education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL

SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES TOPIC TEST

TOPIC: DOPPLER EFFECT

29 APRIL 2024 (PROPOSED DATE)

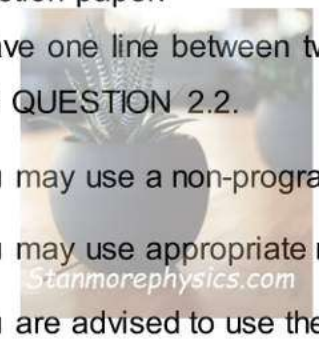
MARKS: 26

TIME: 35 minutes

This question paper consists of 5 pages and 1 data sheet

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of THREE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH Question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, etc, where required.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1 to 1.2) in the ANSWER BOOK, eg. 1.3 E

1.1 The reason why the observed pitch of an ambulance decreases as the ambulance moves away from a stationary observer, is because the…

A amplitude of the sound wave decreases.

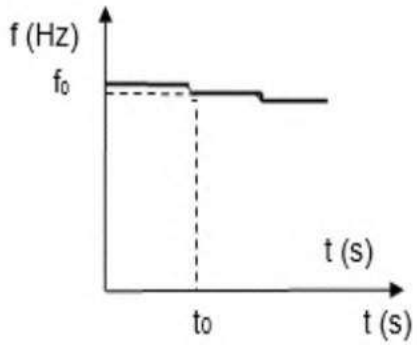
B amplitude of the sound wave increases.

C wavelength of the sound wave decreases.

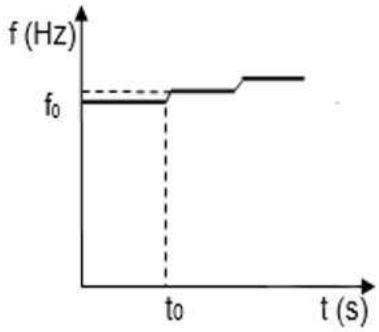
D wavelength of the sound wave increases. (2)

1.2 A stationary fire truck sounds its siren at frequency f_0. An observer walks at a constant velocity towards the fire truck. He passes the fire truck and then walks away from it. Which ONE of the graphs below shows the changes in frequency heard by the observer over the distance he walks?

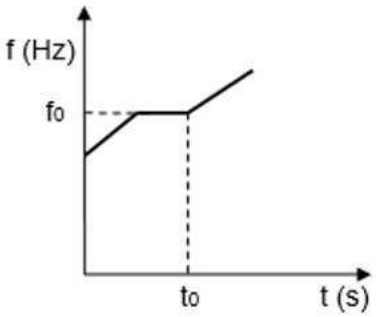
A



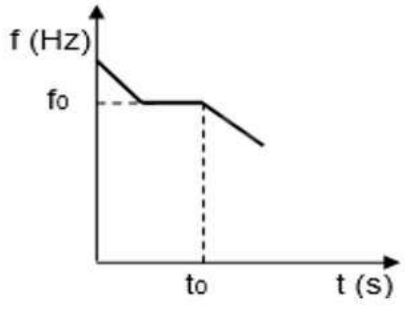
B



C



D

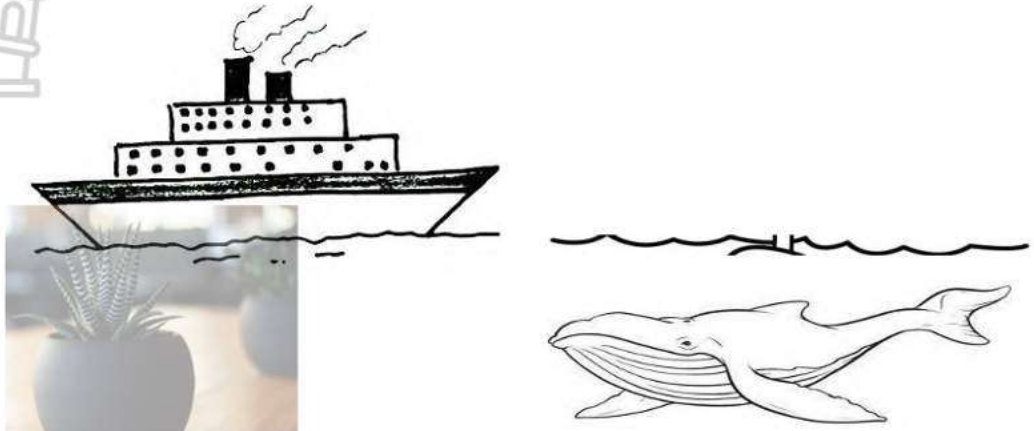


(2)

[4]

QUESTION 2

A whale at rest and just below the surface of the water, detects the frequency of a moving ship as 437 Hz, which is 0,985 times the actual frequency of the sound emitted by the ship, as shown in the diagram below.



The speed of sound in water is 1470 $m \cdot s^{-1}$.

2.1 State the Doppler effect in words. (2)

2.2 Is the ship moving AWAY FROM or TOWARDS the whale? (2)

Give a reason for the answer.

2.3 Calculate the speed of the ship. (5)

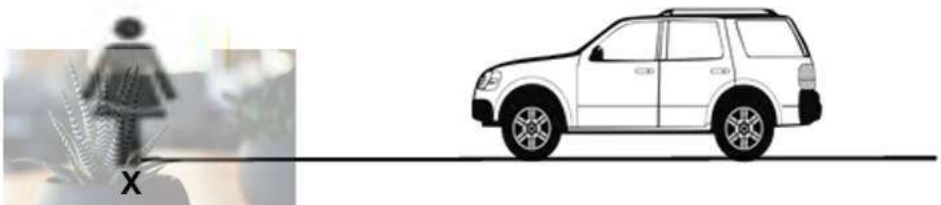
2.4 Explain how the phenomenon known as red shift can be used to explain an expanding universe. (2)

2.5 Name ONE applications of the Doppler effect in Medical Science. (1)

[12]

QUESTION 3

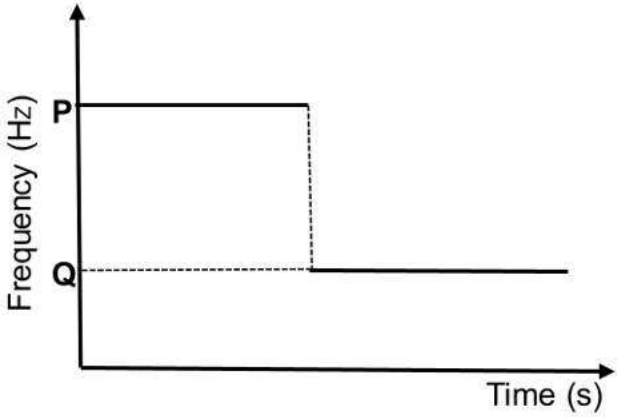
A car which is travelling at a constant speed of 41,10 $m.s^{-1}$ along a straight horizontal road, emits sound of frequency 800 Hz. A girl standing at point **X** next to the road, hears the sound of frequency 910Hz as the car approaches her. The car passes point **X** and continues at the same speed. Take the speed of sound in air as 340 $m.s^{-1}$.



3.1 Write down the frequency the girl hears when the car is at point **X**. (1)

3.2 Calculate the wavelength of sound emitted by the car at point **X**. (3)

3.3 A detector placed at point **X** measures the frequency of the car's sound and the results are shown in the graph below.



3.3.1 Write down the value of frequency **P**, indicated on the graph. (1)

3.3.2 Calculate the value of frequency **Q**, indicated on the graph. (5)

TOTAL: 26 **[10]**

TABLE OF FORMULAE

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$

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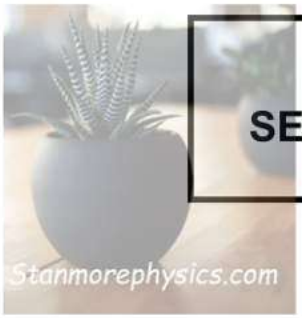

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Marking guidelines

MARKS: 26

These marking guidelines consist of 3 pages

-

QUESTION 1

1.1 D✓✓ (2)

1.2 A✓✓ (2)

[4]

QUESTION 2

2.1 The change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓

[If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark**]** (2)

2.2 Away✓ (from the whale)
The detected/observed frequency is lower than the actual frequency.✓ (2)

2.3 **OPTION 1**

$f_L = \frac{v \pm v_L}{v \pm v_s} fs$✓

$f_L = (0,985)fs$

$437 = (0,985)fs$

$fs = 443,655\ Hz$

$437✓ = \frac{1470}{1470 + vs✓}(443,655)✓$

$Vs = 22,39\ m.s^{-1}$✓

OPTION 2

$\frac{fL}{fs} = \frac{v \pm v_L}{v \pm v_s}$✓

$f_L = \frac{v \pm v_L}{v \pm v_s}$

$0,985✓ = \frac{1470✓}{1470 + v_s✓}$

$Vs = 22,39\ m.s^{-1}$✓

(5)

2.4 Red shift implies that light emitted by stars shows a shift towards the lower frequencies✓ of the spectrum.
(According to the Doppler effect) this means that the source (star) is moving away from the observer.✓ (2)

2.5 To measure the velocity of blood flowing through blood vessels.✓
To scan a foetus/To monitor the heartbeat of the foetus. **[Any one]** (1)

[12]

QUESTION 3

3.1 800 Hz✓ (1)

3.2 $V = f\lambda$✓
$340 = (800)\ \lambda$✓
$\lambda = 0{,}425$ m✓ (3)

3.3.1 910 Hz✓ (1)

3.3.2 $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$✓
$fL = \frac{340-0}{340+41{,}10}(800)$✓✓
$f_L = 713{,}72$ Hz✓ (5)

[10]

TOTAL: 26