SA-STUDENT

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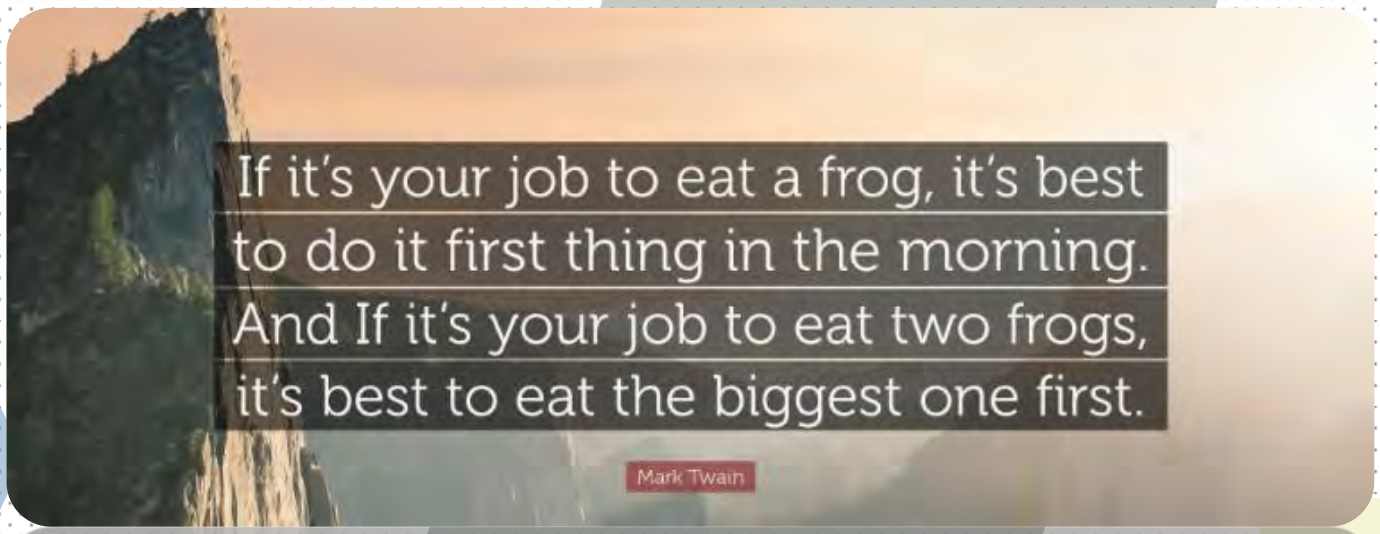


QUESTION 4 /*VRAAG 4*

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.*

In an isolated system the total (linear) momentum is conserved/remains constant. ✓✓ (accept closed system)
In 'n geïsoleerde sisteem bly die totale (lineêre) momentum behoue/ konstant. ✓✓ (aanvaar geslote sisteem)

ACCEPT FOR 1 MARK/*AANVAAR VIR 1 PUNT*
The total (linear) momentum before collision is equal to the total (linear) momentum after collision provided the system is isolated/the net external force on the system is zero.
Die totale (lineêre) momentum voor 'n botsing is gelyk aan die totale (lineêre) momentum na botsing mits die stelsel geïsoleer is/die netto eksterne krag op die stelsel is nul.

(2)

4.2.1

OPTION 1/*OPSIE 1*

RIGHT AS POSITIVE/*REGS AS POSITIEF:*

$\sum p_i = \sum p_f$
$m_A v_{Ai} + m_B v_{Bi} = m_A v_{Af} + m_B v_{Bf}$
$m_A v_{Ai} + m_B v_{Bi} = (m_A + m_B)v_f$
✓Any one/*Enige een*

$(7,2)(0,4) + (0) = (7,2 + 5,3)v_f$ ✓
$v_f = 0,23\ m \cdot s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF:*

$\sum p_i = \sum p_f$
$m_A v_{Ai} + m_B v_{Bi} = m_A v_{Af} + m_B v_{Bf}$
$m_A v_{Ai} + m_B v_{Bi} = (m_A + m_B)v_f$
✓Any one/*Enige een*

$(7,2)(-0,4) + (0) = (7,2 + 5,3)v_f$ ✓
$v_f = -\ 0,23$
$\therefore v_f = 0,23\ m\ s^{-1}$ ✓

OPTION 2/*OPSIE 2*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$
$m_A(v_{Af} - v_{Ai}) = -\ m_B(v_{Bf} - v_{Bi})$
✓Any one/*Enige een*

$(7,2)(v_f - 0,4) = -\ (5,3)(v_f - 0)$ ✓
$v_f = 0,23\ m \cdot s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$
$m_A(v_{Af} - v_{Ai}) = -m_B(v_{Bf} - v_{Bi})$
✓Any one/*Enige een*

$(7,2)(v_f + 0,4) = -\ (5,3)(v_f - 0)$ ✓
$v_f = -\ 0,23$
$\therefore v_f = 0,23\ m\ s^{-1}$ ✓

(3)

4.2.2 **POSITIVE MARKING FROM QUESTIONS 4.2.1.**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 7,2(0,23 - 0,4)$ ✓ $F_{net} = -61,2$ $\therefore F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS NEGATIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 7,2(-0,23 + 0,4)$ ✓ $F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 2/*OPSIE 2* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 5,3(0,23 - 0)$ ✓ $F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 5,3(-0,23 - 0)$ ✓ $F_{net} = -60,95$ $\therefore F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 3/*OPSIE 3* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $0,23 = 0,4 + a(0,02)$ $a = -8,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(-8,5)$ ✓ $= -61,20$ $F_{net} = 61,20$ N ✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $-0,23 = -0,4 + a(0,02)$ $a = 8,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(8,5)$ ✓ $= 61,20$ N $F_{net} = 61,20$ N✓
OPTION 4/*OPSIE 4* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $0,23 = 0 + a(0,02)$ $a = 11,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(11,5)$ ✓ $= 60,95$ N $F_{net} = 60,95$ N✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $-0,23 = 0 + a(0,02)$ $a = -11,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(-11,5)$ ✓ $= -60,95$ N $F_{net} = 60,95$ N✓

(3)
[8]

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.*

In an isolated/closed system the total (linear) momentum is conserved/remains constant. ✓✓
In 'n geïsoleerde/geslote sisteem bly die totale (lineêre) momentum behoue/konstant. (2)

4.2.1

OPTION 1/*OPSIE 1*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\sum p_i = \sum p_f$
$m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ } ✓Any one/*Enige een*

$(1,2)(8)$ ✓ $+ (0,5)(0) = (1,2)(4) + (0,5)(v_{fy})$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIVE/*WES AS POSITIEF*

$\sum p_i = \sum p_f$
$m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ } ✓ Any one/*Enige een*

$(1,2)(-8)$ ✓ $+ (0,5)(0) = (1,2)(-4) + (0,5)(v_{fy})$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

OPTION 2 /*OPSIE 2*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*

$1,2(4 - 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIEF/*WES AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*

$1,2(-4 + 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓ (4)

4.2.2

OPTION 1/*OPSIE 1*

EAST POSITIVE/*OOS POSITIEF:*
For X/*Vir X:*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*

$F_{net}(0,1) = 1,2(4 - 8)$ ✓
$F_{net} = -48$ N ✓
$\therefore F_{net} = 48$ N ✓

WEST POSITIVE/*WES POSITIEF:*
For X /*Vir X:*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*

$F_{net}(0,1) = 1,2(-4 + 8)$ ✓
$\therefore F_{net} = 48$ N ✓

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM QUESTION 4.2.1.
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

EAST AS POSITIVE ***OOS AS POSITIEF***	**WEST AS POSITIVE** ***WES AS POSITIEF***
For Y/*Vir Y:*	**For Y/*Vir Y:***
$F_{net}\Delta t = \Delta p$ ✓Any one/ *Enige een* $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*	$F_{net}\Delta t = \Delta p$ ✓Any one/ *Enige een* $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*
$\underline{F_{net}}\ (0,1) = 0,5(-9,6 - 0)$ ✓	$\underline{F_{net}}\ (0,1) = 0,5(9,6 - 0)$ ✓
$F_{net} = -48$ N	$F_{net} = 48$ N ✓
$\therefore F_{net} = 48$ N ✓	

OPTION 3/*OPSIE 3*

EAST AS POSITIVE for X ***OOS AS POSITIEF vir X***	**WEST AS POSITIVE for X** ***WES AS POSITIEF vir X***
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-4 = -8 + a(0,1)$	$4 = 8 + a(0,1)$
$a = -40\ m\cdot s^{-2}$	$a = 40\ m\cdot s^{-2}$
$F_{net} = ma$ ✓	$F_{net} = ma$ ✓
$F_{net} = (1,2)(-40)$ ✓	$F_{net} = (1,2)(40)$ ✓
$F_{net} = -48$ N	$F_{net} = 48$ N✓
$\therefore F_{net} = 48$ N ✓	

OPTION 4/*OPSIE 4*

EAST AS POSITIVE for X ***OOS AS POSITIEF vir X***	**WEST AS POSITIVE for X** ***WES AS POSITIEF vir X***
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$\Delta x = \left(\frac{8 + 4}{2}\right)(0,1)$	$\Delta x = \left(\frac{-8 - 4}{2}\right)(0,1)$
$\Delta x = 0,6$ m	$\Delta x = -0,6$ m
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓	$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓
$F_{net}(0,6)\cos180^\circ = \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2$✓	$F_{net}(0,6)\cos0^\circ = \frac{1}{2}(1,2)(-4)^2 - \frac{1}{2}(1,2)(-8)^2$✓
$F_{net} = 48$ N ✓	$F_{net} = -48$ N ✓
	$\therefore F_{net} = 48$ N ✓

OPTION 5/*OPSIE 5*

$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$
$$= \frac{\Delta v}{\Delta t}$$
$$= \frac{4 - 8}{0,1}$$
$$= -40\ m\cdot s^{-2}$$

$F_{net} = ma$ ✓
$F_{net} = (1,2)(-40)$ ✓
$F_{net} = -48$ N
$F_{net} = 48$ N ✓

(3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2.1/**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1*

Inelastic/*onelasties* ✓

$E_k = ½mv^2$ ✓

$\sum E_{ki} = ½m_Xv_{Xi}^2 + ½m_Yv_{Yi}^2$
$= \underline{½(1,2)(8)^2} + 0$ ✓
$= 38,4$ J

$\sum E_{kf} = ½m_Xv_{Xf}^2 + ½m_Yv_{Yf}^2$
$= \underline{½(1,2)(4)^2 + ½(0,5)(9,6)^2}$ ✓
$= 32,64$ J

$\sum E_{ki} \neq \sum E_{kf}$ ✓

OPTION 2/*OPSIE 2* (Change in E_{ktotal} total /*verandering in* $E_{ktotaal}$))

Inelastic/onelasties✓

$E_k = ½mv^2$ ✓

$\Delta E_k(X) = ½mv_f^2 - ½mv_i^2$
$= \underline{½(1,2)(4)^2 – ½(1,2)(8)^2}$ ✓
$= - 28,8$ J

$\Delta E_k(Y) = ½mv_f^2 - ½mv_i^2$
$= \underline{½(0,5)(9,6)^2 – ½(0,5)(0)^2}$ ✓
$= 23,04$ J

$\Delta E_k(X) \neq \Delta E_k(Y)$ ✓

Note/*Aantekening*:
If candidate starts with conservation of kinetic energy/*Indien kandidaat begin met behoud van kinetiese energie:* max/*maks* $\frac{4}{5}$

(5)
[14]

QUESTION 4 /*VRAAG 4*

4.1 A system on which the resultant/net external force is zero./*'n Sisteem waarop die resultante/netto eksterne krag nul is*. ✓✓ (2 or/*of* 0) (2)

4.2
1. According to Newton 3rd Law ✓ the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓

OR

2. The toy cart exerts a force on the rocket to the right ✓and the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓

OR

3. The rocket experiences a change in momentum to the right ✓, the toy cart experiences a change in momentum to the left. ✓

OR

4. $\Delta p_{toy\ cart} = -\Delta p_{rocket}$ ✓✓

OR

5. Total momentum is conserved / remains constant. ✓
The momentum of the rocket increases. Therefore, the momentum of the toy cart must decrease. ✓

OR

6. The rocket experiences an impulse to the right ✓ therefore, the toy cart experiences an impulse to the left. ✓

OR

7. $Impulse_{rocket} = -Impulse_{toy\ cart}$ ✓✓

1. Volgens Newton se derde wet ✓ oefen die vuurpyl 'n krag op die speelgoedwaentjie na links uit/ teen die bewegingsrigting. ✓

OF

2. Die speelgoedwaentjie oefen 'n krag op die vuurpyl na regs ✓ en die vuurpyl oefen 'n krag op die speelgoedwaentjie na links/teen die bewegingsrigting ✓.

OF

3. Die vuurpyl ondervind 'n verandering in momentum na regs ✓, die speelgoedwaentjie ondervind 'n verandering in momentum na links. ✓

OF

4. $\Delta p_{speelgoedwaentjie} = -\Delta p_{vuurpyl}$

OF

5. Totale momentum bly behoue. ✓
Die momentum van die vuurpyl neem toe. Dus moet d*ie momentum van die speelgoedwaentjie af neem. ✓*

OF

6. Die vuurpyl ondervind 'n impuls na regs ✓ dus ondervind die *speelgoedwaentjie 'n impuls na links. ✓*

OF

7. $Impuls_{vuurpyl} = -Impuls_{speelgoedwaentjie}$ ✓✓ (2)

4.3

OPTION 1/*OPSIE 1*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$
$mv_i = m_1v_{1f} + m_2v_{2f}$
✓Any one/*Enige een*

$\underline{(20 + m_2)2,5}$ ✓ $= \underline{20(0,6)}$ ✓ $+ \underline{m_2(30)}$ ✓
$m_2 = 1,38$ kg ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$
$mv_i = m_1v_{1f} + m_2v_{2f}$
✓Any one/*Enige een*

$\underline{(20 + m_2)(-2,5)}$ ✓ $= \underline{20(-0,6)}$ ✓ $+ \underline{m_2(-30)}$ ✓
$m_2 = 1,38$ kg ✓

OPTION 2/*OPSIE 2*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\Delta p_{\text{toy cart/}speelgoedwaentjie} = -\Delta p_{\text{rocket/}vuurpyl}$
$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$
✓Any one/*Enige een*

(20) ✓$\underline{(0,6 - 2,5)}$ ✓ $= \underline{-(m)(30 - 2,5)}$ ✓
$m_2 = 1,38$ kg ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\Delta p_{\text{toy cart/}speelgoedwaentjie} = -\Delta p_{\text{rocket/}vuurpyl}$
$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$
✓Any one/*Enige een*

(20) ✓$\underline{[-0,6 - (-2,5)]}$ ✓ $= \underline{-(m)[(-30) - (-2,5)]}$ ✓
$m_2 = 1,38$ kg ✓

(5)
[9]

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 sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*
NOTE/*LET WEL*
If "total" is omitted: minus 1 mark / *Indien "totaal" uitgelaat is: minus 1 punt*

A collision in which both the total momentum and total kinetic energy are conserved.✓✓
'n Botsing waar die totale momentum en die totale kinetiese energie behoue bly. (2)

4.2

OPTION 1/*OPSIE 1*

$\sum E_{Ki} = \sum E_{Kf}$
$\frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2 = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2$
$\frac{1}{2}m_xv_{ix}^2 + \frac{1}{2}m_yv_{iy}^2 = \frac{1}{2}m_xv_{fx}^2 + \frac{1}{2}m_yv_{fy}^2$ ✓Any one/*Enige een*

$\frac{1}{2}(10)(2)^2 + \frac{1}{2}(2)v_{iy}^2$ ✓ $= 0 + 36$ ✓
$v_y = \pm 4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes* ✓ **ACCEPT/*AANVAAR:*** left/*links*

OPTION 2/*OPSIE 2*

$E_{Ki} = \frac{1}{2}\ m_Yv_f^2$
$36 = \frac{1}{2}\ (2)\ v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_xv_{xi} + m_yv_{yi} = m_Xv_{xf} + m_yv_{yf}$ ✓Any one/*Enige een*
$(10)(2) + (2)v_y$ ✓ $= 0 + (2)(6)$ ✓
$v_y = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR***: left/*links*

OPTION 3/*OPSIE 3*

$E_{Ki} = \frac{1}{2}\ m_Yv_f^2$
$36 = \frac{1}{2}\ (2)\ v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\Delta p_X = -\Delta p_Y$
$m_x(v_{Xf} - v_{Xi}) = -\ m_Y(v_{Yf} - v_{Yi})$ ✓Any one/*Enige een*
$(10)(0 - 2)$✓ $= -(2)(6 - v_Y)$ ✓
$v_{Yf} = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR:*** left/*links* (5)

4.3 **POSITIVE MARKING FROM QUESTION 4.2 FOR Y; OPTIONS 1, 3 and 6**
POSITIEWE NASIEN VANAF VRAAG 4.2 VIR Y; OPSIES 1, 3 en 6

OPTION 1/*OPSIE 1* **EAST POSITIVE/*OOS POSITIEF*:** For **Y**/*Vir **Y**:* $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,1) = 2\{6 - (-4)\}$ ✓ $F_{net} = 200$ N ✓	**WEST POSITIVE/*WES POSITIEF:*** For **Y**/*Vir **Y**:* $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,1) = 2(-6 - 4)$ ✓ $F_{net} = -200$ N $F_{net} = 200$ N ✓
OPTION 2/*OPSIE 2* **EAST POSITIVE/*OOS POSITIEF*:** For **X**/*Vir **X**:* $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,1) = 10(0 - 2)$ ✓ $F_{net} = -200$ N $F_{net} = 200$ N ✓	**WEST POSITIVE/*WES POSITIEF*** For **X**/*Vir **X**:* $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,1) = 10\{0 - (-2)\}$ ✓ $F_{net} = 200$ N ✓
OPTION 3/*OPSIE 3* **EAST POSITIVE/*OOS POSITIEF*:** For **Y**/*Vir **Y**:* $v_f = v_i + a\Delta t$ $6 = -4 + a(0,1)$ $a = 100$ m·s^{-2} $F_{net} = ma$ ✓ $= 2(100)$ ✓ $= 200$ N ✓	**WEST POSITIVE/*WES POSITIEF*** For **Y**/*Vir **Y**:* $v_f = v_i + a\Delta t$ $-6 = 4 + a(0,1)$ $a = -100$ m·s^{-2} $F_{net} = ma$ ✓ $= 2(-100)$ ✓ $= -200$ N $F_{net} = 200$ N ✓
OPTION 4/*OPSIE 4* **EAST POSITIVE/*OOS POSITIEF*:** For **X**/*Vir **X**:* $v_f = v_i + a\Delta t$ $0 = 2 + a(0,1)$ $a = -20$ m·s^{-2} $F_{net} = ma$ ✓ $= 10(-20)$ ✓ $= -200$ N $F_{net} = 200$ N ✓	**WEST POSITIVE/*WES POSITIEF*** For **X**/*Vir **X**:* $v_f = v_i + a\Delta t$ $0 = -2 + a(0,1)$ $a = 20$ m·s^{-2} $F_{net} = ma$ ✓ $= 10(20)$ ✓ $F_{net} = 200$ N ✓

OPTION 5/*OPSIE 5*
EAST POSITIVE/*OOS POSITIEF*:
For **X**/*Vir **X**:*

$v_f = v_i + a\Delta t$	$v_f^2 = v_i^2 + 2a\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$0 = 2 + a(0,1)$	$0 = (2)^2 + 2(-20)\Delta x$	$= \left(\frac{0+2}{2}\right)(0,1)$
$a = -20$ m·s^{-2}	$\Delta x = 0,10$ m	$= 0,10$ m

$$W_{net} = \Delta E_k \checkmark$$
$$F_{net}\Delta x\cos\theta = \tfrac{1}{2} m(v_f^2 - v_i^2)$$
$$F_{net}(0,1)\cos 180^\circ = \tfrac{1}{2}(10)(0^2 - 2^2) \checkmark$$
$$F_{net} = 200 \text{ N} \checkmark$$

OPTION 5/*OPSIE 5*
WEST POSITIVE/*WES POSITIEF*:
For **X**/*Vir **X**:*

$v_f = v_i + a\Delta t$ $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$0 = -2 + a(0,1)$ $0 = (-2)^2 + 2(20)\Delta x$ $= \left(\frac{0+(-2)}{2}\right)(0,1)$

$a = 20\ m\cdot s^{-2}$ $\Delta x = -0,10\ m$ $= -0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos180° = ½\ (10)(0^2 - 2^2)$ ✓
$F_{net} = 200\ N$ ✓

OPTION 6/*OPSIE 6*
EAST POSITIVE/*OOS POSITIEF*:
For **Y**/*Vir **Y**:*

$v_f = v_i + a\Delta t$ $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$6 = -4 + a(0,1)$ $(6)^2 = (-4)^2 + 2(100)\Delta x$ $= \left(\frac{6-4}{2}\right)(0,1)$

$a = 100\ m\cdot s^{-2}$ $\Delta x = 0,10\ m$ $= 0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)(6^2 - (-4)^2)$ ✓
$F_{net} = 200\ N$ ✓

OPTION 6/*OPSIE 6*
WEST POSITIVE/*WES POSITIEF*:
For **Y**/*Vir **Y**:*

$v_f = v_i + a\Delta t$ $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$-6 = 4 + a(0,1)$ $(-6)^2 = (4)^2 + 2(-100)\Delta x$ $= \left(\frac{-6+4}{2}\right)(0,1)$

$a = -100\ m\cdot s^{-2}$ $\Delta x = -0,10\ m$ $= -0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)((-6)^2 - (4)^2)$ ✓
$F_{net} = 200\ N$ ✓

(3)
[10]

QUESTION 4/*VRAAG 4*

4.1

NOTE: -1 mark for each key word/phrase omitted in the correct context.
***LET WEL:** -1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

The total (linear) momentum of an isolated/closed system remains constant (is conserved). ✓✓
Die totale (liniêre) momentum in „n geïsoleerde/ geslote sisteem bly konstant (behoue).

Accept/*Aanvaar*
The total (linear) momentum before a collision is equal to the total linear momentum after collision in an isolated/closed system.
Die totale (lineêre) momentum voor botsing is gelyk aan die totale lineêre momentum na botsing in „n geïsoleerde/geslote sisteem. (2)

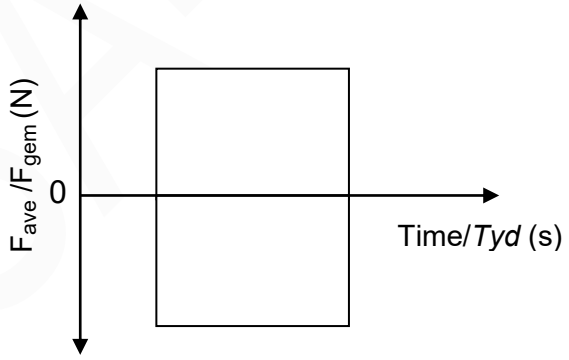
4.2

OPTION 1/*OPSIE 1* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\sum p_i = \sum p_f$ ✓Any one/ *Enige een* $(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ $(2m + 3m)v$ ✓$= (3m)(-\frac{1}{3}v) + 2mv_{Bf}$ ✓ $v_{Bf} = 3v$ ✓upwards/*opwaarts* ✓	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\sum p_i = \sum p_f$ ✓Any one/ *Enige een* $(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ $(2m + 3m)(-v)$✓$= (3m)(\frac{1}{3}v) + 2mv_{Bf}$ ✓ $v_{Bf} = -3v$ $v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓
OPTION 2/*OPSIE 2* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\Delta p_{iA} = -\Delta p_{iB}$ ✓Any one/ *Enige een* $m_A(v_{Af} - v_{Aif}) = -m_A(v_{Bf} - v_{Bi})$ $3m(-\frac{1}{3}v - v)$ ✓$= -(2m)(v_{Bf} - v)$ ✓ $v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\Delta p_{iA} = -\Delta p_{iB}$ ✓Any one/ *Enige een* $m_A(v_{Af} - v_{Aif}) = -m_A(v_{Bf} - v_{Bi})$ $3m[\frac{1}{3}v - (-v)]$ ✓$= (2m)[v_{Bf} - (-v)]$ ✓ $v_{Bf} = -3v$ $v_{Bf} = 3v$ ✓ upwards/*opwaarts*✓

(5)

4.3 Impulse/*Impuls* ✓ (1)

4.4



Marking criteria/*Nasienkriteria*
Exact mirror image
Presiese spieëlbeeld ✓✓

IF/*INDIEN*
Mirror image at different times /
Spieëlbeeld by verskillende tye
Max/*maks* $\frac{1}{2}$

Note/*Let wel*:
If graph is drawn as given in question paper – no mirror image/*Indien grafiek geteken word soos in vraestel – geen spieëlbeeld:* Max/*Maks*: $\frac{1}{2}$

(2)
[10]

OPTION 5/*OPSIE 5*	**OPTION 5: Marking criteria/ *OPSIE 5: Nasienriglyne***
Downwards positive/*Afwaarts positief* $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\underline{1,2}$ ✓= $\underline{0 + \frac{1}{2}(9,8)\,\Delta t^2}$✓ $\Delta t = 0,49$ s t = 1,97 + ✓ 2(0,49) ✓ = 2,96 s ✓ Upwards positive/*Opwaarts positief* $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\underline{-1,2}$ ✓= $\underline{0 + \frac{1}{2}(-9,8)\Delta t^2}$✓ $\Delta t = 0,49$ s t = 1,97 + ✓ 2(0,49) ✓ = 2,96 s ✓	• Formula ✓/*Formule* • Substitution/*Vervanging* $\Delta y = 1,2$ ✓ • Substitution/*Vervanging* $0 + \frac{1}{2}(9,8)\,\Delta t^2$ • 1,97 s + ✓ • 2 Δt ✓ • Final answer/*Finale antwoord*: 2,95 - 2,97 s ✓

(6)
[15]

QUESTION 4/*VRAAG 4*

4.1 (Linear) momentum (of an object) is the $\underline{\text{product of mass and velocity}}$. ✓✓
(Liniêre) momentum (van 'n voorwerp) is die $\underline{\text{produk van massa en snelheid.}}$
(2 or/*of* 0) (2)

4.2.1

OPTION 1/*OPSIE 1*
East as positive/*Oos as positief*
$\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een* $\underline{(0,16)(10) + (0,2)(-15)}$ ✓= $\underline{(0,16)(-5) + (0,2)v_{Qf}}$ ✓ $v_{Qf} = -3$ m·s^{-1} $v_{Qf} = 3$ m·s^{-1} ✓ west/*wes* ✓
OPTION 2/*OPSIE 2*
West as positive/*Wes as positief*
$\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een* $\underline{(0,16)(-10) + (0,2)(15)}$ ✓= $\underline{(0,16)(5) + (0,2)Q_{Nf}}$ ✓ $v_{Qf} = 3$ m·s^{-1} ✓ west/*wes* ✓
OPTION 3/*OPSIE 3*
$\Delta p_p = -\Delta p_Q$ ✓ $\underline{(0,16)(-5 - 10)}$ ✓= $\underline{-(0,2)(v - (-15))}$✓ $v = -3$ m·s^{-1} = 3 m·s^{-1} ✓west/*wes* ✓

(5)

4.2.2

For ball/*Vir bal* P: West as negative/*Wes as negatief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $\Delta p = m(v_{Pf} - v_{Pi})$ } ✓Any one/ *Enige een* $= 0{,}16(-5 - 10)$ ✓ $= -2{,}4$ $\therefore 2{,}4$ N·s ✓ $(2{,}4\ kg{\cdot}m{\cdot}s^{-1})$ **OR/*OF*** West as positive /*Wes as positief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Pf} - v_{Pi})$ } ✓Any one/ *Enige een* $= 0{,}16(5 - (-10))$ ✓ $= 2{,}4$ N·s ✓	**POSITIVE MARKING FROM QUESTION 4.2.1 /*POSITIEWE NASIEN VANAF VRAAG 4.2.1*** For ball/*Vir bal* Q: West as negative/*Wes as negatief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Qf} - v_{Qi})$ } ✓ Any one/ *Enige een* $= 0{,}2[-3 - (-15)]$ ✓ $= 2{,}4$ N·s ✓ $(2{,}4\ kg{\cdot}m{\cdot}s^{-1})$ **OR/*OF*** West as positive /*Wes as positief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Qf} - v_{Qi})$ } ✓Any one/ *Enige een* $= 0{,}16(3 - (15))$ ✓ $= -2{,}4$ N·s $\therefore 2{,}4$ N·s ✓ $(2{,}4\ kg{\cdot}m{\cdot}s^{-1})$

(3)
[10]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. However, **IF**: The word "work" is omitted 0 marks
*Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase. Maar, **INDIEN**: Die woord "arbeid" uitgelaat is, 0 punte*

A force is non-conservative if the work it does on an object (which is moving between two points) depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig (op 'n voorwerp wat tussen twee punte beweeg*) afhanklik is van die pad.*

OR/*OF*
A force is non-conservative if the work it does on an object depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhanklik is van die pad.

OR/*OF*
A force is non-conservative if the work it does in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg, nie-nul is nie. (2)

5.2
$K = \frac{1}{2}mv^2$ / $E_k = \frac{1}{2}mv^2$
$\Delta K = K_f - K_i$
$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}m(v_f^2 - v_i^2)$
$= \frac{1}{2}(200)(2^2 - 4^2)$ ✓
✓Any one /*Enige een*
$\Delta K = -1\ 200$ J ✓ (3)

QUESTION 4/*VRAAG 4*

4.1

NOTE: -1 mark for each key word/phrase omitted in the correct context.
LET WEL: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

Isolated system is a system on which the resultant/net external force is zero.✓✓
Geïsoleerde sisteem is 'n sisteem waarop die resultante / netto eksterne krag nul is.

OR/OF
Isolated system is one that has no net / external force acting on it.
'n Geïsoleerde stelsel is een wat geen netto eksterne krag het wat daarop inwerk nie. (2)

4.2.1

$p = mv$ ✓
$24 = m(480)$ ✓
$m = 0,05$ kg ✓ (3)

Note: p and v must have the same sign
Let wel: p en v moet dieselfde tekens hê

4.2.2

Marking criteria/*Nasienriglyne*
- Appropriate formula including F_{net} or $W_{net.}$ /*Toepaslike formule wat F_{net} of W_{net} insluit.* ✓
- Substitutions/V*ervangings* ✓✓
- Final answer/*Finale antwoord*: 2 000 N ✓
- Correct direction/*Korrekte rigting:* west or left/*Wes of links* ✓

POSITIVE MARKING FROM QUESTION 4.2.1
POSITIEWE NASIEN VANAF VRAAG 4.2.1

OPTION 1/*OPSIE 1*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = (p_{bullet})_f - (p_{bullet})_i$ ✓Any one/*Enige een*
$F_{net}\Delta t = (mv_{bullet})_f - (mv_{bullet})_i$
$F_{net}(0,01)$ ✓ $= \frac{(0,05)(80) - 24}{}$ ✓ or/*of* $\frac{(0,05)(80) - (0,05)(480)}{}$
$F_{net} = -2\,000$ N
$F_{net} = 2\,000$ N ✓ west/*wes* ✓

OPTION 2/*OPSIE 2*

$v_f = v_i + a\Delta t$
$80 = 480 + a(0,01)$ ✓
$a = -40\,000\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= (0,05)(-40\,000)$ ✓
$= -2\,000$ N
$F_{net} = 2\,000$ N ✓ west/*wes* ✓

OPTION 3/*OPSIE 3*

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$= \frac{480 + 80}{2}\ (0,01)$

$= 2,80\ m$

$v_f^2 = v_i^2 + 2a\Delta x$
$\underline{(80)^2 = (480)^2 + 2a(2,80)}$ ✓
$a = -\ 40\ 000\ m{\cdot}s^{-2}$

$F_{net} = ma$ ✓
$= \underline{(0,05)(-40\ 000)}$ ✓
$= -\ 2\ 000\ N$
$F_{net} = 2\ 000\ N$ ✓ west/*wes* ✓

$W_{net} = \Delta K$ ✓
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\underline{F_{net}(2,80)\cos 0°}$ ✓ $= \underline{\frac{1}{2}(0,05)(80^2 - 480^2)}$ ✓
$F_{net} = -2\ 000\ N$
$F_{net} = 2\ 000\ N$ ✓ west/*wes* ✓

OR/*OF*
$\underline{F_{net}(2,80)\cos 180°}$ ✓ $= \underline{\frac{1}{2}(0,05)(80^2 - 480^2)}$ ✓
$F_{net} = 2\ 000\ N$ ✓ west/*wes* ✓

(5)
[10]

QUESTION 5

5.1

Note: -1 mark for each key word/phrase omitted in the correct context.
Let Wel: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*
IF: The word "work" is omitted - 0 marks.
INDIEN**:** *Die woord "arbeid" uitgelaat is - 0 punte.*

A *conservative force* is a force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓
'n Konserwatiewe krag is 'n krag waarvoor die arbeid wat verrig is (om 'n voorwerp tussen twee punte te beweeg) onafhanklik is van die pad wat gevat word.

OR/OF
A conservative force is a force for which the work done in moving an object in a closed path is zero.
'n Konserwatiewe krag is 'n krag waarvoor die arbeid verrig om 'n voorwerp in 'n geslote pad te beweeg, nul is. (2)

5.2 Gravitational (force)/*Gravitasiekrag* ✓

ACCEPT/AANVAAR: Gravitation /Gravity /*Gravitasie* / Weight /*Gewig* (1)

5.3 No/*Nee* ✓
There is friction/non-conservative force (doing work)/It is not isolated system.✓
Daar is wrywing/nie konserwatiewe krag (wat arbeid verrig)./Dit is nie 'n geïsoleerde sisteem nie.

OR/OF
The net work done by the non-conservative forces is not zero/*Die netto arbeid deur die nie-konserwatiewe kragte is nie nul nie.* ✓ (2)

QUESTION 4/*VRAAG 4*

4.1 The total (linear) momentum in a isolated/closed system remains constant./ is conserved ✓✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant/behoue.

OR/*OF*
In an isolated/closed system the total momentum before a collision is equal to the total momentum after the collision. ✓✓
In 'n geslote/geïsoleerde sisteem is die totale momentum voor die botsing gelyk aan die totale momentum na die botsing.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat.
Take the whole statement in context /*Vat die hele stelling in konteks*. (2)

4.2

OPTION 1/*OPSIE 1*

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

1 mark for any
1 punt vir enige

$\{0,45(9) + 0,20(0)\}$✓ $= (0,45 + 0,20)v$✓
$v = 6,23\ m\cdot s^{-1}$✓

OR
$\Delta p_{ball/bal} = -\Delta p_{cont/houer}$✓
$0,45(v - 9)$ ✓ $= -0,2(v - 0)$ ✓
$v = 6,23\ m\cdot s^{-1}$✓

If – sign omitted from formula 0/4
Indien – teken weggelaat uit formula 0/4

OPTION 2/*OPSIE 2*

$\sum p_i = \sum p_f$
$p_{f\ Total} = p_{i\ Total}$

1 mark for any✓
1 punt vir enige

(Thus change in total momentum = 0 /*Dus verandering in momentum is=0*))
0 ✓$= \underline{(0,65v_f) - (9)(0,45)}$✓
$v_f = 6,23\ m\cdot s^{-1}$✓ (4)

4.3

POSITIVE MARKING FROM 4.2/*POSITIEWE NASIEN VANAF 4.2*
$K = ½ mv^2$✓ (or $E_K = ½ mv^2$)
Total kinetic energy before collision:/*Totale kinetiese energie voor botsing:*
$\underline{½ (0,45)(9)^2}$ $\underline{+ 0}$✓= 18,225J

Total kinetic energy after collision:/ *Totale kinetiese energie na botsing:*
$\underline{½ (0,45 + 0,20)(6,23)^2}$✓ = 12,614J

$\sum K_{before/voor} \neq \sum K_{after/na}$
Collision is inelastic. /*Botsing is onelasties*✓✓

If start with/ *indien begin met* $\sum E_{Ki} = \sum E_{Kf}$ 4/5 max/*maks*
No calculation/ *geen berekening*: 0
Do not accept a conclusion of inelastic collision based on any other calculation (such as that of momentum or mechanical energy)./ *Moet geen afleiding van ' n onelastiese botsing aanvaar wat op enige ander berekening gebaseer is nie (soos byvoorbeeld momentum of meganiese energie).*

(5)
[11]

OPTION 12/*OPSIE 12*

Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (7,5)^2$ ✓$+ 2(-9,8)(2,1)$ ✓
$v_f = 3,88\ m\cdot s^{-1}$ ✓

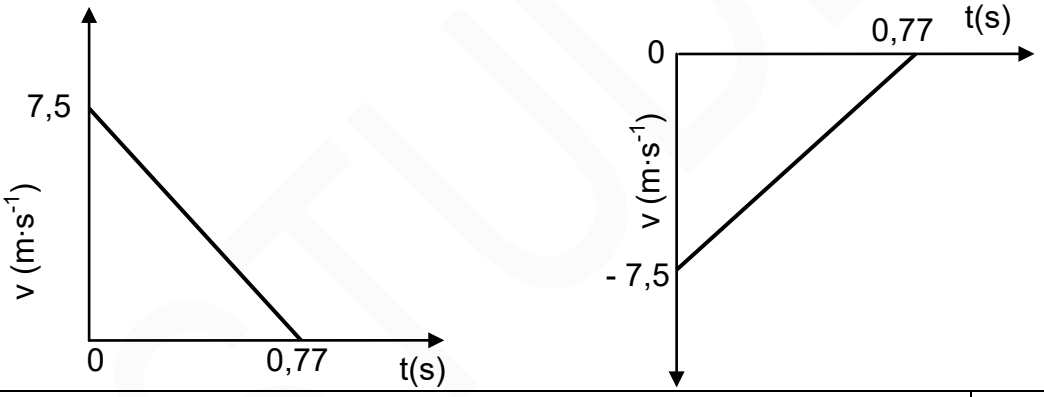
Velocity at **T** is $3,88\ m\cdot s^{-1}$ therefore the ball still moving towards its maximum height ✓✓
*Snelheid by **T** is 3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte*

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (-7,5)^2$ ✓$+ 2(9,8)(-2,1)$✓
$v_f = -3,88\ m\cdot s^{-1}$✓

Velocity at **T** is $-3,88\ m\cdot s^{-1}$ therefore the ball is still moving towards its maximum height ✓✓
*Snelheid by **T** is -3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte* (6)

3.4 **POSITIVE MARKING FROM 3.2 / *POSITIEWE NASIEN VANAF 3.2***



Notes/*Notas*:	
Initial velocity and time for final velocity shown *Beginsnelheid en tyd vir finale snelheid aangedui.*	✓
Correct straight line (including orientation) drawn *Korrekte reguitlyn (insluitend oriëntasie) geteken.*	✓

(2)
[13]

QUESTION 4/*VRAAG 4*

4.1 Momentum is the product of the mass of an object and its velocity ✓✓
Momentum is die produk van die massa van 'n voorwerp en sy snelheid.
[NOTE/LET WEL: 2 or/of 0] (2)

4.2 To the left/*Na links* ✓
Newton's third law/*Newton se derde wet* ✓

ACCEPT/*AANVAAR*:
Principle of conservation of linear momentum / law of action-reaction
Beginsel van behoud van lineêre momentum/wet van aksie-reaksie
Newton's third law **and** Newton's second law/*Newton se derde wet **en** Newton se tweede wet* (2)

NOTE: For QUESTION 4.3 and 4.4 motion to the right has been taken as positive. Candidates may use the opposite direction.
LET WEL: Vir VRAAG 4.3 en 4.4 word beweging na regs as positief geneem. Kandidate mag die teenoorgestelde rigting gebruik.

4.3

OPTION 1/*OPSIE 1*
$\sum p_i = \sum p_f$ ✓
$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$
mass of girl is m / *massa van meisie is m*

Allocate mark if 0 is substituted on left hand side/*Ken punt toe indien 0 aan linkerkant vervang is.*

$\{(m + 2)(0)\} + \{8(0)\}$✓ = $\{(m + 2)(-0,6)\}$✓ + (8)(4)✓
m = 51,33 kg ✓

N**OTE**: Penalise only once for the incorrect sign of the 0,6.
LET WEL: *Penaliseer slegs eenmaal die die inkorrekte teken van 0,6*

OPTION 2/*OPSIE 2*
$\sum p_i = \sum p_f$ ✓
$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$
$0 = m_1v_{1f} + m_2v_{2f}$
0✓ = (8)(4)✓+ m_2(-0,6) ✓
∴ m_2 = 53,33 kg
∴ m_{girl} = 53,33 – 2
∴ m_{girl} = 51,33 kg ✓

OPTION 3/*OPSIE 3*
$\Delta p_{girl} = -\Delta p_{parcel}$ ✓
$m(v_f - v_i) = -m(v_f - v_i)$
(m + 2)(-0,6 - 0) ✓ = – 8(4 – 0) ✓
m = 51,33 kg ✓

(5)

4.4

POSITIVE MARKING FROM *4.3/POSITIEWE NASIEN VANAF 4.3*
Impulse = $\Delta p = m(v_f - v_i)$ ✓
= $\underline{(51,33 + 2)(-0,6 - 0)}$ ✓
= -32 N·s / kg·m·s^{-1}
Magnitude of impulse/*Grootte van die impuls* is 32 N·s /32 kg·m·s^{-1} ✓
OR/*OF*
Impulse = $\Delta p_{parcel/pakket} = m(v_f - v_i)$ ✓
Δp = (8)(4 – 0) ✓ = 32 kg m·s^{-1}
∴$\Delta p_{girl/meisie}$ = 32 kg m·s^{-1}✓

(3)

4.5

POSITIVE MARKING FROM 4.4 /*POSITIEWE NASIEN VANAF 4.4*
32 kg·m·s^{-1} / N·s ✓ to the right/opposite direction /*na regs /teenoorgestelde rigting*✓

(2)
[14]

3.5 Inelastic./*Onelasties*✓
The speeds at which it strikes and leaves the ground are not the same/The kinetic energies will not be the same ✓
Die spoed waarmee dit die grond tref en die grond verlaat is nie dieselfde nie./Die kinetiese energieë sal nie dieselfde wees nie (2)
[16]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum of a closed (isolated) system remains constant (is conserved). ✓✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant (bly behoue)

OR/*OF*
In an isolated system, the total linear momentum before collision is equal to the total linear momentum after collision ✓✓
In 'n geïsoleerde sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing.
(If key words isolated and total missing -1 mark for each.) (2)

4.2 $\Sigma p_i = \Sigma p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ } Any one/ *Enige een* ✓

For the system cat-skate board **A**/*Vir die sisteem kat-skaatsplank*
$\underline{(3,5)(0) + (2,6)(0)}$ ✓ = $\underline{(3,5)v_{skateboard/skaatsplank} + (2,6)(3)}$ ✓

$v_{skateboard/skaatsplank}$ = 2,23 m·s^{-1}✓ to the left/*na links*✓

ACCEPT/AANVAAR v = -2,23 m·s^{-1}✓✓ (5)

4.3 $F_{net}\,\Delta t = \Delta p = mv_f - mv_i$✓
= (3,5)(1,28 - 0) ✓
= 4,48 N·s (4,48 kg·ms^{-1}) ✓

OR/*OF*
$F_{net}\,\Delta t = \Delta p = mv_f - mv_i$✓
= (2,6)(1,28 - 3) ✓
= -4,48 N·s (4,48 kg·ms^{-1})
∴ Δp = 4,48 N·s✓ (3)
[10]

QUESTION 4/*VRAAG 4*

4.1

$E_{(\text{mech top/}meg\ bo)} = E_{(\text{mech bottom/}meg\ onder)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$
$(mgh + ½ mv^2)_{top/bo} = (mgh + ½ mv^2)_{bottom/onder}$
$\underline{(1,5)(9,8)(2) + 0}$ ✓ $= \underline{0 + ½ (1,5)v^2}$ ✓
$v = 6,26\ m\cdot s^{-1}$ ✓

1 mark for any
1 punt vir enigeen

(4)

4.2 In a/an closed/isolated✓ system, the total✓ linear momentum is conserved.
/*In 'n geïsoleerde/geslote sisteem bly die totale liniêre momentum behoue.* (2)

4.3 **POSITIVE MARKING FROM 4.1/*POSITIEWE NASIEN VANAF 4.1***

$\Sigma p_i = \Sigma p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v$
$\underline{(1,5)(6,26) + 0}$ ✓ $= \underline{(1,5 + 2)v_f}$ ✓
$v_f = 2,68\ m\cdot s^{-1}$ ✓

1 mark for any
1 punt vir enige een

(4)

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

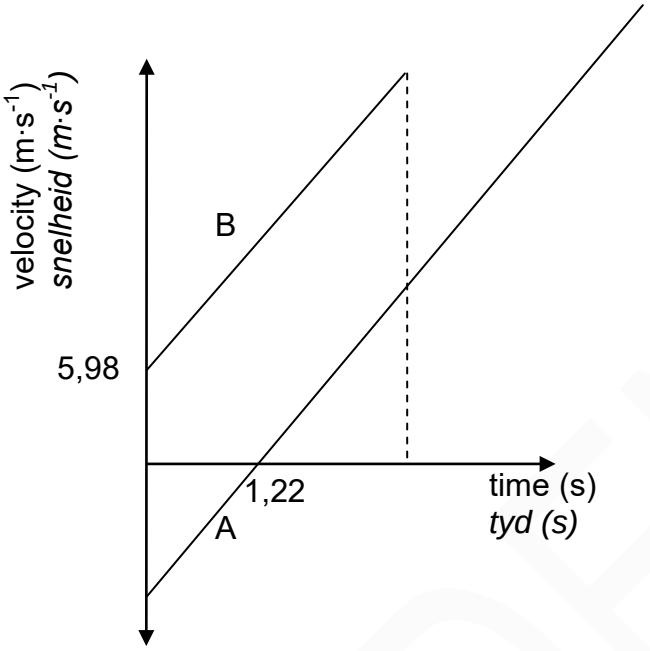
OPTION 1/*OPSIE 1*
$\Delta x = v\Delta t$ ✓
$= (2,68)(3)$ ✓
$= 8,04\ m$ ✓

OPTION 2/OPSIE 2
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{(2,68 + 2,68)}{2}\right)(3)$ ✓
$= 8,04\ m$

OPTION 3/*OPSIE 3*
$\Delta x = v_i\Delta t + ½ a\Delta t^2$ ✓
$= (2,68)(3) + ½ (0)(3)^2$ ✓
$= 8,04\ m$ ✓ (Range 8,04 – 8,05) (2)

[13]

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*



Criteria for graph/*Kriteria vir grafiek*	**Marks/*Punte***
Time 1,22 s shown **correctly**/*Tyd 1,22 s **korrek** getoon*	✓
Initial velocity for stone B at time t = 0 correctly shown with correct signs / *Aanvanklike snelheid vir klip B korrek met korrekte tekens getoon*	✓
Two sloping parallel lines with A **crossing** the time axis /*Twee skuins parallelle lyne met A wat die tyd-as **kruis***	✓
Straight line graph for A parallel to graph B, extending beyond the time when B hits the ground/ *Reguitlyn grafiek A parallel aan grafiek B verleng verby die tyd wanneer B die grond tref*	✓

(4)
[14]

QUESTION 4 /*VRAAG 4*

4.1 The total linear momentum in an isolated/closed system is constant.✓✓
Die totale liniêre momentum in 'n geïsoleerde (geslote) sisteem is konstant

OR/*OF*
In an isolated/closed system, total linear momentum before collision is equal to total linear momentum after collision. ✓✓
In 'n geïsoleerde (geslote) sisteem is die totale liniêre momentum voor die botsing gelyk aan die totale momentum na die botsing. (2)

4.2 $\Sigma p_i = \Sigma p_f$ ✓

$m_B v_{Bi} + m_b v_{bi} = m_B v_{Bf} + m_b v_{bf}$

$\Delta p_{bullet} = -\Delta p_{block}$

$(0,015)(400)$✓ + 0 = $(0,015)v_{Bf}$ + $2(0,7)$✓

V_{Bf} = 306,67 (306,666)$m \cdot s^{-1}$✓ (4)

4.3

OPTION 1/*OPSIE 1*

$F_{net}\Delta t = \Delta p$
$\Delta p = mv_f - mv_i$ ✓

For bullet / *Vir koeël*
$\Delta p = (0,015)(306,666 - 400)$✓
$= -1,4\ kg\cdot m\cdot s^{-1}$
$F_{net}(0,002) = -1,4$
$F_{net} = -700\ N$

For block / *Vir blok*
$\Delta p = (2)(0,7 - 0)$✓
$= 1,4\ kg\cdot m\cdot s^{-1}$
$F_{net}(0,002) = 1,4$
$F_{net} = 700\ N$

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$(700)\Delta x\cos 180^o$ ✓$= ½\ (0,015)(306,67^2 - 400^2)$✓
$\Delta x = 0,71\ m$ ✓

$F_{net} = ma$
$-700 = (0,015)a$
OR/*OF*
$F_{met} = ma$
$700 = (0,015)a$

$a = -46\ 666,67$
or/*of* $46\ 665\ m\cdot s^{-2}$

$\Delta x = v_i\Delta t + ½\ a\Delta t^2$
$= (400)(0,002)$✓ $+ ½(-46\ 666,67)(0,002)^2$✓
$= 0,71\ m\ (0,70667)\ m$✓

OR/OF
$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$
$(306,67)^2$ ✓$= (400)^2 + 2(-46\ 666,67)\Delta x$✓
$\Delta x = 0,71\ m\ (0,70667\ m)$ ✓

OPTION 2/*OPSIE 2*

$v_f = v_i + a\Delta t$✓
$306,666 = 400 + a\ (0,002)$ ✓
$a = -46\ 667\ m\cdot s^{-2}$

$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$
$(306,666)^2$ ✓$= 400^2 + 2(-4667)\ \Delta x$✓
$\Delta x = 0,71\ m\ (0,706\ m)$ ✓

OPTION 3/*OPSIE 3*

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{400 + 306,666}{2}\right)(0,002)$ ✓
$= 0,71\ m\ (0,707)\ m$ ✓

OPTION 4/*OPSIE 4* $W_{net} = \Delta K/\Delta E_k$ ✓ $F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$ $v_f = v_i + a\Delta t$ $306,666 = 400 + a\,(0,002)$ ✓ $a = -46\ 667\ m\cdot s^{-2}$
$W_{net} = \Delta K/\Delta E_k$ $F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$ $(0,015)(46\ 667)\Delta x\cos180^o$✓ $= ½(0,015)(306,666^2 - 400^2)$✓ $\Delta x = 0,71$ m (0,707) ✓
OR/*OF* $W_{nc} = \Delta E_p + \Delta E_k$ $(0,015)(46\ 667)\Delta x\cos180^o$✓ $= ½(0,015)(306,666^2 - 400^2)$✓ $\Delta x = 0,71$ m (0,707) ✓

(5)
[11]

QUESTION 5/*VRAAG 5*

5.1 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 in voorwerp deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

5.2

Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg/ 58,8N / gravitational force / $F_{\text{earth on block}}$ *F_g / F_w / gewig / mg /58,8 N/ gravitasiekrag* / $F_{\text{aarde op blok}}$
T	F_T/ Tension/ *spanning*

5.3

$W_w = w\Delta x\cos\theta$✓ $= mg\Delta x\cos\theta$ $= (6)(9,8)(1,6)\cos0^o$✓ $\therefore W = 94,08$ J ✓	$W_w = -\Delta E_P$ ✓ $= -mg(h_f - h_i)$ $= -(6)(9,8)(0 - 1,6)$ ✓ $= 94,08$ J✓

(3)

QUESTION/*VRAAG 4*

4.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 2/*OPSIE 2***
$v = \frac{\Delta x}{\Delta t}$	$v = \frac{\Delta x}{\Delta t}$	$v = \frac{\Delta x}{\Delta t}$
$= \frac{0,2}{0,4}$	$= \frac{0,4}{0,8}$	$= \frac{0,6}{1,2}$
$= 0,5\ m \cdot s^{-1}$	$= 0,5\ m \cdot s^{-1}$	$= 0,5\ m \cdot s^{-1}$

✓ Formula/*Formule*
✓ Correct substitution in all three equations/*Korrekte vervanging in al drie vergelykings*
✓Correct answer/k*orrekte antwoord*
- If only two calculations used with correct answer, award 2/3
  Indien slegs twee berekenings met korrekte antwoord gebruik word, ken 2/3 toe
- If unit(s) omitted lose 1 mark./*Indien eenhede weggelaat is verbeur 1 punt*

OPTION 2/*OPSIE 2*
Trolley moves with equal displacements in equal time (intervals). (Full marks or zero)
Trollie beweeg met gelyke verplasings in gelyke tydintervalle (Vol punte of nul) (3)

4.2 The total linear momentum of a closed (isolated) system remains constant (is conserved).
Die totale lineêre momentum in 'n geslote (geïsoleerde) sisteem bly konstant (is behoue).

OR/*OF*
In an isolated system, the total linear momentum before collision is equal to the total linear momentum after collision
In 'n geslote (geïsoleerde) sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing. (2)

NOTE:/*LET WEL*
If the words “closed (isolated)” or “total” omitted, award 1/2.
Indien die woorde “geslote (geïsoleerde)” of totaal weggelaat is, ken 1/2 toe

4.3 **POSITIVE MARKING FROM QUESTION 4.1/*POSITIEWE NASIEN VANAF VRAAG 4.1***

OPTION 1/*OPSIE 1*

$\Sigma p_i = \Sigma p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ ✓Any one/*Enige een*

$\underline{(3,5)(0,5)}$✓ = $\underline{(3,5 + 6)v_f}$ ✓
$v_f = v_{6kg}$
$= 0,184\ m{\cdot}s^{-1}$

$F_{net} = ma$
$m\frac{(v_f - v_i)}{\Delta t} = (6)\frac{(0,184 - 0)}{0,05}$
$= 2,21\ N$

For trolley B:/*Vir trollie B:*

$F_{net}\Delta t = \Delta p = m\Delta v$✓
$\underline{F_{net}(0,5) = 6(0,184 - 0)}$ ✓
$F_{net} = 2,21\ N\ (2,24\ N)$✓

OPTION 2/*OPSIE 2*

$\Sigma p_i = \Sigma p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ ✓Any one/*Enige een*

$\underline{(3,5)(0,5)}$ ✓ = $\underline{(3,5 + 6)v_f}$ ✓
$v_f = v_{6kg}$
$= 0,184\ m{\cdot}s^{-1}$

For trolley B:/*Trollie B:* $F_{net}\Delta t = \Delta p = m\Delta v$✓ $\underline{F_{net}(0,5) = 6(0,184 - 0)}$ ✓ $F_{net} = 2,21\ N\ (2,24\ N)$ ✓	For trolley A:/*Trollie A:* $F_{net}\Delta t = \Delta p = m\Delta v$✓ $\underline{F_{net}(0,5) = 3,5(0,184 - 0,5)}$ ✓ $F_{net} = -2,21\ N\ (2,24\ N)$ ∴ Magnitude of the average net force experienced by trolley B = 2,21 N (2,24 N)✓ *∴Grootte van die gemiddelde netto krag deur trollie B ondervind = 2,21 N (2,24 N)*

(6)
[11]

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

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✓
= 17,4m✓

OR/OF

$y_f = y_i + \Delta y$
$= [-22 + (1,2)(3,83)]$✓ ✓
$= -17,4$ 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
$p = mv$✓
$= (0,03)(700)$ ✓
$= 21\ kg\cdot m\cdot s^{-1}$✓

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 = $\frac{60}{220}$ ✓= 0,27 s

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

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

$= \frac{21 - 0}{0,27}$ ✓

= 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*

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

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

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

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

= 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*

$v_f = v_i + a\Delta t$

$a = \frac{700 - 0}{(60/220)}$ ✓

$a = 2592,59\ m{\cdot}s^{-2}$

$F_{net} = ma$ ✓

$F_{net} = (0,03)(2592,59)$ ✓

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 4/*VRAAG 4*

4.1 A system on which the resultant/net external force is zero/*'n Sisteem waarop die resulterende krag/netto eksternekrag nul is* ✓
A system which excludes external forces /*'n Sisteem wat eksterne kragte uitlaat.* (1)

4.2.1

OPTION 1/*OPSIE 1*
$p = mv$✓
$\underline{30\ 000 = (1\ 500)v}$ ✓
$v = 20\ m\cdot s^{-1}$✓

OPTION 2/*OPSIE 2*
$\Delta p = mv_f - mv_i$ ✓
$\underline{0 = (1\ 500)v_f - 30\ 000}$ ✓
$v = 20\ m\cdot s^{-1}$✓ (3)

4.2.2 **POSITIVE MARKING FROM QUESTION 4.2.1/*POSITIEWE NASIEN VANAF VRAAG 4.2.1***

OPTION 1/*OPSIE 1*
$\sum p_i = \sum p_f$
$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ } ✓ 1 mark for any/*1 punt vir enige*
$\underline{30\ 000 + (900)(-15)}$✓ = $\underline{14\ 000 + 900v_B}$✓
$\therefore v_B = 2{,}78\ m\cdot s^{-1}$ ✓east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*)

OPTION 2/*OPSIE 2*
$\Delta p_A = -\Delta p_B$
$p_f - p_i = -(mv_f - mv_i)$ } 1 mark for any/*1 punt vir enige*
$\underline{14\ 000 - 30\ 000}$ ✓= $\underline{900v_f - 900(-15)}$ ✓
$v_f = 2{,}78\ m\cdot s^{-1}$✓ east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*) (5)

4.2.3

OPTION 1/*OPSIE 1*
$$\text{Slope/}\textit{Helling} = \frac{\Delta p}{\Delta t} = F_{net}\checkmark$$
$$= \frac{(14\ 000 - 30\ 000)}{(20{,}2 - 20{,}1)}\ \checkmark\ \checkmark$$
$$= -\ 160\ 000$$
$$F_{net} = 160\ 000\ N\ \checkmark$$

OPTION 2/*OPSIE 2*
$F_{net}\Delta t = \Delta p$ ✓
$F_{net}(0{,}1)$✓ = $\underline{14\ 000 - 30\ 000}$✓
$F_{net} = -\ 160\ 000\ N$
$F_{net} = 160\ 000\ N$ ✓

POSITIVE MARKING FROM QUESTION 4.2.2/POSITIEWE NASIEN VANAF VRAAG 4.2.2

OPTION 3/*OPSIE 3*
$F_{net}\Delta t = \Delta p$ ✓
$F_{net}(0{,}1)$✓ = $\underline{900[(2{,}78) - (-15)]}$✓
$F_{net} = 160\ 020\ N$
$F_A = -F_B$
$F_{net} = 160\ 020\ N$ ✓

OPTION 4/*OPSIE 4*

$p = mv$

$14\ 000 = 1\ 500v_f$ ✓

$v_f = 9{,}33\ m\cdot s^{-1}$

$F_{net} = \frac{m(v_f - v_i)}{\Delta t}$ ✓ $= \frac{1500(9{,}33 - 20)}{0{,}1}$ ✓

$= -160\ 050$

$= 160\ 050\ N$ ✓

$v_f = v_i + a\Delta t$

$9{,}33 = 20 + a(0{,}1)$

$a = -106{,}7\ m\cdot s^{-2}$

$F_{net} = ma$ ✓

$= 1\ 500(-106{,}7)$ ✓

$F_{net} = -160\ 050\ N$

$F_{net} = 160\ 050\ N$ ✓ (4)

[13]

QUESTION 5/*VRAAG 5*

5.1.1 $E_k/K = ½\ mv^2$ ✓

$= ½\ (2)(4{,}95)^2$ ✓

$= 24{,}50\ J$ ✓ (3)

5.1.2

POSITIVE MARKING FROM QUESTION 5.1.1/*POSITIEWE NASIEN VANAF 5.1.1*

OPTION 1/*OPSIE 1*

$E_{mech\ before} = E_{mech\ after}$

$[(E_{mech})_{bob} + (E_{mech})_{block}]_{before/voor} = [(E_{mech})_{Block} + (E_{mech})_{bob}]_{after/na}$ } Any one/ *Enige een*✓

$(mgh + ½\ mv^2)_{before/voor} = (mgh + ½\ mv^2)_{after/na}$

$(5)(9{,}8)h + 0 + 0$ ✓ $= 5(9{,}8)¼h + 0 + 24{,}50$ ✓

$h = 0{,}67\ m$✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$ } Any one/ *Enige een*✓

$0 = \Delta E_p + \Delta E_k$

$-\Delta E_p = \Delta E_k$

$-[(5)(9{,}8)(¼h) - (5)(9{,}8)h]$✓ $= 24{,}50$✓

$h = 0{,}67\ m$ ✓

OPTION 3/*OPSIE 3*

Loss Ep bob = Gain in Ek of block ✓

$mg(¾h) = 24{,}5$

$(5)(9{,}8)(¾h)$✓ $= 24{,}5$ ✓

$h = 0{,}67\ m$ ✓ (4)

OPTION 4 /*OPSIE 4*

Before/*Voor*

$(mgh + ½\ mv^2)_{top/bo} = (mgh + ½\ mv^2)_{bottom/onder}$

$(5)(9{,}8)h + 0 = (5)(9{,}8)h_o + ½\ (5)v^2$

$v_i^2 = 19{,}6h - 19{,}6h_o$

After/*Na*

$(mgh + ½\ mv^2)_{bottom/onder} = (mgh + ½\ mv^2)_{top/bo}$

$(5)(9{,}8)h_o + ½(5)v_f^2 = (5)(9{,}8)(¼h) + 0$

$v_f^2 = 4{,}9h - 19{,}6h_o$

$E_{mech/meg}$ before collision/*voor botsing* = $E_{mech/meg}$ after collision/*na botsing*✓

$½\ mv_i^2$(bob/skietlood) + 0 = $½\ mv_f^2$(bob/skietlood)+ $½\ mv^2$(block/blok)

$½\ (5)(19{,}6h - 19{,}6h_o)$ ✓ $= ½\ (5)(4{,}9h - 19{,}6h_o) + 24{,}5$ ✓

$h = 0{,}67\ m$✓

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in a closed system✓ remains constant./is conserved ✓/*Die totale lineêre momentum in 'n geslote stelsel✓ bly konstant/bly behoue.* ✓

OR/*OF*

In a closed/isolated system, the total momentum before a collision is equal to the total momentum after the collision./*In 'n geslote/geïsoleerde stelsel is die totale momentum voor 'n botsing gelyk aan die totale momentum na die botsing.* (2)

4.2

4.2.1 $\sum p_i = \sum p_f$✓

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$

0✓ = $(0,4)v_{1f} + 0,6\ (4)$✓

$v_{1f} = -\ 6\ m\cdot s^{-1}$

$= 6\ m\cdot s^{-1}$ to the left/*na links*✓

NOTE: Mark for final answer to be forfeited if direction is not given/ ***LET WEL:*** *Punt vir finale antwoord word verbeur indien rigting nie gegee word nie.*

(4)

4.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\Delta p = F_{net}\Delta t$✓ $[(0,6)(4) - 0]$✓ = $F_{net}\ (0,3)$✓ $F_{net} = 8$ N✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,6(4 - 0)$✓= $F_{net}(0,3)$✓ $F_{net} = 8$ N✓	$v_f = v_i + a\,\Delta t$ $4 = 0 + a(0,3)$ $a = 13,33\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,6(13,33)$ $F_{net} = 8$ N✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\Delta p = F_{net}\Delta t$✓ $[(0,4)(6) - 0]$✓ = $F_{net}\ (0,3)$✓ $F_{net} = 8$ N✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,4(6 - 0)$✓= $F_{net}(0,3)$✓ $F_{net} = 8$ N✓	$v_f = v_i + a\,\Delta t$ $6 = 0 + a(0,3)$ $a = 20\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,4(20)$ $F_{net} = 8$ N✓

(4)

4.3 No/*Nee*✓ (1)

[11]

QUESTION/*VRAAG 4*

4.1 The total (linear) momentum of an isolated (closed) system ✓is constant (is conserved) ✓
Die totale (lineêre) momentum van 'n geïsoleerde (geslote) sisteem is konstant (bly behoue)

OR/*OF*
In an isolated (closed) system, the total (linear) momentum ✓before collision is equal to the total linear momentum after collision. ✓
In 'n geïsoleerde (geslote) sisteem is die totale (lineêre) momentum✓ voor botsing gelyk aan die totale (lineêre) momentum van botsing ✓ (2)

4.2.1

$\sum p_i = \sum p_f$
$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$
$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$
$(5)(4) + (3)(0)$ ✓ $= (5 + 3)v_f$✓
$\therefore v = 2,5\ m\cdot s^{-1}$ ✓

1 mark for any
1 punt vir enige

OR/*OF*
$\Delta p_{5kg} = -\Delta p_{3kg}$ ✓
$mv_f - mv_i = mv_f - mv_i$
$5v_f – (5)(4)$✓ $= 3v_f – (3)(0)$ ✓
$v_f = 2,5\ m\cdot s^{-1}$ ✓ (4)

4.2.2

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

$F_{net}\Delta t = \Delta p = (p_f – p_i) = (mv_f – mv_i)$ ✓
$F_{net}(0,3)$ ✓ $= 8\ [(0 – (2,5)]$✓
$F_{net} = - 66,67$ N
$\therefore F_{net} = 66,67$ N✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF 4.2.1
$F_{net} = ma$ ✓
$= \frac{m(v_f - v_i)}{\Delta t}$
$= \frac{8(0 - 2,5)}{0,3}$ ✓ $= - 66,67$ N
$\therefore F_{net} = 66,67$ N✓

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF 4.2.1
$v_f = v_i + a\Delta t$
$0 = 2,5 + a(0,3)$ ✓
$a = - 8,333\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= 8\ (-8,333)$ ✓
$= - 66,67$ N
$\therefore F_{net} = 66,67$ N✓ (4)

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½\, m(v_f^2 - v_i^2)$
$F_{net}\left(\frac{v_f + v_i}{2}\right)\Delta t \cos 180^o = ½\, m(v_f^2 - v_i^2)$
} ✓ Any one/*Enige een*

$F_{net}\left(\frac{2,5 + 0}{2}\right)(0,3)\,(-1)$✓ = ½(8)($0^2 - 2,5^5$)✓
F_{net} = 66,67 N✓

[10]

QUESTION/*VRAAG 5*

5.1 The total mechanical energy in an isolated (closed) system ✓remains constant (is conserved). ✓
Die totale meganiese energie in 'n geslote (geïsoleerde) sisteem✓ *bly konstant (bly behoue)*✓

NOTE/*LET WEL*
If total or isolated/closed is omitted (max: 1/2)
Indien totale of geslote (geïsoleerde) weggelaat is (maks: 1 2) (2)

5.2.1
$W = F\Delta x\cos\theta$✓
$= (30)(\frac{5}{\sin 30^o})\cos\theta$
$= (30)(10)\cos 180^o$
$= (30)(10)(-1)$
} ✓
$= -300$ J✓ (3)

5.2.2
OPTION1/*OPSIE 1*
POSITIVE MARKING FROM 5.2.1/*POSITIEWE NASIEN VANAF 5.2.1*
$W_{nc} = \Delta E_P + \Delta E_K$
$W_{nc} = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
} ✓
-300 ✓= (20)(9,8)(0 - 5) ✓+ ½ (20)(v_f^2 –0) ✓
$v = 8,25\ m\cdot s^{-1}$✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 5.2.1/*POSITIEWE NASIEN VANAF 5.2.1*

$W_{net} = \Delta E_K$
$W_g + W_f = \frac{1}{2}m(v_f^2 - v_i^2)$
} ✓
$W_g + (-300) =$ ½ (20)(v_f^2 -0)✓
$[(20)(9,8)\sin 30^o \frac{5}{0,5} \cos 0\,]$ ✓ + (- 300) ✓ = $10v_f^2$
$v_f = 8,25\ m\cdot s^{-1}$✓ (5)

QUESTION 4/*VRAAG 4*

4.1

OPTION 1/*OPSIE 1*

Take motion to the right as positive/*Neem beweging na regs as positief.*

$\Sigma p_i = \Sigma p_f$
$(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$ ✓
$(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$

Any one/*Enige een*

$(3 + 0{,}02)(0)$ ✓ $= (3)(-1{,}4) + (0{,}02)\ v_{f2}$ ✓
$v_{f2} = 210\ m{\cdot}s^{-1}$ ✓

OR/OF

Take motion to the left as positive/*Neem beweging na links as positief.*

$\Sigma p_i = \Sigma\ p_f$
$(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$ ✓
$(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$

Any one/*Enige een*

$(3 + 0{,}02)(0)$ ✓ $= (3)(1{,}4) + (0{,}02)\ v_{f2}$ ✓
$v_{f2} = -210\ m{\cdot}s^{-1}$
Speed/*Spoed* $= 210\ m{\cdot}s^{-1}$ ✓ (4)

OPTION 2/*OPSIE 2*

Take motion to the right as positive/*Neem beweging na regs as positief.*

$\Delta p_{bullet} = -\Delta p_{block}$ ✓
$m(v_f - v_i) = -\ m(v_f - v_i)$
$(0{,}02)(v_f - 0)$ ✓ $= -(3)(-1{,}4 - 0)$ ✓
$\therefore v_i = 210\ m{\cdot}s^{-1}$ ✓

OR/OF

Take motion to the left as positive/*Neem beweging na links as positief*

$\Delta p_{bullet} = -\Delta p_{block}$ ✓
$m(v_f - v_i) = -\ m(v_f - v_i)$
$(0{,}02)(v_f - 0)$ ✓ $= -(3)(1{,}4 - 0)$ ✓
$\therefore v_i = -210\ m{\cdot}s^{-1}$
Speed/*Spoed* $= 210\ m{\cdot}s^{-1}$ ✓ (4)

4.2

OPTION 1/*OPSIE 1*

$v_f^2 = v_i^2 + 2a\Delta x$✓
$0 = 210^2 + 2a(0,4)$✓
$a = -55\ 125\ m\cdot s^{-2}$

$F_{net} = ma$✓
$= (0,02)(-55\ 125)$✓
$= -1\ 102,5\ N$

Magnitude of force = 1 102,5 N✓
Grootte van krag = 1 102,5 N

OPTION 2/*OPSIE 2*

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$0,4 = \left(\frac{210 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 0,004\ s\ (0,00381 s)$

$F_{net}\Delta t = \Delta p = m\Delta v$✓
$F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓
$= -1\ 050\ N$
Magnitude of force = 1 050 N✓
Grootte van krag = 1 050 N
(Accept/*Aanvaar*: 1102,5 N) (5)

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta x$✓
$0 = 210^2 + 2a(0,4)$✓
$a = -55\ 125\ m\cdot s^{-2}$

$v_f = v_i + a\Delta t$
$0 = 210 - (55\ 125)\Delta t$
$\Delta t = 0,004\ s\ (0,00381\ s)$

$F_{net}\Delta t = \Delta p = m\Delta v$✓
$F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓
$= -1\ 050\ N$
Magnitude of force = 1 050 N✓ (Accept/*Aanvaar*: 1 102,5 N)
Grootte van krag = 1 050 N (5)

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \Delta K = ½\ m(v_i^2 - v_f^2)$ } ✓ Any one/*Enige een*

$F_{net}(0,4)$ ✓$\cos 180^o$✓$= ½\ (0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$✓

OR/OF

$W_{nc} = \Delta E_p + \Delta E_k$
$F_{net}\Delta x\cos\theta = 0 + ½\ m(v_i^2 - v_f^2)$ } ✓ Any one/*Enige een*
$F_{net}(0,4)$ ✓$\cos 180^o$✓$= ½\ (0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$✓ (5)

4.3 The same as/equal✓
Dieselfde as/gelyk (1)
[10]

QUESTION 4/*VRAAG 4*

4.1

$W_{net} = \Delta K$ ✓ $W_{net} = ½ (M + m)(v_f^2 - v_i^2)$ $W_{fr} = f\Delta x\cos\theta$ ✓$= ½ (M + m)(v_f^2 - v_i^2)$ 10 x 2 cos180✓= ½ (7,02)(0-v^2) ✓ v_{bb} = 2,39 m·s^{-1}✓ (2,387) m·s^{-1}	**Notes / *Aantekeninge*** 1 mark for either of the formulae indicated *1 punt vir enige van die formule aangedui* **Accept/*Aanvaar*** $W_{nc} = \Delta K + \Delta U$ with $\Delta U = 0$

(5)

4.2

The total linear momentum of an (isolated) closed system remains constant. *Die totale lineêre momentum in 'n geslote (geïsoleerde) sisteem bly konstant* **ACCEPT/*AANVAAR*** In an isolated system the total momentum before collision equals the total momentum after collision. *In 'n (geïsoleerde) geslote sisteem is die totale momentum voor botsing gelyk aan die totale momentum na botsing.*	**Notes/*Aantekeninge*** 2 or/*of* 0

(2)

4.3.

Positive marking from QUESTION 4.1 **Positiewe nasien vanaf VRAAG 4.1** $\Sigma p_i = \Sigma p_f$ ✓ $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $0,02v_i + (7)(0) = (7,02)(2,39)$ $0,02v_i$✓ = 7,02 (2,39)✓ v_i = 838,89 m·s^{-1} ✓	**Notes / *Aantekeninge*** Accept/*Aanvaar* $(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ 837,84 m·s^{-1} (for learners working with 2,387 m·s^{-1}/*vir leerders wat met* 2,387 m·s^{-1} *werk*)

(4)
[11]

QUESTION 4/*VRAAG 4*

4.1 $p = mv$✓
$= 50(5)$✓
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts)*

OR/*OF*
$p = mv$✓
$= 50(-5)$✓
$= -250\ kg{\cdot}m{\cdot}s^{-1}$
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts)* (3)

4.2 The product of the (net) force and the time interval (during which the force acts)✓✓ (2 or 0)
Die produk van die (netto) krag en die tydinterval (waartydens die krag inwerk) (2 of 0). (2)

4.3

OPTION 1/*OPSIE 1*		
$\Delta p = F_{net}\Delta t$✓ $0 - 250$ ✓$= F_{net}(0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $250 - 0$ ✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $50(0 - (-5))$✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓

(3)

OPTION 2/*OPSIE 2*	
$m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (0 - 5)$ ✓$= F_{net}\ (0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (5 - 0)$ ✓$= F_{net}\ (0,2)$ $F_{net} = 1\ 250\ N$ ✓

(3)

OPTION 3 /*OPSIE 3*	
$v_f = v_i + a\Delta t$ $0 = 5 + a(0,2)$ ✓ $a = -25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (-25)$ $= -1\ 250\ N$ $= 1\ 250\ N$✓	$v_f = v_i + a\Delta t$ $5 = 0 + a(0,2)$ ✓ $a = 25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (25)$ $= 1\ 250\ N$✓

(3)

4.4 Greater than/*Groter as*✓ (1)

4.5 For the same momentum change, ✓
the stopping time (contact time) ✓will be smaller (less) ✓
∴ the (upward) force exerted (on her) is greater.
Vir dieselfde verandering in momentum,
sal die stilhoutyd (kontaktyd) kleiner wees
∴ *die (opwaartse)krag wat (op haar) uitgeoefen word, sal groter wees.* (3)
[12]

QUESTION 5/*VRAAG 5*

5.1.1 In an isolated/closed system, ✓ the total mechanical energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly die totale meganiese energie behoue / bly konstant.

OR/*OF*
The total mechanical energy of a system is conserved/ remains constant ✓ in the absence of friction.✓
Die totale meganiese energie van 'n sisteem bly behoue/bly konstant in die afwesigheid van wrywing.

OR/*OF*
The total mechanical energy of a system remains constant ✓provided the net work done by external non conservative forces is zero.✓
Die totale meganiese energie van 'n sisteem bly konstant, mits die arbeid verrig deur eksterne nie-konserwatiewe kragte, nul is.

OR/*OF*
In the absence of a non-conservative force, the total mechanical energy is conserved/remains constant
In die afwesigheid van 'n nie-konserwatiewe krag, bly die totale meganiese energie behoue / konstant

OR/*OF*
In an isolated/closed system, ✓ the sum of kinetic and gravitational potential energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly som van kinetiese en gravitasionele potensiële energie behoue / bly konstant.

5.1.2 No/*Nee*✓ (1)

5.1.3

OPTION 1/*OPSIE 1*	
Along **AB**/*Langs* **AB** $E_{mechanical\ at\ A} = E_{mechanical\ at\ B}$ $(E_p + E_k)_A = (E_p + E_k)_B$ ✓ $(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ $(10)(9,8)(4) + 0 = 0 + ½ (10) v_f^2$✓ $v_f = 8,85\ m{\cdot}s^{-1}$	Along **AB**/*Langs* **AB** $W_{net} = \Delta E_k$ ✓ $F_g \Delta h \cos\theta = ½ m(v_f^2 - v_i^2)$ $(10)(9,8)(4)\cos 0^o = ½ (10)(v_f^2 - 0)$ ✓ $v_f = 8,85\ m{\cdot}s^{-1}$

(6)

QUESTION 4/*VRAAG 4*

4.1 Momentum is the product of the mass and velocity of an object. ✓✓
Momentum is die produk van die massa en snelheid van 'n voorwerp. (2)

4.2 $\Delta p = 0$ ✓

$F_{net} = \frac{\Delta p}{\Delta t} = 0$ ✓

OR/*OF*

$\Delta p = 0$ ✓

$\Delta v = 0 \therefore a = 0 \therefore F_{net} = ma$ ✓

OR/*OF*

Gradient of graph/ *Gradiënt van grafiek* = $\frac{\Delta p}{\Delta t} = F_{net}$ ✓

Gradient of graph between/*Gradient van grafiek tussen*:
t = 10 s and/*en* 20 s = 0 ✓ (2)

4.3

OPTION 1	**OPTION 2**
$F_{net}\Delta t = \Delta p$ ✓ $= -120 - 50$ ✓ $= -170$ $\therefore F_{net}\Delta t = 170$ N·s / kg·m·s^{-1} ✓	$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{-120 - 50}{50 - 20}$ $\therefore F_{net} = -5,67$ $F_{net}\Delta t = (-5,67)(30)$ ✓ $= -170$ $\therefore F_{net}\Delta t = 170$ N·s / kg·m·s^{-1} ✓

(3)

4.4

OPTION 1/ *OPSIE 1*	**OPTION 2/*OPSIE 2***
$\Sigma p_i = \Sigma p_f$ ✓ $-120 + 70$ ✓ $= 50 + p_{Bf}$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100$ kg·m·s^{-1}✓ west / *wes* ✓	$\Delta p_A = -\Delta p_B$ ✓ $50 - (-120)$ ✓ $= -(p_{Bf} - 70)$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100$ kg·m·s^{-1}✓ west / *wes* ✓
Other formulae/*Ander formules*: $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ or $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or $m_Av_{iA} + m_Bv_{iB} = m_Av_{fA} + m_Bv_{fB}$ $p_{total\ before} = p_{total\ after}$ Accept /*Aanvaar:* $p_{before} = p_{after}$ $p_i = p_f$	**Notes/*Aantekeninge:*** • If no formula/principle – Max. $\frac{4}{5}$ *Indien geen formule/beginsel – Maks.* $\frac{4}{5}$ • Mark direction independently. *Sien rigting onafhanklik na.*

(5)
[12]

Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
First part of the graph starts at v = 2 m·s^{-1} at t = 0 s and extends until v = 6,27 m·s^{-1} at t = 0,44 s. *Eerste deel van die grafiek begin by v = 2 m·s^{-1} by t = 0 s en verleng tot* v = 6,27 m·s^{-1} by *t = 0,44 s.*	✓
Graph is discontinuous and object changes direction at 0,64 s. *Grafiek is nie kontinu nie en voorwerp verander van rigting by 0,64 s.*	✓
Second part of graph starts at v = 4,2 m·s^{-1} at t = 0,64 s until v = 0 m·s^{-1}. *Tweede deel van grafiek begin by v = 4,2 m·s^{-1} by t = 0,64 s tot* v = 0 m·s^{-1}*.*	✓

[17]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in a closed system ✓ remains constant. / is conserved. ✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant / bly behoue.

OR/*OF*
In a closed system ✓ the total linear momentum before collision is equal to the total linear momentum after collision. ✓
In 'n geslote sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing. (2)

4.2 $\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ } ✓ Any one/*Enige een*
$(2m + 4m)(0)$ ✓ $= 2m(2) + 4m(v_{2f})$ ✓
$-4m = 4mv_f$
$\therefore v_f = -1$ m·s^{-1}
$\therefore v_f = 1$ m·s^{-1} ✓ in the opposite direction to that of the boys ✓
in die teenoorgestelde rigting as dié van die seuns (5)

4.3 Greater than / *Groter as* ✓ (1)
[8]

QUESTION 4/*VRAAG 4*

4.1 West / *Wes* ✓ (1)

4.2 (Newton's) Third Law (of Motion) ✓
When object A exerts a force on object B,
object B exerts a force equal in magnitude on object A✓, but opposite in direction. ✓

(Newton) se Derde (Bewegings)wet
Wanneer voorwerp A 'n krag op voorwerp B uitoefen,
oefen voorwerp B 'n krag van gelyke grootte op voorwerp A, maar in die teenoorgestelde rigting. (3)

4.3

OPTION 1/ *OPSIE 1* **East as positive/*Oos as positief:*** $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(4)$ ✓ $\therefore v_f = -0,33$✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓	**OPTION 2/*OPSIE 2*** **East as positive/*Oos as positief:*** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓$- 0 = -[(5)(4) - 0]$ ✓ $\therefore v_f = -0,33$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓
West as positive/*Wes as positief:* $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(-4)$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓✓	**West as positive/*Wes as positief:*** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓$- 0 = -[(5)(-4) - 0]$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓✓
OPTION 3/ *OPSIE 3* **East as positive/*Oos as positief*** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$✓$= -(5)\left(\frac{4-0}{\Delta t}\right)$✓ $v_{Bi} = -0,33\ m\cdot s^{-1}$✓ $= 0,33\ m\cdot s^{-1}$✓	**OPTION 4/ *OPSIE 4*** **West as positive/*Wes as positief*** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$✓$= -(5)\left(\frac{-4-0}{\Delta t}\right)$✓ $v_{Bi} = 0,33\ m\cdot s^{-1}$✓✓

(5)

4.4

4.4.1 Increases / *Verhoog* ✓ (1)

4.4.2 Increases / *Verhoog* ✓

- ∆p package increases, thus ∆p boy increases. ✓
  ∆p pakkie vermeerder, dus ∆p seun vermeerder.
- For the same mass of boy, v will be greater. ✓
  Vir dieselfde massa van die seun sal v groter wees.

OR/*OF*

Increases / *Verhoog*✓
From the equation in QUESTION 4.3: $-m_Av_{Af} = m_Bv_{Bf}$
Vanaf die vegelyking in VRAAG 4.3: $-m_Av_{Af} = m_Bv_{Bf}$

- If mass of package/B doubles/increases, the momentum of the boy / A doubles / increases.✓
  Indien die massa van pakkie / B verdubbel / toeneem, verdubbel / vermeerder die momentum van die seun / A
- For same mass of boy / A, the velocity of boy / A doubles/increases.✓
  Vir dieselfde massa van die seun / A, verdubbel/vermeerder die snelheid van die seun /A.

OR/*OF*

Increases / *Verhoog* ✓
$-m_Bv_{Bf} = m_pv_{pf}$
$v_B = \frac{-m_pv_{pf}}{m_B}$ ✓ for same m_B, if m_P doubles, ✓ then v_B doubles

(3)
[13]

QUESTION 5/*VRAAG 5*

5.1 The total mechanical energy remains constant / is conserved ✓
in a closed / isolated system / in absence of external forces /non-conservative forces. ✓
Die totale meganiese energie in bly konstant / bly behoue
in 'n geslote / geïsoleerde sisteem /in afwesigheid van eksterne kragte /nie-konserwatiewe kragte.

OR/*OF*

The sum of the potential and kinetic energy of a system remains constant ✓
in a closed/isolated system. ✓
Die som van die potensiële en kinetiese energie van *'n sisteem bly konstant in 'n geslote / geïsoleerde sisteem.*

OR/*OF*

When the work done on an object by the non-conservative forces is zero✓, the total mechanical energy is conserved. ✓
Wanneer die arbeid deur die nie-konserwatiewe kragte op 'n voorwerp verrig nul is, bly die totale meganiese energie behoue.

(2)

QUESTION 4/*VRAAG 4*

4.1 The total (linear) momentum remains constant/is conserved ✓
in an isolated/a closed system/the absence of external forces. ✓

Die totale lineêre momentum bly konstant/behoue ✓
in 'n geïsoleerde sisteem/geslote sisteem/die afwesigheid van eksterne kragte. ✓

Notes/*Aantekeninge:*
The mark for 'closed/isolated system' is only awarded if used in conjunction with momentum.
Die punt vir 'geslote/geïsoleerde sisteem' word slegs toegeken indien saam met momentum gebruik.

Accept: The total momentum before a collision equals the total momentum after a collision in a closed system.
Aanvaar: *Die totale momentum voor 'n botsing is gelyk aan die totale momentum na 'n botsing in 'n geslote sisteem.*

(2)

4.2 **To the right as positive/*Na regs as positief:***
$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓
$(0,01)(300)$ ✓$+ (1,99)(0) = (0,01 + 1,99)v_{f2}$ ✓
$\therefore v_{f2} = 1,5\ m\cdot s^{-1}$ ✓

To the right as negative/*Na regs as negatief:*
$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓
$(0,01)(-300)$ ✓$+ (1,99)(0) = (0,01 + 1,99)v_{f2}$ ✓
$\therefore v_{f2} = -1,5\ m\cdot s^{-1}$
$\therefore v_{f2} = 1,5\ m\cdot s^{-1}$ ✓

Other formulae/*Ander formules*:	**Notes/*Aantekeninge:***
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ or/*of* $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or/*of* $m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_{f2}$	If no formula/principle – Max. $\frac{3}{4}$ *Indien geen formule/beginsel – Maks.* $\frac{3}{4}$

(4)

4.3 Inelastic/*Onelasties* ✓
Kinetic energy is not conserved./*Kinetiese energie bly nie behoue nie*.✓

OR/*OF*
Inelastic/*Onelasties*✓
Objects stick together/*Voorwerpe heg aan mekaar*. ✓

OR/*OF*
Inelastic/*Onelasties*✓
Structural damage to the block./*Strukturele skade aan blok*. ✓

OR/*OF*
Inelastic/*Onelasties*✓
There is deformation to the block/bullet./*Daar is vervorming van die blok.*✓

OR/*OF*
Inelastic/*Onelasties* ✓
Energy converted to other forms such as sound and heat./*Energie word omgeskakel na ander vorms soos klank en hitte.*✓

(2)

4.4 **POSITIVE MARKING FROM QUESTION 4.2.**
POSITIEF NASIEN VAN VRAAG 4.2.

Option 1/*Opsie 1*:	**Notes/*Aantekeninge:***
$W_{net} = \Delta K$ ✓ **OR /*OF*** $F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(8)\Delta x\cos 180° \checkmark = \frac{1}{2}(2)(0^2 - 1{,}5^2)$ ✓ $\therefore \Delta x = 0{,}28$ m ✓	Accept/*Aanvaar*: E_k
Option 2/*Opsie 2*: $F_{net} = ma$ $\therefore (-8) = 2a$ ✓ $\therefore a = -4\ m\cdot s^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$ $0^2 = (1{,}5)^2 + 2(-4)\Delta x$ ✓ $\therefore \Delta x = 0{,}28$ m ✓ ✓Both formulae *Beide formules*	**Notes/*Aantekeninge:*** Accept/*Aanvaar*: $v_f^2 = v_i^2 + 2a\Delta y$ $v^2 = u^2 + 2as$

(4)
[12]

QUESTION 5/*VRAAG 5*

5.1 The <u>total mechanical energy remains constant</u>/is conserved✓
in <u>an isolated</u>/closed system. ✓
Die <u>totale meganiese energie bly konstant</u>/bly behoue
in <u>'n geïsoleerde</u>/geslote sisteem

OR/*OF*
The <u>sum of the potential and kinetic energy remains constant</u> ✓
in <u>an isolated</u>/closed system. ✓
Die <u>som van die potensiële en kinetiese energies bly konstant</u>
in <u>'n geïsoleerde</u>/geslote sisteem

Notes/*Aantekeninge:*
The mark for 'closed/isolated system' is only awarded if used in conjunction with energy. *Die punt vir 'geslote/geïsoleerde sisteem' word slegs toegeken indien saam met energie gebruik.*

(2)

QUESTION 4/*VRAAG 4*

4.1 $40\ m\cdot s^{-1}$ ✓east/*oos* ✓ (2)

4.2 The <u>total (linear) momentum remains constant</u>/is conserved ✓
in <u>an isolated</u>/a closed system/the absence of external forces/ if the impulse of external forces is zero. ✓

Die <u>totale (linière) momentum bly konstant/</u>behoue ✓
in 'n <u>geïsoleerde sisteem</u>/geslote sisteem/ die afwesigheid van eksterne kragte./ indien die impuls van eksterne kragte nul is.✓ (2)

4.3 **<u>East positive/*Oos positief:*</u>**
$\Sigma p_i = \Sigma p_f$ ✓
$m(20)$ ✓$+ 2m(-20)$ ✓ $= (m + 2m)v_f$ ✓
$\therefore v_f = -6{,}67\ m\cdot s^{-1}$
$\therefore v_f = 6{,}67\ m\cdot s^{-1}$ ✓ west /wes ✓
<u>East negative/*Oos negatief:*</u>
$\Sigma p_i = \Sigma p_f$ ✓
$m(-20)$ ✓$+ 2m(+20)$ ✓ $= (m + 2m)v_f$ ✓
$\therefore v_f = 6{,}67\ m\cdot s^{-1}$ ✓ west /*wes* ✓ (6)

4.4
4.4.1 F✓
Newton's Third Law of motion/*Newton se Derde Bewegingswet* ✓ (2)

4.4.2 -½ a / ½ a✓
(Same/*Dieselfe* F_{net}), $a \propto \frac{1}{m}$ ✓ (2)

4.4.3 Car driver ✓
(Car - driver system) have <u>greater acceleration</u>. ✓
(Car - driver system) have <u>greater change in velocity /greater Δv</u>.✓

Motorbestuurder ✓
(Motor -bestuurder sisteem) het groter versnelling. ✓
(Motor -bestuurder sisteem) het groter verandering in snelheid / groter <u>Δv</u>.✓ (3)
[17]

QUESTION 4/*VRAAG 4*

4.1 $40\ m\cdot s^{-1}$ ✓east/*oos* ✓ (2)

4.2 The <u>total (linear) momentum remains constant</u>/is conserved ✓
in <u>an isolated</u>/a closed system/the absence of external forces/ if the impulse of external forces is zero. ✓

Die <u>totale (linière) momentum bly konstant/</u>behoue ✓
in 'n <u>geïsoleerde sisteem</u>/geslote sisteem/ die afwesigheid van eksterne kragte./ indien die impuls van eksterne kragte nul is.✓ (2)

4.3 **<u>East positive/*Oos positief:*</u>**
$\Sigma p_i = \Sigma p_f$ ✓
$m(20)$ ✓$+ 2m(-20)$ ✓ $= (m + 2m)v_f$ ✓
$\therefore v_f = -6{,}67\ m\cdot s^{-1}$
$\therefore v_f = 6{,}67\ m\cdot s^{-1}$ ✓ west /wes ✓
<u>East negative/*Oos negatief:*</u>
$\Sigma p_i = \Sigma p_f$ ✓
$m(-20)$ ✓$+ 2m(+20)$ ✓ $= (m + 2m)v_f$ ✓
$\therefore v_f = 6{,}67\ m\cdot s^{-1}$ ✓ west /*wes* ✓ (6)

4.4
4.4.1 F✓
Newton's Third Law of motion/*Newton se Derde Bewegingswet* ✓ (2)

4.4.2 -½ a / ½ a✓
(Same/*Dieselfe* F_{net}), $a \propto \frac{1}{m}$ ✓ (2)

4.4.3 Car driver ✓
(Car - driver system) have <u>greater acceleration</u>. ✓
(Car - driver system) have <u>greater change in velocity /greater Δv</u>.✓

Motorbestuurder ✓
(Motor -bestuurder sisteem) het groter versnelling. ✓
(Motor -bestuurder sisteem) het groter verandering in snelheid / groter <u>Δv</u>.✓ (3)
[17]

QUESTION 4/*VRAAG 4*

4.1 Impulse is the product of the (net/average) force and the time during which the force acts. ✓✓
Impuls is die produk van die (netto/gemiddelde) krag en die tyd waartydens die krag inwerk. ✓✓

OR/*OF*
Impulse is the change in momentum. ✓✓
Impuls is gelyk aan verandering in momentum. ✓✓ (2)

4.2

Option 1/*Opsie 1:*	**Option 2/*Opsie 2:***
Upward positive:/*Opwaarts positief* $F_{net}\Delta t = \Delta p$ ✓ $= m(v_f - v_i)$ $= 0,15(3,62 - (-6,2))$ ✓ $= 1,473$ N·s / kg·m·s^{-1}✓ upward/*opwaarts*	Upward negative:/*Opwaarts negatief* $F_{net}\Delta t = \Delta p$ ✓ $= m(v_f - v_i)$ $= 0,15[(-3,62 - (6.2))$ ✓ $= -1,473$ N·s /kg·m·s^{-1} $F_{net}\Delta t = 1,473$ N·s /kg·m·s^{-1} ✓ upward/*opwaarts*
Option 3/*Opsie 3:*	**Option 4/*Opsie 4:***
Upward positive: /*Opwaarts positief* $F_{net}\Delta t = \Delta p$ ✓ $= mv_f - mv_i$ $= (0,15)(3,62) - (0,15)(-6,2)$ ✓ $= 1,473$ N·s / kg·m·s^{-1}✓ upward/*opwaarts*	Upward negative: /*Opwaarts negatief* $F_{net}\Delta t = \Delta p$ ✓ $= mv_f - mv_i)$ $= (0,15)(-3,62) - (0,15)(6,2)$ ✓ $= -1,473$ N·s /kg·m·s^{-1} $F_{net}\Delta t = 1,473$ N·s /kg·m·s^{-1}✓ upward/*opwaarts*

(3)

4.3 $(U + K)_{top/bo} = (U + K)_{bottom/onder}$✓
$mgh_f + ½ m v_f^2 = mgh_i + ½ m v_i^2$
$(0,15)(9,8)h + 0$ ✓ $= 0 + ½(0,15)(6,2)^2$ ✓
$\therefore$ h = 1,96 m ✓

$\frac{1,96}{3} = 0,65$ m
Yes/Meets requirements ✓

Ja/Voldoen aan vereistes. ✓

K(bottom/*onder*) = U(top/*bo*)
Max.: $\frac{0}{4}$
Other formulae/*Ander formules*:
$E_{mech(A)} = E_{mech(B)}$ / $E_{mech(i)} = E_{mech(f)}$
$E_{mech(top)} = E_{mech(bottom)}$
$(E_p + E_k)_A = (E_p + E_k)_B$
$(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$
$E_p + E_k)_i = (E_p + E_k)_f$
$(U + K)_i = (U + K)_f$
$(U + K)_A = (U + K)_B$
$mgh_B + \frac{1}{2}mv_i^2 = mgh_B + \frac{1}{2}mv_f^2$

(5)
[10]

QUESTION 4 / *VRAAG 4*

4.1 $30\ m\cdot s^{-1}$ ✓east / *oos* ✓

Notes / *Aantekeninge*:
$v_{TP} = v_{TG} - v_{PG} = 40 - 10 = 30$
$\therefore v_{TP} = 30\ m\cdot s^{-1}$ east/*oos*

OR/*OF*
$v_{TP} = v_{TG} + v_{GP} = 40 + (-10) = 30$
$\therefore v_{TP} = 30\ m\cdot s^{-1}$ east/*oos*

(2)

4.2 $70\ m\cdot s^{-1}$ ✓ east / *oos* ✓

Notes / *Aantekeninge*:

Solution 1 / *Oplossing 1*:
$v_{BT} = v_{BP} - v_{TP}$
$= 100 - 30 = 70$
$\therefore v_{BT} = 70\ m\cdot s^{-1}$ east / *oos*

Solution 2 / *Oplossing 2*
$v_{BT} = v_{BP} + v_{PT}$
$= 100 + (-30) = 70$
$\therefore v_{BT} = 70\ m\cdot s^{-1}$ east/*oos*

OR / OF
$v_{BT} = v_{BP} + v_{PG} + v_{GT}$
$= 100 + 10 + (-40)$
$= 70$
$\therefore v_{BT} = 70\ m\cdot s^{-1}$ east / *oos*

Solution 3 / *Oplossing 3*
$v_{BT} = v_{BP} + v_{PG} + v_{GT}$
$= 100 + 10 + (-40)$
$= 70$
$\therefore v_{BT} = 70\ m\cdot s^{-1}$ east / *oos*

Solution 4 / *Oplossing 4*
$v_{BG} = v_{BP} + v_{PG}$
$= 100 + 10 = 110$
$\therefore v_{BG} = 110\ m\cdot s^{-1}$
$v_{BT} = v_{BG} + v_{GT}$
$= 110 + (-40) = 70$
$\therefore v_{BT} = 70\ m\cdot s^{-1}$ east / *oos*

(2)

4.3 The total (linear) momentum remains constant/is conserved / does not change. ✓
in an isolated/a closed system/the absence of external forces. ✓

Die totale (liniêre) momentum bly konstant / behoue / verander nie ✓
in 'n geïsoleerde sisteem / geslote sisteem / die afwesigheid van eksterne kragte. ✓ (2)

4.4

Option 1 / *Opsie 1*:

To the right as positive / *Na regs as positief:*

$\Sigma p_{before/\ voor} = \Sigma p_{after/\ na}$ ✓

$\underline{(1\ 000)(40)}$ ✓+ $\underline{(5\ 000)(-20)}$ ✓ = $\underline{(1\ 000 + 5\ 000)v_f}$ ✓

$\therefore v_f = -10\ m\cdot s^{-1}$ ✓

$\therefore v_f = 10\ m\cdot s^{-1}$ $\underline{\text{left / } na\ links}$ ✓ **OR / *OF*** west / *wes*

Option 2 / *Opsie 2*:

To the right as positive / *Na regs as positief:*

$\Delta p_{car} = -\Delta p_{truck}$✓

$m(v_f - v_i) = -m(v_f - v_i)$

$\underline{(1000)(v_f - (40))}$ ✓= $\underline{-(5\ 000)(v_f}$ ✓– (-20)) ✓

$6\ 000v_f = -60\ 000$

$\therefore v_f = -10\ m\cdot s^{-1}$ ✓

$\therefore v_f = 10\ m\cdot s^{-1}$ $\underline{\text{left / } na\ links}$ ✓ **OR/*OF*** west / *wes* (6)

4.5

Option 1 / *Opsie 1:* Force on car / *Krag op motor:* To the right as positive / *Na regs as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{1\ 000(-10 - 40)}$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ OR/*OF* $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja botsing is fataal.* ✓	Force on car / *Krag op motor:* To the left as positive / *Na links as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{1\ 000(10 - (-40))}$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fatal.* ✓
Option 2 / *Opsie 2:* Force on truck / *Krag op vragmotor:* To the right as positive / *Na regs as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{5\ 000(-10 - (-20))}$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on truck / *Krag op vragmotor:* To the left as positive / *Na links as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{5\ 000(10 - 20)}$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal / *Ja, botsing is fataal.* ✓
Option 3 / *Opsie 3:* Force on car / *Krag op motor:* To the right as positive / *Na regs as positief:* $v_f = v_i + a\,\Delta t$ $\therefore -10 = 40 + a(0,5)$ ✓ $\therefore a = -100$ ✓ Both formulae/ *Beide formules* $F_{net} = ma = (1\ 000)(-100)$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ (-100 000 N) $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on car / *Krag op motor:* To the left as positive / *Na links as positief:* $v_f = v_i + a\,\Delta t$ $\therefore 10 = -40 + a(0,5)$ ✓ $\therefore a = 100$ ✓ Both formulae/ *Beide formules* $F_{net} = ma = (1\ 000)(100)$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓

Option 4 / *Opsie 4*:	
Force on truck / *Krag op vragmotor:* To the right as positive / *Na regs as positief:* $v_f = v_i + a\,\Delta t$ ✓ Both formulae/ *Beide formules* $\therefore$ -10 = -20 + a(0,5) ✓ $\therefore a = 20$ $F_{net} = ma = (5\,000)(20)$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\,000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on truck / *Krag op vragmotor:* To the left as positive / *Na links as positief:* $v_f = v_i + a\,\Delta t$ ✓ Both formulae/ *Beide formules* $\therefore$ 10 = 20 + a(0,5) ✓ $\therefore a = -20$ $F_{net} = ma = (5\,000)(-20)$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ (-100 000 N) $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\,000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓

(5)

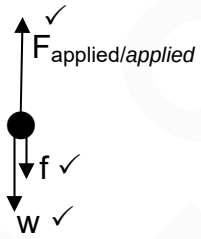
[17]

QUESTION 5 / *VRAAG 5*

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

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

5.2



(3)

5.3 Gravitational force/weight (of soldier) ✓
Gravitasiekrag/gewig (van soldaat) (1)

5.4 $W_{net} = \Delta K$ ✓

$F\Delta y\cos\theta + F_w\Delta y\cos\theta + W_f = \Delta K$

(960)(20)cos0° ✓+ (80)(9,8)(20)cos180° ✓ + W_f = 0 ✓

19 200 – 15 680 + W_f = 0

W_f = - 3 520 J ✓ (5)

[11]

Option 4 / *Opsie 4*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$mg\sin 20° = ma$
$-(3)(9,8)\sin 20° = 3a$ ✓ $\therefore a = -3,35\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = (3)^2 + 2(-3,35)(d)$ ✓

$\therefore d = 1,34\ m$ ✓

[12.1.3] (5)
[12]

QUESTION 6 / *VRAAG 6*

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

$(87)v_{im} + 0$ ✓ $= (87 + 22)(2,4)$ ✓

$v_{im} = 3,01\ m\cdot s^{-1}$ ✓ [12.2.3] (4)

6.2

Option 1/*Opsie 1:*
K(before/*voor*) $= \frac{1}{2}mv^2$ ✓
$= \frac{1}{2}(87)(3,01)^2 + 0$ ✓
$= 394,11\ J$ ✓
$= (391,5$ if $3\ m\cdot s^{-1})$

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

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

Option 2/*Opsie 2:*
ΔK = K(after/*na*) - K(before/*voor*)
$= \frac{1}{2}mv^2$(after/*na*) - $\frac{1}{2}mv^2$(before/*voor*) ✓
$= \frac{1}{2}(109)(2,4)^2$ ✓ – $(\frac{1}{2}(87)(3,01)^2 + 0)$ ✓
$= 313,92 - 394,11$
$= -80,19\ J$ ✓✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

[12.2.3] (6)

6.3

Option 1 / *Opsie 1*:

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta$ ✓ $= ½m(v_f^2 - v_i^2)$
$F_{net}(2)(-1)$ ✓ $= ½(87 + 22)(0^2 - 2,4^2)$ ✓

$\therefore F_{net} = 156,96$ N ✓
If/*indien* – 156,96 N: minus 1

Option 2 / *Opsie 2*:

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

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

$\therefore F_{net} = 156,96$ N ✓

Option 3 / *Opsie 3*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = \left(\frac{0 + 2,4}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 1,67$ s

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

$\therefore F_{net} = -156,65$ N $\therefore F_{net} = 156,65$ N ✓

Option 4 / *Opsie 4*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = \left(\frac{0 + 2,4}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 1,67$ s

$v_f = v_i + a\Delta t \therefore 0 = 2,4 + a(1,67) \therefore a = -1,44$ m·s^{-2}

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

$\therefore F_{net} = 156,96$ N ✓

[12.2.3] (5)
[15]