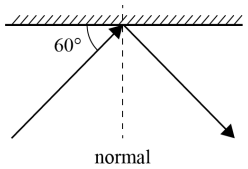
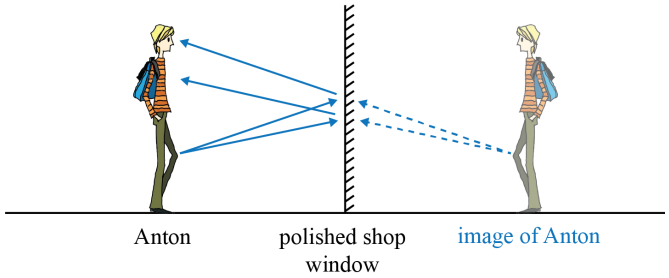
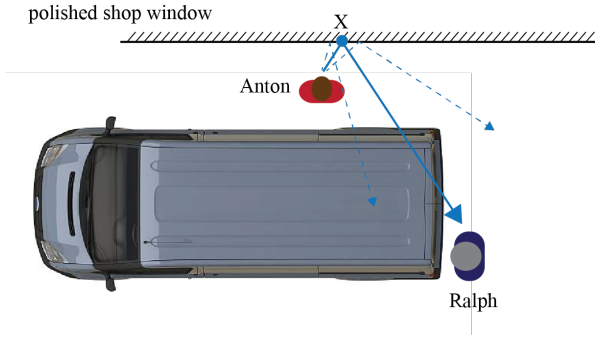
Assessment Schedule – 2020

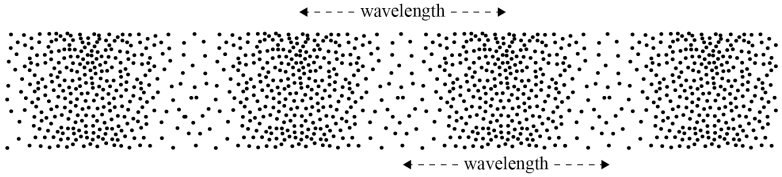
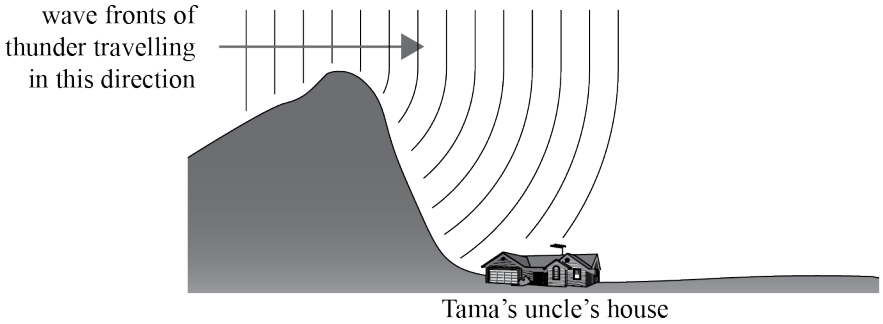
Physics: Demonstrate understanding of aspects of wave behaviour (90938)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$f = \frac{3\times10^{8}}{7.059\times10^{-7}} = 4.25\times10^{14}$ Hz (3 sf)	• Frequency calculated correctly.		
(b)	Diagram completed.  $\theta_{inc} = 30°$	• Normal drawn perpendicular to shop window and reflected ray approx. symmetric about it. OR $\theta_{inc} = 30°$ stated correctly.	• Normal and reflected ray drawn correctly. **Must show arrowheads!** AND $\theta_{inc} = 30°$ stated correctly.	
(c)	 	• One light ray from Anton drawn to reflect off window, back towards Anton $(\theta_{inc} \approx \theta_{refl})$. OR Location and size of Anton's image (knee) identified to reasonable accuracy.	• Two light rays from Anton's knee drawn to reflect off window, back towards Anton $(\theta_{inc} \approx \theta_{refl})$. AND Backtracked behind the window. AND Location and size of Anton's image (knee) identified to reasonable accuracy.	

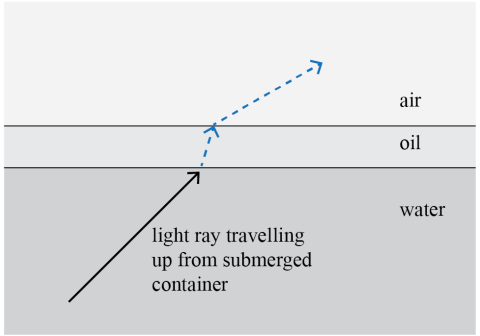
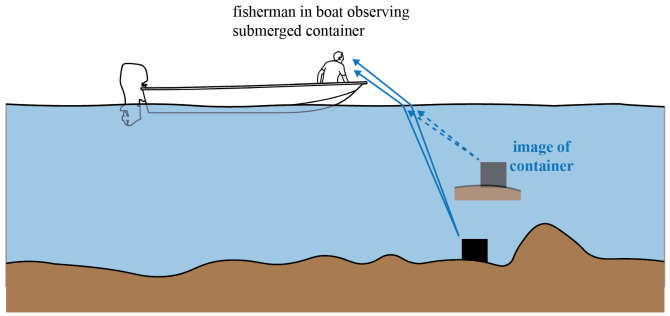
(d)(i)	 Light rays reflect off the window such that the angle of incidence equals the angle of reflection. The point on the window, X, that reflects incident rays to Ralph accordingly is behind the van from where Ralph is standing; hence the reflected rays don't hit him and he can't see Anton.	• Image of Anton drawn in approx. correct **location**. OR Any incident ray drawn to reflect off the window and being blocked by the van. OR Ralph cannot see Anton's image.	• Two light rays drawn from Anton, backtracked behind the window, and image of Anton drawn in approx. correct location. OR Explains or shows diagrammatically that ray hitting the window and reflecting being blocked the van and concluded that Ralph cannot see Anton's image. OR Explains or shows diagrammatically that rays hitting the window left of 'X' are reflected into the van. And rays hitting the window to the right of 'X' are reflected beyond the van and Ralph.	• Image of Anton drawn in approx. correct location. AND Point 'X' labelled on the window in approx. correct location. AND ONE of: • Explains or shows diagrammatically that ray hitting the window at 'X' being blocked the van. And concluded that Ralph cannot see Anton's image OR • Explains or shows diagrammatically that rays hitting the window left of 'X' have a smaller angle of incidence and are reflected at smaller angles, into the van. And rays hitting the window to the right of 'X' have a larger angle of incidence and are reflected at larger angles, beyond the van and Ralph.
(ii)	Anton's image will be behind the car from where Ralph is standing. Rays incident at smaller angles, i.e. hitting the window left of X, are reflected into the van. Rays incident at larger angles, i.e. hitting the window right of X, are reflected past the van but also past Ralph.			

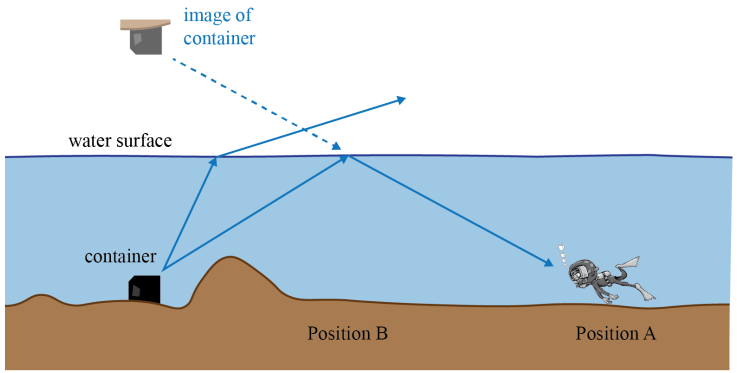
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M	3A OR 1A + 1M OR 1E	4 A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	Diagram annotated.  	• Wavelength correctly labelled.		
(b)	• Light is a transverse wave, but sound is a longitudinal wave. • Light can travel through empty space, but sound requires a material medium to travel through. • Light travels at speeds of 3×10^8 m s^{-1} in vacuum and slower in material media, but sound is much slower, approx. 3×10^2 m s^{-1} in air and faster in denser material media. • Visible light has very small wavelengths, but audible sound has comparatively large wavelengths. (μm vs. mm–m.) • Visible light has very large frequencies, but audible sound has comparatively small frequencies. (100 THz vs. kHz–Hz.)	• One aspect for light AND sound described in sufficient detail. Light travels much faster than sound, wavelengths compared as small vs. large, frequencies compared as large vs. small, etc..	• Two or more aspects for light AND sound described.	
(c)(i)	Diagram completed:  (ii) Diffraction.	• Reasonable attempt at diffracted wave fronts drawn. OR Diffraction stated.	• Diffracted wave fronts **correctly** drawn (with constant and unchanged wavelength) and **would have hit the house** AND Diffraction stated.	

(d)	The time delay between seeing the lightning and hearing the thunder is the time it takes the sound wave to travel from the source to the observer, as light travels that distance almost instantaneously. A sound wave travels at a constant speed of 330 m s^{-1} hence the distance covered is $d = 330 \times t$. For every 3 s of time delay it covers $330 \times 3 = 990$ m or approx. 1 km to the observer. Therefore, Tama can divide the seconds counted by three to calculate the distance covered by the sound wave in units of km and hence the distance to the thunderstorm.	Distance to thunderstorm linked to distance (or time) for sound wave to travel. OR Uses $v = \frac{d}{t}$ or rearranged to calculate show a distance (this can be in words).	• Time delay identified or implied as time for sound wave to travel OR Distance covered in 3 s **stated** or **calculated** to be approx. 1000 m or 1 km. (Equivalent: 0.33 km s^{-1}, 0.33 km in 1 s).	• Light travels the distance almost instantaneously so time delay linked to time taken for sound wave to travel distance between source and observer. AND Distance covered in 3 s found as approx. 1000 m or 1 km from correct **calculation**.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M	3A OR 1A + 1M OR 1E	4 A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$T = \frac{t}{\#} = \frac{11}{3} = 3.67\ s$	• Period calculated correctly.		
(b)(i)	Diagram completed:  	• Light ray drawn towards normal through oil film. OR Drawn away from the normal when entering air. OR TWO out of three correct for (ii).	• Light ray drawn towards normal through oil film. AND Dawn away from the normal when entering air. AND TWO out of three correct for (ii).	
(ii)	Frequency stays the same. Both speed and wavelength decrease.			
(c)(i)	Diagram completed.  The image is virtual, upright, larger (magnified) than the container, and appears at a lesser depth than the container.	• One ray drawn up from container, bending away from the normal at the water-air boundary, towards the divers on the boat. OR Image drawn above container. OR At least two image characteristics stated correctly.	• Two rays drawn up from container, bending away from the normal at the water-air boundary, towards the divers on the boat. AND Image drawn above container (behind), in line with back-tracked virtual rays. AND At least two image characteristics stated correctly	

(d)	The diver can see an image of the container in the water surface above when light from the container is reflected off the surface, towards her. At position A, rays from the container hit the surface at an angle of incidence larger than the critical angle and undergo total internal reflection back into the water, towards her. At position B, the light rays that would reflect back towards her hit the surface at smaller angles of incidence and are instead refracted out of the water, into the air. This way, the light from the container does not reach her at position B and she cannot see it.  	• 'Total internal reflection' stated. OR Light from the container described as reflecting off the surface, towards the diver, at position A. OR Light from the container described as refracting out of the water, into the air (not reflecting), not reaching the diver at position B. *Accept diagrammatical evidence.*	• Light from container described as hitting the surface at an angle of incidence larger than the critical angle, therefore being totally internally reflected towards the diver at position A. OR Light from the container described as hitting the surface at an angle of incidence smaller than the critical angle, therefore being refracted out of the water, into the air (not totally internally reflected).	• Light from container described as hitting the surface at an angle of incidence larger than the critical angle, therefore being totally internally reflected towards the diver at position A. AND Light from the container described as hitting the surface at an angle of incidence smaller than the critical angle, therefore being refracted out of the water, into the air (OR not totally internally reflected, **not reaching the diver** at position B).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1A	2A OR 1M	3A OR 1A + 1M OR 1E	4 A OR 2A + 1M OR 2M OR 1A + 1E	1A + 2M OR 1M + 1E	2A + 2M OR 3M	1A + 1M + 1E	2M + 1E

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 12	13 – 18	19 – 24