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CONSOLIDATION EXERCISE**Question 1****12 minutes**

(Taken from DoE Nov P1 2008)

An ambulance travelling down a road at constant speed emits sound waves from its siren. A lady stands on the side of the road with a detector which registers sound waves at a frequency of 445 Hz as the ambulance approaches her. After passing her, and moving away at the same constant speed, sound waves of frequency 380 Hz are registered. Assume that the speed of sound in air is $343 \text{ m}\cdot\text{s}^{-1}$.

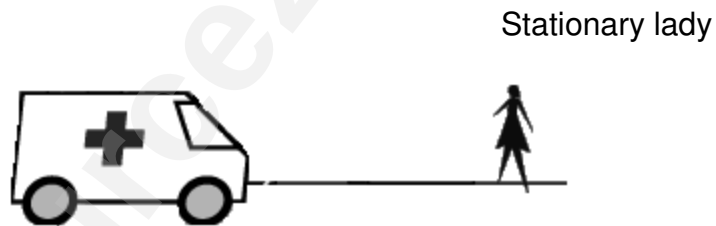
1.1 Name the phenomenon that describes the change in the frequency observed by the lady. (1)

1.2 Calculate:

1.2.1 The speed at which the ambulance is moving. (7)

1.2.2 The frequency at which the siren emits the sound waves. (3)

[11]

**Question 2****15 minutes**

(Taken from DoE Nov P1 2008)

A helium-neon laser emits red light that passes through a single slit. A diffraction pattern is observed on a screen some distance away from the slit.

2.1 Define the term *diffraction*. (2)

2.2 If the wavelength of red light is $644,4 \text{ nm}$ and the slit width is $3\,437 \text{ nm}$, calculate the angle at which the third minimum occurs. (3)

2.3 Briefly describe the diffraction pattern that will be observed on the screen. (2)

The single slit is replaced with a double slit.

2.4 Name ONE similarity and ONE difference in the pattern observed when the single slit is replaced with a double slit. (2)

2.5 Will this pattern be observed if the laser is replaced with a light bulb? Give a reason for your answer. (2)

[11]

Question 3 – 8 minutes

(Taken from DoE Feb/March P1 2009)

Dolphins use ultrasound to scan their environment.

When a dolphin is 100 m from a rock, it emits ultrasound waves of frequency 250 kHz whilst swimming at $20 \text{ m} \cdot \text{s}^{-1}$ towards the rock.

Assume that the speed of sound in water is $1\,500 \text{ m} \cdot \text{s}^{-1}$.

- 3.1 Calculate the frequency of the sound waves detected by a detector on the rock. (4)
- 3.2 When the dolphin is 50m away from the rock, another ultrasound wave of 250kHz is emitted. How will the frequency of the detected sound waves compare with the answer calculated in 3.1? Write down higher, lower, or remains the same. Explain your answer. (2)

[6]

SECTION B: SOLUTIONS AND HINTS

Question 1:

1.1 Doppler effect ✓

(1)

1.2

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

$$\text{When ambulance approaches } 445 \checkmark = \frac{343}{343 - v_S} \cdot f_S \checkmark$$

$$\text{When ambulance moves away } 380 \checkmark = \frac{343}{343 + v_S} \cdot f_S \checkmark$$

$$445(343 - v_S) = 380(343 + v_S) \quad \checkmark$$

$$v_L = 27,02 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \quad (7)$$

Learner Note: You may find these simultaneous equations very difficult to do. Take time and care when going through the steps.

$$1.3 \quad 445(343 - 27,02) \checkmark = 343 f_S \checkmark$$

$$f_S = 409,94 \text{ Hz} \quad \checkmark$$

(3)

[11]

Question 2

2.1 The spreading (or bending) of a wave passing through a small aperture/slit/around a sharp edge/obstacle ✓✓ (2 or 0) (2)

$$2.2 \quad \sin \theta = \frac{m\lambda}{a} \quad \checkmark$$

$$\sin \theta = \frac{(3)644,4 \times 10^{-9}}{3437 \times 10^{-9}} \quad \checkmark$$

$$\theta = 34,23^\circ \quad \checkmark \quad (3)$$

2.3 A broad central red / bright/ light fringe (bands) ✓ followed by alternate dark and red (bright) fringes (bands) on either side ✓ (2)

2.4 Similarity: Alternate red and dark bands ✓

Difference: The red bands are of equal width / no broad central band is observed / The red bands are of equal intensity (brightness) ✓

(2)

2.5 No, ✓ it is not a coherent source / not monochromatic / bands of different colours ✓

(2)

[11]

Learner Note: Make sure you can use your calculator. Also practice converting units e.g milli, micro, nano to SI units

Question 3

3.1

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

$$v \pm v_S$$

$$f_L = \frac{1500 \pm 0}{1500 - 20} \checkmark \times (250 \times 10^3) \checkmark$$

$$1500 - 20$$

$$= 253,38 \times 10^3 \text{ Hz} \checkmark$$

3.2 Remains the same. ✓ The detected frequency is independent of the distance between the source and the observer. ✓