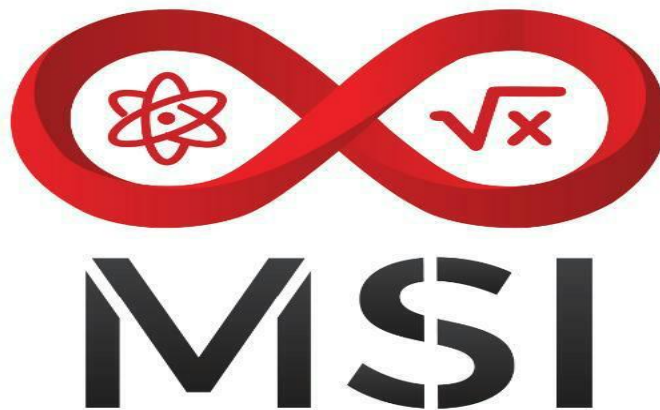




PHYSICAL SCIENCES

MATERIAL FOR GRADE 12

SECOND TERM

DOPPLER EFFECT

MEMORANDA

COMPILED BY EXPERTS: K. NCUBE & T. MJIKWA

QUESTION 8/VRAAG 8

8.1 Doppler effect/Dopplereffek ✓ [12.2.1] (1)

8.2.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ OR/OF $f_s = \frac{v \pm v_s}{v \pm v_L} f_L$ OR/OF

approach/nader: $f_L = \frac{v \pm v_L}{v - v_s} f_s$ OR/OF $f_L = \frac{v}{v - v_s} f_s$

move away/beweeg weg: $f_L = \frac{v \pm v_L}{v + v_s} f_s$ OR/OF $f_L = \frac{v}{v + v_s} f_s$

Ambulance approaching/Ambulans nader dame:

$$445 = f_s \frac{343}{343 - v_s} \checkmark \therefore 445(343 - v_s) = 343f_s \dots\dots\dots (i)$$

Ambulance moving away/Ambulans beweeg weg:

$$380 = f_s \frac{343}{343 + v_s} \checkmark \therefore 380(343 + v_s) = 343f_s \dots\dots\dots (ii)$$

$$445(343 - v_s) = 380(343 + v_s) \checkmark$$

$$v_s = 27,02 \text{ m} \cdot \text{s}^{-1} \checkmark$$

[12.1.3] (7)

8.2.2 $445 = f_s \frac{343 \pm 0}{343 - v_s}$ OR/OF $445(343 - v_s) = 343f_s$

$\therefore 445(343 - 27,02) = 343f_s \checkmark$

$f_s = 409,94 \text{ Hz} \checkmark$

OR/OF

$$380 = f_s \frac{343 \pm 0}{343 + v_s} \text{ OR/OF } 380(343 + v_s) = 343f_s$$

$$380(343 + 27,02) = 343f_s \checkmark$$

$$f_s = 409,94 \text{ Hz} \checkmark$$

[12.2.3] (3)
[11]

QUESTION 7/VRAAG 7

7.1

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

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

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

[12.2.3] (4)

7.2

Remains the same $\checkmark$

The detected frequency is independent of the distance between the source and observer. $\checkmark$

Bly dieselfde $\checkmark$

Die waargenome frekwensie is onafhanklik van die afstand tussen die bron en die waarnemer $\checkmark$

[12.2.2] (2)
[6]

QUESTION 7/VRAAG 7

7.1

Doppler effect/Doppler-effek

[12.2.1] (1)

7.2

Car approaching/Motor kom nader.

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \text{ OR/OF } f_L = \frac{v}{v - v_s} f_s$$

$$= \left(\frac{340}{340 - 16} \right) \checkmark (420) \checkmark$$

$$\therefore f_L = 440,74 \text{ Hz} \checkmark$$

[12.2.3] (4)

7.3.1

Smaller than/Kleiner as $\checkmark$

[12.2.2] (2)

7.3.2

Increases/Toeneem $\checkmark$

[12.2.2] (1)
[9]

QUESTION 7/VRAAG 7

7.1

Doppler effect / Doppler-effek $\checkmark$

[12.2.1] (1)

7.2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark / f_L = \frac{v}{v + v_s} f_s$$

$$\frac{90}{100} f_s \checkmark = \left(\frac{340}{340 + v_s} \right) \checkmark f_s \checkmark$$

$$v_s = 37,78 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$(f_L = \frac{90}{100} f_s)$$

Any other formula /
Enige ander formule 0/5

[12.1.3] (5)
[6]

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v + v_L}{v} f_s$ ✓
 $\therefore 1\,000 \checkmark = \left(\frac{340 + v_L}{340} \right) (960)$ ✓
 $\therefore v_L = 14,17 \text{ m} \cdot \text{s}^{-1}$ ✓ [12.2.3] (4)

6.3 Higher than ✓ [12.2.2] (1)
[6]

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2 Towards ✓ [12.2.2] (1)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ / $f_L = \frac{v}{v - v_s} f_s$
 $\therefore 2\,080 \checkmark = \left(\frac{340 \pm 0}{340 - v_s} \right) 2\,000$ ✓
 $\therefore v_s = 13,08 \text{ m} \cdot \text{s}^{-1}$ ✓ [12.2.3] (4)

$$v_L = \frac{v + v_L}{v - v_s} f_s \quad / \quad v_L = \frac{v - v_L}{v - v_s} f_s \quad \text{Max. } \frac{3}{4}$$

6.4 Equal to (2 000 Hz) ✓
 The passenger moves at the same velocity as the train. / There is no difference in velocity of the passenger relative to the train. ✓ [12.2.2] (2)
[8]

QUESTION 6 / VRAAG 6

6.1 Doppler effect / *Doppler-effek* ✓ (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓
 $\therefore f_L = \frac{340 \pm 0}{340 - 20} \checkmark (458) \checkmark$
 $\therefore f_L = 486,63 \text{ Hz} \checkmark$ (4)

6.3 Decreases/*Verlaag* ✓ (1)

6.4 Equal to/*Gelyk aan* ✓

Velocity of train driver relative to the whistle is zero. ✓
Snelheid van treindrywer relatief tot fluitjie is nul.

OR / OF

Train driver has same velocity as whistle.
Treindrywer het dieselfde snelheid as die fluitjie.

OR / OF

There is no relative motion between source and observer.
Daar is geen relatiewe beweging tussen bron en waarnemer.

(2)
[8]

QUESTION/VRAAG 5

5.1 Higher, ✓ B is moving towards A, the wavelengths will thus be less at A. ✓/
Hoër, ✓ B beweeg nader aan A, dus sal die golflengtes minder wees by A. ✓ [12.2.1] (2)

5.2 $f_L = (v \pm v_L / v \pm v_s) f_s$ ✓
 $= (343 + 0 / 343 - 8,33) \checkmark 13 \times 10^3 \checkmark$
 $= 13\,323,57 \text{ Hz} \checkmark$ [12.1.3] (4)

5.3 When the truck is next to her/*Wanneer die trok langs haar is.* ✓ [12.2.1] (1)

5.4 Doppler effect, ✓ the apparent change in frequency ✓ when a listener and source move with respect to one another. ✓/
Doppler-effek ✓ die skynbare verandering in frekwensie ✓ indien die luisteraar en bron ten opsigte van mekaar beweeg. ✓ [12.2.1] (3)

5.5 Remain the same/*dieselfde* ✓✓ (2)
[12]

QUESTION 6/VRAAG 6

6.1 Smaller than / *Kleiner as* ✓ (1)

6.2 Doppler effect / *Doppler-effek* ✓ (1)

6.3 $v = f\lambda$ ✓
 $345 = f(0,55)$ ✓
 $\therefore f = 627,27 \text{ Hz}$

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR/OR } f_L = \frac{v}{v - v_s} f_s \text{ ✓}$$

$$= \frac{345}{345 - 33,33} (627,27) \text{ ✓}$$

$$= 694,35 \text{ Hz} \text{ ✓} \quad (7)$$

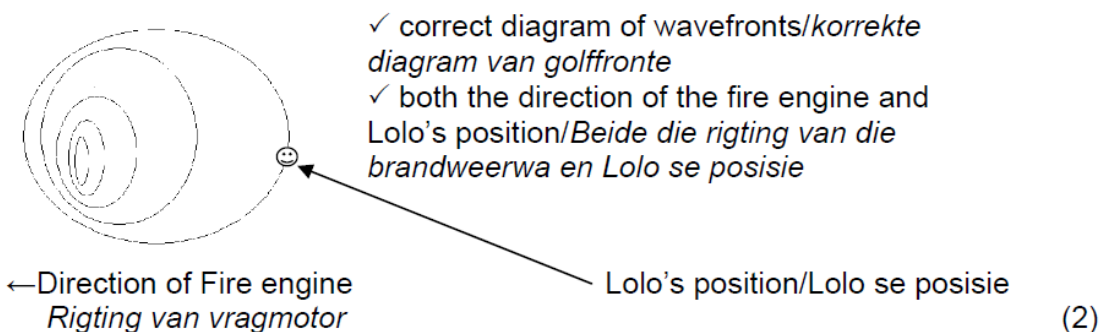
6.4 Decreases / *Verlaag* ✓ (1)
[10]

QUESTION/VRAAG 6

6.1 Doppler effect/Doppler-effek ✓ (1)

6.2 $f_L = (v \pm v_L / v \pm v_s) f_s$ ✓
 $= (340 / 340 + 20) \sqrt{18 \times 10^3}$ ✓
 $= 17 \times 10^3 \text{ Hz}$ ✓ (4)

6.3 The diagram to represent wavefronts/Die diagram stel die golf fronte voor



6.4 Speed of sound in air is much less than speed of light ✓ therefore the velocity of the fire engine produces a noticeable Doppler shift ✓ in the frequency of siren but of no consequences when compared to speed of light. ✓
Die spoed van klank in lug is baie minder as die spoed van lig, daarom het die spoed van die brandweerwa 'n beduidende Doppler skuif in die frekwensie van die sirene, maar geen effek wanneer vergelyk word met die spoed van lig nie. (3)

[10]

QUESTION 6/VRAAG 6

6.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ OR $f_L = \frac{v}{v - v_s} f_s$ ✓
 $\therefore 1\,050 \checkmark = \frac{340 + 0}{340 - v_s} (980) \checkmark$
 $\therefore v_s = 22,67 \text{ m} \cdot \text{s}^{-1} \checkmark$ (4)

6.2 Waves in front of the moving source are compressed.
 The observed wavelength decreases. ✓
 For the same speed of sound, ✓ a higher frequency will be observed.

Golwe voor die bewegende bron word saamgepers.
Die waargenome golflengte verminder. ✓
Vir dieselfde spoed van klank ✓ sal 'n hoër frekwensie waargeneem word. (2)

- 6.3 Any ONE/Enige EEN:
- Determine whether arteries are clogged/narrowed ✓
 so that precautions can be taken in advance/to prevent heart attack/stroke. ✓
Bepaal of are verstop/vernou is, ✓✓
so dat voorsorg getref kan word/om hartaanvalle/beroerte te voorkom. ✓
 - Determine heartbeat of foetus
 to assure that child is alive/does not have a heart defect. ✓
Bepaal die hartklop van 'n fetus
om seker te maak of baba leef/geen hartdefekte het nie. (2)
- [8]

QUESTION 6/VRAAG 6

6.1 Frequency/Frekwensie ✓ (1)

6.2 There is relative motion between the bird and the bird watcher. ✓
Daar is relatiewe beweging tussen die voël en die voëlkyker nie. ✓ (1)

6.3 0,2 m ✓ (1)

6.4

6.4.1 $v = f\lambda$ ✓
 $340 = f(0,2)$ ✓
 $\therefore f = 1\,700 \text{ Hz}$ ✓ (3)

6.4.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ OR/OF $f_L = \frac{v}{v - v_s} f_s$ ✓
 $\therefore 1\,700 \checkmark = \frac{340}{340 - v_s} \checkmark (1\,650) \checkmark$
 $\therefore v_s = 10 \text{ m} \cdot \text{s}^{-1} \checkmark$ (5)

[11]

QUESTION 6/VRAAG 6

6.1 Doppler flow meter / *Dopplervloeimeter* ✓ (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓
 $985 \checkmark = \frac{v}{(v - 10,6)} \checkmark (954,3) \checkmark$
 $v = 340,1 \text{ m} \cdot \text{s}^{-1} \checkmark$ (5)

6.3 Decreases / *Afneem* ✓ (1)

6.4 - For a constant velocity of sound / speed ✓
if the frequency increases, λ decreases. ✓
Vir 'n konstante snelheid van klank /spoed,
as die frekwensie toeneem neem λ af.

OR/OF

$\lambda \propto \frac{1}{f}$ or $f \propto \frac{1}{\lambda}$ ✓ at constant velocity/speed / *by konstante snelheid/spoed..* ✓ (2)
[9]

QUESTION 6

$$6.1 \quad f_L = \frac{v \pm v_L}{v \pm v_S} f_s \quad \checkmark$$

$$580 \checkmark = \frac{340 + 0}{340 - 37,5} \times f_s \quad \checkmark$$

$$f_s = 516,03 \text{ Hz} \quad \checkmark \quad (4)$$

6.2 The apparent change in the frequency of a wave when there is relative motion between the source of the wave and an observer. $\checkmark \checkmark$ (2)

6.3 No $\checkmark$
An increase in the speed of the source producing the sound waves results in a greater number of complete waves reaching the listener per second. $\checkmark$
The apparent frequency increases and becomes greater than 580 Hz, the detector cannot detect frequencies greater than 580 Hz. $\checkmark$ (3)

6.4 Equal to. $\checkmark$
There is no relative motion between the source and the listener. $\checkmark$ (2)

6.5 6.5.1 change in pitch $\checkmark$ (1)

6.5.2 change in colour $\checkmark$ (1)

6.6 The Doppler flow meter $\checkmark$ uses the Doppler effect to measure the speed of blood flowing through a person's blood vessels. $\checkmark$
Abnormal blood speeds could be an indicator of a health risk. $\checkmark$ (3)

[16]

QUESTION 6/VRAAG 6

6.1.1 An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).
'n Skynbare verandering in waargenome frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2 Towards/Na ✓

Observed/detected frequency is greater than the actual frequency. ✓
Waargenome frekwensie is groter as die werklike frekwensie. (2)

6.1.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/OF** $f_L = \frac{v}{v - v_s} f_s$ ✓
 $(1200) = \frac{343}{343 - v_s} 1130$ ✓
 $v_s = 20,01 \text{ m} \cdot \text{s}^{-1}$ ✓
 Accept/Aanvaar: $(19,42 - 20,01 \text{ m} \cdot \text{s}^{-1})$ (5)

6.2 The star is approaching the earth. ✓

Die ster nader die aarde.

OR/OF

The earth and the star are approaching (moving towards) each other. ✓

Die aarde en die ster nader mekaar.

The spectral lines in diagram 2 are shifted towards the blue end/blue shifted. ✓ (2)
Die spektrumlyne in diagram 2 het verskuif na die blou ent/blou verskuiwing [11]

QUESTION 6/VRAAG 6

6.1.1 Frequency of sound detected by the listener (observer)✓
Frekwensie van klank deur luisteraar (waarnemer) waargeneem (1)

6.1.2 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.
Die verandering in frekwensie (of toonhoogte) van die klank deur 'n luisteraar waargeneem omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting het. (2)

6.1.3 Away/Weg van✓
 Detected frequency of source decreases✓
Waargenome frekwensie van bron neem af (2)

6.1.4 **EXPERIMENT/EKSPERIMENT 2**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR/OF } f_L = \frac{v}{v + v_s} f_s \checkmark$$

$$874 = \frac{v}{v + 10} (900) \checkmark$$

$$v = 336,26 \text{ m} \cdot \text{s}^{-1} \checkmark$$

Mark independent of 6.1.3
Merk onafhanklik van 6.1.3

(5)

EXPERIMENT/EKSPERIMENT 3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR/OF } f_L = \frac{v}{v + v_s} f_s \checkmark$$

$$850 = \frac{v}{v + 20} (900) \checkmark$$

$$v = 340 \text{ m} \cdot \text{s}^{-1} \checkmark$$

Mark independent of 6.1.3
Merk onafhanklik van 6.1.3

(5)

EXPERIMENT/EKSPERIMENT 4

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR/OF } f_L = \frac{v}{v + v_s} f_s \checkmark$$

$$827 = \frac{v}{v + 30} (900) \checkmark$$

$$v = 339,88 \text{ m} \cdot \text{s}^{-1} \checkmark$$

Mark independent of 6.1.3
Merk onafhanklik van 6.1.3

(5)

6.2 Away from the Earth✓ (1)
[11]

QUESTION 6/VRAAG 6

- 6.1 It is the (apparent) 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. ✓

Dit is die (skynbare) verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het

OR/OF

An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).

'n (Skynbare) verandering in waargenome frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar

(2)

6.2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s \quad \checkmark$$

$$825 = \frac{v}{v - v_s} (800) \quad \checkmark$$

$$(1,03125)(v - 10) \checkmark = v$$

$$\therefore v = 330 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

Notes/Aantekeninge:

The following values are obtained using other points

Die volgende waardes is verkry deur ander punte te gebruik

$v_s \text{ (m} \cdot \text{s}^{-1})$	Frequencies	$v \text{ (m} \cdot \text{s}^{-1})$
$v_s = 20$	850	310
$v_s = 20$	845	375,56
$v_s = 30$	880	330
40	910	331

Any other Doppler formula, e.g.

Enige ander Doppler-formule, bv:

$$f_L = \frac{v - v_L}{v - v_s} - \text{Max./Maks } \frac{3}{4}$$

Marking rule 1.5: No penalisation if zero substitutions are omitted.

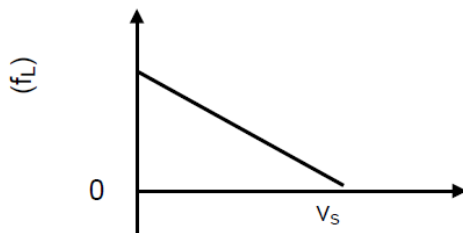
Nasienreël 1.5: Geen penalisering indien nulvervangings uitgelaat is nie.

(5)

- 6.3 Straight line with negative gradient / frequency decreases (linearly) ✓✓

Reguitlyn met negatiewe gradiënt/frekwensie neem af (lineêr)

(2 or/of 0)



(2)

[9]

QUESTION 6/VRAAG 6

- 6.1 The apparent change in the detected frequency (or pitch)(or wavelength) ✓ as a result of the relative motion between a source and an observer (listener). ✓

Die skynbare verandering in waargenome frekwensie (of toonhoogte)(of golflengte) ✓ as gevolg van die relatiewe beweging tussen die bron en waarnemer/luisteraar. ✓

(2)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/OF** $f_L = \frac{v + v_L}{v - v_s} f_s$ ✓

$$f_L = \frac{340 + (340 - 310)}{340} 280$$

$= 304,71 \text{ Hz}$ ✓

(5)

- 6.3 **SMALLER/KLEINEER** ✓

⊖ The listener moves away from the siren, with constant velocity/speed ✓
 λ increases and the frequency decreases. ✓

Die luisteraar beweeg weg van die sirene met konstante snelheid/speed. ✓
 λ neem toe en frekwensie neem af. ✓

OR/OF

$\lambda \propto \frac{1}{f}$ or/of $f \propto \frac{1}{\lambda}$ ✓ At constant velocity (speed) ✓
 By konstante snelheid (speed) ✓

(3)

- 6.4 Determines the rate at which blood flow. } ✓ Any ONE
 Monitor and measures the heartbeat of a foetus }
 Bepaal die tempo waarteen bloed vloei. } ✓ Enige EEN
 Monitor en meet die hartklop van 'n fetus. }

(1)

- 6.5

AWAY/WEG ✓

⊖ Light from a star is shifted towards a longer wavelength/towards the red end of the spectrum. ✓

Die ster se lig word verskuif na 'n langer golflengte/na die rooi kant van die spektrum. ✓

(2)

[13]

QUESTION 6/VRAAG 6

6.1 $v = f\lambda$ ✓
 $= (222 \times 10^3)(1,5 \times 10^{-3})$ ✓
 $= 333 \text{ m.s}^{-1}$ ✓ (3)

6.2
 6.2.1 Towards the bat/*Na die vlermuis toe* ✓ (1)

6.2.2 **POSITIVE MARKING FROM QUESTION 6.1/POSITIEWE NASIEN VANAF VRAAG 6.1**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR/OF } f_L = \frac{v}{v - v_s} f_s \quad \checkmark$$

$$230,3 = \frac{333}{333 - v_s} (222) \quad \checkmark$$

$$76689,9 - 230,3 v_s = 73\,926$$

$$v = 12 \text{ m.s}^{-1} \quad \checkmark \quad (\text{towards bat/na die vlermuis toe})$$

Notes/Notas:

- Any other Doppler formula, e.g./*Enige ander Doppler-formule, bv.:*

$$f_L = \frac{v - v_L}{v - v_s} - \text{Max./Maks. } \frac{3}{4}$$

- Marking rule 1.5: No penalisation if zero substitutions are omitted./*Nasienreël 1.5: Geen penalisering indien nulvervangings uitgelaat is nie.*

(6)
[10]