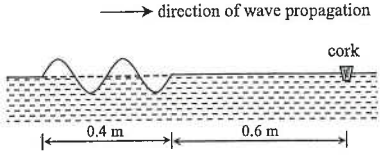


Light travels from air to water through a slit as shown above. Which of the properties of the light in water remain(s) unchanged ?

(1) direction of travel
(2) speed
(3) frequency

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

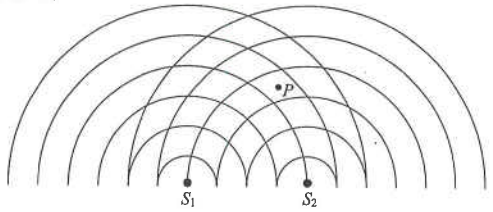
45. **< HKCE 2009 Paper II - 14 >**



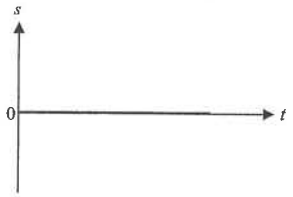
A cork is floating on a calm water surface as shown in the above figure. At time $t = 0$, a water wave is travelling towards the cork with a speed of 0.2 m s^{-1}. When will the cork rise to its highest position for the first time ?

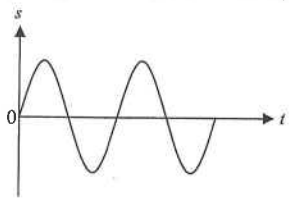
A. 3.00 s
B. 3.50 s
C. 3.75 s
D. 4.00 s

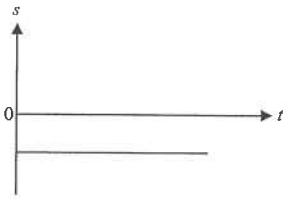
46. **< HKCE 2009 Paper II - 38 >**

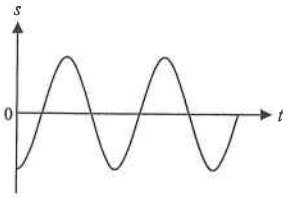


The figure above shows the circular wavefronts produced by two identical dot vibrators, S_1 and S_2, in a ripple tank at time $t = 0$. Solid lines represent crests. A cork is placed at point P on the water surface. Which of the following graphs best represents the variation of the displacement s of the cork with time t ? (Take upward as the positive direction.)

A.


B.


C.


D.


47. **< HKCE 2009 Paper II - 37 >**

A musical note is produced by a guitar string. Which of the following properties about the sound wave produced and the wave in the string is/are the same ?

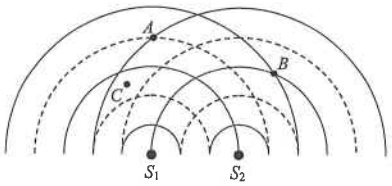
(1) wavelength
(2) frequency
(3) wave speed

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

48. **< HKCE 2010 Paper II - 36 >**

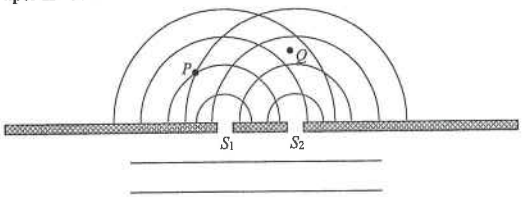
Two point sources S_1 and S_2 are producing circular water waves in a ripple tank. The figure shows the wave pattern at a certain instant. Solid lines represent crests and dotted lines represent troughs. Which of the following statements is/are correct ?

(1) The water particle at A is always at rest.
(2) The water particle at B is always at a crest.
(3) The interference at C is neither constructive nor destructive.



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

49. **< HKCE 2011 Paper II - 37 >**

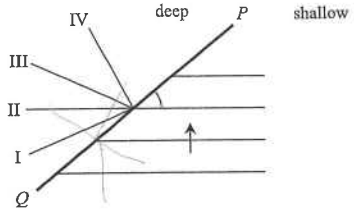


The figure above shows the wavefronts formed in a ripple tank. Solid lines represent crests. S_1 and S_2 are two narrow gaps allowing water waves to pass through and interfere. Which of the following statements is correct ?

A. Refraction occurs when water waves pass through S_1 and S_2.
B. The displacement of the water particles at P and Q are the same at the moment shown above.
C. Constructive interference occurs at Q.
D. The water particle at P is always at a crest.

Part B : HKAL examination questions

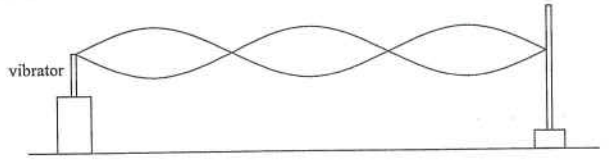
50. **< HKAL 1990 Paper I - 16 >**



The figure shows wave crests moving in the direction of the arrow towards the interface PQ between a shallow region and a deep region as shown in the figure. Which of the lines shown may represent one of the wave crests in the deep region ?

A. I
B. II
C. III
D. IV

51. **< HKAL 1994 Paper IIA - 20 >**



In the above figure, a stationary wave is set up on an elastic string by adjusting the frequency f of the vibrator. Which of the following statements is/are correct ?

(1) If f increases so that another stationary wave is set up, the number of antinodes in the wave pattern increases.
(2) If f increases, the speed of the waves on the string increases.
(3) The waves produced in air by the string have the same speed as the waves on the string.

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

52. **< HKAL 1996 Paper IIA - 12 >**

The waves from two coherent sources must have
(1) the same amplitude
(2) the same wavelength
(3) a constant phase relationship

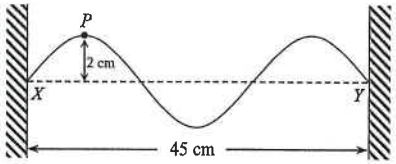
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

53. **< HKAL 2001 Paper IIA - 12 >**

In which of the following cases can the principle of superposition be applied to two overlapping waves of the same nature ?
(1) Two waves that have the same amplitude.
(2) Two waves that travel in opposite directions.
(3) Two waves that are coherent.

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

54. **< HKAL 2005 Paper IIA - 29 >**

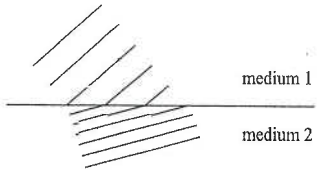


Two identical transverse waves, travelling in opposite directions along string XY fixed at both ends, form a stationary wave. The separations between X and Y is 45 cm. Particle P is an antinode with an amplitude of 2 cm. The above figure shows the shape of the string at an instant when P is at its maximum displacement from the equilibrium position. What is the amplitude and the wavelength of each of the **travelling waves** on the string ?

	Amplitude	Wavelength
A.	1 cm	30 cm
B.	1 cm	15 cm
C.	2 cm	30 cm
D.	2 cm	15 cm

55. **< HKAL 2009 Paper IIA - 15 >**

The diagram shows the wavefronts of a wave passing the boundary of two different media. Which of the following combinations about the type of wave and the two media is/are possible ?



	type of wave	medium 1	medium 2
(1)	light waves	air	water
(2)	sound waves	water	air
(3)	water waves	shallow water	deep water

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

56. **< HKAL 2010 Paper IIA - 14 >**

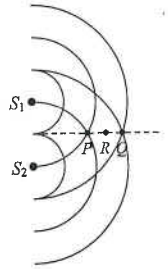


Figure (a)

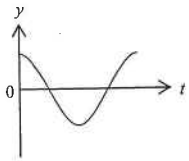
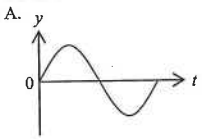
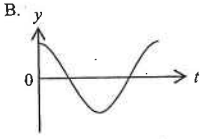
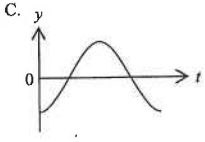


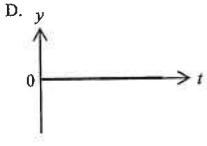
Figure (b)

In a ripple tank, S_1 and S_2 are two coherent sources vibrating with the same frequency. Figure (a) shows the pattern of water waves at time $t = 0$. The solid lines represent the crests of the water waves. Figure (b) shows the displacement-time graph of the particle P. Which of the following displacement-time graphs is correct for the particle R at mid-way between PQ as shown ?

A. 

B. 

C. 

D. 

57. **< HKAL 2012 Paper IIA - 15 >**

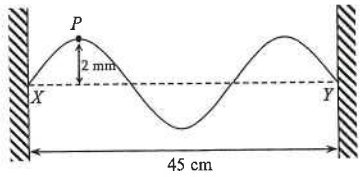
The principle of superposition can be applied to two overlapping waves of the same nature :
(1) only if they have the same frequency.
(2) only if they have the same amplitude.
(3) only if they travel in the same direction.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. None of the above conditions is necessary.

Part C : HKDSE examination questions

58. **< HKDSE Sample Paper IA - 19 >**

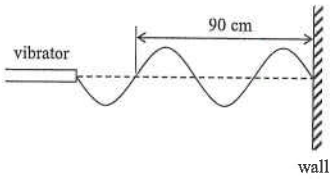
String XY is fixed at both ends. The distance between X and Y is 45 cm. Two identical sinusoidal waves travel along XY in opposite directions and form a stationary wave with an antinode at point P. The figure shows the string when P is 2 mm, its maximum displacement, from the equilibrium position. What is the amplitude and wavelength of each of the **travelling waves** on the string ?



	Amplitude	Wavelength
A.	1 mm	30 cm
B.	1 mm	15 cm
C.	2 mm	30 cm
D.	2 mm	15 cm

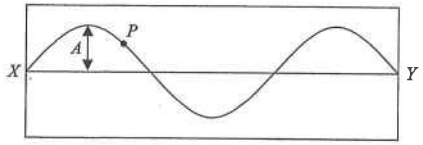
59. **< HKDSE Practice Paper IA - 19 >**

A stationary wave is set up along a string by a vibrator. The waveform at a certain instant is shown. If the frequency of the vibrator is 50 Hz, what is the wave speed along the string ?

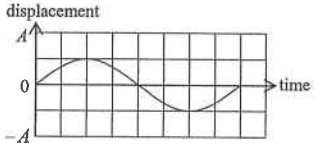


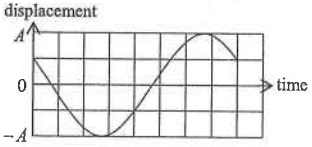
A. 15 m s^{-1}
B. 30 m s^{-1}
C. 45 m s^{-1}
D. 55 m s^{-1}

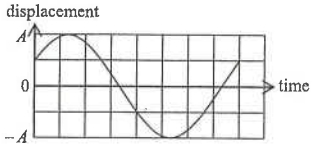
60. **< HKDSE 2012 Paper IA - 18 >**

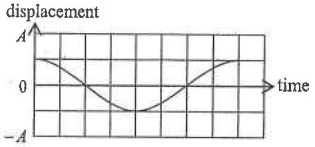


A stationary wave is formed on string fixed at both ends X and Y. The above figure is a snapshot of the string at time $t = 0$. The amplitude of vibration at an antinode is A. If upward displacement is taken as positive, which of the following shows the displacement-time graph of point P on the string for one period ?

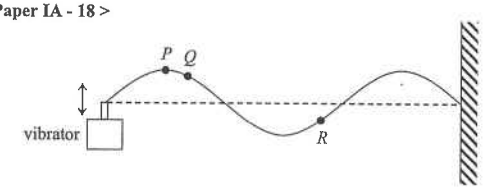
A.


B.


C.


D.


61. **< HKDSE 2013 Paper IA - 18 >**



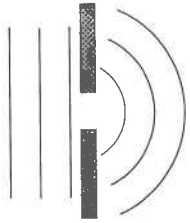
A vibrator generates a stationary wave on a string which is fixed at one end. The figure shows the appearance of the string at a certain instant. Which of the following descriptions about the motion of particles P, Q and R must be correct ?

(1) P and Q are momentarily at rest at this instant.
(2) Q and R take the same time to reach their respective equilibrium positions.
(3) P and R are always in antiphase.

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

62. **< HKDSE 2014 Paper IA - 16 >**

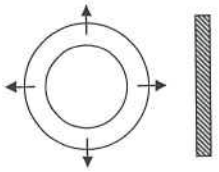
The photograph shows a series of plane sea waves travelling through a gap in a sea wall which exhibits diffraction. Assuming that the frequency of the waves remains unchanged, which of the following will increase the degree of diffraction ?



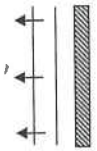
(1) The gap in the sea wall becomes narrower.
(2) The wavelength of the waves increases.
(3) The amplitude of the waves becomes larger.

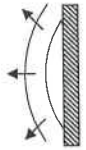
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

63. **< HKDSE 2014 Paper IA - 13 >**

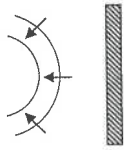


The above figure shows two circular pulses produced by drops of water falling in a ripple tank. The pulses are then reflected by a straight barrier. Which diagram best shows the reflected pulses ?

A.


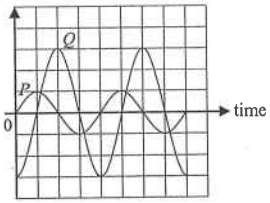
B.


C.


D.


64. **< HKDSE 2015 Paper IA - 13 >**

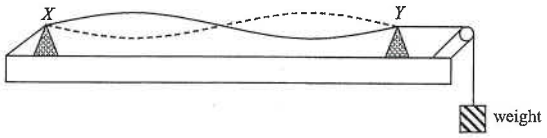
Two waves P and Q travel in the same direction and meet at a point. The graph shows the variation of the displacement of each wave with time at that point. Which of the following statements is/are correct ?

displacement


(1) P and Q have the same frequency.
(2) The oscillation due to P is in anti-phase with that due to Q.
(3) The amplitude of the resultant wave at that point is four times the amplitude of P.

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

65. < HKDSE 2015 Paper IA - 18 >



A string is set to vibrate at frequency f such that a standing wave is formed between two fixed supports X and Y as shown in the above figure.

If the tension in the string is increased by adding weight gradually while the frequency is kept at f, which of the following is a possible mode of vibration at a steady state ?

A.


B.

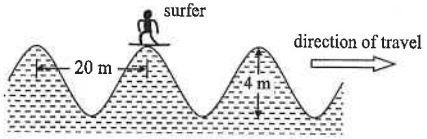

C.


D.


66. < HKDSE 2016 Paper IA - 16 >

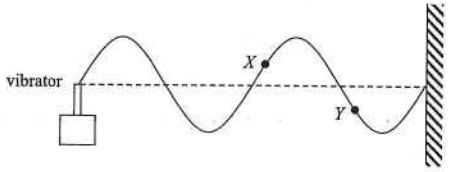
The surfer in the figure reaches a crest at the moment shown. The crests of the water wave are 20 m apart and the surfer descends a vertical distance of 4 m from a crest to a trough in a time interval of 2 s. What is the speed of the wave ?

A. 1 m s^{-1}
B. 2 m s^{-1}
C. 5 m s^{-1}
D. 10 m s^{-1}



67. < HKDSE 2016 Paper IA - 18 >

A string is tied to a vibrator while the other end is fixed to a wall. A stationary wave is formed as shown.

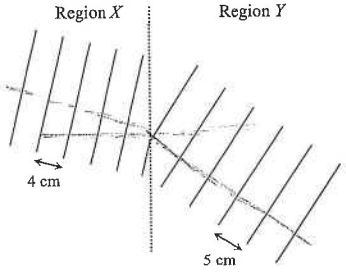


Which statement is correct when the frequency of the vibrator doubles ?

A. The wavelength will double.
B. The wave speed will double.
C. The amplitude will be halved.
D. Particles X and Y will become vibrating in phase.

68. < HKDSE 2017 Paper IA - 16 >

The figure shows plane water waves travelling from region X to region Y. The wavelengths of the water waves in regions X and Y are 4 cm and 5 cm respectively.



Which of the following statements is correct ?

A. The speed of the water waves in region X is higher than that in region Y.
B. The direction of travel of the water waves bends towards the normal as they enter region Y.
C. The frequency of the water waves is the same in both regions.
D. If plane water waves of wavelength 5 cm travel from region Y to region X, the wavelength becomes 6 cm after the waves enter region X.

69. < HKDSE 2017 Paper IA - 17 >

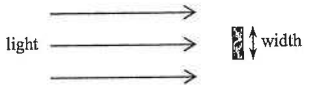
In which of the following situations **MUST** the direction of travel of a wave change ?

(1) when a wave is reflected by a barrier
(2) when a wave enters from one medium to another medium
(3) when a wave travels through a gap smaller than its wavelength

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

70. < HKDSE 2018 Paper IA - 16 >

Light undergoes diffraction round an obstacle.



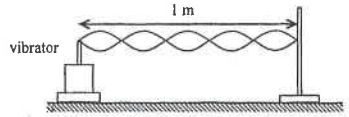
The angle of diffraction would increase when

(1) the amplitude of the incident light is increased.
(2) the width of the obstacle is increased.
(3) the wavelength of the incident light is increased.

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

71. **< HKDSE 2018 Paper IA - 18 >**

The figure shows a string with one end fixed and the other end tied to a vibrator. A stationary wave is formed as shown at a certain frequency.

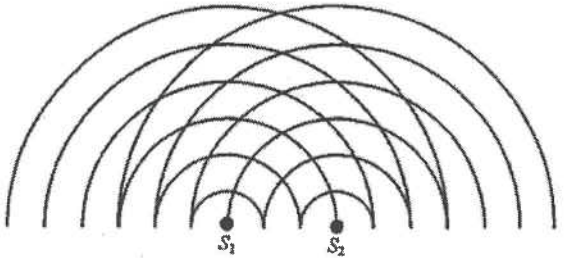


If the speed of the wave along the string is 7 m s^{-1}, what is the frequency of the wave ?

A. 2.8 Hz
B. 7 Hz
C. 17.5 Hz
D. 35 Hz

72. <HKDSE 2019 Paper IA-15>

7 . <HKDSE 2019 Paper IA-16>



The figure shows the circular water waves generated by two dippers S_1 and S_2 vibrating in phase. The lines represent wave crests. What is the number of nodal lines (i.e. minimum amplitude) formed ?

A. 3
B. 4
C. 6
D. 7

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. C	11. C	21. B	31. A	41. D
2. D	12. D	22. D	32. A	42. C
3. B	13. B	23. D	33. D	43. A
4. B	14. C	24. A	34. C	44. B
5. D	15. A	25. D	35. D	45. C
6. D	16. A	26. A	36. D	46. D
7. D	17. A	27. D	37. C	47. B
8. D	18. B	28. C	38. C	48. A
9. B	19. C	29. A	39. A	49. C
10. B	20. B	30. D	40. C	50. C

51. A	61. D	71. C
52. D	62. A	**72. A**
53. D	63. B	**7 .**
54. A	64. A	**7 . A**
55. C	65. D	
56. C	66. C	
57. D	67. D	
58. A	68. C	
59. B	69. B	
60. D	70. B	

M.C. Solution

1. C

✓ (1) From deep to shallow water region, the wavelength would decrease.

× (2) The frequency would remain unchanged during refraction.

✓ (3) The velocity would decrease when water wave travels from deep to shallow water region.

2. D

$\lambda = 0.1 \times 2 = 0.2$ m

$v = f\lambda = (50)(0.2) = 10$ m s^{-1}

3. B

Distance between 2 adjacent nodes is equal to half of a wavelength.

$\therefore (4) \times \frac{\lambda}{2} = (20) \qquad \therefore \lambda = 10 \text{ cm}$

$\therefore v = f\lambda = (5)(10) = 50 \text{ cm s}^{-1}$

4. B

× (1) Same medium gives the same speed.

✓ (2) When the wave passes through narrow slit, diffraction occurs, giving a change in wave pattern.

× (3) Frequency is unchanged during diffraction.

5. D

P is at the crest, thus P is momentarily at rest.

For a stationary wave, all particles within the same loop are in phase, thus A is also momentarily at rest.

6. D

Distance between the 11 crests $= 10\lambda$

$\therefore \lambda = \frac{0.2}{10} \text{m}$

$v = f\lambda = (2) \times \left(\frac{0.2}{10}\right) = \frac{0.4}{10} \text{ m s}^{-1}$

7. D

As the stationary wave is at its maximum vibration,

each particle is at their extreme positions with maximum displacement, thus each particle is momentarily at rest.

8. D

Frequency : no change in source $\Rightarrow$ no change in frequency

Wavelength : no change in medium $\Rightarrow$ no change in speed $\Rightarrow$ no change in wavelength

9. B

X : $\Delta = 1\frac{3}{4}\lambda - 1\lambda = \frac{3}{4}\lambda$ $\therefore$ No interference

Y : $\Delta = 1\frac{1}{2}\lambda - 1\frac{1}{2}\lambda = 0\lambda$ $\therefore$ Constructive interference

Z : $\Delta = 2\lambda - 1\lambda = 1\lambda$ $\therefore$ Constructive interference

10. B

For stationary wave, after $\frac{1}{4}$ period, the particles at antinodes will be at the equilibrium positions.

Therefore, the waveform will become a horizontal line.

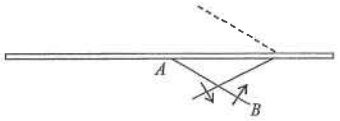
11. C

✓ (1) For the same medium, the same speed is unchanged.

× (2) Diffraction occurs when the wave passes through the slit and spreads out to give a change of direction.

✓ (3) Frequency is unchanged during diffraction.

12. D



Draw the dotted line that the incident pulse appears to be.

Then reflect the dotted line to give the reflected pulse. The reflected pulse should be at the right side of the barrier.

13. B

All the figures in A, B, C give proper diffraction pattern.

However, since it is uniform depth, there is no change in speed, thus no change in wavelength

$\therefore$ B is correct since the wavelength remains the same.

14. C

Wavelength : $\lambda = \frac{20}{4} = 5 \text{ cm}$

Speed : $v = f\lambda = (50)(0.05) = 2.5 \text{ m s}^{-1}$

15. A

$\Delta = 53 - 50 = 3 \text{ cm}$

For constructive interference to occur, $\Delta = n\lambda$ where $n = 0, 1, 2, \ldots$.

A. If $\lambda = 1$ cm, then $\Delta = 3 \text{ cm} = 3\lambda$, thus constructive interference occurs.

B. If $\lambda = 2$ cm, then $\Delta = 3 \text{ cm} = 1.5\lambda$, thus destructive interference should occur.

C. If $\lambda = 4$ cm, then $\Delta = 3 \text{ cm} = 0.75\lambda$, thus neither constructive nor destructive interference occurs.

D. If $\lambda = 6$ cm, then $\Delta = 3 \text{ cm} = 0.5\lambda$, thus destructive interference should occur.

16. A

A, B, C give proper diffraction pattern.

After the wave passes through the slit, it is a deep region, thus the wave speed increases, and the wavelength increases.

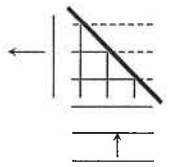
17. A

✓ (1) Path difference at any point on $MN = 0$, thus constructive interference occurs along MN.

× (2) Alternate constructive and destructive interference occurs along PQ .

× (3) Crest and trough can both be formed at points of constructive interference.

18. B



No change in medium, thus no change in speed and no change in wavelength.

19. C

× A. Particle P vibrates vertically about its equilibrium position only; at this instant, P is momentarily at rest
× B. Q is a node, thus it is always at rest
✓ C. R is a node, thus it is always at rest
× D. P has the maximum amplitude while Q has zero amplitude.

20. B

Tilting ⇒ at middle is the same depth but increasing depth to the right and decreasing depth to the left
⇒ increasing wave speed to the right and decreasing wave speed to the left
⇒ increasing wavelength to the right and decreasing wavelength to the left

21. B

× (1) Increase of width gives smaller degree of diffraction.
× (2) Degree of diffraction is independent of the position of the source.
✓ (3) Increase of the wavelength gives greater degree of diffraction

22. D

✓ A. The distance between X and Y, i.e. distance between 2 nodes, is half of the wavelength.
✓ B. All the particles within the same loop vibrate in phase, thus vibrate in the same direction.
✓ C. All particles in the same wave vibrate with the same frequency.
× D. Different particles have different amplitudes in a stationary wave.

23. D

The wave on the string and the wave in air have the same frequency as they come from the same source.

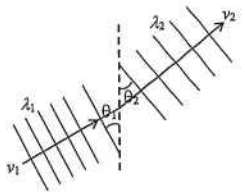
24. A

× A. At this instant, P is the antinode which has the maximum amplitude. Q has smaller amplitude.
✓ B. Particles in the same loop must move in the same phase
✓ C. Q is at maximum displacement and must be momentarily at rest
✓ D. Since distance between 2 nodes is half of the wavelength which is 0.2 m $\therefore \lambda = 0.4$ m

25. D

✓ (1) Bending around the corners is diffraction
✓ (2) No change in depth of water, thus no change in medium, giving no change in speed
✓ (3) The increase of wavelength gives greater degree of diffraction

26. A



Shallow → deep ⇒ speed increases
⇒ wavelength increases
⇒ angle made with the boundary increases

27. D

Wavelength decreases ⇒ speed decreases ⇒ refraction occurs
The wave bends round corner ⇒ diffraction occurs

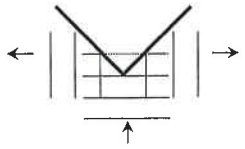
28. C

Water wave travels faster in deep region ⇒ $v_1 > v_2$ ∴ (2) is correct
No change in source ⇒ $f_1 = f_2$ ∴ (3) is not correct
By $v = f\lambda$ ⇒ $\lambda_1 > \lambda_2$ ∴ (1) is correct

29. A

The change of medium results in refraction, but in refraction, there is no change in frequency
Frequency remains the same of 30 Hz

30. D



31. A

The most significant diffraction effect occurs when
① wavelength is greater
② slit size is smaller
∴ A is the best choice.

32. A

Water wave in shallow region travels with a smaller speed, thus the wavelength is decreased.

When entering the shallow region, it moves a shorter distance, thus bending occurs.

33. D

✓ (1) By $v = f\lambda$ as v and f remain unchanged, λ is unchanged.

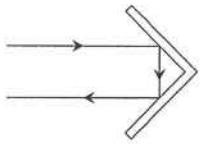
✓ (2) Frequency depends on source only, so it is unchanged.

✓ (3) Speed depends on medium only, so it is unchanged.

34. C

Diffraction occurs when water waves passes through a small opening.

35. D



Consider the direction of travel of the wave, the wave reflects two times and travels backwards.

36. D

× A. During diffraction through the narrow slit, the direction of travel changes from one direction to many direction by spreading out from the slit.

× B. The speed decreases when the water waves travel from deep region to shallow region.

× C. The wavelength decreases when the water waves travel from deep region to shallow region.

✓ D. The frequency remains unchanged during diffraction and refraction.

37. C

✓ (1) A smaller gap can give greater degree of diffraction.

× (2) By increasing the frequency, the wavelength is decreased. Thus, the degree of diffraction is decreased.

✓ (3) By adding more water, depth is increased, thus speed is increased, wavelength is then increased. Therefore, the degree of diffraction is increased.

38. C

✓ (1) Since the path difference at P is equal to 1 λ, constructive interference occurs at P.

× (2) At points of constructive interference, crest or trough may form.

✓ (3) If the wavelength is doubled, path difference : $\Delta = \frac{1}{2}(2\lambda)$, thus destructive interference occurs.

39. A

P is an antinode. After a quarter of a period, it is at the equilibrium position. At that instant, it should move upwards.

Q is a node. It is always at rest.

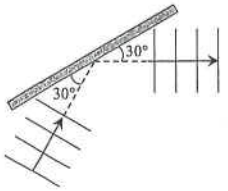
40. C

× (1) Changing the amplitude of the waves would not affect the positions of constructive interference

✓ (2) $\lambda \uparrow \Rightarrow$ separation between two lines of constructive interference $\uparrow$

✓ (3) Separation between the point sources $\downarrow \Rightarrow$ separation between two lines of constructive interference $\uparrow$

41. D



During reflection, incident angle = reflected angle

Note that both the incident angle and the reflected angle equal 60°.

42. C

Since water wave is a transverse wave,

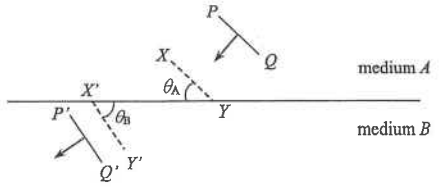
the cork would oscillate vertically up and down about its original position.

43. A

As shown in the above diagram, $\theta_B > \theta_A$

During refraction : $\sin\theta \propto v \propto \lambda$.

$\therefore v_B > v_A$ and $\lambda_B > \lambda_A$



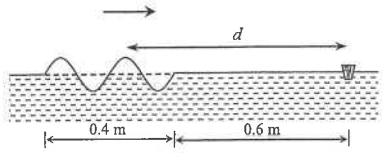
44. B

× (1) Direction of travel would change after diffraction from the slit.

× (2) Speed would change after refraction as the light travels from air to water.

✓ (3) Frequency depends on the source only, it remains unchanged during refraction and diffraction.

45. C



Distance d between the nearest crest and the cork = 0.15 + 0.6 = 0.75 m

By $d = vt$ $\therefore$ $(0.75) = (0.2)\,t$ $\therefore$ $t = 3.75$ s

46. D

At the time instant shown, point P is at the trough position of wave 1 and also trough position of wave 2.

Thus it is at the lowest position.

Moreover, trough and trough gives constructive interference, thus P is at constructive interference.

47. B

As the wave speed depends on the medium, sound wave in air and the wave in the string should have different speeds.

As the two waves come from the same source, they must have the same frequency.

By $v = f\lambda$, they must have different wavelength.

48. A

✓ (1) At A, crest meets trough to give destructive interference, thus the particle there is always at rest.

× (2) At B, crest meets crest to give constructive interference, B then vibrates with the greatest amplitude. However, B would be sometimes at the crest and sometimes at the trough as it vibrates up and down.

× (3) From the graph, $S_1 C = 1.25\,\lambda$ and $S_2 C = 2.25\,\lambda$.
Path difference at $C = 2.25\,\lambda - 1.25\,\lambda = 1\,\lambda$. Thus C is at constructive interference.

49. C

× A. When water waves pass through S_1 and S_2, diffraction occurs.

× B. P is at the crest, with positive displacement; Q is at the trough, with negative displacement.

✓ C. Q is at the position of trough on trough, thus give greater trough to have constructive interference.
The path difference at $Q = 3.5\,\lambda - 2.5\,\lambda = 1\,\lambda$ ∴ constructive interference occurs at Q

× D. At this instant, P is at the crest, but later the displacement of P would vary, it may be at the trough later.

50. C

Water wave in deeper region moves with a greater speed.

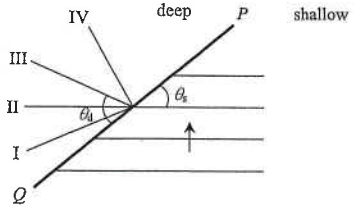
∴ $v_d > v_s \Rightarrow \theta_d > \theta_s$

∴ III is the possible wavefront

IV is not correct

since the wavefront makes a refracted angle greater than 90°

with the boundary, which is impossible.



51. A

✓ (1) $f\uparrow \Rightarrow \lambda\downarrow \Rightarrow$ number of loops increases $\Rightarrow$ number of antinodes on the string ↑

× (2) Speed on the same medium is constant, not affected by the change of frequency.

× (3) The two waves are in different medium, they have different speed.

52. D

× (1) Waves from two coherent sources may have similar amplitude, due to different path lengths.

✓ (2) Two coherent sources must have same frequency, thus same wavelength.

✓ (3) Two coherent sources must have constant phase relationship.

53. D

Principle of Superposition can be applied to :

all types of waves with different frequency, amplitude, directions and phase.

54. A

① Amplitude of each travelling wave $= \frac{1}{2}A = 1$ cm

② Wavelength of each travelling wave $= 45 \times \frac{2}{3} = 30$ cm

55. C

As the wavelength in medium 1 is longer, the wave in medium 1 has greater speed.

✓ (1) light waves travel with greater speed in air than in water

✓ (2) sound waves travel with greater speed in water than in air

× (3) water waves travel with smaller speed in shallow water than in deep water

56. C

P has crest on crest and R has trough on trough, both of them have constructive interference.

At $t = 0$, displacement of R is negative since it is at the trough position.

57. D

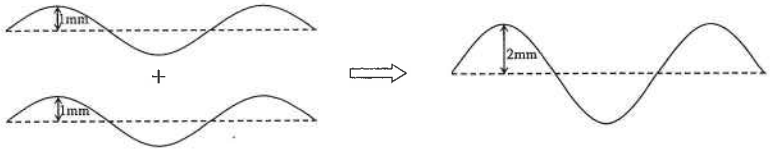
× (1) Two waves with different frequency can be superposed.

× (2) Two waves with different amplitude can be superposed.

× (3) Two waves in opposite directions can be superposed.

The principle of superposition can be applied to any two waves of the same nature.

58. A



① Amplitude

The stationary wave is formed by two travelling waves in opposite direction superpose together.

The amplitude of each travelling wave should be 1 mm so that they add together to give the antinode of 2 mm.

② Wavelength $= 45 \times \frac{2}{3} = 30$ cm

59. B

Wavelength : $\lambda = 90 \times \frac{2}{3} = 60$ cm $= 0.6$ m

Speed : $v = f\lambda = (50)(0.6) = 30$ m s^{-1}

60. D

P is at the extreme point, that is, the crest of its oscillation at $t = 0$.

61. D

× (1) P and Q may not reach the extreme positions, thus they may not be momentarily at rest.

✓ (2) Q and R are in antiphase (opposite phase), they reach their own equilibrium positions at the same time.

✓ (3) P and R are at adjacent loop, they must always be in antiphase.

62. A

✓ (1) If the gap is narrower, the degree of diffraction will increase.

✓ (2) As the wavelength of the waves increases, the degree of diffraction will increase.

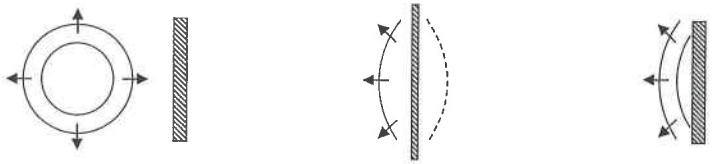
× (3) The degree of diffraction is not affected by the amplitude of the waves.

63. B

The wave grows until it is reflected by the walls.

Use dotted line to show the incident pulse behind the walls.

The reflection of the dotted pulse gives the reflected pulse.



64. A

✓ (1) As shown in the figure, the period T of the two waves are both 4 divisions,
by $f = \frac{1}{T}$, they have the same frequency f.

× (2) When P is at the crest, Q is not at the trough, thus they are no in anti-phase.

× (3) The amplitude of P is 1 division and the amplitude of Q is 3 divisions.
Since the two waves are not in phase,
the amplitude of their resultant wave would not be the sum of their individual amplitudes,
thus the amplitude of their resultant wave would not be 4 divisions, that is, not 4 times of that of P.

65. D

As the tension in the string is increased, speed of the transverse wave along the string increases.

Since the frequency is unchanged,

by $v = f\lambda$, the wavelength increases.

The only option that shows an increase of wavelength of standing wave is D.

66. C

$\lambda = 20$ m

From crest to trough, it is $\frac{1}{2}$ cycle, thus it takes a time of $\frac{1}{2}$ period.

$\therefore \frac{1}{2}T = 2$ s $\quad \therefore T = 4$ s

Speed of the wave :

$$v = \frac{\lambda}{T} = \frac{20}{4} = 5 \text{ m s}^{-1}$$

OR

$$f = \frac{1}{T} = \frac{1}{4} = 0.25 \text{ Hz}$$

$$v = f\lambda = (0.25)(20) = 5 \text{ m s}^{-1}$$

67. D

× A. When the frequency doubles, the wavelength should become halved.

× B. The wave speed is not affected by the frequency, thus it should be unchanged.

× C. The amplitude is not affected by the frequency, thus it should be unchanged.

✓ D. When frequency doubles, the wavelength becomes halved.
The number of loops in the stationary wave changes from 4 loops to 8 loops.
Particle X is 5th loop and particle Y is in the 7th loop, counted from the vibrator.
Particles in these two loops are all vibrating in phase.

68. C

× A. During refraction, speed v is proportional to wavelength λ.
As the wavelength in X is smaller, the speed of water wave in X should be smaller than that in Y.

× B. As shown in the figure, the direction of travel in region Y should be bent away from the normal.

✓ C. The frequency of wave must remain unchanged during refraction.

× D. The ratio of wavelengths in the two regions should remain unchanged.
Thus, the ratio should be 4 : 5, but not 5 : 6.

69. B

✓ (1) When a wave is reflected, it direction must change.

× (2) When a wave enters from one medium to another medium, refraction occurs.
During refraction, the direction may not change if the angle of incidence is 0° along the normal.
Thus, the direction may not change during refraction.

✓ (3) When a wave travels through a gap, diffraction occurs.
The wave spreads out through the gap, thus the direction must change.

70. B

× (1) Degree of diffraction is not affected by the amplitude of the wave.

× (2) To increase the degree of diffraction, width of obstacle should be decreased.

✓ (3) Longer wavelength gives greater degree of diffraction.

71. C

There are 5 loops in the stationary wave. The length of each loop is 0.5 λ.

$\therefore$ $5 \times 0.5\ \lambda = 1$

$\therefore$ $\lambda = 0.4$ m

By $v = f\lambda$

$\therefore$ $(7) = f\ (0.4)$

$\therefore$ $f = 17.5$ Hz

Part A : HKCE examination questions

1. **< HKCE 1979 Paper I - 6 >**

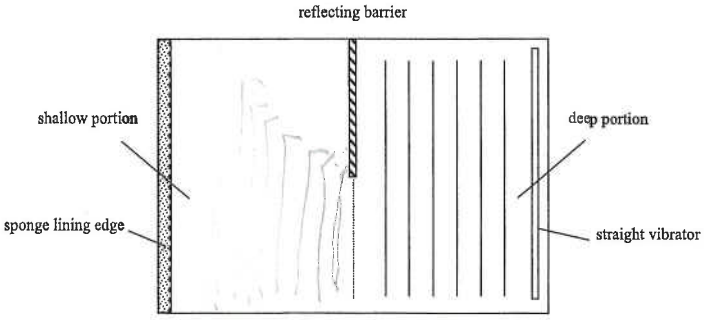
(a) What are the uses of the following parts of a ripple tank in wave experiments ?

(i) a dot vibrator, (1 mark)

(ii) the shallow portion of the tank, (1 mark)

(iii) the spongy lining around the edges of the tank. (1 mark)

(b) In a ripple tank experiment, waves are generated by a straight vibrator as shown below.



(i) In the above figure, sketch the wave pattern at the shallow portion of the tank. (3 marks)

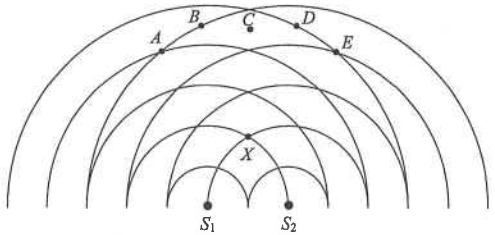
(ii) What phenomena occur in the shallow portion of the tank ? (2 marks)

2. **< HKCE 1984 Paper I - 5 >**

In a ripple tank experiment, a generator produces a train of straight waves travelling towards a barrier with two narrow slits. The distance between two successive wave crests is found to be 2 cm.

(a) The ripple tank is illuminated by a stroboscope lamp. The wave motion appears to be stationary when the frequency of the stroboscope lamp is 10 Hz. What is the speed of the train of waves ? (3 marks)

(b)



Two sources S_1 and S_2 vibrating in phase give out water waves. The above figure shows the pattern of water waves at a certain instant.

(i) Explain why the energy of the water waves is at a maximum at points A and E and is at a minimum at points B and D. (4 marks)

(ii) Since very little or no wave motion is seen at points B and D, a student concludes that energy disappears there. Explain briefly where the energy goes. (2 marks)

(iii) Sketch the water level along the line XC at the above instant. (2 marks)

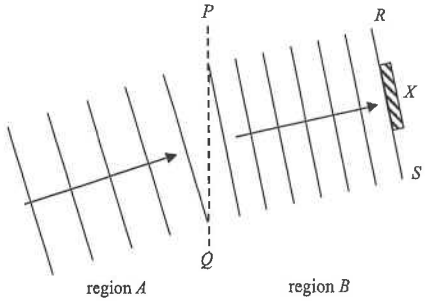
(iv) How would the separation between A and C change if

(1) the frequency of the generator increases, and

(2) the separation between the two sources increases ? (2 marks)

3. **< HKCE 1985 Paper I - 5 >**

In a ripple tank experiment, a train of water waves are produced by a straight vibrator of frequency 10 Hz. The train of waves goes from region A to another region B through a straight boundary PQ as shown in the figure below. The two regions are of different depths. The distance between two successive crests of the waves in region A is 0.03 m while that of the waves in the region B is 0.02 m.



(a) Describe briefly how to set up two regions of different depths in a ripple tank. (2 marks)

(b) Describe briefly how to measure the distance between the crests of two successive wavefronts. (4 marks)

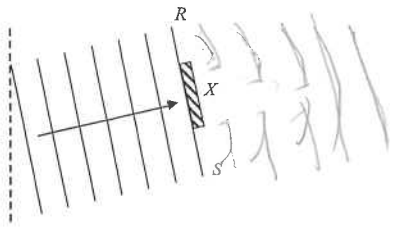
(c) Find the speeds of the trains of water waves in

(i) region A, and

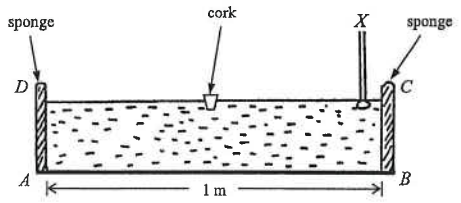
(ii) region B. (4 marks)

(d) Which of the regions, A or B, is deeper ? (1 mark)

(e) If a barrier X is now placed in position RS as shown in the figure, which wave phenomenon would occur ? Sketch the wave pattern that you expect to observe. (2 marks)



4. **< HKCE 1989 Paper I - 5 >**



A glass tank is filled with a liquid. A cork is placed at the mid-point of the tank as shown above. A vibrator X is moving up and down at the surface producing straight waves.

(a) Describe the motion of the cork. (1 mark)

(b) Suggest a simple method of measuring the wavelength of the wave using a stroboscope. (3 marks)

(c) It takes 2 s for the waves generated by X to reach the opposite end AD of the tank. During this time interval, the vibrator makes 5 'up' and 'down'. Find

(i) the frequency,

(ii) the wavelength, and

(iii) the speed of the wave. (6 marks)

(d) If another vibrator placed at the opposite end AD is also moving in exactly the same way as X, what will be the change in the amplitude of the movements of the cork ? Explain briefly. (3 marks)

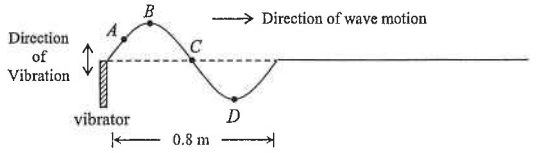
(e) If the tank is tilted so that A is higher than B and X is moving as before, sketch a diagram to show the wave form that would be observed when viewed from the side $ABCD$. (2 marks)

5. **< HKCE 1990 Paper I - 5 >**

A vertical vibrator generates waves on a string. It takes 0.25 s to produce a complete wave of wavelength 0.8 m on the string.

(a) Find the frequency and speed of the waves on the string. (3 marks)

(b) The figure below shows the shape of the string at the instant when the vibrator has made one complete vibration.



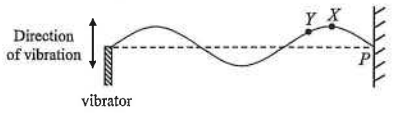
(i) At the instant shown, which of the particles A, B, C, D is/are

(1) moving downwards,

(2) at rest ? (2 marks)

(ii) Sketch the shape of the string after 0.125 s. In your figure show the positions of the particles A, B, C and D. (4 marks)

(c) A certain point P on the string is fixed to the wall so that a stationary wave is formed. The figure below shows the string at the instant of maximum displacement.

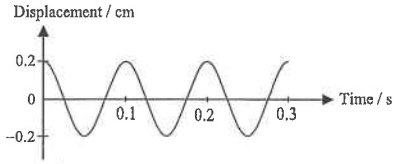


(i) Describe the motion of particles X and Y at this instant.

(ii) Sketch the shape of the string after one quarter on a cycle. (4 marks)

(d) The vibrating string in (c) also sets the neighbouring air vibrating. List two differences between the waves in air and those on the string. (2 marks)

6. **< HKCE 1994 Paper I - 5 >**

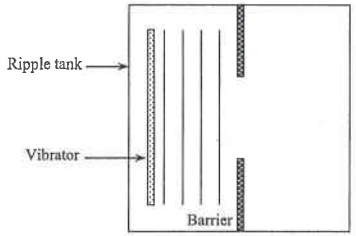


A train of straight waves is generated in a ripple tank. The figure above shows the displacement-time graph of a cork placed in the water. The waves take 0.5 s to travel a distance of 12 cm.

(a) Find the amplitude, frequency, speed and wavelength of the waves. (5 marks)

(b) Suggest one method to prevent water waves from bouncing back at the edges of the tank. (2 marks)

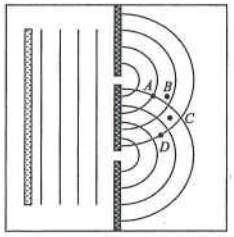
(c) A barrier with an opening is placed in the ripple tank and the waves travel towards it as shown in the figure below.



(i) On the above figure, sketch the wave pattern formed on the other side of the barrier. (2 marks)

(ii) Name this wave phenomenon. (1 mark)

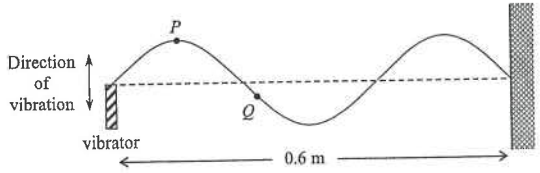
(d) The barrier in (c) is replaced by one with two smaller openings.



(i) The figure above shows the wave pattern at a certain instant. Among the 4 points A, B, C and D, state a point of constructive interference and a point of destructive interference. (2 marks)

(ii) A student says that at a point of constructive interference, a crest is always formed. Is the student correct ? Explain briefly. (3 marks)

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

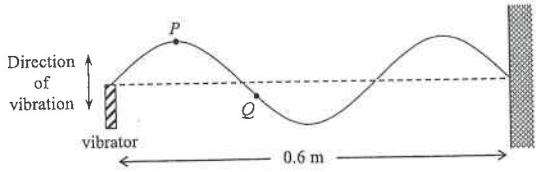


A string is fixed at one end to a wall and a vibrator generates a stationary wave on the string. The distance between the ibrator and the wall is 0.6 m. The figure above shows the string at the instant of maximum displacement.

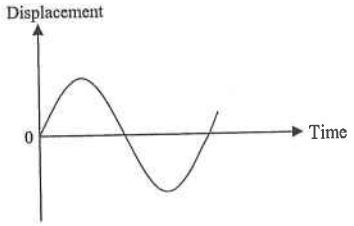
(a) Find the wavelength of the stationary wave. (1 mark)

(b) Describe the motion of particles P and Q at this instant. (2 marks)

(c) In the below figure, mark in the positions of the nodes (labelled as N) and antinodes (labelled as A). (2 marks)



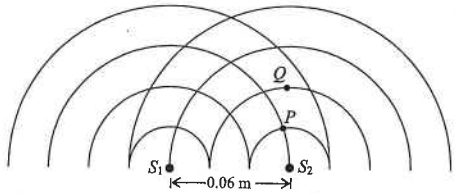
(d) The figure below shows the displacement ~ time graph of particle P.



In the above figure, sketch the displacement-time graph of particle Q. (2 marks)

(e) The vibrating string also sets the neighbouring air into vibration. State two differences between the waves on the string and those in air. (2 marks)

8. **< HKCE 1997 Paper I - 2 >**



Two dippers S_1 and S_2 vibrate in phase producing identical circular water waves in a ripple tank. The Figure above shows the wave pattern at a certain instant. (Note : The dark lines represent crests.) The distance between S_1 and S_2 is 0.06 m and it is known that the water waves travel with a speed of 0.4 m s^{-1}.

(a) Find the wavelength and frequency of the water waves. (3 marks)

(b) The ripple tank has a spongy lining at its edges. Explain the function of the spongy lining. (2 marks)

(c) P and Q are two points at the water surface as shown in the above Figure. Find the path difference at

(i) point P, and

(ii) point Q

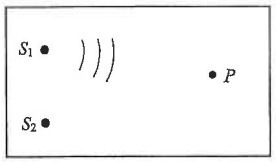
from S_1 and S_2, giving the answers in terms of the wavelength λ of the water waves.

Hence state the types of interference occurring at P and Q. (4 marks)

(d) How would the interference at Q be affected if the frequency of vibration of the two dippers is doubled ? Explain your answer. (Note : You may assume that the speed of the water waves remains unchanged.) (3 marks)

(e) If only one dipper is available, suggest a method of producing an interference pattern in the ripple tank. Illustrate your answer with a diagram. (2 marks)

9. **< HKCE 2001 Paper I - 4 >**



A dipper S_1 is connected to a vibrator and produces circular water waves in a ripple tank. A cork is placed at a point P on the water surface as shown in the above figure.

(a) Describe the motion of the cork as the water waves pass through it. (1 mark)

(b) Suppose another dipper S_2 is connected to the same vibrator and produces identical water waves. It is known that $S_1P = 6.0$ cm, $S_2P = 7.8$ cm and the wavelength of the water waves is 1.2 cm.

(i) Name the wave phenomenon that occurs when both dippers vibrate. (1 mark)

(ii) How would the motion of the cork be affected ? Explain your answer. (3 marks)

10. **< HKCE 2004 Paper I - 5 >**

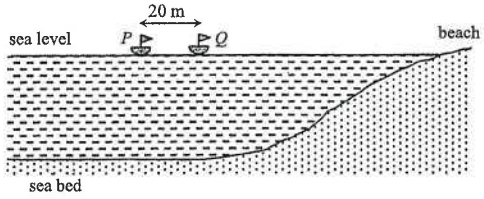


Figure 1

Figure 1 above shows a sectional view of a beach. Two boats are located at positions P and Q as shown, where PQ = 20 m. Straight water waves travel towards the beach. The waves take 4 s to travel from P to Q.

(a) Find the average speed of the waves between P and Q. (2 marks)

10. (b)

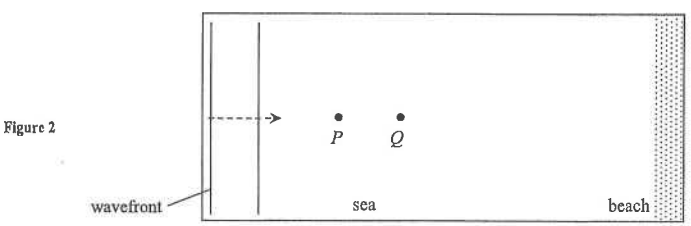


Figure 2 shows the view of the beach from above. In Figure 2, draw the wave pattern observed when the waves travel towards the beach. (2 marks)

(c) Name the wave phenomenon that occurs as the waves travel towards the beach. (1 mark)

11. **< HKCE 2005 Paper I - 5 >**

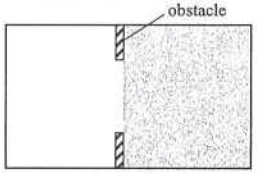


Figure 1

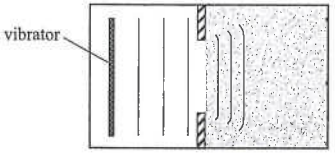


Figure 2

Figure 1 shows a ripple tank with a deep region P and a shallow region Q.

(a) Suppose that two obstacles are added in the ripple tank as shown in Figure 1.

(i) Name two wave phenomena that may occur if water waves travel from P to Q. (2 marks)

(ii) Figure 2 shows the wave pattern observed when straight water waves are generated in P. Compare the wavelength and speed of the waves travelling in Q with those in P. (2 marks)

(b)

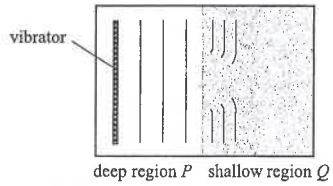


Figure 3

Suggest one method of obtaining the wave pattern in Q as shown in Figure 3. Illustrate your answer by completing Figure 3. (2 marks)

12. **< HKCE 2008 Paper I - 5 >**

Figure 1 shows a plastic box floating on the water surface of a pool which has a deep region and a shallow region. A boy tries to get the box back. He throws a stone into the water to produce waves and he expects that the water waves will "push" the box towards the poolside.

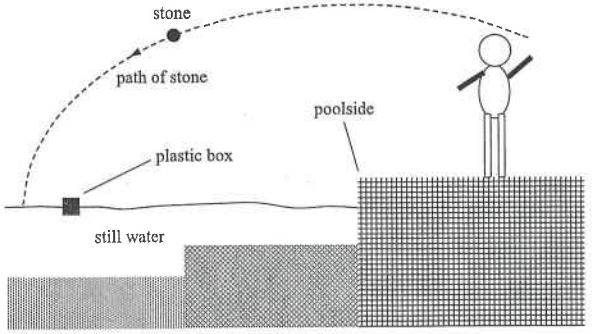


Figure 1

(a) According to the direction of motion of the water molecules, state the kind of wave produced on the water surface. (1 mark)

(b) Explain whether the water waves can "push" the box to the poolside. (2 marks)

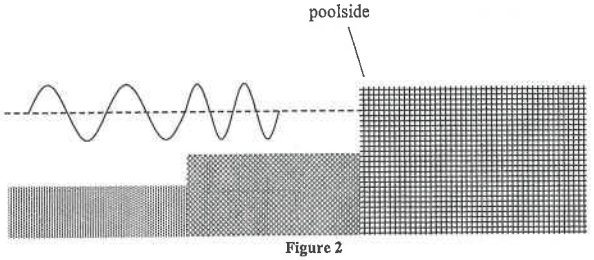


Figure 2

(c) Figure 2 shows a continuous water wave traveling towards the poolside. Deduce the relationship between the velocity of the water wave and the depth of water on the pool. Show your reasoning. (3 marks)

13. **< HKCE 2009 Paper I - 10 >**

In a ripple tank, initially five tiny plastic beads (P, Q, R, S, T) float on the calm water surface. A vibrator begins to produce straight waves at time $t = 0$. Figure 1 shows the positions of beads on the waves at $t = 7$ s. Figure 2 shows the displacement-time graph of S.

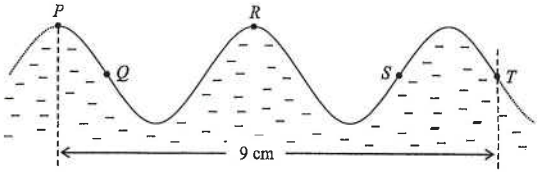


Figure 1

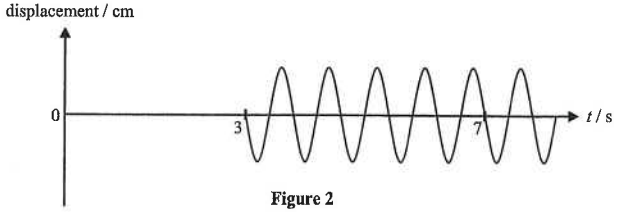


Figure 2

(a) (i) Find the wavelength of the wave. (1 mark)

(ii) Find the frequency of the wave. (2 marks)

(iii) Find the distance between the vibrator and S. (3 marks)

(b) State the bead(s) that is/are moving

(i) in the same direction with T at time $t = 7$ s, (1 mark)

(ii) in the opposite direction with T at time $t = 7$ s. (1 mark)

(c) In Figure 1, sketch the waveform between P and T at a quarter of period after $t = 7$ s. Mark the position of S. (2 marks)

14. **< HKCE 2010 Paper I - 11 >**

Figure 1 shows three points, A, B and X, in a ripple tank where $AX = 15$ cm and $BX = 25$ cm.

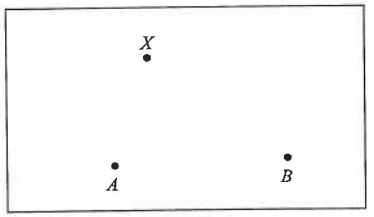


Figure 1

A dipper placed at A vibrates and produces circular water waves of wavelength 10 cm. Figure 2 shows the displacement-time graph for a water particle at X. (Take displacement upward as positive.)

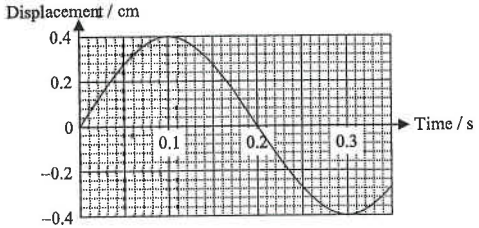


Figure 2

(a) (i) Find the amplitude of the water wave at X. (1 mark)

(ii) Find the speed of the water wave. (3 mark)

(iii) In Figure 3, sketch the waveform along the straight line AX at time $t = 0.2$ s. (Take displacement upward as positive.) (2 marks)

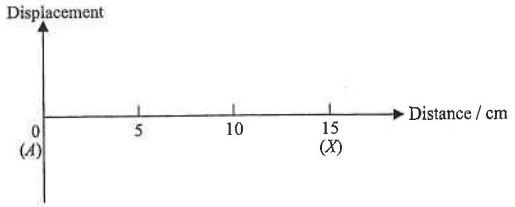


Figure 3

(b) Another dipper is now placed at B and always moves in the same direction as the dipper at A. Determine the type of interference occurring at X. (3 marks)

15. **< HKCE 2011 Paper I - 3 >**

Read the following passage about tsunamis and answer the questions that follow.

Tsunami

When earthquakes occur under the sea, the water above is vertically displaced and waves are formed as water attempts to regain equilibrium. When large areas of sea floor rise or sink, a tsunami can be produced. Other than earthquakes, landslides and undersea volcanic eruptions can also cause tsunamis.

Tsunamis are different from wind-generated waves. Wind-generated waves we usually see at beaches may have a wavelength of 150 m and a period of about 10 s. A tsunami, however, can have a wavelength exceeding 100 km and a period of a few hours.

As a result of their long wavelengths, tsunamis behave as shallow-water waves. Shallow-water waves move at a speed given by the equation $v = \sqrt{g\,d}$
where g is the acceleration due to gravity and d is water depth.

Tsunamis can travel great distances with limited energy losses. As tsunamis leave the deep water of the open sea and approach the coast, their wave speed decreases but their height grows. Tsunamis may reach a height onshore above sea level of 20 m or more and cause serious destruction.

(a) Name two natural phenomena that can cause tsunamis. (2 marks)

(b) The typical water depth is about 4000 m in the Pacific Ocean. Estimate the speed of a tsunami generated there. (1 mark)

(c) As shown in the map in the figure below, an undersea earthquake occurs at S and produces tsunamis. Both islands Q and R are struck by the tsunamis.

(i) Although island R is sheltered from S by island Q, why is it still struck by the tsunamis ? (1 mark)

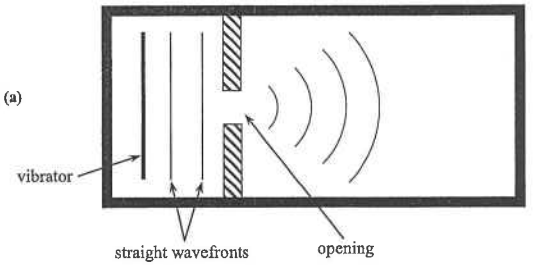
(ii) When the undersea earthquake occurs, a ship is at point P which is in the open sea deep water area as shown in the above figure. On receiving the tsunami warning, the captain of the ship decides to stay at P rather than going back to island Q. Referring to the given passage, comment on whether the captain's decision is correct or not. (2 marks)

Part B : HKDSE examination questions

16. **< HKDSE Practice Paper IB - 5 >**

(a) Two rectangular barriers are put into a ripple tank. A vibrator vibrating at 25 Hz produces water waves with straight wavefronts. The wavelength of the water waves is 0.8 cm. Circular wavefronts are observed after the water waves pass through the opening between the two barriers. Figure (a) shows the top view of the set-up.

Figure (a)



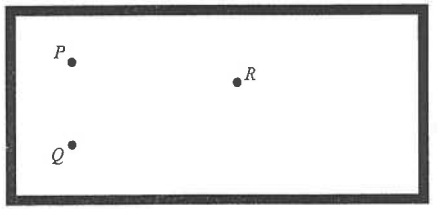
(i) Name the wave phenomenon that takes place when the water waves pass through the opening. (1 mark)

(ii) Calculate the speed of the water waves in the ripple tank. (2 marks)

(iii) If the experiment is repeated using a higher vibrator frequency, describe the changes, if any, in the wave pattern shown in Figure (a). (2 marks)

(b) Figure (b) shows three points, P, Q and R, in a ripple tank such that $PR = 8$ cm and $QR = 10$ cm. A dipper is put at P to produce circular water waves of wavelength 0.8 cm.

Figure (b)



Another identical dipper, vibrating in phase with the one at P, is later put at Q. Explain the change, if any, in the amplitude of the water wave at R. (3 marks)

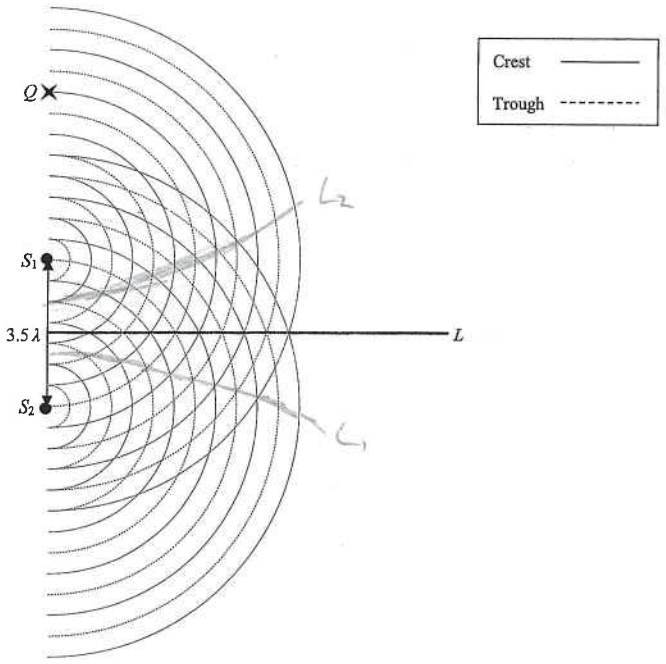
17. **< HKDSE 2012 Paper IB - 6 >**

In a ripple tank, circular water waves are produced by two vibrators S_1 and S_2 of the same frequency vibrating in phase. Their separation is 3.5 λ, where λ is the wavelength of the waves.

Figure (a) shows the two circular waves propagating on the water surface at a certain moment.

Line L is a line connecting all points P which have path difference $S_1P - S_2P = 0$.

Figure (a)



(a) (i) Draw and label a line in Figure (a) connecting all points P which have path difference

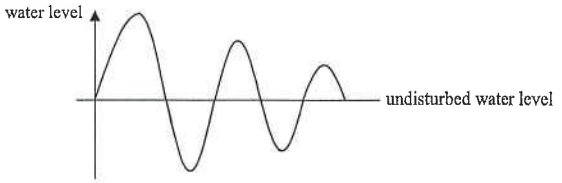
(1) $S_1P - S_2P = \lambda$ (label it as L_1)

(2) $S_1P - S_2P = -\frac{3}{2}\lambda$ (label it as L_2) (2 marks)

(ii) What would happen to L_1 and L_2 if the separation between S_1 and S_2 is reduced slightly ? (1 mark)

17. (b) Figure (b) shows the profile of the water level along line L at a certain instant. Sketch on the same figure the profile at a time $\frac{1}{2}T$ later, where T is the period of the water waves. (1 mark)

Figure (b)

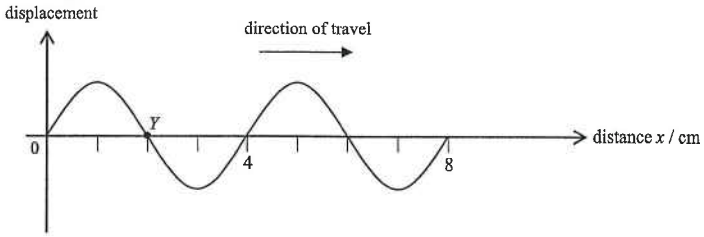


(c) Q is a point on the line joining S_1 and S_2 as shown in Figure (a). State the kind of interference that occurs at Q and give a reason for this occurrence. (2 marks)

18. **< HKDSE 2017 Paper IB - 6 >**

(a) A dipper vibrating with a frequency of 5 Hz is put in a water tank. Figure 1 shows the displacement-distance graph of the water wave at time $t = 0$. Y is a particle in the water tank.

Figure 1

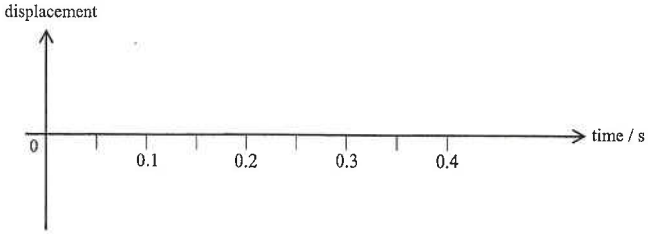


(i) Determine the wave speed of the water wave. (2 marks)

(ii) State the direction of motion of particle Y at $t = 0$. (1 mark)

(iii) Sketch the displacement-time graph of particle Y between $t = 0$ and $t = 0.4$ s in Figure 2. (2 marks)

Figure 2



18. (b) In Figure 3, A and B are two dippers vibrating in phase in a water tank. The distance between A and B is 6 cm. OP is the perpendicular bisector of AB. Q is a second minimum from P, where $AQ = 12$ cm and $BQ = 15$ cm.

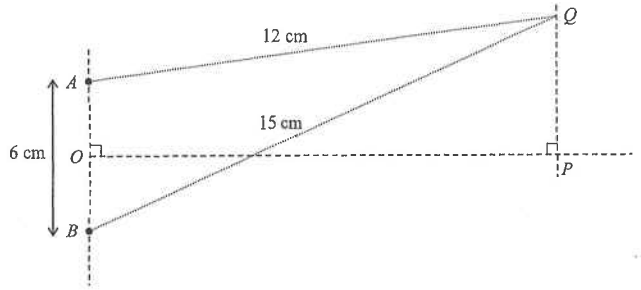


Figure 3

(i) Explain why a minimum occurs at Q. (2 marks)

(ii) Determine the wavelength of the water wave. (2 marks)

(iii) Sketch in Figure 4 how the **AMPLITUDE** of the water wave varies along the line OP. (1 mark)

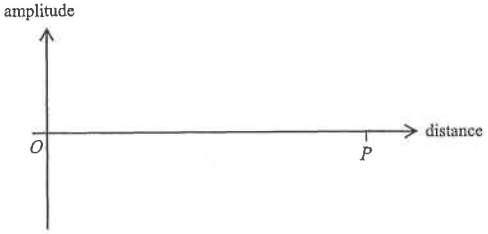


Figure 4

there is question in next page

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.

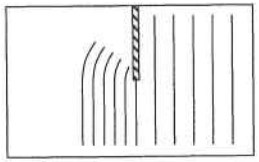
Question Solution

1. (a) (i) To act as a point source for producing circular wavefront. [1]

(ii) To show the phenomenon of refraction. [1]

(iii) To absorb the waves and prevent the rebounding of waves at the edges. [1]

(b) (i)



< wavefronts closer together > [1]

< waves spread out > [1]

< circular wavefronts shown > [1]

(ii) Diffraction and refraction occurs [2]

2. (a) f = 10 Hz [1]

$v = f\lambda = 10 \times 2$ [1]

$= 20$ cm s^{-1} [1]

(b) (i) At A and E, constructive interference occurs [2]

At B and D, destructive interference occurs [2]

(ii) Energy goes to the points of constructive interference [2]

(iii)

[2]

(iv) (1) separation would decrease [1]

(2) separation would decrease [1]

3. (a) Place a transparent plastic sheet totally immersed in water to give a shallow region [2]

(b) Freeze the wave pattern using a stroboscope [1]

Place a metre rule closed to the ripple tank. [1]

The position of 2 successive crests is marked on the metre rule. [1]

The length between the two marks is the wavelength. [1]

5. A ripple tank has a shallow region P and a deep region Q. Straight water wave of frequency 10 Hz is travelling in the shallow region as shown in Figure 5.1 when viewed from above.

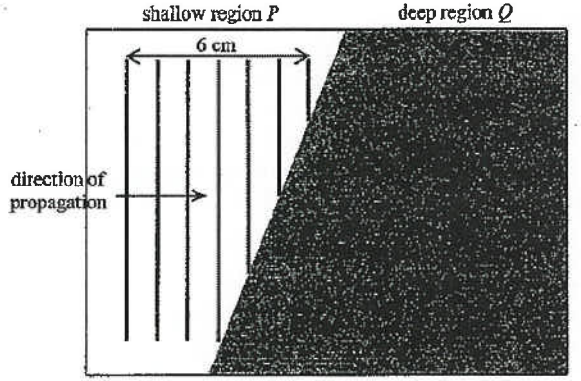


Figure 5.1 Top view

(a) The separation between seven crests in the shallow region is found to be 6 cm as shown.

(i) Find the wavelength of the wave in the shallow region. (1 mark)

(ii) What is the wave speed in the shallow region ?

(b) The water wave then propagates into the deep region where the wavelength of the wave is double that in the shallow region.

(i) State the frequency of the water wave in the deep region. (1 mark)

(ii) On Figure 5.1, sketch the wave pattern in the deep region. (2 marks)

(iii) Name the phenomenon occurred across the boundary and explain its cause. (2 marks)

3. (c) (i) $v = f\lambda = 10 \times 0.03$ [1]

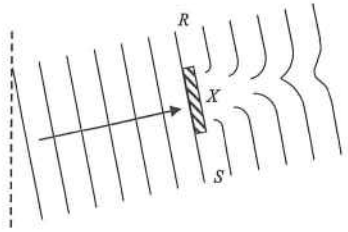
$= 0.3 \text{ m s}^{-1}$ [1]

(ii) $v = 10 \times 0.02$ [1]

$= 0.2 \text{ m s}^{-1}$ [1]

(d) Region A [1]

(e) Diffraction occurs [1]



[1]

4. (a) The cork moves up and down. [1]

(b) The wave motion can be frozen by viewing through a stroboscope. [1]

A metre rule is placed close to the tank. [1]

The wavelength is measured by marking the position of 2 successive wave crests on the meter rule. [1]

(c) (i) $f = \frac{5}{2}$ [1]

$= 2.5 \text{ Hz}$ [1]

(ii) $\lambda = \frac{1}{5}$ [1]

$= 0.2 \text{ m}$ [1]

(iii) $v = f\lambda = 2.5 \times 0.2$ **OR** $v = \frac{d}{t} = \frac{1}{2}$ [1]

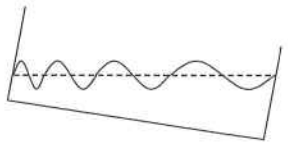
$= 0.5 \text{ m s}^{-1}$ $= 0.5 \text{ m s}^{-1}$ [1]

(d) Since the path difference at the cork is zero, [1]

constructive interference occurs. [1]

The cork will move up and down with greater amplitude. [1]

(e) [2]



5. (a) Frequency = 4 Hz [1]

$v = \frac{d}{t} = \frac{0.8}{0.25} = 3.2 \text{ m s}^{-1}$ [2]

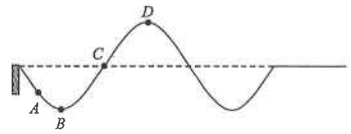
OR

$v = f\lambda = 4 \times 0.8 = 3.2 \text{ m s}^{-1}$ [2]

(b) (i) (1) A [1]

(2) B and D [1]

(ii)



< For wave form > [2]

< 0.5 mark for each particle > [2]

(c) (i) X and Y are both at rest. [2]

(ii)

[2]

(d) **Any TWO of the followings :** [2]

* Waves in air are longitudinal waves but waves on string are transverse waves.
* Waves in air are travelling waves but waves on the string are stationary waves.
* Waves in air and waves on string have different wavelengths (**OR** speeds).

6. (a) Amplitude = 0.2 cm [1]

Frequency $= \frac{1}{10} = 10 \text{ Hz}$ [1]

Speed $= \frac{d}{t} = \frac{0.12}{0.5} = 0.24 \text{ m s}^{-1}$ [1]

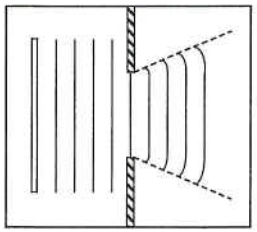
Wavelength $\lambda = \frac{v}{f} = \frac{0.24}{10}$ [1]

$= 0.024 \text{ m}$ [1]

(b) **Any ONE of the following :** [2]

* Insert spongy plastic (cotton wool) around the edge of the tank.
* Use water tanks that have sloping edges.

6. (c) (i)



[2]

(ii) Diffraction. [1]

(d) (i) A (or C) is a point of constructive interference. [1]

D is a point of destructive interference. [1]

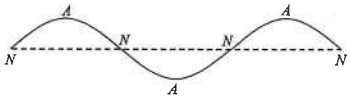
(ii) No. [1]

A trough can also be formed at points of constructive interference. [2]

7. (a) $\lambda = 0.4$ m [1]

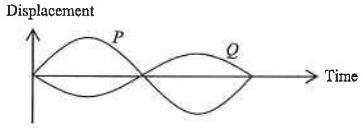
(b) Both P and Q are at rest at this instant. [2]

(c)



[2]

(d)



< Q and P are in opposite phase > [1]

< Amplitude of Q less than that of P > [1]

(e) **Any TWO of the following :** [2]

- Waves in air are travelling waves but waves on string are stationary waves
- Waves in air are longitudinal waves but waves on string are transverse wave
- Waves in air and waves on string have different wavelengths (or speeds)

8. (a) Wavelength = 0.02 m [1]

Frequency $= \frac{v}{\lambda} = \frac{0.4}{0.02} = 20$ Hz [2]

(b) To prevent water waves from bouncing back at the edges of the tank. [2]

OR

To absorb the water waves. [2]

8. (c) (i) Path difference at $P = 2\lambda$ [1]

$\therefore$ Constructive interference occurs at P. [1]

(ii) Path difference at $Q = 1\frac{1}{2}\lambda$ [1]

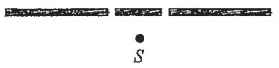
$\therefore$ Destructive interference occurs at Q. [1]

(d) If the frequency of vibration is doubled, the wavelength of the water waves would become halved. [1]

The path difference at Q would then be equal to 3 times the wavelength of the water waves, [1]

so the interference at Q becomes constructive. [1]

(e) Place a barrier with two small openings in front of the dipper. [1]



[1]

9. (a) The cork will move up and down. [1]

(b) (i) It is called interference. [1]

(ii) Path difference at $P = S_2P - S_1P$

$= 7.8 - 6.0 = 1.8$ cm [1]

$= 1\frac{1}{2}\lambda$ [1]

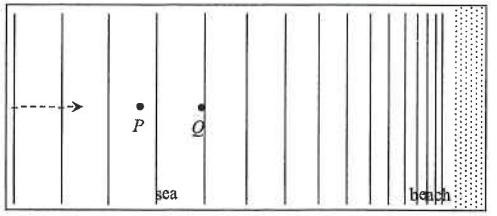
Since destructive interference occurs at P, the amplitude of vibration would decrease (**OR** become zero). [1]

10. (a) $v = \frac{d}{t}$ [1]

$= \frac{20}{4}$

$= 5\ \text{m s}^{-1}$ [1]

(b)



< wavelength shorter at right hand side > [1]

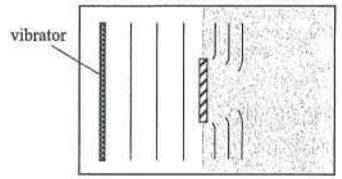
< correct pattern > [1]

(c) Refraction [1]

11. (a) (i) diffraction and [1]
refraction [1]

(ii) wavelength in Q is smaller than that in P [1]
speed in Q is smaller than that in P [1]

(b) Add an obstacle into the ripple tank. [1]



[1]

12. (a) transverse wave [1]

(b) As the water wave travels to the pool deck, the water particles only move up and down. [1]
Therefore, the water wave cannot push the box to the pool deck. [1]

(c) The wavelength decreases as the wave travels to the shallow region. [1]
As the frequency remains unchanged, [1]
the velocity of the water wave decreases as the depth decreases. [1]

13. (a) (i) $\lambda = \dfrac{9}{2.25} = 4$ cm [1]

(ii) $T = \dfrac{7-3}{5} = 0.8$ s [1]

$f = \dfrac{1}{T} = 1.25$ Hz [1]

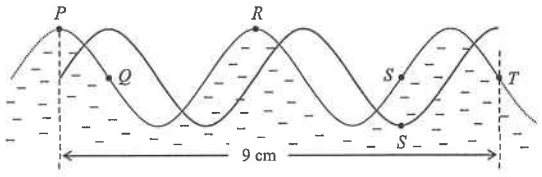
(iii) $v = f\lambda = (1.25)(4) = 5$ cm s^{-1} [1]

$d = vt = (5) \times (3)$ [1]
$= 15$ cm [1]

(b) (i) Q [1]

(ii) S [1]

(c)



< correct waveform > [1]
< correct position of S > [1]

14. (a) (i) Amplitude = 0.4 cm [1]

(ii) $T = 0.4$ s

$f = \dfrac{1}{T} = \dfrac{1}{0.4} = 2.5$ Hz [1]

$v = f\lambda$ [1]

$= (2.5)(0.1) = 0.25$ m s^{-1} < accept 25 cm s^{-1} > [1]

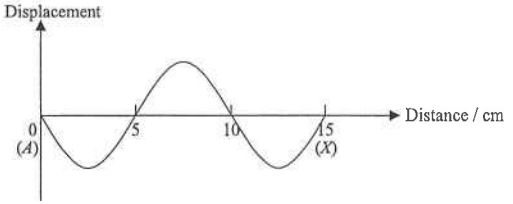
OR

$v = \dfrac{d}{t}$ [1]

$= \dfrac{0.1}{0.4}$ [1]

$= 0.25$ m s^{-1} [1]

(iii)



< zero displacement at A, X > [1]
< 1.5 waves drawn correctly > [1]

(b) Path difference = 25 – 15 [1]
= 10 cm = 1 λ [1]

Constructive interference occurs at X. [1]

15. (a) **Any TWO of the followings :** [1+1]
- ✶ earthquakes
- ✶ landslides
- ✶ volcanic eruptions

(b) $v = \sqrt{g\,d} = \sqrt{9.81 \times 4000} = 198$ m s^{-1} [1]

(c) (i) The tsunamis undergo diffraction and get around island Q. [1]

(ii) **Any ONE of the following reason :** [1]
- ✶ The height of the tsunami grows as it travels near to the coast.
- ✶ The height of the tsunami is small in open sea.
- ✶ The tsunami may cause serious damage near the shore.

So, the captain's decision is correct. [1]

16. (a) (i) Diffraction [1]

(ii) $v = f\lambda = (25) \times (0.8)$ [1]

$= 20 \text{ cm s}^{-1}$ [1]

(iii) The wavelength of the water wave decreases. [1]

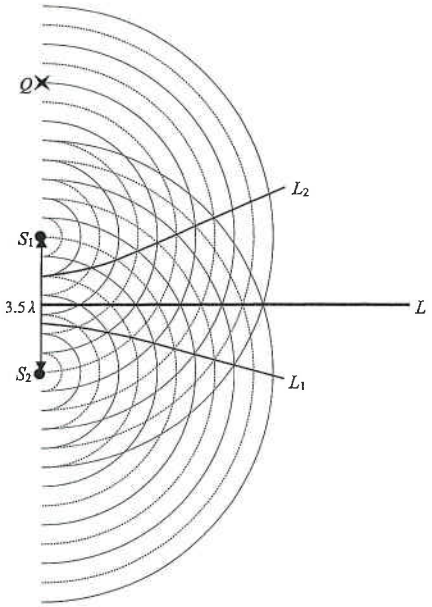
The degree of diffraction decreases. [1]

(b) Path difference at R = 2.0 cm = 2.5 λ [1]

Destructive interference occurs at R. [1]

Amplitude of the water wave at R decreases when another dipper is placed at Q. [1]

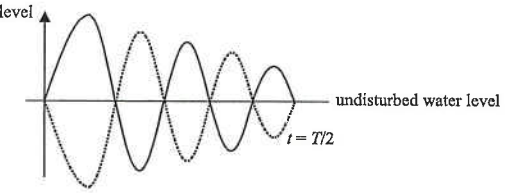
17. (a) (i)



[1]

(ii) L_1 and L_2 will be further away from L. [1]

(b)



[1]

(c) The path difference at Q is 3.5 λ. ($QS_1 = 4\lambda$ and $QS_2 = 7.5\lambda$) [1]

Thus, destructive interference occurs at Q. [1]

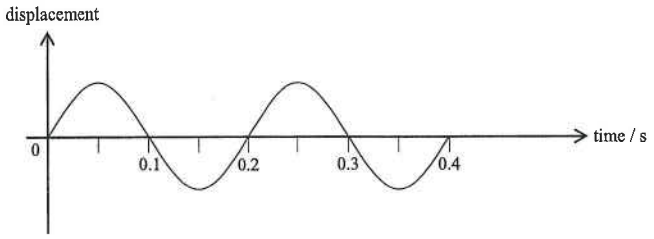
18. (a) (i) $v = f\lambda$

$= 5 \times 4$ [1]

$= 20 \text{ cm s}^{-1}$ < accept 0.2 m s^{-1} > [1]

(ii) Y is moving upwards [1]

(iii)



< Two waves drawn > [1]

< All the shapes are correct > [1]

(b) (i) The water waves from A and B meeting at Q are in opposite phase. [1]

OR

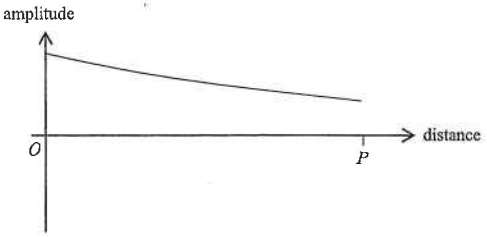
The path difference at Q is equal to 1.5 λ. [1]

Thus, destructive interference occurs to form a minimum. [1]

(ii) Path difference at Q = 1.5 λ = 3 cm [1]

Wavelength : λ = 2 cm [1]

(iii)



< a line (curve or straight line) gradually decreases in amplitude > [1]

19. (a) (i) wavelength $\lambda = \frac{0.06}{7-1}$

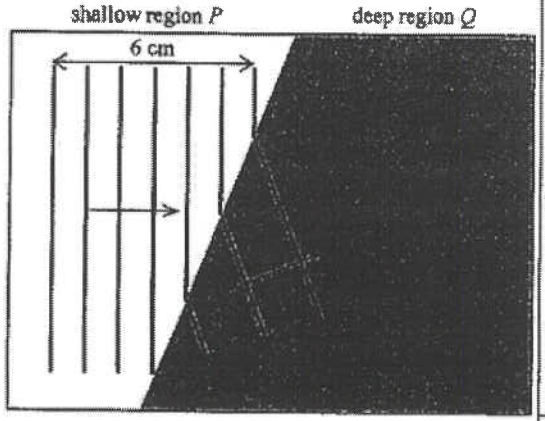
$= 0.01$ m ($= 1$ cm) — 1A — 1

(ii) speed $v = f\lambda = 10 \times 0.01$

$= 0.1$ m s^{-1} ($= 10$ cm s^{-1}) — 1M/1A — 1

(b) (i) frequency = 10 Hz — 1A — 1

(ii)



1A

1A

2

(iii) Refraction.
It is due to the change in wavelengths / wave speeds in different media / depths.

1A
1A

2