Western Cape Government
Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1) - MEMORANDUM

SEPTEMBER 2024

MARKS: **150**

TIME: **3 hours**

GRADE 12 **MARKING GUIDELINE** **SEPTEMBER 2024**

QUESTION 1

1.1 D ✓✓

1.2 B ✓✓

1.3 D ✓✓

1.4 C ✓✓

1.5 C ✓✓

1.6 D ✓✓

1.7 C ✓✓

1.8 A ✓✓

1.9 A ✓✓

1.10 D ✓✓

[20]

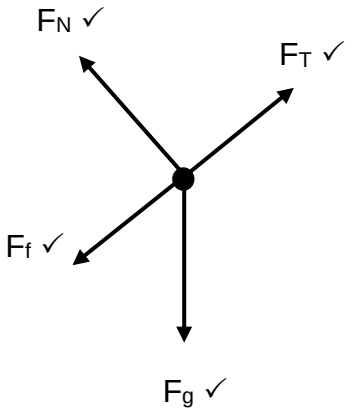
QUESTION 2

2.1.1

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 sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

A body will remain in(its state of)rest or motion at constant velocity unless a non-zero resultant/net force/unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.
OR/*OF*
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net /unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto/ongebalanseerde krag daarop inwerk. (2)

2.1.2



Accepted Labels:

w	F_g / F_w / weight / mg / gravitational force/ force of gravity
T	F_T / Tension / F_{string}
f_k	$F_{friction}$ / F_f / Friction
N	F_{Normal} / Normal / F_N

Notes:

Mark awarded for label and arrow
Do not penalise for length of arrows since drawing is not to scale.
Any other additional force(s) → Max 3/4
If force(s) do not make contact with body → Max 3/4
NO MARK awarded for drawing F_g components .

(4)

2.1.3 $f_k = \mu_k N$ ✓
$f_k = (0,2)(9,8 \times 8)\cos 30^o$ ✓
$f_k = 13,579$ (or 13,58) N ✓ (3)

2.1.4 **POSITIVE MARKING from 2.1.3.**

8 kg Block

$F_{net} = ma$ ✓

$T + f_k + F_{g//} = ma$

$T - 13,579 - (8 \times 9,8)\sin 30^o$ ✓ $= 0$

$T = 52,779$ N

m_2 Block

$F_{net} = ma$

$F_g - T = ma$

$9,8m_2 - 52,779$ ✓ $= 0$

$9,8m_2 = 52,78$

$m_2 = 5,386$ kg OR $5,39$ kg ✓

✓ any one subst. of 0

Note: Accept using energy principles for full marks.
Note: if using the systems approach, max. 2 marks.[1 mark for formula and 1 mark for final answer only] (5)

2.1.5 INCREASE. ✓

From point Y onwards the 8 kg block is moving on a frictionless surface therefore force acting up the slope is greater / force acting down the slope is less.
OR
Net force increases since frictional force is absent.
OR
There is now an unbalanced force acting on the object.
OR
Acceleration is no longer zero. ✓ (2)

2.2.1 Every body in the universe attracts every other body with a force which is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres ✓ (2)

2.2.2

$$F = \frac{Gm_1m_2}{r^2} \quad ✓$$

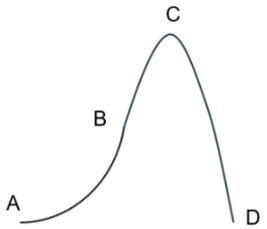
$$Fg = \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(6,417 \times 10^{23}) ✓}{(6,38 \times 10^6 + 4,50 \times 10^9 + 3,3895 \times 10^6)^2 ✓}$$

$Fg = 1,2585 \times 10^{19}$ (or $1,26 \times 10^{19}$) N ✓ (4)

[22]

QUESTION 3

3.1 1,8 (s) – t_2 . ✓ (1)



3.2 **Marking criteria:**

- Correct formula for a ✓
- Correct substitution into formula ✓
- Final answer correct WITH direction ✓

- Accept gradient method for full marks.
- Accept using energy principles for full marks.

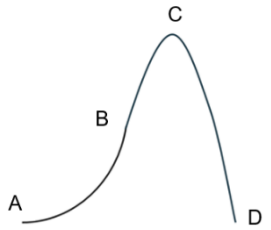
OPTION 1: (AB)	**OPTION 2: (AB)**
UPWARDS AS POSITIVE: $v_f = v_i + a\Delta t$ ✓ 29,7 = 0 + a(1,8) ✓ a = 16,50 m·s^{-2} up ✓ Do not penalise for a = 16,5 m·s^{-2} up	**DOWNWARDS AS POSITIVE:** $v_f = v_i + a\Delta t$ ✓ -29,7 = 0 + a(1,8) ✓ a = - 16,50 m·s^{-2} a = 16,50 m·s^{-2} up ✓
OPTION 3: $F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $ma = \frac{m(v_f - v_i)}{\Delta t}$ $a = \frac{(29,7-0)}{1,8}$ ✓ a = 16,50 m·s^{-2} , up ✓	

(3)

3.3 POSITIVE MARKING FROM 3.2

Marking criteria:

- Correct formula with Δy ✓
- Correct substitution into formula ✓
- Correct substitution into: $v_f^2 = v_i^2 + 2a\Delta y$ ✓
- Addition of displacements for max height ✓
- Final answer correct ✓



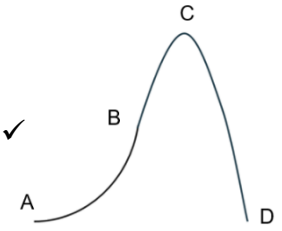
OPTION 1 **UPWARDS AS POSITIVE:** **Δy: (AB)** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(29,7)^2 = (0)^2 + 2(16,50)\Delta y$ ✓ $\Delta y = 26,73$ m, (upwards) **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 45,005$ m (upwards) Max height = 26,73 +✓ 45,0046 = 71,735 (or 71,73) m ✓	**OPTION 2** **DOWNWARDS AS POSITIVE:** **Δy: (AB)** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-29,7)^2 = (0)^2 + 2(-16,50)\Delta y$ ✓ $\Delta y = -26,73$ m $\Delta y = 26,73$ m, upwards **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -45,0046$ m $\Delta y = 45,005$ m, upwards Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓
OPTION 3 **UPWARDS AS POSITIVE:** **Δy: (AB)** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (0)(1,8) + \frac{1}{2}(16,5)(1,8)^2$ ✓ $\Delta y = 26,73$ m **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 45,005$ m (upwards) Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓	**OPTION 4** **DOWNWARDS AS POSITIVE:** **Δy: (AB)** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (0)(1,8) + \frac{1}{2}(-16,5)(1,8)^2$ ✓ $\Delta y = -26,73$ m $\Delta y = 26,73$ m, upwards **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -45,0046$ m $\Delta y = 45,005$ m, upwards Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓

OPTION 5	**OPTION 6**
UPWARDS AS POSITIVE:	**DOWNWARDS AS POSITIVE:**
Δy: (AB)	**Δy: (AB)**
$\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(29,7)}{2}(1,8)$ ✓ Δy = 26,73 m	$\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(-29,7)}{2}(1,8)$ ✓ Δy = - 26,73 m Δy = 26,73 m, upwards
Δy: (BC)	**Δy: (BC)**
$v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ Δy = 45,0046 m (upwards)	$v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ Δy = - 45,0046 m Δy = 45,0046 m, upwards
Max height = 26,73 + ✓45,0046 = 71,7346 (or 71,73) m ✓	Max height = 26,73 +✓ 45,0046 = 71,7346 (or 71,73) m ✓

(5)

Marking criteria:

- Correct formula with Δy ✓
- Correct substitution into formula ✓
- Correct substitution of Δt into: $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓
- Addition for max height ✓
- Final answer correct ✓



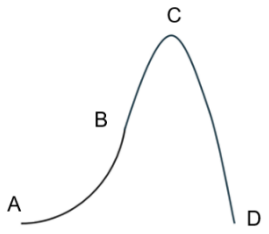
OPTION 7 **UPWARDS AS POSITIVE:**	**OPTION 8** **DOWNWARDS AS POSITIVE:**
Δy: (AB) $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(29,7)}{2}(1,8)$ ✓ Δy = 26,73 m	**Δy: (AB)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(-29,7)}{2}(1,8)$ ✓ Δy = - 26,73 m Δy = 26,73 m, upwards
Δt: (BC) $v_f = v_i + a\Delta t$ 0 = 29,7 + (-9,8) Δt Δt = 3,0306 s	**Δt: (BC)** $v_f = v_i + a\Delta t$ 0 = (-29,7) + (9,8) Δt Δt = 3,0306 s
Δy: (BC) $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ $\Delta y = \frac{(29,7)+(0)}{2}(3,0306)$ ✓ Δy = 45,0044 m	**Δy: (BC)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ $\Delta y = \frac{(-29,7)+(0)}{2}(3,0306)$ ✓ Δy = - 45,0044 m Δy = 45,0044 m, upwards
Max height = 26,73 + ✓ 45,0044 = 71,7344 (or 71,73) m ✓	Max height = 26,73 + ✓ 45,0046 = 71,7344 (or 71,73) m ✓

(5)

3.4 POSITIVE MARKING FROM 3.3

Marking criteria:

- Formula with Δt ✓
- Correct substitution into formula Δt ✓
- Addition of total time ✓
- Final answer correct ✓



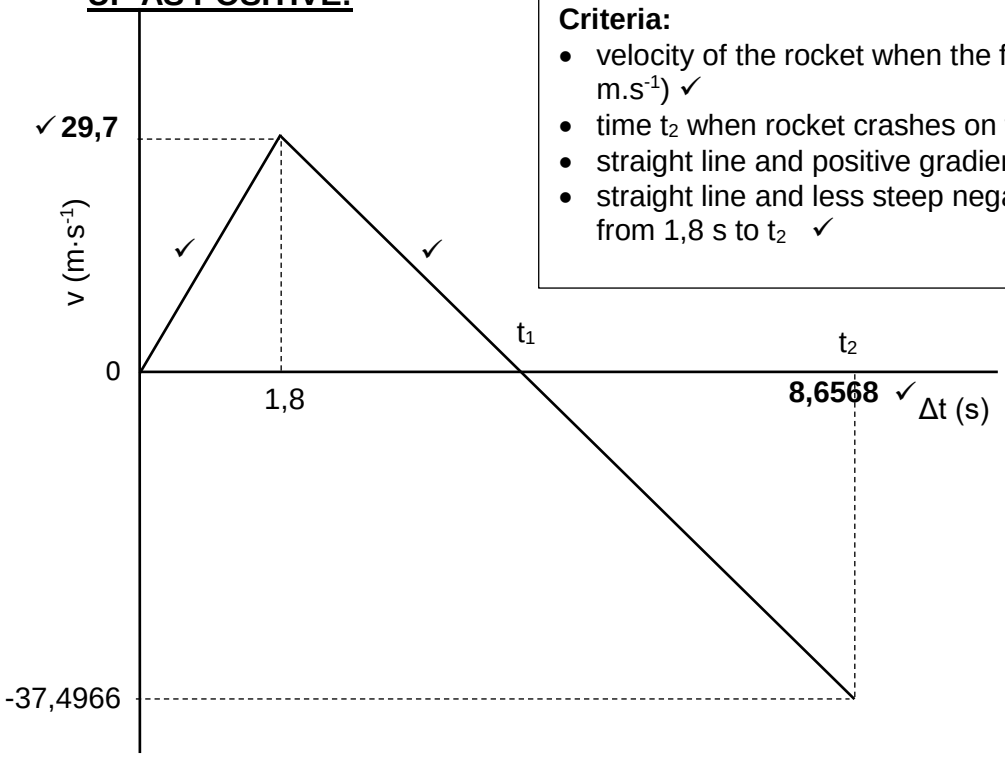
OPTION 1:	**OPTION 2:**
UPWARDS POSITIVE **Δt: (BD)** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $-26,73 = (29,7)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 6,8568$ s **Value of t_2** $t_2 = 1,8 + 6,8568$ ✓ $= 8,6568$ (or 8,66) s ✓	**DOWNWARDS POSITIVE** **Δt: (BD)** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $26,73 = (-29,7)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 6,8568$ s **Value of t_2** $t_2 = 1,8 + 6,8568$ ✓ $= 8,6568$ (or 8,66) s ✓
OPTION 3:	**OPTION 4:**
UPWARDS POSITIVE **Δt: (CD)** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $-71,7346 = (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 3,82618$ s **Value of t_2** $t_2 = 1,8 + 3,0306 + 3,82618$ ✓ $= 8,65678$ (or 8,66) s ✓	**DOWNWARDS POSITIVE** **Δt: (CD)** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $71,7346 = (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 3,82618$ s **Value of t_2** $t_2 = 1,8 + 3,0306 + 3,82618$ ✓ $= 8,65678$ (or 8,66) s ✓

OPTION 5	**OPTION 6**
UPWARDS AS POSITIVE: **v_f: (BD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (29,7)^2 + 2(-9,8)(-26,73)$ $v_f = -37,4966\ m.s^{-1}$ **Δt: (BD)** $v_f = v_i + a\Delta t$ ✓ $(-37,4966) = (29,7) + (-9,8)\Delta t$ ✓ $\Delta t = 6,8568$ s s **Value of t_2** **t_2** = 1,8 + 6,8568 ✓ = 8,6568 (or 8,66) s ✓	**DOWNWARDS AS POSITIVE:** **v_f: (BD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (-29,7)^2 + 2(9,8)(26,73)$ $v_f = 37,4966\ m.s^{-1}$ **Δt: (BD)** $v_f = v_i + a\Delta t$ ✓ $(37,4966) = (-29,7) + (9,8)\Delta t$ ✓ $\Delta t = 6,8568$ s s **Value of t_2** **t_2** = 1,8 + 6,8568 ✓ = 8,6568 (or 8,66) s ✓
OPTION 7 **UPWARDS AS POSITIVE:** **v_f: (CD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + 2(-9,8)(-71,7346)$ $v_f = -37,4966\ m.s^{-1}$ **Δt: (CD)** $v_f = v_i + a\Delta t$ ✓ $(-37,4966) = (0) + (-9,8)\Delta t$ ✓ $\Delta t = 3,82618$ s **Value of t_2** **t_2** = 1,8 + 3,0306 + 3,82618 ✓ = 8,65678 (or 8,66) s ✓	**OPTION 8** **DOWNWARDS AS POSITIVE:** **v_f: (CD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (-0)^2 + 2(9,8)(\ 71,7346)$ $v_f = 37,4966\ m.s^{-1}$ **Δt: (CD)** $v_f = v_i + a\Delta t$ ✓ $(37,4966) = (-0) + (9,8)\Delta t$ ✓ $\Delta t = 3,82618$ s **Value of t_2** **t_2** = 1,8 + 3,0306 + 3,82618 ✓ = 8,65678 (or 8,66) s ✓

(4)

3.5 **POSITIVE MARKING FROM 3.3 and 3.4**

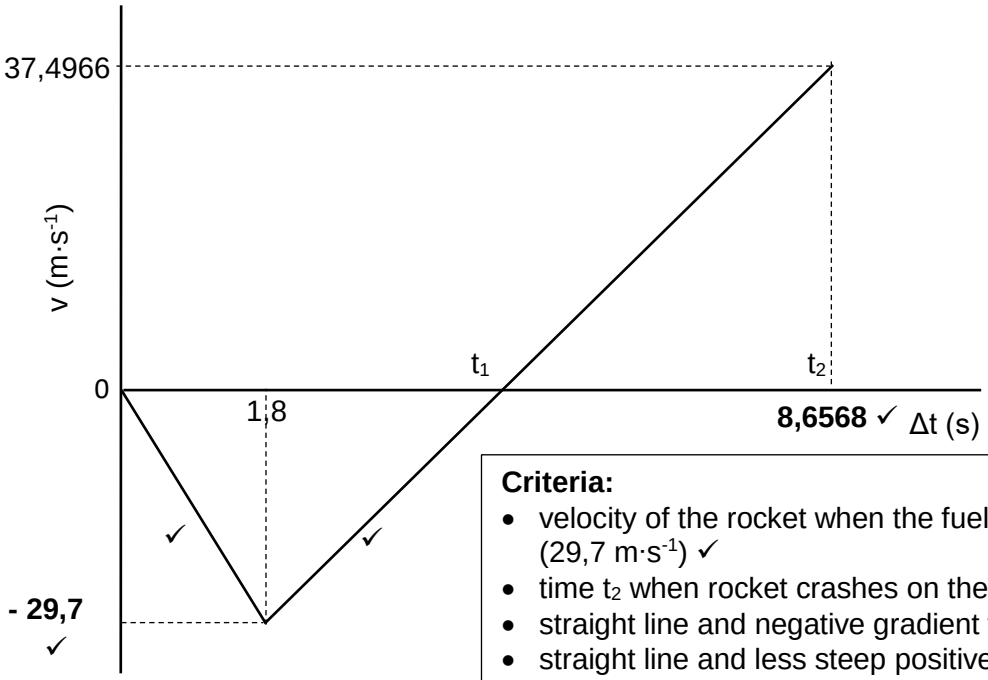
UP AS POSITIVE:



Criteria:
- velocity of the rocket when the fuel runs out (29,7 $m.s^{-1}$) ✓
- time t_2 when rocket crashes on the ground ✓
- straight line and positive gradient for first 1,8 s ✓
- straight line and less steep negative gradient from 1,8 s to t_2 ✓

(4)

DOWN AS POSITIVE:



Criteria:
- velocity of the rocket when the fuel runs out (29,7 $m·s^{-1}$) ✓
- time t_2 when rocket crashes on the ground ✓
- straight line and negative gradient for first 1,8 s ✓
- straight line and less steep positive gradient from 1,8 s to t_2 ✓

(4)
[17]

QUESTION 4

4.1 In an isolated system ✓ the <u>total</u> mechanical energy remains constant/is conserved ✓

OR

In an isolated system ✓The sum of gravitational potential energy and kinetic energy remains constant ✓ (2)

4.2

$$(E_p + E_k)_{Before} = (E_p + E_k)_{After}$$

$$(mgh + \tfrac{1}{2}mv^2)_{Before} = (mgh + \tfrac{1}{2}mv^2)_{After} \quad ✓$$

$$(3)(9,8)(1,2) ✓ + \tfrac{1}{2}(3)(0)^2 = (3)(9,8)(0) + \tfrac{1}{2}(3)v^2 \quad ✓$$

$$v = 4,8497 \text{ or } 4,85 \text{ m·s}^{-1} ✓$$

Accept W_{NC} for full marks. (4)

4.3 In an isolated system ✓ <u>total</u> linear momentum remains constant /is conserved. ✓

OR

In an isolated system the <u>total</u> linear momentum before collision equals the <u>total</u> momentum after collision. ✓ → [1 mark]

<u>NOTE: NO marks to be awarded if **closed system** is used.</u> (2)

4.4 **POSITIVE MARKING FROM 4.2**

Right +

$$\sum p_{before} = \sum p_{after} \quad ✓$$

$$m_p v_{pi} + m_b v_{bi} = m_p v_{pf} + m_p v_{bf}$$

$$(3)(4,8497) ✓ + (1)(0) = (3)(1,8) + (1)v_{bf} ✓$$

$$v_{bf} = 9,1491 \text{ (9,15) m·s}^{-1} ✓ \text{ (right)}$$

(4)

4.5 **POSITIVE MARKING FROM 4.4**

$$(E_p + E_k)_{Before} = (E_p + E_k)_{After}$$

$$(mgh + \tfrac{1}{2}mv^2)_{Before} = (mgh + \tfrac{1}{2}mv^2)_{After}$$

$$(1)(9,8)(0) + \tfrac{1}{2}(1)(9,1491)^2 ✓ = (1)(9,8)h ✓ + \tfrac{1}{2}(1)(0)^2$$

$$h = 4,27 \text{ m} ✓$$

Accept W_{NC} for full marks

Do NOT accept equations of motion. (3)

[15]

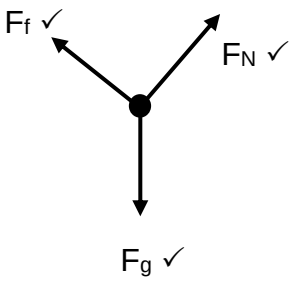
QUESTION 5

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 work done on an object by a force is equal to the change in the object's kinetic energy. ✓✓ OR
The work done on an object by a resultant / net force is equal to the change in the object's kinetic energy. ✓✓ (2)

5.2



Accepted Labels:

w	F_g / F_w / weight / mg / gravitational force/ force of gravity
f_k	$F_{friction}$ / F_f / Friction
N	F_{Normal} / Normal / F_N

Notes:

Mark awarded for label and arrow
Do not penalise for length of arrows since drawing is not to scale.
Any other additional force(s) → Max 2/3
If force(s) do not make contact with body → Max 2/3

(3)

5.3

OPTION 1

$$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity} \checkmark$$

$$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$$

$$W_{net} = 0 + \underline{(0,42)(850)(9.8)(\cos 30°)} \checkmark \underline{(200)(\cos 180°)} \checkmark + \underline{(850)(9,8)(200)(\cos 60°)} \checkmark$$

$$W_{net} = (-\ 605\ 975{,}2955) + 833\ 000$$

$$W_{net} = 227\ 024{,}7045 \text{ (or } 227\ 024{,}7) \text{ J} \checkmark$$

OR

$$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity} \checkmark$$

$$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$$

$$W_{net} = 0 + \underline{(0,42)(850)(9.8)(\cos 30°)} \checkmark \underline{(200)(\cos 180°)} \checkmark + \underline{(850)(9,8)\sin 30^0(200)(\cos 0°)} \checkmark$$

$$W_{net} = (-\ 605\ 975{,}2955) + 833\ 000$$

$$W_{net} = 227\ 024{,}7045\ (227\ 024{,}7) \text{ J} \checkmark$$

(Check the range)

OPTION 2

$$W_{net} = \Delta E_K \checkmark$$

$$(W_{Fnormal}) + W_{friction} + W_{Fgravity} = \Delta E_K$$

$$(0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta = \Delta E_K$$

$$0 + \underline{(0,42)(850)(9.8)(\cos 30°)}\checkmark\underline{(200)(\cos 180°)}\checkmark + \underline{(850)(9,8)(200)(\cos 60°)}\checkmark = \Delta E_K$$

$$- 605\,975,2955 + 833\,000 = \Delta E_K$$

$$W_{net} = \Delta E_K = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

OPTION 3

$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity} \checkmark$

$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$

$W_{net} = (0) + \underline{(0,42)(850)(9.8)(\cos 30°)}\checkmark\underline{(200)(\cos 180°)}\checkmark + \underline{(850)(9,8)(100)(\cos 0°)}\checkmark$

$W_{net} = (- 605\,975,2955) + 833\,000$

$W_{net} = 227\,024,7045$ (or $227\,024,7$) J ✓

OPTION 4

$$W_{net} = \Delta E_K \checkmark$$

$$(W_{Fnormal}) + W_{friction} + W_{Fgravity} = \Delta E_K$$

$$(0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta = \Delta E_K$$

$$0 + \underline{(0,42)(850)(9.8)(\cos 30°)}\checkmark\underline{(200)(\cos 180°)}\checkmark + \underline{(850)(9,8)(100)(\cos 0°)}\checkmark = \Delta E_K$$

$$- 605\,975,2955 + 833\,000 = \Delta E_K$$

$$W_{net} = \Delta E_K = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

OPTION 5

$$F_{net} = F_{g\,//} - F_k$$

$$F_{net} = (850)(9,8)(\sin 30°) – (0,42)(850)(9,8)(\cos 30°) \checkmark$$

$$F_{net} = 1135,123522 \text{ N}$$

$$W_{net} = F_{net}.\Delta x.\cos\theta \checkmark$$

$$W_{net} = (1135,123522) \checkmark (200)(\cos 0°) \checkmark$$

$$W_{net} = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

(5)

5.4

$\Delta E_{K \text{ from B to C}} = E_{Kf} - E_{Ki}$

$\underline{- 108\,950 = E_{Kf} - 227\,024,7045}$ ✓

$E_{Kf \text{ at C}} = 118\,074,7045$

OPTION 1

$W_{net} = \Delta E_K$ ✓

$W_{Fnormal} + W_{Fgravity} + W_{friction} + W_{Fbrakes} = \Delta E_K$

$0 + 0 + \mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = E_{Kf \text{ at D}} - E_{Ki \text{ at C}}$

$0 + 0 + \underline{(0,42)(850)(9.8)}$ ✓$\underline{(50)(\cos 180°)}$ ✓ $+ \underline{F_{brakes}.(50)(\cos 180°)}$ ✓ $= \underline{0 - 118\,074,7045}$ ✓

$F_{brakes} = - 1137,106 \text{ N}$

$\therefore$ magnitude of $F_{brakes} = 1137,106 \text{ N}$ ✓

OPTION 2

$W_{nc} = \Delta E_P + \Delta E_K$ ✓

$W_{friction} + W_{Fbrakes} = (E_{P \text{ at D}} - E_{P \text{ at C}}) + (E_{Kf \text{ at D}} - E_{Ki \text{ at C}})$

$\mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = (mgh_D - mgh_C) + (E_{Kf \text{ at D}} - E_{Ki \text{ at C}})$

$\underline{(0,42)(850)(9.8)}$✓$\underline{(50)(\cos 180°)}$✓ $+ \underline{F_{brakes}.(50)(\cos 180°)}$✓ $= (0 - 0) + \underline{(0 - 118\,074,7045)}$ ✓

$F_{brakes} = - 1137,106 \text{ N}$

$\therefore$ magnitude of $F_{brakes} = 1137,106 \text{ N}$ ✓

OPTION 3 and 4

$\Delta E_{K \text{ from B to C}} = E_{Kf} - E_{Ki}$

$\underline{-108\,950 = E_{Kf} - 227\,024,7045}$ ✓

$E_{Kf \text{ at C}} = 118\,074,7045$ J

$E_{K \text{ at C}} = \frac{1}{2}mv^2$

$118\,074,7045 = \frac{1}{2}(850)v^2$

$v_{at\ C} = 16,6680$ m·s^{-1}

OPTION 3

$W_{net} = \Delta E_K$ ✓

$W_{Fnormal} + W_{Fgravity} + W_{friction} + W_{Fbrakes} = \frac{1}{2}m(v_f^2 - v_i^2)$

$0 + 0 + \mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$

$\underline{(0,42)(850)(9,8)}$ ✓$\underline{(50)(\cos 180°)}$ ✓ + $\underline{F_{brakes}.(50)(\cos 180°)}$ ✓ $= \frac{1}{2}(850)(0^2 - 16,6680^2)$ ✓

$F_{brakes} = -1137,106$ N

∴ magnitude of $F_{brakes} = 1137,106$ N ✓

OPTION 4

$W_{nc} = \Delta E_P + \Delta E_K$ ✓

$W_{friction} + W_{Fbrakes} = (E_{P \text{ at D}} - E_{P \text{ at C}}) + \frac{1}{2}m(v_f^2 - v_i^2)$

$\mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = (mgh_D - mgh_C) + \frac{1}{2}m(v_f^2 - v_i^2)$

$\underline{(0,42)(850)(9,8)}$ ✓$\underline{(50)(\cos 180°)}$ ✓ + $\underline{F_{brakes}.(50)(\cos 180°)}$ ✓ $= (0 - 0) + \frac{1}{2}(850)(0^2 - 16,6680^2)$ ✓

$F_{brakes} = -1137,106$ N

∴ magnitude of $F_{brakes} = 1137,106$ N ✓

(7)
[17]

QUESTION 6

6.1 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. ✓ **OR**

The apparent change in frequency/pitch/wavelength ✓ of the sound detected by the listener due to the relative motion between listener and source. ✓ (2)

6.2

Moving Towards

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$253\,380 = \frac{v}{v-20} f_s$ ✓

$f_s = \frac{(253\,380)(v-20)}{v}$

✓ (Converting)

Moving Away

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$

$246\,710 = \frac{v}{v+20} f_s$ ✓

$f_s = \frac{(246\,710)(v+20)}{v}$

Equate

$\frac{(253\,380)(v-20)}{v} = ✓ \frac{(246\,710)(v+20)}{v}$

$v = 1\,499,52\ m \cdot s^{-1}$ ✓

(6)

6.3 REMAINS THE SAME ✓
Frequency emitted by the source does not depend on the speed of the source.

OR

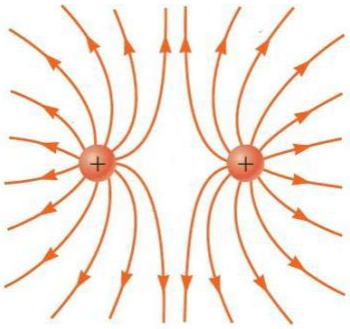
Frequency of the source is the same. ✓ (2)

[10]

QUESTION 7

7.1 S ✓ (1)

7.2



Criteria for sketch	Marks
Correct direction of field lines & minimum of 8 lines per charge	✓
Correct shape of the electric field lines between charges and on the outside of the charges.	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge.	✓
Note: If learner draws field pattern of two opposite charges: 0/3 **If only one charge is drawn, max: 1/3 for direction.**	

(3)

7.3

$$Q_{new} = \frac{Q_1 + Q_2}{2}$$

$$Q_{new} = \frac{6\times10^{-6} + 2\times10^{-6}}{2}$$ ✓

$$\therefore Q_s = +4\times10^{-6}\ C$$ ✓

$$Q_{new} = \frac{Q_1 + Q_2}{2}$$

$$Q_{new} = \frac{6 + 2}{2}$$ ✓

$$\therefore Q_s = 4\ \mu C$$ ✓

(2)

7.4 **Positive marking from 7.3.**

Charge S

(a) $\Delta Q = 4\times10^{-6} - 2\times10^{-6}$

$= +2\times10^{-6}\ C$

(b) $n = \frac{Q}{e}$ ✓

$n = \frac{2\times10^{-6}}{1,6\times10^{-19}}$ ✓

$n = 1,25\times10^{13}$ electrons ✓

Charge R

(a) $\Delta Q = 4\times10^{-6} - 6\times10^{-6}$

$= -2\times10^{-6}\ C$

(b) $n = \frac{Q}{e}$ ✓

$n = \frac{-2\times10^{-6}}{-1,6\times10^{-19}}$ ✓

$n = 1,25\times10^{13}$ electrons ✓

(3)

7.5.1

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 sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓ (2)

7.5.2 **POSITIVE MARKING FROM 7.3**

$E_{net} = E_{R\ on\ X} + E_{S\ on\ X}$

$E_{net} = \frac{kQ_R}{r^2} + \frac{kQ_S}{r^2}$ ✓ [Any formula]

$= \frac{(9x10^9)(4x10^{-6})}{(10x10^{-3})^2}$ ✓ + ✓ $\frac{(9x10^9)(4x10^{-6})}{(2x10^{-3})^2}$ ✓

$= 3{,}6 \times 10^8 + 9 \times 10^9$

$E_{net} = 9{,}36 \times 10^9$ N·C^{-1} right ✓

Marking Criteria:
- ✓ Formula
- ✓ First Substitution
- ✓ Second Substitution
- ✓ Addition
- ✓ Final answer with direction

$E_{R\ on\ X} = \frac{kQ_R}{r^2}$ ✓ [Any formula]

$= \frac{(9x10^9)(4x10^{-6})}{(10x10^{-3})^2}$ ✓

$= 3{,}6 \times 10^8$ N·C^{-1}

$E_{S\ on\ X} = \frac{kQ_R}{r^2}$

$= \frac{(9x10^9)(4x10^{-6})}{(2x10^{-3})^2}$ ✓

$= 9 \times 10^9$ N·C^{-1}

$E_{net} = (3{,}6 \times 10^8) +$ ✓ (9×10^9)

$E_{net} = 9{,}36 \times 10^9$ N·C^{-1} right ✓

(5)

[16]

QUESTION 8

8.1.1 12 V ✓ (1)

8.1.2 12 – 8
= 4 V ✓ (1)

8.1.3

Option 1

gradient = $\frac{\Delta I}{\Delta V}$ ✓

$-\frac{1}{r}$ ✓ = $\frac{0-6}{12-0}$ ✓ [or any suitable co-ordinates]

$-\frac{1}{r} = -\frac{6}{12}$

r = 2 Ω ✓

Option 2

r = $-\frac{1}{\text{gradient}}$ ✓

r = $-\frac{1}{\frac{\Delta I}{\Delta V}}$ ✓

r = $-\frac{1}{\frac{0-6}{12-0}}$ ✓ [or any suitable co-ordinates]

r = 2 Ω ✓

Option 3

$V_{int} = Ir$ [lose formula mark]

4 ✓ $= 2r$ ✓ [or any suitable co-ordinates]

r = 2 Ω ✓ [max 3 marks] (4)

8.2.1 The <u>maximum (total) energy</u> ✓ provided by a battery <u>per unit (positive) charge / per coulomb</u> passing through it. ✓ OR

The <u>maximum (total) work done</u> ✓ by a battery <u>per unit (positive) charge</u> passing through it. ✓ (2)

8.2.2 19,125 V ✓ (1)

8.2.3

OPTION 1

V_{int} = Ir ✓

6,5 = I(0,5) ✓

$I_{circuit}$ = 13 A ✓

OPTION 2

$\varepsilon = V_{ext}$ + Ir ✓

19,125 = (19,125 – 6,5) + I(0,5) ✓

$I_{circuit}$ = 13 A ✓

(3)

8.2.4

OPTION 1

(a) $\frac{1}{R_p} = \frac{1}{R1} + \frac{1}{R2}$ ✓

$= \frac{1}{5} + \frac{1}{2,5}$ ✓

= 0,6 Ω

R_{A1} = 1,6667 + 10 = 11,6667 Ω

(b) V_p = 19,125 – 6,5

= 12,625 V

(c) $R = \frac{V_P}{I_{A1}}$

$11,6667 = \frac{12,625}{I_{A1}}$ ✓

I_{A1} = 1,08 A ✓

OPTION 2

(a) $\frac{1}{R_p} = \frac{1}{R1} + \frac{1}{R2}$ ✓

$= \frac{1}{5} + \frac{1}{2,5}$ ✓

= 0,6 Ω

R_{A1} = 1,6667 + 10 = 11,6667 Ω

(b) V_p = 19,125 – 6,5 ✓

= 12,625 V

(c) $V_{10\Omega} = \frac{10}{11,6667} \times 12,625$

= 10,8214 V

(d) $R_{10\Omega} = \frac{V_{10\Omega}}{I_{A1}}$

$10 = \frac{10,8214}{I_{A1}}$ ✓

I_{A1} = 1,08 A ✓

(4)

8.2.5 **POSITIVE MARKING FROM 8.2.3 AND 8.2.4**

OPTION 1

(a) $I_{circuit} = I_{A1} + I_{A2}$

$13 = 1,08 + I_{A2}$ ✓

$I_{A2} = 11,92$ A

(b) $R = \frac{V_P}{I_{A2}}$

$= \frac{12,625}{11,92}$ ✓

R = 1,06 Ω ✓

OPTION 2

(a) $\varepsilon = I(R + r)$

$19,125 = 13(R + 0,5)$ ✓

$R_{ext} = 0,97115$ Ω

(b) $\frac{1}{R_{ext}} = \frac{1}{R1} + \frac{1}{R2}$

$\frac{1}{0,97115} = \frac{1}{11,6667} + \frac{1}{R}$ ✓

R = 1,06 Ω ✓

OPTION 3

(a) $R_T = \frac{V_T}{I_T}$

$= \frac{19,125}{13}$ ✓

$R_T = 1,47115$ Ω

(b) $R_{ext} = R_T - r$

$R_{ext} = 1,47115 - 0,5$

$R_{ext} = 0,97115$ Ω

(c) $\frac{1}{R_{ext}} = \frac{1}{R1} + \frac{1}{R2}$

$\frac{1}{0,97115} = \frac{1}{11,6667} + \frac{1}{R}$ ✓

R = 1,06 Ω ✓

(3)

8.2.6 Decrease ✓

- Total external resistance of the circuit decreases. ✓
- current in the circuit increases] ✓
- V_{int} (= Ir) increases

From: emf = V_{ext} + V_{int}

- emf remains constant ✓

Therefore V (= V_{ext}) decreases (4)

[23]

QUESTION 9

9.1

Marking criteria

If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.

The process whereby <u>electrons are emitted / ejected from a metal</u> surface when <u>light</u> of suitable frequency is <u>incident on that surface</u>. (2)

9.2 $5,4 \times 10^{-7}$ ✓ (m) (1)

9.3 **POSITIVE MARKING FROM 9.2**

<u>OPTION 1</u>

$$E = W_o + Ek_{max} \quad ✓$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \tfrac{1}{2} m_e v^2$$

$$\frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(3,2 \times 10^{-7})} ✓ = \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(5,4 \times 10^{-7})} ✓ + \tfrac{1}{2} (9,11 \times 10^{-31}) v^2 \ ✓$$

$$v^2 = 5,55937 \times 10^{11}$$

$$v = 745\,611,829 \text{ m·s}^{-1} / \ 7,4561 \times 10^{5} \text{ m·s}^{-1} \ ✓$$

<u>OPTION 2</u> (a)

$$E = \frac{hc}{\lambda}$$

$$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(3,2 \times 10^{-7})} ✓$$

$$= 6,2156 \times 10^{-19} \text{ J}$$

(b)

$$W_0 = \frac{hc}{\lambda_0}$$

$$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(5,4 \times 10^{-7})} ✓$$

$$= 3,6833 \times 10^{-19} \text{ J}$$

(c)

$$E = W_o + Ek_{max} ✓$$

$$(6,2156 \times 10^{-19}) = (3,6833 \times 10^{-19}) + Ek_{max}$$

$$Ek_{max} = 2,5323 \times 10^{-19} \text{ J}$$

(c)

$$Ek_{max} = \tfrac{1}{2} mv^2$$

$$2,5323 \times 10^{-19} = \tfrac{1}{2} (9,11 \times 10^{-31}) v^2 ✓$$

$$v = 745\,611,677 \text{ m·s}^{-1} / \ 7,456 \times 10^{5} \text{ m·s}^{-1} \ ✓$$

(5)

9.4 REMAIN THE SAME ✓
Intensity only affects number of photons incident onto the metal <u>per second</u> (and therefore the number of photoelectrons emitted from a metal surface per second)
OR
Intensity does not affect the kinetic energy of photoelectrons.
OR
Only frequency affects the kinetic energy of photoelectrons. ✓ (2)

TOTAL: 150

