basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

NOVEMBER 2025

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

QUESTION 1/*VRAAG 1*

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

[20]

QUESTION 2/*VRAAG 2*

2.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

When the net/resultant force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp

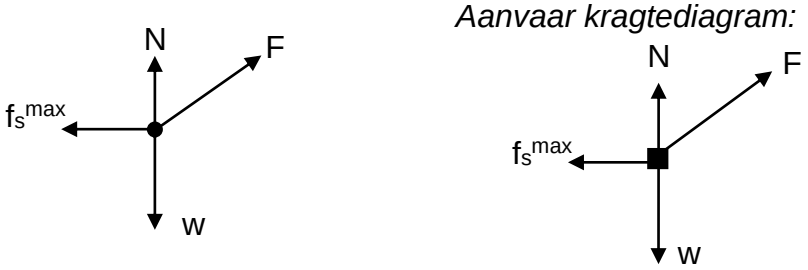
OR/*OF*

The net/resultant force acting on an object is equal to the rate of change of momentum of the object (in the direction of the net force). **(2 or 0)**
Die netto/resulterende krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die netto krag).

(2)

2.2

Accept force diagram/
Aanvaar kragtediagram:



Accepted labels/*Aanvaarde byskrifte*	
w	F_g /F_w /$F_{earth\ on\ P}$ /weight /mg /49 N /gravitational force *F_g /F_w /$F_{aarde\ op\ P}$ /gewig /mg /49 N /gravitasiekrag*
F	F_A /18 N / Applied force / *Toegepaste krag*
f_s^{max}	F_f / f_s /f /Friction (force) / (static) friction / *(statiese) wrywingskrag*
N	F_N /Normal (force) /F_{normal} /*$F_{normaal}$ /Normaal(krag)*

Notes/*Aantekeninge*
- Mark awarded for label and arrow./*Punt toegeken vir byskrif en pyltjie.*
- f_k not accepted as label/*f_k word nie aanvaar nie*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks:* $^3/_4$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks:* $^3/_4$
- If force(s) do not make contact with the dot /*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks:* $^3/_4$

(4)

2.3.1

$F_x = F\cos\theta$ $\underline{15 = 18\cos\theta}$ ✓ $\theta = 33{,}56^\circ$ ✓	**OR/*OF*** $\underline{9{,}95 = 15\tan\theta}$ ✓ $\theta = 33{,}56^\circ$ ✓	**OR/*OF*** $\underline{9{,}95 = 18\sin\theta}$ ✓ $\theta = 33{,}56^\circ$ ✓
NOTE/*NOTA:* If answer only/*Indien slegs antwoord* 1/2		

(2)

2.3.2

POSITIVE MARKING FROM QUESTION 2.3.1/*POSITIEWE NASIEN VANAF VRAAG 2.3.1*

Marking criteria/*Nasienkriteria*

- Formula / *Formule* $f_s^{max} = \mu_s N$ ✓
- Correct substitution of f_s^{max} / *Korrekte vervanging van* f_s^{max} ✓
- Correct calculation of F_y / *Korrekte berekening van* F_y ✓
- Subtraction for the calculation of N from F_g thus: $\underline{(5)(9{,}8)}$ – ✓$(18\sin 33{,}56°)$
  Aftrek *vir die berekening van N van* F_g
- Correct final answer/ *Korrekte finale antwoord*: 0,38 ✓

OPTION 1/*OPSIE 1*

$f_s^{max} = \mu_s N$
$f_s^{max} = \mu_s(mg - F\sin\theta)$ ✓ Anyone/*Enigeen*

15✓ $= \mu_s$ $\underline{[(5)(9{,}8)}$ ✓ $\underline{18\sin}$ ✓ $\underline{33{,}56°]}$

$\mu_s = 0{,}38$✓

OPTION 2/*OPSIE 2*

$F_{net} = 0$
$F_N + F_y - F_g = 0$
$F_N + F_y = F_g$

$F_N = \underline{(5)(9{,}8)}$ – ✓ $(\underline{18\sin 33{,}56°})$ ✓

$F_N = 39{,}05$ N

$f_s^{max} = \mu_s N$ ✓
15✓ $= \mu_s(39{,}05)$
$\mu_s = 0{,}38$✓

OPTION 3/*OPSIE 3*

$F_y = \sqrt{(18)^2 - (15)^2}$ ✓
$= 9{,}95$ N

$F_{net} = 0$
$F_N + F_y - F_g = 0$
$F_N = F_g - F_y$

$F_N = \underline{(5)(9{,}8)}$ – ✓$(9{,}95)$

$F_N = 39{,}05$ N

$f_s^{max} = \mu_s N$ ✓
15✓ $= \mu_s(39{,}05)$
$\mu_s = 0{,}38$✓

NOTE: If N calculation NOT shown ($^3/_5$)
NOTA: Indien berekening van N nie getoon ($^3/_5$)

(5)

2.4

Increases ✓ • Vertical component of F decreases ✓ • Normal force increases ✓ • μ_s remains constant, f_s^{max} is directly proportional to N✓	*Neem toe* • *Vertikale component van F neem af* • *Normaalkrag neem toe* • μ_s *bly konstant,* f_s^{max} *direk eweredig aan N*
OR Decreases ✓ • Horizontal component of F increases ✓ • The block will move (F_{net} will increase)✓ • $f_k < f_s^{max}$ ✓	***OF*** *Neem af* • *Horisontale komponent van F neem toe* • *Die blok sal beweeg (F_{net} sal toeneem)* • $f_k < f_s^{maks}$
OR Remains the same ✓ • Explain using relevant calculation NB: In the calculation, candidates must choose a $\mu_k < \mu_s$ value and θ that together with the μ_k value will give an answer of 15 N for f_k	***OF*** *Bly dieselfde* ✓ • *Verduidelik deur van 'n gepaste berekening gebruik te maak* *NB: In die berekening moet die kandidaat 'n waarde $\mu_k < \mu_s$ en θ wat saam met μ_k waarde 'n antwoord van 15 N gee vir f_k*

(4)
[17]

QUESTION 3/*VRAAG 3*

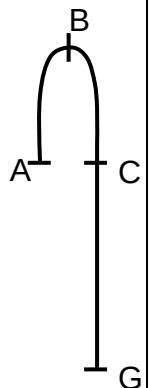
3.1 Motion under the influence of weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gewig/gravitasiekrag.
(2* or/*of* 0*)

NOTE: If projectile defined **0/2** ***NOTA:*** *Indien projektiel gedefinieer* ***0/2*** (2)

3.2

Marking criteria/*Nasienkriteria*
- Formula with Δt/*Formule met Δt* ✓
- Correct substitution into formula/*Korrekte vervanging in formule* ✓
- Correct final answer / *Korrekte finale antwoord*: 1,53 s ✓

NOTE for 3.2 and 3.3: If energy principles used ($^1/_3$) for the final answer
NOTA vir 3.2 en 3.2: *Indien energiebeginsels gebuik* ($^1/_3$) *vir finale antwoord*



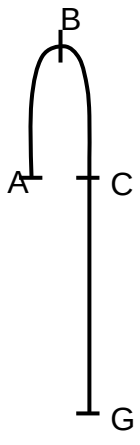
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
A-B: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = 15 + (-9{,}8)\Delta t$ ✓ $\Delta t = 1{,}53$ (s) ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = -15 + (9{,}8)\Delta t$ ✓ $\Delta t = 1{,}53$ (s) ✓	**B-C:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-15 = 0 + (-9{,}8)\Delta t$ ✓ $\Delta t = 1{,}53$ (s) ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $15 = 0 + (9{,}8)\Delta t$ ✓ $\Delta t = 1{,}53$ (s) ✓

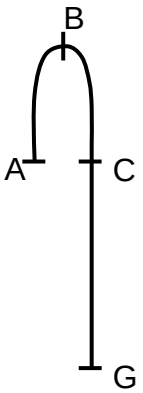
OPTION 3/*OPSIE 3* A-C:	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-15 = 15 + (-9,8)\Delta t}$ ✓	$\underline{15 = -15 + (9,8)\Delta t}$ ✓
$\Delta t = 3,06$	$\Delta t = 3,06$
$p = 3,06 \div 2$	$p = 3,06 \div 2$
$p = 1,53$ (s) ✓	$p = 1,53$ (s) ✓

(3)

3.3

POSITIVE MARKING FROM QUESTION 3.2/*POSITIEWE NASIEN VANAF VRAAG 3.2*	
Marking criteria/*Nasienkriteria* • Formula with v_f./*Formule met v_f.* ✓ • Correct substitution into formula./*Korrekte vervanging in formule.* ✓ • Correct final answer/*Korrekte finale antwoord*: 17,97 $m\cdot s^{-1}$ ✓ • **[RANGE: 17,93 – 18,33]**	
OPTION 1/*OPSIE 1* A-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$✓ $v_f^2 = \underline{(15)^2 + 2(-9,8)(-5)}$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-15)^2 + 2(9,8)(5)}$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**OPTION 2/*OPSIE 2* A-G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:** $v_f = v_i + a\Delta t$ ✓ $= \underline{(15) + (-9,8)(3,36)}$ ✓ $= -17,93$ $= 17,93$ $(m\cdot s^{-1})$ ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:** $v_f = v_i + a\Delta t$ ✓ $= \underline{(-15) + (9,8)(3,36)}$ ✓ $= 17,93$ $(m\cdot s^{-1})$ ✓
OPTION 3/*OPSIE 3* C-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-15)^2 + 2(-9,8)(-5)}$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**C-G:** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(15)^2 + 2(9,8)(5)}$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓
OPTION 4/*OPSIE 4* B-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (-15)^2 + 2(-9,8)\Delta y$ $\Delta y = -11,48$ m From B to C $= -11,48 + (-5)$ $= -16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(0)^2 + 2(-9,8)(-16,48)}$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**B-G** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (15)^2 + 2(9,8)\Delta y$ $\Delta y = 11,48$ m From B to C $= 11,48 + 5$ $= 16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(0)^2 + 2(9,8)(16,48)}$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓





OPTION 5/*OPSIE 5* C-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-5 = -15\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $\Delta t = 0,3$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-5 = \left(\frac{-15 + v_f}{2}\right)(0,3)$ ✓ $v_f = -18,33$ $v_f = 18,33$ (m·s^{-1}) ✓	**C-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $5 = 15\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $\Delta t = 0,3$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $5 = \left(\frac{15 + v_f}{2}\right)(0,3)$ ✓ $v_f = 18,33$ (m·s^{-1}) ✓
OPTION 6/*OPSIE 6* **UPWARDS AS POSITIVE** ***OPWAARTS AS POSITIEF:*** **A-G** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-5 = \left(\frac{15 + v_f}{2}\right)(3,36)$ ✓ $v_f = -17,98$ $v_f = 17,98$ (m·s^{-1}) ✓	**DOWNWARDS AS POSITIVE** ***AFWAARTS AS POSITIEF:*** **A-G** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $5 = \left(\frac{-15 + v_f}{2}\right)(3,36)$ ✓ $v_f = 17,98$ (m·s^{-1}) ✓
OR/*OF* **B-G** $v_f = v_i + a\Delta t$ ✓ $v_f = 0 + \underline{(-9,8)(3,36 - 1,53)}$ ✓ $v_f = -17,93$ $v_f = 17,93$ (m·s^{-1}) ✓	**OR/*OF*** **B-G** $v_f = v_i + a\Delta t$ ✓ $= 0 + \underline{(9,8)(3,36 - 1,53)}$ ✓ $v_f = 17,93$ (m·s^{-1}) ✓
OR/*OF* **C-G** $v_f = v_i + a\Delta t$ ✓ $v_f = \underline{-15 + (-9,8)(0,3)}$ ✓ $v_f = -17,94$ $v_f = 17,94$ (m·s^{-1}) ✓	**OR/*OF*** **C-G** $v_f = v_i + a\Delta t$ ✓ $v_f = \underline{15 + (9,8)(3,36 - 2(1,53))}$ ✓ $v_f = 17,94$ (m·s^{-1}) ✓

(3)

3.4 Inelastic. ✓
The height decreased/smaller. ✓
The **velocity** with which the ball strikes the ground is not the same as the velocity with which it left the ground. / **Kinetic energy** is converted to heat and sound energy / Kinetic energy is NOT conserved. / The kinetic energy is not the same before and after the ball strikes the ground ✓
ACCEPT: Kinetic energy is lost.
NOTE: DO NOT ACCEPT ANY CALCULATION AS AN EXPLANATION.

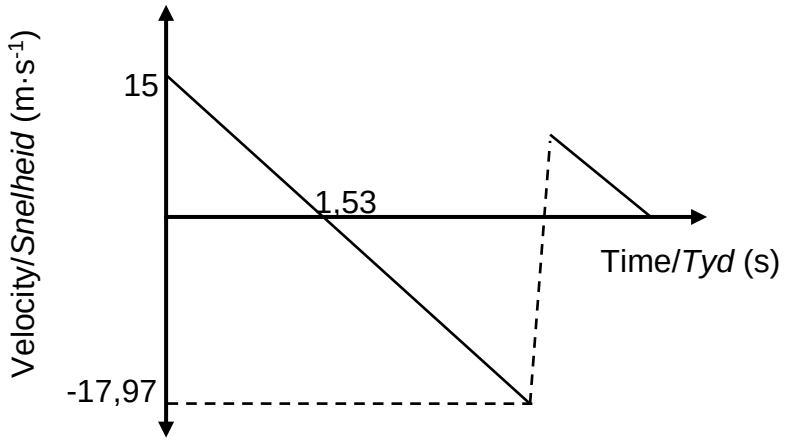
Onelasties.
Die hoogte neem af/kleiner.
*Die **snelheid** waarmee die bal die grond tref is nie dieselfde as die snelheid waarmee dit die grond verlaat nie. / **Kinetiese energie** is omgeskakel na hitte en klank / Kinetiese energie is nie behoue nie./ Die kinetiese energie is nie dieselfde voor en na die bal die grond tref nie.*
***AANVAAR**: Kinetiese energie is verloor*
***LET WEL: GEEN BEREKENINGE WORD AANVAAR AS VERDUIDELIKING NIE*.** (3)

3.5 **POSITIVE MARKING FROM QUESTION 3.2 AND 3.3**
POSITIEWE NASIEN VANAF VRAAG 3.2 EN 3.3

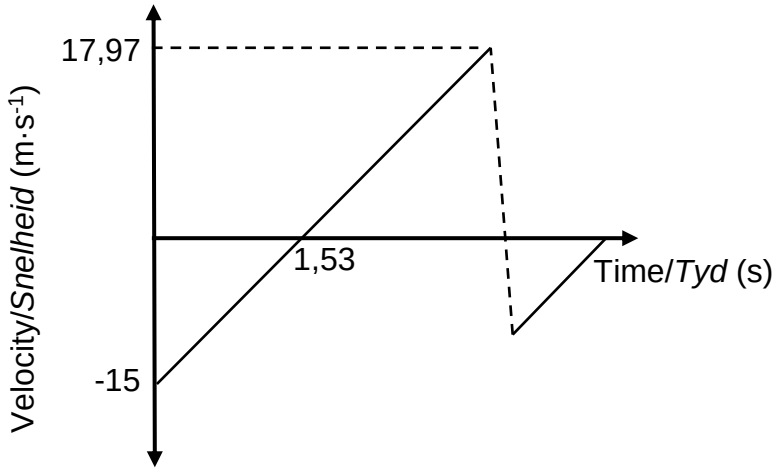
Criteria for graph/*Kriteria vir grafiek*	
• Straight line starting at v = 15 m·s^{-1} with negative final velocity or straight line starting at v = –15 m·s^{-1} with positive final velocity. *Reguitlyn wat begin by v = 15 m·s^{-1}met negatiewe finale snelheid of reguitlyn wat begin v = –15 m·s^{-1}* met positiewe finale snelheid.	✓
• Straight line cuts time axis at time calculated in Question 3.2/ *Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.*	✓
• Correct velocity as calculated in Q 3.3 and the ball is on the ground/ *Korrekte snelheid bereken in Vr 3.3 en die bal is op die grond*	✓
• Velocity of the second line is less than calculated in question Q 3.3, lines are drawn parallel and ends at v = 0 / *Snelheid van tweede lyn is minder as die waarde bereken in Vr 3.3, lyne is parallel geteken en eindig by v = 0*	✓
NOTE: Accept if no contact time is shown on the graph. ***NOTA**: Aanvaar indien geen kontaktyd op die grafiek getoon word*	

(4)

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



[15]

QUESTION 4/*VRAAG 4*

4.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The product of the resultant/net force acting on an object and the time the (net) force acts on the object.✓✓
Die produk van die resulterende/netto krag wat op 'n voorwerp inwerk en die tyd wat die (netto) krag op die voorwerp inwerk.

OR/*OF*

The product of the resultant/net force and the contact time.
Die produk van die resulterende/netto krag en die kontak tyd (2)

4.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
Gradient/F_{net} $= \frac{\Delta p_f}{\Delta(\Delta t)}$ $= \frac{4,5 - 0}{0,03 - 0,01}$ ✓ ✓ $= 225$ N F_{net} = 225 N to the right / opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*	$F_{net}\Delta t = \Delta p$ $F_{net}(0,01) = 0 - p_i$ ✓ ..... eq (1) $F_{net}(0,03) = 4,5 - p_i$ ✓ ..... eq (2) $4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$ F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*

OPTION 3/*OPSIE 3*

$F_{net}\Delta t = \Delta p$

$F_{net}(0,01) = 0 - 0,15v_i$ ✓ ..... eq (1)

$F_{net}(0,03) = 4,5 - 0,15v_i$ ✓ ..... eq (2)

$4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$

F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓

Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal (3)

4.2.2

POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF VRAAG 4.2.1

OPTION 1/*OPSIE 1*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = p_f - p_i$
$F_{net}\Delta t = mv_f - mv_i$
✓ Any one / *enige een*

$(225)(0,03)$ ✓ $= 4,5 - (0,15)v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = p_f - p_i$
$F_{net}\Delta t = mv_f - mv_i$
✓ Any one / *enige een*

$(225)(0,01)$ ✓ $= 0 - (0,15)v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 3/*OPSIE 3*

$p_f = F_{net}\Delta t + p_i$

$4,5 = 225(0,03) + p_i$ ✓

$p_i = -2,25$

$p_i = mv_i$ ✓

$-2,25 = 0,15v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 4/*OPSIE 4*

$F_{net} = ma$

$225 = 0,15a$ ✓

$a = 1500\ m\cdot s^{-2}$

$p_f = mv_f$

$4,5 = 0,15v_f$

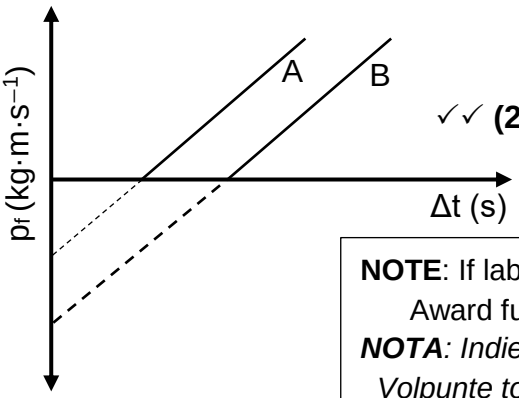
$v_f = 30\ m\cdot s^{-1}$

$a = \frac{\Delta v}{\Delta t}$ ✓

$1500 = \frac{30 - v_i}{0,03 - 0}$ ✓

$v_i = 15\ m\cdot s^{-1}$ ✓ (4)

4.3



✓✓ **(2 or 0)**

NOTE: If labels A and B not indicated ($^0/_2$)
Award full marks for solid lines with labels.
***NOTA**: Indien lyne nie benoem A en B ($^0/_2$)*
Volpunte toegeken vir soliede benoemde lyne

(2)
[11]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓
Die netto/totale arbeid wat (op 'n voorwerp) verrig is, is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/*OF*
The work done (on an object) by a resultant/net force is equal to the change in the object's kinetic energy.
Die arbeid verrig (op 'n voorwerp) deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

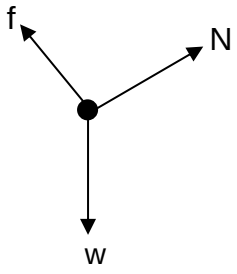
5.2

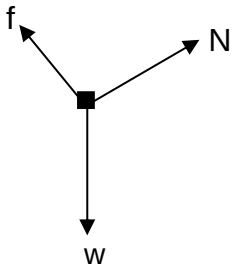
$W_{net} = \Delta E_k$
$W_{FA} = \Delta E_k$
$F_A \Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓ Any one / *Enige een*
$W_{nc} = \Delta E_p + \Delta E_k$

$(12)(7)\cos 0° = E_{kf} - 0$ ✓
$E_{kf} = 84$ J ✓ (3)

5.3

ACCEPT/*AANVAAR*:





Accepted labels/*Aanvaarde benoemings*	
w	F_w / F_g / mg /gravitational force / 29,4 N/ *gravitasiekrag* / weight / *gewig*
f	F_f / f_k / (kinetic) Friction / 21 N *(kinetiese) wrywing* / F_w
N	F_N / Normal (force) / *Normaal (krag)*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks* $^2/_3$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $^2/_3$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^2/_3$

(3)

5.4 **POSITIVE MARKING FROM 5.2/*POSITIEWE NASIEN VANAF VRAAG 5.2***

MARKING CRITERIA/NASIENKRITERIA:

- Correct substitution to calculate W_{Fg}/*Korrekte vervanging om W_{Fg} te bereken* ✓
- Correct substitution to calculate W_f/*Korrekte vervanging om W_f te bereken* ✓
- Correct substitution to calculate ΔE_k/*Korrekte vervanging om ΔE_k te bereken* ✓
- Correct final answer/*Korrekte finale antwoord* ✓
- Conclusion/*Gevolgtrekking* ✓

NOTE: ACCEPT for all options: cos70° of sin20°
NOTA: *AANVAAR vir alle opsies*: cos70° of sin20°

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = E_{kf} - E_{ki}$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = E_{kf} - E_{ki}$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$\underline{(3)(9,8)\sin 20°\Delta x\cos 0°}$ ✓ $\underline{+ 21\Delta x\cos 180°}$ ✓ $= 0 \underline{- 84}$ ✓
$\Delta x = 7,68$ m ✓

7,68 m > 6,8 m
The crate will pass point C. ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = \Delta E_k$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = \Delta E_k$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$\underline{(3)(9,8)\sin 20°(6,8)\cos 0°}$ ✓ $\underline{+ (21)(6,8)\cos 180°}$ ✓ $= \underline{E_{kf} - 84}$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52\ m\cdot s^{-1}$

9,58 J > 0 J **OR** $2,52\ m\cdot s^{-1} > 0\ m\cdot s^{-1}$
The crate will pass point C. ✓

OPTION 3/*OPSIE 3*

$\sin 20° = \frac{h}{6,8}$
$h = 2,326$ m

$W_{nc} = \Delta E_k + \Delta E_p$
$f_k\,\Delta x\cos\theta = + \Delta E_k + \Delta E_p$
$\underline{(21)(6,8)\cos 180°}$ ✓ $= (\underline{E_{kf} - 84})$ ✓ $\underline{- (3)(9,8)(2,326)}$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52\ m\cdot s^{-1}$

9,58 J > 0 J **OR** $2,52\ m\cdot s^{-1} > 0\ m\cdot s^{-1}$
The crate will pass point C. ✓

OPTION 4/*OPSIE 4*

Relative to C:
E_p at B = mgh = (3)(9,8)(6,8)sin 20°
= 68,38 J

$W_{nc} = \Delta E_k + \Delta E_p$
$\underline{(21)(6,8)\cos 180°}$ ✓ $= (\underline{E_{kf} - 84})$ ✓ + $(0 \underline{- 68,38})$ ✓
$E_{kf} = 9,58$ J ✓

The crate will pass point C. ✓

OPTION 5/*OPSIE 5*
$W_{net} = \Delta E_k$ $F_{net}\Delta x\cos\theta = E_{kf} - E_{ki}$ $[(3)(9,8)\sin 20° - 21]\checkmark\Delta x\cos 0°\checkmark = 0 - 84\checkmark$ $\Delta x = 7,68$ m ✓ 7,68 m > 6,8 m The crate will pass point C. ✓ **OR/*OF*** $[3(9,8)\sin 20° - 21]\checkmark(6,8)\cos 0°\checkmark = E_{kf} - 84$ ✓ $E_{kf} = 9,58$ J ✓ The crate will pass point C. ✓ (5)

[13]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*
The change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ *Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het.* **OR/OF** Is an (apparent) change in (observed/detected) frequency (pitch) as a result of the relative motion between a sound source and an observer. *Die (skynbare) verandering in (waargenome) frekwensie (toonhoogte) as gevolg van relatiewe beweging tussen die klankbron en 'n luisteraar* (2)

6.2.1 Velocity/speed/v_s of the ambulance/source ✓
Snelheid van die ambulans/klankbron (1)

6.2.2 **Frequency**/wavelength of the sound produced by the **ambulance siren** / f_s / **speed of sound**/ **density/temperature** of air/**detector/listener** is stationary ✓
***Frekwensie**/golflengte van die klank voortgebring deur die **sirene van die ambulans** / f_s / **spoed van klank** / **digtheid/temperatuur** van lug / **detektor/luisteraar** staan stil* (1)

6.3 As the velocity of the ambulance increases, the detected frequency decreases. ✓✓
Soos die snelheid van die ambulans toeneem, sal die waargenome frekwensie afneem.
NOTE: If inversely proportional indicated ***NOTA**: Indien omgekeerd eweredig* ($^0/_2$) (2)

6.4

Ambulance approaching/*Ambulans beweeg nader*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V - V_S} f_S$ ✓ Either/ *Enige*

✓ $1298 = \frac{v}{v - 25} f_S$

$v f_S = 1298(v - 25)$ ..... eq. (1)

Ambulance moving away/*Ambulans beweeg weg*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V + V_S} f_S$ ✓ Either/ *Enige*

✓ $1115 = \frac{v}{v + 25} f_S$

$v f_S = 1115(v + 25)$ ..... eq. (2)

(1) = (2) **OR/*OF*** (1) ÷ (2)

$\underline{1298(v - 25) = 1115(v + 25)}$ ✓ **OR/*OF*** $1{,}164(v - 25) = v + 25$

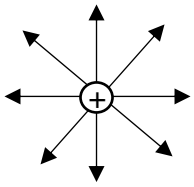
$v = 329{,}64\ m \cdot s^{-1}$ ✓

(6)
[12]

QUESTION 7/*VRAAG 7*

7.1 A region of space in which an electric charge experiences a force. ✓✓
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind **(2 or 0)** (2)

7.2



Marking criteria/*Nasienkriteria*:	
Direction / *Rigting*	✓
Field lines radially outward/*Veldlyne radiaal uitwaarts*	✓
Two or more field lines inside sphere / not touching sphere / cross each other: deduct 1 mark *Twee of meer veldlyne binne sfeer / raak nie aan sfeer / kruis: trek 1 punt af* If more than one charge drawn/*Indien meer as een lading geteken*: $^0/_2$	

(2)

7.3

$E = \frac{kQ}{r^2}$ ✓

$1{,}08 \times 10^6$ ✓ $= \frac{(9 \times 10^9)(3 \times 10^{-7})}{r^2}$ ✓

$r = 0{,}05$ m (3)

7.4

NOTE: Ignore if negative charges are substituted.
***NOTA**: Ignoreer indien negatiewe ladings invervang is*

OPTION 1/*OPSIE 1*

$F_{XY} = \frac{kQ_XQ_Y}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓

$= 0,54$ N

$F_{XZ} = \frac{kQ_XQ_Z}{r^2}$

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,68$ N

$F_{net}(E) = F_{XZ} + F_{XY}$
$= \underline{0,68 - 0,54}$ ✓
$= 0,14$ N

No/*Nee* ✓
$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 2/*OPSIE 2*

$E_{net} = \frac{kQ}{r^2} + \frac{kQ}{r^2}$

$= \frac{(9 \times 10^9)(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(4 \times 10^{-7})}{(0,04)^2}$ ✓

$E_{net} = 450\ 000$ N·C^{-1}

$F_{net} = qE$ ✓
$F_{net} = \underline{(3 \times 10^{-7})(450\ 000)}$ ✓
$F_{net} = 0,14$ N

No/*Nee* ✓
$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 3/*OPSIE 3*

$F_{net}(E) = \frac{kQ_XQ_Y}{r^2} - \frac{kQ_XQ_Z}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,14$ N

$0,0427 = 0,14 - f$ ✓
$f = 0,0923$ N ✓

No/*Nee* ✓

(6)

7.5 Decrease/*Neem af* ✓✓ (2)

[15]

QUESTION 8/*VRAAG 8*

8.1 Maximum/ Total energy provided / work done by a battery/ cell per unit/ coulomb of charge passing through it. ✓✓
Die maksimum/ totale energie gelewer/ arbeid verrig deur battery per eenheids/ coulomb-lading wat daardeur vloei. **(2 or 0)** (2)

8.2
$$R = \frac{V}{I}\checkmark$$
$$0{,}1 = \frac{V}{120}\checkmark$$
$$V = 12\ V\ \checkmark$$
(3)

8.3.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P = I^2R$ ✓ $15 = I^2(12)$ ✓ $I = 1{,}12\ A$ ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13{,}42\ V$ $P = VI$ ✓ $15 = (13{,}42)I$ ✓ $I = 1{,}12\ A$ ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13{,}42\ V$ $V = IR$ ✓ $13{,}42 = I(12)$ ✓ $I = 1{,}12\ A$ ✓

(3)

8.3.2

POSITIVE MARKING FROM QUESTION 8.3.1 ***POSITIEWE NASIEN VANAF VRAAG 8.3.1***
$A_1 = (1{,}12)(2)$ $= 2{,}24\ A$ ✓

(1)

8.4

POSITIVE MARKING FROM QUESTION 8.2 and 8.3.2
POSITIEWE NASIEN VANAF VRAAG 8.2 en 8.3.2

[RANGE: 13,42 V – 13,47 V]

OPTION 1/*OPSIE 1*

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

$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{12}$ ✓

$R_p = 6\ \Omega$

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

$R_p = \frac{(12)(12)}{12 + 12}$ ✓

$R_p = 6\ \Omega$

When S_1 closed and S_2 open/*Wanneer S_1 gesluit en S_2 oop is*:

$\varepsilon_1 = I(R + r)$ ✓

$= 2{,}24(6 + r)$ ✓

When S_1 open and S_2 closed/*Wanneer S_1 oop en S_2 gesluit is*:

$\varepsilon_2 = I(R + r)$

$= 120(0{,}1 + r)$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)

$2{,}24(6 + r) = 120(0{,}1 + r)$ ✓

$r = 0{,}012\ \Omega$

$\varepsilon = I(R + r)$
$= 2{,}24(6 + 0{,}012)$
$= 13{,}46$ V ✓

OR/*OF*

$\varepsilon = IR + Ir$
$= 120(0{,}1 + 0{,}012)$
$= 13{,}47$ V ✓

OPTION 2/*OPSIE 2*

$\varepsilon_1 = IR + Ir$ ✓

$= 12 + 120r$ ✓

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

$15 = \frac{V^2}{12}$ ✓

$V = 13{,}42$ V

OR/*OF*

$V_p = IR$
$= 2{,}24(6)$ ✓
$= 13{,}44$ V

OR/*OF*

$V_P = IR$
$= 1{,}12(12)$ ✓
$= 13{,}44$ V

$\varepsilon_2 = V_{ext} + Ir$

$= 13{,}42 + 2{,}24r$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)

$12 + 120r = 13{,}42 + 2{,}24r$ ✓

$r = 0{,}012\ \Omega$

$\varepsilon_1 = IR + Ir$
$= 12 + (120)(0{,}012)$
$= 13{,}47$ V ✓

$\varepsilon_2 = IR + Ir$
$= 13{,}42 + (2{,}24)(0{,}012)$
$= 13{,}45$ V ✓

(6)

8.5

Decrease✓
- Total/External resistance decreases ✓
- Total current increases. ✓
- $V_{internal}$ increases✓
- Voltage across the light bulbs decreases / $V_{external}$ decreases. ✓

NOTE: Calculation given as explanation $^{1}/_{5}$

Neem af
- *Totale/Eksterne weerstand neem af*
- *Totale stroom neem toe*
- V_{intern} *neem toe*
- *Potensiaalverskil oor die gloeilamp neem af /* $V_{ekstern}$ *neem af*

NOTA: Berekening gegee as verduideliking $^{1}/_{5}$

ACCEPT/*AANVAAR:*
NOTE/*NOTA*: max: $^{3}/_{5}$
Mark for INCREASES will ONLY be awarded if explanation is correct
Punt vir TOENEEM sal SLEGS toegeken word indien verduideliking korrek is

Refer to the explanation first to check if the candidate is referring to Q8.2
Verwys na verduideliking eerste om te bepaal of die kandidaat verwys Vr8.2

Increases ✓
- Initial reading of A_1 = 0 A when switch S_1 is open ✓
- Now both switch closed the current is flowing through the circuit. ✓

Toeneem
- *Aanvanklike lesing op* A_1 *= 0 A wanneer skakelaar* S_1 *oop is*
- *Nou is beide skakelaars gesluit en stroom vloei deur die stroombaan*

(5)
[20]

QUESTION 9/*VRAAG 9*

9.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die* ***korrekte konteks*** *uitgelaat is, trek 1 punt af.*
The AC potential difference /voltage that produces/dissipates the same amount of energy as an equivalent DC potential difference/voltage. ✓✓
Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente GS-potensiaalverskil.

NOTE: If DC written first/ energy or heating effect is omitted/ alternating current is defined: $^{0}/_{2}$
LET WEL: *Indien GS eerste geskryf/ energie of verhittingseffek uitgelaat is/ wisselstroom gedefinieer :* $^{0}/_{2}$ (2)

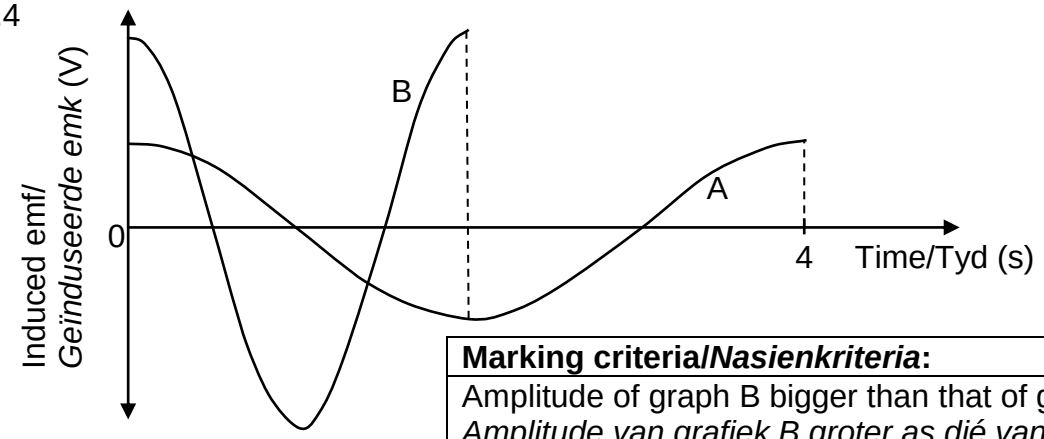
9.2 N/North/*Noord* ✓✓ (2)

9.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW cost = PΔt × tariff $= \underline{0,80659(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW E = PΔt $= \underline{0,80659(1,5)}$ = 1,21 kWh ✓ for both/*beide* cost = E × tariff $= \underline{1,21(3,33)}$ = R4,03 ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$P_{ave} = V_{rms}I_{rms}$ ✓ $= \left(\frac{311,11}{\sqrt{2}}\right)$ ✓ $\left(\frac{220}{60}\right)$ ✓ $= 806,67$ W $= 0,8067$ kW cost = PΔt × tariff $= \underline{0,8067(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $W = \frac{V^2}{R}\Delta t$ ✓ $= \frac{(219,99)^2}{60}(1,5)(10^{-3})$ ✓ = 1,21 kWh Cost = E x tariff $= \underline{(1,21)(3,33)}$ ✓ = R4,03 ✓

(5)

9.4



Marking criteria/*Nasienkriteria*:	
Amplitude of graph B bigger than that of graph A *Amplitude van grafiek B groter as dié van A*	✓
Period of B is half of A/*Periode van B helfte van A*	✓
Correct shape and one cycle(Cosine graph)/ *Vorm en een siklus(cos-grafiek)*	✓

(3)

9.5 By <u>replacing slip rings</u> with <u>split ring commutator / split ring / commutator</u>.✓
Vervang sleepringe met splitring kommutator / splitring / kommutator (1)

[13]

QUESTION 10/*VRAAG 10*

10.1.1 **Marking criteria/*Nasienkriteria***

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

Minimum energy needed for the electrons to be emitted from the metal surface ✓✓

Die minimum energie benodig om 'n elektron uit die oppervlak van 'n metaal vry te stel.

NOTE: If threshold frequency defined

***NOTA**: Indien drumpelfrekwensie gedefinieer:* $^0/_2$ (2)

10.1.2 $1{,}045 \times 10^{15}$ Hz ✓ (1)

10.1.3 Greater than ✓

- The maximum kinetic energy of electrons from sodium is smaller. ✓
- E is constant / same frequency used / same light used ($E_{K(max)}$ is smaller; W_0 is larger).✓

Groter as

- *Die maksimum kinetiese energie van die elektrone van natrium sal kleiner wees.*
- *E is konstant/ dieselfde frekwensie gebruik/dieselfde lig gebruik is (sal $E_{k(maks)}$ kleiner wees; W_0 groter)* (3)

10.1.4 No ✓

- The intensity of light does not have any effect on the ejection of electrons for metal M ✓ **OR**
- The frequency of light has not changed / Energy of a photon has not changed.

Nee

- *Die intensiteit van die lig het geen invloed op die vrystelling van elektrone vir metaal M nie **OF***
- *Die frekwensie van lig het nie verander nie/ Energie van fotone het nie verander* (2)

10.2.1

OPTION 1/*OPSIE 1*

$E = hf$ ✓

$\underline{5{,}7 \times 10^{-19} - 1{,}3 \times 10^{-19}}$ ✓ $= \underline{(6{,}63 \times 10^{-34})\, f}$ ✓

$f = 6{,}64 \times 10^{14}$ Hz ✓

Accept $E_3 - E_1$ **OR** $E_1 - E_3$ in all options
Aanvaar: $E_3 - E_1$ **OF** $E_1 - E_3$ in alle opsies

OPTION 2/*OPSIE 2*

$\Delta E = E_1 - E_3$

$= \underline{1{,}3 \times 10^{-19} - 5{,}7 \times 10^{-19}}$ ✓

$= -4{,}4 \times 10^{-19}$

$E = hf$ ✓

$4{,}4 \times 10^{-19} = \underline{(6{,}63 \times 10^{-34})f}$ ✓

$f = 6{,}64 \times 10^{14}$ Hz ✓

f must be positive/ *f moet positief wees*

(4)

10.2.2 No ✓ The energy does not correspond to any transition in this atom ✓

Nee Die energie stem nie ooreen met enige oorgang in hierdie atoom nie (2)

[14]

TOTAL/*TOTAAL*: 150