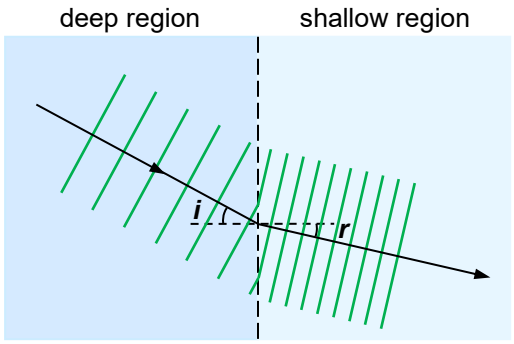
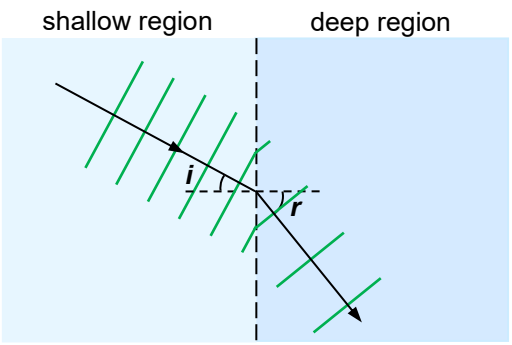
Drawing refracted wavefronts of straight waves

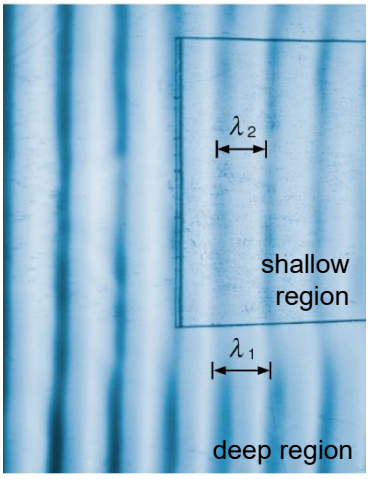
Book 3B Ch 5 p.51
Skill: drawing

When a water wave enters a region of different depth at an angle, refraction occurs. The speed, the wavelength and the travelling direction of the wave change. However, the frequency remains the same.

Let us see how water waves change during refraction.

	From a deep region to a shallow region	From a shallow region to a deep region
		
Frequency	unchanged	
Wave speed	↓	↑
Wavelength	↓	↑
Travelling direction	bend towards the normal ($i > r$)	bend away from the normal ($i < r$)

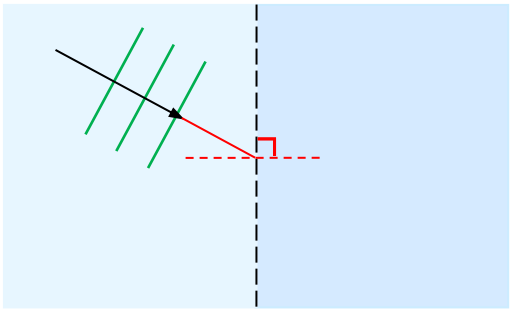
Note that if the wave enters another region normally, the wave speed and the wavelength of the wave will change but the travelling direction will not change.



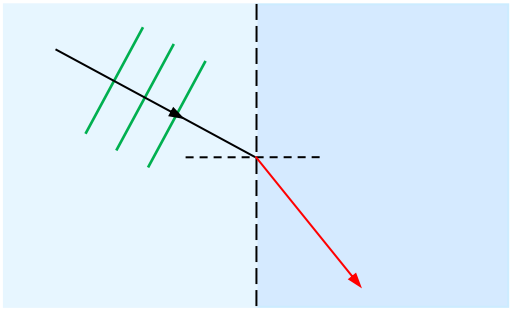
Drawing refracted wavefronts of straight waves

The following steps show how the refracted wavefronts can be drawn.

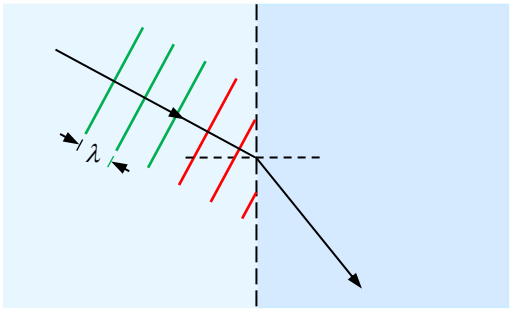
① Extend the arrow showing the direction of the incident wave (the incident ray) to meet the boundary. Draw a normal at the meeting point.



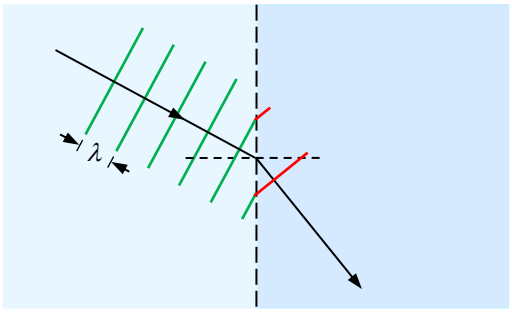
② Draw the direction of the refracted wave (the refracted ray) according to the change in water depth across the boundary.



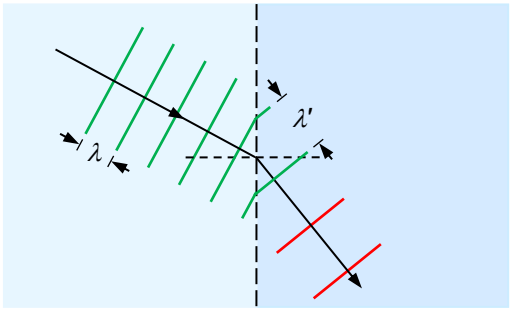
③ Draw the remaining incident wavefronts. λ (the separation between successive wavefronts) should remain the same.



④ At the points where the incident wavefronts meet the boundary, draw the refracted wavefronts. The refracted wavefronts should be perpendicular to the refracted ray.



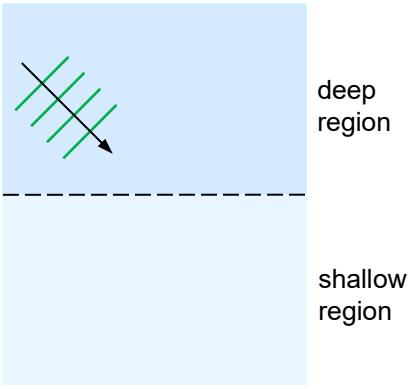
⑤ With λ' remaining constant, draw the remaining refracted wavefronts.



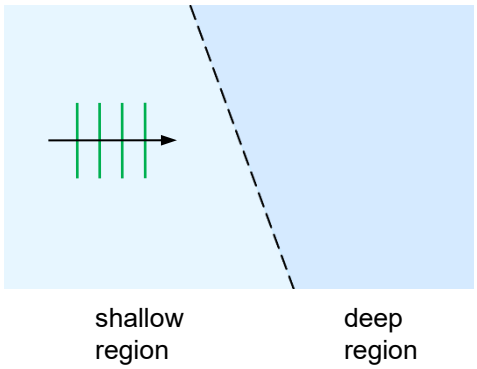
Exercise

1 In each of the following cases, draw an arrow to indicate the travelling direction of the wave after refraction. Hence draw the refracted wavefronts.

(a)

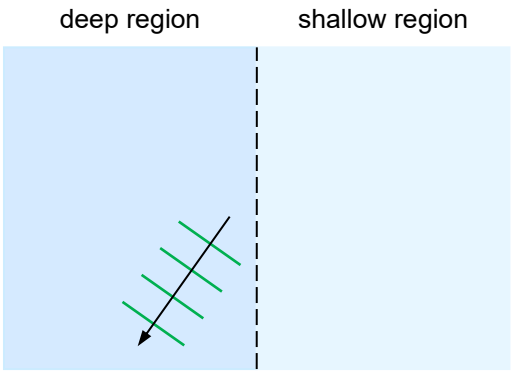


(b)

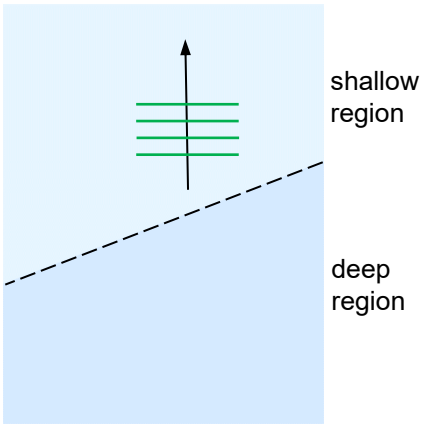


2 In each of the following cases, the refracted wave is given. Draw an arrow to indicate the travelling direction of the incident wave. Hence draw the incident wavefronts.

(a)

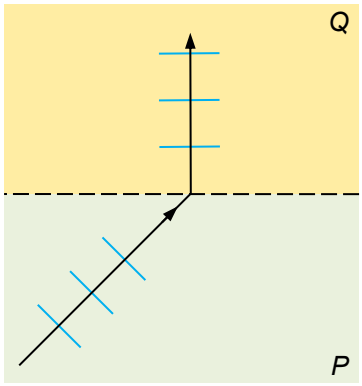


(b)

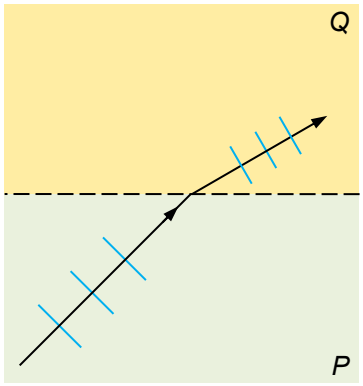


3 A straight water wave travels from region *P* to region *Q*. Which of the following is possible?

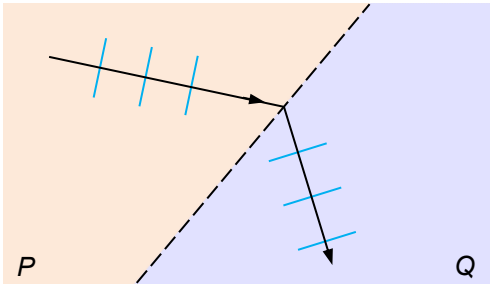
A



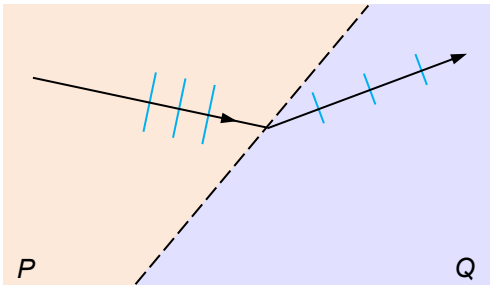
B



C

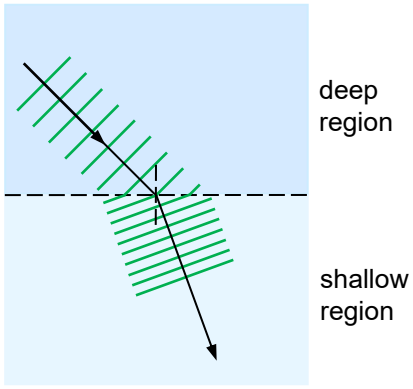


D

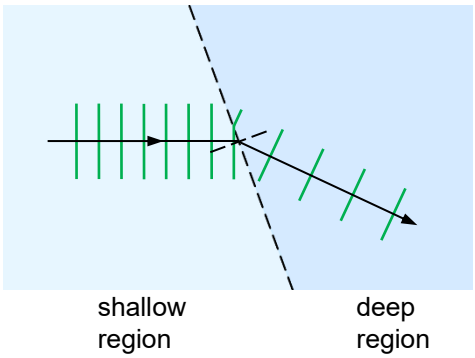


Answers

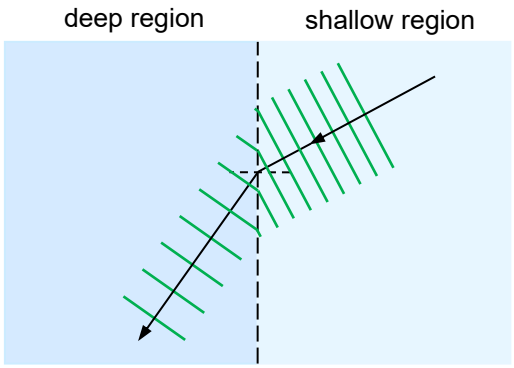
1 **(a)**



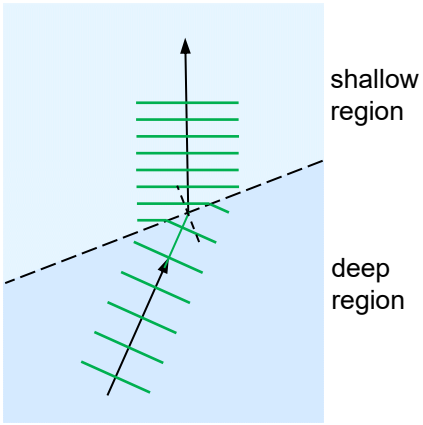
(b)



2 **(a)**



(b)



3 D