1. Nov/2021/Paper_21/No.4

(a) By reference to the direction of transfer of energy, state what is meant by a *longitudinal* wave.

....

.... [1]

(b) A vehicle travels at constant speed around a wide circular track. It continuously sounds its horn, which emits a single note of frequency 1.2 kHz. An observer is a large distance away from the track, as shown in the view from above in Fig. 4.1.

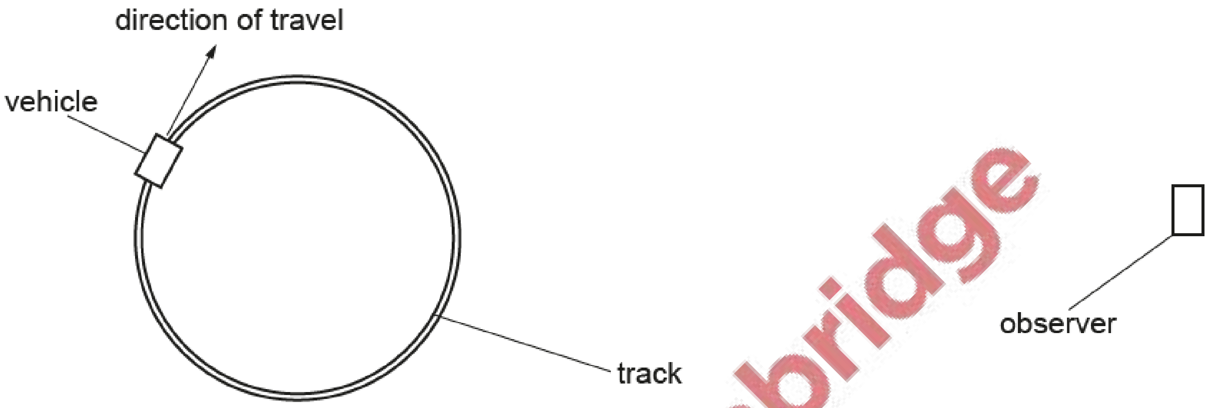

Fig. 4.1 (not to scale)

Fig. 4.2 shows the variation with time of the frequency *f* of the sound of the horn that is detected by the observer. The time taken for the vehicle to travel once around the track is *T*.

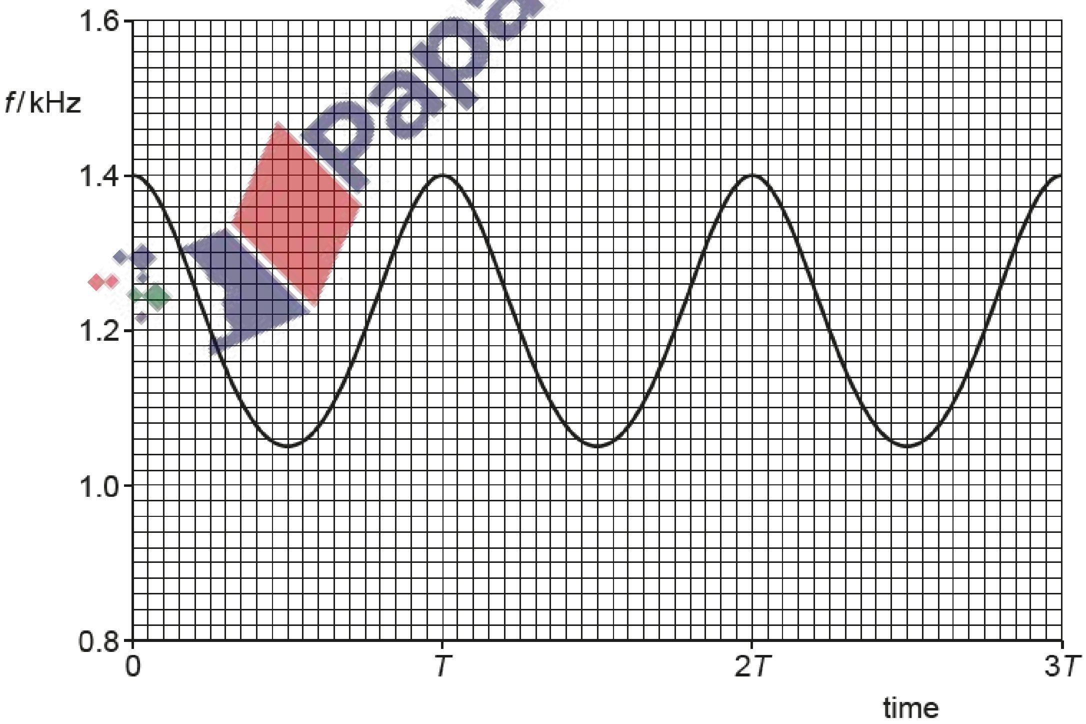

Fig. 4.2

(i) Explain why the frequency of the sound detected by the observer is sometimes above and sometimes below 1.2 kHz.

....

....

....

.... [2]

(ii) State the name of the phenomenon in **(b)(i)**.

.... [1]

(iii) On Fig. 4.1, mark with a letter X the position of the vehicle when it emitted the sound that is detected at time *T*. [1]

(iv) On Fig. 4.1, mark with a letter Y the position of the vehicle when it emitted the sound that is detected at time $\frac{9T}{4}$. [1]

(c) The speed of the sound in the air is $320\,m\,s^{-1}$.

Use Fig. 4.2 to determine the speed of the vehicle in **(b)**.

speed = ... $m\,s^{-1}$ [3]

[Total: 9]

2. Nov/2021/Paper_22/No.4

A child sits on the ground next to a remote-controlled toy car. At time $t = 0$, the car begins to move in a straight line directly away from the child. The variation with time t of the velocity of the car along this line is shown in Fig. 4.1.

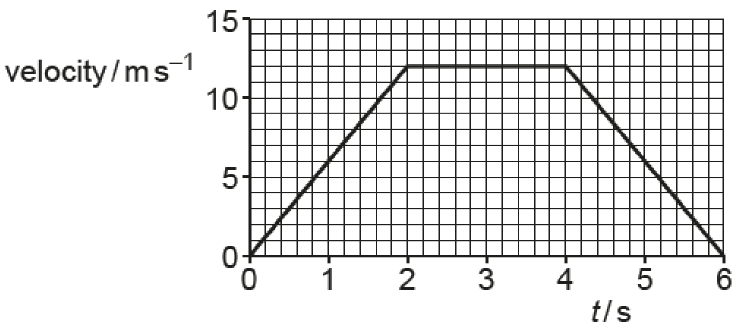

Fig. 4.1

The car's horn continually emits sound of frequency 925 Hz between time $t = 0$ and time $t = 6.0$ s. The speed of the sound in the air is 338 m s^{-1}.

(a) Describe qualitatively the variation, if any, in the frequency of the sound heard, by the child, that was emitted from the car horn:

(i) from time $t = 0$ to time $t = 2.0$ s

.... [1]

(ii) from time $t = 4.0$ s to time $t = 6.0$ s.

.... [1]

(b) Determine the frequency, to three significant figures, of the sound heard, by the child, that was emitted from the car horn at time $t = 3.0$ s.

frequency = ... Hz [2]

(c) Determine the time taken for the sound emitted at time t = 4.0 s to travel to the child.

time taken = ... s [2]

[Total: 6]

3. Nov/2021/Paper_23/No.3d

(d) The aircraft in **(c)** travels from X to Y in a time of 14 s. Fig. 3.3 shows that, as the aircraft travels from X to Y, it moves directly towards an observer who is standing on the ground.

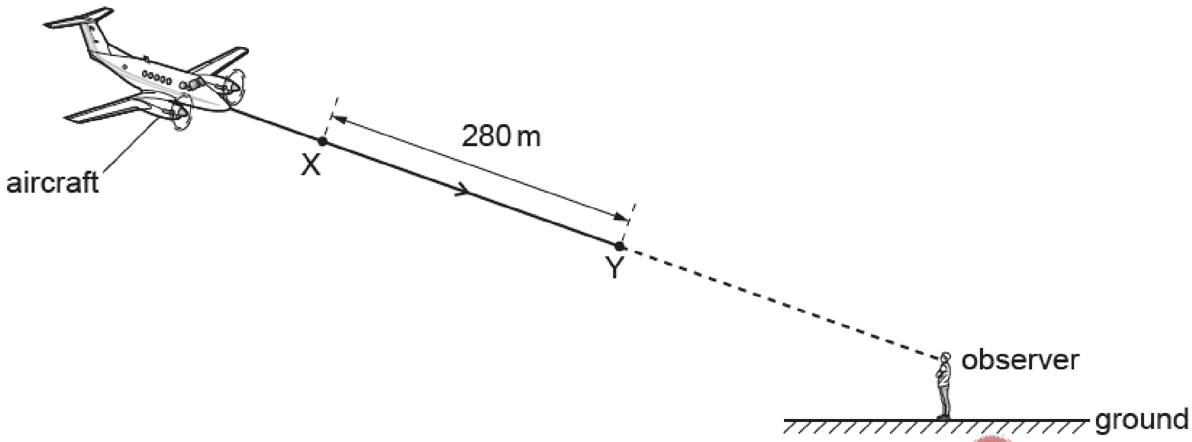

Fig. 3.3 (not to scale)

The aircraft emits sound as it travels from X to Y. The observer hears sound of frequency 450 Hz. The speed of the sound in the air is $340\,\text{m}\,\text{s}^{-1}$.

Calculate the frequency of the sound that is emitted by the aircraft.

frequency = ... Hz [3]

[Total: 11]

4. Nov/2021/Paper_23/No.5

(a) For a progressive wave on a stretched string, state what is meant by *amplitude*.

....

.... [1]

(b) Light from a laser has a wavelength of 690 nm in a vacuum.

Calculate the period of the light wave.

period = ... s [3]

(c) A two-source interference experiment uses the arrangement shown in Fig. 5.1.

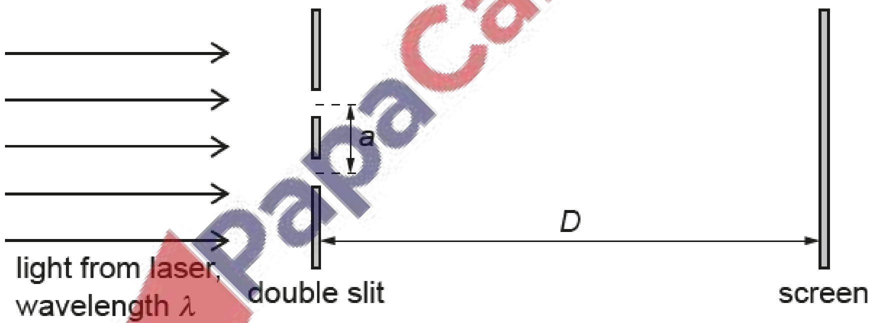

Fig. 5.1 (not to scale)

Light from a laser is incident normally on a double slit. A screen is parallel to the double slit.

Interference fringes are seen on the screen at distance D from the double slit. The separation of the centres of the slits is a. The light has wavelength λ.

The separation x of the centres of adjacent bright fringes is measured for different values of distance D.

The variation with D of x is shown in Fig. 5.2.

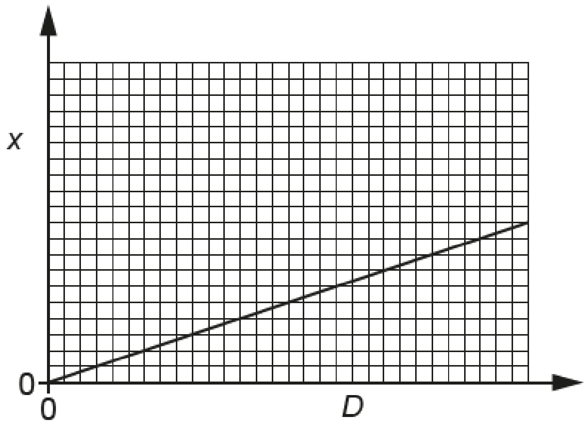

Fig. 5.2

The gradient of the graph is G.

(i) Determine an expression, in terms of G and λ, for the separation a of the slits.

a = ... [2]

(ii) The experiment is repeated with slits of separation $2a$. The wavelength of the light is unchanged.

On Fig. 5.2, sketch a graph to show the results of this experiment. [2]

[Total: 8]

5. March/2021/Paper_22/No.5

A source of sound is attached to a rope and then swung at a constant speed in a horizontal circle, as illustrated in Fig. 5.1.

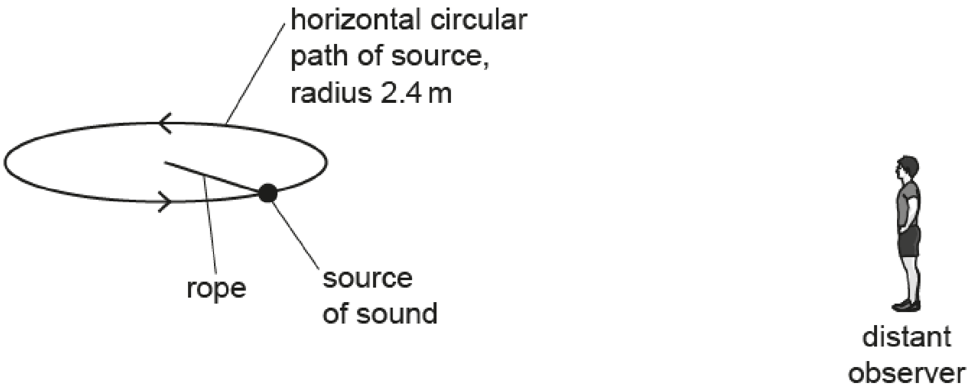

Fig. 5.1 (not to scale)

The source moves with a speed of $12.0\,m\,s^{-1}$ and emits sound of frequency 951 Hz. The speed of the sound in the air is $330\,m\,s^{-1}$. An observer, standing a very long distance away from the source, hears the sound.

(a) Calculate the minimum frequency, to three significant figures, of the sound heard by the observer.

minimum frequency = ... Hz [2]

(b) The circular path of the source has a radius of 2.4 m.

Determine the shortest time interval between the observer hearing sound of minimum frequency and the observer hearing sound of maximum frequency.

time interval = ... s [2]

[Total: 4]