basic education

Department:
Basic Education
**REPUBLIC OF SOUTH AFRICA**

# NATIONAL SENIOR CERTIFICATE *NASIONALE SENIOR SERTIFIKAAT*

## GRADE/*GRAAD* 12

## PHYSICAL SCIENCES: PHYSICS (P1)
## *FISIESE WETENSKAPPE: FISIKA (V1)*

**NOVEMBER 2024**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 22 pages.**
***Hierdie nasienriglyne bestaan uit 22 bladsye.***

## QUESTION 1/*VRAAG 1*

| | | |
|---|---|---|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | A ✓✓ | (2) |
| 1.4 | C ✓✓ | (2) |
| 1.5 | C ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | C ✓✓ | (2) |
| 1.9 | D ✓✓ | (2) |
| 1.10 | D ✓✓ | (2) |

**[20]**

## QUESTION 2/*VRAAG 2*

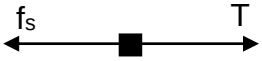
2.1

| **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 force that opposes the tendency of motion of a stationary object relative/parallel to a surface ✓✓/ *Die krag wat die geneigdheid vir beweging van 'n stilstaande voorwerp relatief/parallel tot die oppervlak teenstaan.* (2)

2.2


Accept/Aanvaar




| | **Accepted labels/*Aanvaarde benoemings*** |
|---|---|
| **$f_s$** | static friction/*statiese wrywing*/ f / $F_f$ /$F_w$ *(only Afrikaans)* |
| **T** | $F_T$/$F_{string}$/tension/*spanning*/$F_{tou}$ |

**Notes/*Aantekeninge***
- Do not penalize if vertical forces (w, N) are shown/ *Moenie penaliseer indien vertikale kragte (w, N) getoon nie.*
- Mark is awarded for label and arrow/*Punt word toegeken vir byskrif en pyltjie.*
- Do not penalize for length of arrows/*Moenie vir die lengte van die pyltjies penaliseer nie*.
- If arrows do not touch the dot/*Indien pyle nie die kolletjie raak nie*: Max/*Maks* $^1/_2$
- Any other additional force(s) except w and N/*Enige ander addisionele krag(te) behalwe w en N: Max/Maks* $^1/_2$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $^1/_2$ (2)

2.3.1

**OPTION 1/*OPSIE 1***

**For hanging m/*Vir hangende m*:**

$F_{net} = ma$
$mg - T = 0$ or $T - mg = 0$
$T = mg$
$T = 4,2(9,8)$ ✓
$= 41,16$ N

**For crate/*Vir krat:***

$F_{net} = ma$
$T - f_s^{max} = ma$
$T - \mu_s mg = ma$
$T - f_s^{max} = 0$
$f_s^{max} = T$
$\mu_s N = T$
$f_s^{max} = \mu_s N$

✓Any one / *Enige een*

$\mu_s(8,5)(9,8)$ ✓ $= 41,16$
$\mu_s = 0,49$ ✓

**OPTION 2/*OPSIE 2***

$f_s^{max} = T = w_{hanging}$

$f_s^{max} = m_{hanging}g$
$\mu_s N = m_{hanging}g$
$\mu_s m_{crate}.g = m_{hanging}g$
$f_s^{max} = \mu_s N$

✓Any one / *Enige een*

$\mu_s(8,5)(9,8)$ ✓ $= 4,2(9,8)$ ✓

**OR**

$\mu_s(8,5) = 4,2$
$\mu_s = 0,49$ ✓

(4)

2.3.2

**For crate/*Vir krat:***

$F_{net} = ma$
$T - f_k = ma$
OR $f_k - T = ma$
$T - \mu_k mg = ma$

✓Any one /*Enige een*

$T - 0,4(8,5)(9,8)$ ✓$= 8,5a$ …… Eqn (1)

**For hanging mass/*Vir hangende massa:***

$F_{net} = ma$
$mg - T = ma$
$7,4(9,8) - T$ ✓$= 7,4a$ …….. Eqn (2)

✓Any one /*Enige een*

$Y = a = 2,47\ (m \cdot s^{-2})$ ✓

**NOTE**: T can be calculated first (54,32 N)
***NOTA**: T kan eerste bereken word (54,32 N)* (5)

2.4 INCREASES ✓ $f_s^{max}$ α N **OR** $f_s^{max}$ α m **OR** $f_s^{max} = \mu_s N$ **OR** the normal force acting on the crate increases **OR** increase in mass/weight of crate (increases the normal force) ✓

*NEEM TOE* $f_s^{maks}$ *α N* **OF** $f_s^{max}$ α m ***OF*** $f_s^{max} = \mu_s N$ ***OF*** *die normaalkrag wat op die krat inwerk, neem toe* ***OF*** *toename in massa/gewig van krat veroorsaak (toename in normaalkrag)* (2)

**[15]**

## QUESTION 3/*VRAAG 3*

3.1.1

**Marking criteria/*Nasienkriteria***

- Formula with $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ /*Formule met* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
- Correct substitution into formula for ball A/*Korrekte vervanging in formule vir bal A* ✓
- Correct substitution into formula for ball B/*Korrekte vervanging in formule vir bal B*✓
- $\Delta y_A = \Delta y_B$ ✓

Final answer/*Finale antwoord*: 4 (s) ✓

**OPTION 1/*OPSIE 1***

**UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF***

**Ball A/*Bal A***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$= 12t + \frac{1}{2}(-9,8)t^2$ ✓ .....Eqn (1)

**Ball B/*Bal B***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= -5,4(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$✓..... Eqn (2)

$12t + \frac{1}{2}(-9,8)t^2 = -5,4(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***

**Ball A/*Bal A***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$= -12t + \frac{1}{2}(9,8)t^2$ ✓ .....Eqn (1)

**Ball B/*Bal B***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= 5,4(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓.....Eqn (2)

$-12t + \frac{1}{2}(9,8)t^2 = 5,4(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

**OPTION 2/*OPSIE 2***

**UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF***

***Take time for ball B as x/Neem tyd vir bal B as x***

**Ball A/*Bal A***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$= 12(x + 2) + \frac{1}{2}(-9,8)(x + 2)^2$ ✓

$=(-4,9)x^2 - (7,6)x + (4,4)$ .....Eqn (1)

**Ball B/*Bal B***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= (-5,4)x + \frac{1}{2}(-9,8)x^2$ ✓

$= (-5,4)x + (-4,9)x^2$ ..... Eqn (2)

$(-4,9)x^2 - (7,6)x + (4,4) = (-5,4)x + (-4,9)x^2$ ✓

$x = 2$

$t = 4$ (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
**Ball A/*Bal A***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$=(-12)(x + 2) + \frac{1}{2}(9,8)(x + 2)t^2$ ✓
$=(4,9)x^2 + (7,6)x + (-4,4)$ .....Eqn (1)

**Ball B/*Bal B***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (5,4)x + \frac{1}{2}(9,8)x^2$ ✓ ..... Eqn (2)

$\boxed{(4,9)x^2 + (7,6)x + (-4,4) = (5,4)x + (4,9)x^2}$ ✓
$x = 2$
$t = 4$ (s) ✓

**<u>OPTION 3/*OPSIE 3*</u>:**
**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF***

$v_f = v_i + a\Delta t$
$-12 = 12 + (-9,8)t$
$\Delta t = 2,45$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
**Ball A**: $\Delta y = (-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2$ .....Eq 1 ✓
**Ball B**: $\Delta y = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ....Eq 2 ✓
Equating
$(-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2 = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ✓
$t = 4$ (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***

$v_f = v_i + a\Delta t$
$12 = -12 + (9,8)\Delta t$
$\Delta t = 2,45$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
**Ball A**: $\Delta y = (12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2$ .....Eq 1 ✓
**Ball B**: $\Delta y = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ....Eq 2 ✓
Equating
$(12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2 = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓
$t = 4$ (s) ✓

(5)

**NOTE:**
**Dashed arrows**: prior calculation not necessary to show, subsequent substitutions need to be correct for marks to be awarded. If first calculations are wrong, no credit given for subsequent substitutions.
(This will be applied if a candidate changes a single step calculation into a multistep calculation.)
**Solid arrows**: prior calculation(s) necessary for subsequent substitution(s). Marks may be awarded for follow-up marking.

***NOTA:***
***Gebroke pyle****: vorige berekening nie nodig om te wys nie, alle volgende invervangings moet korrek wees om punte toe te ken. Indien eerste berekening verkeerd is, geen punte toegeken vir volgende invervangings nie.*
*(Dit word toegepas wanneer 'n kandidaat 'n enkel-stap berekening verander in 'n multi-stap berekening)*
***Soliede pyle****: vorige berekeninge is nodig vir alle volgende invervangings. Punte mag toegeken word vir opvolg nasien.*

**POSITIVE MARKING FROM QUESTION 3.1.1/*POSITIEWE NASIEN VANAF VRAAG 3.1.1***

3.1.2

**Marking criteria/*Nasienkriteria***
- Correct formula to calculate $\Delta y$./*Korrekte formule om $\Delta y$ te bereken.* ✓
- Correct substitution to calculate $\Delta y$./*Korrekte vervanging om $\Delta y$ te bereken.* ✓
- Correct final answer./*Korrekte finale antwoord:* 30,4 m ✓

**UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF***

**OPTION 1/*OPSIE 1***

**Ball A/*Bal A***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$= (12)(4) + \frac{1}{2}(-9,8)(4)^2$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

**OPTION 2/*OPSIE 2***

**Ball B/*Bal B***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$= (-5,4)(4 - 2) + \frac{1}{2}(-9,8)(4 - 2)^2$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

**Ball A/*Bal A***

$v_f = v_i + a\Delta t$

$v_f = 12 + (-9,8)(4)$

$v_f = -27,2\ m{\cdot}s^{-1}$

**OPTION 3/*OPSIE 3***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(-27,2)^2 = (12)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

**OPTION 4/*OPSIE 4***

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \left(\frac{12 + (-27,2)}{2}\right)4$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

**Ball B/*Bal B***

$v_f = v_i + a\Delta t$

$v_f = -5,4 + (-9,8)(4 - 2)$

$v_f = -25\ m{\cdot}s^{-1}$

**OPTION 5/*OPSIE 5***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(-25)^2 = (-5,4)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

**OPTION 6/*OPSIE 6***

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \left(\frac{-5,4 + (-25)}{2}\right)(4 - 2)$ ✓

$\Delta y = -30,4$ m

Z = 30,4 (m) ✓

<table>
<tr><th colspan="2">DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF</th></tr>
<tr><td><u>OPTION 1/OPSIE 1</u><br>Ball A/Bal A<br>$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓<br>$= (-12)(4) + \frac{1}{2}(9,8)(4)^2$ ✓<br>$\Delta y = 30,4$ m<br>Z = 30,4 (m) ✓</td><td><u>OPTION 2/OPSIE 2</u><br>Ball B/Bal B<br>$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓<br>$= (5,4)(4 - 2) + \frac{1}{2}(9,8)(4 - 2)^2$ ✓<br>$\Delta y = 30,4$ m<br>Z = 30,4 (m) ✓</td></tr>
<tr><td rowspan="2">Ball A/Bal A<br>$v_f = v_i + a\Delta t$<br>$v_f = -12 + (9,8)(4)$<br>$v_f = 27,2\ m\cdot s^{-1}$</td><td><u>OPTION 3/OPSIE 3</u><br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$(27,2)^2 = (12)^2 + 2(9,8)\Delta y$ ✓<br>$\Delta y = -30,4$ m<br>Z = 30,4 (m) ✓</td></tr>
<tr><td><u>OPTION 4/OPSIE 4</u><br>$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$= \left(\frac{-12 + 27,2}{2}\right)4$ ✓<br>$\Delta y = 30,4$ m<br>Z = 30,4 (m) ✓</td></tr>
<tr><td rowspan="2">Ball B/Bal B<br>$v_f = v_i + a\Delta t$<br>$v_f = 5,4 + (9,8)(4 - 2)$<br>$v_f = 25\ m\cdot s^{-1}$</td><td><u>OPTION 5/OPSIE 5</u><br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$(25)^2 = (5,4)^2 + 2(9,8)\ \Delta y$ ✓<br>$\Delta y = 30,4$ m<br>Z = 30,4 (m) ✓</td></tr>
<tr><td><u>OPTION 6/OPSIE 6</u><br>$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$= \left(\frac{5,4 + 25}{2}\right)(4 - 2)$ ✓<br>$\Delta y = 30,4$ m<br>Z = 30,4 (m) ✓</td></tr>
</table>

(3)

3.1.3 **POSITIVE MARKING FROM QUESTION 3.1.1 and 3.1.2**
***POSITIEWE NASIEN VANAF VRAAG 3.1.1 en 3.1.2***

**Marking criteria/*Nasienkriteria***
- Correct equation to calculate $\Delta y$./*Korrekte vergelyking om $\Delta y$ te bereken.* ✓
- Correct substitution to calculate $\Delta y$./*Korrekte vervanging om $\Delta y$ te bereken.* ✓
- Adding 30,4 to $\Delta y$/ *Bytel van 30,4 by $\Delta y$* ✓
- Correct final answer./*Korrekte finale antwoord:* 37,75 m ✓
- Range/*Gebied* 37,72 – 37,75 m
- **Note/*Nota*: $v_f$ and $v_i$ can be interchanged / $v_f$ en $v_i$ *kan omgeruil wees***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF***

**OPTION 1/*OPSIE 1***

**Ball A/*Bal A***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (12)^2 + 2(-9,8)\Delta y$ ✓
$\Delta y = 7,35$ m

**Ball A/*Bal A***

$v_f = v_i + a\Delta t$
$0 = 12 + (-9,8)\Delta t$
$\Delta t = 1,22$ s

**OPTION 2/*OPSIE 2***

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{12 + 0}{2}\right)1,22$ ✓
$\Delta y = 7,32$ m

**OPTION 3/*OPSIE 3***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (12)(1,22) + \frac{1}{2}(-9,8)(1,22)^2$ ✓
$\Delta y = 7,35$ m

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***

**OPTION 1/*OPSIE 1***

**Ball A/*Bal A***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (-12)^2 + 2(9,8)\Delta y$ ✓
$\Delta y = 7,35$ m

**Ball A/*Bal A***

$v_f = v_i + a\Delta t$
$0 = -12 + (9,8)\Delta t$
$\Delta t = 1,22$ s

**OPTION 2/*OPSIE 2***

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{-12 + 0}{2}\right)1,22$ ✓
$\Delta y = -7,32$ m

**OPTION 3/*OPSIE 3***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (-12)(1,22) + \frac{1}{2}(9,8)(1,22)^2$ ✓
$\Delta y = -7,35$ m

$Y = 7,35 + 30,4$ ✓
$= 37,75$ (m) ✓

(4)

3.2 **POSITIVE MARKING FROM QUESTION 3.1.1**
***POSITIEWE NASIEN VANAF VRAAG 3.1.1***

**Marking criteria:**

- Correct initial velocities of both balls A and B with correct shape (straight lines with both positive / both negative slopes) ✓
- Correct initial times for balls A and B with B starts after the intercept of A ✓
- Both graphs end at 4 s (accept t) ✓
- Graphs parallel to each other and B to the right of A ✓

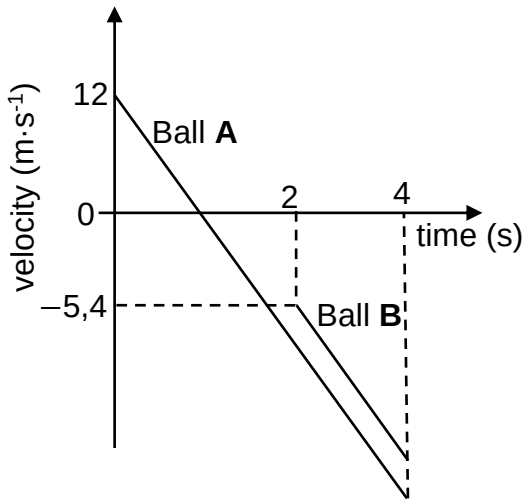
**NB:** No labels A and B, deduct 1 mark

***Nasienkriteria:***

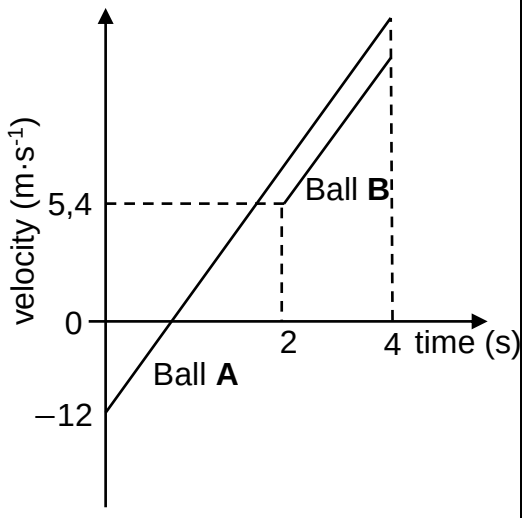
- *Korrekte aanvanklike snelhede van beide bal A en B met korrekte vorm (reguit lyne met beide positiewe / beide negatiewe helling)*
- *Korrekte aanvanklike tye van beide bal A en B met B wat begin na die afsnit van A*
- *Beide grafieke eindig by 4 s (aanvaar t)*
- *Grafieke parallel tot mekaar en B is regs van A*

***NB:** Geen byskrifte A and B, trek 1 punt af*

**UPWARDS AS POSITIVE/**
***OPWAARTS AS POSITIEF***




**DOWNWARDS AS POSITIVE/**
***AFWAARTS AS POSITIEF***




(4)
**[16]**

## QUESTION 4/*VRAAG 4*

4.1 **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 total mechanical energy/sum of gravitational potential energy and kinetic energy, in an isolated system remains constant/is conserved. ✓✓
*Die totale meganiese energie/som van gravitasie potensiële energie en kinetiese energie in 'n geïsoleerde sisteem bly konstant/ behoue.* (2)

4.2

**OPTION 1/*OPSIE 1***

Total $E_{mech(top/bo)}$ = Total $E_{mech(bottom/onder)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$
$(mgh + ½mv^2)_{top/bo} = (mgh + ½mv^2)_{bottom/onder}$
✓Any one/*Enige een*

$(2)(9,8)(1,5) + 0$ ✓ $= 0 + ½(2)v^2$ ✓ **OR/*OF***
$(9,8)(1,5) + 0 = 0 + ½v^2$
$v = 5,42\ m\cdot s^{-1}$ ✓

**OPTION 2/*OPSIE 2***

$W_{nc} = \Delta E_k + \Delta E_p$
$W_{nc} = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$
✓Any one/*Enige een*

✓ ✓
$0 = [0 - ½v_i^2] + [(9,8)(1,5 - 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

**OPTION 3/*OPSIE 3***

$W_{net} = \Delta E_k$
$F_g\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$
$mg\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$
✓Any one/*Enige een*

$(9,8)(1,5)\cos180^\circ$ ✓ $= 0 - ½v_i^2$ ✓
$v_i = 5,42\ m\cdot s^{-1}$ ✓

**OPTION 4/*OPSIE 4***

$\Delta E_k = -\Delta E_p$ ✓
$[0 - ½v_i^2]$✓ $= -[(9,8)(1,5$ ✓$- 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

**OR/*OF***

$-\Delta E_k = \Delta E_p$ ✓
$-[0 - ½v_i^2]$✓ $= [(9,8)(1,5$ ✓$- 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

**OPTION 5/*OPSIE 5***

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0$ ✓ $= v_i^2 + 2(9,8)(-1,5)$ ✓
$v_f = -5,42\ m\cdot s^{-1}$
speed $= 5,42\ m\cdot s^{-1}$ ✓

**OR/*OF***

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0$ ✓ $= v_i^2 + 2(-9,8)(1,5)$ ✓
speed $= v_f = 5,42\ m\cdot s^{-1}$ ✓

(4)

**NOTE**: $v_i$ and $v_f$ can be interchanged but then 9,8 and 1,5 must have the same signs/***NOTA**: $v_i$ en $v_f$ kan omgeruil word maar dan moet 9,8 en 1,5 dieselfde tekens hê.*

4.3.1 **POSITIVE MARKING FROM QUESTION 4.2**
***POSITIEWE NASIEN VANAF VRAAG 4.2***

$\Delta p = mv_f - mv_i$
$F_{net}\Delta t = \Delta p$
✓ any one /enige een

$= \underline{2(5,42 - 0)}$ ✓ **OR/*OF*** $\underline{2(-5,42 - 0)} = -10,84\ kg\cdot m\cdot s^{-1}$
$= \underline{10,84\ kg\cdot m\cdot s^{-1}\ right/regs}$ ✓ (3)

4.3.2 **POSITIVE MARKING FROM QUESTION 4.3.1**
***POSITIEWE NASIEN VANAF VRAAG 4.3.1***
$\underline{10,84\ kg\cdot m\cdot s^{-1}\ left/links/opposite\ direction/teenoorgestelde\ rigting}$ ✓ (1)

4.4 **POSITIVE MARKING FROM QUESTION 4.2 and 4.3.1**
***POSITIEWE NASIEN VANAF VRAAG 4.2 en 4.3.1***

| | | |
|---|---|---|
| $\Delta p_A = mv_f - mv_i$ | | $\Sigma p_i = \Sigma p_f$ |
| $\underline{-10,84 = 1,5(v_f - 0)}$ ✓ | **OR/OF** | $\underline{0 = 1,5v_f + (2)(5,42)}$ ✓ |
| $v_f = -7,23\ m\cdot s^{-1}$ | | $v_f = -7,23\ m\cdot s^{-1}$ |
| $v = 7,23\ m\cdot s^{-1}$ ✓ | | $v = 7,23\ m\cdot s^{-1}$ ✓ |
| $\underline{10,84 = 1,5(v_f - 0)}$ ✓ | **OR/OF** | $\underline{0 = 1,5v_f + (2)(-5,42)}$ |
| $v = 7,23\ m\cdot s^{-1}$ ✓ | | $v = 7,23\ m\cdot s^{-1}$ ✓ |

(2)
**[12]**

## QUESTION 5/*VRAAG 5*

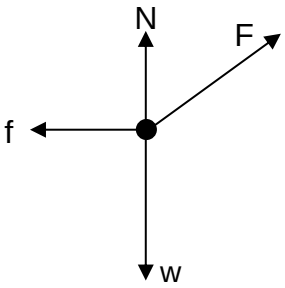
5.1

**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.*

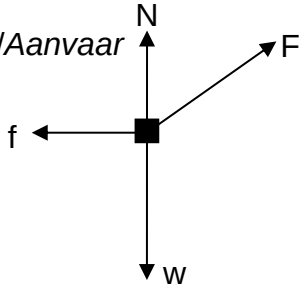
The work done on an object by a constant force F is F Δx cos θ, where F is the magnitude of the force, Δx the magnitude of the displacement and θ the angle between the force and the displacement. ✓✓
*Die arbeid verrig op 'n voorwerp deur 'n konstante krag F is F Δx cos θ, waar F die grootte van die krag, Δx die grootte van die verplasing en θ die hoek tussen die krag en die verplasing is.*

**OR/*OF***
The work done on an object is the product of the force and the displacement of the object in the direction of the displacement ✓✓
*Die arbeid verrig op 'n voorwerp is die produk van die krag en die verplasing van die voorwerp in die rigting van die verplasing.* (2)

5.2




Accept/*Aanvaar*




| **Accepted labels/*Aanvaarde benoemings*** | |
|---|---|
| w | $F_w$ / $F_g$ / mg /58,8 N / gravitational force / *gravitasiekrag* / weight / *gewig* |
| f | $F_f$ / $f_k$ / (kinetic) Friction / *(kinetiese) wrywing* / $F_w$ *(Afrikaans)* |
| N | $F_N$ / Normal force / *Normaalkrag* |
| F | $F_A$ / Applied force /*Toegepaste krag* / $F_T$ *(Afrikaans)* |

**Notes/*Aantekeninge:***
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalize 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* $^3/_4$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $^3/_4$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^3/_4$
- If components drawn for F/*Indien komponente van F geteken:* Max/maks $^3/_4$

(4)

5.3

**Marking criteria/*Nasienkriteria***

- Correct formula for/ *korrekte formule vir* $W_{net}$ / $W_{nc}$. ✓
- Correct substitution to calculate work done by the forces/ *Korrekte vervanging om arbeid verrig deur die kragte te bereken* ✓
- Correct substitution to calculate change in kinetic energy and gravitational potential energy/ *Korrekte vervanging vir die berekening van die verandering in kinetiese energie en gravitasie potensiële energie*✓
- Correct final answer / *Korrekte finale antwoord: 20,79 N* ✓
- Range/Gebied: 20,769 - 20,79 N

**OPTION 1/*OPSIE 1***

$$W_{nc} = \Delta E_k + \Delta E_p$$
$$W_{nc} = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$
$$W_F + W_f = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$

✓ Any one/ *Enige een*

$F(1, 5)\cos30° + 10(1,5)\cos180°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓ $+ 0$

$F = 20,78$ N ✓

**OPTION 2/*OPSIE 2***

$$W_{net} = \Delta E_k$$
$$W_F + W_f = \Delta E_k$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓Any one/ *Enige een*

$F(1,5)\cos30° + 10(1,5)\cos180°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓

$F = 20,78$ N ✓

**OPTION 3/*OPSIE 3***

$$W_{net} = \Delta E_K$$
$$(F\cos\theta - f)\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓ Any one/ *Enige een*

$(F\cos30° - 10)(1,5)\cos0°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓

$F = 20,78$ N ✓

**OPTION 4/*OPSIE 4***

$$W_{net} = \Delta E_K$$
$$(F_x - f)\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓ Any one/ *Enige een*

$(F_x - 10)(1,5)\cos0^o = ½(6)(2^2 - 0^2)$ ✓

$F_x = 18$ N

$F_x = F\cos 30°$

$18 = F\cos 30°$ ✓

$F = 20,78$ N ✓

(4)

5.4 REMAINS THE SAME / *BLY DIESELFDE* ✓✓ (2)

**[12]**

**QUESTION/*VRAAG 6***

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

6.2 Away from / W*eg van* ✓
Wavelength of sound detected/observed by the listener is longer than wavelength of sound emitted by the source ✓
**OR**
Frequency detected by the listener is lower than the frequency of the source.
**OR**
$\lambda_L > \lambda_S$
**OR**
$f_L < fs$
*Golflengte van die klank wat deur die luisteraar waargeneem word, is langer as die golflengte van klank wat deur die bron vrygestel word.*
***OF***
*Frekwensie waargeneem deur luisteraar is laer as die frekwensie van die bron*
***OF***
$\lambda_L > \lambda_S$
***OF***
$f_L < fs$ (2)

6.3.1 $v = f\lambda$ ✓
$343 = f(0,38)$ ✓
$f = 902,63$ Hz ✓ (3)

If c = fλ used, penalize 1 mark
*Indien c = fλ gebruik penaliseer 1 punt*

If 340 used, penalize 1 mark for answer
*Indien 340 gebruik penaliseer 1 punt vir antwoord*

6.3.2
**POSITIVE MARKING FROM QUESTION 6.3.1/**
***POSITIEWE NASIEN VANAF VRAAG 6.3.1***
$v = f\lambda$
$343 = f(0,4)$ ✓
$f_L = 857,5$ Hz

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S \quad \textbf{OR/}\textit{OF} \quad f_L = \frac{v}{v + v_S} f_S \ ✓$$

$$857,5 ✓ = \frac{343}{343 + v_S} ✓ (902,63) ✓$$

$v_S = 18,05 \text{ m·s}^{-1}$ ✓ (Range/*Gebied*: 18,05 m·s$^{-1}$ to/*tot* 18,45 m·s$^{-1}$)

If wavelengths are substituted instead of frequencies/*Indien golflengtes invervang in plaas van frekwensies* max/*maks* $^2/_6$
If wavelengths are swopped/*Indien golflengtes omgeruil* max/*maks* $^3/_6$ (6)

**[12]**

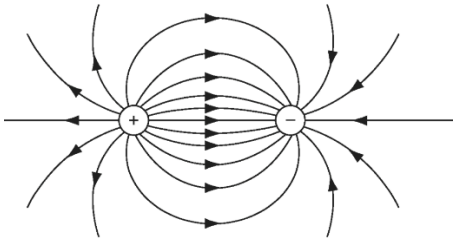
## QUESTION 7/VRAAG 7

7.1

$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9 \times 10^{9})(2 \times 10^{-9})}{(0,06)^2} \checkmark$$
$$= 5 \times 10^{3}\ N \cdot C^{-1} \checkmark\ (5\ 000\ N \cdot C^{-1})$$

(3)

7.2



| **Criteria for sketch/*Kriteria vir skets*** | Marks/*Punte* |
|---|---|
| Correct direction of field lines. /*Korrekte rigting van veldlyne.* | ✓ |
| Correct shape of the electric field lines between charges and on the outside of the charges. /*Korrekte vorm van elektrieseveld tussen ladings en die buitekant van die ladings.* | ✓ |
| No field lines crossing each other. Field lines must touch the charge, but not go inside the charge. /*Geen veldlyne wat mekaar kruis nie. Veldlyne moet die lading raak*, *maar nie die lading binnegaan nie*. | ✓ |
| Note: If learner draws field pattern of two like charges: $^0/_3$<br>If only one charge is drawn, $^0/_3$<br>*Nota: Indien leerder elektrieseveld van twee gelyke ladings teken:* $^0/_3$.<br>*Indien slegs een lading geteken is,* $^0/_3$ | |

(3)

7.3.1

**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 point charge is directly proportional to the product of the magnitudes of their charges and inversely proportional to square of the distance between them. ✓✓
*Die grootte van die elektrostatiese krag wat een puntlading op 'n ander puntlading uitoefen is direk eweredig aan die produk van die groottes van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.*

(2)

**NOTE**: If reference to masses / If the word FORCE in context omitted $^0/_2$
***NOTA**: Indien verwysing na massa* / Indien die woord KRAG in konteks uitgelaat $^0/_2$

7.3.2 POSITIVE / *POSITIEF* ✓ (1)

7.3.3 **POSITIVE MARKING FROM Q 7.1 IN TERMS OF CONVERSIONS /**
***POSITIEWE NASIEN VANAF V 7.1 IN TERME VAN OMSKAKELINGS***

**OPTION 1/*OPSIE 1***

**Marking criteria/*Nasienkriteria:***

- Formula for Coulomb's law./ Formule vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's formula for BOTH $F_{ST}$ and $F_{PT}$./ *Korrekte vervanging in Coulomb se formule vir BEIDE $F_{ST}$ en $F_{PT}$.* ✓
- Substitution of 2,5 x $10^{-4}$ N for $F_{net}$. ✓/*Vervanging van 2,5 x $10^{-4}$ N vir $F_{net}$.*
- Subtraction of/*Aftrek van* ($F_S - F_P$ **OF/*OR*** $F_P - F_S$) ✓
- Correct final answer/*Korrekte finale antwoord*: 6,25 x $10^{-9}$ C✓

$F = \frac{kQ_1Q_2}{r^2}$ ✓ ✓Both/*Beide*

$F_{ST} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$ $F_{PT} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$

$F_{net} = F_{ST} - F_{PT}$

$2,5 \times 10^{-4}$ ✓$= \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$ ✓ $- \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$

$Q_T = 6,25 \times 10^{-9}$ C ✓

**OR/*OF***

$-F_{net} = F_{PT} - F_{ST}$

$-2,5 \times 10^{-4}$ ✓$= \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$ ✓ $- \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$

$Q_T = 6,25 \times 10^{-9}$ C ✓

**OPTION 2/*OPSIE 2***

**Marking criteria/*Nasienkriteria***

- Correct substitution for S to find $E_S$./*Korrekte vervanging vir S om $E_S$ te verkry* ✓
- Subtraction of /*Aftrek van* ($E_P - E_S$) **OF/*OR*** ($E_S - E_P$ ) ✓
- Formula /*Formule*: F = Eq ✓
- Correct substitution in /*Korrekte vervanging in* F = Eq ✓.
- Final answer /*Finale antwoord*: $Q_T$= 6,25 x $10^{-9}$ C ✓

**RIGHT AS POSITIVE/*REGS AS POSITIEF***

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

$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= 45\,000$ N·C$^{-1}$

$E_{net} = E_P - E_S$

$E_{net} = 5 \times 10^3 - \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= -4 \times 10^4$ N·C$^{-1}$ (40 000)

F = Eq ✓

$-2,5 \times 10^{-4} = (-4 \times 10^4)Q_T$ ✓

$Q_T = 6,25 \times 10^{-9}$ C ✓

**LEFT AS POSITIVE/*LINKS AS POSITIEF***

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

$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= 45\,000$ N·C$^{-1}$

$E_{net} = E_S - E_P$

$= \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓ $- 5 \times 10^3$

$= 4 \times 10^4$ N·C$^{-1}$

F = Eq ✓

$2,5 \times 10^{-4} = (4 \times 10^4)Q_T$ ✓

$Q_T = 6,25 \times 10^{-9}$ C ✓

(5)
**[14]**

## QUESTION 8/*VRAAG 8*

8.1 The rate at which work is done/dissipated OR energy transferred OR Work done per unit time ✓✓ **(2 or/*of* 0)**
*Die tempo waarteen arbeid verrig OF energie oorgedra word OF Arbeid verrig per eenheidstyd* (2)

8.2.1

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| P = VI✓<br>48 = 32 I✓<br>I = 1,5 A✓ | $P = \frac{V^2}{R}$<br>$48 = \frac{32^2}{R}$<br>R = 21,33 Ω<br>$P = I^2R$✓ : 48 = $I^2$(21,33)✓ : I = 1,5 A ✓<br>V = IR✓ : 32 = I(21,33)✓ : I = 1,5 A✓ |

(3)

8.2.2

**POSITIVE MARKING FROM QUESTION 8.2.1.**
***POSITIEWE NASIEN VANAF VRAAG 8.2.1.***

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| For $L_1$ / *Vir* $L_1$<br>P = VI<br>36 = 20I✓<br>I = 1,8 A | $P = \frac{V^2}{R}$<br>$36 = \frac{20^2}{R}$<br>R = 11,11 Ω<br>$P = I^2R$ : 36 = $I^2$(11,11)✓ : I = 1,8 A<br>V = IR : 20 = I(11,11)✓ : I =1,8 A |

$I_{TOT}$ = 1,5 + 1,8 ✓
= 3,3 A ✓

(3)

8.2.3

**POSITIVE MARKING FROM QUESTION 8.2.2.**
***POSITIEWE NASIEN VANAF VRAAG 8.2.2.***

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $V_{R1} + V_{L1} = V_{//}$<br>$V_{R1}$ + 20 = 32<br>$V_{R1}$ = 12 V<br>V = IR ✓<br>12 ✓= 1,8 $R_1$ ✓<br>$R_1$ = 6,67 Ω ✓ | V = IR ✓<br>32 = 1,8R ✓<br>R = 17,77 Ω<br>$P = \frac{V^2}{R}$<br>$36 = \frac{20^2}{R}$<br>R = 11,11 Ω<br>$R_1$ = 17,77 – 11,11 = 6,67 Ω ✓ |

(4)

8.2.4

**POSITIVE MARKING FROM QUESTION 8.2.2. AND 8.2.3**
***POSITIEWE NASIEN VANAF VRAAG 8.2.2. EN 8.2.3***

**OPTION 1/ *OPSIE 1***

$V_2 = I_{TOT} R_2$
$= \underline{3,3(4)}$
$= 13,2$ V

$\varepsilon = V_{ext} + Ir$ ✓
$= \underline{(13,2 + 32)}$ ✓ $+ \underline{3,3(0,6)}$ ✓
$= 47,18$ V ✓
Range/*Gebied*: 47,16 – 47,19 V

**OPTION 2/*OPSIE 2***

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{21,33} + \frac{1}{11,11 + 6,67}$

**OR/OF**

$R_{12} = \left(\frac{R_1 R_2}{R_1 + R_2}\right)$

$= \frac{21,33(11,11 + 6,67)}{21,33 + 11,11 + 6,67}$

$R_p = 9,69\ \Omega$

$R_{ext} = R_p + Rs$
$R_{ext} = 9,69 + 4$
$= 13,69\ \Omega$

**OPTION 3/*OPSIE 3***

$V = IR$
$32 = 3,3R$
$R_p = 9,7\ \Omega$

$R_{ext} = R_p + Rs$
$R_{ext} = 9,69 + 4$
$= 13,69\ \Omega$

$\varepsilon = I(R + r)$ ✓

$= \underline{3,3(13,69)}$ ✓ $+ \underline{3,3(0,6)}$ ✓
$= 47,18$ V ✓

Range/*Gebied*:
47,16 – 47,19 V

(4)

8.3

**POSITIVE MARKING FROM QUESTION 8.2.1. AND 8.2.4**
***POSITIEWE NASIEN VANAF VRAAG 8.2.1. EN 8.2.4***

NO / NEE ✓ Accept Not glow / Aanvaar Nie gloei nie

$P = \frac{V^2}{R}$

$48 = \frac{32^2}{R}$ ✓

$R_{L2} = 21,33\ \Omega$

$R_{L2} = \frac{V}{I}$

$= \frac{32}{1,5}$ ✓

$= 21,33\ \Omega$

$\varepsilon = I(R + r)$ ✓

$\underline{47,18 = I(21,33 + 4 + 0,6)}$ ✓

$I = 1,82$ A ✓

**NOTE**: If 21,33 Ω already calculated previously award mark
***NOTA**: Indien 21,33 Ω alreeds bereken in vorige vraag, ken punt toe*

(5)
**[21]**

**QUESTION 9/*VRAAG 9***

9.1 DC/*GS* (generator) ✓ (1)

9.2 Mechanical/Kinetic to Electrical ✓✓ **(2 or/*of* 0)**
*Meganies*/*Kineties na Elektries* (2)

9.3 Power / Energy / Voltage loss cannot be reduced / will be too large✓
*Verlies aan drywing / energie / spanning kan nie verminder word nie / sal te groot wees*
**OR/*OF***
I (current) cannot be made smaller /*I (stroom)kan nie verlaag word nie*
**Accept**:
Transformers do not use DC / Cannot be stepped-up or down /
***Aanvaar***:
*Transformators gebruik nie GS nie / Kan nie verhoog of verlaag nie* (1)

9.4 $f = \frac{1}{T} = \frac{1}{0,02}$ ✓ = 50 Hz ✓
**OR/*OF***
$f = \frac{\text{number of waves/cycles}}{\text{time}} = \frac{2}{0,04}$ ✓ = 50 Hz ✓ (2)

9.5 **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.*

Root-mean-square current is the alternating current that dissipates the same amount of energy as an equivalent DC current. ✓✓
*Die wortelgemiddeldekwadraat-stroom is die wisselstroom wat dieselfde hoeveelheid energie verbruik as 'n ekwivalente gelykstroom.* (2)

9.6 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$= \frac{1,2}{\sqrt{2}}$ ✓
= 0,85 A ✓ (3)

9.7 Speed of rotation halved / *Rotasiespoed halveer* ✓✓
Accept: Frequency was halved / Period was doubled /
*Aanvaar: Frekwensie halveer / periode verdubbel*
If speed of rotation slower / frequency decreases / period increased $^1/_2$
*Indien rotasiespoed stadiger / frekwensie verlaag / periode verhoog* : $^1/_2$ (2)
**[13]**

## QUESTION 10/*VRAAG 10*

10.1

**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 process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident/shining on that surface.✓✓
*Die proses waarmee elektrone vanaf 'n metaaloppervlak vrygestel word wanneer lig (van 'n geskikte frekwensie) invallend is/skyn op die oppervlak* (2)

10.2.1 Green/*Groen* ✓ (1)

10.2.2 Only green and blue light eject electrons / red light does not eject electrons.✓
Green has a lower frequency than blue / Green has longer wavelength than blue / Photons of blue light has more energy than photons of green light ✓
and therefore ejects electrons with the lower kinetic energy. /
$f_{green} < f_{blue}$ / blue has a higher frequency than green
*Slegs blou en groen lig stel elektrone vry / rooi lig stel nie elektrone vry nie*
*Groen lig het 'n laer frekwensie as blou lig / Groen het 'n langer golflengte as blou en stel dus elektrone / fotone van blou lig het meer energie as fotone van groen lig en stel elektrone met laer kinetiese energie vry / $f_{groen} < f_{blou}$ / blou het hoër frekwensie as groen* (2)

10.2.3

**OPTION 1/*OPSIE 1***

$E = W_0 + E_{k(max)}$
$hf = W_0 + E_{k(max)}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $= W_0 + 2,65 \times 10^{-20}$ ✓
$W_0 = 3,61 \times 10^{-19}$ J

$hf = W_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = 3,61 \times 10^{-19} + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓

**OPTION 2/*OPSIE 2***

$E = W_0 + E_{k(max)}$
$hf_1 - E_{k(max)1} = hf_2 - E_{k(max)2}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $- 2,65 \times 10^{-20}$ ✓ $= (6,63 \times 10^{-34})f_2 - 6,96 \times 10^{-20}$ ✓
$f_2 = 6,5 \times 10^{14}$ Hz ✓

**OPTION 3/*OPSIE 3***

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$ ✓ $= 6,63 \times 10^{-34} f_0 + 2,65 \times 10^{-20}$ ✓
$f_0 = 5,45 \times 10^{14}$ Hz

$hf = hf_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = (6,63 \times 10^{-34})(5,45 \times 10^{14}) + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓ (5)

10.2.4 Remains the same/*Bly dieselfde* ✓✓ (2)

10.3.1 (Line) emission spectrum/*(Lyn) emissiespektrum* ✓ (1)

10.3.2 Coloured lines represent (associated) frequencies/wavelengths/energy of the emitted (photons) ✓ when atoms / electrons move to a lower energy level ✓
*Gekleurde lyne verteenwoordig (geassosieerde) frekwensies/golflengtes/energie van die vrygestelde (fotone) wanneer atome/elektrone na 'n laer energievlak beweeg.* (2)
**[15]**

**TOTAL/*TOTAAL*: 150**