SA-STUDENT

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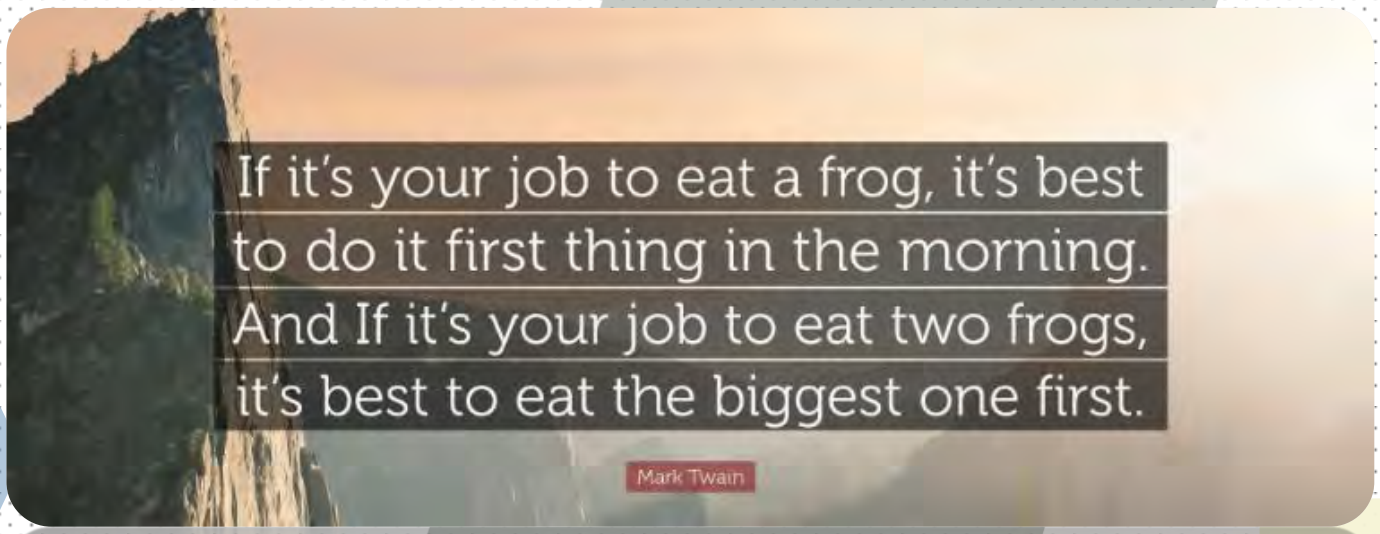
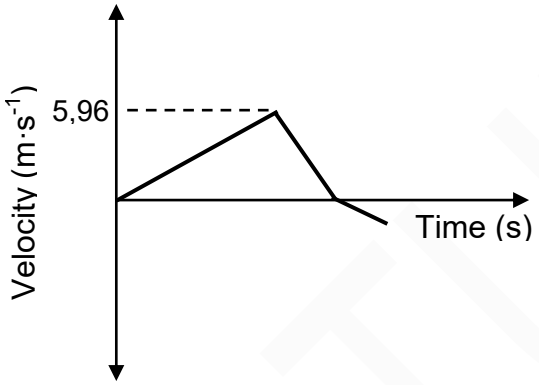


5.5 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

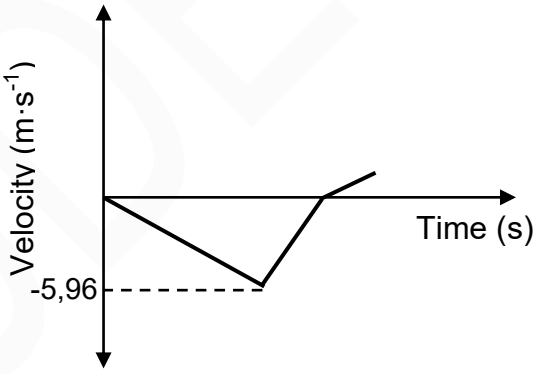
Marking criteria/*Nasienkriteria:*
- First straight line starting at zero with positive gradient, reaching a maximum velocity./*Eerste reguit lyn met 'n positiewe gradiënt begin by nul en bereik maksimum snelheid.* ✓
- Second straight line with negative gradient from maximum velocity to zero./ *Tweede reguit lyn met negatiewe gradiënt vanaf maksimum snelheid na zero.* ✓
- Third straight line continuing from second line at zero and extending below the x-axis./*Derde reguit lyn wat aangaan vanaf tweede lyn vanaf nul en verleng onder die x-as.* ✓
- Third line has a smaller negative gradient than the second line./*Derde reguit lyn het 'n kleiner negatiewe gradiënt as die tweede lyn* ✓

Note/Aantekening:
Direction of gradients opposite for graph 2./*Rigting van hellings teenoorgesteld vir grafiek 2.*
No marks given for values of velocities./*Geen punte toegeken vir waardes van snelhede nie.*

UPWARDS AS POSITIVE
OPWAARTS *AS POSITIEF:*



DOWNWARDS AS POSITIVE
AFWAARTS *AS POSITIEF:*



(4)
[17]

QUESTION 6/*VRAAG 6*

6.1.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓
Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

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

6.1.2

$f_L = \frac{v \quad v}{v \quad v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v}{v} f_S$

$f_L = \left(\frac{340 + 22}{340}\right)$ ✓ 24 000 ✓

f_L = 25 552,94 Hz

$f_L = \frac{v \quad v}{v \quad v_s} f_S$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_S$

$f_L = \left(\frac{340}{340 - 22}\right)$ ✓ 25 552,94 ✓

f_L = 27 320,75 Hz ✓ (6)

6.2 The frequencies of the spectral lines would have decreased./*Die frekwensies van die spektrale lyne sou verminder het.*✓✓

OR/*OF*
The spectral lines from the distant star are shifted towards lower frequency end of the spectrum./*Die spektrale lyne van die ver af ster sou verskuif na 'n laer frekwensie op die spektrum*. (2)
[10]

QUESTION 7/*VRAAG 7*

7.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*
If any refrence is made to mass/*Indien enige verwysing gemaak is na massa*: $^0/_2$

The magnitude of the electrostatic force exerted by one (stationary) point charge ($\mathbf{Q_1}$) on another (stationary) point charge ($\mathbf{Q_2}$) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (**r**) between them.✓✓

*Die grootte van die elektrostatiese krag uitgeoefen deur een (stilstaande) puntlading ($\mathbf{Q_1}$) op 'n ander puntlading ($\mathbf{Q_2}$) is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (**r**) tussen hulle.* (2)

QUESTION/*VRAAG 6*

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

6.2 Measurement of foetal heartbeat./*Meting van die hartklop van 'n fetus.*✓

OR/*OF*
Measurement of blood flow./*Meting van bloedvloei.* ✓

OR/*OF*
Doppler flow meter/*Doppler vloeimeter* ✓
(1)

6.3 $f_L \propto f_s$ ✓

OR/*OF*
Directly (proportional)/*Direk (eweredig)* (1)

6.4

Marking criteria/*Nasienkriteria*

- Doppler formula/*Doppler formule* ✓
- Correct substitution for v and v_S./*Korrekte vervanging van v en v_S.* ✓
- Substitution for $\frac{f}{f} = 1{,}06$ **OR** $f_L = 1{,}06\ f_s$ **OR** any set of values for f_L and f_S so that $f_L = 1{,}06\ f_S$ / *Vervanging van $\frac{f}{f} = 1{,}06$ **OF** $f_L = 1{,}06\ f_s$ **OF** enige stel waardes vir f_L en f_S sodat $f_L = 1{,}06\ f_S$* ✓✓
- Final answer/*Finale antwoord:* 20,4 $m \cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*

$$f_L = \frac{v \quad v}{v \quad v_s} f_S \checkmark \quad \textbf{OR/}\textit{OF} \quad f_L = \frac{v + v}{v} f_S$$

$$\frac{f}{f_s} = \frac{v \quad v}{v \quad v_s}$$

$$1{,}06 = \left(\frac{340 + v}{340}\right) \checkmark\checkmark$$

$$v_L = 20{,}4\ m \cdot s^{-1} \checkmark$$

OPTION 2/*OPSIE 2*

$$\text{Gradient} = \frac{0\text{-}f}{0\text{-}f}$$

$$1{,}06 = \frac{0\text{-}f}{0\text{-}f} \checkmark\checkmark$$

$$f_L = 1{,}06\ f_S$$

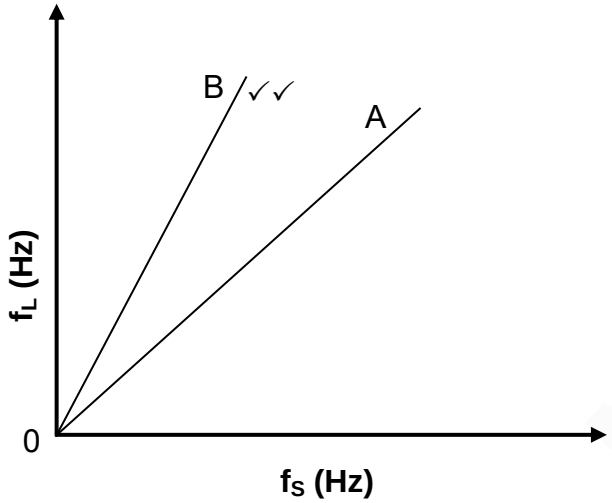
$$f_L = \frac{v \quad v}{v \quad v_s} f_S \checkmark \quad \textbf{OR/}\textit{OF} \quad f_L = \frac{v + v}{v} f_S$$

$$1{,}06\ f_S = \left(\frac{340 + v}{340}\right) f_S \checkmark$$

$$v_L = 20{,}4\ m \cdot s^{-1} \checkmark$$

(5)

6.5



Marking criteria/*Nasienkriteria*	
Graph is a straight line starting at the origin./ Grafiek is 'n reguitlyn wat by die oorsprong begin.	✓
Gradient of B is greater than gradient of A./ *Gradiënt van B is groter as gradiënt van A.*	✓

(2)
[10]

QUESTION 7/VRAAG 7

7.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The magnitude of the electrostatic force exerted by one point charge on another is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓
Die grootte van die elektrostatiese krag wat een puntlading op 'n ander uitoefen, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

7.2 Negative/*negatief* ✓ (1)

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓
Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

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

6.2

$v = f$ ✓
$340 = (880)\lambda$ ✓
$\lambda = 0{,}39$ m (0,386) ✓ (3)

6.3

OPTION 1/*OPSIE 1*

$f_L = \frac{v \quad v}{v \quad v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v}{v} f_S$

$f_L = \left(\frac{340 + 10}{340}\right)$ ✓ 880 ✓

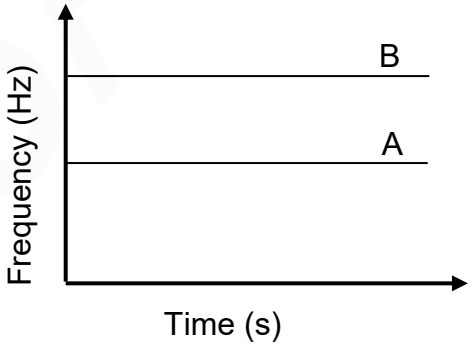
$f_L = 905{,}88$ Hz ✓

POSITIVE MARKING FROM QUESTION 6.2/
POSITIEWE NASIEN VANAF VRAAG 6.2

OPTION 2/*OPSIE 2*

$v = f$ ✓
$340 + 10$ ✓ $= f_L(0{,}39)$ ✓
$f_L = 897{,}44$ Hz ✓ (4)

6.4



Marking criteria/*Nasienkriteria*
B parallel with A and above A. ✓✓
B parallel aan A en bokant A. **2 or/*of* 0**

(2)
[11]

QUESTION 6/*VRAAG 6*

6.1 $v = f\lambda$ ✓
$340 = 680\lambda$ ✓
$\lambda = 0,5$ m ✓ (3)

6.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The change in frequency/pitch/wavelength 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/toonhoogte/golflengte van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting 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)

6.3.1 Decreased/*Afgeneem* ✓ (1)

6.3.2 Increased/*Toegeneem* ✓ (1)

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

OPTION 1/*OPSIE 1*

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

$f_L = \frac{v}{\lambda_L}$
$= \frac{340}{0,5 - 0,05}$ ✓
$= \frac{340}{0,45}$
$= 755,56$ Hz

$755,56 = \left(\frac{340 + 0}{340 - v_s}\right) 680$ ✓

$v_s = 34$ m·s^{-1} ✓ (33,67 - 34,04)

OPTION 2/*OPSIE 2*

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

$\frac{v}{\lambda_L} = \left(\frac{v + 0}{v - v_s}\right) f_s$

$\frac{340}{0,5 - 0,05}$ ✓ $= \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ 680 ✓

$\frac{340}{0,45} = \left(\frac{340 + 0}{340 - v_s}\right) 680$

$v_s = 34$ m·s^{-1} ✓ (33,67 - 34,04)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓ $\frac{v}{\lambda_L} = \left(\frac{v+0}{v - v_s}\right)\frac{v}{\lambda_s}$ $\therefore \quad \frac{1}{\lambda_L} = \left(\frac{v+0}{v - v_s}\right)\frac{1}{\lambda_s}$ $\frac{1}{0,5-0,05}$ ✓ = $\left(\frac{340+0}{340-v_s}\right)$ ✓ $\frac{1}{0,5}$ ✓ $\frac{1}{0,45} = \left(\frac{340+0}{340-v_s}\right)\frac{1}{0,5}$ v_s = 34 m·s^{-1} ✓ (33,67 - 34,04)	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓ $v_1 = v_2$ $f_s\lambda_1 = f_L\lambda_2$ $\underline{(600)(0,5) = f_L(0,45)}$ ✓ f_L = 755,56 Hz $755,56 = \left(\frac{340+0}{340-v_s}\right)$ ✓ 680 ✓ v_s = 34 m·s^{-1} ✓ (33,67 - 34,04)

(5)
[12]

QUESTION 7/*VRAAG 7*

7.1.1 Added/*Toegevoeg* ✓ (1)

7.1.2

NOTE/*LET WEL*
Ignore signs of the charges./ *Ignoreer tekens van die ladings.*

$n = \frac{Q}{q_e}$ ✓

$= \frac{-1,95 \times 10^{-6}}{-1,6 \times 10^{-19}}$ ✓

= 1,22 x 10^{13} ✓ (1,21875 x 10^{13}) (3)

7.1.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The (electrostatic) force experienced per unit positive charge placed at that point.
Die (elektrostatiese) krag per eenheid positiewe lading wat by die punt geplaas is.

NOTE/*LET WEL* (1 mark for:/*1 punt vir:*)
An electric field is a region of space in which an electric charge experiences a force.
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

7.1.4 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9 \times 10^9)(1,95 \times 10^{-6})}{(0,5)^2}$ ✓

= 7,02 x 10^4 N·C^{-1} ✓ (3)

OPTION 8/*OPSIE 8*

From R to the wall/*Vanaf R na die muur*:

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$
$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$
$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$
✓Any one/*Enige een*

$(9,8)(5,8) + 0 = 0 + (½)v^2$ ✓
$v = 10,66 \text{ m·s}^{-1}$

Into the wall / *In die muur in*:
$v_f^2 = v_i^2 + 2a\Delta x$
$0 = (10,66)^2 + (2)a(0,25)$✓
$a = -227,36 \text{ m·s}^{-1}$ (- 227,356)

$F_{wall/muur} = ma$
$F_{wall/muur} = (1\,250)(-227,356)$ ✓
$F_{wall/muur} = - 284\,200$ (-284 195)
$F_{wall/muur} = 284\,200$ N ✓ (284 195) (5)

[14]

QUESTION 6/*VRAAG 6*

6.1 **NOTE:** -1 mark for each key word/phrase omitted in the correct context.
LET WEL: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

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 waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het.

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

'n Skynbare verandering in waargenome frekwensie (toonhoogte), as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.2.1 700 Hz ✓
Learner/observer/listener velocity/speed = zero.
Luisteraar/waarnemer/leerder se spoed/snelheid = nul

OR/OF
No relative motion between source and listener. ✓
Geen relatiewe beweging tussen bron en luisteraar nie.

OR/OF
Listener and source both stationary.
Luisteraar en bron altwee in rus. (2)

6.2.2 Away ✓/ *Weg*
Observed frequency smaller (than actual frequency / frequency of source.) ✓
Waargenome frekwensie is kleiner as die werklike frekwensie/ frekwensie van die bron.

OR/*OF*
$f_L < f_s$

OR/*OF*
The (observed) frequency decreases / *Die (waargenome) frekwensie neem af* (2)

6.2.3

OPTION 1/*OPSIE 1*

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

$679{,}1 \overset{\checkmark}{=} \left(\frac{v - 10}{v}\right) \overset{\checkmark}{(700)}$ ✓

$\therefore$ v = 334,93 m·s^{-1} ✓(333,33 m·s^{-1})

OPTION 2/*OPSIE 2*

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

$658{,}2 \overset{\checkmark}{=} \left(\frac{v - 20}{v}\right) \overset{\checkmark}{(700)}$ ✓

$\therefore$ v = 334,93 m·s^{-1} ✓(333,33 m·s^{-1})

OPTION 3/*OPSIE 3*

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

$\frac{679{,}1}{658{,}2} \overset{\checkmark}{=} \frac{\frac{v - 10}{v} f_s}{\frac{v - 20}{v} f_s}$ ✓

$1{,}032 = \frac{v - 10}{v - 20}$

v = 332,50 m·s^{-1} ✓

Note/*Aantekening*:
If ratio is used/*Indien verhoudings gebruik:*
- Any correct formula/*Enige korrekte formule* ✓
- Any correct f value/E*nige korrekte f waarde* ✓
- Any correct substitution/*Enige korrekte vervanging* - v_L ✓
- Correct ratio/*Regte verhouding* ✓
- Final answer/*Finale antwoord*: 332,50 m·s^{-1}✓

OPTION 4/*OPSIE 4*

$f_L = \frac{v - v_L}{v} f_s$ ✓

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

Gradient $= -\frac{f_s}{v}$ ✓

$\frac{658{,}2 - 679{,}1}{20 - 10}$ ✓ $= -\frac{700}{v}$ ✓

v = 334,93 m·s^{-1}✓

(5)
[11]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase

The change in frequency✓ (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓
Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

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

6.2 Towards/*Nader* ✓ (1)

6.3

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

$3148 \checkmark = \left(\frac{340+0}{340-v_s}\right) f_s$ ✓ $2073 \checkmark = \left(\frac{340-0}{340+v_s}\right) f_s$ ✓

$$\frac{3148(340-v_s)}{340+0} = \frac{2073(340+v_s)}{340-0}$$

$v_s = 70\ m \cdot s^{-1}$✓ $(69,95 - 70,16\ m \cdot s^{-1})$ (6)

6.4

POSITIVE MARKING FROM QUESTION 6.3
POSITIEWE NASIEN VANAF VRAAG 6.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$\Delta t = \frac{\Delta x}{v}$ $\Delta t = \frac{350}{70}$ ✓ $\Delta t = 5\ s$ ✓	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $350 = 70\Delta t + 0$ ✓ $\Delta t = 5\ s$ ✓	$\Delta x = \left(\frac{v_i + v_f}{2}\right) \Delta t$ $350 = \left(\frac{70+70}{2}\right) \Delta t$ ✓ $\Delta t = 5\ s$ ✓

(2)
[11]

5.4

OPTION 1/*OPSIE 1*	**OPTION 2/OPSIE 2**
$E_P = mgh$ ✓ $= \underline{(1,8)(9,8)\ (1,5)}$ ✓ $= 26,46$ J ✓	$W_w = -\Delta E_p$ ✓ $(1,8)(9,8)(h - 0)\cos 180^o = -(E_{pA} - E_{p(ground)})$ $\underline{(1,8)(9,8)(1,5)(-1) = -E_{pA}}$ ✓ $E_p = 26,46$ J✓ **OR/*OF*** $W = F\Delta x\cos\theta$ $= mg\Delta h\cos\theta$ ✓Any one/*Enige een* $= \underline{(1,8)(9,8)\ (1,5)\cos 0^o}$ ✓ $= 26,46$ J✓

(3)

5.5

POSITIVE MARKING FROM QUESTION 5.4 /
POSITIEWE NASIEN VANAF VRAAG 5.4

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta K + \Delta U$
$W_f = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*
$= \underline{½(1,8)(4^2 - 0,95^2)}$ ✓+ $\underline{(0 - 26,46)}$ ✓
$= -12,87$ J ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$
$W_f + W_g = ½mv_f^2 - ½mv_i^2$
$W_f + mgh = ½m(v_f^2 - v_i^2)$ ✓Any one/*Enige een*
$W_f + mgh = ½mv_f^2 - ½mv_i^2$
$\underline{W_f + 26,46}$ ✓$= \underline{½(1,8)[(4)^2 - (0,95)^2]}$ ✓
$W_f = -12,87$ J (- 12,872 J) ✓

OPTION 3/*OPSIE 3*

$E_{(mech/meg)A} = E_{(mech)B} - W_f$
$(E_p + E_k)_A = (E_p + E_k)_B - W_f$ ✓Any one/*Enige een*
$(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B - W_f$
$\underline{26,46 + ½(1,8)(0,95^2)}$ ✓ $= 0 + ½(1,8)(4^2) - W_f$ ✓
$W_f = -12,87$ J ✓

(4)

5.6 $W_{net} = 0$ (J) / zero✓ (1)

[13]

QUESTION 6/*VRAAG 6*

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

6.2 (Q): (records sounds with) longer period/ longer time per wave / lower frequency.
(Q): (teken klank aan met) langer periode / langer tyd per golf / laer frekwensie.

OR/*OF*

P: (records sounds with) shorter period/ shorter time per wave / higher frequency. ✓
P: (teken klank aan met) korter periode/ korter tyd per golf / hoër frekwensie.

ACCEPT/*AANVAAR*

(Q): longer wavelength. /P: shorter wavelength.
(Q): langer golflengte./P: korter golflengte het. (1)

6.3 **OPTION 1/*OPSIE 1***

$f = \frac{1}{T}$ ✓ $= \frac{1}{17 \times 10^{-4}}$ ✓ = 5,88 x 10^2 = 588,24 Hz ✓

OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***
speed = $\frac{\text{distance}}{\text{time}}$ 340 = $\frac{\text{distance}}{25{,}5 \times 10^{-4}}$ Distance = 0,867 m Distance = 1 ½ λ ∴λ = 0,578 m v = fλ ✓ 340 = f(0,578) ✓ f = 588,24 Hz ✓	v = $\frac{\lambda}{T}$ 340 = $\frac{\lambda}{17 \times 10^{-4}}$ ∴λ = 0,578 m v = fλ ✓ 340 = f(0,578) ✓ f = 588,24 Hz ✓

(3)

6.4 **POSITIVE MARKING FROM QUESTIONS 6.2 AND 6.3.**
POSITIEWE NASIEN VANAF VRAE 6.2 EN 6.3
Do not penalise if 10^{-4} is again omitted. *Moenie penaliseer indien 10^{-4} weer uitgelaat is nie.*

OPTION 1/*OPSIE 1*

$f = \frac{1}{18 \times 10^{-4}}$ ✓ = 5,56 x 10^2 = 555,56 Hz

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

555,56 ✓ $= \left(\frac{340}{340 + v}\right)$ ✓ 588,24 ✓

v = 20 m·s^{-1} ✓

Range/*Gebied* 19,57 – 20,09 m·s^{-1}

OPTION 2/*OPSIE 2*

$f_L = \frac{1}{18 \times 10^{-4}}$ ✓

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

$\frac{1}{18 \times 10^{-4}}$ ✓ $= \left(\frac{340}{340 + v}\right)$ ✓ $\frac{1}{17 \times 10^{-4}}$ ✓

v = 20 m·s^{-1} ✓

Range/*Gebied* 19,57 – 20,09 m·s^{-1}

(6)
[11]

QUESTION 6/*VRAAG 6*

6.1.1 $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$
$300 = v_i (10)$ ✓
$v_i = 30\ m\cdot s^{-1}$✓

$v = \frac{d}{t} = \frac{300}{10}$✓$=30 m\cdot s^{-1}$✓

NOTE/*LET WEL*:
Accept/*Aanvaar* $\Delta x = v_i\Delta t$ (2)

6.1.2 The change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of sound propagation. ✓✓
Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium 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.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat (2)

6.1.3 Car/source (just) passes observer ✓✓
Motor beweeg net verby die waarnemer
Accept:
Car moves away from observer ✓✓
No relative motion between car and observer ✓✓
Car and observer at the same place/position✓✓

***Aanvaar**:*
Motor beweeg verby waarnemer
Geen relatiewe beweging tussen motor en waarnemer
Motor en waarnemer by dieselfde plek/posisie. (2)

6.1.4

POSITIVE MARKING FROM 6.1.1/*POSITIEWE NAISEN VANF 6.1.1*

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

✓ $932 = \frac{340}{340 - 30} f_s$ ✓

$f_s = 849{,}76$ Hz ✓ (4)

Notes/*Aantekeninge*:

- Any other Doppler formula, e.g. /*Enige ander Doppler formula b.v.*

  $f_L = \frac{v - v_L}{v - v_s} f_s$ - Max/*Maks*. $^3/_4$

Marking rule 1.5: No penalisation if zero substitutions are omitted.
Nasienreël 1.5. Geen penalisering indein nul vervangings uitgelaat word

6.2 Doppler / Blood flow meter
Dopplervloeimeter/ bloedvloeimeter
Measuring the heartbeat of a foetus
Meting van hartklop van 'n fetus
Radar
Sonar
Used to determine whether stars are receding or approaching earth/
Gebruik om te bepaal of sterre na of weg van die aarde beweeg

Any 2 ✓✓
Enige 2

(2)
[12]

QUESTION 6/*VRAAG 6*

6.1 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. ✓✓
Die verandering in frekwensie (of toonhoogte) (golflengte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/*OF*
An (apparent) change in observed/detected frequency (pitch), 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)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

6.2 Away from/*Weg vanaf* ✓
Observed frequency lower/*Waargenome frekwensie is laer* ✓ (2)

6.3
$v = f\lambda$ ✓
$340 = f(0{,}34)$ ✓
$f = 1\,000$ Hz ✓ (3)

6.4
POSITIVE MARKING FROM 6.3/*POSITIEWE NASIEN VANAF 6.3*

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

$950 \overset{\checkmark}{=} \left(\frac{340 - v_L}{340 + 0}\right)^{\checkmark} 1\,000$ ✓

$v_L = 17\ m \cdot s^{-1}$

distance/*afstand* $x = v\Delta t$
$= (17)(10)$ ✓
$= 170$ m ✓

OR/*OF*

$f_L = \frac{v - v_L}{v} f_s$ ✓

$950 \overset{\checkmark}{=} \left(\frac{340 - x/_{10}}{340 + 0}\right)^{\checkmark} (1000)^{\checkmark}$

distance/*afstand* $x = 170$ m ✓

ACCEPT/*AANVAAR*

$v_L = \Delta f\lambda$ ✓
$= (50)$✓✓$(0,34)$✓
$= 17\ m\cdot s^{-1}$

distance/*afstand* $x = v\Delta t$
$= (17)(10)$ ✓
$= 170$ m ✓

(6)

[13]

QUESTION 7/*VRAAG 7*

7.1

$$Q_{net/netto} = \frac{Q_1 + Q_2 + Q_3}{3}$$

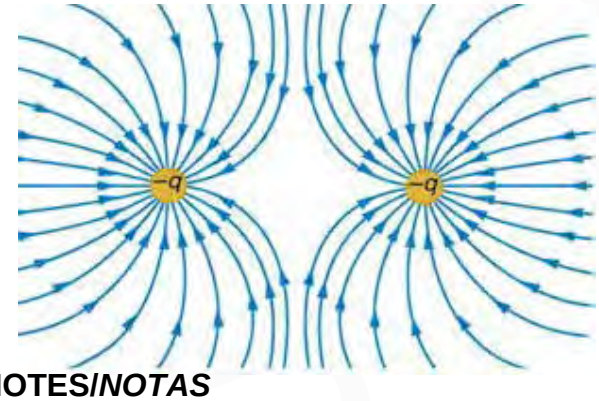
$$-3 \times 10^{-9} = \frac{-15\times10^{-9} + Q + 2\times10^{-9}}{3}$$ ✓

$Q = +4 \times 10^{-9}$ C✓

NOTE/*LET WEL*
✓ for addition of the three correct charges
✓ correct answer

(2)

7.2



NOTES/*NOTAS*
Correct shape /*Korrekte vorm* ✓
Correct direction/*Korrekte rigting* ✓
Lines must not cross and must touch spheres ✓
Lyne moet nie kruis nie en moet die sfere raak

(3)

7.3 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) <u>is directly proportional to the product of the (magnitudes) of the charges</u> and <u>inversely proportional to the square of the distance (r) between them</u> ✓✓
Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading (Q_1) op 'n ander puntlading (Q_2) <u>is direk eweredig aan die produk van die (groottes) van die ladings en omgekeerde eweredig aam die kwadraat van die afstand (r) tussen hulle.</u>

(2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If masses used (0/2)
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien massas gebruik word, (0/2)*

QUESTION 6/*VRAAG 6*

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

6.2 Towards A./*Na A*✓
Recorded frequency higher./*Aangetekende frekwensie is hoër*✓ (2)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

FOR A/*VIR A*

$$690 \overset{\checkmark}{=} \left(\frac{340}{340 - v_s}\right) f_s \overset{\checkmark}{}$$ (1)

FOR B/*VIR B*:

$$610 \overset{\checkmark}{=} \left(\frac{340}{340 + v_s}\right) f_s \overset{\checkmark}{}$$ (2)

$$\frac{690}{610} = \frac{340 + v_s}{340 - v_s}$$

$1{,}131\,(340 - v_s) = 340 + v_s$
$v_s = 20{,}90\ m.s^{-1}$✓ (20.90 to 20.92 $m.s^{-1}$) (6)

6.4 **ANY ONE/*ENIGE EEN***
Doppler flow meter/*Doppler-vloeimeter* ✓
Measuring foetal heartbeat/*Meet van fetale hartslag*
Measure speed of blood flow
Ultra sound/*Ultraklank*
Sonar
Radar (for speeding/*vir jaag*) (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 verandering in frekwensie (of toonhoogte) van die klank (waargeneem deur 'n luisteraar) omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting 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)

NOTE:/*LET WEL*
If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.*

6.2

OPTION1/*OPSIE1*

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

$(5100) = \frac{340}{340 - 240} f_s$ ✓✓✓

f_s = 1 500 Hz

$v = f\lambda$ ✓
$340 = (1\,500)\lambda$ ✓
λ = 0,23 m ✓ (7)

OPTION 2/*OPSIE 2*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v - v_s}\left(\frac{v}{\lambda_s}\right)$

$(5100) = \left(\frac{340}{340 - 240}\right)\left(\frac{340}{\lambda_s}\right)$ ✓✓✓✓

λ= 0,23 m ✓ (7)

6.3 Greater than ✓/*Groter as* (1)
[10]

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_K / \Delta K$ ✓

For the 4 kg mass / *Vir die 4 kg massa*

$T(1,6)\cos 0^o + [(0,4)(9,8)(4)](1,6)\cos 180^o$ ✓ $= ½(4)v^2 - 0)$

For the 6 kg mass/*Vir die 6 kg massa*

$(6)(9,8)(1,6)]\cos 0^o + T(1,6)\cos 180^o$ ✓ $= ½(6)(v^2 - 0)$

Adding the two equations / *Optel van twee vergelykings*

$68,992 = ½(4)v^2 + ½(6)v^2$ ✓

$5v^2 = 68,992$

$v = 3,71\ m\cdot s^{-1}$ ✓

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$ ✓

$F_{net}\ \Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$

$(F_g - f)\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$

$[(6)(9,8) - (0,4)(4)(9,8)]$ ✓ $(1,6)\cos 0^o$ ✓ $= ½(10)(v_f^2 - 0)$ ✓

$v_f = 3,71 m.s^{-1}$ ✓ (5)

[12]

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

6.2.1 170 Hz✓ (1)

6.2.2 130 Hz✓ (1)

6.3 **POSITIVE MARKING FROM QUESTIONS 6.2.1 and 6.2.2/**
POSITIEWE NASIEN VANAF VRAAG 6.2.1 en 6.2.2

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

$$170 \overset{\checkmark}{=} \frac{(340 + 0)}{(340 - v_s)} \overset{\checkmark}{\times} f_s \text{ ---------- (1)}$$

$$130 \overset{\checkmark}{=} \frac{(340 - 0)}{340 + v_s} \overset{\checkmark}{\times} f_s \text{ ---------- (2)}$$

$v_s = 45,33\ m\cdot s^{-1}$ ✓ $(45,33 - 45,45\ m\cdot s^{-1})$ (6)

[10]

QUESTION/*VRAAG 6*

6.1

6.1.1 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/*OF*

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

Die skynbare verandering in frekwensie (toonhoogte) as gevolg van die relatiewe beweging tussen die bron en die waarnemer. (2)

6.1.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

✓ ✓ ✓

$365 = \frac{(340 + 0)}{(340 - v_s)} \times 330$

$v_s = 32{,}60\ m \cdot s^{-1}$ ✓ (5)

6.2 According to the Doppler Effect if the star moves away ✓from the observer a lower frequency/longer wavelength ✓is detected. This lower frequency/ longer wavelength corresponds to the red end of the spectrum✓

Volgens die Doppler-effek as die ster weg vanaf die waarnemer beweeg word 'n laer frekwensie/langer golflengte waargeneem. Hierdie laer frekwensie/ langer golflengte stem ooreen met die rooi ent van die spektrum. (3)

[10]

QUESTION/*VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes of the) charges✓ and inversely proportional to the square of the distance (r) between them. ✓

Die grootte van die elektrostatiese krag uitgeoefen deur een punt lading (Q_1) op 'n ander puntlading (Q_2) is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. (2)

OPTION 2/*OPSIE 2*

$F_{net} = 0$
$F_{gcage} + F_{gcount} + F_{motor} = F_{net}$ ✓ 1 mark for any one/*1 punt vir enige een*

-117600✓ $+ 9310$✓ $+ F_{motor} = 0$
$F_{motor} = 2450$ N

$P_{ave} = Fv_{ave}$✓
$= 2450 \frac{55}{180}$✓
$= 748{,}61$ W

OPTION 3/*OPSIE 3*

$P_{ave} = Fv_{ave}$ ✓✓
$= [1200\ (9{,}8) - 950(9{,}8)] \frac{55}{180}$ ✓
$= 748{,}61$ W✓

(6)
[13]

QUESTION 6/*VRAAG 6*

6.1.1 The Doppler effect./*Die Doppler-effek*✓ (1)

6.1.2 Measuring the rate of blood flow/*Meet die tempo van bloedvloei*

OR/*OF*
Ultrasound (scanning)/*Ultraklank (skandering)*✓ (1)

6.1.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$2600 = \frac{340}{(340 - v_s)} f_s$ ✓✓
$1750 = \frac{340}{(340 + v_s)} f_s$ ✓
$2600(340 - v_s) = 1750(340 + v_s)$
$v_s = 66{,}44\ m \cdot s^{-1}$ ✓

(6)

6.1.4 (a) Increase/*Toeneem*✓ (1)

(b) Decrease/*Afneem* ✓ (1)

6.2.1 The spectral lines (light) from the star are shifted towards longer wavelengths. ✓✓ (2)
Die spektraallyne van die ster (lig) is na ander golflengtes toe verskuif.

6.2.2 Decrease/*Neem af* ✓ (1)
[13]

5.2 The net/total work done on an object is equal ✓to the change in the object's kinetic energy ✓
Die netto/totale arbeid op 'n voorwerp verrig is gelyk aan die verandering in die kinetiese energie van die voorwerp.

OR/*OF*
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.
Die arbeid verrig op 'n voorwerp deur 'n resulterende/netto krag is gelyk aan die voorwerp se verandering in kinetiese energie. (2)

5.3

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_K$ ✓
$W_f + mg\Delta y\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$
$W_f + (2)(9,8)(0,5)\cos 180^o$ ✓ $= \frac{1}{2}(2)(2^2 - 4,95^2)$ ✓
$W_f = -10,7$ J ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_K + \Delta U$
$W_{nc} = \Delta E_K + \Delta E_P$ } ✓
$W_f = \frac{1}{2}(2)(2^2 - 4,95^2)$ ✓ $+ (2)(9,8)(0,5-0)$ ✓
$= -10,7$ J ✓ (4)

[13]

QUESTION 6/*VRAAG 6*

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

6.1.2 $v = f\lambda$ ✓
$340 = f(0,28)$ ✓
$f_s = 1\,214,29$ Hz ✓ (3)

6.1.3 **POSITIVE MARKING FROM QUESTION 6.1.2/*POSITIEWE NASIEN VANAF VRAAG 6.1.2***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v \pm v_L}{v \pm v_s} \times \frac{v}{\lambda_s}$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \frac{f_s}{1 - \frac{v_s}{v}}$ ✓

✓

$f_L = (\frac{340}{340 - 30}✓) 1214{,}29$✓ **OR/*OF*** $f_L = (\frac{340}{340 - 30}) \times \frac{340}{0{,}28}$ **OR/*OF*** $f_L = \frac{1214{,}29}{1 - \frac{30}{340}}$

= 1 331,80 Hz✓ (1 331,80 Hz – 1 335,72 Hz) (5)

6.1.4 Decreases/*Verlaag*✓ (1)

6.2 The spectral lines of the star are/should be shifted towards the lower frequency ✓ end, which is the red end (red shift) of the spectrum. ✓
Die spektraallyne van die van die ster is verskuif na die laer frekwensie ent, wat die rooi ent van die spektrum is. (2)
[13]

QUESTION 7/*VRAAG 7*

7.1.1 The (magnitude of the) electrostatic force exerted by one (point) charge on another is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between their (centres) them. ✓
Die (grootte) van die elektrostatiese krag wat een (punt) lading op 'n ander uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

7.1.2 F_E/Electrostatic force/*Elektrostatiese krag*✓ (1)

7.1.3 The electrostatic force is inversely proportional to the square of the distance between the charges ✓
Die elektrostatiese krag is omgekeerd eweredig aan die kwadraat van die afstand tussen die ladings

OR/OF
The electrostatic force is directly proportional to the inverse of the square of the distance between the charged spheres (charges). ✓
Die elektrostatiese krag is direk eweredig aan omgekeerde van die kwadraat van die afstand tussen die gelaaide sfere (ladings).

OR/OF
$F \alpha \frac{1}{r^2}$ ✓

OR/*OF*
They are inversely proportional to each other /*Hulle is omgekeerd eweredig aan mekaar* (1)

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***

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

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

$76689,9 - 230,3\ v_s = 73\ 926$
$v = 12 \text{ m.s}^{-1}$ ✓ (towards bat/*na die vlermuis toe*)

Notes/*Notas*:
- Any other Doppler formula, e.g./*Enige ander Doppler-formule, bv.:*
  $f_L = \frac{v - v_L}{v - v_s}$ - 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]

QUESTION 7/*VRAAG 7*

7.1 The magnitude of the charges are equal✓/ The balls repel each other with the same/identical force or force of equal magnitude✓/*Die grootte van die ladings is gelyk*✓/*Die balle stoot mekaar af met dieselfde/identiese kragte of krag van dieselfde grootte.* ✓ (1)

7.2 The electrostatic force of attraction between two point charges is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them. ✓/*Die elektrostatiese aantrekkingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings*✓ *en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.*✓ (2)

7.3
7.3.1 $T\cos 20^{o} = w$✓
$= mg$
$= (0,1)(9,8)$✓ $= 0,98$ N
$\therefore T = 1,04$ N✓ (3)

5.3

$F = w_{//} + f$
$= (100)(9,8)\sin 30^o + 25$ ✓
$= 515$ N

$P_{ave} = Fv_{ave}$ ✓
$= (515)(2)$✓
$= 1\ 030$ W✓

(4)
[14]

QUESTION/*VRAAG 6*

6.1 **X** ✓ (1)

6.2 As ambulance approaches the hospital the waves are compressed✓or wavelengths are shorter. Since the speed of sound is constant✓ the observed frequency must increase✓. Therefore the hospital must be located on the side of X (from $v = f\lambda$)
Soos die ambulans die hospitaal nader word die golwe saamgepers of golflengtes word korter. Aangesien die spoed van klank konstant is, moet die waargenome frekwensie verhoog. Die hospitaal moet dus aan die kant van X wees (vanaf $v = f\lambda$)

OR/*OF*
The number of wave fronts per second reaching the observer are more at X✓✓. For the same constant speed, this means that the observed frequency increases ✓therefore the hospital must be located on the side of X. (from $v = f\lambda$)
Die aantal golffronte per sekonde wat die waarnemer bereik, is meer by X. Vir dieselfde konstante spoed moet die waargenome frekwensie verhoog, dus is die hospitaal aan die kant van X geleë (vanaf $v = f\lambda$) (3)

6.3

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓
$f_L = \frac{340\ ✓}{(340 \overset{✓}{-} 30)} \overset{✓}{(400)}$
$f_L = 438,71$ Hz✓

NOTE/*LET WEL*
If any other value for the speed of sound is used subtract 2 marks. One for substitution and one for answer / *Indien enige ander waarde vir die spoed van klank gebruik word, trek 2 punte af. Een vir vervanging en een vir die antwoord.* (5)

6.4

$v = f\lambda$✓
$340 = 400\lambda$✓
$\lambda = 0,85$ m✓

(3)
[12]

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 apparent change in frequency or pitch of 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

OPTION 1/OPSIE 1

EXPERIMENT/*EKSPERIMENT* 2

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

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

v = 336,15 m·s^{-1}✓ (Accept/*Aanvaar* : 336,15 m·s^{-1} – 323,33 m·s^{-1}) (5)

EXPERIMENT/*EKSPERIMENT* 3

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

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

v = 340 m·s^{-1}✓ (Accept/*Aanvaar* : 313,33 m·s^{-1} – 340 m·s^{-1}) (5)

EXPERIMENT 4/*EKSPERIMENT* 4

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

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

v = 339,86 m·s^{-1}✓ (Accept/*Aanvaar* : 339,86 m·s^{-1} – 345 m·s^{-1}) (5)

OPTION 2/OPSIE 2

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

Experiment/Eksperiment 2 and/en 3

$\frac{874(v+10)}{v}$ ✓ $= \frac{850(v+20)}{v}$ ✓

874v + 8740 = 850v + 1700 ✓ both frequencies / beide frekwensies

$\therefore v = 344{,}17\ m \cdot s^{-1}$ ✓

Experiment/Eksperiment 2 and/en 4

$\frac{874(v+10)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

874v + 8740 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore v = 341{,}91\ m \cdot s^{-1}$ ✓

Experiment/Eksperiment 3 and/en 4

$\frac{850(v+20)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

850v + 1700 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore v = 339{,}57\ m \cdot s^{-1}$ ✓ (5)

6.2 Away from the Earth/*Weg vanaf die aarde*✓ (1)

[11]

QUESTION 6/*VRAAG 6*

6.1.1 $v = f\lambda$ ✓

$\lambda = \frac{340}{520}$

$= 0,65$ m ✓ (2)

6.1.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = \frac{340}{(340-15)}(520)$ ✓ ✓

$f_L = 544$ Hz

$v = f\lambda$

$\lambda = \frac{340}{544}$ ✓

$= 0,63$m ✓ (6)

Notes / *Aantekeninge*
Accept/*Aanvaar*

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

6.2 The wavelength in QUESTION 6.1.2 is shorter because the waves are compressed as they approach the observer. ✓ ✓
Die golflengte in VRAAG 6.1.2 is korter omdat die golwe saamgedruk word soos hulle die waarnemer nader. (2)

6.3 The red shift occurs when the spectrum of a distant star moving away from the earth is shifted toward the red end of the spectrum. ✓ ✓
Rooi verskuiwings vind plaas wanneer die spektrum van 'n vêr afgeleë ster wat vanaf die aarde wegbeweeg na die rooi ent van die spektrum skuif. (2)
[12]

OPTION 2/*OPSIE 2*

$W_f + W_{app} + W_N + W_g = 0$ ✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 180^o)$✓ + $(F_{app}\Delta x\cos 0) + 300(9{,}8)\Delta x\cos 115^o$✓ = 0

$F_{app} = 1748{,}76$ N
$P_{ave} = Fv_{ave}$✓
$= (1748{,}76)(0{,}5)$✓
$= 874{,}38$ W✓ (6)

OPTION 3/*OPSIE 3*

$W_f + W_{app} + W_N + W_g = 0$✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\sin\theta\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 0)$ ✓ + $(F_{ap}\Delta x\cos 0) + 300(9{,}8)\sin 25^o\,\Delta x\cos 180)$ ✓ = 0
$F_{app} = 1\,748{,}76$ N

$P_{ave} = Fv_{ave}$✓
$= (1\,748{,}76)(0{,}5)$✓
$= 874{,}38$ W✓ (6)
[18]

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 ✓
$v_s = 20{,}01\ m\cdot s^{-1}$✓
Accept/*Aanvaar:* $(19{,}42 – 20{,}01\ m\cdot s^{-1})$ (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]**

POSITIVE MARKING FROM 5.3/*POSITIEWE NASIEN VANAF VRAAG 5.3*

5.4 $P = \frac{W}{\Delta t}$ ✓

$= \frac{2{,}78 \times 10^6}{60}$ ✓

$= 4{,}63 \times 10^4$ W ✓ (3)

5.5 Smaller than /*Kleiner as*✓
Weight / gravitational force does positive work on the truck. ✓
Gewig / gravitasiekrag verrig positiewe arbeid op die trok. (2)
[16]

QUESTION 6/*VRAAG 6*

6.1 Away (from the observer) ✓

Detected frequency must be less than or equal to 800 Hz. ✓
If the car moves away from the observer, less waves reaches her per unit time. ✓

OR/OF
Away (from the observer) ✓
The apparent wavelength increases. ✓
For the same speed of sound, the apparent frequency decreases. ✓ (3)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

800 ✓ = $\frac{340}{340 + v_s}$ ✓ (850) ✓

$\therefore v_s = 21{,}25$ m·s^{-1} ✓

(5)

6.3 **ANY ONE:**
Measurement of foetal heart beat. ✓
Measurement and monitoring blood flow./ Doppler flow meter (1)
[9]

QUESTION 6/*VRAAG 6*

6.1 Smaller than / *Kleiner as* ✓ (1)

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

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

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

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

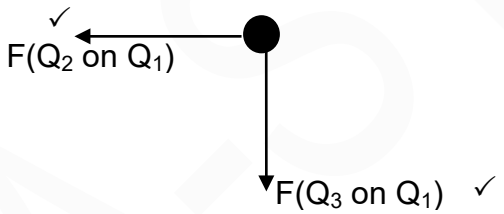
= 694,35 Hz ✓ (7)

6.4 Decreases / *Verlaag* ✓ (1)
[10]

QUESTION 7/*VRAAG 7*

7.1 The (magnitude) of the electrostatic force exerted by one charge on another is directly proportional to the (magnitudes of the) charges ✓ and inversely proportional to the square of the distance between their centres. ✓
Die (grootte) van die elektrostatiese krag wat een lading op 'n ander uitoefen, is direk eweredig aan die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

7.2



(2)

OPTION 5/*OPSIE 5*
$W_{net} = \Delta K$ ✓
$W_{w\|\|} + W_f = ½m(v_f^2 - v_i^2)$
$mg\sin\theta\Delta x\cos\theta + f\Delta x\cos\theta = ½ m(v_f^2 - v_i^2)$
$mg\left(\frac{1}{\Delta x}\right)\Delta x\cos 0° + f\Delta x\cos 180° = ½ m(v_f^2 - v_i^2)$
$(5)(9,8)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 - 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓
OPTION 6/*OPSIE 6*
$W_{net} = \Delta K$ ✓
$F_{net}\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
$(10 - 49\sin\theta)\Delta x\cos 180° = ½ m(v_f^2 - v_i^2)$
$(10 - 49\left(\frac{1}{\Delta x}\right)$)✓$\Delta x\cos 180° = ½ m(v_f^2 - v_i^2)$
$(10\Delta x - 49)(-1)$✓ $= ½(5)(4^2 - 8,85^2)$ ✓
$\Delta x = 20,48$ m
OPTION 7/*OPSIE 7*
$W_{nc} = \Delta E_p + \Delta E_k$✓
$f\Delta x\cos\theta = (mgh_f - mgh_i) + (½ mv_f^2 - ½ mv_i^2)$
$(10)\Delta x\cos 180°$ ✓$= [0 - (5)(9,8)(1)]$ ✓ $+ [½ (5)(4)^4 - ½ (5)(8,85)^2$✓
$\Delta x = 20,48$ m✓

(5)

5.6 Equal to / *Gelyk aan* ✓ (1)

[15]

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 ✓ $= \frac{v}{(v - 10,6)}$ ✓$(954,3)$ ✓

$v = 340,1$ m·s^{-1} ✓ (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*

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

[9]

QUESTION 6/*VRAAG 6*

6.1 The approaching observer (higher f) passes the source at t = 6 s and moves away (lower f) from the source. ✓
Die naderende waarnemer (hoër f) beweeg verby die bron by t = 6 s en beweeg weg (laer f) van die bron af. (1)

6.2

6.2.1

OPTION 1/*OPSIE 1* Approaching observer: *Naderende waarnemer:* $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_s$ ✓ $\therefore 900$ ✓ = $\frac{340 + v_L}{340}$ ✓(850) ✓ $\therefore v_L = 20\ m \cdot s^{-1}$ ✓	**Notes:** • Any other Doppler formula, e.g. $f_L = \frac{v - v_L}{v - v_s}$ - Max. $^3/_4$ ***Aantekeninge:*** • *Enige ander Dopplerformule, bv.* $f_L = \frac{v - v_L}{v - v_s}$ - *Maks.* $^3/_4$
OPTION 2 / *OPSIE 2* Observer moving away: *Waarnemer beweeg weg:* $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v - v_L}{v} f_s$ ✓ $\therefore 800$ ✓ = $\frac{340 - v_L}{340}$ ✓(850) ✓ $\therefore v_L = 20\ m \cdot s^{-1}$ ✓	

(5)

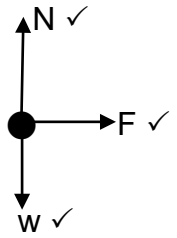
6.2.2 **POSITIVE MARKING FROM QUESTION 6.2.1**
POSITIEWE NASIEN van VRAAG 6.2.1

Option 1/*Opsie 1*: $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ = (20)(6) ✓+ ½(0)Δt $\therefore \Delta x = 120$ m ✓	**Notes/Aantekeninge** Accept/*Aanvaar*: s = ut / s = vt $s = ut + \frac{1}{2} at^2$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
Option 2/*Opsie 2*: $\Delta x = v \Delta t$ ✓ = (20)(6) ✓ $\therefore \Delta x = 120$ m ✓	

(3)
[9]

QUESTION 5/*VRAAG 5*

5.1



(3)

5.2 The net (total) work (done on an object) is equal to ✓
the change in kinetic energy (of the object.) ✓
Die netto (totale) arbeid verrig (op 'n voorwerp) is gelyk aan ✓
die verandering in kinetiese energie (van die voorwerp). ✓ (2)

5.3

5.3.1 $W_{net} = \Delta E_k/\Delta K$ ✓ **OR/*OF*** $F_{net}\Delta x\cos\theta = ½ m(v_f^2 - v_i^2)$
$F_{net}(1{,}02)\cos180° ✓ = ½ (1\,200)(0 - 20^2)$ ✓
$F_{net} = 235\,294{,}12$ N ✓ ($2{,}35 \times 10^5$ N)
(4)

5.3.2

OPTION 1 /*OPSIE 1*	**OPTION 2/*OPSIE 1***
$F_{net}\Delta t = m\Delta v$ ✓ $\therefore (-235\,294{,}12)\Delta t$ ✓$= (1\,200)(0 - 20)$ ✓ $\therefore \Delta t = 0{,}1$ s ✓(0,102 s)	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ 1,02 ✓$= \left(\frac{20 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 0{,}1$ s✓

(4)
[13]

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

6.4.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓
$\therefore 1\,700$ ✓ $= \frac{340}{340 - v_s}$ ✓ (1 650) ✓
$\therefore v_s = 10$ m·s^{-1} ✓
(5)
[11]

QUESTION 6/*VRAAG 6*

6.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ OR $f_L = \frac{v}{v - v_s} f_s$ ✓

$\therefore 1\,050$ ✓$= \frac{340 + 0}{340 - v_s}(980)$ ✓

$\therefore\ v_s = 22{,}67\ m \cdot s^{-1}$ ✓ (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, ✓✓
  sodat 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 Doppler effect / *Doppler-effek* ✓ (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$\therefore f_L = \frac{340 \pm 0}{340 - 20}$ ✓ (458) ✓

$\therefore f_L = 486{,}63$ Hz ✓ (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 7 / *VRAAG 7*

7.1 Light of a single wavelength **OR** single frequency. ✓✓
*Lig van 'n enkele golflengte **OF** enkele frekwensie.* ✓✓ (2)

7.2

Criteria for investigative question: ***Kriteria vir ondersoekende vraag:***	**Mark/** ***Punt***
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Asks a question about the relationship between dependent and independent variables. *Vra 'n vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.*	✓

Examples/*Voorbeelde:*
- How will the broadness / width of the central band change / differ when slit width changes / is increased / is decreased?
  Hoe sal die breedte / wydte van die sentrale helderband verander / verskil wanneer die spleetwydte verander / toeneem / afneem?

- What is the relationship between the broadness of the central bright band and slit width?
  Wat is die verwantskap tussen die breedte van die sentrale helderband en spleetwydte? (2)

QUESTION 7/*VRAAG 7*

7.1 Towards the person / *Na die persoon toe* ✓ [12.1.2] (1)

7.2 When the source moves towards a stationary observer
waves in front of the source is compressed ✓
resulting in a shorter wavelength ✓, resulting in a higher frequency
(speed of sound constant)

Wanneer die bron 'n stilstaande waarnemer nader,
word golwe voor die bron saamgepers ✓
wat 'n korter golflengte tot gevolg het ✓ wat 'n hoër frekwensie tot gevolg het (spoed van klank konstant) [12.2.2] (2)

7.3 Formulae accepted / *Formules aanvaar:*

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

$\therefore$ 450 ✓= $(\frac{340}{340 \checkmark 20})f_s$ [12.2.3] (4)

$\therefore f_s$ = 423,53 Hz ✓ **[7]**

QUESTION 8/*VRAAG 8*

8.1 A (chemical) substance that (selectively) absorb light of certain frequencies / colours and (selectively) transmits / reflects others. ✓✓

'*n (Chemiese) stof wat (selektief) lig van sekere frekwensies / kleure absorbeer en ander (selektief) deurlaat / weerkaats.* [12.2.1] (2)

8.2 The manufacturing of pigments made all colours affordable for all people./ *Vervaardiging van pigmente het alle kleure vir alle mense bekostigbaar gemaak.* ✓

At the same time people, e.g. the Mexicans, could have lost their jobs and only income. / *Terselfdertyd het mense, bv. die Meksikane, hulle werk en enigste inkomste verloor.* ✓ [12.3.1] (2)

8.3 Subtractive / *Subtraktief* ✓ [12.2.1] (1)

8.4 A: magenta + yellow / *geel* ✓
B: magenta + cyan / *siaan* ✓ [12.2.3] (2)