Q1.

Four students and their teacher do an experiment to measure the speed of sound in air.
The teacher stands at a distance and fires a starting pistol into the air.
The students see the flash when the pistol is fired.
They measure the time from when they see the flash to when they hear the bang.
A student drew a diagram of the arrangement as shown in Figure 5.

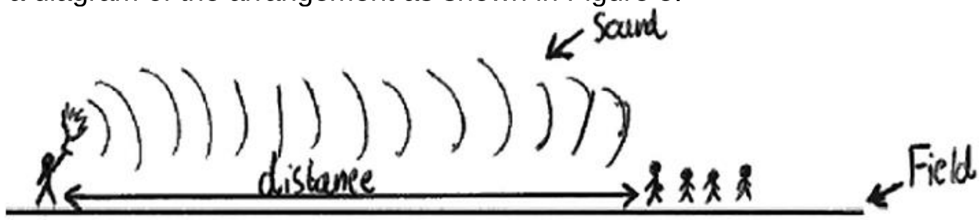

Figure 5

The students obtained a value of 240 m/s for the speed of sound.
The accepted value, in a science data book, is 343 m/s.

(i) Calculate the difference between the students' value and the accepted value as a percentage of the accepted value.

(2)

(ii) When the distance was 100 m, the students measured the following times:

0.43 s   0.35 s   0.50 s   0.38 s

Explain why their times vary so much.

(2)

(iii) Explain **one** way the students might improve this experiment.

(2)

Q2.

The distance between the Earth and the Sun is 1.50×10^{11} m.
Light takes 500 s to travel from the Sun to the Earth.
The wavelength of red light is 670 nm.
Calculate the frequency of red light, using only the data provided.

(4)

Q3.

A radio station transmits on 97.4 MHz.
To receive the waves an aerial needs a length equal to half the wavelength of the radio waves being transmitted.
Calculate the length of the aerial needed.
The speed of the radio waves is 3.00×10^8 m / s.

(3)

Q4.

A different water wave has a wavelength of 0.25 m and a frequency of 1.5 Hz.
Calculate the wave speed.

(2)

Q5.

Figure 1 shows part of a wave.

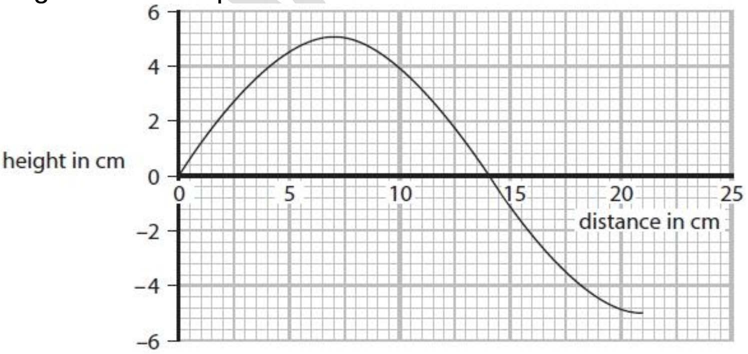

Figure 1

Use data from Figure 1 to calculate the wavelength of the wave.

(2)

Q6.

(i) A microwave oven uses waves of frequency 2.45 GHz.
Calculate the wavelength of the microwaves.
The velocity of light is 3.00×10^8 m/s.

(3)

(ii) The microwave oven is 55% efficient and transfers 42 000 J of energy to some food when it is heated.
Calculate the total amount of energy that must be supplied to the oven.

(3)

Q7.

Figure 1 shows a ripple tank.
This is used to study the behaviour of water waves.

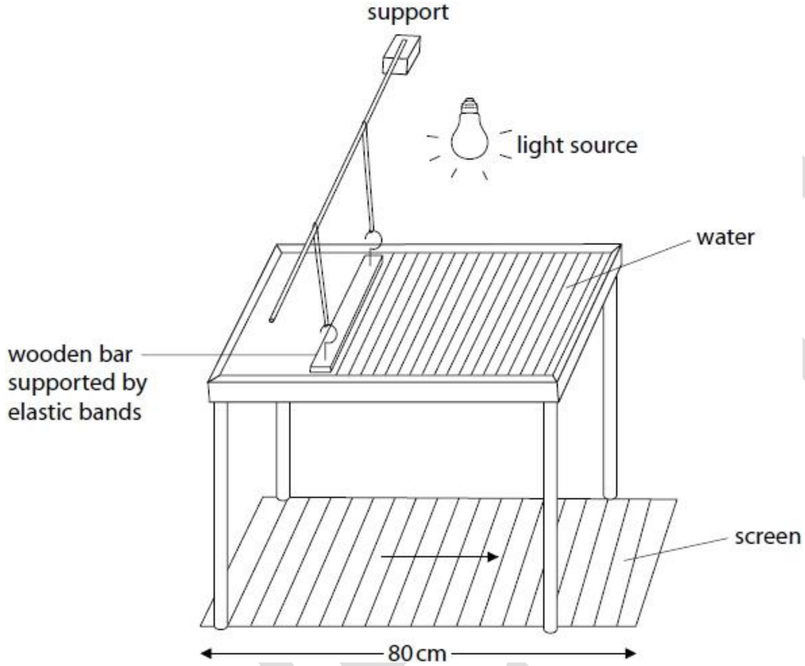

Figure 1

Water waves are produced in the tank.
The shadow of the waves is projected onto the screen below the tank.
The waves appear to move in the direction of the arrow.

(i) Describe how to determine the frequency of the waves.

(2)

(ii) The screen is 80 cm long.
What is the approximate wavelength of the waves as seen on the screen?

(1)

☐ **A** 4 cm
☐ **B** 8 cm
☐ **C** 40 cm
☐ **D** 80 cm

(iii) A student uses the image to estimate the speed of the water wave as 75 cm/s.
Which of these is a reason why the estimate is not correct?

(1)

☐ **A** the student used a ruler without mm markings
☐ **B** the light was not bright enough
☐ **C** the student's measurement was inaccurate
☐ **D** the wave seen on the screen is magnified

Q8.

A class is learning about refraction of waves.
The teacher shows them a demonstration using a battery-powered toy car travelling across a smooth road and onto some sand.
The car slows down as it enters the sand.
Figure 4 shows the car just before it meets the sand.

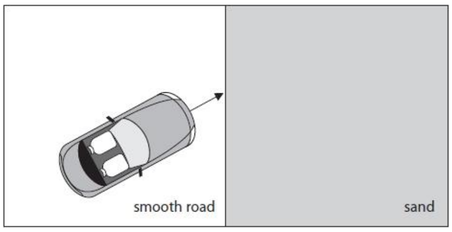

Figure 4

(i) Draw an arrow on the diagram to show the direction of the car as it travels across the sand.

(1)

(ii) Explain why this is a useful model for refraction of light.

(2)

Q9.

Sound travels slower in air than it does in water.
Figure 6 shows the direction of travel of a sound wave approaching a boundary between air and water.
The sound wave refracts at the boundary between air and water.

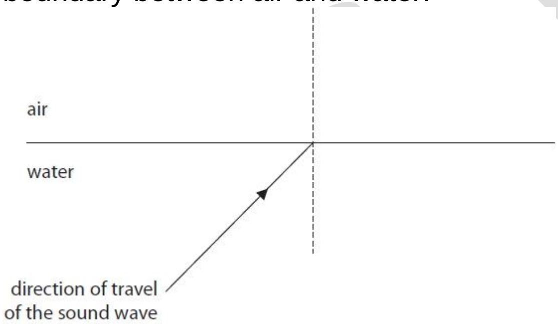

Figure 6

Complete the diagram in Figure 6 to show the direction the sound wave travels in the air.

Q10.

There are many different types of waves.
Waves on the surface of water are transverse waves.
Sound waves are longitudinal waves.
Describe the difference between transverse waves and longitudinal waves.

(2)

Q11.

Figure 5 shows a long metal rod and a hammer.
The rod is hit at one end by the hammer.
This causes a sound wave to travel along the inside of the metal rod.

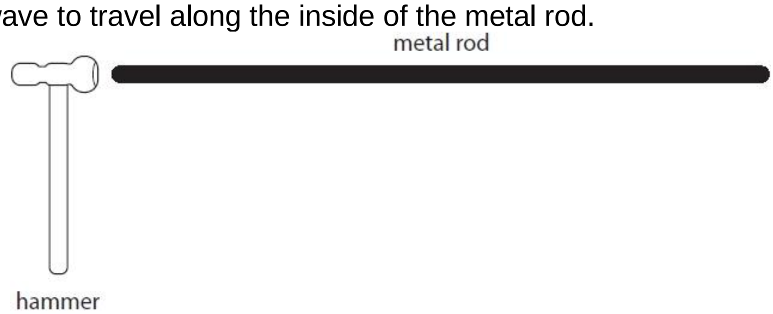

Figure 5

Describe how hitting the rod causes a sound wave to travel along the inside of the rod.

(2)

Q12.

* Figure 13 shows a beam of red light approaching one side of a rectangular glass block.
The beam of light will pass through the block and leave through the opposite side.
AB is a wavefront.

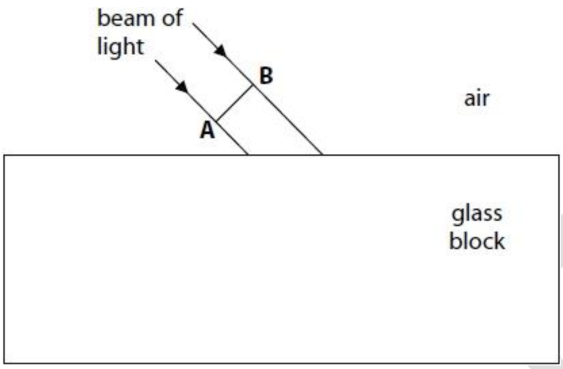

Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

Q13.

Figure 6 represents a sound wave coming from a loudspeaker and shows the effects on particles of the air at one instant in time.

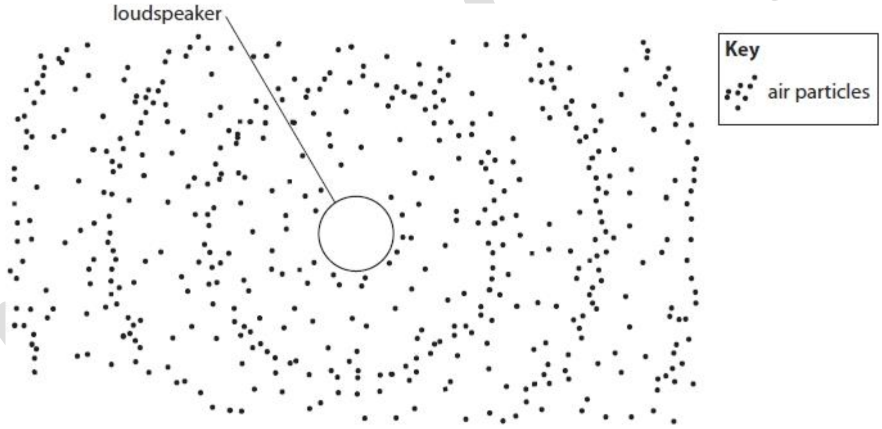

Figure 6

(i) Draw and label a distance of one wavelength in Figure 6.

(1)

(ii) Describe the motion of the particles as the wave travels through the air.

(2)

Q14.

The diagram in Figure 4 shows two students, P and Q, trying to measure the speed of sound in air.

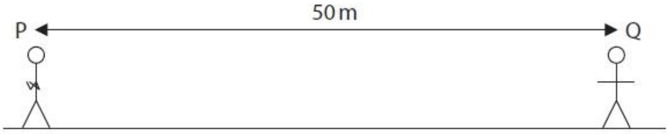

Figure 4

P will clap his hands together.
When Q sees P clap his hands, she will start a timer.
When Q hears the clap, she will stop the timer.
Explain **one** way the students could improve their method. (2)

Q15.

Figure 4 is a simplified diagram to show radio waves from a transmitter moving upwards, then meeting a boundary between lower and upper layers of the atmosphere.

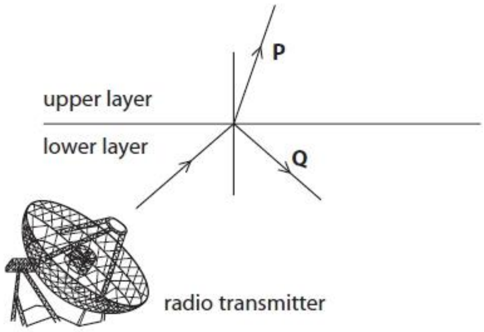

Figure 4

Explain what happens to the radio waves after they meet the boundary between the lower and upper layers as shown in Figure 4.
Your explanation should refer to changes in direction and speed of the waves.

(4)

Q16.

The speed of light is 3.0×10^8 m/s.
The wavelength of yellow light is 5.8×10^{-7} m.
Calculate the frequency of yellow light.
State the unit.
Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

(3)

Q17.

When white light crosses the boundary between air and glass, it can split up into the colours of the spectrum.
Explain, in terms of speed, why the light behaves like this.

(3)

Q18.

State **three** differences between radio waves and sound waves.

(3)

Q19.

Figure 5 shows how a glass prism is used to produce a spectrum from a beam of sunlight.

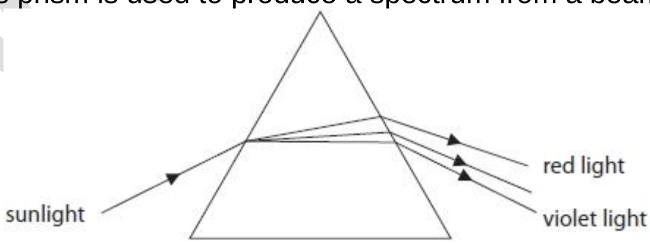

Figure 5

(i) Explain, in terms of refraction and wavelength, the paths taken by the light through the prism.

(3)

(ii) Describe how a student could develop the procedure shown in Figure 5 to search for evidence that sunlight consists of additional electromagnetic waves with frequencies lower than visible light.

(2)

Q20.

Sound travels slower in cold air than it does in warm air.
The equation relating the speed of sound in air to the density of the air is

$$\text{speed of sound} = \frac{K}{\sqrt{(\text{density})}} \qquad \text{where K is a constant.}$$

The table in Figure 7 gives some data about the speed of sound in air and the density of air.

	speed of sound in m/s	density of air in kg / m³
in cold air	331	1.29
in warm air		1.16

Figure 7

Use the equation and the data in the table in Figure 7 to calculate the speed of sound in warm air.
Give your answer to an appropriate number of significant figures.

(3)

Q21.

Figure 1 is a diagram of a water wave.
A cork is floating on the water.

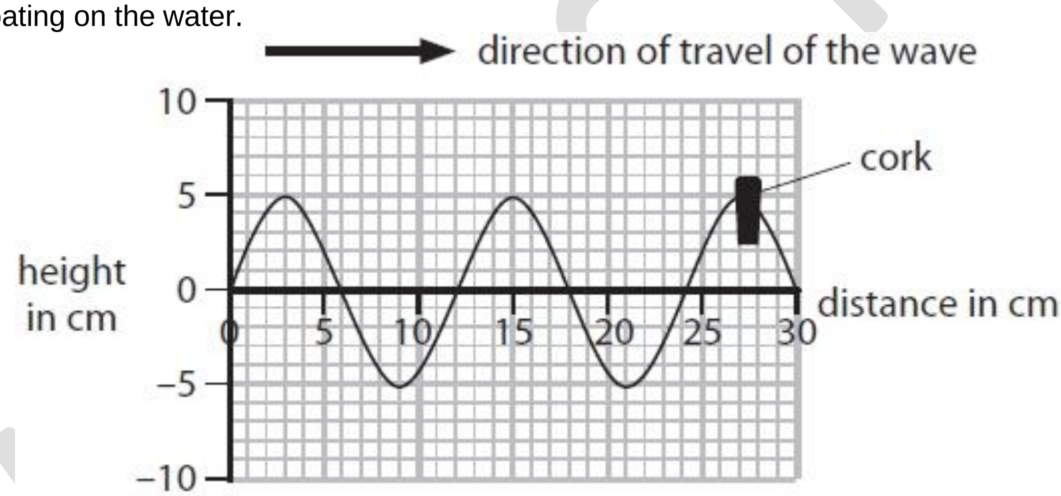

Figure 1

(i) Use the scale on the diagram to measure the wavelength of the wave.

(2)

wavelength = ... cm

(ii) Describe the motion of the cork.
You should include how the cork moves relative to the direction of travel of the wave.

(2)

Q22.

Figure 7 shows a tuning fork.

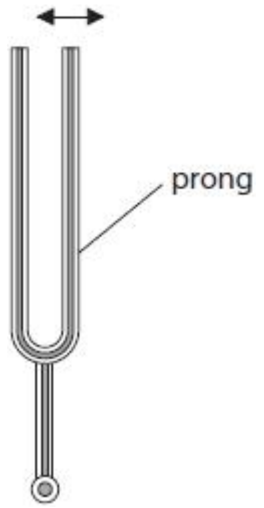

Figure 7

When the prongs of the tuning fork are struck, the prongs vibrate in the directions shown by the arrows on Figure 7.
Describe how the vibrating tuning fork causes a sound wave to travel through the air.
You may add to the diagram if it helps your answer.

(2)

Q23.

(i) Figure 2 shows a student sitting on the shore of a lake watching ripples on the surface of the water moving past a toy boat.

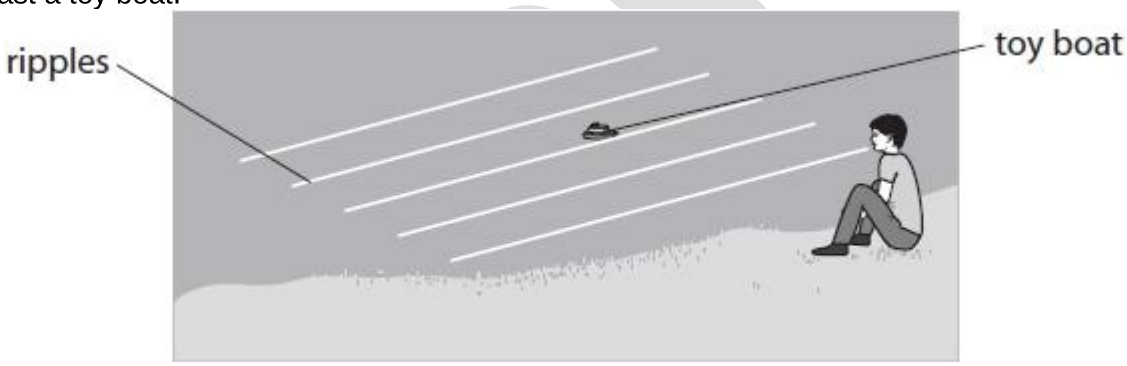

Figure 2

The student has a stopwatch.
Describe how the student could determine the frequency of the ripples on the lake.

(3)

(ii) The speed of a water wave is 1.5 m/s.
The frequency of the wave is 0.70 Hz.
Calculate the wavelength of this wave.
Use the equation

$$v = f \times \lambda$$

(2)

(iii) Water waves are transverse waves.
Describe the difference between transverse waves and longitudinal waves.

(2)

Q24.

* Explain the differences between longitudinal and transverse waves.
Your explanation should refer to ultraviolet, ultrasound and seismic waves.

(6)

Q25.

A light wave from a star has a frequency of 6.67×10^{14} Hz and a wavelength of 4.50×10^{-7} m.
The star is 4.00×10^{16} m away from Earth.
Calculate the time it takes light from the star to reach the Earth.

(3)