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)

FEBRUARY/MARCH/*FEBRUARIE/MAART* 2017

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 26 pages.
Hierdie memorandum bestaan uit 26 bladsye.

GENERAL MARKING GUIDELINES PAPER 1
ALGEMENE NASIEN RIGLYNE VRAESTEL 1

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.
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.
*Geen punte sal toegeken word waar 'n **verkeerde of ontoepaslike formule gebruik** word nie, selfs al is daar relevante simbole en relevante substitusies.*
*Wanneer 'n fout gedurende **substitusie in 'n korrekte formule** begaan word, sa 'n punt vir die korrekte formule en vir korrekte substitusies toegeken word, maar **geen verdere punte** sal toegeken word nie.*

1.3   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**.*

1.4   **No penalisation if zero substitutions are omitted** in calculations where **correct formula**/principle is given correctly.
*Geen penalisering indien **nulwaardes nie getoon** word nie in berekeninge waar die **formule/beginsel korrek gegee is nie**.*

1.5   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

1.6   Marks are only awarded for a formula if a **calculation has 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.*

1.7   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 formule ingestel is en nie vir waardes wat voor 'n berekening gelys is nie.

1.8   All calculations, when not specified in the question, must be done to a minimum of TWO decimal places.
Alle berekenings, wanneer nie in die vraag gespesifiseer word nie, moet tot 'n minimum van twee desimale plekke gedoen word.

1.9   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 van '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, insluitende substitusies korrek is.

1.10   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 aan die antwoord as die oorspronklike data bring nie, sal geen punte tel nie.

2.   **UNITS/*EENHEDE***

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

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

2.3   Marks are only awarded for an answer, and not for a unit *per se*. 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 en nie vir 'n eenheid per se toegeken 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*

2.4   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.

3.   **GENERAL/*ALGEMEEN***

3.1   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.

3.2   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.

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

4.   **POSITIVE MARKING**

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

4.1   **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (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 word korrek in 3.2 of 3.3 vervang, word **volpunte** vir die daaropvolgende subvraag toegeken.*

4.2   **Multi-step 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.   **NEGATIVE MARKING/*NEGATIEWE NASIEN***

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. 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 e.g. QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should 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 VRAAG 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op bv. VRAAG 3.1 egter op 'n berekening gebaseer is, kan die motivering vir die verkeerde antwoord in VRAAG 3.2 oorweeg word.

QUESTION 1/*VRAAG 1*

1.1   D✓✓   (2)

1.2   C✓✓   (2)

1.3   A✓✓   (2)

1.4   D✓✓   (2)

1.5   B✓✓   (2)

1.6   C✓✓   (2)

1.7   B✓✓   (2)

1.8   A✓✓   (2)

1.9   D✓✓   (2)

1.10   B✓✓   (2)
                                                                                               [20]

QUESTION 2/*VRAAG 2*

2.1   0 N/zero/*nul*✓   (1)

2.2
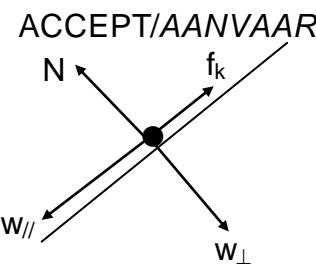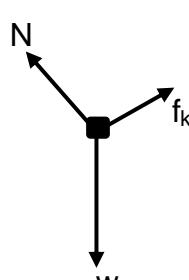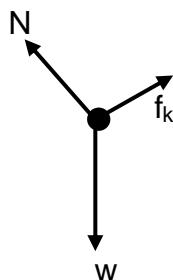
Accepted labels/*Aanvaarde benoemings*	
w	F_g/F_w/weight/mg/gravitational force/N/19,6 N *F_g/F_w/gewig/mg/gravitasiekrag/19,6 N*
f	$F_{friction}$/F_f/friction/f_k *$F_{wrywing}$/F_w/wrywing/f_k*
N	F_N/F_{normal}/normal force *F_N/$F_{normaal}$/normaalkrag*
	Deduct 1 mark for any additional force. *Trek een punt af vir enige addisionel krag*
	Mark is given for both arrow and label *Punt word toegeken vir beide pylpunt en benoeming*

ACCEPT/*AANVAAR*

1 mark if BOTH components of weight are shown.
All other rules in the table apply.
1 punt indien BEIDE komponente van die gewig getoon is
Al die ander reels in die tabel geld

(3)

2.3.1 $F_{net} = ma$
$f_k - mgsin\theta = 0$ ✓   1 mark for any of these/*1 punt vir enige van hierdie*
$f_k = mgsin\theta$

$f_k = (2)(9,8) \sin7^o$ ✓
$f_k = 2,39$ N ✓   (2,389) N   (3)

2.3.2   **POSITIVE MARKING FROM QUESTION 2.3.1/*POSITIEWE NASIEN VANAF VRAAG 2.3.1***
$f_k = \mu_k N$
$= \mu_k mgcos7^o$ ✓   1 mark for any of these/*1 punt vir enige van hierdie*

$2,389 = \mu_k(2)(9,8)cos7^o$ ✓
$\mu_k = 0,12$ ✓   (3)

2.3.3   **POSITIVE MARKING FROM QUESTION 2.3.2/*POSITIEWE NASIEN VANAF VRAAG 2.3.2***
OPTION 1/*OPSIE 1*

$F_{net} = ma$
$- f_k = ma$
$- \mu_k N = ma$
$- \mu_k (mg) = ma$

> ✓ | 1 mark for any of these/*1 punt vir enige van hierdie*

$\underline{- (0,12)(2)(9,8)}$ ✓ $= 2a$✓
$a = -1,176$ m.s^{-2} $(-1,18)$

$v_f^2 = v_i^2 + 2a\Delta x$
$\underline{0 = (1,5)^2 + 2(-1,176)\Delta x}$✓
$\Delta x = 0,96$ m

Distance is/*Afstand is* 0,96 m✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$

$W_{net} = \Delta E_K$

$W_{nc} = \Delta K + \Delta U$

$W_{nc} = \Delta E_K + \Delta E_P$

$\mu_k N \Delta x \cos \theta = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

> 1 mark for any of these/ *1 punt vir enigie van hierdie*

> **NOTE**: substituting into any of the above equations will lead to the following:
> **LET WEL**: *vervanging in enige van hierdie vergelyking sal lei to die volgende*

$(0,12) (2)(9,8)$ ✓ $\Delta x \cos 180^o$ ✓ $= 0 - \frac{1}{2} (2)(1,5)^2$✓

$\Delta x = 0,957$ m✓

(5)
[15]

QUESTION 3/*VRAAG 3*

3.1   (Motion of) an object in which the only force acting is the gravitational force. ✓✓
Beweging van 'n voorwerp waarop die gravitasiekrag die enigste krag is wat op die voorwerp inwerk.

OR/*OF*
(Motion of)an object which has been given an initial velocity and which follows a path *entirely* determined by the effects of gravitational acceleration/force. ✓✓
Beweging van 'n voorwerp waaraan 'n beginsnelheid gegee is en wat 'n baan volg wat deur die effekte van gravitasionele versnelling bepaal word/ gravitasiekrag.

OR/*OF*
The (motion of)an object that is projected, thrown or shot either upwards or downwards into the air and on which the only force considered/acting is gravitational. ✓✓
Die beweging van 'n voorwerp wat geprojekteer word, gegooi word of wat opwaarts geskiet is of afwaarts geskiet is in die lug en waar die enigste krag op die voorwerp inwerk, gravitasie is.

(2)

Note/: *Let Wel* 2 or/*of* 0

3.2   No/*Nee* ✓
The balloon is <u>not accelerating at the rate of 9,8 m·s^{-2}/moving with constant velocity</u>/acceleration is 0 *m·s^{-2}*✓

Die ballon versnel nie teen 9,8 m·s^{-2} nie/beweeg teen konstante snelheid dus is versnelling 0 m·s^{-2}

(2)

OR/OF
There are other forces (e.g.,friction) acting on the balloon besides gravity./*Daar is ander kragte wat op die ballon inwerk behalwe (buiten) gravitasie*✓
Net force acting on the balloon is zero/*Die nettokrag (resultante krag) op die ballon is nul*

3.3   **OPTION 1/*OPSIE 1***
Upward positive/*Opwaarts positief*
Δy = v$_i$Δt + ½ aΔt^2✓
-22✓ = <u>(-1,2) Δt + ½ (-9,8)Δt^2</u>✓
Δt = 2 s✓

Downward positive/*Afwaarts positief*
Δy = v$_i$Δt + ½ aΔt^2✓
22✓ = <u>(1,2) Δt + ½ (9,8)Δt^2</u>✓
Δt = 2 s✓

OPTION 2/*OPSIE 2*
Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (-1,2)^2 + (2)(-9,8)(-22)$ ✓

$v_f = -20,8 \text{ m·s}^{-1}$

For both equations/*vir beide vergelykings*✓

$v_f = v_i + a\Delta t$

$\underline{-20,8 = -1,2 + -9,8\Delta t}$✓

$\Delta t = 2 \text{ s}$✓

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (1,2)^2 + (2)(9,8)(22)$ ✓

$v_f = 20,8 \text{ m·s}^{-1}$

For both equations/*vir beide vergelykings*✓

$v_f = v_i + a\Delta t$

$\underline{20,8 = 1,2 + 9,8\Delta t}$✓

$\Delta t = 2 \text{ s}$✓

OPTION 3/*OPSIE 3*
Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = [(-1,2)^2 + (2)(-9,8)(-22)]$ ✓

$v_f = -20,8 \text{ m·s}^{-1}$

For both equations/*vir beide vergelykings*✓

$\Delta y = \dfrac{v_i + v_f}{2} \Delta t$

$-22 = \left(\dfrac{-1.2 + -20,8}{2} \right) \Delta t$ ✓

$\Delta t = 2 \text{ s}$✓

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = [1,2^2 + (2)(9,8)(22)]$ ✓

$v_f = 20,8 \text{ m·s}^{-1}$

For both equations/*vir beide vergelykings*✓

$\Delta y = \dfrac{v_i + v_f}{2} \Delta t$

$22 = \left(\dfrac{1.2 + 20,8}{2} \right) \Delta t$ ✓

$\Delta t = 2 \text{ s}$✓

OPTION 4/ *OPSIE 4*

OPTION 4/ *OPSIE 4*

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$

$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$

$(mgh + \frac{1}{2}mv^2)_{Top/Bo} = (mgh + \frac{1}{2}mv^2)_{Bottom/Onder}$

$W_{net} = \Delta E_K$

} 1 mark for any
1 punt vir enige

$\underline{(9,8)(22) + \frac{1}{2}(1,2)^2 = 0 + (\frac{1}{2})(v_f^2)}$ ✓

$v_f = 20,80\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$

$\underline{20,8 = 1,2 + 9,8\Delta t}$ ✓

$\underline{\Delta t = 2\ s}$ ✓

NOTES/*AANTEKENINGE*:

Each substitution must include the correct values of 22 m and the velocity of 1,2 m·s⁻¹

Elke vervanging moet die korrekte waardes van 22 m en die snelheid van 1,2 m.s⁻¹ insluit.

The values of v_f and v_i can also be used with $F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$ *Die waardes van v_f en v_i kan ook met $F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$ gebruik word.*

(4)

3.4　　**Upward positive/*Opwaarts positief***

POSITIVE MARKING FROM QUESTION 3.3/*POSITIEWE NASIEN VANAF VRAAG 3.3*

$v_f = v_i + a\Delta t$ ✓

$0 = 15 + (-9,8)\Delta t$ ✓

$\Delta t = 1,53\ s$

Total time elapsed = $\underline{2 + 1,53 + 0,3}$ ✓　　For addition/*vir optelling*

Totale tyd verstryk = 3,83 s

OR/*OF*　　　　　　　　OR/*OF*

Displacement of the balloon/
Verplasing van ballon:

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

$= -(1,2)(3,83)$ ✓

$= -4,6\ m$

Height /*Hoogte*:

$= \underline{22 - 4,6}$ ✓

$= 17,4\ m$ ✓

$y_f = y_i + \Delta y$

$= [22 - (1,2)(3,83)]$ ✓ ✓

$= 17,4\ m$

Height/*Hoogte* = 17,4 m ✓

Downward Positive/Afwaarts positief
POSITIVE MARKING FROM QUESTION 3.3/*POSITIEWE NASIEN VANAF VRAAG 3.3*

$v_f = v_i + a\Delta t$ ✓
$0 = -15 + (9,8)\Delta t$ ✓
$\Delta t = 1,53$ s
Total time elapsed = 2 + 1,53 + 0,3 ✓
Totale tyd verstryk = 3,83 s

For addition/*vir optelling*

OR/OF   OR/OF

Displacement of the balloon/
Verplasing van ballon:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
     = (1,2)(3,83) ✓
     = 4,6 m
Height /*Hoogte*:
     = 22 - 4,6 ✓
     = 17,4 m ✓

$y_f = y_i + \Delta y$
     = [-22 + (1,2)(3,83)] ✓ ✓
     = -17,4 m
Height/*Hoogte* = 17,4 m ✓

(6)
[14]

QUESTION 4/*VRAAG 4*

4.1   It is the product of the resultant/net force acting on an object ✓ and the time the resultant/net force acts on the object. ✓
Dit is die produk van die resulterende/netto krag wat op die voorwerp inwerk en die tyd wat die resulterende/netto krag op die voorwerp inwerk.   (2)
NOTE: **ONLY 1 MARK FOR "CHANGE IN MOMENTUM"/*SLEGS 1 PUNT VIR VERANDERING IN MOMENTUM***

4.2.1

$p = mv$ ✓   = (0,03)(700) ✓   = 21 kg·m·s⁻¹ ✓   Note: 2/3 if $\Delta p = (p_f - p_i) = (mv_f - mv_i)$ is used.   *Let Wel: 2/3 indien $\Delta p = (p_f - p_i) = (mv_f - mv_i)$ gebruik is.*

(3)

4.2.2   **OPTION 1/*OPSIE 1***
POSITIVE MARKING FROM 4.2.1/*POSITIEWE NASIEN VANAF 4.2.1*

Δt for a bullet = $\dfrac{60}{220}$ ✓ = 0,27 s

$F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$

$F_{ave \ gun \ on \ bullet/gem \ gew \ eer \ op \ koeël} = \dfrac{\Delta p}{\Delta t}$ ✓ | 1 mark for any one/*1 punt vir enige een* |

$= \dfrac{21 - 0}{0,27}$ ✓

$= 77,01$ N ✓ (77,78 N)

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*
= 77,01 N/ 77,8 N to the west/*na wes* ✓ OR/*OF*
-77,01 N / - 77,78 N

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 4.2.1/*POSITIEWE NASIEN VANAF 4.2.1*

$F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$

$F_{av} = \dfrac{\Delta p}{\Delta t}$ ✓ | 1 mark for any one/*1 punt vir enige een* |

$\Delta p_{tot} = (21)(220) = 4\ 620$ kg·m·s⁻¹ ✓

$F_{ave \ gun \ on \ bullet/gem \ gew \ eer \ op \ koeël} = \dfrac{4\ 620 - 0}{60}$ ✓

$= 77,00$ N✓

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*
= 77,01 N /77,78 N to the west/*na wes* ✓
OR/*OF*
- 77,01 N / -77,78 N

OPTION 3/*OPSIE 3*
$v_f = v_i + a\Delta t$

$a = \dfrac{700 - 0}{(60/220)}$ ✓

$a = 2592,59\ m·s^{-2}$

$F_{net} = ma$ ✓
$F_{net} = (0,03)(2592,59)$ ✓
$F_{av} = 77,78$ N✓

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*
= 77,01 N / 77,78 N to the west/*na wes* ✓ OR
= - 77,01 N/ -77,78   (5)
NOTE: ACCEPT RANGE: 77 N - 77,78 N

4.3   **POSITIVE MARKING FROM 4.2.2/*POSITIEWE NASIEN VANAF 4.2.2***

77 N/77,78 N✓ to the east/*na oos*✓   (2)
                                                                                      [12]

QUESTION 5/*VRAAG 5*

5.1 The rate at which work is done/ Rate at which energy is expended. ✓✓
Die tempo waarteen arbeid verrig word / Die tempo waarteen energie verbruik is. (2)

5.2.1

OPTION 1/*OPSIE 1*
$W = F\Delta x \cos\theta$ ✓
$W_{gravity/gravitasie} = mg\Delta y \cos\theta$
$= (1\ 200)(9,8)(55)\cos 180^o$ ✓
$= -646\ 800$ J $(6,47 \times 10^5$ J) ✓

OPTION 2/*OPSIE 2*	-1 if either negative is omitted or $E_p = mgh$ is used
$W = -\Delta E_p$ ✓	instead of W / *-1 indien negatief weggelaat is of*
$= -(1200)(9,8)(55-0)$ ✓	*indien $E_p = mgh$ gebruik is in plaas van W*
$= -646800$ J ✓	

(3)

5.2.2

$W_{counterweight} = mg\Delta y \cos\theta$
$= (950)(9,8)(55)\cos 0^o$ ✓
$= 512\ 050$ J $(5,12 \times 10^5$ J) ✓

(2)

5.3

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM QUESTIONS 5.2.1 AND 5.2.2
POSITIEWE NASIEN VANAF VRAE 5.2.1 en 5.2.2
$W_{net} = \Delta E_K$ ✓

$W_{gravity} + W_{countweight} + W_{motor} = 0$
$W_{motor} = -(W_{gravity} + W_{countweight})$ 1 mark for any one/ 1 punt vir enige een
$W_{nc} = \Delta E_K + \Delta E_p$

NOTE: Substituting into any of the above equations will lead to:
LET WEL: *Vervanging in enige van die bogenoemde vergelykings sal lei tot*

-646800 ✓ $+ 512050$ ✓ $+ W_{motor} = 0$

$\therefore W_{motor} = 134\ 750$ J

$P_{ave\ motor} = \dfrac{W}{\Delta t}$ ✓
$= \dfrac{134750}{180}$ ✓
$= 748,61$ W ✓

OPTION 2/*OPSIE 2*

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

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

$P_{ave} = Fv_{ave}$✓

$= 2450 \dfrac{55}{180}$ ✓

$= 748{,}61$ W

OPTION 3/*OPSIE 3*

$P_{ave} = Fv_{ave}$ ✓✓

$= [1200 (9{,}8)$ ✓ $- 950(9{,}8)]$ ✓ $\dfrac{55}{180}$ ✓

$= 748{,}61$ W✓

(6)

[13]

QUESTION 6/*VRAAG 6*

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

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

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

6.1.3

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

$2600 = \dfrac{340}{(340 - v_s)}$ ✓ f_s ✓

$1750 = \dfrac{340}{(340 + v_s)}$ ✓ f_s

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

(6)

6.1.4   (a)   Increase/*Toeneem*✓ (1)

(b)   Decrease/*Afneem* ✓ (1)

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

6.2.2   Decrease/*Neem af* ✓ (1)

[13]

QUESTION 7/*VRAAG 7*

7.1.1   Removed/*Verwyder* ✓   (1)

7.1.2

$n = \dfrac{Q}{e}$ ✓

> Do not penalise for negative sign of charge used in calculation

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

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

7.2.1   Negative/*Negatief* ✓   (1)

7.2.2
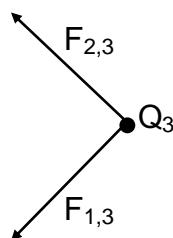
NOTE/*LET WEL*:
Vectors not drawn to scale/*Vektore nie volgens skaal geteken nie.*
Learners forfeit 1 mark for:/*Kandidate sal 1 punt verbeur vir:*
(i) Wrong directions/*verkeerde rigtings*

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

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

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

7.2.3

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓

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

ACCEPT/*AANVAAR*

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

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

7.2.4 **POSITIVE MARKING FROM QUESTION 7.2.3/*POSITIEWE NASIEN VANAF VRAAG 7.2.3***
OPTION 1/*OPSIE 1*

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

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

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

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

> 1 mark for the addition
> *1 punt vir optelling*

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

r = 1,128 m $\checkmark$

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

OPTION 2/*OPSIE 2*

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

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

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

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

$\checkmark$

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

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

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

$\therefore r = 1,128\ m \checkmark$

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

(4)

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

7.3.2

OPTION 1/*OPSIE 1*

$E = \dfrac{kQ}{r^2}$ ✓

$100 = \dfrac{(9 \times 10^9)Q}{(0,6)^2}$ ✓✓

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

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

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

$50 = \dfrac{(9 \times 10^9)(4 \times 10^{-9})}{r^2}$ ✓

$\quad$ | For the equation/*vir die vergelyking*

$r = 0,85$ m $(0,845)$ m ✓

OPTION 2/*OPSIE 2*

$E = \dfrac{kQ}{r^2}$ ✓

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

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

$\therefore r = 0,85$ m $(0,849$ m$)$ ✓

(5)

[21]

$\qquad\qquad$

QUESTION 8/*VRAAG 8*

NEGATIVE MARKING FOR 8.1.1,8.1.2 AND 8.1.3/NEGATIEWE *NASIEN VIR VRAAG 8.1.1, 8.1.2 EN 8.1.3*

8.1.1   **P** and **Q** burn with the same brightness ✓ same potential difference/same current✓
P en Q brand met dieselfde helderheid ✓dieselfde potensiaalverskil / dieselfde stroom✓   (2)

8.1.2   **P is dimmer (less bright) than R/*P is minder helder as P***
OR/*OF*
R is brighter than P/*R is helderder as* P✓
R is connected across the battery alone therefore the voltage (terminal pd) is the same as the emf source (energy delivered by the source). ✓
R is alleen aan die battery gekoppel ✓ dus is die potensiaalverskil (terminale potensiaalverskil)dieselfde as die emk bron (energie gelewer deur die bron).✓

OR/*OF*
The potential difference across **R** is twice (larger/greater than) that of **P**./The current through **R** is twice (larger/greater than) that of **P**.
Die potensiaalverskil oor R is twee maal dié van P./Die stroom deur R is twee maal dié van P.

OR/*OF*

P and **Q** are in series and are both connected across the same battery, ✓ hence the voltage (terminal pd) is shared equally ✓(P and Q are potential dividers) Therefore R is brighter.
P en Q is in serie en beide is oor dieselfde battery gekoppel, ✓ dus word die potensiaalverskil gelyk verdeel ✓(P en Q is potensiaal verdelers) Dus is R helderder.

OR/*OF*

Potential difference across **P** is half that across **R/***Die potensiaalverskil oor P is die helfte die oor R*   (2)

8.1.3   **T** does not light up at all✓
T brand glad nie

ACCEPT/*AANVAAR*
T is dimmer (less bright) than R/T *is minder helder as R*✓

R is brighter than **T**✓
R is helderder as T

Reason/*Rede*
The wire acts as a short circuit. ✓
Die draad dien as 'n kortsluiting

OR/*OF*
The potential difference across T / current in T is zero.✓
Die potensiaalverskil oor T/stroom in T is nul.   (2)

8.2.1   **OPTION 1/*OPSIE 1***

$$\frac{1}{R_{//}} = \frac{1}{R_5} + \frac{1}{R_{10}}$$ ✓

$$\frac{1}{R_{//}} = \frac{1}{5} + \frac{1}{10}$$ ✓

$$\therefore R_{//} = 3,33\ \Omega\ (3,333\ \Omega)$$

$$R_{//} = \frac{R_5 R_{10}}{R_5 + R_{10}}$$ ✓

$$= \frac{(5)(10)}{(5+10)}$$ ✓ $= 3,33\ (3,333\ )\Omega$

$$R_{tot} = R_8 + R_{//} + r$$
$$= (8 + 3,33 + 1)$$ ✓
$$= 12,33\ \Omega$$

$$I = \frac{V}{R}$$ ✓

$$I_{tot} = \frac{20}{12,33}$$ ✓ $= 1,62\ A$

$$\therefore I_8 = 1,62\ A$$ ✓

$$\varepsilon = I(R + r)$$ ✓
$$20 = I[(\ 11,33 + 1)$$ ✓] ✓
$$I = 1,62\ A$$ ✓

OPTION 2/*OPSIE 2*

$\dfrac{1}{R_{//}} = \dfrac{1}{R_5} + \dfrac{1}{R_{10}}$ ✓

$\dfrac{1}{R_{//}} = \dfrac{1}{5} + \dfrac{1}{10}$ ✓

$\therefore R_{//} = 3{,}33\ \Omega\ (3{,}333\ \Omega)$

$R_{//} = \dfrac{R_5 R_{10}}{R_5 + R_{10}}$ ✓

$= \dfrac{(5)(10)}{(5+10)}$ ✓ $= 3{,}33\ (3{,}333\ )\Omega$

$R_{tot} = R_8 + R_{//} + r$

$= (8 + 3{,}33 + 1)$ ✓

$= 12{,}33\ \Omega$

$V_8 = \dfrac{8}{12{,}33} \times 20 = 12{,}973\ V$

$I = \dfrac{V}{R}$ ✓

$\therefore I_{tot} = I_8 = \dfrac{12{,}973}{8}$ ✓

$= 1{,}62\ A$ ✓

(6)

8.2.2

OPTION 1/*OPSIE 1*

$V = IR$

$V_5 = \mathcal{E} - (V_8 + V_1)$ } Any one/*Enige een* ✓

$= 20$ ✓ $- [\ \underline{1{,}62(8 + 1)}]$ ✓

$= 5{,}42\ V$ ✓

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$R_{//} = \dfrac{(5)(10)}{(5+10)} = 3{,}33\ \Omega$

$V_{R//} = \dfrac{R_{//}}{R_{tot}} \times V_{tot}$ ✓

$V_{R//} = \dfrac{(3{,}33)}{(12{,}33)}(20)$ ✓✓

$= 5{,}41\ V$ ✓

$V_{\parallel} = IR_{\parallel}$ ✓

$= (1{,}62)(3.33)$ ✓✓

$= 5{,}39\ V$ ✓

OPTION 3/*OPSIE 3*

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$I_5\ R_5 = I_{10}R_{10}$ ✓

$\underline{5I_5 = 10(1{,}62 - I_5)}$ ✓

$I_5 = 1{,}08\ A$

$V_5 = (1{,}08\ )(5)$ ✓

$= 5{,}4\ V$ ✓

(4)

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 4/*OPSIE 4*

$I_5 = \dfrac{10}{15} \times I_{tot}$ ✓

$= \dfrac{2}{3}(1,62)$

$= 1,08$ A

$\underline{V_5 = I_5 R_5}$ ✓

$V_5 = (1,08)(5)$ ✓

$= 5,4$ V ✓

(4)

8.2.3

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

OPTION 1/*OPSIE 1*

$P = IV = I\mathcal{E}$ ✓

$= (1,62)(20)$ ✓

$= 32,4$ W ✓

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 2/*OPSIE 2*

$P = IV$ ✓

$P_{tot} = P_{8\Omega} + P_{//} + P_{1\Omega}$

$= IV_8 + IV_{//} + IV_1$

$= I^2(R_8 + R_{//} + R_1)$

$= (1,62)^2[8 + 3,33 + 1)]$ ✓

$= 32,36$ W ✓

POSITIVE MARKING FROM 8.2.1 AND 8.2.2/*POSITIEWE NASIEN VANAF*
OPTION 3/*OPSIE 3*
8.2.1 EN 8.2.2

$P = I^2R$ ✓

$I_5 = \dfrac{V_5}{R_5} = \dfrac{5,4}{5} = 1,08$ A

$\therefore I_{10} = 0,54$ A

$P_{tot} = I_8^2R_8 + I_1^2R_1 + I_5^2R_5 + I_{10}^2R_{10}$

$= (1,62)^2[8 + 1] + (1,08)^2(5) + (0,54)^2(10)$ ✓ $= 32,37$ W ✓

OPTION 4/*OPSIE 4*

$P = \dfrac{V^2}{R}$ ✓	$P = I^2R_{tot}$ ✓
	$= (1,62)^2(12,33)$ ✓
$P = \dfrac{20^2}{(8 + 1 + 3,33)}$ ✓	$= 32,36$ W ✓
$= 32,44$ W ✓	

(3)

NOTE/*LET WEL*: Range/*Gebied* 32,35- 32,45

**[19]**

QUESTION 9/*VRAAG 9*

9.1   Slip rings/*Sleepringe* ✓   (1)

9.2
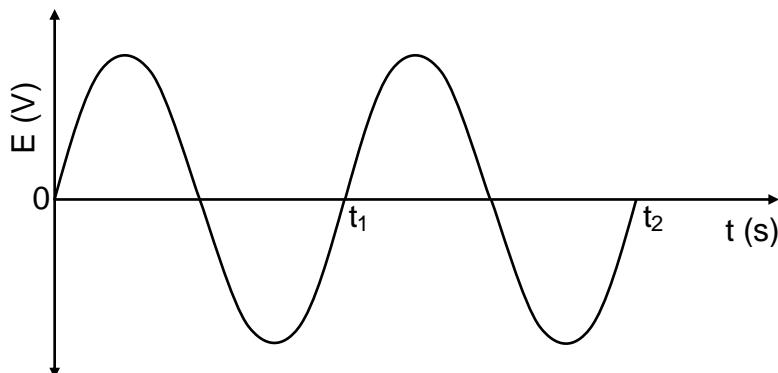
Marking criteria/*Nasienriglyne*	
Sine graph starts from 0. *Sinusgrafiek begin by 0*	✓
Two complete waves (between t_0 and t_2) *Twee volledige golwe tussen (t_0 en t_2)*	✓

(2)

9.3   Any TWO/*Enige TWEE*
Increase the speed of rotation/*Verhoog die rotasie spoed*✓
Increase the number of coils (turns)/*Verhoog die getal spoele*✓
Use stronger magnets/*Gebruik sterker magne**te***
ACCEPT/*AANVAAR*: Increase surface area/*Verhoog die oppervlakarea*   (2)

9.4   The rms value of an AC voltage it that value of the AC voltage which will dissipate the same amount of energy as DC.
Die wgk waarde van WS potensiaalverskil/stroom hoeveelheid energie as GS verkwis

OR/*OF*
The rms value of an AC voltage it that value of the AC voltage which will produce the same joule heating effect as DC.
Die wgk waarde van WS potensiaalverskil is die waarde van die WS potensiaalverskil wat dieselfde joule verhittingseffek as GS lewer.   (2)

9.5

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$P_{ave/gem} = I_{rms/w\,gk}V_{rms/w\,gk}$ ✓	$P_{ave} = \dfrac{V^2}{R}$ ✓
$\underline{1500 = I_{rms/w\,gk}(240)}$ ✓	$1500 = \dfrac{240^2}{R}$
$I_{rms/w\,gk} = \dfrac{1500}{240}$	$R = 38{,}4\ \Omega$
$\qquad = 6{,}25\ A$ ✓	$I_{rms} = \dfrac{V}{R}$
	$\qquad = \dfrac{240}{38{,}4}$ ✓
	$\qquad = 6{,}25\ A$ ✓

(3)

[10]

QUESTION 10/*VRAAG 10*

10.1   The <u>minimum frequency of light</u> ✓needed to <u>emit electrons from a certain metal surface.</u>✓
Die minimum frekwensie van lig benodig om elektrone vanaf die oppervlak van 'n sekere metaal vry te stel.

OR/*OF*
The <u>minimum frequency of light</u>✓ <u>below which electrons will not be emitted from the surface of a certain metal.</u> ✓
Die minimum frekwensie van lig waaronder elektrone nie vanaf die oppervlak van 'n sekere metaal vrygestel sal word nie.   (2)

10.2   The speed remains unchanged. ✓
Die spoed bly onveranderd.   (1)

10.3

> **OPTION 1/*OPSIE 1***
> $c = f\lambda$✓,
> <u>$3 \times 10^8 = f(6 \times 10^{-7})$</u> ✓
>
> ∴ $f = 5 \times 10^{14}$ Hz✓
>
> <u>The value of f is less than the threshold frequency of the metal,</u> ✓ therefore <u>photoelectric effect is not observed.</u>✓
> *Die <u>waarde van f is laer as die drumpelfrekwensie van die metal,</u> ✓en gevolglik sal <u>foto- nie waargeneem word nie.</u>* ✓

> **OPTION 2/*OPSIE 2***
> For the given metal/*Vir die gegewe metaal*
> $W_0 = hf_0$✓
> $= (6,63 \times 10^{-34})(6,8 \times 10^{14})$✓
> $= 4,51 \times 10^{-19}$ J
>
> For the given wavelength/*Vir die gegewe golflengte*
> $E_{photon/foton} = \dfrac{hc}{\lambda}$
>
> $= \dfrac{(6,63 \times 10^{-34})(3 \times 10^8)}{6 \times 10^{-7}}$ ✓
>
> $= 3,32 \times 10^{-19}$ J
>
> > $E_{photon/foton} = hf$
> > $= (6,63 \times 10^{-34})(5 \times 10^{14})$ ✓
> > $= 3,32 \times 10^{-19}$ J
>
> <u>This energy is less than the work function</u>✓ of the metal, therefore <u>photoelectric effect is not observed.</u>✓
> *<u>Hierdie energie is minder as die werksfunksie</u> ✓of die metal, en gevolglik sal <u>foto-elektriese nie waargeneeme word nie.</u>* ✓

(5)

OPTION 3/*OPSIE 3*

$c = f_0\lambda_0$ ✓
$3 \times 10^8 = 6{,}8 \times 10^{14}(\lambda_0)$ ✓
$\lambda_0 = 4{,}41 \times 10^{-7}$ m ✓

The threshold wavelength (λ_0) is smaller than 6×10^{-7} m ✓ therefore photoelectric effect is not observed. ✓
Die drumpelgolflengte (λ_0) is kleiner as 6×10^{-7} m ✓ en gevolglik sal foto-elektriese effek nie waargeneem word nie. ✓

10.4

$E = W_o + E_{k(max)}$

$E = W_o + \dfrac{1}{2}mv_{max}^2$

$h\dfrac{c}{\lambda} = hf_0 + \dfrac{1}{2}mv_{max}^2$

$hf = hf_0 + \dfrac{1}{2}mv_{max}^2$

Any one of the three/*Enige van die drie* ✓

$\underline{(6{,}63 \times 10^{-34})(7{,}8 \times 10^{14})}$ ✓ $= \underline{(6{,}63 \times 10^{-34})(6{,}8 \times 10^{14})}$ ✓ $+ \dfrac{1}{2}mv_{max}^2$

½ $mv_{max}^2 = 6{,}63 \times 10^{-20}$ J
½ $(9{,}11 \times 10^{-31})v_{max/maks}^2$ ✓ $= 6{,}63 \times 10^{-20}$
$v_{max/maks} = 3{,}82 \times 10^5$ m·s^{-1} ✓

(5)

[13]

TOTAL/*TOTAAL*:   150