education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NASIONALE
SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

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MEMORANDUM

PUNTE: 150

This memorandum consists of 19 pages.
Hierdie memorandum bestaan uit 19 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.*

GENERAL GUIDELINES/*ALGEMENE RIGLYNE*

1. CALCULATIONS/*BEREKENINGE*

1.1 Marks will be awarded for: correct formula, correct substitution, correct answer with unit.
Punte sal toegeken word vir: korrekte formule, korrekte substitusie, korrekte antwoord met eenheid.

1.2 No marks will be awarded if an incorrect or inappropriate formula is used, even though there may be relevant symbols and applicable substitutions.
Geen punte sal toegeken word waar 'n verkeerde of ontoepaslike formule gebruik word nie, selfs al is daar relevante simbole en relevante substitusies.

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
*Wanneer 'n fout gedurende **substitusie in 'n korrekte formule** begaan word, sal 'n punt vir die korrekte formule en vir korrekte substitusies toegeken word, maar **geen verdere punte** sal toegeken word nie.*

1.4 If no formula is given, but all substitutions are correct, a candidate will forfeit one mark.
Indien geen formule gegee is nie, maar al die substitusies is korrek, verloor die kandidaat een punt.

1.5 No marks will be awarded if no formula is given, but correct substitutions OMITTING ZERO SUBSTITUTIONS, are given.
Geen punte sal toegeken word indien 'n kandidaat geen formule gee nie, maar korrek substitueer met WEGLATING VAN NULWAARDES.

1.6 No penalisation if zero substitutions are omitted in calculations where correct formula/principles are given.
Geen penalisering indien nulwaardes nie getoon word nie in berekeninge waar die formule/beginsels korrek gegee is.

1.7 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
Wiskundige manipulasies en verandering van die onderwerp van toepaslike formules tel geen punte nie, maar indien 'n kandidaat met die korrekte formule begin en dan die onderwerp van die formule verkeerd verander, sal punte vir die formule en korrekte substitusies toegeken word. Die punt vir die verkeerde numeriese antwoord word verbeur.

1.8 Marks are only awarded for a formula if a calculation had been **attempted**, i.e. substitutions have been made or a numerical answer given.
*Punte word slegs vir 'n formule toegeken indien 'n **poging** tot 'n berekening aangewend is, d.w.s. substitusies is gedoen of 'n numeriese antwoord is gegee.*

1.9   Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
Punte kan slegs toegeken word vir substitusies wanneer waardes in formules vervang is en nie vir waardes wat voor 'n berekening gelys is nie.

1.10   All calculations, when not specified in the question, must be done to two decimal places.
Alle berekenings, wanneer dit nie in die vraag gespesifiseer word nie, moet tot twee desimale plekke gedoen word.

2.   DEFINITIONS/*DEFINISIES*

Two marks will be awarded for a correct definition. No marks will be awarded for an incorrect or partially correct definition.
Twee punte sal vir 'n korrekte definisie toegeken word. Geen punte sal vir 'n verkeerde of gedeeltelik korrekte definisie toegeken word nie.

3.   UNITS/*EENHEDE*

3.1   Candidates will only be penalised once for the repeated use of an incorrect unit **within a question or subquestion**.
*Kandidate sal slegs een keer gepenaliseer word vir die herhaaldelike gebruik van 'n verkeerde eenheid **in 'n vraag of subvraag**.*

3.2   Units are only required in the final answer to a calculation.
Eenhede word slegs in die finale antwoord op 'n berekening verlang.

3.3   Marks are only awarded for an answer, and not for a unit. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit
Punte word slegs vir 'n antwoord toegeken en nie vir 'n eenheid nie. Kandidate sal derhalwe die punt vir die antwoord in die volgende gevalle verbeur:
- Korrekte antwoord + verkeerde eenheid
- Verkeerde antwoord + korrekte eenheid
- Korrekte antwoord + geen eenheid nie

3.4   SI units must be used, except in certain cases, e.g. $V{\cdot}m^{-1}$ instead of $N{\cdot}C^{-1}$, and $cm{\cdot}s^{-1}$ or $km{\cdot}h^{-1}$ instead of $m{\cdot}s^{-1}$ where the question warrants this.
SI-eenhede moet gebruik word, behalwe in sekere gevalle, bv. $V{\cdot}m^{-1}$ in plaas van $N{\cdot}C^{-1}$, en $cm{\cdot}s^{-1}$ of $km{\cdot}h^{-1}$ in plaas van $m{\cdot}s^{-1}$ waar die vraag dit regverdig.

4.   GENERAL/*ALGEMEEN*

4.1   If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.

4.2   For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted
Vir nasiendoeleindes sal alternatiewe simbole (s, u, t, ens.) ook aanvaar word.

4.3   Separate compound units with a multiplication dot, not a full stop, for example, $m \cdot s^{-1}$. For marking purposes $m.s^{-1}$ will also be accepted.
Skei saamgestelde eenhede met 'n vermenigvuldigpunt en nie met 'n punt nie, byvoorbeeld $m \cdot s^{-1}$. Vir nasiendoeleindes sal $m.s^{-1}$ ook aanvaar word.

5.   POSITIVE MARKING/POSITIEWE NASIEN

Positive marking regarding calculations will be followed in the following cases:
Positiewe nasien met betrekking tot berekenings sal in die volgende gevalle geld:

5.1   **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent subquestions.
Subvraag na subvraag: *Wanneer 'n sekere veranderlike in een subvraag (bv. 3.1) bereken word en dan in 'n ander vervang moet word (3.2 of 3.3), bv. indien die antwoord vir 3.1 verkeerd is en korrek in 3.2 of 3.3 vervang word, word **volpunte** aan die daaropvolgende subvrae toegeken.*

5.2   **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.
'n Vraag met veelvuldige stappe in 'n subvraag: *Indien 'n kandidaat byvoorbeeld die stroom verkeerd bereken in 'n eerste stap as gevolg van 'n substitusiefout, verloor die kandidaat die punt vir die substitusie sowel as die finale antwoord.*

5.3   If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
Indien 'n finale antwoord tot 'n berekening korrek is, sal volpunte nie outomaties toegeken word nie. Nasieners sal altyd verseker dat die korrekte/toepaslike formule gebruik word en dat bewerkings, insluitend substitusies, korrek is.

5.4   Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded, provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.
Vrae waar 'n reeks berekenings gedoen moet word (bv. 'n stroomdiagramvraag) hoef nie noodwendig dieselfde volgorde te hê nie. VOLPUNTE sal toegeken word op voorwaarde dat dit 'n geldige oplossing vir die probleem is. Enige berekening wat egter nie die kandidaat nader as die oorspronklike data aan die antwoord bring nie, sal geen punte tel nie.

5.5 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.

5.6 Normally, if based on a conceptual mistake, an incorrect answer cannot be correctly motivated. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for 3.1. is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.
'n Verkeerde antwoord, indien dit op 'n konsepsuele fout gebaseer is, kan normaalweg nie korrek gemotiveer word nie. Indien 'n kandidaat gevra word om in VRAAG 3.2 die antwoord op VRAAG 3.1 te motiveer en 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op 3.1 egter op 'n berekening gebaseer is, kan die motivering vir die verkeerde antwoord in 3.2 oorweeg word.

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* ✓   [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·s^{-2} at its maximum height./constant downwards …✓✓

       … is 9,8 m·s^{-2} by sy maksimum hoogte./konstant afwaarts …

       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 momentum of the bullet is equal in magnitude but opposite in
       direction to the momentum of the gun.
       … die momentum van die koeël gelyk in grootte maar teenoorgesteld
       in rigting aan die momentum van die geweer.

       OR/*OF*
       …. the change in momentum of the bullet is the same as the change in
       momentum of the gun ✓✓
       … die verandering in momentum van die koeël dieselfde as die
       verandering in momentum van die geweer.

       OR/*OF*
       ... the magnitude of the force that the bullet exerts on the gun is the
       same as the magnitude of the force that the gun exerts on the bullet.
       … die grootte van die krag wat die koeël op die geweer uitoefen
       dieselfde as die grootte van 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 …   [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 No/*Nee* ✓
All falling objects experience the same acceleration ✓ (in the absence
of air friction) and thus reach the ground at the same time. ✓
Alle vallende voorwerpe ondervind dieselfde versnelling (in die
afwesigheid van lugwrywing) en bereik dus die grond gelyktydig. [12.2.3] (3)

4.2.1 Drop from same height/*Laat val van dieselfde hoogte* ✓
Drop both at same time/*Laat val beide op dieselfde tyd (gelyktydig)* ✓ [12.1.1] (2)

4.2.2 Friction is not absent/*Wrywing is nie afwesig nie.* ✓ [12.1.1] (1)

4.3 $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓

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

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

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

8 ✓ $= v_i(1,28 - 0,6)$ ✓ $+ \frac{1}{2} (9,8)(1,28 - 0,60)^2$ ✓

$\therefore v_i = 8,43$ ms^{-1} ✓ [12.1.3] (7)

> Accept/*Aanvaar*:
> $s = ut + \frac{1}{2} at^2$
>
> Accept/*Aanvaar*:
> Δx

[13]

QUESTION 5/*VRAAG 5*

5.1 $F_{net} = ma$ ✓
        $-30 = (3)a$ ✓
        $a = -10$ m·s^{-2}

        $v_f^2 = v_i^2 + 2a\Delta x$ ✓
        $v_f^2 = (7)^2$ ✓ $+ 2(-10)(2)$ ✓
        $v_f = 3$ m·s^{-1} [12.1.3]   (5)

5.2

$W_{parallel}$
OR/*OF* mgsin20°
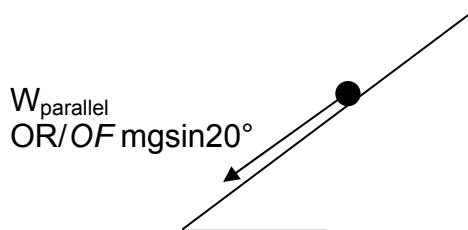
Checklist/*Kontrolelys*	
Criteria for free-body diagram/ *Kriteria vir vryliggaamdiagram:*	Mark *Punt*
Direction of force correctly indicated/ *Rigting van krag korrek aangedui*	✓
Correct label/ *Korrek benoem*	✓

                                                                [12.1.2]   (2)

5.3   Option 1/*Opsie 1*:
        $(U + K)top = (U + K)bottom$ ✓
        $(3)(9,8)h + 0$ ✓ $= 0 + \frac{1}{2}(3)(3)^2$ ✓
        $(3)(9,8)dsin20°$ ✓ $= \frac{1}{2}(3)(3)^2$ (h = dsin 20°)
        $\therefore d = 1,34$ m ✓

E_p(top/*bo*) = E_k(bottom/*onder*)
U(top/*bo*) = K (bottom/*onder*)
Max./*Maks.* $\frac{1}{5}$ for h = dsin 20°

Any one as formula:
Enige een as formule:
$E_{mech(i)} = E_{mech(f)}$
$(E_p + E_k)_i = (E_p + E_k)_f$
$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$
$(U + K)_i = (U + K)_f$
$\Delta E_p = \Delta E_k$
$\Delta U = \Delta K$

        Option 2/*Opsie 2*:
        $W_{net} = \Delta K$ ✓

        $W_{gravity} = K_f - K_i$
        $mgh = 0 - \frac{1}{2}mv^2$
        $(3)(9,8)h$ ✓ $= \frac{1}{2}(3)(3)^2$ ✓
        $(3)(9,8)dsin20°$ ✓ $= \frac{1}{2}(3)(3)^2$ (h = dsin20°)
        $\therefore d = 1,34$ m ✓

        Option 3/*Opsie 3*:
        $F_{net} = ma$ ✓ $v_f^2 = v_i^2 + 2a\Delta x$ ✓
        mgsin20° = (3)a ✓ $0^2 = (3)^2 + 2(3,35)\Delta x$ ✓
        $a = -3,35$ m·s^{-2} $\Delta x = 1,34$ m ✓   [12.1.3]   (5)

                                                                             [12]

QUESTION 6/*VRAAG 6*

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

$(87)v_{im} + 0$ ✓ $= (109)(2,4)$ ✓	Any one as formula: *Enige een as formule:* $\Sigma m_i v_i = \Sigma m_f v_f$ $\Sigma p_{before/voor} = \Sigma p_{after/na}$ $m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$ $m_1 v_{i1} + m_2 v_{i2} = (m_1 + m_2)v_f$ Accept/*Aanvaar:* $p_{before} = p_{after}$ $p_i = p_f$

$v_{im} = 3,01 \text{ m·s}^{-1}$ ✓

[12.2.3]   (4)

6.2   K(before/*voor*) $= \frac{1}{2}mv^2$ ✓
                        $= (7)(3,01)^2 + 0$ ✓
                        $= 394,11 \text{ J}$ ✓

K(after/*na*) $= \frac{1}{2}mv^2$
                        $= \frac{1}{2}(109)(2,4)^2$ ✓
                        $= 313,92 \text{ J}$ ✓

K is not conserved – collision is inelastic ✓
K bly nie behoue nie – botsing is nie-elasties

[12.2.3]   (6)

6.3

Option 1/*Opsie 1*:
$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x \cos\theta$ ✓ $= \frac{1}{2}m(v_f^2 - v_i^2)$
$-F_{net}(2)$ ✓ $= \frac{1}{2}(87 + 22)(0^2 - 2,4^2)$ ✓
$\therefore F_{net} = 156,96 \text{ N}$ ✓

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

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

Option 3/*Opsie 3*:
$\Delta x = \left(\dfrac{v_f + v_i}{2}\right)\Delta t \ \therefore 2 = \left(\dfrac{0 + 2,4}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 1,67 \text{ s}$

$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓
$F_{net}(1,67) = (87 + 22)(0 - 2,4)$ ✓
$\therefore F_{net} = -156,96 \text{ N}$
$\therefore F_{net} = 156,96 \text{ N}$ ✓

> Option 4/*Opsie 4*:
>
> $\Delta x = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$ $\therefore$ 2 = $(\dfrac{0+2,4}{2})\Delta t$ ✓ $\therefore \Delta t = 1,67$ s
>
> $v_f = v_i + a\Delta t \therefore 0 = 2,4 + a(1,67)$ ✓ $\therefore a = -1,44$ m·s^{-2}
>
> $F_{net} = f = ma$ ✓ $= (87 + 22)(-1,44)$ ✓
> $\therefore F_{net} = -156,96$ 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
        <u>waves in front of the source is compressed</u> ✓
        <u>resulting in a shorter wavelength</u> ✓, thus a higher frequency.
        Wanneer die bron 'n stilstaande waarnemer nader,
        word <u>golwe voor die bron saamgepers</u>
        <u>wat 'n korter golflengte tot gevolg het</u> en dus 'n hoër frekwensie lei.   [12.2.2]   (2)

7.3 $f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \dfrac{v}{v - v_s} f_s$ ✓

        Fire brigade approaching/*Brandweerwa nader*:

        $\therefore$ 450 ✓ $= (\dfrac{340}{340 - 20})f_s$ ✓

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

                                                                         [7]

QUESTION 8/*VRAAG 8*

8.1   Chemical substance/fine particles that selectively absorb(s) light of certain frequencies and selectively transmits/reflects others. ✓✓

Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

'*n Chemiese stof/fyn deeltjies wat selektief lig van sekere frekwensies absorbeer en ander 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   Yellow light/*Geel lig* ✓
Cyan paint will <u>reflect only the green light</u> ✓ (in yellow light) and will <u>absorb the red light</u> ✓ (in yellow light and thus appear green in yellow light.)
Siaanverf sal <u>slegs groen lig weerkaats</u> (in geel lig) en <u>die rooi lig absorbeer</u> (in geel lig en dus groen vertoon in geel lig.)   [12.2.3]   (3)

[10]

QUESTION 9/*VRAAG 9*

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

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

9.2.2   Each point on a wave front moving through the single slit acts as a source of wave fronts that spreads out on the other side of the slit. Dark bands form where wave fronts interfere destructively. ✓
Red bands form where wave fronts interfere constructively. ✓

Elke punt op 'n golffront wat deur die enkelspleet beweeg, dien as 'n bron van golffronte wat aan die ander kant van die spleet uitsprei. Donker bande vorm waar golffronte destruktiewe interferensie ondergaan.
Rooi/helder bande vorm waar golffronte konstruktiewe interferensie ondergaan.   [12.1.4]   (2)

9.2.3   Diffraction is inversely proportional to the slit width ✓✓
Diffraksie is omgekeerd eweredig aan die spleetwydte

OR/*OF*
The amount of diffraction increases with decreasing slit width.
Mate van diffraksie neem toe met afname in spleetwydte   [12.1.4]   (2)

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

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

QUESTION 10/*VRAAG 10*

10.1

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

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

F = -1,35 N
∴F = 1,35 N ✓ (attractive/*aantrekkend*)   [12.2.3]   (4)
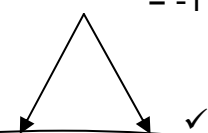
10.2   *four /vier* (4) ✓   [12.2.2]   (1)

10.3

$$E(6\ \mu C) = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9\times10^9)(6\times10^{-6})}{(0,2)^2 \checkmark} \overset{\checkmark}{} = 1,35 \times 10^6\ \text{N·C}^{-1} \text{ to the left/}\textit{na links}$$

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

$$= \frac{(9\times10^9)(4\times10^{-6})}{(0,6)^2 \checkmark} \overset{\checkmark}{} = 1 \times 10^5\ \text{N·C}^{-1} \text{ to the right/}\textit{na regs}$$

F(net/*netto*) = 1.25 × 10⁶ N·C⁻¹ to the left/*na links* ✓   [12.1.3]   (6)

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

= -1 × 10⁻⁶ C

$$U = \frac{kQ_1Q_2}{r} \checkmark$$

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

∴ U = 0,0225 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 ✓
*Potensiaalverskil gemeet wanneer die skakelaar oop is/geen stroom
vloei nie/stroombaan oop is*   [12.2.2]   (2)

11.2

Option 1/*Opsie 1*:
$V_{terminal}$ = emf – Ir = 9 – (3)(0,3) ✓ = 8,1 V

$R_1 = \frac{1}{2} R_2$ (ratio)

$\therefore V_1 = \frac{8,1}{3}$ ✓ = 2,7 V

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

Option 2/*Opsie 2*:
$R_t = \frac{V}{I}$ ✓ = $\frac{9}{3}$ ✓ = 3 Ω

$R_2 + R_1 = 3 - 0,3$ ✓ = 2,7 Ω

$R_2 = 2R_1$ (ratio)

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

Option 3/*Opsie 3*:
$V_{external}$ = emf – Ir ✓ = 9 – (3)(0,3) ✓ = 8,1 V

$V_{ext} = I(R_1 + R_2)$
8,1 = 3 ✓$(R_1 + 2R_1)$ ✓
$R_1 = 0,9$ Ω ✓

[12.1.3]   (5)

11.3.1   Decreases/*afneem* ✓   [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 $I_{rms} = \dfrac{V_{rms}}{R}$ ✓ $= \dfrac{36}{12}$ ✓ $= 3\text{ A}$✓

                                                                         [12.2..3]   (3)

12.1.2 $I_{rms} = \dfrac{I_{max}}{\sqrt{2}}$ ✓

         $3 = \dfrac{I_{max}}{\sqrt{2}}$ ✓

         $I_{max} = 4{,}24\text{ A}$ ✓   [12.2.3]   (3)

12.1.3 $P_{ave} = I^2_{rms}R$ ✓ $= (3)^2(4)$ ✓ $= 36\text{ W}$✓   [12.2.3]   (3)

12.2   Smaller/*Kleiner* ✓

       $P_{ave} = I^2_{rms}R$, but since $\underline{I_{rms}}$ is constant/*omdat I_{wgk}* konstant is✓
       $P \propto R$ ✓   [12.2.2]   (3)
                                                                      [12]

QUESTION 13/*VRAAG 13*

13.1   (electro)magnetic induction/Faraday's law ✓
         (elektro)magnetiese induksie/Faraday se wet   [12.2.1]   (1)

13.2   Provides a (sliding) contact (between coil and conducting wires) ✓
         Verskaf 'n (glyende) kontak (tussen die spoel en die geleidende drade)   [12.2.1]   (1)

13.3
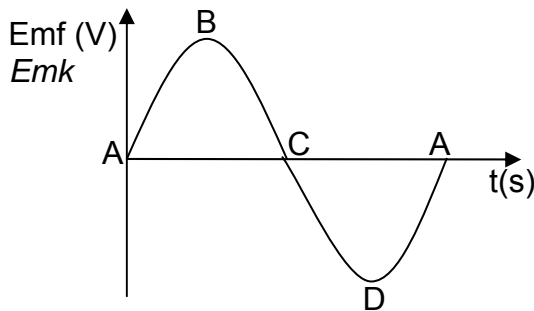
Checklist/*Kontrolelys*	Marks/
Criteria for graph/*Kriteria vir grafiek*	*Punte*
Correct shape/*Korekte vorm*	✓
Points A, B, C and D correctly indicated/ *Punte A, B, C en D korrek aangedui*	✓
Correct labels on axes/ *Korrekte benoemings op asse*	✓

                                                                [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*:

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

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

$$\therefore W_0 = 3,58 \times 10^{-19}\ J\ \checkmark$$

Option 2/*Opsie 2*:

$$hf = W_0 + \frac{1}{2}mv^2\ \checkmark$$

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

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

$$\therefore W_0 = 3,58 \times 10^{-19}\ J\ \checkmark$$

Option 3/*Opsie 3*:

$$f = \frac{c}{\lambda} = \frac{3\times10^{8}}{555\times10^{-9}}\ \checkmark = 5,4 \times 10^{14}\ Hz$$

$$E = hf = (6,63 \times 10^{-34})(5,4 \times 10^{14})\ \checkmark = 3,58 \times 10^{-19}\ J$$

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

$$\therefore W_0 = 3,58 \times 10^{-19}\ J\ \checkmark$$

[12.1.3]   (6)

14.4   Increases/*Vermeerder* ✓
With light of higher intensity <u>more photons strikes the metal surface per second</u>/*Met lig van hoër intensiteit <u>tref meer fotone die metaaloppervlak per sekonde</u>* ✓
Thus <u>more (photo)electrons per second are emitted</u>, ✓resulting in a bigger current.*/Dus word <u>meer (foto-)elektrone per sekonde vrygestel</u> 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**