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CONSOLIDATION EXERCISE**Question 1 – 10 minutes**

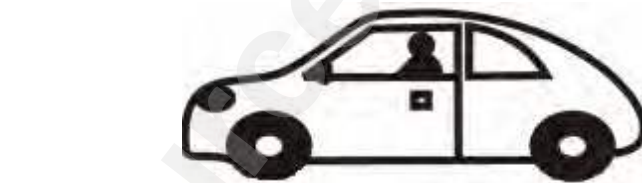
(Adapted from DoE Additional Exemplar P1 2008)

The sketch below shows a stationary ambulance. The siren of the ambulance emits sound waves of frequency 700 Hz.

The driver of a car approaching the ambulance and passing it at constant speed, observes the frequency of the emitted sound waves to change by 80 Hz.



Stationary ambulance



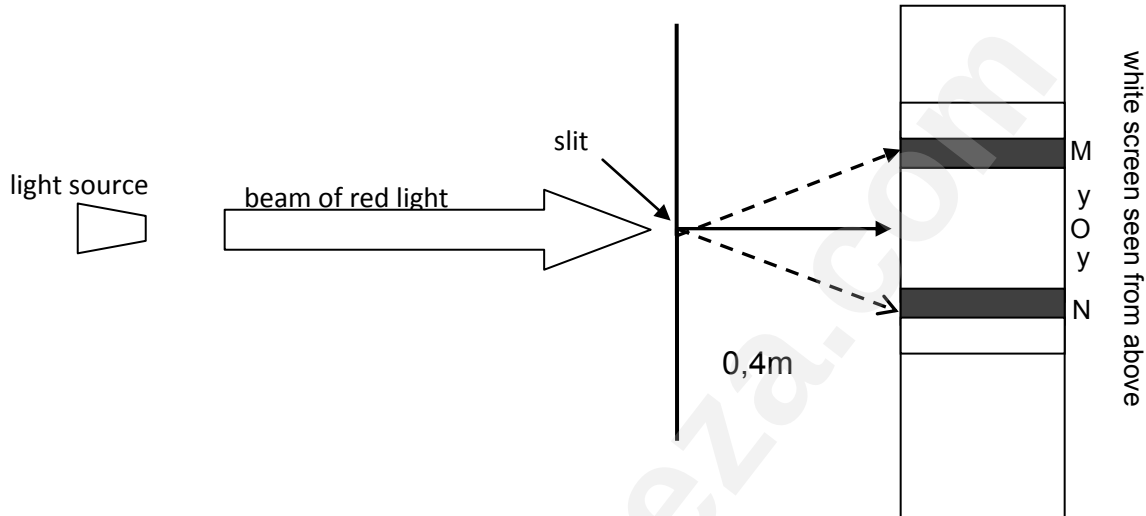
Car passing at constant speed

1.1 Name and state the wave phenomenon illustrated above. (3)

1.2 Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$ and calculate the speed at which the car passes the ambulance. (5)
[8]

Question 2 – 15 minutes*(Taken from DoE Additional Exemplar P1 2008)*

During a demonstration of a wave phenomenon, monochromatic red light passes through a slit of width $1,8 \times 10^{-4}$ m and shines on a flat screen a distance of 0,4 m away from the slit. The wavelength of the light is 675 nm.



- 2.1 Name the phenomenon demonstrated above. (1)
 - 2.2 Briefly explain how the dark bands in the observed pattern are formed. (2)
 - 2.3 Calculate the width $2y$ of the central bright band. (6)
 - 2.4 How will your answer to QUESTION 9.3 change if the width of the slit is changed to $1,8 \times 10^{-6}$ m? Write only INCREASES, DECREASES or REMAINS THE SAME. Give a reason for your choice. (3)
- [12]**

SECTION B: SOLUTIONS AND HINTS

Question 1:

1.1 Doppler effect ✓

A change in observed frequency (pitch) due to relative motion between observer and sound source. ✓✓

OR

A change in observed frequency (pitch) because the sound source and observer have different velocities with respect to the medium. ✓✓ (3)

1.2

$$f_L = \frac{v \pm v_L}{v \pm v_S} \cdot f_S \quad \checkmark$$

When the car approaches $f_L = \frac{340+v_L}{340 \pm 0} \times 700 \checkmark$

When the car moves away $f_L = \frac{340-v_L}{340 \pm 0} \times 700 \checkmark$

$$\frac{340+v_L}{340 \pm 0} \times 700 - \frac{340-v_L}{340 \pm 0} \times 700 = 80 \quad \checkmark$$

$$v_L = 19,43 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

Learner Note: Simultaneous equations may be difficult to do. Take time and care when going through the steps and do not take short cuts.

Question 2

2.1 Diffraction (1)

2.2 Wavelets originating from different points in the slit reach the screen out of phase and interfere destructively on the screen. (2)

2.3 $\sin \theta = \frac{m\lambda}{a} \quad \checkmark$

$$\sin \theta = \frac{(1)675 \times 10^{-9}}{1,8 \times 10^{-4}} \quad \checkmark$$

$$\theta = 0,21^\circ \quad \checkmark$$

$$\tan 0,21^\circ = y/0,4 \quad \checkmark$$

$$\therefore y = 1,47 \times 10^{-3} \text{ m (1,47 mm)} \quad \checkmark$$

Width of central bright band

$$2y = 2(1,47 \times 10^{-3}) = 2,93 \times 10^{-3} \text{ m (2,93 mm)} \quad \checkmark (6)$$

2.4 Increases ✓

Diffraction is inversely proportional to the width of the slit. ✓✓

OR

Amount of diffraction is determined by the ratio λ/a . If a decreases, λ/a will increase. ✓✓ (3)



SECTION E: SOLUTIONS TO SESSION 11 HOMEWORK

Question 1

1.1 A broad central band of bright red light flanked by alternating narrower black and not so bright red bands

- 1.2
- All the bands will have equal width and ✓
 - All the bands will be equally bright ✓

1.3

$$\sin \theta = \frac{m\lambda}{d} = \frac{1(700 \times 10^{-9})}{5 \times 10^{-6}} = 0.14$$

$$\theta = 8.05^\circ$$

$$\tan 8.05^\circ = \frac{\frac{1}{2} \text{ width}}{\text{distance}} = \frac{\frac{1}{2} \text{ width}}{2}$$

$$\text{width} = 0.028 \times 2 = 0.056 \text{ m}$$

2.1

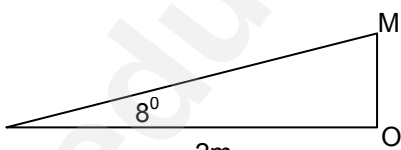
$$\sin \theta = \frac{m\lambda}{d}$$

$$\sin 8^\circ = \frac{1 \cdot \lambda}{4.59 \times 10^{-6}}$$

$$\lambda = \sin 8^\circ \cdot 4.59 \times 10^{-6}$$

$$= 6.38804 \times 10^{-7} \text{ m} = 638.80 \text{ nm}$$

2.2



$$MN = 2 \cdot \tan 8^\circ \cdot MO$$

$$= 0.281 \text{ m}$$

$$\tan \theta = \frac{MN}{d}$$

$$\tan 8^\circ = \frac{MN}{2}$$

Distance MN = 2 x MO

$$= 0.28 \times 2$$

$$= 0.56 \text{ m}$$