education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NASIONALE
SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

NOVEMBER/*NOVEMBER* 2009(1)

MEMORANDUM

PUNTE: 150

This memorandum consists of 21 pages.
Hierdie memorandum bestaan uit 21 bladsye.

Learning Outcomes and Assessment Standards ***Leeruitkomste en Assesseringstandaarde***		
LO1/*LU1*	**LO2/*LU2***	**LO3/*LU3***
AS12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. *Ontwerp, beplan en voer 'n wetenskaplike ondersoek uit om data te versamel ten opsigte van akkuraatheid, betroubaarheid en die kontroleer van veranderlikes.* **AS12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. *Soek patrone en tendense, stel dit in verskillende vorms voor, verduidelik die tendense, gebruik wetenskaplike beredenering om gevolgtrekkings te maak en te evalueer, en formuleer veralgemenings.* **AS12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. *Kies en gebruik geskikte probleemoplossingstrategieë om (ongesiene) probleme op te los.* **AS12.1.4:** Communicate and defend scientific arguments with clarity and precision. *Kommunikeer en verdedig wetenskaplike argumente duidelik en presies.*	**AS12.2.1:** Define, discuss and explain prescribed scientific knowledge. *Definieer, bespreek en verduidelik voorgeskrewe wetenskaplike kennis.* **AS12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in the candidate's own words. *Verduidelik en druk voorgeskrewe wetenskaplike beginsels, teorieë, modelle en wette uit deur die verwantskap tussen verskillende feite en konsepte in die kandidaat se eie woorde aan te dui.* **AS12.2.3:** Apply scientific knowledge in everyday-life contexts. *Pas wetenskaplike kennis in kontekste van die alledaagse lewe toe.*	**AS12.3.1** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims. *Doen navorsing, bespreek, vergelyk en evalueer wetenskaplike en inheemse kennissisteme en kennisaansprake deur die ooreenkoms tussen hulle aan te dui, en verduidelik die aanvaarding van verskillende aansprake.* **AS12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. *Vors gevallestudies na en bied etiese en morele argumente aan uit verskillende perspektiewe om die impak (voordele en nadele) van verskillende wetenskaplike en tegnologiese toepassings aan te dui.* **AS12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally. *Evalueer die impak van wetenskaplike en tegnologiese navorsing en dui die bydrae tot bestuur, benutting en ontwikkeling van bronne aan om volhoubaarheid kontinentaal en globaal te verseker.*

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 (gravitational) potential (energy) ✓
(gravitasionele) potensiële (energie) [12.2.1] (1)

1.2 watt / W ✓ [12.2.1] (1)

1.3 Coherent / coherence ✓
Koherent [12.2.1] (1)

1.4 gamma rays /-*strale* ✓

OR/*OF*
γ rays /γ -*strale* [12.2.1] (1)

1.5 Photons / *fotone* ✓

OR/*OF*
Quanta / *kwanta* [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 … is 9,8 $m \cdot s^{-2}$ at its maximum height. ✓✓
… is 9,8 $m \cdot s^{-2}$ by sy maksimum hoogte.

OR/*OF*
… the velocity is zero at its maximum height./… *die snelheid is nul by sy maksimum hoogte*. [12.2.1] (2)

2.2 … the **magnitude of the MOMENTUM** of the bullet is equal (opposite in direction) to the magnitude of the momentum of the gun. ✓✓
… die **grootte van die MOMENTUM** van die *koeël is gelyk (teenoorgesteld in rigting) aan die grootte van die momentum van die geweer.*

OR/OF
...the **MOMENTUM** of the bullet is **opposite in direction** to the momentum of the gun
... *die **MOMENTUM** van die koeël is **teenoorgesteld in rigting** aan die momentum van die geweer*

OR/OF
… the **MOMENTUM** of the bullet is equal to, but opposite in direction to the momentum of the gun.
*… die **MOMENTUM** van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die momentum van die geweer.*

OR/*OF*
…. the **CHANGE in MOMENTUM (impulse**) of the bullet is equal in magnitude (opposite in direction) to the change in momentum of the gun.
… die verandering in MOMENTUM van die koeël is gelyk in grootte (teenoorgesteld in rigting) aan die verandering in momentum van die geweer.

OR/*OF*
…. the **CHANGE in MOMENTUM (impulse**) of the bullet is equal to, but opposite in direction to the change in momentum of the gun.
*… die **VERANDERING in MOMENTUM** (**impuls**) van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die verandering in momentum van die geweer.*

OR/*OF*
... the **magnitude of the FORCE** that the bullet exerts on the gun is **equal** (opposite in direction) to the force that the gun exerts on the bullet.
*… die **grootte van die KRAG** wat die koeël op die geweer uitoefen is **gelyk** (teenoorgesteld in rigting) aan die krag wat die geweer op die koeël uitoefen.*

OR/*OF*
... the **FORCE** that the bullet exerts on the gun is **equal to, but opposite in direction** to the force that the gun exerts on the bullet.
*… die **KRAG** wat die koeël op die geweer uitoefen is **gelyk aan, maar teenoorgesteld in rigting,** aan die krag wat die geweer op die koeël uitoefen.* [12.2.3] (2)

2.3 … result of diffraction / interference ✓✓
… gevolg van diffraksie / interferensie

OR/*OF*
… by a triangular prism …
… deur 'n driehoekige prisma … [12.2.3] (2)

2.4 … different potential differences … ✓✓
… verskillende potensiaalverskille …

OR/*OF*
Identical resistors …
Identiese resistors …

OR/OF
Identical resistors …connected in parallel
Identiese resistors …in parallel geskakel

OR/OF
Non-identical resistors .....in parallel ....different current
Nie identiese resistors ... in parallel ... verskillende stroom [12.2.2] (2)

2.5 A line absorption spectrum … ✓✓
'n Lynabsorpsiespektrum …

OR/*OF*
… when electrons move from higher to lower energy levels.
… wanneer elektrone van hoër na laer energievlakke beweeg. [12.2.1] (2)
[10]

QUESTION 3/*VRAAG 3*

3.1 C ✓✓ [12.1.2] (2)

3.2 A ✓✓ [12.2.3] (2)

3.3 B ✓✓ [12.1.2] (2)

3.4 C ✓✓ [12.2.3] (2)

3.5 A ✓✓ [12.2.1] (2)
[10]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1

Option 1/*Opsie 1*
Statements not correct (or no) / *Stellings nie reg nie (of nee*) ✓

The bricks will experience the same (gravitational) acceleration / free fall ✓ and thus reach the ground at the same time. ✓

Die bakstene ondervind dieselfde (gravitasie) versnelling /vryval ✓*en bereik dus die grond gelyktydig.* ✓

Option 2/*Opsie 2*
Pete is correct or Alex is wrong / *Pete is reg of Alex is verkeerd* ✓

The smaller brick experiences less air resistance, thus larger acceleration ✓
and reaches the ground first. ✓

Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling ✓
en tref die grond eerste. ✓

Option 3/*Opsie 3*
Alex is correct or Pete is wrong / *Alex is reg of Pete is verkeerd* ✓

In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration ✓
and reaches the ground first ✓

In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa 'n groter netto afwaartse krag, dus grootste versnelling ✓
en *tref die grond eerste.* ✓

Option 4/*Opsie 4*
Both are correct / *Beide is reg* ✓

Pete correct: The smaller brick experiences less air resistance, thus larger acceleration and reaches the ground first. ✓
Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling en tref die grond eerste ✓

Alex correct: In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration and reaches the ground first ✓
In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa, 'n groter netto afwaartse krag, dus grootste versnelling en tref grond eerste. ✓

[12.2.3] (3)

4.2.1 Any two / *Enige twee:*

- Ensure that both bricks are dropped from same height
  Maak seker dat beide bakstene vanaf dieselfde hoogte laat val word
- Ensure that both bricks are dropped at the same time
  Maak seker dat beide bakstene gelyktydig laat val word

  OR/*OF*
  Ensure that the stopwatch starts at instant that each brick is released and stopped at the instant that each brick reaches the ground
  Maak seker dat die stophorlosie begin die oomblik as elk van die bakstene gelos word, en gestop word die oomblik as elke baksteen die grond bereik
- Repeat the experiment several times and use the average of the results
  Herhaal die eksperiment verskeie kere en gebruik die gemiddelde van die resultate
- Make sure that $v_i = 0$ for both bricks
  Maak seker dat $v_i = 0$ vir beide bakstene
- Make sure that there is no strong wind
  Maak seker dat daar geen sterk wind is nie
- Use bricks made of the same material / of same density
  Gebruik bakstene gemaak van dieselfde materiaal / met dieselfde digtheid [12.1.1] (2)

4.2.2 External force(s) may be present e.g. friction/air resistance / strong wind blowing
Eksterne krag(te) kan teenwoordig wees bv. wrywing / lugweerstand / sterk wind wat waai [12.1.1] (1)

4.3

Option 1/*Opsie 1*:

Downward direction positive / *Afwaartse rigting positief:*

A:

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

8 ✓ $= (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓

$\therefore \Delta t = 1,28$ s

B:

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

8 ✓ $= v_{iB}(1,28 - 0,6)$ ✓ $+ \frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓

$\therefore v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward motion negative / *Afwaartse beweging negatief:*

A:

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

-8 ✓ $= (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\therefore \Delta t = 1,28$ s

B:

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

-8 ✓ $= v_{iB}(1,28 - 0,6)$ ✓ $+ \frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓

$\therefore v_{iB} = -8,43\ m\cdot s^{-1}$

$\therefore v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 2/*Opsie 2*:

Downward direction positive / *Afwaartse rigting positief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(9,8)(8)$ ✓ $\therefore v_f = 12,52\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ $\therefore 12,52 = 0 + (9,8)\Delta t$ ✓ $\therefore \Delta t = 1,28$ s

B:

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

8 ✓ $= v_{iB}(1,28 - 0,6)$ ✓ $+ \frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓

$\therefore v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward direction negative / *Afwaartse rigting negatief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(-9,8)(-8)$ ✓ $\therefore v_f = -12,52\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ $\therefore -12,52 = 0 + (-9,8)\Delta t$ ✓ $\therefore \Delta t = 1,28$ s

B:

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

-8 ✓ $= v_{iB}(1,28 - 0,6)$ ✓ $+ \frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓

$\therefore v_{iB} = -8,43\ m\cdot s^{-1}$

$\therefore v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 3/*Opsie 3*:

Downward direction positive / *Afwaartse rigting positief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ = $0^2 + 2(9,8)(8)$ ✓ ∴ $v_f = 12,52\ m\cdot s^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ∴ $8 = \frac{(0+12,52)}{2}\Delta t$ ✓ ∴ $\Delta t = 1,28\ s$

B:

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

8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓

∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward direction negative / *Afwaartse rigting negatief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ = $0^2 + 2(-9,8)(-8)$ ✓ ∴ $v_f = -12,52\ m\cdot s^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ∴ $8 = \frac{(0-12,52)}{2}\Delta t$ ✓ ∴ $\Delta t = 1,28\ s$

B:

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

8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓

∴ $v_{iB} = -8,43\ m\cdot s^{-1}$

∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 4/*Opsie 4*:

A:

$W_{net} = \Delta K$

$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$m(9,8)(8) = \frac{1}{2}mv_f^2 - 0$ ✓

∴ $v_f = 12,52\ m\cdot s^{-1}$

A:

$(U + K)_i = (U + K)_f$

$mgh + 0 = 0 + \frac{1}{2}mv_f^2$

$m(9,8)(8) + 0 = 0 + \frac{1}{2}mv_f^2$ ✓

∴ $v_f = 12,52\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ ∴ $12,52 = 0 + (9,8)\Delta t$ ✓

∴ $\Delta t = 1,28\ s$

B:

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

8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓

∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

[12.1.3] (7)

[13]

QUESTION 5/*VRAAG 5*

5.1

Option 1/*Opsie 1*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$-30 = (3)a$ ✓
$\therefore a = -10\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= (7)^2$ ✓ $+ 2(-10)(2)$ ✓
$\therefore v_f = 3\ m\cdot s^{-1}$

Option 2/*Opsie 2*:

$W_{net} = \Delta K$ ✓ or/*of* ΔE_k
$F\Delta x\cos\theta$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(30)(2)\cos180°$ ✓ $= \frac{1}{2}(3)v_f^2$ ✓ $- \frac{1}{2}(3)(7)^2$ ✓
$-60 = 1{,}5v_f^2 - 73{,}5 \therefore v_f = 3\ m\cdot s^{-1}$

Option 3/*Opsie 3*:

$W_{appl} = \Delta U + \Delta K - W_f$ **Max./*Maks.*:** $^4/_5$

$0 = 0 + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) - F\Delta x\cos\theta$ ✓
$0 = 0 + \frac{1}{2}(3)v_f^2$ ✓ $- \frac{1}{2}(3)(7)^2$ ✓ $- (30)(2)\cos180°$ ✓
$0 = 1{,}5v_f^2 - 73{,}5 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

$W_{appl} = \Delta U + \Delta K + W_f$ $^0/_5$

Option 4 / *Opsie 4*:

$(U + K)_i + W_f = (U + K)_f$ **Max./*Maks.*:** $^4/_5$

$(0 + \frac{1}{2}mv_i^2) + F\Delta x\cos\theta$ ✓ $= 0 + \frac{1}{2}mv_f^2$
$0 + \frac{1}{2}(3)(7)^2$ ✓ $+ 30(2)\cos180°$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓
$73{,}5 - 60 = 1{,}5v_f^2 \therefore v_f = 3\ m\cdot s^{-1}$

$(U + K)_i - W_f = (U + K)_f$ $^0/_5$

Option 5 / *Opsie 5*:

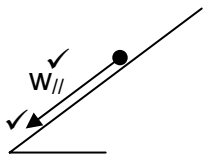
$(U + K)_i = (U + K)_f - W_f$ **Max./*Maks.*:** $^4/_5$

$(0 + \frac{1}{2}mv_i^2) = 0 + \frac{1}{2}mv_f^2 - F\Delta x\cos\theta$ ✓
$0 + \frac{1}{2}(3)(7)^2$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓ $- 30(2)\cos180°$ ✓
$73{,}5 = 1{,}5v_f^2 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

$(U + K)_i = (U + K)_f + W_f$ $^0/_5$

[12.1.3] (5)

5.2



Any one of the following labels / *Enige een van volgende benoemings:*

- $w_{parallel}$ or/of $w_{//}$
- $F_{g(parallel)}$ or/of $F_{g//}$
- mgsin20°
- Component of weight parallel to incline / *komponent van gewig parallel aan skuinste*

Checklist / *kontrolelys* Free-body diagram / *vrye kragtediagram*	
Direction of force indicated as parallel to and down incline (not needed to show incline) *Rigting van krag getoon as parallel aan en afwaarts teen skuinste (skuinste hoef nie getoon te word nie)*	✓
Correct label / korrekte benoeming	✓

[12.1.2] (2)

5.3

Option 1/*Opsie 1*:

$(U + K)_i = (U + K)_f$ ✓
$0 + \frac{1}{2}mv_i^2 = mgh + 0$
$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓
$\therefore$ h = 0,46 m

$\sin 20° = \frac{h}{d}$ ✓ $= \frac{0,46}{d}$ $\therefore$ d = 1,34 m ✓

As single step/*As een stap:*
$(U + K)_i = (U + K)_f$ ✓
$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓
$\frac{1}{2}(3)(3)^2 = (3)(9,8)(d\sin 20°)$ ✓
$\therefore$ d = 1,34 m ✓

Option 2/*Opsie 2*:

$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)
$F_{g//}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(3)(9,8)\sin 20°$ ✓ $(d)\cos 180°$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓
$-10,06d = -13,5$ $\therefore$ d = 1,34 m ✓

Option 3/*Opsie 3*:

$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)
$W_{gravity} = K_f - K_i$
$mgh\cos 180°$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(3)(9,8)h(-1)$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓ $\therefore$ h = 0,46 m

$\sin 20° = \frac{h}{d}$ ✓ $= \frac{0,46}{d}$ $\therefore$ d = 1,34 m ✓

Option 4 / *Opsie 4*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$mg\sin20° = ma$
$-(3)(9,8)\sin20° = 3a$ ✓ $\therefore a = -3,35\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = (3)^2 + 2(-3,35)(d)$ ✓

$\therefore d = 1,34\ m$ ✓

[12.1.3] (5)
[12]

QUESTION 6 / *VRAAG 6*

6.1 $m_m v_{im} + m_b v_{bi} = (m_m + m_b)v_f$ ✓

$(87)v_{im} + 0$ ✓ $= (87 + 22)(2,4)$ ✓

$v_{im} = 3,01\ m\cdot s^{-1}$ ✓ [12.2.3] (4)

6.2

Option 1/*Opsie 1:*
K(before/*voor*) $= ½mv^2$ ✓
$= ½(87)(3,01)^2 + 0$ ✓
$= 394,11$ J ✓
$= (391,5$ if $3\ m\cdot s^{-1})$

K(after/*na*) $= ½mv^2$
$= ½(109)(2,4)^2$ ✓
$= 313,92$ J ✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

Option 2/*Opsie 2:*
ΔK = K(after/*na*) - K(before/*voor*)
$= ½mv^2$(after/*na*) - $½mv^2$(before/*voor*) ✓
$= ½(109)(2,4)^2$ ✓ – $(½(87)(3,01)^2 + 0)$ ✓
$= 313,92 - 394,11$
$= -80,19$ J ✓✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

[12.2.3] (6)

6.3

Option 1 / *Opsie 1*:

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta$ ✓ $= ½m(v_f^2 - v_i^2)$
$F_{net}(2)(-1)$ ✓ $= ½(87 + 22)(0^2 - 2,4^2)$ ✓

$\therefore F_{net} = 156,96$ N ✓
If/*indien* – 156,96 N: minus 1

Option 2 / *Opsie 2*:

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = 2,4^2 + 2a(2)$ ✓ $\therefore a = -1,44$ m·s^{-2}

$F_{net} = ma$ ✓ $= (87 + 22)(-1,44)$ ✓ $= -156,96$ N

$\therefore F_{net} = 156,96$ N ✓

Option 3 / *Opsie 3*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = \left(\frac{0 + 2,4}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 1,67$ s

$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓
$F_{net}(1,67) = (87 + 22)(0 - 2,4)$ ✓

$\therefore F_{net} = -156,65$ N $\therefore F_{net} = 156,65$ N ✓

Option 4 / *Opsie 4*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = \left(\frac{0 + 2,4}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 1,67$ s

$v_f = v_i + a\Delta t \therefore 0 = 2,4 + a(1,67) \therefore a = -1,44$ m·s^{-2}

$F_{net} = ma$ ✓ $= (87 + 22)(-1,44)$ ✓ $= -156,96$ N

$\therefore F_{net} = 156,96$ N ✓

[12.2.3] (5)
[15]

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*

$U = \frac{kQ_1Q_2}{r}$ ✓

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

$\therefore$ 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)

11.2

Option 1 / *Opsie 1*:

Emf = IR + Ir ✓
9 ✓= 3(3R) ✓ + 3(0,3) ✓

$\therefore R = R_1 = \frac{9-0,9}{9} = 0,9\ \Omega$ ✓

Option 2 / *Opsie 2*:

Emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$V_{ext} = I(R_1 + R_2)$
8,1 = 3(3R) ✓ ∴ R_1 = 0,9 Ω ✓

Option 3 / *Opsie 3*:

emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$\therefore V_1 = \frac{8,1}{3} = 2,7$ V ($R_1 + R_2 = 3R$)

$R_1 = \frac{V_1}{I} = \frac{2,7}{3}$ ✓ = 0,9 Ω ✓

Option 4 / *Opsie 4*:

$R_t = \frac{V}{I}$ ✓ $= \frac{9}{3}$ ✓ = 3 Ω

$R_2 + R_1$ = 3 – 0,3 ✓ = 2,7 Ω = 3R

$\therefore R_1 = R = \frac{2,7}{3}$ ✓ = 0,9 Ω ✓

Option 5 / *Opsie 5*:

V_{int} = Ir ✓ = (3)(0,3) ✓ = 0,9 V

V_{ext} = 9✓ – 0,9 = = 8,1 V

$V_1 = IR_1 \therefore V_1 = 3R$
$V_{R2} = IR_2 \therefore V_{R2} = 3(2R) = 6R$

$V_1 + V_{R2} = 3R + 6R = 9R$
∴ 8,1 = 9R ✓ ∴ R = 0,9 Ω ✓

[12.1.3] (5)

11.3.1 Decreases / *Verminder* ✓ [12.2.2] (1)

11.3.2 Increases / *Vermeerder* ✓
Resistance decreases / *Weerstand verminder* ✓
Current increases / *Stroom vermeerder* ✓
Ir increases / *Ir vermeerder*

OR/*OF*
Increases / *Vermeerder* ✓
Current passes through wire QN / wire QN shorts the parallel combination of resistors R_2 and R_3 ✓
All the current passes through R_1 and also through battery, thus Ir increases ✓
Die stroom gaan deur draad QN / draad QN veroorsaak 'n kortsluiting van die parallelle kombinasie resistors R_2 en R_3
Al die stroom gaan deur R_1 en deur die battery, dus verhoog Ir [12.2.2] (3)

[11]

QUESTION 12/*VRAAG 12*

12.1.1 $I_{rms} = \frac{V_{rms}}{R}$ ✓ = $\frac{36}{12}$ ✓ = 3 A✓

OR/*OF*
$V_{4\,\Omega} + V_{8\,\Omega}$ = 36 V and/en $V_{4\,\Omega}:V_{8\,\Omega}$ = 1:2
$\therefore$ $V_{4\,\Omega}$ = 12 V
$I_{4\,\Omega} = \frac{V}{R}$ ✓ = $\frac{12}{4}$ ✓ = 3 A ✓ [12.2..3] (3)

12.1.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$\therefore$ 3 = $\frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max}$ = 4,24 A ✓ [12.2.3] (3)

12.1.3 $P_{ave} = I^2_{rms}R$ ✓ = $(3)^2(4)$ ✓ = 36 W✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = V_{rms}I_{rms}$ ✓ = (12)(3) ✓ = 36 W ✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = \frac{V^2_{rms}}{R}$ ✓ = $\frac{12^2}{4}$ ✓ = 36 W ✓ [12.2.3] (3)

12.2 $P_{4\,\Omega}$ = ½ P_8 or $P_{8\,\Omega}$ = 2 $P_{4\,\Omega}$ or /*of*
Smaller / *Kleiner* ✓($P_{4\,\Omega} < P_{8\,\Omega}$) or/*of* $P_{8\,\Omega} > P_{4\,\Omega}$)

$P_{ave} = I^2_{rms}R$, but since
I_{rms} is constant / *omdat* I_{wgk} *konstant is*✓
$P \alpha R$ ✓

OR/*OF*
$P_{4\,\Omega}$ = ½ P_8 or $P_{8\,\Omega}$ = 2 $P_{4\,\Omega}$ or /*of*
Smaller / *Kleiner* ✓

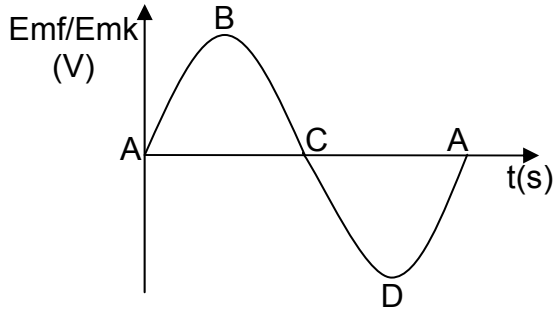
$P_{ave} = V_{rms}I_{rms}$, since
I_{rms} is constant / *omdat* I_{wgk} *konstant is* ✓
$P_{ave} \alpha V$ ✓ [12.2.2] (3)
[12]

QUESTION 13 / *VRAAG 13*

13.1 Electromagnetic induction / Faraday's law ✓
Elektromagnetiese induksie / Faraday se wet [12.2.1] (1)

13.2 Provides a (sliding) contact (between coil and conducting wires) ✓/ Ensures free rotation
Verskaf 'n (glyende) kontak (tussen die spoel en die geleidende drade)/ Verseker dat spoel vrylik roteer [12.2.1] (1)

13.3



Checklist / *Kontrolelys* Criteria for graph / *Kriteria vir grafiek*	Marks/ *Punte*
Correct shape **with full cycle (ignore if more than one cycle shown** / *Korrekte vorm **met volle siklus (ignoreer indien meer as een siklus getoon word)***	✓✓
Points A, B, C and D correctly indicated/Punte A, B, C en D korrek aangedui,	✓

[12.1.2] (3)

13.4 Increase the speed at which the coil rotates ✓
Verhoog die spoed waarteen die spoel roteer [12.2.3] (1)

13.5 (Splitring) commutator ✓
(Splitring)kommutator [12.2.3] (1)
[7]

QUESTION 14/*VRAAG 14*

14.1 Photoelectric effect / *Foto-elektriese effek* ✓ [12.2.1] (1)

14.2 The minimum energy of light needed to emit (photo)electrons from a metal ✓✓
Die minimum energie benodig deur lig om (foto-)elektrone uit 'n metaal vry te stel [12.2.1] (2)

14.3

Option 1 / *Opsie 1*:

$E/hf = \frac{hc}{\lambda}$ ✓ $= \frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ $= 3{,}58 \times 10^{-19}$ J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ $3{,}58 \times 10^{-19} = W_0 + 0$ ✓

∴ $W_0 = 3{,}58 \times 10^{-19}$ J ✓

Option 2 / *Opsie 2*:

$hf = W_0 + \frac{1}{2}mv^2$ ✓

$\frac{hc}{\lambda}$ ✓$= W_0 + \frac{1}{2}mv^2$

$\frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ $= W_0 + 0$ ✓

∴ $W_0 = 3{,}58 \times 10^{-19}$ J ✓

Option 3 / *Opsie 3*:

$f = \frac{c}{\lambda} = \frac{3\times10^{8}}{555\times10^{-9}}$ ✓ $= 5{,}41 \times 10^{14}$ Hz

$E = hf = (6{,}63 \times 10^{-34})(5{,}41 \times 10^{14})$ ✓$= 3{,}59 \times 10^{-19}$ J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ $3{,}59 \times 10^{-19} = W_0 + 0$ ✓

∴ $W_0 = 3{,}59 \times 10^{-19}$ J ✓

Option 4 / *Opsie 4*:

$W_0 = hf_0$ ✓✓ $= \frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ $= 3{,}58 \times 10^{-19}$ J ✓

[12.1.3] (6)

14.4 Increases / *Vermeerder* ✓

With light of higher intensity more photons strikes the metal surface per second / *Met lig van hoër intensiteit tref meer fotone die metaaloppervlak per sekonde* ✓

Thus more (photo)electrons are emitted per second, ✓resulting in a bigger current./ *Dus word meer (foto-)elektrone per sekonde vrygestel wat 'n hoër stroom tot gevolg het.* [12.2.2] (3)

14.5 Decreases / *Verminder* ✓ [12.2.2] (1)

[13]

TOTAL SECTION B / *TOTAAL AFDELING B:* 125
GRAND TOTAL / *GROOTTOTAAL:* 150