GRADE 12 REVISION 2013
MECHANICS: MOMENTUM AND FRAMES OF REFERENCE-MEMORANDUM

ONE WORD ITEMS: MOMENTUM AND IMPULSE

1. Impulse
2. Impulse
3. Elastic
4. Isolated/closed (system)
5. Momentum
6. Isolated/closed (system)
7. Net force
8. N·s or kg·m·s^{-1}

ONE WORD ITEMS: FRAMES OF REFERENCE

9. Relative velocity
10. Frames of Reference

MULTIPLE CHOICE QUESTIONS: MOMENTUM AND IMPULSE

1.	C	2.	C	3.	C	4.	C
5.	C	6.	B	7	C	8	B
9.	A	10.	C	11.	D	12.	B

MULTIPLE CHOICE QUESTIONS: FRAMES OF REFERENCE

13.	D	14.	A	15.	A	16.	A

STRUCTURED QUESTIONS: MOMENTUM

QUESTION 1

1.1 When the airbag inflates during a collision, the <u>contact time of a passenger/driver with an air bag is longer than without an airbag</u> and thus the <u>force on the passenger/driver is reduced</u> according to $F_{net} = \frac{\Delta p}{\Delta t}$.

Wanneer die lugsak opblaas tydens 'n botsing, is die kontaktyd van die passasier/bestuurder met 'n lugsak langer as sonder 'n lugsak ✓en dus is die krag op die passasier/bestuurder kleiner volgens $F_{net} = \frac{\Delta p}{\Delta t}$.

1.2.1 Take to the right as negative/*Neem na regs as negatief*:

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

$\therefore F_{net}\Delta t = 1,2 \times 10^3\ (-2 - 12) = -1,68 \times 10^4$

$\therefore$ Impulse = $1,68 \times 10^4$ N·s to the right/*na regs* or/*of* away from wall/*weg vanaf muur*

OR/*OF*

$v_f = v_i + a\Delta t$

$\therefore -2 = 12 + a(0,1)$

$\therefore\ a = -140$ m·s^{-2}

$\therefore\ = 140$ m·s^{-2} to the right/*na regs*

$\therefore F_{net} = ma = (1,2 \times 10^3)(-140) = -1,68 \times 10^5$

$\therefore\ F_{net} = 1,68 \times 10^5$ N to the right/*na regs* or/*of* away from wall/*weg vanaf muur*

Impulse = $F_{net}\Delta t = (1,68 \times 10^5)(0,1)$

$= 1,68 \times 10^4$ N·s to the

1.2.2 $F_{net}\Delta t = \Delta p = -1,68 \times 10^4$

$\therefore F_{net}(0,1) = -1,68 \times 10^4$

$\therefore F_{net} = -1,68 \times 10^5$ N

$\therefore\ F_{net} = 1,68 \times 10^5$ N to the right/*na regs*

OR/*OF*

Take to the right as negative:

$v_f = v_i + a\Delta t$

$\therefore$ -2 = 12 + a(0,1) $\therefore$ a = -140 $m\cdot s^{-2}$

$\therefore F_{net}$ = ma = (1,2 x 10^3)(-140) = -1,68 x 10^5

$\therefore F_{net}$ = 1,68 x 10^5 N to the right/*na regs* or/*of* away from the wall/*weg van die muur af*

1.3 Decreases/*Neem af*

The final velocity of the car is zero and thus Δp decreases

Die finale snelheid van die motor is nul en dus neem Δp af.

QUESTION 2

2.1 Consider motion to the right as positive:/*Beskou beweging na regs as positief:*

$P(total)_{before} = p(total)_{after}$

$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$

(1 600)(30) + (3 000)(-20) = (1 600 + 3 000) v_f

48 000 – 60 000 = (4 600)v_f

v_f = - 2,6 $m\cdot s^{-1}$ $\therefore$ v_f = 2,6 $m\cdot s^{-1}$ to the right/*na regs*

2.2 Before collision/*voor botsing*:

$E_k = \frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2 = \frac{1}{2}(1\ 600)(30)^2 + \frac{1}{2}(3\ 000)(20)^2$

= 720 000 + 600 000 = 1,32 x 10^6 J

After collision/*na botsing*:

$E_k = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2 = \frac{1}{2}(1\ 600 + 3\ 000)(2,6)^2$ ✓= 384 000 = 5 980 J

E_k before collision not equal to E_k after collision – thus the collision is inelastic

E_k voor botsing nie gelyk aan E_k na botsing – dus is die botsing nie-elasties

2.3 During a collision, the crumple zone/ airbag **increases the time** during which momentum changes and according to the equation

$F_{net} = \frac{\Delta p}{\Delta t}$ the **force during impact will decrease**.

*Tydens 'n botsing sal die frommelsone/lugsak die **tyd** waartydens die momentum verander **verhoog** en volgens die vergelyking $F_{net} = \frac{\Delta p}{\Delta t}$ sal die **krag tydens impak verlaag.***

QUESTION 3

3.1 1,96 x 10^4 N, upward/opwaarts

3.2 **West as +/Wes as +:**

$p_{before} = p_{after}$

$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$

(0) + (2 000)(3) = (1 500 + 2 000) v_f

v_f = 1,71$m\cdot s^{-1}$ $\therefore$ v_f = 1,71 $m\cdot s^{-1}$ west/*wes*

3.3 $F_{net}\Delta t = \Delta p$

$F_{net} = \frac{m(v-u)}{\Delta t} = \frac{2000(1{,}71-3)}{0{,}5}$ = - 5 160 N

Magnitude = 5 160 N

3.4 Air bubbles will increase the time of impact and thus reduce the force. This may minimize damage to equipment.

QUESTION 4

4.1 Consider to the left as positive/*Beskou na links as positief*

$\Sigma m_i v_i = \Sigma m_f v_f$ OR $m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$ OR $m_A u_A + m_B u_B = m_A v_A + m_B v_B$

$(1\ 000)(0) + (1\ 200)(18) = (1000)(12) + (1\ 200)v_{fB}$

$9\ 600 = (1\ 200)v_{i2}$

$v_{fB} = 8\ m \cdot s^{-1}$

4.2 Not an isolated system / external forces present / frictional forces present / driver in front car has his foot on the brake.
Nie 'n geïsoleerde sisteem nie/ eksterne kragte is teenwoordig/ wrywingskragte teenwoordig / bestuurder van voorste motor het sy voet op die rem.

4.3 During the collision, both cars experience a force of equal magnitude
This net force on the car with larger mass causes it to experience a smaller acceleration therefore the passenger will experience a smaller change in velocity and will be less injured.

OR

For a specific/Vir spesifieke $F_{net} \Delta t$:

$\Delta p(\text{heavy car}) = \Delta p(\text{light car})$

$m_H(v_f - v_i)_H = m_L(v_f - v_i)_L$

but $m_H > m_L$

$(v_f - v_i)_H < (v_f - v_i)_L$

Therefore a passenger will experience a smaller change in velocity and gets injured less/*Dus sal 'n passasier 'n kleiner verandering in snelheid ondervind en minder beseer word.*

QUESTION 5

5.1 Consider to the left as positive/*Beskou na links as positief*

$\Sigma m_i v_i = \Sigma m_f v_f$ OR $m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$ OR $m_A u_A + m_B u_B = m_A v_A + m_B v_B$

$(1\ 000)v_{icar} + (3\ 200)(-10) = (4\ 200)(0)$

$\therefore v_{i(car)} = 32\ m \cdot s^{-1}$

$32\ m \cdot s^{-1} = \frac{32 \times 3600}{1000} = 115{,}2\ km \cdot h^{-1}$

Exceeded speed limit./*Het spoedgrens oorskrei*.

5.2 To the right as +:

$F_{res}\Delta t = m(v_f - v_i)$

$F_{res}(0{,}4) = 3200(0 - (-10))$

$F_{res} = 80\ 000\ N$

$F_{res} = 80\ 000\ N$; opposite to direction of motion / *teenoorgesteld aan rigting van beweging*

5.3 If the bus suddenly stops, the child will continue to move forward due to Newton's First Law of motion.

QUESTION 6

6.1 $m_m v_{im} + m_b v_{bi} = (m_m + m_b)v_f$
$(87)v_{im} + 0 = (87 + 22)(2,4)$
$v_{im} = 3,01\ m{\cdot}s^{-1}$

6.2 **<u>Option 1/*Opsie 1:*</u>**
K(before/*voor*) $= ½mv^2$
$= ½(87)(3,01)^2 + 0$
$= 394,11$ J
$= (391,5$ if $3\ m{\cdot}s^{-1})$
K(after/*na*) $= ½mv^2$
$= ½(109)(2,4)^2$
$= 313,92$ J
Collision is <u>inelastic</u> / <u>No</u>
Botsing is <u>nie-elasties / Nee</u>

6.3 $W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
$F_{net}(2)(-1) = ½(87 + 22)(0^2 - 2,4^2)$
$\therefore F_{net} = 156,96$ N

OR

$v_f^2 = v_i^2 + 2a\Delta x$
$0^2 = 2,4^2 + 2a(2) \quad \therefore a = -1,44\ m{\cdot}s^{-2}$
$F_{net} = ma = (87 + 22)(-1,44) = -156,96$ N
$\therefore F_{net} = 156,96$ N

QUESTION 7

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

7.2 $(U + K)_{bottom} = (U + K)_{top}$
$0 + \frac{1}{2}(m_1 + m_2)v^2 = mgh + 0$
$\frac{1}{2}(0,015 + 5)(v_f^2) = (0,015 + 5)(9,8)(0,15)$
$\therefore v_f = 1,71\ m{\cdot}s^{-1}$

7.3 p_t(before/*voor*) $= p_t$(after/*na*) OR $m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$
$(0,015)v_{i1} + 0 = (0,015 + 5)(1,71)$
$\therefore v_{i1} = 571,71\ m{\cdot}s^{-1}$

7.4 According to Newton's third law, the <u>gun will exert a force on the bullet</u> and the <u>bullet will exert an equal but opposite force on the gun</u>.
The <u>force of the gun on the officer</u> pushes him slightly backwards.
Volgens Newton se derde wet oefen die <u>geweer 'n krag op die koeël uit</u> en die <u>koeël oefen 'n gelyke, maar teenoorgestelde krag op die geweer uit.</u>
Die <u>krag van die geweer op die polisieman druk hom effens terugwaarts</u>.

QUESTION 8

8.1 When two vehicles are involved in a head-on collision, the velocity of each one relative to the other is the sum of their velocities. Therefore the statement is valid.

8.2 Direction of truck as positive: (T is "truck", C is 'car" and R is "road"

$v_{tr} = v_{tc} + v_{cr} = -v_{ct} + v_{cr}$

$= -(-50) + (-20)$

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

8.3 Direction of truck as positive:

p_t(before/*voor*) = p_t(after/*na*) OR $mv_{TC} = mv_T + mv_C$

$(6\,000)v_{TC} = (5\,000)(30) + (1\,000)(-20)$

$\therefore\ v_{TC} = 21{,}67\ m \cdot s^{-1}$

QUESTION 9

9.1 **Option 1: East +** ***Opsie 1: Oos*** **+**

$\Sigma p(\text{before}) = \Sigma p(\text{after})$

$(1630)(-20) + (1200)(35) = (1630 + 1200)v_f$

$\therefore v_f = 3{,}22\ m \cdot s^{-1}$

$\therefore\ v_f = 3{,}22\ m \cdot s^{-1}$ east/oos

Option 1: West + ***Opsie 1: Wes*** **+**

$\Sigma p(\text{before}) = \Sigma p(\text{after})$

$(1630)(20) + (1200)(-35) = (1630 + 1200)v_f$

$\therefore v_f = -\ 3{,}22\ m \cdot s^{-1}$

$\therefore\ v_f = 3{,}22\ m \cdot s^{-1}$ east/oos

9.2 Let X be the heavier car of X and Y. / *Laat X die swaarder motor van X en Y wees:*

In terms of magnitude: / *In terme van grootte:*

F(Y) = F(X)

$$\frac{m\Delta v}{\Delta t}(Y) = \frac{m\Delta v}{\Delta t}(X)$$

But $m_Y < m_X$

For $t_Y = t_X$, $\Delta v_Y > \Delta v_X$

Learner is correct./*Leerder is korrek.*

OR/*OF*

F (Y) = F (X)

ma (Y) = ma (X)

m(Y) < m(X)

a_Y(Y) > a(X)

For $t_Y = t_X$, $\Delta v_Y > \Delta v_X$

Learner is correct./*Leerder is korrek.*

QUESTION 10

10.1

10.1.1 **Away from bat: +**

$v_{ball-bat} = v_{ball-g} + v_{g-bat}$
$= v_{ball-g} - v_{bat-g}$
$= -95 - (+40)$
$= -135\ km\cdot h^{-1}$
$v_{ball-bat} = 135\ km\cdot h^{-1}$; towards bat

Towards bat: +

$v_{ball-bat} = v_{ball-g} + v_{g-bat}$
$= v_{ball-g} - v_{bat-g}$
$= 95 - (-40)$
$= 135\ km\cdot h^{-1}$
$v_{ball-bat} = 135\ km\cdot h^{-1}$; towards bat

10.1.2 **Away from bat: +**

$v_{bat-ball} = v_{bat-g} + v_{g-ball}$
$= v_{bat-g} - v_{ball-g}$
$= 30 - (+100)$
$= -70\ km\cdot h^{-1}$
$v_{bat-ball} = 70\ km\cdot h^{-1}$; towards bat

Towards bat: +

$v_{bat-ball} = v_{bat-g} + v_{g-ball}$
$= v_{bat-g} - v_{ball-g}$ g
$= -30 - (-100)$
$= 70\ km\cdot h^{-1}$
$v_{bat-ball} = 70\ km\cdot h^{-1}$; towards bat

10.2

10.2.1 Towards material: + / *Na materiaal toe:* +

$$F = \frac{m\Delta v}{\Delta t}$$
$$= \frac{0{,}009(0-35)}{1\times 10^{-4}}$$
$$= -32850\ N$$

(a) 2F (double)
(b) ½F (halved)

QUESTION 11

11.1 $K / E_k = ½ mv^2$
$37{,}5 = ½ (12)v^2$
$v = 2{,}5\ m\cdot s^{-1}$

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

11.3 Σ p(before) = Σ p(after)
$(30)v_i + (12)(2,5) = (30 + 12)(3,2)$
$\therefore v_i = 3,48 \text{ m·s}^{-1}$

11.4 **Trolley X:**
$F_{net}\Delta t = m\Delta v$ OR $F_{net}\Delta t = \Delta p$
$F_{net}(0,2) = 30(3,2 – 3,48)$
$F_{net} = -42$ N
$\therefore$ magnitude of $F_{net} = 42$ N

OR
Trolley Y:
$F_{net}\Delta t = m\Delta v$ OR $F_{net}\Delta t = \Delta p$
$F_{net}(0,2) = 12(3,2 – 2,5)$
$F_{net} = 42$ N

QUESTION 12

12.1 $v_{TP} = v_{TG} – v_{PG} = 40 – 10 = 30$
$\therefore v_{TP} = 30 \text{ m·s}^{-1}$ east/*oos*

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

12.2 **<u>OPTION1</u>**
$v_{BT} = v_{BP} – v_{TP}$
$= 100 – 30 = 70$
$\therefore v_{BT} = 70 \text{ m·s}^{-1}$ east / *oos*

<u>OPTION2</u>
$v_{BT} = v_{BP} + v_{PT}$
$= 100 + (–30) = 70$
$\therefore v_{BT} = 70 \text{ m·s}^{-1}$ east/*oos*

<u>OPTION 3</u>
$v_{BT} = v_{BP} + v_{PG} + v_{GT}$
$= 100 + 10 + (–40)$
$= 70$
$\therefore v_{BT} = 70 \text{ m·s}^{-1}$ east / *oos*

<u>OPTION 4</u>
$v_{BG} = v_{BP} + v_{PG}$
$= 100 + 10 = 110$
$\therefore v_{BG} = 110 \text{ m·s}^{-1}$
$v_{BT} = v_{BG} + v_{GT}$
$= 110 + (–40) = 70$
$\therefore v_{BT} = 70 \text{ m·s}^{-1}$ east / *oos*

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

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

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

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

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

$\therefore v_f = 10\ m\cdot s^{-1}$ <u>left / *na links*</u> **OR/*OF*** west / *wes*

12.5 **<u>OPTION 1</u>**

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

$\therefore F_{net} = 1 \times 10^5$ 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:*

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

$F_{net}(0,5) = 1\ 000(10 - (-40))$

$\therefore F_{net} = 1 \times 10^5$ N (100 000 N)

$\therefore F_{net} > 85\ 000$ N

Yes, collision is fatal. / *Ja, botsing is fatal.*

<u>OPTION 2</u>

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.*

QUESTION 13

13.1 **<u>OPTION 1: LEFT +/*OPSIE 1: LINKS +*</u>**

$\Delta p = mv_f - mv_i$

$= 560(-2) - 560(30)$

$= -17\ 920\ kg\cdot m\cdot s^{-1}$

$\Delta p = 17\ 920\ kg\cdot m\cdot s^{-1}$ right / *regs* away from wall / *weg van muur*

<u>OPTION 2: RIGHT +/*OPSIE 2: REGS +*</u>

$\Delta p = mv_f - mv_i$

$= 560(2) - 560(-30)$

$\Delta p = 17\ 920\ kg\cdot m\cdot s^{-1}$

$\Delta p = 17\ 920\ kg\cdot m\cdot s^{-1}$ right / *regs* away from wall / *weg van muur*

13.2 **OPTION 1: LEFT +/*OPSIE 1: LINKS* +**

$$F_{net} = \frac{\Delta p}{\Delta t} = \frac{-17\ 920}{0{,}1} = -179\ 200\ N$$

OPTION 2: RIGHT +/*OPSIE 2: REGS* +

$$F_{net} = \frac{\Delta p}{\Delta t} = \frac{17\ 920}{0{,}1} = 179\ 200\ N$$

13.3 $F_{net} = \frac{\Delta p}{\Delta t}$ Crumple zones increase the time taken to stop the car. The average force acting on the passengers decreases.

$F_{net} = \frac{\Delta p}{\Delta t}$ *Frommelsones vermeerder die tyd wat dit die motor neem om te stop. Die gemiddelde krag op die passasiers verminder*.

QUESTION 14

14.1 A system in which no external force acts.

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

$\Delta p = m(v_f - v_i)$
$= 0{,}75(-2{,}5 - 4)$
$= -4{,}88\ kg{\cdot}m{\cdot}s^{-1}$

$\therefore \Delta p = 4{,}88\ kg{\cdot}m{\cdot}s^{-1}$ in the opposite direction/left
in die teenoorgestelde rigting/links

To the right negtaive/*Na regs negatief*:

$\Delta p = m(v_f - v_i)$
$= 0{,}75(2{,}5 - (-4))$
$= 4{,}88\ kg{\cdot}m{\cdot}s^{-1}$

$\therefore \Delta p = 4{,}88\ kg{\cdot}m{\cdot}s^{-1}$ in the opposite direction/left
in die teenoorgestelde rigting/links

14.3 $4{,}88\ kg{\cdot}m{\cdot}s^{-1}$ in the original direction of A/ to the right

14.4 $0\ kg{\cdot}m{\cdot}s^{-1}$

14.5 $F_{net}\Delta t = \Delta p$
$F_{net}(0{,}2) = 4{,}88$
$\therefore F_{net} = 24{,}4$ N

QUESTION 15

15.1 $40\ m{\cdot}s^{-1}$ east

15.2 The total (linear) momentum remains constant/is conserved in an isolated/a closed system/the absence of external forces OR if the impulse of external forces is zero.

15.3

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

15.4

15.4.1 F Newton's Third Law of motion

15.4.2 -½ a / ½ a

Same/*Dieselfe* F_{net}), $a \propto \frac{1}{m}$

15.4.3 Car driver

(Car - driver system) have greater acceleration.
(Car - driver system) have greater change in velocity /greater Δv.
Motorbestuurder
(Motor -bestuurder sisteem) het groter versnelling.
(Motor -bestuurder sisteem) het groter verandering in snelheid / groter Δv.

QUESTION 16

16.1 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.

16.2 **Option 1/*Opsie 1:***

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*

16.3 $U + K)_{top/bo} = (U + K)_{bottom/onder}$
$mgh_f + \frac{1}{2} m v_f^2 = mgh_i + \frac{1}{2} m v_i^2$
$(0{,}15)(9{,}8)h + 0 = 0 + \frac{1}{2}(0{,}15)(6{,}2)^2$
$\therefore h = 1{,}96$ m

$\frac{1{,}96}{3} = 0{,}65$ m

Yes/Meets requirements/ J*a/Voldoen aan vereistes.*

QUESTION 17

17.1 The total linear momentum in a closed/isolated system is conserved in magnitude and direction.

17.2 $\Sigma p_i = \Sigma p_f$
$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v$
$(0,01)(300) + 0 = (0,01 + 1,99)v$
$v = 1,5 \text{ m·s}^{-1}$

17.3 Inelastic. Total kinetic energy after collision is less than before collision

17.4 $F_{net} = ma$
$-8 = 2a$
$a = -4 \text{ m·s}^{-2}$
$v_f^2 = v_i^2 + 2a\Delta x$
$(1,5)^2 = 0 + 2(-4)\triangle x$
$\triangle x = 0,28 \text{ m}$

QUESTION 18

18.1 The total linear momentum in a closed/isolated system is conserved in magnitude and direction.

18.2 (U + K)top/*bo* = (U + K)bottom/*onder*
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$
$(80)(9,8)(10) + 0 = 0 + \frac{1}{2}(80)v_f^2$
$\therefore v_f = 14 \text{ m·s}^{-1}$

$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
$(80)(14) + (50)(0) = (80 + 50)v_f$
$v_f = 8,62 \text{ m·s}^{-1}$

18.3 No. Collision is inelastic/total kinetic energy after collision is less than before collision.

18.4 Smaller than

QUESTION 19

19.1 Non-elastic collision / Inelastic collision
19.2 The total linear momentum in a closed system remains constant in magnitude and direction.

OR
The total momentum before collision in a closed system remains the same as the total momentum after collision.

19.3 $m_Av_{iA} + m_Bv_{iB} = (m_A + m_B)v_f$
$(2200)(14) + (1\ 200)(-40) = (2200+1\ 200)v_f$
$V_f = -5,06 \text{ m·s}^{-1}$
$\therefore v_f = 5,06 \text{ m·s}^{-1}$ west

19.4

19.4.1 Equal in size but opposite in direction / OF $\Delta p(A) = -\Delta p(B)$

19.4.2 The change in momentum for both cars are equal in magnitude.
The contact time (Δt) is the same for both cars.
$m_H (v_f - v_i)_H = m_L(v_i - v_f)_L$
$(v_f - v_i)_H < (v_f - v_i)_L$
It is a safer situation for the passenger in the heavier car because of the smaller change in velocity for the car and therefore the statement is correct.

QUESTION 20

20.1 The total (linear) momentum remains constant/is conserved in an isolated/a closed system/the absence of external forces OR if the impulse of external forces is zero.

20.2 Initial direction of car as positive:
$\Sigma p_i = \Sigma p_f$
$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v$
$(670)(30) + 0 = (15\,000 + 670)v_f$
$v_f = 1{,}28 \text{ m·s}^{-1}$

20.3 By wearing a seatbelt.

STRUCTURED QUESTIONS: FRAMES OF REFERENCE

QUESTION 21

21.1 0 m·s^{-1}

21.2

Key / *Sleutel*
J: Jeep C: Coal / *Steenkool* P: Paal / *Pole* G: Ground / *Grond*

OPTION 1: EAST +/*OPSIE 1: OOS* +	**OPTION 2: WEST +/*OPSIE 2: WES* +**
$v_{JC} = v_{JG} + v_{GC}$ $v_{JC} = v_{JG} - v_{CG}$ $= 21 - (+3)$ $= 18 \text{ m}\cdot\text{s}^{-1}$ v_{JC} = 18 m·s^{-1}; east / *oos*	$v_{JC} = v_{JG} + v_{GC}$ $v_{JC} = v_{JG} - v_{CG}$ $= -21 - (-3)$ $= -18 \text{ m}\cdot\text{s}^{-1}$ v_{JC} = 18 m·s^{-1}; east / *oos*

21.3

OPTION 1: EAST +/*OPSIE 1: OOS* +	**OPTION 2: WEST +/*OPSIE 2: WES* +**
$v_{PJ} = v_{PG} + v_{GJ}$ $v_{PJ} = v_{PG} - v_{JG}$ $= 0 - (+21)$ $= -21 \text{ m}\cdot\text{s}^{-1}$ v_{PJ} = 21 m·s^{-1}; west / *wes*	$v_{PJ} = v_{PG} + v_{GJ}$ $v_{PJ} = v_{PG} - v_{JG}$ $= 0 - (-21)$ $= 21 \text{ m}\cdot\text{s}^{-1}$ v_{PJ} = 21 m·s^{-1}; west / *wes*

QUESTION 22

OPTION 1

$v_{boat/\textit{boot}-man} = v_{boat-water} + v_{water-land} + v_{land-man}$
$= v_{boat-water} + v_{water-land} - v_{man-land}$
$= 5 + (-1) - (2)$
$= 2\ m \cdot s^{-1}$
$v_{boat/\textit{boot}-man} = 2\ m \cdot s^{-1}$; west to east

OPTION 2

$v_{man-water} = v_{man-land} + v_{land-water}$
$= v_{man-land} - v_{water-land}$
$= 2 - (-1)$
$= 3\ m \cdot s^{-1}$

$v_{boat/\textit{boot}-man} = v_{boat-water} + v_{water-man}$
$= v_{boat-water} - v_{man-water}$
$= 5 - (3)$
$= 2\ m \cdot s^{-1}$
$v_{boat/\textit{boot}-man} = 2\ m \cdot s^{-1}$; west to east

OPTION 3

$v_{boat/\textit{boot}-man} = v_{boat/boot-water} + v_{water-land} + v_{land-man}$
$= v_{boat/boot-water} + v_{water-land} - v_{man-land}$
$= -5 + (1) - (-2)$
$= -2\ m \cdot s^{-1}$
$v_{boat/\textit{boot}-man} = 2\ m \cdot s^{-1}$; west to east