Province of the
EASTERN CAPE
EDUCATION

GRADE 12/*GRAAD 12*

PHYSICAL SCIENCES/*FISIESE WETENSKAPPE*
PAPER 1 (PHYSICS)/
VRAESTEL 1 (FISIKA)

JUNE 2016/*JUNIE 2016*

MEMORANDUM

MARKS: 150/*PUNTE: 150*

This memorandum consists of 11 pages.
Hierdie memorandum bestaan uit 11 bladsye.

QUESTION 1/*VRAAG 1*

1.1 A
1.2 B
1.3 C
1.4 D
1.5 A
1.6 C
1.7 A
1.8 C
1.9 A
1.10 D

[20]

QUESTION 2/*VRAAG 2*

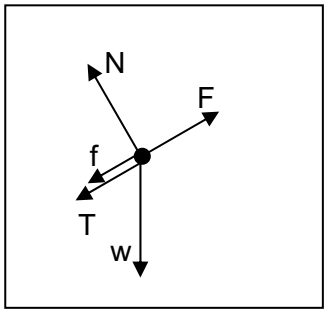
2.1 The force that opposes the motion of an object ✓ and which acts parallel to the surface. ✓

Die krag wat die beweging van 'n voorwerp teenwerk ✓en wat parallel met die oppervlak inwerk. ✓ (2)

2.2 When a resultant/net force acts on an object, the object accelerates in the direction of the (net) force ✓ at an acceleration 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 (netto) krag ✓teen 'n versnelling direk eweredig aan die krag ✓ en omgekeerd eweredig aan die massa van die voorwerp. ✓ (3)

2.3



Marking criteria	***Nasienkriteria***
Correct arrow and label for each force: ✓ Comparative lengths of arrows are not required. Components of forces are **not** accepted.	*Korrekte pyl en byskrif vir elke krag: ✓* *Vergelykende lengtes van pyle word nie vereis nie.* *Komponente van kragte word **nie** aanvaar **nie**.*

Accepted labels/*Aanvaarbare byskrifte*	
w	F_w/F_g/mg/F_{weight}/Weight/Gravitational force/Force of gravity F_w/F_g/mg/F_{gewig}/*Gewig/Gravitasiekrag*
F	$F_{applied}$ $F_{toegepas}$
T	F_T/Tension/Force of rope on block F_T/Spanning/Spankrag/Spanningskrag/*Krag van tou op blok*
f	$F_{friction}$/F_f/Friction/Frictional force/Force of friction $F_{wrywing}$/F_f/Wrywing/*Wrywingskrag*
N	F_N/F_{normal}/Normal force F_N/$F_{normaal}$/*Normaalkrag*

(5)

2.4

OPTION 1 / *OPSIE 1*

$f_k = \mu_k N$ ✓
$= \mu_k mg\cos\theta$
$= \underline{(0,589)}$ x $\underline{(2)(9,8)\cos 30°}$
✓ ✓
$= 10$ N ✓

Accept / Aanvaar
$f = \mu N$

OPTION 2 / *OPSIE 2*

$N = mg\cos\theta$
$= (2)(9,8)(\cos 30°)$ ✓
$= 16,974$ N

$f_k = \mu_k N$ ✓
$= (0,589)(16,974)$ ✓
$= 10$ N ✓

Accept / *Aanvaar*
$f = \mu N$

OPTION 3 / *OPSIE 3*

If proportion is used: First proof that $\mu_2 = \mu_4$. If not; **max 2/4**.
As eweredigheid gebruik word: Bewys eers dat $\mu_2 = \mu_4$. Indien nie; **maks 2/4**.

Accept / Aanvaar
$f = \mu N$

$f_k = \mu_k N$ ✓
$= \mu_4 mg\cos\theta$
$20 = \mu_4(4)(9,8)\cos 30°$ ✓
$\mu_4 = 0,589$

$m_2 : m_4 = 1 : 2$ } ✓
$f_2 : f_4 = 1 : 2$ }
$f_2 = ½ \times 20 = 10$ N ✓

(4)

2.5 From 2.4 / *Vanaf 2.4*

OPTION 1 / *OPSIE 1* (+ ↗)

$F_{net} = ma$ ✓

4 kg: $\underline{73,8 - T - 20}$ $\underline{- (4)(9,8)(\sin 30°)}$ $= \underline{4a}$ ✓
✓ ✓ ✓

2 kg: $\underline{T - 10}$ $\underline{- (2)(9,8)(\sin 30°)}$ $= 2a$
✓ ✓

$T = 24,6$ N ✓

OPTION 2 / *OPSIE 2* (+ ↙)

$F_{net} = ma$ ✓

4 kg: $\underline{-73,8 + T + 20}$ $\underline{+ (4)(9,8)(\sin 30°)}$ $= \underline{-4a}$ ✓
✓ ✓ ✓

2 kg: $\underline{-T + 10}$ $\underline{+ (2)(9,8)(\sin 30°)}$ $= -2a$
✓ ✓

$T = 24,6$ N ✓

OPTION 3 / *OPSIE 3* (+ ↗)

System method: Max: 4/6
Sisteemmetode: Maks: 4/6

$F_{net} = ma$ ✓

$\underline{73,8 - 20 - 10 - (4)(9,8)(\sin 30°) - (2)(9,8)(\sin 30°)}$ $= 6a$ ✓
✓

$T = 24,6$ N ✓

OPTION 4 / *OPSIE 4* (+ ↙)

System method: Max: 4/6
Sisteemmetode: Maks: 4/6

$F_{net} = ma$ ✓

$\underline{-73,8 + 20 + 10 + (4)(9,8)(\sin 30°) + (2)(9,8)(\sin 30°)}$ $= -6a$ ✓
✓

$T = 24,6$ N ✓

(6)

2.6.1 Remains the same. (✓✓) Bly dieselfde. (✓✓) (2)

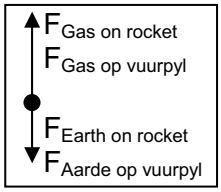
2.6.2 Remains the same. (✓✓) Bly dieselfde. (✓✓) (2)

2.6.3 Increases (✓✓) Vermeerder (✓✓) (2)

[26]

QUESTION 3/VRAAG 3

3.1



Marking criteria	***Nasienkriteria***
Up arrow and correct label: ✓	*Op-pyl en korrekte byskrif:* ✓
Down arrow and correct label: ✓	*Af-pyl en korrekte byskrif:* ✓
Up arrow > down arrow: ✓	*Op-pyl > af-pyl:* ✓
If dot not shown: **max 2/3**	As kol nie gewys is nie: **maks 2/3**

Accepted labels / *Aanvaarbare byskrifte*	
$F_{Earth\ on\ rocket}$ $F_{Aarde\ op\ vuurpyl}$	w / F_w / F_g / mg / F_{weight} / Weight / Gravitational force / Force of gravity w / F_w / F_g / mg / F_{gewig} / *Gewig / Gravitasiekrag*
$F_{Gas\ on\ rocket}$ $F_{Gas\ op\ vuurpyl}$	$F_{propulsion}$ / $F_{applied}$ / Propulsion / Propulsive force $F_{stukrag}$ / $F_{toegepas}$ / *Stukrag / Aandrywingskrag*

(3)

3.2.1 Upwards✓ *Opwaarts*✓ (1)

3.2.2 Downwards✓ *Afwaarts*✓ (1)

3.3 Q ✓  Weight is the only force acting on the rocket. ✓
Gewig is die enigste krag wat op die vuurpyl inwerk. (2)

3.4.1

OPTION 1 / *OPSIE* 1 ↑ +

$v_f = v_i + a\Delta t$ ✓
$112,8 = 0 + a(4)$ ✓
$a = 28,2\ m{\cdot}s^{-2}$ ✓

OPTION 2 / *OPSIE 2* ↑ +

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$225,6 = 0 + \frac{1}{2}(a)(4^2)$ ✓
$a = 28,2\ m{\cdot}s^{-2}$ ✓

OPTION 3 / *OPSIE 3* ↑ +

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$112,8^2 = 0^2 + 2(a)(225,6)$ ✓
$a = 28,2\ m{\cdot}s^{-2}$ ✓

If downwards is chosen as positive: **max 2/3**.
Indien afwaarts as positief gekies is: ***maks 2/3***.

Example for option 1 / *Voorbeeld vir opsie 1*

$v_f = v_i + a\Delta t$ ↓ +
$-112,8 = 0 + a(4)$
$a = -28,2\ m{\cdot}s^{-2}$

Similar for options two and three.
Soortgelyk vir opsie twee en drie.

(3)

3.4.2

OPTION 1 / *OPSIE 1* ↑ +

Δt(RG) $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-225,6 = 112,8\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
✓ ✓ ✓
$\Delta t = 24,872$ s

Δt (total / *totaal*) = 24,872 + 4 ✓
= 28,87 s ✓

If downwards is chosen as positive: **max 4/6**.
*Indien afwaarts as positief gekies is: **maks 4/6**.*

Example: Option 1 / *Voorbeeld: Opsie 1* ↓ +

Δt(RG) $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$225,6 = -112,8\Delta t + \frac{1}{2}(9,8)\Delta t^2$
$\Delta t = 24,872$ s
Δt (total / *totaal*) = 24,872 + 4
= 28,87 s

Similar for options two and three.
Soortgelyk vir opsie twee en drie.

OPTION 2 / *OPSIE 2* ↑ +

Δt(RS)

$v_f = v_i + a\Delta t$ ✓
$0 = 112,8 + (-9,8)\Delta t$ ✓
$\Delta t = 11,510$ s

Δy(RS)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (112,8)(11,510) + \frac{1}{2}(-9,8)(11,510)^2$ ✓
= 649,176 m

OR / OF

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$= \left(\frac{0 + 112,8}{2}\right)(11,510)$ ✓
$= 649,164$ m

OR / *OF*

$v_f^2 = v_i^2 + 2a\Delta x$
$0^2 = (112,8^2) + 2(-9,8)\Delta x$ ✓
$\Delta x = 649,176$ m

Δt(SG)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$(-649,176 - 225,6) = 0 + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 13,361$ s

Δt (total / *totaal*) = 4 + 11,510 + 13,361 ✓
= 28,87 s ✓

OPTION 3 / *OPSIE 3* ↑ +

v at ground / v *by grond*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= (112,8^2) + 2(-9,8)(-225,6)$ ✓
$v_f = -130,941$ m·s^{-1}

Δt(RG)

$v_f = v_i + a\Delta t$
$-130,941 = 112,8 + (-9,8)\Delta t$
✓ ✓
$\Delta t = 24,872$ s

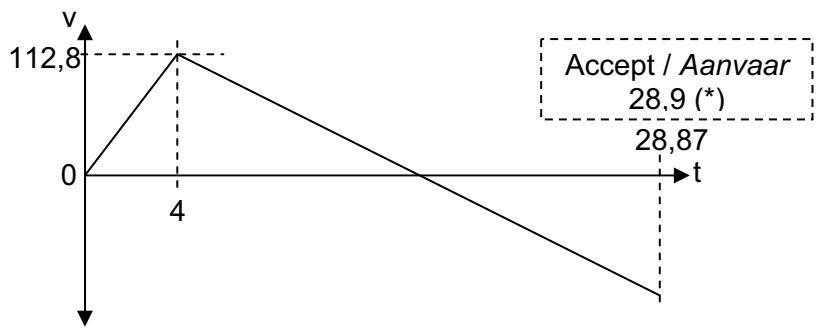
OR / OF

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$-225,6$ ✓ $= \left(\frac{-130,941 + (+112,8)}{2}\right)\Delta t$ ✓
$\Delta t = 24,872$ s

Δt (total / *totaal)* = 4 + 24,872 ✓
= 28,87 s ✓

(6)

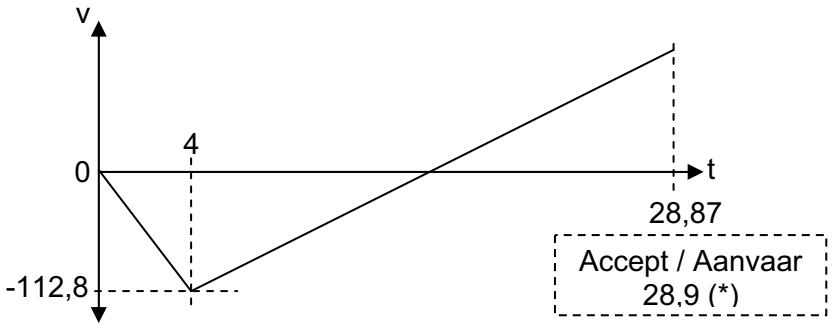
3.5



Marking criteria / *Nasienkriteria*	
(0;0) indicated.	1
(4;112,8) indicated.	1
t = 28,87(*) indicated; positive marking from Q3.4.2.	1
Graph starts at (0;0); straight line from (0;0) to (4;112,8) with positive gradient.	1
From (4;112,8): Straight line with negative gradient and ends at t = 28,87(*). Last value = positive marking from Q3.4.2.	1
From (4;112,8): Straight line intersects the time axis between t = 4 and t = 28,87(*). Last value = positive marking from Q3.4.2.	1

If downwards is chosen as positive: **max 4/6**.
Indien afwaarts as positief gekies is: **maks 4/6**.

Graph should be as indicated below, with similar marking criteria.
Grafiek moet wees soos hieronder aangedui met soortgelyke nasienkriteria.



Marking criteria / Nasienkriteria	
(0;0) indicated.	1
(4;-112,8) indicated.	1
t = 28,87(*) indicated; positive marking from Q3.4.2.	1
Graph starts at (0;0); straight line from (0;0) to (4;-112,8) with negative gradient.	1
From (4;-112,8): Straight line with positive gradient and ends at t = 28,87(*). Last value = positive marking from Q3.4.2.	1
From (4;-112,8): Straight line intersects the time axis between t = 4 and t = 28,87(*). Last value = positive marking from Q3.4.2.	1

(6)
[22]

QUESTION 4/*VRAAG 4*

4.1 Momentum is the product of an object's mass and its velocity. (✓✓)

Momentum is die produk van 'n voorwerp se massa en sy snelheid. (✓✓) (2)

4.2

OPTION 1 / *OPSIE 1*

Dir of motion: + *Rig van beweging:*

$\Delta p = mv_f - mv_i$ ✓
$= (175)(0 - (+20))$ ✓
$= -3\ 500\ kg{\cdot}m{\cdot}s^{-1}$ ✓

$\therefore \Delta p = 3\ 500\ kg{\cdot}m{\cdot}s^{-1}$; opposite to direction of motion` *teenoorgesteld aan bewegingsrigting* ✓

OPTION 2 / *OPSIE 2*

Dir opposite to motion: *Rig teenoorgesteld* + aan beweging:

$\Delta p = mv_f - mv_i$ ✓
$= (175)(0 - (-20))$ ✓
$= 3\ 500\ kg{\cdot}m{\cdot}s^{-1}$ ✓

$\therefore \Delta p = 3\ 500\ kg{\cdot}m{\cdot}s^{-1}$; opposite to direction of motion` *teenoorgesteld aan bewegingsrigting* ✓

(4)

4.3

OPTION 1 / OPSIE 1

Dir of motion: + Rig *van beweging:*

$F_{net}\Delta t = \Delta p$ ✓
$f(8) = -3\ 500$ ✓
$f = -437{,}5$ N ✓

$\therefore f = 437{,}5$ N; opposite to direction of motion *teenoorgesteld aan bewegingsrigting* ✓

OPTION 2 / *OPSIE 2*

Dir opposite to motion: Rig teenoorgesteld + aan beweging:

$F_{net}\Delta t = \Delta p$ ✓
$f(8) = 3\ 500$ ✓
$f = 437{,}5$ N ✓

$\therefore f = 437{,}5$ N; opposite to direction of motion *teenoorgesteld aan bewegingsrigting* ✓

(4)

4.4 The net/total work done on an object ✓ is equal to the change in the object's kinetic energy. ✓

Die netto/totale arbeid verrig op 'n voorwerp ✓ 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 'n resulterende/netto krag ✓ is gelyk aan die verandering in *die voorwerp se kinetiese energie*. ✓ (2)

4.5

f = 437,5 N from / van 4.3

OPTION 1 / *OPSIE 1*

Dir of motion: + Rig *van beweging*:

$W_f = \Delta K$ ✓
$= ½(175)(0^2) - ½(175)(+20^2)$ ✓
$= -35\ 000$ J ✓

OPTION 3 / *OPSIE 3*

Dir of motion: + Rig *van beweging*:

$W_f = \Delta K + \Delta U$ ✓
$= ½(175)(0^2) - ½(175)(+20^2) + 0$ ✓
$= -35\ 000$ J ✓

OPTION 2 / *OPSIE 2*

Dir of motion: + Rig *van beweging:*

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$= \left(\frac{0+20}{2}\right)(8)$ ✓
$= 80\,m$

$W_f = f\Delta x\cos\theta$ ✓
$= (437{,}5)(80)(\cos 180°)$
$= -35\ 000$ J ✓

(3)

[15]

QUESTION 5/*VRAAG 5*

5.1 In an isolated system ✓ the total mechanical energy (sum of gravitational potential energy and kinetic energy) remains constant. ✓

In 'n geslote sisteem ✓ bly die totale meganiese energie (som van gravitasie-potensiële energie en kinetiese energie) konstant. ✓ (2)

5.2

E_M (Top/Bo) = E_M (Bottom/Onder) ✓
$(E_p + E_k) = (E_p + E_k)$
$mgh + ½ mv^2 = mgh + ½ mv^2$ } Anyone / *Enigeen*
$(1,6)(9,8)(1,5) + ½(1,6)v^2 = 0 + ½(1,6)(5,6^2)$
✓ ✓ ✓

$v = 1,40 \text{ m·s}^{-1}$ ✓ (5)

5.3 Total linear momentum of a closed system ✓ remains constant/is conserved. ✓

Totale lineêre momentum in 'n geslote sisteem ✓ bly konstant/behoue. ✓ (2)

5.4

OPTION 1 / *OPSIE 1*

+

$\Sigma p_i = \Sigma p_f$ } ✓ Anyone / Enigeen
$m_1v_1 + m_2v_2 = m_{1+2}v$
$0,005v_1 + 1,595(0)$ ✓ $= 1,6(1,40)$ ✓
$v_1 = 448 \text{ m·s}^{-1}$

Magnitude of vel/speed = 448 m·s^{-1} ✓
Grootte van snelheid/spoed

OPTION 2 / *OPSIE 2*

+

$\Delta p_1 = -\Delta p_2$ } ✓ Anyone / Enigeen
$m_1\Delta v_1 = -m_2\Delta v_2$
$0,005(1,4 - v_1)$ ✓ $= -1,595(1,4 - 0)$ ✓
$v_1 = 448 \text{ m·s}^{-1}$

Magnitude of vel/speed = 448 m·s^{-1} ✓
Grootte van snelheid/spoed

(4)
[13]

QUESTION 6/*VRAAG 6*

6.1 Speed ✓ *Spoed ✓* (1)

6.2 3 ✓ ($m \cdot s^{-1}$) (1)

6.3.1 It is 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. ✓

Dit is 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 het waarin die klank voortgeplant word. ✓ (2)

6.3.2 345 ✓ ($m \cdot s^{-1}$) (1)

6.3.3

$$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_S \quad ✓$$

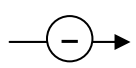
$$= \left(\frac{345 + 0}{345 - 57{,}5}\right)\left(\frac{1000}{1}\right) \quad ✓ ✓$$

$$= 1200 \text{ Hz} \quad ✓$$

(4)

6.3.4 295 ✓ (K) Accept: The same temperature *Aanvaar: Dieselfde temperatuur* (1)

6.4.1 (Diagram) 3 ✓ (1)

6.4.2 1 ✓  The source is stationary. ✓ *Die bron staan stil.* (2)

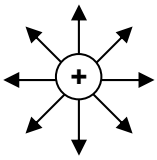
[13]

QUESTION 7/*VRAAG 7*

7.1.1 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)

7.1.2



Marking criteria		***Nasienkriteria***	
Correct shape	✓	*Korrekte patroon*	✓
Direction of field lines	✓	*Rigting van veldlyne*	✓

(2)

7.1.3

$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9 \times 10^{9})(2 \times 10^{-9})}{1^2} \checkmark$$
$$= 18\ N \cdot C^{-1} \checkmark$$

(3)

7.2.1 Y to/na X ✓ (1)

7.2.2

OPTION 1 / *OPSIE 1*

$$Q = \frac{Q_X + Q_Y}{2} \checkmark$$
$$= \frac{(+2)+(-7)}{2} \checkmark$$
$$= -2{,}5\ nC \checkmark$$

OPTION 2 / *OPSIE 2*

$$Q = \frac{Q_X + Q_Y}{2} \checkmark$$
$$= \frac{(+2 \times 10^{-9})+(-7 \times 10^{-9})}{2} \checkmark$$
$$= -2{,}5 \times 10^{-9}\ C \checkmark$$

(3)

7.2.3 The magnitude of the electrostatic force exerted by one point charge on another point charge ✓ is directly proportional to the product of the magnitudes of the charges ✓ and inversely proportional to the square of the distance between them. ✓

Die grootte van die elektrostatiese krag wat een puntlading op 'n ander puntlading uitoefen, ✓ *is direk eweredig aan die produk van die grootte van die ladings* ✓ *en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.* ✓

(3)

7.2.4

OPTION 1 / *OPSIE 1*

$$F = \frac{kQQ}{r^2} \checkmark$$
$$= \frac{(9 \times 10^{9})(2{,}5 \times 10^{-9})(2{,}5 \times 10^{9})}{2^2} \checkmark\checkmark$$
$$= 1{,}41 \times 10^{-8}\ N \checkmark$$

F = 1,41 x 10^{-8} N; repulsive / to the left
afstotend / na links ✓

OPTION 2 / *OPSIE 2*

$$F = \frac{kQQ}{r^2} \checkmark$$
$$= \frac{(9 \times 10^{9})(-2{,}5 \times 10^{-9})(-2{,}5 \times 10^{9})}{2^2} \checkmark\checkmark$$
$$= 1{,}41 \times 10^{-8}\ N \checkmark$$

F = 1,41 x 10^{-8} N; repulsive / to the left
afstotend / na links ✓

(5)
[19]

QUESTION/*VRAAG 8*

8.1 Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.
Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag direk eweredig aan die produk van hul massas en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle middelpunte. (2)

8.2 $g \text{ at } h = \frac{GMe}{(r_e + h)^2}$

$= \frac{6{,}67 \times 10^{-11} \times 5{,}98 \times 10^{24}}{(6{,}38 \times 10^{6} + 0{,}05 \times 6{,}38 \times 10^{6})^2}$

$= 8{,}89 \text{ m.s}^{-2}$ (5)

8.3 Increases/*Neem toe* (1)

8.4 Factor of 4 ✓ /*Faktor van 4.*
The force is inversely proportional to the distance r between their centres. ✓✓
Die krag is omgekeerd eweredig aan die afstand r tussen hulle middelpunte. ✓✓ (3)
[11]

QUESTION/*VRAAG 9*

9.1 Impulse is defined as the product of the resultant/net force acting on an object and the time the resultant/net force acts on the object. ✓✓
Impuls word definieer as die produk van die resultant/netto krag wat op 'n voorwerp inwerk en die tyd wat die resultant/netto lrag op die voorwerp inwerk. ✓✓ (2)

9.2 Impulse = $F_{net}.\Delta t = \Delta p = m\Delta v$ (Towards the barrier is taken as positive)
(*Na die voorwerp word geneem as positief)*
Impulse = $m\Delta v$
$= 1\,500(0 - 13{,}89)$ ($50 \text{ km.h}^{-1} = 50 \times 10\,003\,600 = 13{,}89 \text{ m.s}^{-1}$)
$= -20\,833{,}33 \text{ N.s}$
= 20 833,33 away from the barrier/*weg vanaf die voorwerp* (5)

9.3 Impulse = $F_{net}.\Delta t$
$-20\,833{,}33 = F_{net} \times 0{,}15$
Fnet = −138888,87 N
Fnet = 138 888,87 N away from the barrier/*weg vanaf die voorwerp* (4)
[11]

TOTAL/*TOTAAL:* 150