SA-STUDENT

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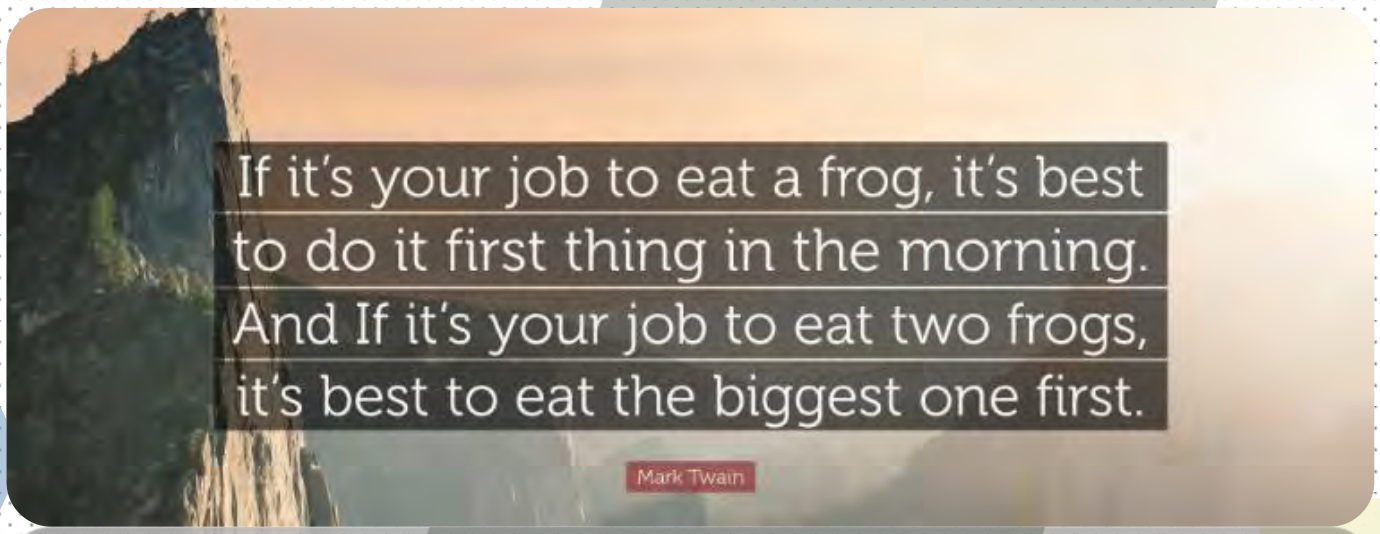


6.1.2

$f_L = \frac{v \quad v}{v \quad v_s} f_S$ ✓ **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*

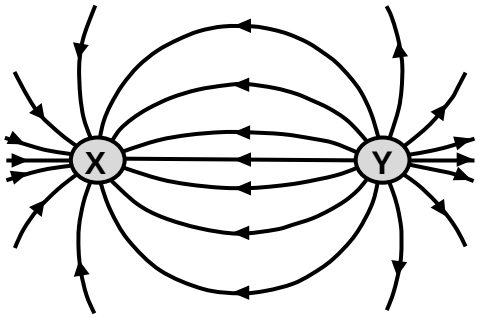
7.1

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)

7.2



Criteria for graph/*Kriteria vir grafiek:*	
Correct shape/ *Korrekte vorm*	✓
Correct direction from **Y** to **X**. /*Korrekte rigting van **Y** na **X**.*	✓
Lines must not cross and must touch charges./ *Lyne mag nie kruis nie en moet die ladings raak.*	✓

Note/*Aantekening*:
- If the net electric field pattern is drawn for two like charges: $^0/_3$
  Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is: $^0/_3$
- Ignore labels for point charges/ *Ignoreer byskrifte vir puntladings.*

(3)

7.3 $F = \frac{k \; Y \; X}{r^2}$ ✓

$F = \frac{\left(9 \quad 10^9\right)\left(7{,}2 \times 10^{-9}\right)\left(7{,}2 \times 10^{-9}\right)}{(0{,}03)^2}$ ✓

$= 5{,}18 \times 10^{-4}$ N ✓ (0,000518 N) (3)

7.4 E_Y✓ E_Z ✓ **accept/** ***aanvaar*** E_Z ✓ E_Y✓ **OR/*OF*** E_Z ✓ E_Y✓

Notes/*Aantekeninge:*
- 1 Mark for arrows in opposite directions./*1 Punt vir pyle in teenoorgestelde rigtings.*
- 1 Mark for correct labels./*1 Punt vir korrekte benoemings.*
- Do not penalise for length of arrow since drawing is not to scale./*Moenie penaliseer vir die lengte van die pyltjie nie aangesien tekening nie volgens skaal is nie.*
- Accept Y and Z as labels./*Aanvaar Y en Z as benoeming*.

(2)

7.5

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria*

- Formula for electric field./*Formule vir elektriese veld.* ✓
- Substitution of E_{net}./*Vervanging van* E_{net}. ✓
- Correct substitution into $\frac{k}{r^2}$ equation for charge Z or charge Y✓

  Korrekte vervanging in $\frac{k}{r}$ *.vergelyking vir lading Z of lading Y*
- Subtraction of electric fields ($E_Z + E_Y$)/*Aftrek van elektriese velde* ($E_Z + E_Y$) ✓
- Correct final answer✓/*Korrekte finale antwoord*: 6,25 x 10^{-9}C
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

OPTION 1/*OPSIE 1*

$E_{net} = E_Z + E_Y$

$= E_Z - E_Y$

$E_{net} = \frac{k\ z}{r^2}\checkmark + \frac{k\ y}{r^2}$

$4,91 \times 10^5\checkmark = \left(\frac{(9 \times 10^9)(\ z)}{0,01^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})}{0,03^2}\right)\checkmark$

$Q_Z = 6,25 \times 10^{-9}$ C ✓

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM QUESTION 7.3/
POSITIEWE NASIEN VANAF VRAAG 7.3

Marking criteria/*Nasienkriteria*

- Correct formula for electric field./*Korrekte formule vir elektriese veld.* ✓
- Substitution of F_{net}./*Vervanging van* F_{net}. ✓
- Correct substitution into $\left(\frac{k\ z\ x}{r^2}\right)$ for charge Z. ✓

  Korrekte vervanging in $\left(\frac{k\ z\ x}{r^2}\right)$ *vir lading Z*
- Subtraction of forces✓./*Aftrek van kragte.*
- Correct final answer/*Korrekte finale antwoord:* 6,26 x 10^{-9} C ✓
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

$E = \frac{F}{Q}$ ✓

$4,91 \times 10^5 = \frac{F}{7,2 \times 10^{-9}}$

$F_{net} = 3,54 \times 10^{-3}$ N

$F_{net} = F_{Z\ on\ X} + F_{Y\ on\ X}$

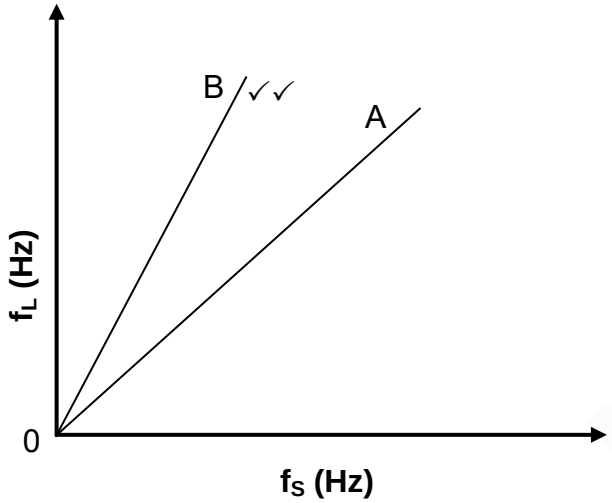
$F_{net} = \left(\frac{k\ z\ x}{r^2}\right) + \left(\frac{k\ Y\ x}{r^2}\right)$

$(3,54 \times 10^{-3})\checkmark = \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})\ z}{(0,01)^2}\right)\checkmark - (5,18 \times 10^{-4})$

$Q_Z = 6,26 \times 10^{-9}$ C ✓

(5)
[15]

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

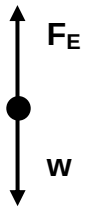
7.1

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)

7.3



Accepted labels/*Aanvaarde byskrifte*	
F_E	$F_{electrostatic}$/ F/ $F_{M\ ON\ N}$/ electrostatic force/ F_M *$F_{elektrostaties}$/ F/ $F_{M\ OP\ N}$/ elektrostatiese krag/ F_M*
w	F_g / w/ mg/ gravitational force / F_w/ weight/ gravity F_g / w/ mg/ *gravitasiekrag*/ F_w/ *gewig*/ *swaartekrag*

Notes/*Aantekeninge*:

- Do not penalise for length of arrows./*Moenie vir lengte van die pyltjie penaliseer nie.*
- Any other additional force(s)/*Enige addisionele krag(te)*: Max/M*aks* $^1/_2$
- If arrows are omitted but correctly labelled/*Indien pyltjies weggelaat is, maar korrek benoem*: Max/*Maks* $^1/_2$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^1/_2$

(2)

7.4

Marking criteria/*Nasienkriteria*

- Correct substitution to calculate weight of M./*Korrekte vervanging om gewig van M te bereken.* ✓
- Coulomb's formula/*Coulomb se formule* ✓
- Substitute/*Vervang* $F_{net} = 0$/ $mg = \frac{}{r^2}$ (equating forces)/
  $0,02 = \frac{}{r^2}$ (equating forces)✓
- Correct substitution into $\frac{}{r^2}$/*Korrekte vervanging in* $\frac{}{r}$ ✓
- Correct final answer (accept negative value)/*Korrekte finale antwoord (aanvaar negatiewe waarde):*
  $2,33 \times 10^{-6}$ C to/*tot* $2,32 \times 10^{-6}$ C✓

$F_g = mg$
$= (2,04 \times 10^{-3})(9,8)$ ✓
$= 0,02$ N

$F = \frac{}{r^2}$ ✓

$F_{net} = mg - \frac{}{r^2}$

$0 = 0,02 - \frac{(9 \times 10^9)(\quad)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

IF/*INDIEN*:

$F = \frac{}{r^2}$ ✓

$2,04 \times 10^{-3})(9,8)$ ✓ ✓ $= \frac{(9 \times 10^9)(\quad)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

(5)

7.5.1 Equal/*Gelyk* ✓

OR/*OF*
Same/*Dieselfde* (1)

7.5.2 Opposite **OR** upwards/*Teenoorgesteld **OF** opwaarts*✓ (1)

7.6 **POSITIVE MARKING FROM QUESTION 7.4.**
POSITIEWE NASIEN VANAF VRAAG 7.4.

Marking criteria/*Nasienkriteria*

- Formula for E./*Formule vir E.* ✓
- Correct substitution for M **OR** N./*Korrekte vervanging vir M **OF** N.* ✓
- Subtraction of $E_M - E_N$ **OR** $E_N - E_M$ /*Aftrekking van $E_M - E_N$ **OF** $E_N - E_M$.* ✓
- Correct final answer/*Korrekte finale antwoord:*
  $5{,}31 \times 10^4$ N.C^{-1} to/*tot* $5{,}37 \times 10^4$ N·C^{-1}✓
- Correct direction/*Korrekte rigting*: upwards/*opwaarts* ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*

$E = \frac{}{r^2}$ ✓

$$E_{net} = \left(\frac{(9 \times 10^9)(2{,}33 \times 10^{-6})}{(0{,}4)^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(8{,}6 \times 10^{-8})}{(0{,}1)^2}\right) \checkmark$$

E_{net} = 131 062,5 - 77 400
= 53 662,5 N·C^{-1} ✓ ($5{,}36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

$E_{net} = \frac{}{r^2}$ ✓

$$E_{net} = \left(\frac{(9 \times 10^9)(8{,}6 \times 10^{-8})}{(0{,}1)^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(2{,}33 \times 10^{-6})}{(0{,}4)^2}\right) \checkmark$$

E_{net} = 77 400 – 131 062,5
= - $5{,}37 \times 10^4$ N·C^{-1}
∴ E_{net} = 53 662,5 N·C^{-1} ✓ ($5{,}36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓ (5)

[17]

QUESTION 7/*VRAAG 7*

7.1.1

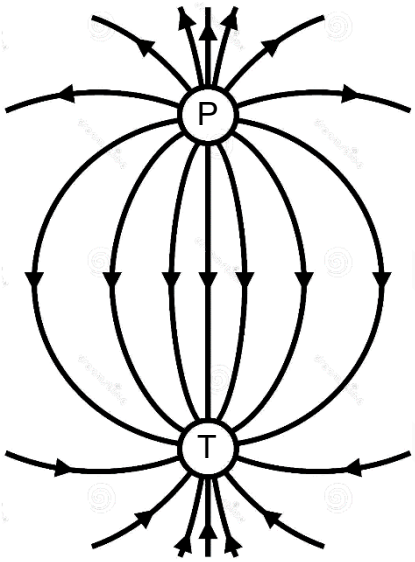
Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.*

The 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 wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.1.2



Criteria for graph/*Kriteria vir grafiek:*	
Correct shape *Korrekte vorm*	✓
Correct direction from P to T. *Korrekte rigting van P na T.*	✓
Lines must not cross and must touch spheres. *Lyne mag nie kruis nie en moet die sfere raak.*	✓
NOTE/*AANTEKENING*: If the net electric field pattern is drawn for two like charges: *Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is:*	0/3

(3)

7.1.3 positive/ *positief* ✓ (1)

7.1.4

Marking criteria/*Nasienkriteria*
- Equation for Coulomb's law./Vergelyking vir *Coulomb se wet.* ✓
- Correct substitution into Coulomb's equation for for F_{TP}. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_{TP}.
- Correct substitution into Coulomb's equation for F_{TS}. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_{TS}.
- Correct substitution into resultant force equation (Pythagoras equation). ✓
  Korrekte vervanging in resultante krag vergelyking (Pythagoras vergelyking).
- Substitute into Q = ne. /*Vervang in* Q = ne. ✓
- Final answer/*Finale antwoord*: 3,05 x10^{13} ✓

$$F_{net}^2 = F_{TP}^2 + F_{TS}^2$$

$$= \left(\frac{kQ_1Q_2}{r^2}\right)^2 \text{ ✓} + \left(\frac{kQ_1Q_2}{r^2}\right)^2$$

$$10^2 = \left(\frac{(9\ \ 1\ 0^9)(3\ \ 1\ 0^{-6})(3\ \ 1\ 0^{-6})}{0,1^2}\right)^2 \text{ ✓} + \left(\frac{(9\ \ 1\ 0^9)(3\ \ 1\ 0^{-6})\ \ 2}{0,15^2}\right)^2 \text{ ✓}$$

$Q_S = 4,887 \times 10^{-6}$ C

↓ $Q_S = ne$

$4,887 \times 10^{-6} = n(1,6 \times 10^{-19})$ ✓

$n = 3,05 \times 10^{13}$ ✓ electrons/*elektrone* (6)

7.2.1 E is directly proportional to $\frac{1}{r^2}$ ./*E is direk eweredig aan* $\frac{1}{r^2}$. ✓

OR/*OF*

$E \alpha \frac{1}{r^2}$ (1)

7.2.2

Gradient = $\frac{\Delta E}{\Delta \frac{1}{r^2}}$ ✓ 680 ✓ = $\frac{E\ -\ (0)}{\frac{1}{0,04^2} - (0)}$ ✓ $E_A = 4,25 \times 10^5$ N·C^{-1}✓	**ACCEPT/*AANVAAR*** $E = \frac{kQ}{r^2}$ ✓ $E_A = \frac{680}{0,04^2}$ ✓ ✓ $= 4,25 \times 10^5$ N·C^{-1}✓ **OR/*OF*** y = mx + c / y = mx✓ $E_A = 680$✓$\left(\frac{1}{0,04^2}\right)$✓ $= 4,25 \times 10^5$ N·C^{-1}✓

(4)

7.2.3 Greater than / *Groter as* ✓

The gradient is equal to kQ./The gradient is proportional to Q. ✓
Graph of sphere B has a steeper gradient than graph of sphere A. ✓
Die gradiënt is gelyk aan kQ./Die gradiënt is proporsioneel aan Q.
Grafiek vir sfeer B het 'n steiler gradiënt as die grafiek vir sfeer A.

OR/*OF*

For the same $\frac{1}{r^2}$, E is greater for sphere B. ✓✓
Vir dieselfde $\frac{1}{r^2}$, is E groter vir sfeer B.

(3)
[20]

QUESTION 8/*VRAAG 8*

8.1 A conductor (resistor) which obeys Ohm's law./*'n Geleier wat Ohm se wet gehoorsaam*. ✓✓ **(2 or/*of* 0)**

OR/OF
V always directly proportional to I at constant temperature. ✓✓ **(2 or/*of* 0)**
V is altyd direk eweredig aan I by konstante temperatuur.

OR/OF
$\frac{V}{I}$ = constant / k / c*onstant at constant temperature.* ✓✓ **(2 or/*of* 0)**
$\frac{V}{I}$ = konstant / k / *konstant bly by 'n konstante temperatuur.*

OR/OF
A conductor for which the resistance remains constant at constant temperature when voltage or current change. ✓✓ **(2 or/*of* 0)**
'n Geleier waar die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander. (2)

8.2.1
$R = -$ ✓
$4 = \frac{3,2}{-}$ ✓
$I = 0,8$ A ✓ (3)

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)

7.2

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria:*

- Coulomb's Law formula/*Coulomb se formule* ✓
- Correct substitution for F_{q1} **OR** F_{q2} into $\frac{kQ_1Q_2}{r^2}$ ✓

  *Korrekte substitusie van F_{q1}**OF** F_{q2}* in $\frac{kQ_1Q_2}{r^2}$
- Correct substitution of 1,38 N for $F_{(net)}$ /*Korrekte substitusie van 1,38 N* vir $F_{(net)}$ ✓
- Subtracting (vector addition) electrostatic forces /*Aftrek (vektoraddisie) van elektrostatiese kragte* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$F_{E(net)} = F_{q2} + F_{q1}$

$1,38$ ✓$= \left(+\frac{kQ_1Q_2}{r^2}\right) + \left(-\frac{kQ_1Q_2}{r^2}\right)$ ✓

$1,38 = \left(+\frac{(9\times10^9)(1,95\times10^{-6})q_2}{(0,03)^2}\right) + \left(-\frac{\checkmark(9\times10^9)(1,95\times10^{-6})q_2}{(0,05)^2}\right)$ ✓

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*:

- $E = \frac{kQ}{r^2}$ ✓
- Correct substitution of 7,08 x 10^5 N·C^{-1}/*Korrekte substitusie van 7,08 x10^5 N·C^{-1}* ✓
- Correct substitution for E_{q1} **OR** E_{q2} into $\frac{kQ_2}{r^2}$ ✓

  *Korrekte substitusie van E_{q1} **OF** E_{q2} in* $\frac{kQ_2}{r^2}$
- Subtracting electric fields/*Aftrek van elektriese velde* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$E = \frac{F}{q} = \frac{1,38}{1,95\times10^{-6}}$

= 7,08 x 10^5 N·C^{-1} (707692,30)

$E_{net} = E_{q2} + E_{q1}$

7,08 x 10^5 ✓$= \left(+\frac{kQ_2}{r^2}\right) + \left(-\frac{kQ_1}{r^2}\right)$ ✓

$= \left(+\frac{(9\times10^9)q_2}{(0,03)^2}\right) + \left(-\frac{\checkmark(9\times10^9)q_1}{(0,05)^2}\right)$ ✓

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

(5)

[14]

QUESTION 7/*VRAAG 7*

7.1

NOTE: -1 mark for each key word/phrase omitted in the correct context. If the word "force" is omitted 0 marks
***LET WEL**: -1 punt vir elke sleutel woord/frase in die korrekte konteks weggelaat. Indien die woord "krag" uitgelaat word 0 punte.*

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 wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. (2)

7.2

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

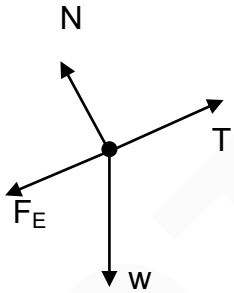
$$1{,}2 \times 10^{-3} = \frac{(9 \times 10^{9})(6 \times 10^{-9})(5 \times 10^{-9})}{r^2} \checkmark$$

$$r = 0{,}015 \text{ m} \checkmark (0{,}02 \text{ m})$$

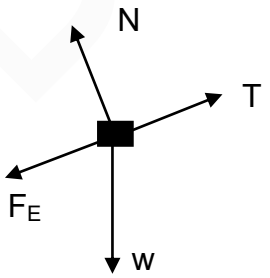
Note /*Aantekening*:
- 1 mark for all substitutions/ *1 punt vir alle vervangings*
- If negative charge substituted / *Indien negatiewe lading vervang is* Max / *Maks* 2/3

(3)

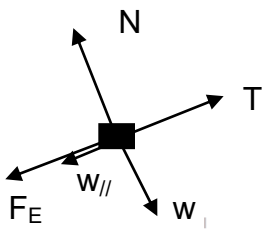
7.3



ACCEPT/*AANVAAR*



ACCEPT/*AANVAAR*



Accept the following symbols:/*Aanvaar die volgende simbole:*	
N ✓	F_N / Normal / *Normaal* / Normal force /*Normaalkrag*
w ✓	F_g,/mg / weight / $F_{Earth\ on\ sphere}$ / 0,098 N / *g*ravitational force / g*ewig* / $F_{aarde\ op\ sfeer}$ / *gravitasiekrag*
T ✓	Tension / *Spanning* / F_T / F_A / F_s /F_p
F_E ✓	F_R / F/ Coulombic Force / Electrostatic force / *Coulombkrag* / *elektrostatiese krag*

Notes/*Aantekeninge*
- Mark awarded for label and arrow / *Punt toegeken vir benoeming en pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te)* Max/*Maks* $\frac{3}{4}$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{3}{4}$
- If w is not shown but $w_{//}$ and $w_{\perp}$ are shown give 1 mark for both.
  Indien w nie aangetoon is nie maar $w_{//}$ and $w_{\perp}$ *is getoon, ken 1 punt toe vir beide.*

(4)

7.4.1

$F_{net} = ma$
$T - F_E - w_{||} = ma$ } ✓Any one/*Enige een*
$T - F_E - w_{||} = 0$
$T - \underline{1,2 \times 10^{-3}}$ ✓ $\underline{- (0,01)(9,8)\sin 25°}$✓ = 0
$T = 0,04$ N ✓ (0,0426 N)

OR/OF
$F_{net} = ma$ ✓
$T - F_E - w_{||} = ma$
$T - F_E - w_{||} = 0$
$T - \underline{1,2 \times 10^{-3}}$ ✓ $\underline{- (0,01)(9,8)\cos 65°}$✓ = 0
$T = 0,04$ N ✓ (0,0426 N)

(4)

7.4.2 **POSITIVE MARKING FROM QUESTION 7.2**
POSITIEWE NASIEN VANAF VRAAG 7.2

$E = k\frac{Q}{r^2}$
$E_{net} = E_R + E_S$
$E_{net} = E_R + (-E_S)$
$E_{net} = k\frac{Q_R}{r^2} - k\frac{Q_S}{r^2}$
$E_{net} = k\frac{Q_R}{r^2} + k\frac{Q_S}{r^2}$
} ✓Any one/*Enige een*

$E_{net} = \frac{(9\times10^9)(5\times10^{-9})}{(0,015+0,03)^2}$ ✓ - $\frac{(9\times10^9)(6\times10^{-9})}{(0,03)^2}$ ✓
= - 37 777,78
= 37 777,78 N·C^{-1}✓ ($3,78 \times 10^4$) down (the incline) / towards the charges
afwaarts (teen skuinsvlak) /na die ladings ✓

(5)
[18]

QUESTION 7/*VRAAG 7*

7.1

$$n = \frac{Q}{e} \checkmark$$

$$= \frac{(-)4 \times 10^{-6}}{(-)1,6 \times 10^{-19}} \checkmark$$

$$= 2,5 \times 10^{13} \checkmark$$

(3)

7.2 **Electrostatic force on B due to A:/*Elektrostatiese krag op B a.g.v. A:***

$$F_{AB} = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$= \left[\frac{9 \times 10^{9} (4 \times 10^{-6})(3 \times 10^{-6})}{0,2^2}\right] \checkmark$$

Ignore negative signs
Ignoreer negatiewe tekens

$$= 2,7 \text{ N} \checkmark$$

(3)

7.3

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

Electric field is a region (in space) where (in which) an (electric) charge experiences a (electric) force. ✓✓
Elektriese veld is 'n gebied (in die ruimte) waarin 'n (elektriese) lading 'n (elektriese) krag ondervind.

(2)

7.4

Marking criteria/*Nasienriglyne*

- Appropriate formula/*Geskikte formule* ✓
- Correct substitution for A and B/*Korrekte vervanging van A en B* ✓✓
- Subtraction of electric fields/*Aftrek van elektrieseveldе*✓
- Final answer/*Finale antwoord*: 2,3 x10^6 N·C^{-1}✓

OPTION 1/*OPSIE* 1

Electric field at M due to / *Elektriese veld by M as gevolg van*: -4 x10^{-6} C

$E_{AM} = k\frac{Q}{r^2}$ ✓

$= 9\times10^9 \frac{(4\,x10^{-6})}{(0,3)^2}$ ✓

= 4,0 x 10^5 N·C^{-1} (to left /*links*)

Electric field at M due to / *Elektriese veld by M as gevolg van*: +3 x10^{-6} C,

$E_{BM} = k\frac{Q}{r^2}$

$= 9x10^9 \frac{(3\,x10^{-6})}{(0,1)^2}$ ✓

= 2,7 x10^6 N·C^{-1} (to right /*regs*)

Net electric field at M /*Netto elektrieseveld by M*

$E_{net} = E_{BM} + E_{AM}$

= 4,0 x10^5 – 2,7 x10^6 ✓

= 2,3 x10^6 N·C^{-1} ✓(right/*regs*)

OR/*OF*

Net electric field at M /*Netto elektrieseveld by M*

$E_{net} = E_{BM} + E_{AM}$

= -4,0 x10^5 + 2,7 x10^6 ✓

= - 2,3 x10^6 N·C^{-1}

= 2,3 x10^6 N·C^{-1} ✓(right)

OPTION 2/*OPSIE* 2

$F_{AM} = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(4\times10^{-6})Q}{(0,3)^2}$ ✓ = 4 x 10^5Q N

$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(3\times10^{-6})Q}{(0,1)^2}$ ✓ = 2,7 x 10^6Q N

F_{net} = 2,7 x 10^6Q + (-4 x 10^5Q)✓ = 2,3 x 10^6Q

$E = \frac{F}{q}$ ✓= $\frac{2,3\times10^6 Q}{Q}$ = 2,3 x 10^6 N·C^{-1} ✓(right/*regs*)

(5)

7.5 Positive/*Positief* ✓ (1)

7.6

POSITIVE MARKING FROM 7.2/*POSITIEWE NASIEN VANAF 7.2*

Marking criteria/*Nasienriglyne*

- Correct substitution into Pythagoras's equation/*Korrekte vervanging in Pythagoras se vergelyking* ✓
- Correct substitution into Coulomb's Law/*Korrekte vervanging in Coulomb se wet* ✓
- Correct answer/*Korrekte antwoord* ✓

$(F_{net})^2 = (F_{AD})^2 + (F_{AB})^2$

$(7,69)^2 = (F_{AD})^2 + (2,7)^2$ ✓

$F_{AD} = 7,2$ N

$$F_{AD} = \frac{kQ_1Q_2}{r^2}$$

$$7,2 = \frac{(9\times10^9)(4\times10^{-6})Q}{(0,15)^2}$$ ✓

$Q_D = 4,5 \times 10^{-6}$ C ✓

OR/*OF*

$$F_{AD} = k\frac{Q_1Q_2}{r^2}$$

$$= 9\times10^9 \frac{(4\times10^{-6})Q}{0,15^2}$$ ✓

$= 1,6 \times 10^6$ Q

$F_{net} = \sqrt{F_{AB}^2 + F_{AD}^2}$ **OR/*OF*** $F_{net}^2 = F_{AB}^2 + F_{AD}^2$

$7,69 = \sqrt{2,7^2 + (1,6\times10^6 Q)^2}$ ✓

$Q = 4,50 \times 10^{-6}$ C ✓ (3)

[17]

QUESTION 7/*VRAAG 7*

7.1.1 Positive/*Positief* ✓ (1)

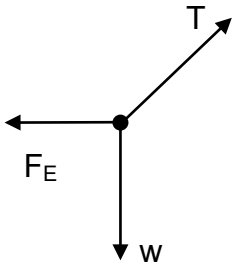
7.1.2

Marking criteria/*Nasienriglyne:*
- Appropriate formula /*Toepaslike formule*✓
- Whole substitution *Hele vervanging*✓/
- Final answer/*finale antwoord*: 2,26 x 10^{-6} C ✓

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE 2***
$F = \frac{kQ_1Q_2}{r^2}$ ✓ $3,05 = \frac{(9 \times 10^9)(6 \times 10^{-6})Q}{0,2^2}$ ✓ Q = 2,26 x 10^{-6} C ✓ (2,259 x 10^{-6} C)	$E = \frac{kQ}{r^2}$ $= \frac{(9 \times 10^9)(6 \times 10^{-6})}{0,2^2}$ = 1,35 x 10^6 N·C^{-1} F = Eq✓ 3,05 = (1,35 x 10^6)q✓ q = 2,26 x 10^{-6} N✓

(3)

7.1.3



Accepted labels/*Aanvaarde benoemings*	
w✓	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T✓	F_T / tension / *spanning*
F_E/F✓	Electrostatic force/ Coulomb force/ $F_{E\ Field}$/$F_{x\ on\ Y}$ / 3,05 N *Elektrostatiese krag/ Coulombkrag*

Notes/*Aantekeninge*
- Mark is awarded for label and arrow. /*Punt word toegeken vir byskrif en pyltjie.*
- Do not penalise for length of arrows.
  Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force /*Trek 1 punt af vir enige addisionele krag*
- If force(s) do not make contact with dot /*Indien krag(te) nie met die kolletjie kontak maak nie:* Max/*Maks* $\frac{2}{3}$
- If arrows missing/*Indien pyltjies uitgelaat word*: Max/*Maks* $\frac{2}{3}$

(3)

7.1.4

$F_{net} = 0$
$F_E = T\sin10°$
$F_E = T\cos80°$
[3,05 = Tsin10°✓]✓ [**IF *IINDIEN*** $T\cos10^o = 3,05\ (\frac{1}{3})$]

OR/OF

[3,05 = Tcos80°✓]✓ [**IF/*INDIEN*** $T\sin80^o = 3,05\ (\frac{1}{3})$]

T = 17,56 N ✓ (17,564 N) (3)

7.2.1

Marking criteria/*Nasienriglyne*
-1 mark for each key word/phrase omitted in the correct context.
-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.

The electric field at a point is the (electrostatic) force experienced per unit positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die (elektrostatiese) krag wat per positiewe eenheidslading wat by die punt geplaas is, ondervind word.

[**IF** the word "unit" or phrase "positive charge" is omitted in this definition: -1 for each
INDIEN *die woord "eenheid" of frase "positiewe lading" uitgelaat is in hierdie definisie: -1 vir elk*]

OR/*OF*
The electric field at a point is the (electrostatic) force experienced by a UNIT positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die (elektrostatiese) krag wat deur 'n positiewe EENHEIDSlading wat by die punt geplaas is, ondervind word.

[**If "UNIT" is omitted in this definition, then 0 marks.**
Indien "EENHEIDS" uitgelaat word in hierdie definisie, dan 0 punte.] (2)

7.2.2

OPTION 1/*OPSIE 1*

Electric field at **M** due to **A** ($+2 \times 10^{-5}$ C):

$E_A = \frac{kQ}{r^2}$ ✓

$= 9\times10^9 \frac{(2\times10^{-5})}{(0,2)^2}$ ✓

$= 4,5 \times 10^6$ N·C^{-1}

Electric field at **M** due to **B** (-4×10^{-5} C):

$E_B = \frac{kQ}{r^2}$ **OR/*OF*** $q_B = 2q_A$

$= 9\times10^9 \frac{(4\times10^{-5})}{(0,2)^2}$ ✓ $E_B = 2E_A$ ✓

$= 9 \times 10^6$ N·C^{-1} $= 9 \times 10^6$ N·C^{-1}

E_{net} at **M** = $E_A + E_B$
= $(4,5 \times 10^6 + 9 \times 10^6)$ ✓
= $1,35 \times 10^7$ N·C^{-1} ✓ to the right/*na regs*/towards B/*na B*
/*away from A / weg vanaf A*✓

OPTION 2/OPSIE 2

Net electrostatic force at M / *Netto elektrostatiese krag by M*

$F_{net} = \frac{kQ_1Q_2}{r^2} + \frac{kQ_1Q_2}{r^2}$

If/*Indien* $F = \frac{kQ}{r^2}$ Max/*Maks* $\frac{2}{6}$

$= \frac{(9\times10^9)(2\times10^{-5})q}{(0,2)^2} + \frac{(9\times10^9)(4\times10^{-5})q}{(0,2)^2}$ ✓ (any one/ *enige een)*

$= 4,5 \times 10^6 q$ +✓ 9×10^6 q

$= 1,35 \times 10^7 q$ N

$F_{net} = E_{net}q$ ✓

$1,35 \times 10^7 q$ ✓$= E_{net}q$

$E_{net} = 1,35 \times 10^7$ N·C^{-1} ✓to the right/*na regs* ✓/towards B / *na B* (6)

[18]

QUESTION 7/*VRAAG 7*

7.1 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die elektrostatiese krag *wat per eenheid positiewe lading wat by daardie punt geplaas word, ervaar word.* ✓✓

NOTE/*LET WEL*:
-1 for each key word/phrase omitted. If definition of electric field: 0/2
-1 vir elke sleutel woorde/frase weggelaat. Indien definisie van elektriese veld 0/2 (2)

7.2 q_2 is positive ✓

The electric field due to q_1 points to the right because q_1 is negative. ✓ Since the net field is zero, field due to q_2 must point to the left away from q_2, ✓ hence q_2 is positive.

q_2 is positief

Die elektriese veld as gevolg van q_1 is na regs gerig omdat q_1 negatief is. Aangesien die net veld nul is, moet die veld as gevolg van q_2 na links weg van q_2 wees.

OR/OF

q_2 is positive ✓

Since E_{net} is zero, E_1 and E_2 are in opposite directions ✓ therefore q_1 and q_2 are oppositely charged. ✓

q_2 is positief ✓
Omdat E_{net} nul is, is E_1 en E_2 in teenoorgestelde rigtings ✓*daarom is q_1 en q_2 teenoorgesteld gelaai.* ✓ (3)

7.3

$E = k\frac{Q}{r^2}$ ✓

$E_{net} = 0$

$\therefore\ k\frac{q_1}{r_1^2} = k\frac{q_2}{r_2^2}$ OR

$\frac{q_1}{r_1^2} = \frac{q_2}{r_2^2}$

$\frac{(9\times10^9)(3\times10^{-9})}{(0,1)^2}$ ✓ $= \frac{(9\times10^9)q_2}{(0,4)^2}$ ✓

$q_2 = +4,8 \times 10^{-8}$ C✓

1 mark for formula
1 mark for equating the two fields
1 mark for both substitutions
1 mark for answer
1 punt vir vergelyking
1 punt vir twee velde gelyk gestel
1 punt vir altwee substitusies
1 punt vir antwoord

(4)

7.4 The electrostatic force (of attraction/repulsion) 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 krag(aantekking/afstotend) tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.If masses used instead of charges 0
-1 vir elke sleutel woorde/frase weggelaat Indien massas gebruik 0

7.5

POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(3\times10^{-9})(4,8\times10^{-8})}{(0,3)^2}$ ✓

$= 1,44 \times 10^{-5}$ N✓

(3)

7.6 **POSITIVE MARKING FROM 7.2 AND 7.3/*POSITIEWE NASIEN van 7.2 en 7.3***
YES/*JA*✓
Both charges are equal and positive ✓
Beide ladings is gelyk en positief

Accept calculation which shows charges the same and positive/ *Aanvaar berekening wat toon dat ladings dieselfde en positief is.*

If the answer is YES, mark according to the memo, if NO check 7.2 first for sign of charge. If stated NEGATIVE at 7.2, then answer is:
No✓, the direction is incorrect. ✓
Positiewe nasien vanaf 7.2: Indien antwoord vir 7.2 NEGATIEF, dan is hierdie antwoord: Nee ✓, die rigting is verkeerd. ✓

(2)
[16]

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

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

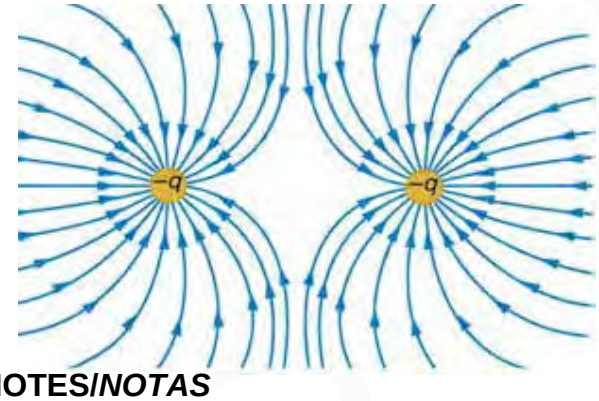
$$-3 \times 10^{-9} = \frac{-15\times10^{-9} + Q + 2\times10^{-9}}{3}$$ ✓

$Q = +4 \times 10^{-9}$ 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)*

7.4

OPTION 1/*OPSIE 1*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{SP} = \frac{(9\times10^{9})(3\times10^{-9})(3\times10^{-9})}{(0,1)^2}$ ✓

= 8,1 x 10^{-6} N downwards/*afwaarts*

$F_{TP} = \frac{(9\times10^{9})(3\times10^{-9})(3\times10^{-9})}{(0,3)^2}$ ✓

= 9 x 10^{-7} N left/*links* (0,9 X 10^{-6} N to the left/*na links*

$F_{net}^2 = (F_{SP})^2 + (F_{TP})^2$

$F_{net} = \sqrt{(F_{SP})^2 + (F_{TP})^2}$ ✓ for either

$F_{net} = \sqrt{(8,1\times10^{-6})^2 + (0,9\times10^{-6})^2}$

F_{net} = 8,15 x 10^{-6} N ✓

OPTION 2/*OPSIE 2*

$E_s = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,1)^2}$

= 2 700 N.C^{-1}

$E_T = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,3)^2}$ ✓ both substitutions
beide vervangings

= 300 N.C^{-1}

$E_{net} = \sqrt{E_S^2 + E_T^2}$

$= \sqrt{(2700)^2 + (30)^2}$ ✓

= 2 716,62 N.C^{-1}

F = Eq

= (2 716,62)(3 x 10^{-9}) ✓

= 8,15 x 10^{-6} N ✓ (5)

7.5

POSITIVE MARKING FROM 7.4 / *POSITIEWE NASIEN VANAF 7.4*

OPTION 1/*OPSIE 1*

$E = \frac{F}{q}$ ✓

$= \frac{8,15\times10^{-6}}{3\times10^{-9}}$ ✓

= 2,72 x 10^{3} N.C^{-1} ✓ (3)

OPTION 2/*OPSIE 2*

$E_s = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,1)^2}$ ✓

$= 2\ 700\ N.C^{-1}$

$E_T = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,3)^2}$ ✓

$= 300\ N.C^{-1}$

$E_{net} = \sqrt{E_S^2 + E_T^2}$

$= \sqrt{(2700)^2 + (30)^2}$

$= 2\ 716,62\ N.C^{-1}$ ✓

NOTE/*LET WEL*
Mark Allocation/*Puntetoekenning*
✓ correct formula/*korrekte formula*
✓ both subsitutions/*beide vervangings*
✓ correct answer/*korrekte antwoord*
If calculation done in 7.4 award full marks for answer written here. / *Indien berekening in 7.4 gedoen is, moet volle punte vir die antwoord wat hier geskryf is, toegeken word.*

7.6.1 Sphere/*Sfeer* P or/*of* T✓ (1)

7.6.2 **SPHERE P/*SFEER P***

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-15\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 9,38 \times 10^{10}$

mass gained/*massa gewin* = $n_e m_e$
m gained /*gewin*= $(9,38 \times 10^{10})(9,11 \times 10^{-31})$✓
$= 8,55 \times 10^{-20}$ kg ✓

SPHERE T/*SFEER T*

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-5\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 3,125 \times 10^{10}$

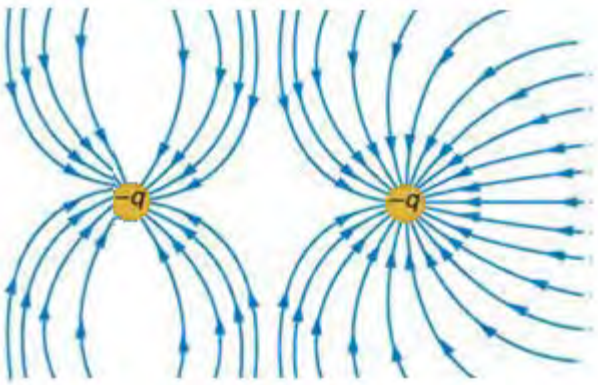
mass gained/*massa gewin* = $n_e m_e$
m gained /*gewin*= $(3,125 \times 10^{10})(9,11 \times 10^{-31})$✓
$= 2,85 \times 10^{-20}$ kg ✓ (3)

[19]

ADDENDUM

QUESTION 7.2

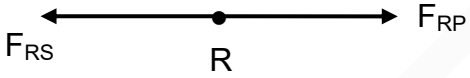
Accept the following electric field diagram which would be formed if the effect of the third charge is considered.
Aanvaar die volgende elektrieseveld diagram wat gevorm sal word indien die effek van die derde lading in ag geneem is.



QUESTION 7/*VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge 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 uitgeoefen deur een puntlading op 'n ander puntlading is direk eweredig aan die produk (van die groottes) van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (2)

7.2



NOTE/*LET WEL*: (2)
One mark for each force, correctly shown./*Een punt vir elke krag korrek getoon.*

7.3 Taking right as positive/*Neem regs as positief*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{netR} = F_{PR} + F_{SR}$

$$F_{net} = \frac{kQ_1Q_2}{r^2} + \frac{kQ_1Q_2}{r^2}$$

$$-1,27 \times 10^{-6} = \left\{\frac{(9\times10^9)(1,5\times10^{-9})(Q)}{(0,3)^2} - \frac{(9\times10^9)(2\times10^{-9})(Q)}{(0,2)^2}\right\}$$

✓ ✓ ✓ ✓

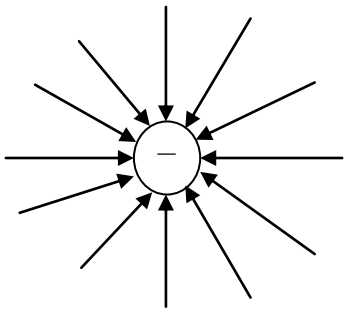
$-1,27\times10^{-6} = 150Q - 450Q$ ✓ (for subtraction/*vir aftrekking*)

$Q = 4,23\text{x}10^{-9}$ C✓ (7)

Accept answers where left is taken as positive. **[11]**

QUESTION 8/*VRAAG 8*

8.1



Shape (radial)/*Vorm (radiaal)*✓
Polarity (sign) of A/*Polariteit (Teken) van A*✓
Do not penalize for incorrect direction/*Moet nie penaliseer vir verkeerde rigting nie*

(2)

8.2 $E = \frac{kQ}{r^2}$ ✓

$3 \times 10^7 = \frac{(9 \times 10^9)(Q)}{(0,5)^2}$

$Q = 8,33 \times 10^{-4}$ C✓ (3)

8.3 $Q = ne$✓

$= (10^5)(1,6 \times 10^{-19})$ ✓

$= 1,6 \times 10^{-14}$ C

$E = \frac{F}{Q}$ ✓

$3 \times 10^7 = \frac{F}{1,6 \times 10^{-14}}$ ✓

$F = 4,8 \times 10^{-7}$ N✓ Right/*Regs*✓

(**Positive marking from 8.2 for this option)**

$F = k\frac{Q_1 Q_2}{r^2}$ ✓

$F = (9 \times 10^9)\frac{(8,33 \times 10^{-4})(1,6 \times 10^{-14})}{(0,5)^2}$ ✓

$= 4,8 \times 10^{-7}$ N✓ Right/*Regs*✓

(6)
[11]

QUESTION 7/*VRAAG 7*

7.1 The two forces must be equal in magnitude ✓ but in opposite directions ✓/*Die twee kragte moet gelyke groottes hê maar in teenoorgestelde rigtings werk*.

OR/*OF*
The force experienced by Q due to P, must be equal in magnitude ✓but opposite in direction to the force experienced by Q due to V.✓/*Die krag wat Q agv P ondervind moet gelyk in grootte maar teenoorgesteld in rigting wees met die krag wat Q agv V ondervind* (2)

7.2 The magnitude of the electrostatic force exerted by one point charge on another point charge 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 puntlading op 'n ander puntlading is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.
OR/*OF*
The force of attraction or repulsion 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 aantrekkings- of afstotingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (2)

NOTE:/*LET WEL*
If mass is mentioned instead of charges. $^{0}/_{2}$
Indien massa in plaas van ladings genoem word. $^{0}/_{2}$

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.*

7.3

OPTION 1/OPSIE 1

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{PQ} = \frac{(9\times10^{9})(Q)(5\times10^{-6})}{(x)^2}$ ✓

$= \frac{45\times10^{3}Q}{x^2}$

$F_{VQ} = \frac{(9\times10^{9})(Q)(7\times10^{-6})}{(1-x)^2}$ ✓

$= \frac{63\times10^{3}Q}{(1-x)^2}$

($F_{net} = F_{PQ} - F_{VQ} = 0$)

$\frac{45\times10^{3}Q}{x^2} = \frac{63\times10^{3}Q}{(1-x)^2}$ ✓ (equating two equations)

$6{,}708(1 - x) = 7{,}937x$

$x = 0{,}458$ m

x is 0,46 m✓ (away from P/*weg van P)* (5)

OPTION 2/*OPSIE 2*

$E = \frac{kQ_p}{r^2}$ ✓

$E_{net} = \frac{kQ_p}{r^2} - \frac{kQ_v}{r^2}$

($E_{net} = E_p - E_v = 0$)

$0 = \frac{(9\times10^{9})(5\times10^{-6})}{x^2}$ ✓ - $\frac{(9\times10^{9})(7\times10^{-6})}{(1-x)^2}$ ✓

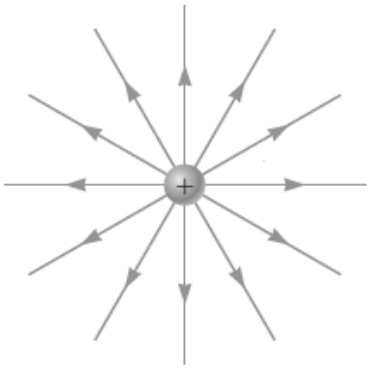
$\frac{(9\times10^{9})(5\times10^{-6})}{x^2} = \frac{(9\times10^{9})(7\times10^{-6})}{(1-x)^2}$ ✓ (equating two equations)

$\therefore x = 0{,}46$ m ✓(away from P/*weg van P)* (5)

[9]

QUESTION 8/*VRAAG 8*

8.1 (2)



Criteria for sketch/*Kriteria vir skets*	Marks/ *Punte*
Lines are directed away from the charge / *Lyne is weg vanaf die lading*	✓
Lines are radial, start on sphere and do not cross./*Lyne is radiaal, begin op die sfeer en kruis nie*	✓

8.2

$Q = ne$✓
$= (8 \times 10^{13})(-1,6 \times 10^{-19})$ ✓ or/*of* $(8 \times 10^{13})(1,6 \times 10^{-19})$
$= -12,8 \times 10^{-6}$
Net charge on the sphere $= (+ 6 \times 10^{-6}) + (-12,8 \times 10^{-6})$ ✓
$Q_{net} = - 6,8 \times 10^{-6}$ C

$$E = \frac{kQ}{r^2}$$ ✓

$$E = \frac{(9 \times 10^{9})(6,8 \times 10^{-6})}{(0,5)^2}$$ ✓

$= 2,45 \times 10^{5}$ N·C^{-1}✓ towards sphere ✓/*na die sfeer* (7)

[9]

QUESTION 9/*VRAAG 9*

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstate temperatuur.

OR/*OF*
The ratio of potential difference across a conductor to the current in the conductor is constant, provided the temperature remains constant.
Die verhouding van potensiaalverskil oor die geleier tot stroom in die geleier is konstant indien die temperatuur konstant bly. (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.*

9.1.2

$V_1 = IR$ ✓
$= (0,6)(4)$ ✓
$= 2,4$ V ✓ (3)

QUESTION 7 / *VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge 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 puntlading op 'n ander puntlading is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

OR/*OF*

The force of attraction or repulsion 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 aantrekkings- of afstotingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

7.2

OPTION 1/ *OPSIE 1*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^{9})(6\times10^{-6})(8\times10^{-6})}{(0,2)^2}$ ✓ ✓

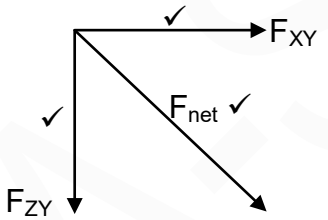
= 10,8 N✓

OPTION 2/ *OPSIE 2*

$E = \frac{kQ}{r^2} = \frac{(9\times10^{9})(8\times10^{-6})}{(0,2)^2}$ ✓ = 1,8 x 10^4 N·C^{-1}

F = Eq = (1,8 x 10^4)(6 x 10^{-6})✓ = 10,8 N✓ (4)

7.3



(3)

7.4

OPTION 1 /*OPSIE 1*

$F_{net}^2 = F_{XY}^2 + F_{ZY}^2$

$15{,}20^2 = 10{,}8^2 + F_{ZY}^2$

F_{ZY} = 10,696 N

$F_{ZY} = k\frac{Q_Z Q_Y}{r^2}$

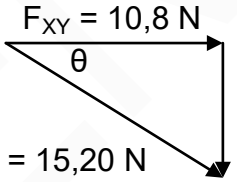
$10{,}696\checkmark = 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0{,}30)^2}\checkmark$

Q_Z = 1,34 x 10^{-5} C✓

OPTION 2 /*OPSIE 2*

$\cos\theta = \frac{10{,}8}{15{,}2}$

$\theta = 44{,}72^o$



$\sin 44{,}72 = \frac{F_{ZY}}{15{,}2}\checkmark$ **OR/*OF*** $\tan 44{,}72 = \frac{F_{ZY}}{F_{XY}}$

F_{ZY} = 10,696 N

$F_{ZY} = k\frac{Q_Z Q_Y}{r^2}$

$10{,}696\checkmark = 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0{,}30)^2}\checkmark$

Q_Z = 1,34 x 10^{-5} C✓

(4)
[13]

QUESTION 8 / *VRAAG 8*

8.1 Electric field at a point is the force per <u>unit</u> <u>positive</u> charge placed at that point. ✓✓
Elektriese veld by 'n punt is die krag per <u>eenheids</u> <u>positiewe</u> lading geplaas by daardie punt. (2)

8.2

$E = \frac{kQ}{r^2}\checkmark$

$E_{net} = (E_A + E_B)$

$= 9\times10^9 \frac{(1{,}5\times10^{-6})\checkmark}{(0{,}4)^2} + 9\times10^9 \frac{(2{,}0\times10^{-6})}{(0{,}3)^2}\checkmark$

= 2,84 x 10^5 N·C^{-1} ✓ (4)

8.3

OPTION 1/*OPSIE 1*

$F_E = qE$ ✓

= (3,0 x 10^{-9})(2,84 x 10^5) ✓

= 8,52 x 10^{-4} N ✓

OPTION 2/*OPSIE 2*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = (F_A + F_B)$

$= \left(\frac{(9\times10^9)(3\times10^{-6})(1{,}5\times10^{-6})}{(0{,}4)^2} + \frac{(9\times10^9)(3\times10^{-6})(2{,}0\times10^{-6})}{(0{,}3)^2} \right)$ ✓

$= 8{,}53 \times 10^{-4}$ N ✓ (3)

[9]

QUESTION 9 / *VRAAG 9*

9.1.1 The potential difference (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓
Die potensiaalverskil (spanning) oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.
OR/*OF*
The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if temperature is constant✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is. (2)

9.1.2 (Equivalent) resistance/ (*Ekwivalente) weerstand*✓ (1)

9.1.3 Gradient/*Helling* = $\frac{\Delta V}{\Delta I}$

$= \frac{2-0}{0{,}5-0}$ ✓ = 4 (Ω)✓ (2)

9.1.4 **OPTION 1/*OPSIE 1***

In series $R_1 + R_2 = 4\ \Omega$ ✓.....(1)

In parallel $\frac{R_1R_2}{R_1+R_2} = 1\ \Omega$ ✓✓.....(2)

$R_1R_2 = 4\ \Omega$

$\therefore R_1 = R_2 = 2\ \Omega$ ✓

OPTION 2/*OPSIE 2*

For graph X/*Vir grafiek X*:

$R_1 + R_2 = 4$……(1) ✓

For graph Y/*Vir grafiek Y*

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\left\{ \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = \left(\frac{1}{1} \right) \right\}$ ✓✓.....(2)

$R_1^2 - 4R_1 + 4 = 0$

$R_1 = 2\ \Omega$✓ (4)

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*

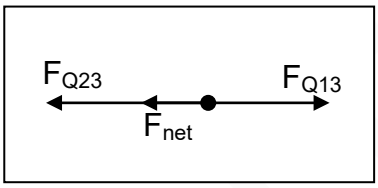
7.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes of the) charges✓ and inversely proportional to the square of the distance (r) between them. ✓

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)

7.2.1 Negative/*Negatief*✓✓ (2)

7.2.2 $F = k\frac{Q_1Q_3}{r^2}$ ✓ (Accept/*Aanvaar* $F = k\frac{Q_1Q_2}{d^2}$)

$0,012 = \frac{(9\times10^9)Q_1(2\times10^{-6})}{(2,5)^2}$ ✓



$Q_1 = 4,17 \times 10^{-6}$ C ✓

$F_{net} = F_{Q13} + F_{Q23}$ ✓

$-0,3 = 0,012 - \frac{(9\times10^9)(Q_2)(2\times10^{-6})}{1^2}$ ✓✓

OR/***OF***

$0,3 = -0,012 + \frac{(9\times10^9)(Q_2)(2\times10^{-6})}{1^2}$ ✓✓

$Q_2 = 1,73 \times 10^{-5}$ C ✓

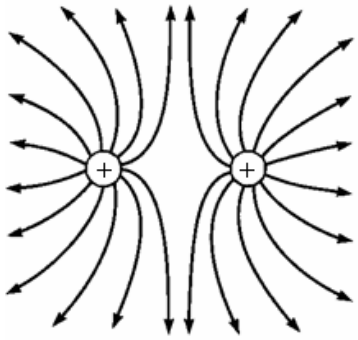
Do not penalise for the nature of the charges.
Moenie vir die aard van die ladings penaliseer nie.

(7)
[11]

QUESTION/*VRAAG 8*

8.1 Electric field is a region of space in which an electric charge experiences a force. ✓✓
Elektriese veld is 'n gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

8.2



Criteria for sketch/*Kriteria vir skets*	Marks/ *Punte*
Correct shape as shown. *Korrekte vorm soos getoon.*	✓
Direction away from positive *Rigting weg van positief .*	✓
Field lines start on spheres and do not cross for correct diagram. *Veldlyne begin op elke sfeer en kruis nie.*	✓

(3)

8.3 $E_{PA} = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(5\times10^{-6})}{(1,25)^2}$ ✓

$= 2,88 \times 10^{4}$ N·C^{-1} to the right/*na regs*

$E_{PB} = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(5\times10^{-6})}{(0,75)^2}$ ✓

$= 8,00 \times 10^{4}$ N·C^{-1} to the left/*na links*

$E_{net} = E_{PA} + E_{PB}$

$= 2,88 \times 10^{4} + (-8,00 \times 10^{4})$

$= 5,12 \times 10^{4}$ N·C^{-1} ✓

✓Vector addition/*Vektoroptelling*

(5)
[10]

QUESTION 7/*VRAAG 7*

7.1.1 Removed/*Verwyder* ✓ (1)

7.1.2 $n = \frac{Q}{e}$ ✓

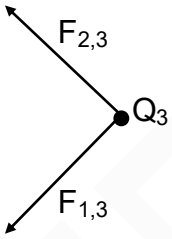
Do not penalise for negative sign of charge used in calculation

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

$= 3{,}75 \times 10^{13}$ ✓electrons/*elektrone* (3)

7.2.1 Negative/*Negatief* ✓ (1)

7.2.2



NOTE/*LET WEL*:
Vectors not drawn to scale/*Vektore nie volgens skaal geteken nie*.
Learners forfeit 1 mark for:/*Kandidate sal 1 punt verbeur vir:*
(i) Wrong directions/*verkeerde rigtings*

OR/*OF*
(ii) Arrows not shown/*Pyltjies nie aangedui nie*

Give credit to the required forces even if a triangle of forces is drawn./*Gee krediet vir die vereiste kragte*

ACCEPT/*AANVAAR*: two separate diagrams /*twee aparte diagramme*
ACCEPT/*AANVAAR*:*correctly drawn vector but no labels/korrek getekende vektore sonder byskifte* (2)

7.2.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{1,3x} = \frac{(9 \times 10^9)(2 \times 10^{-6})(6 \times 10^{-6})}{r^2}(\cos 45°)$ ✓ $= \frac{(0{,}0764)}{r^2}$ ✓

ACCEPT/*AANVAAR*

$F = \frac{kQ_1Q_2}{r^2}$

$F_{1,3x} = \frac{k(Q_1)(Q_3)}{r^2}(\cos 45°)$ (3)

7.2.4 **POSITIVE MARKING FROM QUESTION 7.2.3/*POSITIEWE NASIEN VANAF VRAAG 7.2.3***

OPTION 1/*OPSIE 1*

$$F = \frac{kQ_1Q_2}{r^2}$$

$$F_{2,3x} = \frac{(9\times10^{9})(2\times10^{-6})(6\times10^{-6})}{r^2}(\cos 45^{\circ}) \checkmark = \frac{0,0764}{r^2}$$

$$F_x = F_{1,3x} + F_{2,3x}$$

$$F_x = \frac{0,0764}{r^2} + \frac{0,0764}{r^2} = 2\frac{0,0764}{r^2}$$

1 mark for the addition
1 punt vir optelling

NOTE/*LET WEL*: $F_{y\ net} = 0$

$$(0,12) \checkmark = \frac{0,1528}{r^2}$$

$r = 1,128$ m ✓

OPTION 2/*OPSIE 2*

$$F_{net}^{\ 2} = (F_{1,3})^2 + (F_{2,3})^2$$

$$= (k\frac{Q_1Q_3}{r^2})^2 + (k\frac{Q_2Q_3}{r^2})^2$$

$$= 2(k\frac{Q_1Q_3}{r^2})^2$$

✓ 1 mark for any of the three
1 punt vir enige van die vier

$$= 2\left[(9\times10^{9})\frac{(2\times10^{-6})(6\times10^{-6})}{r^2}\right]^2 \checkmark$$

$$= 2\frac{(0,108)^2}{r^4}$$

NOTE/*LET WEL*
$F_{net} = F_{net(x)}$ since/*aangesien* $F_{net\ (y)} = 0$

$$(0,12)^2 \checkmark = 2\frac{(0,108)^2}{r^4}$$

$\therefore r = 1,128$ m✓ (4)

7.3.1 The electric field at a point is the <u>(electrostatic) force experienced</u> ✓<u>per unit positive charge</u> ✓placed at that point
Die elektriese veld by 'n punt is die <u>(elektrostatiese) krag</u> ✓<u>wat per eenheid positiewe lading</u> ✓wat by daardie punt ✓geplaas word, ervaar word. (2)

7.3.2

OPTION 1/*OPSIE 1*

$E = \frac{kQ}{r^2}$ ✓

$100 \overset{✓}{=} \frac{(9\times10^9)Q}{(0,6)^2}$ ✓

$Q = 4 \times 10^{-9}$ C

When the electric field strength 50 is $N\cdot C^{-1}$/
Waar die elektrieseveld sterkte 50 $N\cdot C^{-1}$ is

$E = \frac{kQ}{r^2}$

$50 = \frac{(9\times10^9)(4\times10^{-9})}{r^2}$ ✓

For the equation/*vir die vergelyking*

r = 0,85 m (0,845) m✓

OPTION 2/*OPSIE 2*

$E = \frac{kQ}{r^2}$ ✓

$\therefore \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$

$\frac{100}{50} \overset{✓}{=} \frac{r^2}{(0,6)^2}$ ✓

$\therefore$ r = 0,85 m (0,849 m)✓

(5)
[21]

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)

7.1.4

OPTION 1/OPSIE 1

1 mark for using slope/
1 punt vir die gebruik van helling

Slope/*Helling* = $\frac{\Delta F_E}{\Delta \frac{1}{r^2}}$ ✓ $= \frac{(0,027 - 0)}{(5,6 - 0)}$ ✓

$= 4,82 \times 10^{-3}\ N \cdot m^2$ $(4,76 \times 10^{-3} – 5 \times 10^{-3})$

Slope/*Helling* = $F_E r^2 = kQ_1Q_2 = kQ^2$ ✓

$4,82 \times 10^{-3}$ ✓ $= \frac{9 \times 10^9}{} \frac{Q^2}{}$ ✓

$\therefore Q = 7,32 \times 10^{-7} C$ ✓

OPTION 2/*OPSIE 2*

Accept any pair of points on the line/*Aanvaar enige paar punte op die lyn*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

( ) ✓ $= \frac{(9 \times 10^9)Q^2}{(\ )}$ ✓✓

$Q = 7,32 \times 10^{-7} C$ ✓ $(7,32 \times 10^{-7} – 7,45 \times 10^{-7}\ C)$

Examples/*Voorbeelde*

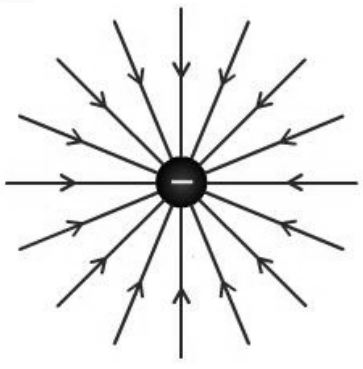
(0,005) ✓ $= \frac{(9 \times 10^9)Q^2}{(\ 1\ )}$ ✓✓

$Q = 7,45 \times 10^{-7}\ C$ ✓

(0,027) ✓ $= \frac{(9 \times 10^9)Q^2}{(\ \frac{1}{5,6}\ )}$ ✓✓

$Q = 7,32 \times 10^{-7}\ C$ ✓ (6)

7.2.1



Criteria for drawing electric field: ***Kriteria vir teken van elektriese veld:***	**Marks/*Punte***
Direction /*Rigting*	✓
Field lines radially inward/*Veldlyne radiaal inwaarts*	✓

7.2.2 $E = \frac{kQ}{r^2}$ ✓

Take right as positive/*Neem regs as positief*

$E_{PA} = \frac{(9 \times 10^9)(0{,}75 \times 10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5$ N·C^{-1} to the left/*na links*

$E_{PB} = \frac{(9 \times 10^9)(0{,}8 \times 10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6$ N·C^{-1} to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= [-8{,}33 \times 10^5 + (-8 \times 10^6)]$ ✓

$= -8{,}83 \times 10^6$

$= 8{,}83 \times 10^6$ N·C^{-1} ✓

1 mark for the addition of same signs/
1 punt vir optelling van dieselfde tekens

Take left as positive/*Neem links as positief*

$E_{PA} = \frac{(9 \times 10^9)(0{,}75 \times 10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5$ N·C^{-1} to the left/*na links*

$E_{PB} = \frac{(9 \times 10^9)(0{,}8 \times 10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6$ N·C^{-1} to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= \underline{(8{,}33 \times 10^5} + \underline{8 \times 10^6)}$ ✓

$= 8{,}83 \times 10^6$ N·C^{-1} ✓

1 mark for the addition of same signs/
1 punt vir optelling van dieselfde tekens

(5)
[17]

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)

7.3.2 **POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3***

$F_{electrostatic/elektrostaties} = T\sin 20^o$✓

$\frac{kQ_1Q_2}{r^2}$ ✓$= (1,04)\sin 20^o$

$\frac{kQ_1Q_2}{r^2} = 0,356$

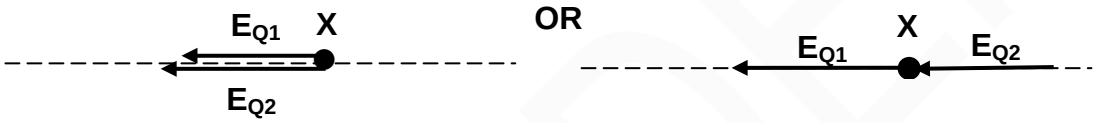
$\frac{(9\times10^9)(250\times10^{-9})(250\times10^{-9})}{r^2}$ ✓$= 0,356$✓

$\therefore r = 0,0397$ m ✓ (5)

[11]

QUESTION 8/*VRAAG 8*

8.1



Vectors E_{Q1} and E_{Q2} in the same direction✓✓/*Vektore E_{Q1} en E_{Q2} in dieselfde rigting*✓✓

Correct drawing of vectors E_{Q1} and E_{Q2}✓✓/*Korrekte tekening van vektore E_{Q1} en E_{Q2}*✓✓/

The fields due to the two charges add up because <u>they come from the same direction.</u> Hence the field cannot be zero./*Die velde as gevolg van die twee ladings word bymekaar getel omdat <u>hulle uit dieselfde rigting inwerk</u>. Die veld kan dus nie nul wees nie.* (4)

8.2 $E = k\frac{Q}{r^2}$ ✓

$E_{-2,5\mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(2,5\times10^{-6})}{(0,3)^2}$✓$= 250\ 000$ N.C^{-1} to the left/*na links*

$E_{6\,\mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(6\times10^{-6})}{(1,3)^2}$✓$=31\ 952,66$ N.C^{-1} to the left/*na links*

$E_P = E_{6\mu C} + E_{-2,5\mu C}$ ✓

$= 31\ 952,66 + 250\ 000$

$= 281\ 952,66$ N.C^{-1} ✓to the left/*na links* ✓ (6)

[10]

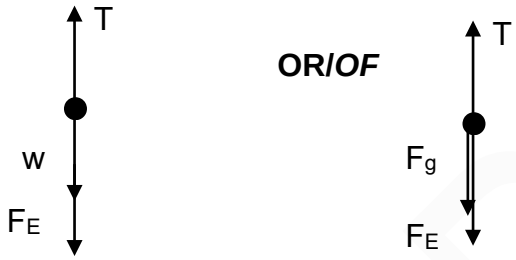
QUESTION/*VRAAG 7*

7.1

$n = \frac{Q}{e}$ ✓ $= \frac{-32 \times 10^{-9}}{-1,6 \times 10^{-19}}$ ✓ = 2 x 10^{11} ✓electrons/*elektrone* **NOTE:/*LET WEL*** Answer must be positive (-1 mark) *Antwoord moet positief wees (-1 punt)*	$n = \frac{Q}{e}$ ✓ $= \frac{32 \times 10^{-9}}{1,6 \times 10^{-19}}$ ✓ = 2 x 10^{11} ✓ electrons/*elektrone*

(3)

7.2



Accepted labels/*Aanvaarde byskrifte*	
w	F_g/F_w/weight/mg/gravitational force *F_g/F_w/gewig/mg/gravitasiekrag*
T	F_T/tension F_s/*spanning*
F_E	$F_{electrostatic}$/F_{Q1Q2} /Coulomb force/F $F_{elektrostatiese}$$F_{Q1Q2}$ /*Coulomb krag/F*

(3)

7.3

$F_{net} = 0$
$mg + F_E = T$
$mg + k\frac{Q_1Q_2}{r^2}$ ✓ $- T = 0$
$(0,007)(9,8)$ ✓ $+ (9 \times 10^9)\frac{(32 \times 10^{-9})(55 \times 10^{-9})}{(0,025)^2}$ ✓ $= T$
$\therefore T = 9,39(4) \times 10^{-2}$ N ✓ (Accept/*Aanvaar*: 0,1 N)

ACCEPT/*AANVAAR*
$F_E = w_{Q2}$ ✓
$(0,007)(9,8)$ ✓ $+ (0,007)(9,8)$ ✓✓ $= T$
T = 0,137 N ✓

(5)
[11]

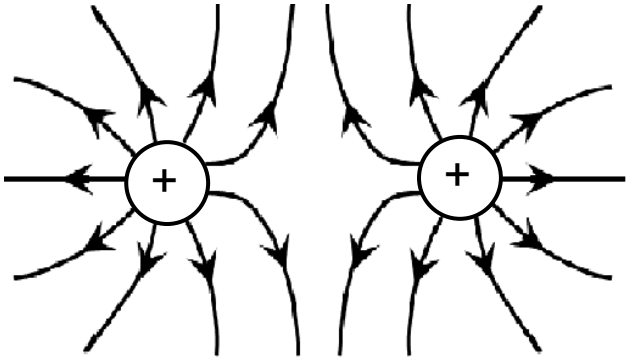
QUESTION/*VRAAG 8*

8.1 The (electrostatic) force experienced by a unit positive charge (placed at that point).✓✓

Die (elektrostatiese) krag ondervind per eenheid positiewe lading by daardie punt.

NOTE/*LET WEL*
If the words "unit positive" is omitted (max 1/2)
Indien die woorde "eenheid positiewe" weggelaat is (maks 1/2) (2)

8.2



Guideline for allocating marks/*Riglyne vir toekenning van punte*		
	Lines must not cross / Lines must touch the spheres but not enter spheres *Lyne moet nie kruis nie/Lyne moet die sfere raak maar nie binnegaan nie*	✓
	Arrows point outwards *Pyle uitwaarts gerig*	✓
	Correct shape *Korrekte vorm*	✓

(3)

8.3

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_{Q1X} = \frac{(9\times10^{9})(30\times10^{-6})}{(x)^2} \checkmark$$

$$E_{Q2X} = \frac{(9\times10^{9})(45\times10^{-6})}{(0,15+x)^2} \checkmark$$

$E_{net} = 0$

$E_{Q1X} = E_{Q2X}$

$$\frac{(9\times10^{9})(30\times10^{-6})}{(x)^2} \checkmark = \frac{(9\times10^{9})(45\times10^{-6})}{(0,15+x)^2}$$

For equating equations
Vir gelykstelling van vergelykings

$$\frac{5,477}{x} = \frac{6,708}{0,15+x}$$

$x = 0,67$ m $(0,667$ m) ✓ (5)

[10]

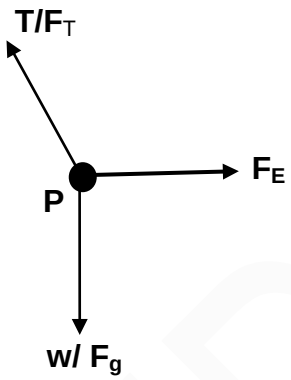
QUESTION 7/*VRAAG 7*

7.1 $n = \frac{Q}{e}$ ✓

$n = \frac{0,5 \times 10^{-6}}{1,6 \times 10^{-19}}$ ✓

$n = 3,13 \times 10^{12}$ ✓electrons/*elektrone* (3)

7.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	F_T / tension F_T / *spanning*
F_E	Electrostatic force/F_C/ Coulombic force/F_Q /$F_{RP/PR}$ *Elektrostiesekrag / Coulombkrag / F_Q /$F_{RP/PR}$*

(3)

7.3 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 wat deur een puntlading (Q_1) op 'n ander puntlading (Q_2)uitgeoefen word, is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aam die kwadraat van die afstand (r) tussen hulle. (2)

7.4

OPTION 1/*OPSIE 1*

$F_E = k\frac{Q_1Q_2}{r^2}$ ✓

$T\sin\theta/(T\cos\theta) = F_E$

$\therefore T\sin7^o/(T\cos83^o)$✓ $= \frac{(9\times10^9)(0{,}5\times10^{-6})(0{,}9\times10^{-6})}{(0,2)^2}$ ✓ ✓

$\therefore T = 0{,}83$ N✓ (Accept/*Aanvaar* 0,82 N) (5)

OPTION 2/*OPSIE 2*

$F_E = \frac{kQ_1Q_2}{r^2}$ ✓

$F_E = \frac{(9\times10^9)(0{,}5\times10^{-6})(0{,}9\times10^{-6})}{(0{,}2)^2}$ ✓ ✓

$= 0{,}101$ N

$\tan7^o = \frac{T_x}{T_Y} = \frac{0{,}101}{T_Y}$ ✓

$T_Y = 0{,}823$ N

$T = \sqrt{T_X^2 + T_Y^2} = \sqrt{(0{,}101)^2 + (0{,}823)^2} = 0{,}83\,N$ ✓ (5)

OPTION 3/*OPSIE 3*

$F = \frac{kQ_1Q_2}{r^2}$ ✓$= \frac{(9\times10^9)(0{,}5\times10^{-6})(0{,}9\times10^{-6})}{(0{,}2)^2}$ ✓ ✓ $= 0{,}101$ N

$\frac{F_E}{\sin7^o} = \frac{T}{\sin90^o}$

$\frac{0{,}101}{\sin7^o} = \frac{T}{\sin90^o}$ ✓

$T = 0{,}83$ N ✓ (5)

[13]

QUESTION 8/*VRAAG 8*

8.1 $E_X = E_2 + E_{(-8)}$ ✓

$= \frac{kQ_2}{r^2} + \frac{kQ_{-8}}{r^2}$ ✓correct equation /*korrekte vergelyking*

$= \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓ + $\frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 2,88 \times 10^6 + 3,2 \times 10^6$

$= 6,08 \times 10^6$ N·C^{-1} ✓ to the east/*na oos* ✓

OR/*OF*

$E = k\frac{Q}{r^2}$ ✓

$E_2 = \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓

$= 2,88\times 10^6$ NC^{-1} to the east/*na oos*

$E_{-8} = \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 3,2 \times 10^6$ N·C^{-1} to the east/*na oos*

$E_X = E_2 + E_{(-8)}$

$= (2,88 \times 10^6 + 3,2 \times 10^6)$ ✓

$= \underline{6,08 \times 10^6}$ $\underline{\text{N·C}^{-1}}$ ✓ to the east/*na oos*✓ (6)

8.2

<u>OPTION 1/*OPSIE 1*</u>

$F_E = QE$✓

$= (-2 \times 10^{-9})(6,08 \times 10^6)$✓

$= -12,16 \times 10^{-3}$ N

$= 1,22 \times 10^{-2}$ N✓ <u>to the west/*na wes*</u>✓ (4)

<u>OPTION 2/*OPSIE 2*</u>

$F_{(-2)Q1} = qE_{(2)}$ ✓

$= (2 \times 10^{-9})(2,88\times 10^6)$

$= 5,76 \times 10^{-3}$ N to the west/*na wes*

$F_{(-2)Q2} = qE_{(8)}$

$= (2 \times 10^{-9})(3,2 \times 10^6)$

$= 6,4 \times 10^{-3}$ N to the west/*na wes*

$F_{net} = \underline{5,76 \times 10^{-3} + 6,4 \times 10^{-3}}$ ✓

$= 1,22 \times 10^{-2}$ N ✓to the west/*na wes*✓ (4)

OPTION 3/*OPSIE 3*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{(-2)2} = \frac{(9\times10^{9})(2\times10^{-9})(2\times10^{-5})}{(0,25)^2}$

$= 5,76 \times 10^{-3}$ N to the west/*na wes*

$F_{(-2)(-8)} = \frac{(9\times10^{9})(2\times10^{-9})(8\times10^{-6})}{(0,15)^2}$

$= 6,4 \times 10^{-3}$ N to the west/*na wes*

$F_{net} = (5,76 \times 10^{-3} + 6,4 \times 10^{-3})$ ✓

$= 1,22 \times 10^{-2}$ N ✓to the west/*na wes* ✓ (4)

8.3 $2,44 \times 10^{-2}$ N✓ (1)
[11]

QUESTION 9/*VRAAG 9*

9.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. (provided temperature and all other physical conditions are constant) ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly)
OR/*OF*
.
The current in a conductor is directly proportional to the potential difference across the conductor, provided temperature and all other physical conditions are constant ✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur mits temperatuur en alle fisiese toestande konstant bly (2)

9.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V = IR$✓	$V = IR$✓
$V_8 = (0,5)(8)$✓ $= 4$ V	$V_8 = (0,5)(8)$ ✓ $= 4$ V
$V_8 = V_{16}$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$\therefore V_{16} = 4$ V	$= \frac{1}{8} + \frac{1}{16}$ ✓
$I_{16} = \frac{V}{R} = \frac{4}{16} = 0,25$ A	$R = 5,33\ \Omega$
$I_{tot//} = A_1 = (0,5 + 0,25)$ ✓ $= 0,75$ A✓	$I_{tot//} = \frac{4}{5,33}$
	$A_1 = 0,75$ A✓

(4)

QUESTION 7/*VRAAG 7*

7.1 The net electrostatic force on a charged particle due to the presence of another charged particle is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them (their centres) ✓

Die netto elektrostatiese krag op 'n gelaaide deeltjies as gevolg van die teenwoordigheid van 'n ander gelaaide deeltjie is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (hul middelpunte)

OR/*OF*

The force of attraction or repulsion 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 aantrekkings- of afstotingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

OR/*OF*

Any two charged particles will exert an electrostatic force on each other where the force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charged particles. (their centres)

Enige twee gelaaide deeltjies sal 'n elektrostatiese krag op mekaar uitoefen waar die krag direk eweredig is aan die produk van die ladings en omgekeerd eweredig is aan die kwadraat van die afstand tussen hulle (tussen hul middelpunte) (2)

7.2

7.2.1 $F = \frac{KQ_1Q_2}{r^2}$ ✓

$1,44 \times 10^{-1} = \frac{(9 \times 10^9)Q^2}{(0,5)^2}$ ✓

$Q = 2 \times 10^{-6}$ C✓ (4)

7.2.2 **Positive marking from QUESTION 7.2.1**
Positiewe nasien vanaf VRAAG 7.2.1

Q = ne✓

$2 \times 10^{-6} = n(1,6 \times 10^{-19})$ ✓

$n = 1,25 \times 10^{13}$ electrons/*elektrone*✓ (3)

7.3

7.3.1 Left /*Links* (west/*wes*) ✓ (1)

7.3.2 Take right as positive/*Neem regs as positief*

$E_{net} = E_A + E_B$ ✓

$$(3\times10^4) = -\frac{(9\times10^9)(2\times10^{-6})}{(1{,}5)^2} + \frac{(9\times10^9)Q_{final}}{(1)^2}$$ ✓

$Q_{final} = 4{,}22 \times 10^{-6}$ C ✓

$Q = ne$

$4{,}22 \times 10^{-6} = \frac{n(1{,}6\times10^{-19})}{}$ ✓

$n_f = 2{,}64 \times 10^{13}$ electrons/*elektrone* ✓

electrons removed/*elektrone verwyder*

$= (2{,}64 \times 10^{13} + 1{,}25 \times 10^{13})$ ✓

$= 3{,}89 \times 10^{13}$ electrons/*elektrone* ✓ (8)

[18]

Notes / *Aantekeninge*

No. electrons should be removed $= n_f - n_i$
allocate the 1 mark for the subtraction
Aantal elektrone wat verwyder moet word $= n_f - n_i$
Ken 1 punt toe vir aftrekking

QUESTION 8/*VRAAG 8*

8.1.1 Ensure that the wires have:/*Maak seker dat die drade*
The same length/*dieselfde lengte het*.✓
The same thickness/cross-sectional area/*dieselfde dikte/deursnit-area/ oppervlakte het*✓ (2)

8.1.2 Wire **A** (Resistor A)/*Draad A* ✓

$R = \frac{\Delta V}{\Delta I}$ ✓

$R_A = \frac{4{,}4}{0{,}4}$ ✓ $= 11\ \Omega$ ✓

$R_B = \frac{2{,}2}{0{,}4}$ ✓ $= 5{,}5\ \Omega$ ✓

$E = I^2 R\Delta t$ ✓

-

Accept any correct coordinates chosen from the graph
Aanvaar enige korrekte koördinate van die grafiek gekies.

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde tyd en stroom, sal die verwarming in A hoër wees omdat sy weerstand groter is as die van B.

ACCEPT/***AANVAAR***: $P = I^2R$
For the same current, the heat produced per unit time in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde stroom, sal die hitte vrygestel per eenheidstyd in A hoër wees omdat sy weerstand groter is as die van B. (8)

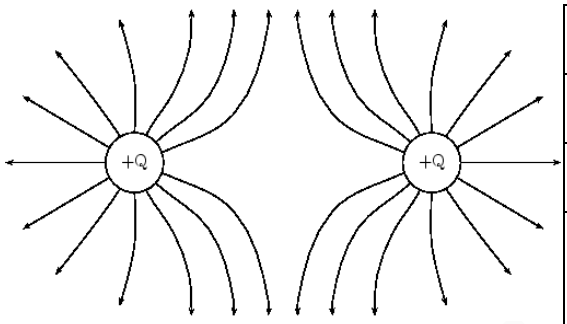
QUESTION 7/*VRAAG 7*

7.1 To ensure that charge does not leak to the ground/insulated. ✓
Om te verseker dat die lading nie na die grond toe lek nie/isoleer. (1)

Notes/*Aantekeninge*
Accept/*Aanvaar* In order retain original charge✓/To insulate the charges./ *Om oorspronklike lading te behou/ Om lading te isoleer.*

7.2 Net charge/*Netto lading* = $\frac{Q_R + Q_S}{2} = \frac{+8 + (-4)}{2}$ ✓= 2 µC✓ (2)

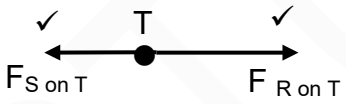
7.3



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Correct direction of field lines *Korrekte rigting van veldlyne*	✓
Shape of the electric field *Vorm van elektrieseveld*	✓
No field line crossing each other / No field lines inside the spheres/ *Geen veldlyne wat maekaar kruis nie / Geen veldlyne binne sfeer nie*	✓

(3)

7.4



(2)

7.5

OPTION 1/*OPSIE 1*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{ST} = (9\times10^9)\frac{(1\times10^{-6})(2\times10^{-6})}{(0,2)^2}$ ✓✓ = 0,45 N / 4,5 x 10^{-1} N left/*links*

OR/*OF*

$F_{TS} = \frac{1}{4}F_{RT} = \frac{1}{4}(1,8) = 0,45$ N

$F_{RT} = 9\times10^9 \times \frac{(2\times10^{-6})(1\times10^{-6})}{(0,1)^2}$ ✓ = 1,8 N right/*regs*

OR/*OF*

$F_{RT} = 4F_{ST} = 4(0,45) = 1,8$ N right /*regs*

$F_{net} = F_{ST} + F_{RT} = \underline{1,8 + (-0,45)}$ ✓

= <u>1,35 N</u> or towards sphere S / *na sfeer* or/*of* <u>right/*regs* S</u>✓ (6)

OPTION 2/*OPSIE 2*

$E_R = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 N.C^{-1} right/*regs*

$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ ✓= 4,5 x 10^5 N.C^{-1} left/*links*

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 ✓= 1,35 x 10^6 N.C^{-1}right/*regs*

F = EQ ✓= (1,35 x 10^6)(1 x 10^{-6}) ✓
= 1,35 N towards sphere S / na sfeer S right/*regs* ✓ (6)

7.6 Force experienced ✓per unit positive charge ✓placed at that point.
Krag ondervind per eenheid positiewe lading by daardie punt. (2)

7.7

OPTION 1/*OPSIE 1*

$E = \frac{F}{q}$✓ = $\frac{1,35}{1\times10^{-6}}$✓= 1,35 x 10^6 N·C^{-1}✓ (3)

OPTION 2/*OPSIE 2*

$E_R = \frac{kQ}{r^2}$✓ = $\frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 N·C^{-1} right/*regs*

$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ = 4,5 x 10^5 N·C^{-1} left/*links*

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 N·C^{-1}✓ (3)

OPTION 3/*OPSIE 3*

$E = \frac{F}{q}$✓ = $\frac{1,8}{1\times10^{-6}}$✓= 1,8 x 10^6 N·C^{-1}

$E = \frac{F}{q} = \frac{0,45}{1\times10^{-6}}$ = 4,5 x 10^5 N·C^{-1}

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 N·C^{-1}✓ (3)

[19]

QUESTION 8/*VRAAG 8*

8.1 Coulomb's law / *Coulomb se wet* ✓ (1)

8.2 A: Field lines too dense in relation to C/ Number of field lines differ. /*A: Veldlyne te dig in vergelyking met C/ Aantal veldlyne verskil.* ✓
B: Field lines are crossing each other. /*B: Veldlyne kruis mekaar.* ✓
C: Direction of field lines should be away from C/ *C: Rigting van veldlyne moet weg van C af wees.* ✓ (3)

8.3

OPTION 1/*OPSIE 1*

$F_{AC} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,06)^2}$ ✓

$= 2,5 \times 10^4$ N to the right/*na regs*

$F_{BC} = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,03)^2}$ ✓

$= 1 \times 10^5$ N to the right/*na regs*

✓Any one

$F_{net} = F_{AC} + F_{BC}$
$= 2,5 \times 10^4 + 1 \times 10^5$
$= 1,25 \times 10^5$ N ✓ to the right/*na regs* ✓

OPTION 2/*OPSIE 2*

$F_{AC} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,06)^2}$ ✓

$= 2,5 \times 10^4$ N to the right/*na regs*

$r_{BC} = ½ r_{AC}$
$F_{BC} = 4 F_{BC}$ ✓ $= 4(2,5 \times 10^4) = 1 \times 10^5$ N to the right

$F_{net} = F_{AC} + F_{BC}$
$= 2,5 \times 10^4 + 1 \times 10^5$
$= 1,25 \times 10^5$ N ✓ to the right/*na regs* ✓

(6)

8.4 Net force acting on charge at B = 0 N/
Netto krag wat op lading inwerk by B = 0 N ✓
$F_{AB} = - F_{CB}$ ✓ (2)
[12]

QUESTION 6/*VRAAG 6*

6.1 Smaller than / *Kleiner as* ✓ (1)

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

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

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

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

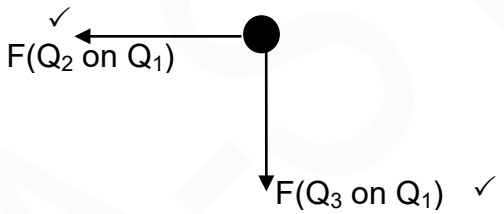
= 694,35 Hz ✓ (7)

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)

7.3 $F = k\frac{Q_1Q_2}{r^2}$ ✓

$F(Q_2 \text{ on } Q_1) = (9 \times 10^9)\frac{(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓ ✓ $= 1{,}6 \times 10^4$ N (to left/*na links*)

$F(Q_3 \text{ on } Q_1) = (9 \times 10^9)\frac{(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓ $= 1{,}6 \times 10^4$ N

(downwards/*afwaarts*)

$F_{net} = \sqrt{(F_{Q2 \text{ on } Q1})^2 + (F_{Q3 \text{ on } Q1})^2}$

$= \sqrt{(1{,}6 \times 10^4)^2 + (1{,}6\times10^4)^2}$ ✓

$= 2{,}26 \times 10^4$ N

$\tan\theta = \left(\frac{F_{Q3 \text{ on } Q1}}{F_{Q2 \text{ on } Q1}}\right)$

$\tan\theta = \left(\frac{1{,}6\times10^4}{1{,}6\times10^4}\right)$ ✓

$\therefore \theta = 45°$

$F_{net} = 2{,}26 \times 10^3$ N ✓ SW / 225° / 45° south of west / *suid van wes* ✓ (8)

[12]

QUESTION 8/*VRAAG 8*

8.1 The force ✓per unit charge ✓ at that point.
Die krag per eenheidslading by daardie punt. (2)

8.2 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^9)(6{,}5\times10^{-12})}{(0{,}003)^2}$ ✓

$= 6{,}5 \times 10^3$ N·C^{-1} ✓ (3)

8.3 **At point X/*By punt X***

$E_Q = 6{,}5 \times 10^3$ N·C^{-1} west/*wes* ✓

$E_R = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(6{,}5\times10^{-12})}{(0{,}003)^2}$

$= 6{,}5 \times 10^3$ N·C^{-1} east/*oos* ✓

$E_{net} = E_Q + E_R$ ✓

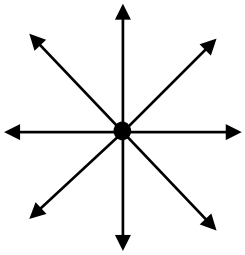
$= 6{,}5 \times 10^3 + (-6{,}5 \times 10^3)$

$= 0$ N·C^{-1} ✓ (4)

[9]

QUESTION 8/*VRAAG 8*

8.1



Criteria for sketch:/*Kriteria vir skets:*	
Correct shape - field lines radially around charge. *Korrekte vorm – veldlyne radiaal uitwaarts.*	✓
Direction of field lines away from charge. *Rigting van veldlyne weg van lading af.*	✓

(2)

8.2 Non-uniform / *Nie-uniform* ✓ (1)

8.3
$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9\times10^{9})(16\times10^{-6})}{(0,12)^2} \checkmark$$
$$= 1 \times 10^{7}\ N\cdot C^{-1} \checkmark \text{ east/}oos \checkmark$$ (5)

8.4 Positive / *Positief* ✓ (1)

8.5

West: positive	**West: negative**
$E_A + E_B = E_{net}$	$E_A + E_B = E_{net}$
$-1 \times 10^{7} + E_B$ ✓$= 1 \times 10^{7}$✓	$1 \times 10^{7} + E_B$ ✓$= -1 \times 10^{7}$✓
$\therefore E_B = 2 \times 10^{7}\ N\cdot C^{-1}$	$\therefore E_B = -2 \times 10^{7}\ N\cdot C^{-1}$ $= 2 \times 10^{7}\ N\cdot C^{-1}$
$E_B = \frac{kQ_B}{r^2}$	$E_B = \frac{kQ_B}{r^2}$
$\therefore 2 \times 10^{7}$✓ $= \frac{(9\times10^{9})Q_B}{(0,23)^2}$ ✓	$\therefore 2 \times 10^{7}$ ✓$= \frac{(9\times10^{9})Q_B}{(0,23)^2}$ ✓
$\therefore Q_B = 1,18\times10^{-4}$ C ✓	$\therefore Q_B = 1,18\times10^{-4}$ C ✓
(5)	(5)

(5)

[14]

QUESTION 9/*VRAAG 9*

9.1 12 J of energy are transferred to / work done on ✓
each coulomb (of charge) / per C charge ✓ passing through the battery.

12 J energie word oorgedra aan / arbeid word verrig op
elke coulomb (lading) / per C lading wat deur die battery beweeg. (2)

QUESTION 8/*VRAAG 8*

8.1 Stores (electric) charge/energy. ✓
Stoor (elektriese) lading/energie.

OR/*OF*
Releases (stored) charge instantly/very fast. ✓
Stel (gestoorde) lading onmiddellik vry/baie vinnig vry. (1)

8.2 The brightness of the bulb decreases (gradually) ✓
until it stops glowing/dies.
Die helderheid van die gloeilamp verminder (geleidelik).

OR/*OF*
The bulb glows dimmer ✓
until it stops glowing/dies.
Die gloeilamp gloei flouer totdat dit ophou gloei/uitbrand. (1)

8.3
8.3.1 0 (V) ✓ (1)

8.3.2 12 V ✓ (1)

8.4 **POSITIVE MARKING FROM QUESTION 8.3.2.**
POSITIEWE NASIEN VAN VRAAG 8.3.2.

8.4.1 $E = \frac{V}{d}$ ✓

$= \frac{12}{5{,}4 \times 10^{-3}}$ ✓

$= 2{,}22 \times 10^{3}\ V \cdot m^{-1}$ ✓ $(2\ 222{,}22\ V \cdot m^{-1})$ (3)

8.4.2 **POSITIVE MARKING FROM QUESTION 8.4.1.**
POSITIEWE NASIEN VAN VRAAG 8.4.1.

$E = \frac{F}{q}$ ✓

$\therefore 2{,}22 \times 10^{3} = \frac{F}{1{,}6 \times 10^{-19}}$ ✓

$\therefore F = 3{,}56 \times 10^{-16}\ N$ ✓ (3)

8.5
8.5.1 5,4 mm – 3,8 mm = 1,6 mm ✓ (1)

8.5.2 **POSITIVE MARKING FROM QUESTION 8.4.2 & 8.5.1.**
POSITIEWE NASIEN VAN VRAAG 8.4.2 & 8.5.1.

$W = F\Delta x\cos\theta$ ✓
$= (3{,}56 \times 10^{-16})(1{,}6 \times 10^{-3})$✓$\cos 0°$✓
$= 5{,}69 \times 10^{-19}$ J ✓

(4)
[15]

QUESTION 9/*VRAAG 9*

9.1
9.1.1 Potential difference/*Potensiaalverskil* ✓ (1)

9.1.2 Temperature/*Temperatuur* ✓
Resistance/*Weerstand* (1)

9.1.3 Current is directly proportional to potential difference. ✓✓
Stroom is direk eweredig aan potensiaalverskil

OR/*OF*
The ratio of potential difference to current is constant. ✓✓
Die verhouding van potensiaalverskil tot stroom is konstant.

IF/*INDIEN*:
Current is proportional to potential difference. ✓
Stroom is eweredig aan potensiaalverskil. (2)

9.1.4 Gradient/m $= \frac{0{,}18 - 0}{0{,}5 - 0}$ ✓ ✓ $= 0{,}36$

$R = \frac{1}{0{,}36} = 2{,}78\ \Omega$ ✓✓ (4)

Notes/*Aantekeninge:*
Accept any set of correct values from the graph.
Aanvaar enige stel waardes vanaf die grafiek.

9.2
9.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{6} + \frac{1}{10}$ ✓

$\therefore R_p = 3{,}75\ \Omega$ ✓ (3)

QUESTION 7/*VRAAG 7*

7.1 Double slit/*Dubbelspleet* ✓ (1)

7.2 (Alternate) dark and bright/blue bands. ✓
Bright / blue bands of equal broadness (width). ✓
(Afwissellende) donker en helder/blou bande. ✓
Helder / blou bande van gelyke breedte. ✓ (2)

7.3

7.3.1

$$\tan\theta = \frac{\frac{1}{2}\text{central band}}{\text{screen distance}} \;/\; \frac{\frac{1}{2}\textit{sentraleband}}{\textit{skermafstand}}$$

$$\therefore \tan\theta = \frac{\frac{1}{2}(0{,}22)}{1{,}4} \checkmark$$

$$\therefore \theta = 4{,}49° \checkmark$$ (3)

7.3.2

OPTION 1/*OPSIE 1:*	**OPTION 2/*OPSIE 2:***
$\sin\theta = \frac{m\lambda}{a}$ ✓	$\sin\theta = \frac{m\lambda}{a}$ ✓
$\sin 4{,}49 = \frac{(1)(470\times10^{-9})}{a}$ ✓ ✓	$\sin(-4{,}49°) = \frac{(-1)(470\times10^{-9})}{a}$ ✓ ✓
$\therefore a = 6\times10^{-6}$ m ✓(6 003,67 nm)	$\therefore a = 6\times10^{-6}$ m ✓ (6 003,67 nm)

(5)

7.4 $\lambda_{\text{red light}} > \lambda_{\text{blue light}}$ ✓
(Degree of) diffraction/sin θ / θ α wavelength (λ) ✓
$\lambda_{\textit{rooilig}} > \lambda_{\textit{bloulig}}$ ✓
Diffraksie α *golflengte* (λ) ✓ (2)
[13]

QUESTION 8/*VRAAG 8*

8.1 $R = \frac{V}{I}$ ✓

$1\,000 = \frac{12}{I}$ ✓

$\therefore I = 0{,}01$ A ✓ (3)

8.2 12 V ✓ (1)

8.3 $C = \frac{Q}{V}$ ✓

$120 \times 10^{-6} = \frac{Q}{12}$ ✓

$\therefore Q = 1{,}44 \times 10^{-3}$ C ✓ (3)

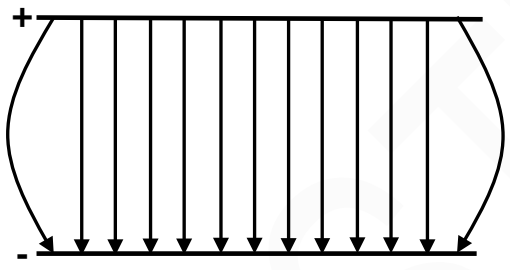
8.4

8.4.1 Decreases/*Verminder* ✓ (1)

8.4.2 Increases/*Vermeerder* ✓ (1)

8.5

8.5.1



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Parallel lines equally spaced. *Parallelle lyne eweredig gespasieer.*	✓
Direction from positive plate towards negative plate.(Polarity of plates must be indicated) *Rigting vanaf positiewe plaat na negatiewe plaat.(Polariteit van plate moet aangedui word)*	✓
Field curved at the ends of the plates. *Veld gekrom aan einde van die plate.*	✓

(3)

8.5.2

$E = \frac{V}{d}$ ✓

$= \frac{12}{12 \times 10^{-3}}$ ✓

$\therefore E = 1\,000$ V·m^{-1} ✓ (3)

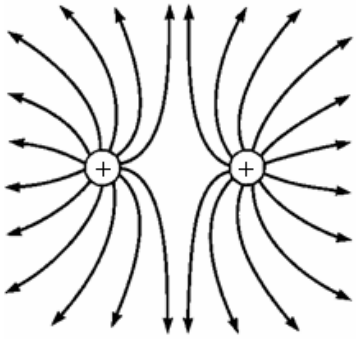
[15]

QUESTION 8/*VRAAG 8*

8.1 The (electrostatic) force experienced at a point ✓
per unit charge at that point. ✓
Die elektrostatiese krag ondervind by 'n punt ✓
per eenheidslading by daardie punt. ✓

OR/*OF*
The (electrostatic) force experienced ✓
by a charge placed at that point divided by the charge itself. ✓
Die (elektrostatiese) krag ondervind ✓
deur 'n lading geplaas by daardie punt gedeel deur die lading self. ✓ (2)

8.2



Criteria for sketch/*Kriteria vir skets*	Marks/ *Punte*
Correct shape as shown. *Korrekte vorm soos getoon*	✓
Direction from positive to negative. *Rigting van positief na negatief.*	✓
Field lines start on spheres and do not cross. *Veldlyne begin op elke sfeer en kruis nie.*	✓

(3)

8.3 $E_P = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(5\times10^{-9})}{(30\times10^{-3})^2}$ ✓

$= 5 \times 10^4$ N·C^{-1} to the right/*na regs*

$E_Q = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(5\times10^{-9})}{(10\times10^{-3})^2}$ ✓

$= 4{,}5 \times 10^5$ N·C^{-1} to the right/*na regs*

$E_{net} = 5 \times 10^4 + 4{,}5 \times 10^5$

$= 5 \times 10^5$ N·C^{-1} to the right/*na regs* ✓ (6)

8.4 **POSITIVE MARKING FROM QUESTION 8.3 TO QUESTION 8.4/**
POSITIEWE NASIEN VAN VRAAG 8.3 NA VRAAG 8.4

$E = \frac{F}{q}$ ✓

$5 \times 10^5 = \frac{F}{1{,}6\times10^{-19}}$ ✓

$F = 8 \times 10^{-14}$ N ✓ (3)

[14]

7.3 Wavelength (of light) / Frequency (of light) / Colour of light/ Light source ✓
Distance between slit and screen. ✓

Golflengte (van lig) / Frekwensie (van lig) / Kleur van lig / Ligbron ✓
Afstand tussen spleet en skerm. ✓ (2)

7.4 Increases / *Vermeerder* ✓
Diffraction is inversely proportional to slit width. ✓
Diffraksie is omgekeerd eweredig aan spleetwydte. ✓

OR/*OF*
Increases / *Vermeerder* ✓
Diffraction / *Diffraksie* OR/*OF* $\sin\theta \propto \frac{1}{a}$ ✓ (2)

7.5 **Option 1 / *Opsie 1:***

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin\theta = \frac{(2)(4\times10^{-7})}{2{,}2\times10^{-6}}$ ✓✓

$\therefore\ \theta = 21{,}32°$ ✓

Option 2 / *Opsie 2:*

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin\theta = \frac{(-2)(4\times10^{-7})}{2{,}2\times10^{-6}}$ ✓✓

$\therefore\ \theta = -21{,}32°$ ✓ (5)

[13]

QUESTION 8 / *VRAAG 8*

8.1 T to/*na* P ✓ (1)

8.2 $Q = \frac{3\times10^{-9}+(-6\times10^{-9})}{2}$ ✓ = -1,5 x 10^{-9} C

$\Delta Q_P = Q_P(\text{final}) - Q_P(\text{initial})$
$= -1{,}5 \times 10^{-9} - 3 \times 10^{-9}$ ✓
$= -4{,}5 \times 10^{-9}$ C ✓

OR / *OF*

$\Delta Q_T = Q_T(\text{final}) - Q_T(\text{initial})$
$= -1{,}5 \times 10^{-9} - (-6 \times 10^{-9})$ ✓
$= 4{,}5 \times 10^{-9}$ C ✓ (3)

8.3 Number of electrons / *Getal elektrone* = $\frac{-4{,}5\times10^{-9}}{-1{,}6\times10^{-19}}$ ✓
$= 2{,}81 \times 10^{10}$ ✓ (2)

8.4

Option 1 / *Opsie 1*

$F_{TR} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^{9})(1{,}5\times10^{-9})(3\times10^{-9})}{1^2}$ ✓

$= 4{,}05 \times 10^{-8}$ N to the left/towards P
na links/na P toe

✓Any one
Enige een

$F_{PR} = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^{9})(1{,}5\times10^{-9})(3\times10^{-9})}{0{,}5^2}$ ✓

$= 1{,}62 \times 10^{-7}$ N to the right/towards T
na regs/na T toe

To the right / towards T as positive: / *Na regs* / *na T toe as positief*
$F_{net} = 1{,}62 \times 10^{-7} - 4{,}05 \times 10^{-8}$
$= 1{,}22 \times 10^{-7}$ N $(1{,}215 \times 10^{-7}$ N)
$= 1{,}22 \times 10^{-7}$ N ✓ to the right / towards T / *na regs / na T toe* ✓ (6)

[12]

QUESTION 9 / *VRAAG 9*

9.1 Current / I / *stroom* ✓ (1)

9.2
9.2.1 (4,0 ✓ ; 0,64) ✓ (2)

9.2.2 Temperature was not kept constant. ✓✓
Temperatuur is nie konstant gehou nie. ✓✓ (2)

9.3 Gradient/m = $\frac{\Delta y}{\Delta x} = \frac{0{,}64 - 0}{4 - 0}$ ✓ ✓ = 0,16

$R = \frac{1}{0{,}16} = 6{,}25\ \Omega$ ✓✓ (4)

[9]

QUESTION 10 / *VRAAG 10*

10.1 12 V ✓ (1)

10.2.1

Option 1 / *Opsie 1:*	**Option 2 / *Opsie 2:***
$I = \frac{V}{R}$ ✓ $= \frac{9{,}6}{2{,}4}$ ✓ = 4 A	emf = IR + Ir✓ 12 = I(2,4) + 2,4✓ ∴ I = 4 A✓

(3)

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 ✓= $(\frac{340}{340 \checkmark 20})f_s$

$\therefore f_s$ = 423,53 Hz ✓ [12.2.3] (4)
[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)

8.5 **Option 1/*Opsie 1:***
Yellow light / *Geel lig* ✓

Cyan paint reflects blue and green light ✓
(Yellow light contains green light and red light)
Only green light (in yellow light) will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
(Geel lig bevat groen en rooi lig)
Slegs groen lig (in geel lig) sal weerkaats word ✓en dit kom groen voor

Option 2/*Opsie 2:*
Green light / *Groen lig* ✓

Cyan paint reflects blue and green light ✓
When green light shines onto it, only green light will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
Wanneer groen lig daarop skyn, word slegs groen lig weerkaats ✓en dit kom groen voor. [12.2.3] (3)
[10]

QUESTION 9 / *VRAAG 9*

9.1 Diffraction / *Diffraksie* ✓ [12.1.2] (1)

9.2.1 Each point on a wave front acts as a source of (spherical) secondary wave fronts / wavelets (that propagates in the forward direction). ✓✓
Elke punt op 'n golffront dien as 'n bron van (sferiese) sekondêre golffronte / golfies (wat in 'n voorwaartse rigting voortplant). [12.2.1] (2)

9.2.2 Dark bands form where **wave fronts / wavelets** interfere destructively.✓
Red/bright bands form where **wave fronts / wavelets** interfere constructively. ✓

*Donker bande vorm waar **golffronte / golwe** destruktiewe interferensie ondergaan.* ✓
*Rooi/helder bande vorm waar **golffronte / golwe** konstruktiewe interferensie ondergaan.* ✓ [12.1.4] (2)

9.2.3 Diffraction is inversely proportional to the slit width / Diffraction $\alpha \frac{1}{a}$ ✓✓

Diffraksie is omgekeerd eweredig aan die spleetwydte /
Diffraksie $\alpha \frac{1}{a}$ ✓✓

OR/*OF*
The degree of diffraction / Angle at which minima occurs increases with decreasing slit width
Mate van diffraksie / Hoek waar minima voorkom neem toe met afname in spleetwydte [12.1.4] (2)

9.2.4 *White light* consists of different colours with <u>different wavelengths</u> ✓
Amount of diffraction differs for different colours / different wavelengths. ✓

Wit lig bestaan uit verskillende kleure met <u>verskillende golflengtes</u>. ✓
Mate van diffraksie verskil vir verskillende kleure / golflengtes. ✓ [12.1.4] (2)
[9]

QUESTION 10 / *VRAAG 10*

10.1 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(6\times10^{-6})}{(0,4)^2}$ ✓ ✓

F = 1,35 N ✓

OR/*OF*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(-6\times10^{-6})}{(0,4)^2}$ ✓ ✓

F = -1,35 N
Magnitude of / *Grootte van* F = 1,35 N ✓ [12.2.3] (4)

10.2 four / *vier (4)* ✓ [12.2.2] (1)

10.3 $E(6\ \mu C) = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(6\times10^{-6})}{(0,2)^2}$ ✓✓

$= 1,35 \times 10^{6}\ N\cdot C^{-1}$ to the left/*na links*

$E(4\ \mu C) = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(4\times10^{-6})}{(0,6)^2}$ ✓✓

$= 1 \times 10^{5}\ N\cdot C^{-1}$ (to the right / *na regs)*

To the right as positive/*Na regs as positief:*

$E_{net/netto} = -1,35 \times 10^{6} + 1 \times 10^{5} = -1,25 \times 10^{6}\ N\cdot C^{-1}$ ✓

$E_{net/netto} = 1,25 \times 10^{6}\ N\cdot C^{-1}$ to the left / *na links* ✓

OR/*OF*

$E_{net} = \frac{kQ}{r^2}$ ✓ $= 9 \times 10^{9}(\frac{-6\times10^{-6}}{(0,2)^2} + \frac{(4\times10^{-6})}{(0,6)^2})$ ✓✓

$= -1,35 \times 10^{6} + 1 \times 10^{5} = -1,25 \times 10^{6}$

$E_{net/netto}$ = 1,25 x 10^{6} N·C^{-1} in the direction of the field of the 6 μC charge/*in die rigting van veld van die 6* μ*C lading* ✓ [12.1.3] (6)

10.4 New charge/*Nuwe lading* = $\frac{(+4\times10^{-6}) + (-6\times10^{-6})}{2}$ ✓

$= -1 \times 10^{-6}$ C or/*of* – 1 μ*C*

$U = \frac{kQ_1Q_2}{r}$ ✓

$= \frac{(9\times10^{9})(-1\times10^{-6})(-1\times10^{-6})}{(0,4)}$ ✓

∴ U = 2,25 x 10^{-2} J ✓ (0,02 J)

[12.1.3] (5)

[16]

QUESTION 11 / *VRAAG 11*

11.1 9 V ✓

Potential difference measured when:
switch is open / no current flows / circuit is open/no work done is in external circuit ✓
Potensiaalverskil gemeet wanneer:
die skakelaar oop is / geen stroom vloei nie / stroombaan oop is / geen arbeid verrig word in die eksterne stroombaan nie [12.2.2] (2)

