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WTS TUTORING

WTS

DOPPLER EFFECT MEMO

GRADE : 12

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MEMO FOR PAST PAPERS

QUESTION/*VRAAG* 6

6.1	Doppler effect / *Doppler-effek* ✓		(1)
6.2	The number of waves reaching the detector per unit ✓ time decreases ✓. **OR** As the ambulance is moving away from the scene /detector, the wavelengths become longer resulting in less waves reaching the detector ✓ per unit time ✓ hence the frequency decreases. *Die aantal golwe wat die detektor per eenheid ✓ tyd neem af.* ✓ **OF** *Soos die ambulans wegbeweeg vanaf die toneel / detektor, word die golflengte langer wat veroorsaak dat minder golwe die detektor ✓ per eenheidstyd ✓ bereik en dus neem die frekwensie af.*		(2)
6.3	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v}{v+v_s} f_s$ ✓ any one / *enige een* 90% × 890 ✓ $= \frac{340}{340+v_s}$ ✓ × 890 ✓ $801 = \frac{340 \times 890}{340+v_s}$ $340 + v_s = \frac{340 \times 890}{801}$ $v_s = 37{,}78\ m \cdot s^{-1}$ ✓		(5)
6.4	Doppler flow meter is used to determine whether arteries are clogged / narrowed ✓ **OR** to determine the rate of flow of blood ✓ *Die Doppler-vloeimeter word gebruik om te bepaal of die are vernou/verstop is* ✓ **OF** *om die tempo van bloedvloei te bepaal.* ✓		(1)
6.5	6.5.1	The shift is to a longer wavelength, lower frequency, as the star is moving away from the Earth. ✓ *Die skuif is na 'n langer golflengte, laer frekwensie, so die ster beweeg weg van die Aarde.* ✓	(1)
	6.5.2	A greater shift, therefore it shows that the distant star is moving away at a greater speed than a nearby star. ✓✓ *'n Groter skuif, so dit toon dat die verafgeleë ster beweeg weg teen 'n groter spoed as die nabygeleë ster.* ✓✓	(2)
			[12]

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QUESTION / *VRAAG* 6

6.1 6.1.1 It is the apparent change in frequency of a source when there is relative motion between the source and the observer. ✓✓
Die 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. (2)

6.1.2

$$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s \checkmark$$

$$v_L = (v + v_s)\ \frac{f_L}{f_s}$$

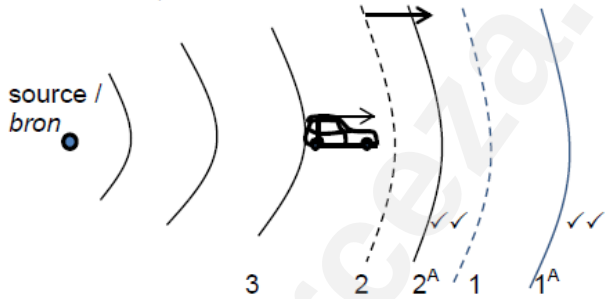
$$= (340 + 0) \checkmark \times \left[\frac{360}{340}\right] \checkmark$$

$$= 17{,}90\ ms^{-1}$$

$$= 17{,}895 \times \left[\frac{3600}{1000}\right] \checkmark$$

$$= 64{,}42\ km{\cdot}h^{-1} \checkmark$$ (5)

6.2



Since the driver is moving in the same direction as the waves, the wavefronts will pass him at delayed intervals, thus making the wavelengths longer hence hearing a lower frequency.
Aangesien die bestuurder beweeg in dieselfde rigting as die golwe, sal die golffronte verby beweeg teen vertraagde intervalley wat dus maak dat die golflengtes langer word en hy dus 'n laer frekwensie hoor. (4)

6.3 Speed trap cameras, Doppler flow meter for measuring the speed of blood, ultra sound foetus scan ✓✓
Spoedvang kameras, Dopplervloei meter vir die meting van die spoed van bloed, ultraklank fetus skandering (2)
[13]

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QUESTION 6

6.1 Doppler Effect. ✓ It is 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. ✓✓

OR
Doppler Effect. ✓ It is the change in the observed frequency of a sound wave when the source of sound is moving relative to the listener.✓✓ (3)

6.2 56,56 $m.s^{-1}$✓✓ (2)

6.3

$$f_L = \frac{v}{v - v_s} f_s \quad ✓$$

$$298{,}84 \overset{✓}{=} \frac{340 \quad ✓}{340 - 56{,}56} f_s \quad ✓$$

$$f_s = 250\,Hz \quad ✓$$

(5)

6.4 Determine whether arteries are clogged/narrowed ✓
Determine heartbeat of foetus✓ (2)
[11]

QUESTION 6// *VRAAG 6*

6.1 There must be relative motion between observer and source of sound. ✓// (1)
Daar moet relatiewe beweging wees tussen die waarnemer en die klankbron.

6.2

θ

(Towards) **X** ✓

As the car approaches **X**, the wave lengths are shortened/waves are compressed. ✓ for the same speed of sound,✓the frequency increases ✓// *Soos die motor na X beweeg word die golwe saamgepers . Spoed van klank dieselfde so frekwensie neem toe*

OR//*OF*:

Towards **X** ✓// *Na **X***

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(4)

6.3.1

$$f_{LX} = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s \checkmark$$

$$538 \checkmark = \left(\frac{340}{340-15}\right) f_s \checkmark$$

$$\therefore f_s = 514{,}265 \text{ Hz} \checkmark$$

(4)

6.3.2

$$f_{LX} = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s \checkmark$$

$$= \left(\frac{340}{340+15}\right) \checkmark (514{,}265) \checkmark$$

$$= 492{,}535 \text{ Hz} \checkmark$$

(4)

6.4 **ANY ONE** / ***ENIGE EEN:***

- To measure rate of blood flow. ✓/ *meet spoed van bloedvloei.*
- To measure the heartbeat of foetus. ✓/ *meet hartklop van fetus.*

(1)

[14]

QUESTION 6

6.1 The number of waves that passes a fixed point ✓ per second ✓
Die aantal golwe wat per sekonde by 'n vaste punt verby beweeg (2)

6.2 Wavelength (λ) in front of source decreases ✓
More waves per second reaches the listener ✓
Frequency will increase (2)

6.3

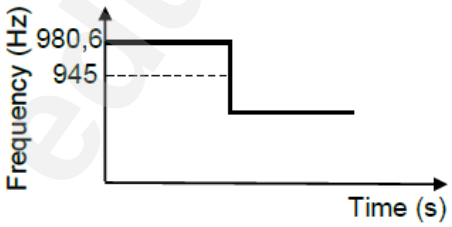
$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S \checkmark$$

$$980{,}6 \checkmark = \left(\frac{340}{340 - v_s}\right)(945) \checkmark$$

$$v_s = 12{,}34 \text{ m·s}^{-1} \checkmark$$

(4)

6.4



Criteria for graph

Horizontal line at 980,6 Hz	✓
Horizontal line below 945 Hz	✓
945 Hz correctly indicated	✓

(3)

[11]

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QUESTION 6 / VRAAG 6

6.1 Doppler Effect ✓/ Doppler Effek ✓

Doppler Effect is 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✓.

Doppler Effek is die 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. (3)

OR/*OF*
The change in the observe frequency when there is relative motion between the source and the observer.
Die verandering in die waargenomefrekwensie as daar relatiewe beweging tussen die klankbron en die luisteraar.

6.2

$f_l = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ OR/*OF* $f_l = \frac{v}{v \pm v_s} f_s$

$$f_L = \frac{340 ✓}{(340 - 16) ✓}(420) ✓$$

$f_L = 440.74\ Hz$ ✓ (5)

6.3.1 Smaller than ✓/ Kleiner as ✓ (1)

6.3.2 Increases ✓/ Toeneem✓ (1)

6.4 Sun and stars emit light.

When a star moves away from the Earth, its spectrum shifts to longer wavelength ✓ (lower frequency) in other words, the **red shift** ✓
[NB - Red has a longer wavelength then blue).
The stars then appears red.

The Universe is expanding ✓

Sun en sterre straal lig uit.

As 'n ***ster weg van die aarde*** *beweeg, verskuif sy spectrum na 'n* ***langer golflengte*** ✓ *(laer frekwensie) in ander woorde,* ***rooi verskuiwing*** ✓ *(NB Rooi het 'n langer golflengte as blou).*
Die ster kom dan voor as rooi.
Die heelal brei uit✓ (3)

[13]

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QUESTION 6/*VRAAG 6*

6.1.1 The (apparent) change in the frequency/pitch of the sound detected✓ by a listener because the sound source and listener have different velocities relative to the medium of sound propagation.✓
Dit is die (skynbare) verandering in die frekwensie/toonhoogte van die klank waargeneem deur deur die luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het. (2)

6.1.2 B. ✓There is an increase in the detected/observed frequency✓by the listener.
B. Daar is 'n toename in die waargenome frekwensie deur die luisteraar. (2)

6.1.3

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

$f_L = \frac{v + v_L}{v} f_s$

$620 = \frac{340 - v}{340}$ ✓ ✓ $680 = \frac{340 + v_L}{340} 650$ ✓

$v_L = 15{,}69\ m.s^{-1}$ ✓ $v_L = 15{,}69\ m.s^{-1}$ ✓

(5)

6.1.4 The listener is moving towards the source with a constant accelaration/constant increase in velocity. ✓✓
Die luisteraar nader die bron met 'n konstante versnelling/konstante toename in snelheid. (2)

6.1.5 Measurement of foetal heart beat.✓OR
Measurement and monitoring of blood flow.
Meting van hartklop van fetus. OF
Meting en waarneming van bloedvloei. (1)

[12]

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***QUESTION / VRAAG* 6**

6.1 6.1.1 It is the apparent change in frequency of a source when there is relative motion between the source and the observer. ✓✓

Dit is die skynbare verandering in frekwensie van 'n bron wanneer daar 'n relatiewe verandering in beweging tussen die bron en die waarnemer is. ✓✓ (2)

6.1.2 Away / *Weg*✓ (1)

6.1.3

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

$$73 \checkmark = \frac{340}{340 + v_s} 75 \checkmark$$

$$v_s = 9{,}32\ m \cdot s^{-1} \checkmark$$ (4)

6.2
- The absorption spectrum observed for elements on a distant star compared to spectrum of elements on the earth or sun. ✓
- Absorption lines in spectrum from star shifted to red end of the spectrum/ red shifted. ✓
- Wavelengths in the absorption spectrum lines have increased. ✓
- According to the Doppler effect the star is thus moving away from the earth. ✓

- *The absorbsiespektrum waargeneem vir elemente van 'n verafgeleë ster in vergelyking met die spektrum van elemente nader aan die aarde of die son.* ✓
- *Absorbsielyne in die spektrum van ster verskuif na die rooi kant van die spektrum/ rooiverskuiwing.* ✓
- *Golflengte in the absorbsiespektrumlyne vermeerder.* ✓
- *Volgens die Doppler effek beweeg die ster dus verder van die aarde.* ✓ (4)

6.3 Ultrasound scans / *ultraklankskandering*✓
Measuring rate of flow of blood (Blood-flow meter) / *Meting van die tempo waarteen bloed vloei (bloedvloeimeter)*✓ (2)
[13]

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QUESTION 6

6.1 The apparent/observed (*change in the*) frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to each other. ✓✓ (**ALL** or **NOTHING** marking) (2)

6.2

$v = f \times \lambda$ ✓
$340 = f \times 0{,}72$ ✓
$f = 472{,}22$ Hz ✓ (3)

Positive marking from **6.2** to **6.4**.

6.3 Towards. ✓ The frequency of the sound waves heard by the traffic official is greater than the frequency of the sound waves emitted by the hooter/ Observed frequency is greater than 433,64 Hz✓ (2)

6.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$472{,}22$ ✓ $= \frac{340}{340 - v_s}$ ✓ $\times$ $433{,}64$ ✓

$v_s = 27{,}78\ m.s^{-1}$

The speed limit is 100 $km.h^{-1}$(27,78 $m.s^{-1}$), while the speed of the car is 100 $km.h^{-1}$ (27,78 $m.s^{-1}$) ✓ .The car is not exceeding the speed limit✓ (6)

6.5 less than✓ (1)

[14]

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QUESTION 6

6.1

6.1.1 The Doppler Effect is the change in the observed 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.✓ ✓ (2 or 0)

OR

The change in the (observed) frequency when there is relative motion between the source and the observer.✓ ✓ (2 or 0)

6.1.2 away (1)

6.1.3

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

$$88 \checkmark = \frac{340 - 0}{340 + v_s} \checkmark \times 90 \checkmark$$

$$v_s = 7{,}73 \text{ m.s}^{-1} \checkmark$$ (5)

(note: it is not necessary to show the zero)

6.2

6.2.1 Red Shift occurs when <u>absorption lines are shifted towards smaller frequencies</u> (or larger wavelengths) (which is the red end of the spectrum) ✓✓ (2)

6.2.2 absorption (spectrum) ✓ (1)

6.2.3 F.✓ fastest galaxy✓/highest velocity (2)

[14]

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QUESTION 6

6.1.1 The apparent change in frequency in sound heard due to the relative motion between listener and/or source.✓✓ (2)

6.1.2 $f_L = (\frac{v \pm v_L}{v \pm v_S})f_S$ ✓

$\therefore 0{,}93 \text{ x } f_s$ ✓ $= (\frac{335-0}{335+v_S})f_S$ ✓

$\therefore 0{,}93(335 + v_S) = 335$

$\therefore 0{,}93v_S = 335 - 0{,}93 \text{ x } 335$

$\therefore v_S = \frac{0{,}07 \text{ x } 335}{0{,}93} = 25{,}22 \text{ m·s}^{-1}$ ✓ (4)

6.2.1 Absorption (line spectrum) ✓ (1)

6.2.2 Red-shift ✓ (1)

6.2.3 Away from ✓ (1)

[9]

QUESTION 6/*VRAAG 6*

6.1 v = fλ = ✓
340 =f(0,72) ✓
f = 472,22 Hz✓ (3)

6.2 The apparent change in the observed frequency as a result of relative motion between the source and the listener.✓✓/
Die skynbare verandering in die waargenome frekwensie as gevolg van die relatiewe beweging tussen die bron en die luisteraar

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)

6.3 Towards/*Na*. ✓
The frequency of the sound waves heard by the traffic official is greater than the frequency of the sound waves emitted by the hooter.✓
Die frekwensie van die klankgolwe wat deur die verkeersbeampte gehoor word is groter as die frekwensie van die klankgolwe wat deur die toeter vrygestel word. (2)

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6.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$472{,}22$✓ $= \frac{340}{340 - v_s}$ ✓$(433{,}64)$✓

$v_s = 27{,}28\ m{\cdot}s^{-1}$ ✓

The car is not exceeding the speed limit✓ as the speed limit is 100 $km{\cdot}h^{-1}$ ($27{,}78\ m.s^{-1}$), while the speed of the car is 100 $km{\cdot}h^{-1}$($27{,}78\ m.s^{-1}$) ✓
Die motor oorskry nie die spoedgrens nie aangesien dit 100 $km{\cdot}h^{-1}$ ($27{,}78\ m{\cdot}s^{-1}$) is , terwyl die spoed van die motor is 100 $km{\cdot}h^{-1}$ ($27{,}78\ ms^{-1}$) is (6)

6.4 Less than / *Minder as* ✓ (1)

[14]

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