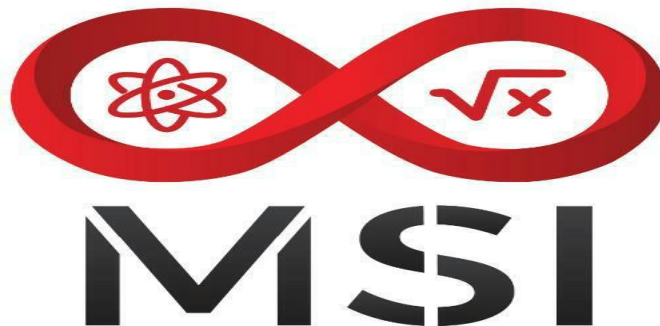




PHYSICAL SCIENCES

MATERIAL FOR GRADE 12

GRADE 11 WORK

NEWTON'S LAWS OF MOTION

MEMORANDA

COMPILED BY EXPERTS: K. NCUBE & T. MJIKWA

A

QUESTION 2/VRAAG 2

- 2.1 When a resultant (net) force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force✓ and inversely proportional to the mass of the object.✓

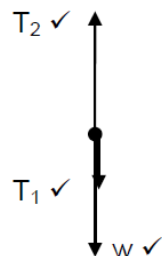
Wanneer 'n resulterende (netto) krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/OF

The net force acting on an object is equal to the rate of change of momentum ✓✓ of the object (in the direction of the force). (2 or 0)

Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum van die voorwerp (in die rigting van die krag).(2 of 0) (2)

2.2



(3)

2.3

OPTION 1/OPSIE 1

$$F_{\text{net}} = ma \checkmark$$

For 5 kg block/Vir 5 kg-blok

$$T_2 + (-mg) + (-T_1) = ma$$

$$250 - (5)(9,8) - T_1 \checkmark = 5a \checkmark$$

$$201 - T_1 = 5a$$

$$T_1 = 201 - 5a \dots\dots(1)$$

For 20 kg block/Vir 20 kg-blok

$$T_1 + (-mg) = ma \dots\dots(2)$$

$$T_1 + [-20(9,8)] \checkmark = 20a$$

$$5 = 25a$$

$$a = 0,2 \text{ m} \cdot \text{s}^{-2} \text{ upwards/opwaarts}$$

$$\therefore T_1 = 201 - 5(0,2) \checkmark$$

$$= 200 \text{ N} \checkmark$$

$$\text{OR/OF } T_1 = 20(9,8) + 20(0,2) \checkmark$$

$$= 200 \text{ N} \checkmark$$

(6)

OPTION 2 /OPSIE 2

$$F_{\text{net}} = ma \checkmark$$

For 5 kg block/Vir 5 kg-blok

$$T_2 + (-mg) + (-T_1) = ma$$

$$250 - (5)(9,8) - T_1 \checkmark = 5a \checkmark$$

$$201 - T_1 = 5a$$

$$T_1 = 201 - 5a \dots\dots(1)$$

For 20 kg block/Vir 20 kg-blok ,

$$T_1 + (-mg) = ma \dots\dots(2)$$

$$T_1 + [-20(9,8)] \checkmark = 20a$$

$$(1) \times 4 : 4T_1 = 804 - 20a$$

$$\therefore T_1 - 196 = 804 - 4T_1 \checkmark$$

$$\therefore 5T_1 = 1000$$

$$\therefore T_1 = 200 \text{ N} \checkmark$$

(6)

OPTION 3/OPSIE 3

$$F_{\text{net}} = ma \checkmark$$

For 5 kg block/Vir 5 kg-blok

$$T_2 + (-mg) + (-T_1) = ma$$

$$250 - (5)(9,8) - T_1 \checkmark = 5 a \checkmark$$

$$201 - T_1 = 5 a$$

$$T_1 = 201 - 5a \dots\dots\dots(1)$$

$$\therefore a = \frac{201 - T_1}{5}$$

For 20 kg block/Vir 20 kg-blok ,

$$T_1 + (-mg) = ma \dots\dots\dots(2)$$

$$T_1 + [-(20)(9,8)] \checkmark = 20a$$

$$\therefore T_1 - 196 = 20\left(\frac{201 - T_1}{5}\right) \checkmark$$

$$\therefore T_1 = 200 \text{ N} \checkmark$$

(6)

2.4

Q ✓

(1)

[12]

B

QUESTION 2/VRAAG 2

- 2.1 When one body exerts a force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.
Wanneer een liggaam 'n krag op 'n tweede liggaam uitoefen, oefen die tweede liggaam 'n krag van gelyke grootte in die teenoorgestelde rigting op die eerste liggaam.

OR/OF:

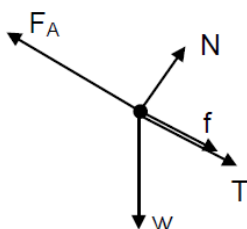
When body A exerts a force on body B, body B will exert a force of equal magnitude but opposite in direction on body A.
Indien liggaam A 'n krag uitoefen op liggaam B, sal B 'n krag van gelyke grootte maar teenoorgesteld in rigting op liggaam A uitoefen.

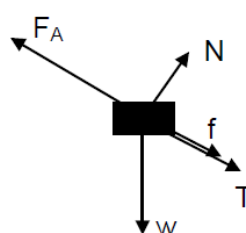
ACCEPT/AANVAAR (for 1 mark only/vir slegs 1 punt)

Action and reaction are equal and opposite.
Aksie en reaksie is gelyk en teenoorgesteld

(2)

2.2



Accept/Aanvaar	Notes/Aantekeninge
Force diagram Kragtediagram	Do not penalise for length of arrows Moenie vir die lengte van die pyltjies penaliseer nie
	If w is not shown but $F_{\parallel}$ and $F_{\perp}$ are shown give 1 mark for both. Indien w nie aangetoon is nie maar $F_{\parallel}$ en $F_{\perp}$ is getoon, ken 1 punt toe vir beide.

Accept the following symbols/Aanvaar die volgende simbole.	
N	F_N ; Normal;/Normaal ✓
F_A	40 N ✓
f	F_f, f_k ✓
w	F_G Weight/Gewig; Gravitational force/Gravitasiekrag ✓
T	Tension/Spinning; F_T ; ✓

(5)

2.3.1 **OPTION 1/OPSIE 1**

For the 1 kg block/Vir die 1 kg blok;

$$\begin{aligned} f_k &= \mu_k N \\ &= \mu_k mg \cos \theta \checkmark \\ &= 0,29 (1 \times 9,8 \cos 30^\circ) \checkmark \\ &= 2,46 \text{ N} \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

BY PROPORTION:/DEUR EWEREDIGHEID

The smaller mass = $\frac{1}{4}$ of the larger mass $\checkmark$

Die kleiner massa = $\frac{1}{4}$ die groter massa

$$\begin{aligned} \therefore \text{frictional force/wrywingskrag} &= \frac{1}{4} (10) \checkmark \\ &= 2,5 \text{ N} \checkmark \end{aligned}$$

(3)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.2 POSITIEWE NASIEN VANAF VRAAG 2.2**

OPTION 1/OPSIE 1

$$F_{\text{net}} = ma \checkmark$$

For 1 kg block/Vir 1 kg blok

$$\begin{aligned} F_A - \{(T + f_k) + mg \sin \theta\} &= ma \\ 40 - \{T + 2,46 + 1(9,8)(\sin 30^\circ)\} &= (1 \times) a \checkmark \\ 40 - T - 7,36 &= a \end{aligned}$$

$$32,64 - T = a \dots \dots (1)$$

For 4 kg block/Vir 4 kg blok

$$\begin{aligned} T - (mg \sin \theta + f_k) &= 4a \\ T - (4 \times 9,8 \sin 30^\circ + 10) &= 4a \checkmark \\ T - 29,6 &= 4a \dots \dots (2) \end{aligned}$$

From (1) and (2)/Vanaf (1) en (2)

$$\begin{aligned} a &= 0,61 \text{ m} \cdot \text{s}^{-2} \\ T &= 29,6 + (4(0,61)) \checkmark \\ T &= 32,04 \text{ N} \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

Consider the blocks as a single system.

Beskou die blokke as 'n enkele sisteem.

$$\begin{aligned} F_A - [(f_{\text{tot}}) - \{(4+1) g \sin 30^\circ\}] &= (4+1)a \\ 40 - (10 - 2,46) - (5(9,8) \sin 30^\circ) &= 5a \checkmark \\ \therefore a &= 0,61 \text{ m} \cdot \text{s}^{-2} \end{aligned}$$

For 1 kg block/Vir 1 kg blok

$$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ F_A - \{(T + f_k) + mg \sin \theta\} &= ma \\ 40 - \{T + 2,46 + 1(9,8)(\sin 30^\circ)\} &= (1 \times) a \checkmark \\ 40 - T - 7,36 &= a \\ 32,64 - T &= 0,61 \checkmark \\ T &= 32,04 \text{ N} \checkmark \end{aligned}$$

Notes/Aantekeninge

Learners need not show how (1) and (2) were combined
Leerders hoef nie aan te toon hoe (1) en (2) gekombineer is nie.

The first correct substitution for equation (1) should carry 2 marks.

The second substitution must carry 1 mark.

Die eerste korrekte vervanging vir vergelyking (1) moet 2 punte tel.

Die tweede vervanging tel 1 punt.

OR/OF

For 4 kg block/*Vir 4 kg blok*

$F_{\text{net}} = ma$

$$T - (mg \sin \theta + f_k) = 4a$$

$$T - (4 \times 9,8 \sin 30^\circ + 10) = 4a \checkmark$$

$$T - 29,6 = 4a$$

$$T = 29,6 + (4)(0,61) \checkmark$$

$$= 32,04 \text{ N} \checkmark$$

(6)

[16]

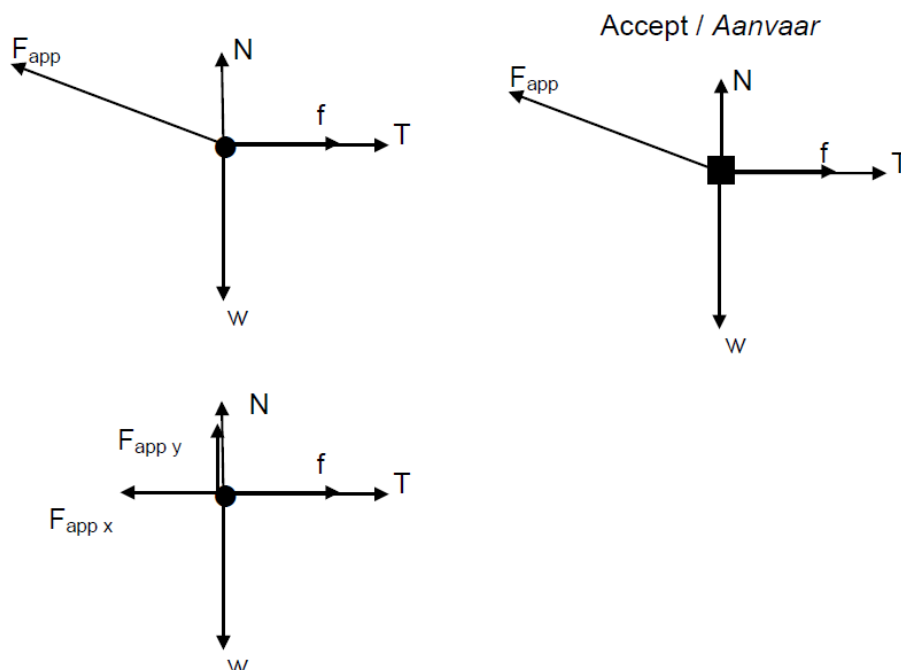
C

QUESTION 2/VRAAG 2

2.1

Accepted labels/Aanvaarde benoemings		
W	✓	F_g / F_w / weight / mg / gravitational force F_g / F_w / gewig / mg / gravitasiekrag
T	✓	F_T / tension F_T / spanning
F	✓	F_a / F_{60} / 60 N / F_{applied} / F_t / F_{toegepas}
N	✓	F_N
f	✓	F_f

(5)



Notes/Aantekeninge

- Mark awarded for label and arrow / Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale. / Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s) / Enige ander addisionele krag(te) Max/Maks $\frac{4}{5}$
- If force(s) do not make contact with body / Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{4}{5}$

2.2.1

$$\left. \begin{aligned} F_{60y} &= F_{60} \sin \theta \\ F_{60y} &= 60 \sin 10^\circ \\ &= 10,42 \text{ N} \end{aligned} \right\} \checkmark \quad \text{OR/OF} \quad \left. \begin{aligned} F_{60Y} &= F_{60} \cos \theta \\ F_{60Y} &= 60 \cos 80^\circ \end{aligned} \right\} \checkmark$$

(2)

2.2.2

$$\left. \begin{aligned} F_{60x} &= F_{60} \cos \theta \\ F_{60x} &= 60 \cos 10^\circ \\ &= 59,09 \text{ N} \end{aligned} \right\} \checkmark \quad \text{OR/OF} \quad \left. \begin{aligned} F_{60x} &= F_{60} \sin \theta \\ F_{60x} &= 60 \sin 80^\circ \end{aligned} \right\} \checkmark$$

(2)

- 2.3 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓

Wanneer 'n resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/OF

The net force acting on an object is equal to the rate of change of momentum.
Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. (2)

- 2.4

**POSITIVE MARKING FROM 2.2
POSITIEWE NASIEN VANAF 2.2**

$$N = mg - F_{60y}$$

$$N = \{5(9,8) - 10,42\} \checkmark$$

$$= 38,58 \text{ N} \checkmark$$

OR/OF

$$F_y + N = w$$

$$N = w - F_y = mg - F_y \checkmark$$

$$[(5)(9,8) - 10,42] \checkmark$$

$$= 38,58 \text{ N} \checkmark$$

(2)

- 2.5

**POSITIVE MARKING FROM 2.2.2 and 2.4
POSITIEWE NASIEN VANAF 2.2,2 en 2.4**

$$F_{\text{net}} = ma$$

$$T - m_2g = m_2a \checkmark$$

$$T - 2(9,8) = 2a$$

$$T - 19,6 \checkmark = 2a \dots (1)$$

$$F_{60x} = (f + T) = m_3a$$

$$60\cos 10^\circ - (f + T) = 5a$$

$$60\cos 10^\circ - [(\mu_k N) \checkmark + T] = 5a \dots$$

$$59,09 - (0,5 \times 38,58) - T \checkmark = 5a$$

OR/OF $60 \sin 80^\circ - [f + T] = 5a$

$$39,8 - T = 5a \dots (2)$$

$$a = 2,886 \text{ ms}^{-2}$$

$$T - 19,6 = 2(2,886) \checkmark$$

$$T = 25,37 \text{ N} \checkmark$$

OR/OF

From equation/Uit vergelyking (2)
 $T = 25,37 \text{ N}$

NOTE: 1 mark for either $\mu_k N$ or substitution./
LET WEL: 1 punt vir $\mu_k N$ óf vervanging.

OR/OF

$$T - 19,6 = 2a \dots (1) \times 5$$

$$59,09 - 19,29 - T = 5a \dots (2) \times 2$$

$$7T - 177,6 = 0 \checkmark$$

$$T = 25,37 \text{ N} \checkmark$$

(7)

2.5

NOTES: ACCEPT FOR 5 MARKS
NOTAS: AANVAAR VIR 5 PUNTE

$$F_{\text{net}} = ma \checkmark \text{ OR/OF}$$

$$F_{60x} - (f + m_2g) = (m_5 + m_2)a$$

$$60\cos 10^\circ - (\mu_k N) \checkmark + (2)(9,8) = 7a$$

$$59,09 - [(0,5 \times 38,58) + 19,6] \checkmark = 7a$$

$$a = 2,886 \text{ ms}^{-2}$$

$$T - m_2g = m_2a$$

$$T - 2(9,8) = 2(2,886) \checkmark$$

$$T = 25,37 \text{ N} \checkmark$$

$$F_{60x} - (f + T) = m_8a$$

$$60\cos 10^\circ - (f + T) = 5a.$$

$$60\cos 10^\circ - [(\mu_k N) + T] = 5a..$$

$$59,09 - (0,5 \times 38,58) - T = 5(2,886) \checkmark$$

$$T = 25,37 \text{ N} \checkmark$$

[20]

D

info@mathsandscienceinfinity.org.za | www.mathsandscienceinfinity.org.za

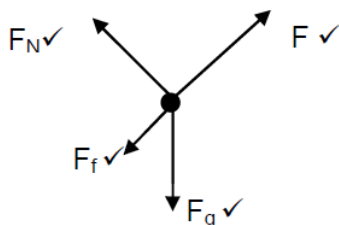
QUESTION 2/VRAAG 2

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

OR/OF

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

2.2



(4)

- 2.3 2.3.1 Up the incline as positive/Teen die skuinste op as positief:

$$\begin{aligned} F_{\text{net}} &= ma \\ F + (f_{kA} + f_{kB} + F_{g\parallel}) &= ma \\ F + (f_{kA} + f_{kB} + mgsin30^\circ) &= (m_A + m_B)a \end{aligned} \quad \left. \begin{aligned} &\checkmark \\ &\checkmark \\ &\checkmark \end{aligned} \right\} \text{Any ONE/Enige EEN}$$

$$F - \frac{6,8}{10} - \frac{3,4}{10} \checkmark - \frac{(12)(9,8)\sin 30^\circ}{10} \checkmark = 0 \checkmark$$

$$F = 69 \text{ N} \checkmark \quad (5)$$

2.3.2 $f_k = \mu_k F_N \checkmark$
 $3,40 = \mu_k (4)(9,8) \cos 30^\circ \checkmark$
 $\mu_k = 0,10 \checkmark \quad (3)$

- 2.4 2.41 REMAIN THE SAME/BLY DIESELFDE ✓ (1)

2.4.2 DECREASES/NEEM AF ✓

⊖ Since θ increases, $F_{g\perp}$ decreases, ✓ therefore F_N decreases ✓/ $f_k \propto F_N \checkmark$ Omdat θ toeneem, sal $F_{g\perp}$ afneem, ✓ dus sal F_N afneem ✓/ $f_k \propto F_N \checkmark$ (3)
[18]

E

QUESTION 2/VRAAG 2

- 2.1.1 When body A exerts a force on body B, body B exerts a force of equal magnitude in the opposite direction on body A.

Wanneer liggaam A 'n krag uitoefen op liggaam B, oefen liggaam B 'n krag van gelyke grootte in die teenoorgestelde rigting op liggaam A uit.

OR/OF

If body A exerts a force on body B, then body B exerts an equal and opposite force on body A

Indien liggaam A 'n krag uitoefen op liggaam B, dan sal liggaam B 'n gelyke maar teenoorgestelde krag op liggaam A uitoefen

Accept for 1 mark:/Aanvaar vir 1 punt:

For every action, there is an equal and opposite reaction/Action and reaction are equal and opposite

Vir elke aksie is daar 'n gelyke en teenoorgestelde reaksie/Aksie en reaksie is gelyk maar teenoorgesteld.

(2)

- 2.1.2 For 2,5 kg block/Vir 2,5 kg blok

$$T = mg \checkmark$$

$$\therefore T = 2,5 (9,8) \checkmark$$

$$= 24,5 \text{ N} \checkmark$$

(3)

- 2.1.3 **POSITIVE MARKING FROM 2.1.2**
POSITIEWE NASIEN VANAF 2.1.2

For mass M:/Vir mass M

$$T - f_s = 0 \checkmark$$

$$\therefore 24,5 = f_s$$

$$\text{But } f_s = \mu_s N \checkmark$$

$$\therefore N = \frac{24,5}{0,2} \checkmark = 122,5 \text{ N}$$

$$N = Mg = w_p = 122,5 \text{ N}$$

$$\underline{M(9,8) = 122,5 \text{ N} \checkmark}$$

$$M = 12,5 \text{ kg} \checkmark$$

OR/OF

$$T - f_s = 0 \checkmark$$

$$\therefore T = f_s$$

$$\mu_s N \checkmark = \mu_s Mg$$

$$24,5 \checkmark = (0,2) \underline{M(9,8)} \checkmark$$

$$M = 12,5 \text{ kg} \checkmark$$

(5)

- 2.1.4 For the 5 kg block/Vir die 5 kg blok:

$$f_k = \mu_k N$$

$$f_k = (0,15)(5)(9,8) \checkmark$$

$$= 7,35 \text{ N}$$

$$F_{\text{net}} = ma \checkmark$$

$$T - f_k = ma$$

$$T - 7,35 = 5a \dots\dots\dots(1) \checkmark$$

For the 2,5 kg block:/Vir die 2,5 kg blok

$$w_Q - T = m_Q a$$

$$\underline{(2,5)(9,8) - T = 2,5 a \dots\dots\dots(2) \checkmark}$$

$$\{1 + 2\}$$

$$17,15 = 7,5 a$$

$$a = 2,29 \text{ m} \cdot \text{s}^{-2} \checkmark$$

Accept for 3 marks

Aanvaar vir 3 punte

$$F_{\text{net}} = ma \checkmark$$

$$mg - f = ma$$

$$mg - \underline{\mu_s N} = (m_p + m_q)a$$

but /maar

$$mg = T$$

$$\underline{24,5 - [(0,15)(5)(9,8)] = (7,5) \checkmark a}$$

$$a = 2,29 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(5)

2.2

$$F = G \frac{m_1 m_2}{r^2} \checkmark$$

$$W = \frac{(6,67 \times 10^{-11})(6,5 \times 10^{20})(90)}{(550 \times 10^3)^2} \checkmark$$

$$= 12,90 \text{ N} \checkmark (12,899 \text{ N})$$

(4)

OR/OF

$$g = \frac{Gm}{r^2} \checkmark$$

$$g = \frac{(6,67 \times 10^{-11})(6,5 \times 10^{20})}{(550 \times 10^3)^2} \checkmark$$

$$= 0,143 \dots \text{m.s}^{-2}$$

$$W = mg \checkmark$$

$$= 90 \times 0,143 \dots$$

$$= 12,89 \text{ N} \checkmark (\text{Accept/Aanvaar } 12,87/12,9 \text{ N})$$

(4)

[19]

QUESTION 2/VRAAG 2

2.1 For the 5 kg mass/Vir die 5 kg massa:

2.1.1 $T - f = ma$

$$T - \mu_k(mg) = ma \checkmark$$

$$T - (0,4)(5)(9,8) \checkmark = 5a \checkmark \dots\dots\dots(1)$$

NOTE/LET WEL:

1 mark for any of the 2 formulae
1 punt vir enige van die 2 formules

For the 20 kg mass/Vir die 20 kg massa

$$mg - T = ma$$

$$20(9,8) - T = 20a \checkmark \dots\dots\dots(2)$$

$$176,4 = 25a \quad (1) + (2)$$

$$\therefore a = 7,06 \text{ (7,056) m} \cdot \text{s}^{-2} \checkmark$$

(5)

ACCEPT/AANVAAR (4 marks/4 punte)

$$F_{\text{net}} = ma$$

$$Mg - f = (M + m) a \checkmark$$

$$[20(9,8) - (0,4)(5)(9,8)] \checkmark = 25a \checkmark$$

$$\therefore a = 7,06 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(4)

2.1.2 **POSITIVE MARKING FROM QUESTION 2.1.1**

POSITIEWE NASIEN VANAF VRAAG 2.1.1

OPTION 1/OPSIE 1

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$= 0 \checkmark + (2)(7,056)(6) \checkmark$$

$$v_f = 9,20 \text{ m} \cdot \text{s}^{-1} \checkmark$$

POSITIVE MARKING FROM QUESTION 2.1.1

POSITIEWE NASIEN VANAF VRAAG 2.1.1

OPTION 2/OPSIE 2

The 5 kg mass travels as fast as the 20 kg mass

Die 5 kg massa beweeg net so vinnig soos die 20 kg massa

$$W_{\text{net}} = \Delta K \checkmark$$

$$(5)(7,056)(6 \cos 0^\circ) \checkmark = \frac{1}{2}(5)(v_f^2 - 0) \checkmark$$

$$v_f = 9,20 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 3/OPSIE 3

For the 20 kg mass/Vir die 20 kg massa

$$W_{\text{net}} = \Delta K \checkmark$$

$$Mg - T = Ma$$

$$(20)(9,8) - T = (20)(7,056) \checkmark$$

$$T = 54,88 \text{ N}$$

$$W_{\text{net}} = \Delta K$$

$$W_T + W_g = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$(54,88)(6)(\cos 180) + 20(9,8)(6)(\cos 0) = \frac{1}{2}(20)(v_f^2 - 0) \checkmark$$

$$v_f = 9,202 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 4/OPSIE 4

$$W_{nc} = \Delta K + \Delta U \checkmark$$

$$W_{nc} = f_k \Delta x \cos \theta = \mu_k N \Delta x \cos \theta = \Delta U + \Delta K$$

$$(0,4)(5)(9,8)(6) \cos 180^\circ \checkmark = (20)(9,8)(0 - 6) + \frac{1}{2}(25)(v_f^2 - 0) \checkmark$$

$$-117,6 = (20)(9,8)(-6) + \frac{1}{2}(25)(v_f^2 - 0)$$

$$v_f = 9,202 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(4)

2.1.3 6 m ✓

(1)

2.2

2.2.1 Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres. ✓

Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag wat direk eweredig is aan die produk van hul massas ✓ en omgekeerd eweredig is aan die kwadraat van die afstand tussen hul middelpunte. ✓

(2)

2.2.2

$$F = \frac{Gm_1m_2}{r^2} \checkmark$$

On the mountain/Op die berg

$$F_g = \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(65)}{(6,38 \times 10^6 + 6 \times 10^3)^2} \checkmark$$

$$= 627,2 \text{ N}$$

On the ground/Op die grond

$$F_g = W = mg$$

$$= (65 \times 9,8) \checkmark$$

$$= 637 \text{ N}$$

$$F_g = \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(65)}{(6,38 \times 10^6)^2}$$

$$= 636,94 \text{ N}$$

$$\text{Difference/Verskil} = (637 - 627,2) \checkmark$$

$$= 9,8 \text{ N} \checkmark$$

(6)

[18]

G

QUESTION 2/VRAAG 2

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

OR/OF

The resultant/net force acting on the object is equal (is directly proportional to) to the rate of change of momentum of an object (in the direction of the force). ✓✓

Die resulterende/netto krag wat op 'n voorwerp inwerk, is gelyk aan (is direk eweredig aan) die tempo van verandering van momentum van die voorwerp (in die rigting van die netto krag).

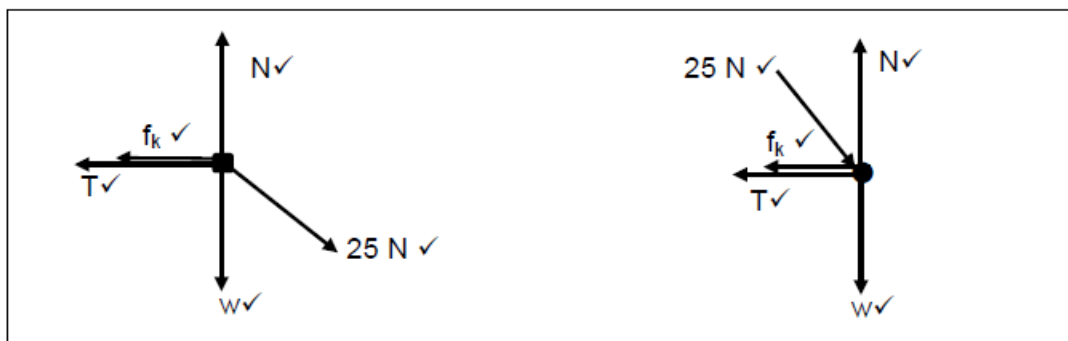
(2)

2.2

$$\begin{aligned} f_k &= \mu_k N \checkmark = \mu_k mg \\ &= (0,15)(3)(9,8) \checkmark \\ &= 4,41 \text{ N} \checkmark \end{aligned}$$

(3)

2.3



Accepted Labels/Aanvaarde benoemings	
W	F_g/F_w /force of Earth on block/weight/14,7 N/mg/gravitational force F_g/F_w /krag van Aarde op blok/gewig/14,7 N/mg/gravitasiekrag
N	F_N/F_{normal} /normal force F_N/F_{normaal} /normalekrag
T	Tension/ F_T Spanning/ F_T
f_k	$f_{\text{kinetic friction/kinetiesewrywing}}/f_{f/w}/F_{f/w}$ kinetic friction/kinetiesewrywing
25 N	$F_{\text{applied}}/F_A/F$ $F_{\text{toegepas}}/F_A/F$

2.4.1	OPTION 1/OPSIE 1 $f_k = \mu_k N = \mu_k (25 \sin 30^\circ + mg)$ $= 0,15[(25 \sin 30^\circ) + (1,5)(9,8)]$ $= 4,08 \text{ N}$ ✓	OPTION 2/OPSIE 2 $f_k = \mu_k N = \mu_k (25 \cos 60^\circ + mg)$ $= 0,15[(25 \cos 60^\circ) + (1,5)(9,8)]$ $= 4,08 \text{ N}$ ✓	(3)
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2.4.2	POSITIVE MARKING FROM QUESTION 2.2 AND QUESTION 2.4.1 POSITIEWE NASIEN VANAF VRAAG 2.2 EN VRAAG 2.4.1 OPTION 1/OPSIE 1 For the 1,5 kg block/Vir die 1,5 kg blok $F_{\text{net}} = ma$ $F_x + (-T) + (-f_k) = ma$ ✓ $25 \cos 30^\circ - T - f_k = 1,5a$ $(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a$ $17,571 - T = 1,5a \dots\dots\dots(1)$ For the 3 kg block Vir die 3 kg blok $T - f_k = 3a$ $T - 4,41 \checkmark = 3a \dots\dots\dots(2)$ $13,161 = 4,5 a$ $a = 2,925 \text{ m} \cdot \text{s}^{-2}$ $T = 13,19 \text{ N} \checkmark \quad (13,17 \text{ N} - 13,19 \text{ N})$	✓ either one enigeen
-------	---	----------------------

OPTION 2/OPSIE 2

For the 1,5 kg block/Vir die 1,5 kg blok

$$F_{\text{net}} = ma$$

$$F_x + (-T) + (-f_k) = ma \quad \checkmark$$

$$25 \cos 30^\circ - T - f_k = 1,5a$$

$$(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a$$

$$17,571 - T = 1,5a \dots\dots\dots(1)$$

For the 3 kg block

Vir die 3 kg blok

$$T - f_k = 3a$$

$$T - 4,41 \checkmark = 3a \dots\dots\dots(2)$$

$$35,142 - 2T = T - 4,41$$

$$T = 13,18 \text{ N} \checkmark$$

✓ either one
enigteen

OPTION 3/OPSIE 3

For the 1,5 kg block/Vir die 1,5 kg blok

$$F_{\text{net}} = ma$$

$$F_x + (-T) + (-f_k) = ma \quad \checkmark$$

$$25 \cos 30^\circ - T - f_k = 1,5a$$

$$(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a$$

$$17,571 - T = 1,5a \dots\dots\dots(1)$$

$$a = \frac{17,571 - T}{1,5}$$

For the 3 kg block

Vir die 3 kg blok

$$T - f_k = 3a$$

$$T - 4,41 \checkmark = 3a \dots\dots\dots(2)$$

$$a = \frac{T - 4,41}{3}$$

$$\frac{17,571 - T}{1,5} = \frac{T - 4,41}{3}$$

$$T = 13,18 \text{ N} \checkmark$$

✓ either one
enigteen

(5)

[18]

H

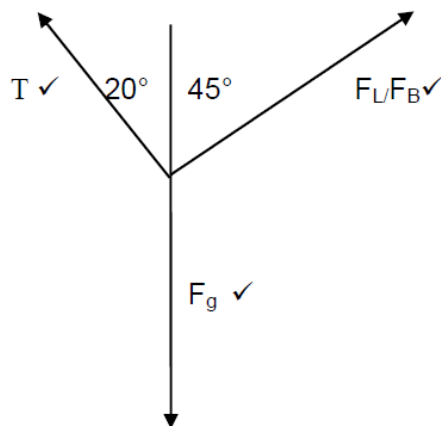
QUESTION/VRAAG 2

2.1 The resultant of the forces is zero. ✓

Die resultant van die kragte is nul. ✓

(1)

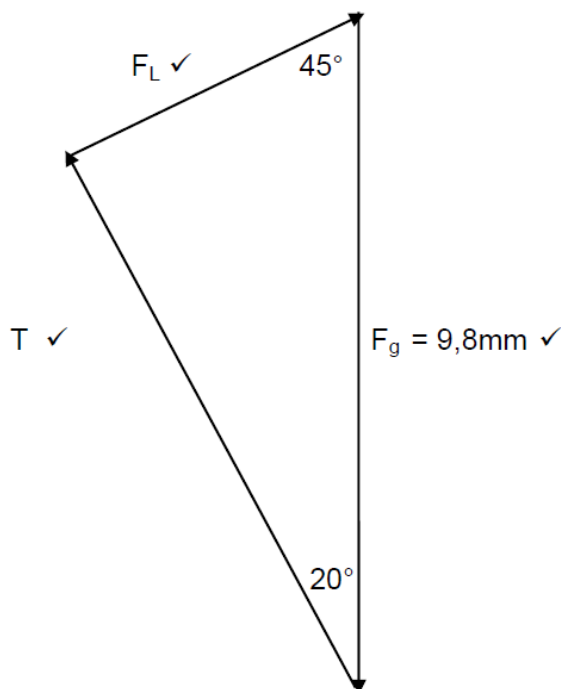
2.2



ACCEPTED LABELS/AANVAARDE BYSKRIFTE	
F_g	F_w /W/Weight/mg/gravitational force/force due to gravity F_w /W/gewig/mg/gravitasiekrag
T	F_T /Tension/Tension in rope F_T /Spanning/Spanning in tou
F_L F_B	F_{legs} /Force of legs on wall F_{bene} /Krag van bene op muur

(3)

- 2.3 $F_g = mg = (50)(9,8) = 490 \text{ N} \checkmark$
 SCALE/SKAAL $10 \text{ mm} = 50 \text{ N}$
 $F_g = 490 \text{ N} = 98 \text{ mm}$ (Accept/Aanvaar $97 - 99 \text{ mm}$)



$$\begin{aligned} T &= 76,5 \times 5 = 382,5 \text{ N} \checkmark \quad (\text{Accept/Aanvaar } 76,4 - 76,6 \text{ mm}) \\ F_L &= 37,0 \times 5 = 185 \text{ N} \checkmark \quad (\text{Accept/Aanvaar } 184,5 - 186,5 \text{ mm}) \end{aligned} \quad (8)$$

NOTES/AANTEKENINGE

- Mark awarded for correct label and direction./
- Punt toegeken vir korrekte benoeming en pyltjie.
- ANY TWO angles indicated./✓✓
- ENIGE TWEE hoeke aangedui. ✓✓

OR/OF

CALCULATIONS instead of CONSTRUCTION/
 BEREKENINGE in plaas van KONSTRUKSIES

max/maks $\frac{5}{8}$

$$\frac{F_g}{\sin 115^\circ} = \frac{F_T}{\sin 45^\circ} \Rightarrow F_T = \frac{490 \sin 45^\circ}{\sin 115^\circ} \checkmark = 382,50 \text{ N} \checkmark$$

$$\frac{F_r}{\sin 20^\circ} = \frac{F_g}{\sin 115^\circ} \Rightarrow F_R = \frac{490 \sin 20^\circ}{\sin 115^\circ} \checkmark = 184,91 \text{ N} \checkmark$$

[12]

QUESTION/VRAAG 3

3.1 $f_s = F_{g\parallel} = mg \sin \theta = (60)(9,8) \sin 30^\circ \checkmark = 294 \text{ N} \checkmark$

Any one/Enige een $\checkmark$

(3)

3.2 $\mu_s = \tan \theta \checkmark = \tan 30^\circ \checkmark = 0,58 \checkmark$

OR/OF

$f_s = \mu_s F_N = \mu_s F_{g\perp} = \mu_s mg \cos \theta \checkmark$

$294 = \mu_s (60)(9,8) \cos 30^\circ \checkmark$

$\mu_s = 0,58 \checkmark$

(3)

3.3 3.3.1 REMAINS THE SAME/BLY DIESELFDE $\checkmark$

(1)

3.3.2 DECREASES/NEEM AF $\checkmark$

$\ominus$

$F_{g\perp}$ will decrease, $\checkmark$ therefore F_N will decrease/ $f_k \propto F_N \checkmark$

$F_{g\perp}$ sal afneem, $\checkmark$ dus sal F_N afneem $\checkmark$ / $f_k \propto F_N \checkmark$

(3)

[10]

QUESTION/VRAAG 4

- 4.1 When a resultant/net force acts on an object, the object accelerates in the direction of the force. This acceleration is directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓

Indien 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die (resulterende/netto) krag ✓ en omgekeerd eweredig aan die massa van die voorwerp. ✓

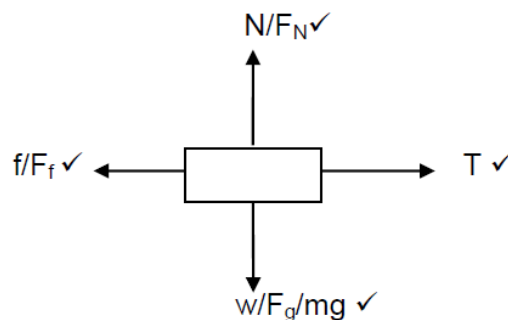
OR/OF

The net force acting on an object is equal to the rate of change of momentum ✓✓ of the object (in the direction of the force). (2 or 0)

Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum ✓✓ van die voorwerp (in die rigting van die krag). (2 of 0)

(2)

4.2



(4)

NOTES/AANTEKENINGE

- Mark awarded for label and arrow./Punt toegeken vir benoeming en pyltjie.
- Any other additional force(s)/Enige ander addisionele krag(te). Max/Maks $\frac{3}{4}$
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie. Max/Maks $\frac{3}{4}$

4.3 4.3.1 **OPTION/OPSIE 1**

For the 6kg block./Vir 6kg blokkie:

$$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ T + (-f_f) &= ma \\ T - 11,76 \checkmark &= 6a \quad \dots\dots\dots(1) \end{aligned}$$

For the 2kg block./Vir 2kg blokkie:

✓ For either/vir of/6a or/of 2a

$$\begin{aligned} F_{\text{net}} &= ma \\ 2 + w + (-T) &= ma \\ 2 + (2 \times 9,8) - T \checkmark &= 2a \\ T &= 21,6 - 2a \quad \dots\dots\dots(2) \\ \text{Substitute (2) into (1)/Stel (2) in (1):} \\ 21,6 - 2a - 11,76 &= 6a \\ a &= 1,23 \text{ m.s}^{-2} \checkmark \end{aligned}$$

OPTION/OPSIE 2:

$$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ 2 + w + (-F_f) \checkmark &= ma \\ 2 + (2 \times 9,8) - F_f \checkmark &= 8a \checkmark \\ 2 + (2 \times 9,8) - 11,76 &= 8a \\ a &= 1,23 \text{ m.s}^{-2} \checkmark \end{aligned} \quad (5)$$

4.3.2 **POSITIVE MARKING from QUESTION 4.3.1** **POSITIEWE NASIEN van VRAAG 4.3.1**

$$\begin{aligned} T &= 21,6 - 2a \\ &= 21,6 - 2(1,23) \checkmark \\ &= 19,14 \text{ N} \checkmark \end{aligned}$$

OR/OF

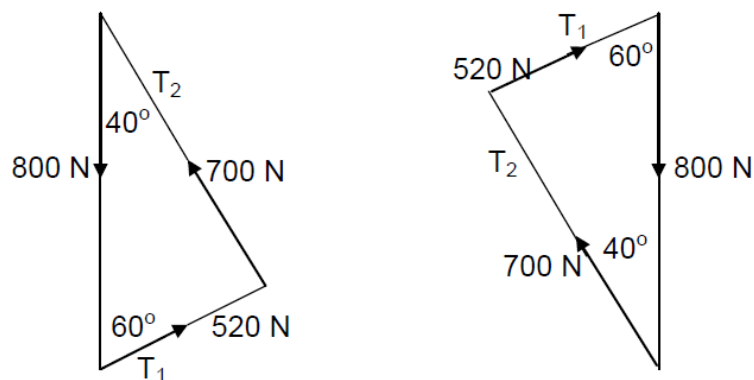
$$\begin{aligned} T - 11,76 &= 6a \\ T &= 11,76 + 6(1,23) \checkmark \\ &= 19,14 \text{ N} \checkmark \end{aligned} \quad (2)$$

4.4 **INCREASES/TOENEEM** ✓

(1)
[14]

QUESTION 2/VRAAG 2

2.1 CHECK ANSWER BY CONSTRUCTION AND MEASUREMENT VERGELYK ANTWOORD DEUR KONSTRUKSIE EN METING



NOTES/AANTEKENINGE	
Weight (w) measured to accuracy of ± 5 N / Gewig (w) gemeet tot akkuraatheid van ± 5 N Anything beyond ± 10 N should attract 1 mark only <i>Enigiets bo ± 10 N kan slegs 1 punt kry</i>	✓
Tension force T_1 measured to accuracy of ± 10 N <i>Spanning T_1 korrek gemeet tot 'n akkuraatheid van ± 10 N</i>	✓✓
Tension force T_2 measured to accuracy of ± 10 N <i>Spanning T_2 korrek gemeet tot 'n akkuraatheid van ± 10 N</i>	✓✓
Angle of 60° and 40° accurately obtained (may not be indicated, but must be measured to ascertain). <i>Hoek van 60° en 40° akkuraat verkry (mag nie aangedui word nie, maar moet gemeet word om te bepaal).</i>	✓✓

Penalise 1 mark if distance (cm) instead of forces indicated on diagram (if final answer is correctly written).
Penaliseer 1 punt indien afstand (cm) in plaas van kragte op diagram aangedui word (indien finale antwoord korrek geskryf is).

Penalise 1 mark if no scale is indicated.
Penaliseer 1 punt indien geen skaal aangedui is nie

If no answer is given but sketch correctly shown in cm, award only 3 marks.
Indien geen antwoord gegee is nie, maar die skets is korrek in cm getoon, ken slegs 3 punte toe.

2.1 BY CALCULATION / DEUR BEREKENING

OPTION 1/OPSIE 1

$$T_1 \sin 30 + T_2 \sin 50 = 800 \checkmark \dots\dots\dots(1)$$

$$T_1 \cos 30 = T_2 \cos 50 \checkmark \dots\dots\dots(2)$$

$$T_2 = \frac{T_1 \cos 30}{\cos 50}$$

$$\therefore \frac{(T_1 \cos 30)(\sin 50)}{\cos 50} + T_1 \sin 30 = 800$$

$$1,532 T_1 = 800$$

$$T_1 = 522,19 \text{ N} \checkmark$$

$$T_2 = \frac{(522,19)(\cos 30)}{\cos 50} \checkmark$$

$$= 703,54 \text{ N} \checkmark$$

OPTION 2/OPSIE 2

$$\frac{T_2 \checkmark}{\sin 60} = \frac{800 \checkmark}{\sin 80}$$

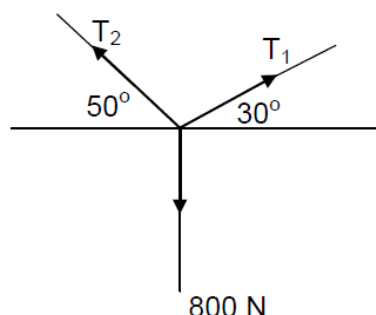
$$T_2 = \frac{(800)(\sin 60)}{\sin 80} \checkmark$$

$$T_2 = 703,51 \text{ N} \checkmark$$

$$\frac{T_1 \checkmark}{\sin 40} = \frac{800}{\sin 80}$$

$$T_1 = \frac{(800)(\sin 40)}{\sin 80} \checkmark$$

$$= 522,16 \text{ N} \checkmark$$



NOTE/LET WEL:

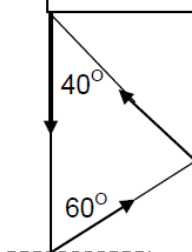
Do not penalise if sketch is not shown.

Moenie penaliseer indien skets nie getoon is nie

NOTE/LET WEL:

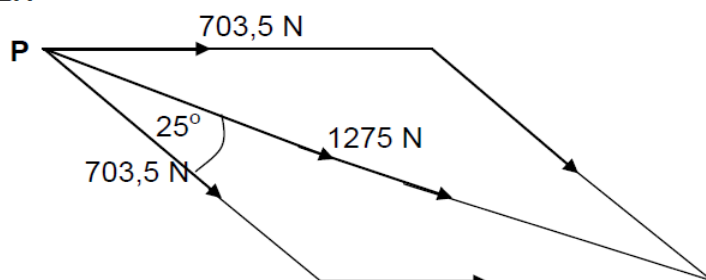
Do not penalise if sketch is not shown

Moenie penaliseer indien skets nie getoon is



(7)

2.2 **BY CONSTRUCTION AND MEASUREMENT: DEUR KONSTRUKSIE EN METING**
POSITIVE MARKING FROM QUESTION 2.1/ POSITIEWE NASIEN VANAF VRAAG 2.1

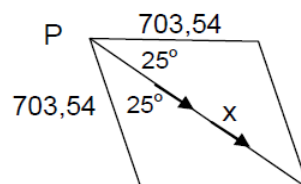


Parallelogram drawn with adjacent sides equal to T_2 <i>Parallelogram getrek met aangrensende kante gelyk aan T_2</i>	✓✓
Angle of 50° or 25° accurately obtained May not be indicated, but must be measured to ascertain. <i>Hoek van 50° of 25° akkuraat verkry</i> <i>Mag nie aangedui word nie, maar moet gemeet word om te bepaal.</i>	✓
Reaction force recorded as $1\,275\,N \pm 10\,N$ <i>Reaksiëkrag aangeteken as $1\,275\,N \pm 10\,N$</i>	✓
Penalise 1 mark if distance (cm) instead of forces indicated on diagram (if final answer is correct). <i>Penaliseer 1 punt indien afstand (cm) in plaas van kragte aangedui word op diagram (indien finale antwoord korrek is).</i>	
If no answer is given but sketch shown in cm, award only 1 mark. <i>Indien geen antwoord gegee word nie, maar skets getoon in cm, ken slegs 1 punt toe.</i>	

2.2 **BY CALCULATION: (POSITIVE MARKING FROM QUESTION 2.1)**
DEUR BEREKENING (POSITIEWE NASIEN VANAF VRAAG 2.1)
OPTION 1/OPSIE 1

$$\frac{703,54}{\sin 25} = \frac{x}{\sin 130}$$

$$x = \frac{(703,54)(\sin 130)}{\sin 25}$$

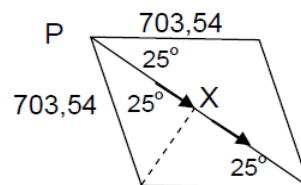


reaction force / reaksiëkrag = $1\,275,25\,N$ ✓ at 25° below the horizontal/ onder die horisontaal ✓ (or/of 335°)

OPTION 2/OPSIE 2

$$\sin 65 = \frac{PX}{703,54} \quad \checkmark$$

$$PX = 637,62$$



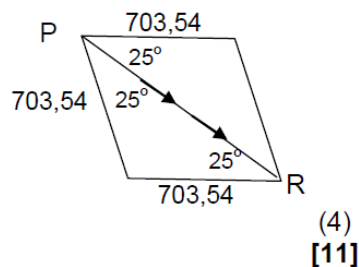
Reaction force/Reaksiëkrag = $2PX$ ✓ = $1\,275,25\,N$ ✓ at 25° below the horizontal/onder die horisontaal ✓ (or/of 335°)

OPTION 3/OPSIE 3

$$c^2 = a^2 + b^2 - 2ab \cos C \quad \checkmark$$

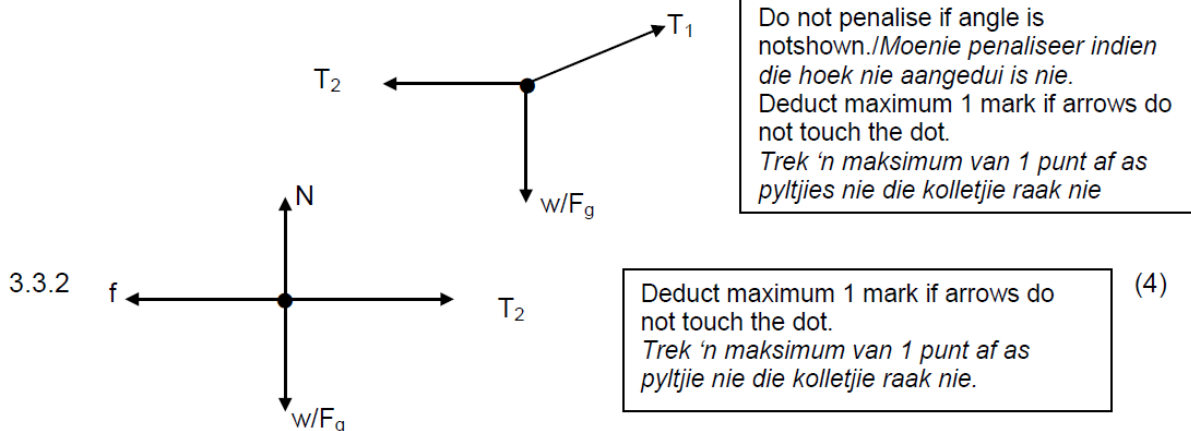
$$\therefore PR^2 = 703,54^2 + 703,54^2 - 2(703,54)(703,54) \cos 130^\circ$$

$$PR = 1275,25 \text{ N at } 25^\circ \text{ below the horizontal / onder die horisontaal (or/of } 335^\circ)$$



QUESTION 3/VRAAG 3

- 3.1 The force that opposes the tendency of motion of a stationary object relative to a surface. ✓✓ / Die krag wat die neiging tot beweging van 'n stilstaande liggaam relatief tot 'n oppervlak teenwerk.
OR/OF
The force of friction developed between two surfaces that are at rest. / Die krag of wrywing wat ontwikkel word tussen twee oppervlakke wat in rus is. (2)
- 3.2 The resultant of all forces ✓ acting at point S is zero ✓ / Die resultaat van al die kragte wat op punt S inwerk, is nul.
Net force ✓ at S equals zero ✓ / Netto krag by S is gelyk aan nul.
There is no acceleration ✓✓ / Daar is geen versnelling nie (2)
- 3.3.1 (3)



- 3.4 For the string/ *Vir die toutjie*
 $-T_2 + T_1 \cos 35^\circ = 0$
 $\therefore T_1 \cos 35^\circ = T_2 \dots\dots\dots(1) \checkmark$
 $T_1 \sin 35^\circ = w_P \dots\dots\dots(2) \checkmark$

For the block/ *Vir die blok*
 $T_2 - f_s = 0$
 $T_2 = f_s = \mu_s N \checkmark$
 $T_2 = 0,25 (70)(9,8) \dots\dots\dots(3) \checkmark$

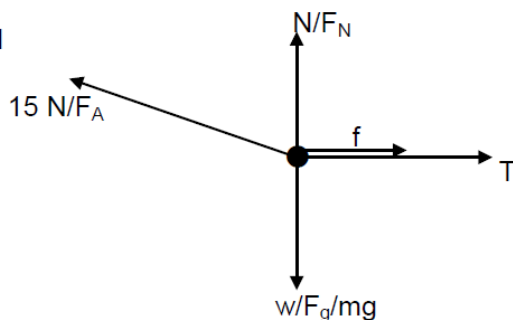
$$T_1 = \frac{(0,25)(70)(9,8)}{\cos 35^\circ} \text{ from (1)/ vanaf (1)}$$

From (2) and (3)/ *Vanaf (2) en (3)*
 $0,25(70)(9,8) \sin 35^\circ \checkmark = w_P$
 $120,09 \text{ N} \checkmark$

(7)
[18]

QUESTION 4/VRAAG 4

4.1



(5)

NOTE/LET WEL:

1 mark for each force correctly shown emanating from the dot.
 1 punt vir elke krag korrek aangetoon wat uit die kolletjie voortspruit.

- 4.2 When a net force is applied to an object of mass m , it accelerates in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object. $\checkmark\checkmark$
Wanneer 'n netto krag op 'n liggaam met massa m toegepas word, versnel dit in die rigting van die krag teen 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig is aan die massa van die liggaam.

OR/OF

When a net force acts on an object of mass m , the acceleration that results is directly proportional to the net force, has a magnitude that is inversely proportional to the mass and a direction that is the same as that of the net force. $\checkmark\checkmark$

Wanneer 'n netto krag op 'n liggaam met massa m inwerk, is die gevolglike versnelling direk eweredig aan die netto krag, het 'n grootte wat omgekeerd eweredig is aan die massa en 'n rigting wat diedelfde is as dié van die netto krag.

(2)

- 4.3 $N = w - F_A \sin \theta \checkmark$
 $= 8(9,8) - 15 \sin 30^\circ \checkmark$
 $= 70,9 \text{ N} \checkmark$

(3)

4.4 POSITIVE MARKING FROM QUESTION 4.3 POSITIEWE NASIEN VANAF VRAAG 4.3

For the 8 kg block/Vir die 8 kg-blok

$$\begin{aligned} 15 \cos 30^\circ - T - f_k &= ma \checkmark \\ 15 \cos 30^\circ - T - \mu_k N &= 8a \\ \frac{15(0,866) - T - (0,25)(70,9)}{-4,735 - T} &= 8a \checkmark \\ -4,735 - T &= 8a \dots\dots\dots(1) \end{aligned}$$

For the 5 kg block/Vir die 5 kg-blok

$$\begin{aligned} T - w &= ma \checkmark \\ T - 5(9,8) &= 5a \checkmark \dots\dots\dots(2) \\ \text{From (1) and (2)/ Vanaf (1) en (2)} \\ -53,735 &= 13a \\ a &= -4,133 \text{ m}\cdot\text{s}^{-2} \end{aligned}$$

$$\begin{aligned} \text{from/vanaf (1)} \\ -4,735 - T &= 8(-4,133) \checkmark \end{aligned}$$

$$\begin{aligned} T &= 28,32(9) \text{ N} \checkmark \\ \text{OR/OF} \\ \text{From /vanaf (2)} \\ T - 5(9,8) &= 5(-4,133) \checkmark \\ T &= 28,33(5) \text{ N} \checkmark \end{aligned}$$

(6)
[16]

QUESTION 5/VRAAG 5

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

5.2 $w = mg \checkmark$
 $m = 14,29 \text{ (14,286 kg)} \checkmark$

$$F = G \frac{m_1 m_2}{r^2} \quad \text{OR/OF} \quad F = G \frac{M_E m}{R_E^2} \checkmark$$

$$= 6,67 \cdot 10^{-11} \times \frac{(5,98 \times 10^{24})(14,286)}{[(6,38 \times 10^6)^2]} \checkmark$$

$$= 33,31 \text{ N}$$

Change /Verandering = $\frac{140 - 33,31}{140} \times 100 = 76,21 \% \checkmark$

OPTION B/OPSIE B

$$w = mg \checkmark$$

$$m = 14,29 \text{ (14,286 kg)} \checkmark$$

$$w = mg = G \frac{M_E m}{R_E^2}$$

$$g' = G \frac{M_E}{R_E^2} \checkmark$$

$$= 6,67 \times 10^{-11} \frac{(5,98 \times 10^{24})}{[(6,38 + 6,7) \times 10^6]^2}$$

$$g' = 2,331 \text{ m} \cdot \text{s}^{-2}$$

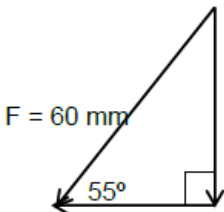
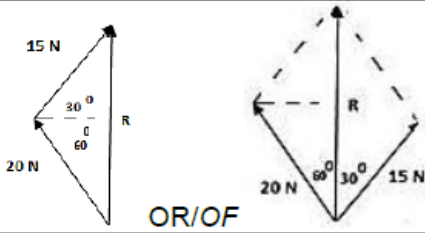
$$\begin{aligned} \text{(New weight / Nuwe gewig)} w' &= mg' = 14,286 \times 2,331 \\ &= 33,301 \text{ N} \end{aligned}$$

$$\text{Change/Verandering} = (140 - 33,30) = 106,699 \text{ N}$$

$$\begin{aligned} \% \text{ change/verandering} &= \frac{106,699}{140} \times 100 \\ &= 76,21 \% \checkmark \end{aligned}$$

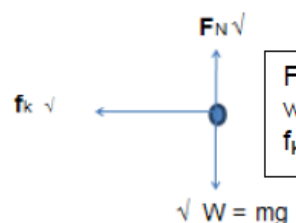
(8)
[10]

QUESTION/VRAAG 3

3.1	3.1.1	 $F = 60 \text{ mm}$ $= 55^\circ$ $X = 34 \text{ mm}$ (accept/aanvaar 33 – 35) 102 N (accept/aanvaar 99 N – 105 N) left/links $Y = 49 \text{ mm}$ (accept/aanvaar 48 – 50) 147 N (accept/aanvaar 144 N – 150 N) down/af All 3 arrows correct/AI 3 pyle korrek If a calculation was done instead of a construction – max 4 out of 7 Indien 'n berekening gedoen is i.p.v. 'n konstruksie – maks. 4 uit 7 Right angled triangle with information shown/Reghoekige driehoek met inligting getoon All 3 arrows correct/AI 3 pyle korrek $X = 180 \cos 55^\circ = 103,24 \text{ N}$ $Y = 180 \sin 55^\circ = 147,45 \text{ N}$	(7)
	3.1.2	Positive marking from Q3.1.1/Positiewe nasien vanaf Vr3.1.1 $w = mg = 30(9,8) = 294 \text{ N}$ normal force/normaalkrag = $294 + 147 = 441 \text{ N}$	(3)
3.2		A single vector with the same effect as a number of vectors acting on an object. 'n Enkel vektor wat dieselfde effek het as 'n aantal vektore wat saam op 'n voorwerp inwerk.	(2)
3.3	3.3.1	one mark for correct vector diagram/een punt vir korrekte vektordiagram $R = \sqrt{20^2 + 15^2} = 25 \text{ N}$	(3)
	3.3.2	$\tan \theta = \frac{15}{20}$ $\theta = 36,87^\circ$ thus/dus $6,87^\circ$ (clockwise from the positive y-axis/ kloksgewys vanaf die y-as)	(2)
			
3.4		When three or more vectors drawn head to tail form a closed figure, their resultant is zero or they are in equilibrium/balanced. Wanneer drie of meer vektore kop-stert geteken word en 'n geslote figuur vorm, is hul resultant nul of is hulle in ewewig/gebalanseerd	(2)

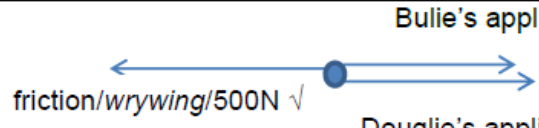
[19]

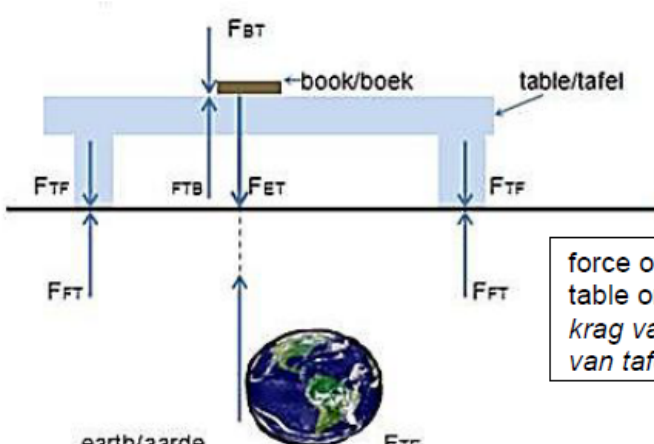
QUESTION/VRAAG 4

4.1		 F_N – normal force/normaalkrag W – weight/gewig f_k – friction/wrywing	(3)
4.2	4.2.1	The kinetic frictional force is the only force acting on the sled in x direction and opposes the motion of the sled so the net force is given by/Die kinetiese wrywingskrag is die enigste krag op die skild in x-rigting en staan die beweging van die slee teen sodat die krag gegee word deur: $F_{net} = ma \quad \checkmark \quad \text{OR/OF} \quad f_k = \mu_k N \quad \checkmark = 0,06 \text{ m} (9,8) \quad \checkmark = 0,588 \text{ m N}$ $\mu_k mg \quad \checkmark = ma \quad \checkmark \quad F_{net} = ma \quad \checkmark 0,588 \text{ m} = m a$ $\mu_k g = a \quad \checkmark \quad a = 0,588 \text{ m.s}^{-2} \quad \checkmark \text{ or/of } 0,59 \text{ m.s}^{-2}$ $6 \times 10^{-2} \times 9,8 = a \quad \checkmark$ $a = 0,588 \text{ m.s}^{-2} \quad \checkmark \text{ or/of } 0,59 \text{ m.s}^{-2}$	(4)
	4.2.2	POSITIVE MARKING FROM QUESTION 4.2.1 POSITIEWE NASIEN VAN VRAAG 4.2.1 $v_f^2 = v_i^2 + 2a\Delta x \quad \checkmark$ $0^2 = 6^2 + 2(-0,588) \Delta x \quad \checkmark \text{ (the sled decelerates/die slee vertraag)}$ $\Delta x = 30,61 \text{ m} \quad \checkmark \text{ (if/as } a = 0,59 \text{ m.s}^{-2} \text{ then/dan } \Delta x = 30,51 \text{ m)}$	(3)

[10]

QUESTION/VRAAG 5

5.1			(3)
5.2		$F_{net} = ma = 400 + 250 + (-500) \quad \checkmark = 2000 \text{ a} \quad \checkmark$ $150 = 2000 \times a$ $a = 0,075 \text{ m.s}^{-2} \quad \checkmark \text{ to the right/na regs} \quad \checkmark$	(4)
5.3		$F_{g//} = F_g \sin \theta = mg \sin \theta \quad \checkmark$ $= 2000 (9,8) \sin 5^\circ$ $= 1708,25 \text{ N} \quad \checkmark$	(2)
5.4		accelerate down the incline/versnel teen die steilte af $\checkmark$	(1)
5.5		Inertia is the tendency of an object to resist change $\checkmark$ Traagheid is 'n voorwerp se vermoë om verandering teen te staan $\checkmark$	(1)

5.6	A person will keep on moving forward in a straight line at constant velocity unless acted on by a resultant force ✓ The seatbelt acts as a net force ✓ which hold you safely in the seat. <i>’n Liggaam sal aanhou beweeg in ’n reguit lyn teen ’n konstante snelheid tensy ’n resultante krag daarop inwerk. ✓ Die veiligheids gordel is die net krag ✓ wat jou veilig in die sitplek hou.</i> OR/OF In an accident seatbelts hold you safely in place because of Newton’s First law of motion and inertia. ✓ When a car suddenly slows down the seatbelt acts as net force ✓ which helps the passengers from being hurt. <i>In ’n ongeluk hou die veiligheids gordel jou veilig in plek a.g.v. Newton se eerste wet/traagheid. ✓ Wanneer ’n motor skielik stadiger ry, tree die veiligheids gordel as die netto krag op ✓ wat help dat die passasier nie seerkry nie.</i>	(2)
5.7	Newton’s third law of motion states that when object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object B. ✓✓ <i>Volgens Newton se derde bewegingswet: as voorwerp A ’n krag op voorwerp B uitoefen, oefen voorwerp B terselfde tyd ’n teenoorgestelde krag van dieselfde grootte op A uit. ✓✓</i>	(2)
5.8	 force of book on table – force of table on book ✓ <i>krag van boek op tafel – krag van tafel op boek</i> force of floor on table - force of table on floor ✓ <i>krag van vloer op tafel – krag van tafel op vloer</i> force of earth on table - force of table on earth ✓ <i>krag van aarde op tafel – krag van tafel op aarde</i>	(3)

[18]

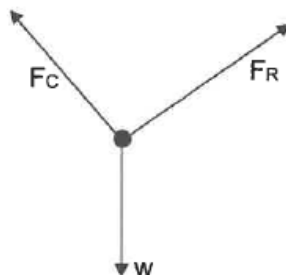
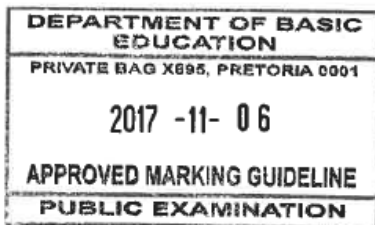
QUESTION/VRAAG 6

6.1	$F_{\text{sun earth}} = G \frac{M_{\text{sun}} M_{\text{earth}}}{d^2} \checkmark$ $= \frac{6,67 \times 10^{-11} \checkmark (1,99 \times 10^{30})(5,98 \times 10^{24}) \checkmark}{(2 \times 10^{11})^2 + (4 \times 10^8)^2 \checkmark}$ $= 1,98 \times 10^{22} \text{ N} \checkmark$	(5)
6.2	$g_{\text{moon}} = \frac{GM_{\text{moon}}}{d^2} \checkmark \quad \text{OR/OF} \quad F = m g = \frac{G m M}{d^2}$ $= \frac{6,67 \times 10^{-11} (7,35 \times 10^{22}) \checkmark}{(1,6 \times 10^6)^2 \checkmark}$ $= 1,92 \text{ m.s}^{-2} \checkmark$	(4)
6.3	$W = mg \checkmark = 50 \times 10^{-3} \times 9,8 \checkmark = 0,49 \text{ N} \checkmark$	(3)

[12]

QUESTION/VRAAG 2

- 2.1 The vector sum of two or more vectors. ✓✓
 Die vektorsom van twee of meer vektore. ✓✓
OR/OF
 The single vector which has the same effect as two or more vectors (acting) together.
 Die enkele vektor met dieselfde effek as twee of meer vektore saam. (2)
- 2.2 0 N ✓ (Accept 0/Zero Aanvaar 0/Nul) (1)
- 2.3 (3)



Notes: Accepted Labels/Aanvaarbare Byskrifte		Mark/Punt
w	weight/ F_G/F_g gewig/gravitasiekragswaartekrag	✓
F_C	Tension force in cable/ T_C Spanningskragsin kabel/ T_C	✓
F_R	Tension force in rope/ T_R Spanningskragsin tou/ T_R	✓
	Any additional force: deduct 1 mark (maximum $\frac{2}{3}$) Enige addisionele krag: trek 1 punt af (maksimum $\frac{2}{3}$)	
	Lines must touch object otherwise (maximum $\frac{2}{3}$) Lyne moet voorwerp raak anders (maksimum $\frac{2}{3}$)	
	Subtract one mark if arrows are not shown Trek een punt af indien pylpunte nie gewys word nie	

- 2.4 200 N ✓ (to the left/links) (1)
- 2.5 **POSITIVE MARKING FROM QUESTION 2.4**
POSITIEWE NASIEN VANAF VRAAG 2.4

$$F_{RY} = \frac{200}{\tan 35^\circ} \checkmark = 285,63 \text{ N}$$

$$F_g = mg = 56(9,8) \checkmark = 548,8 \text{ N}$$

$$\begin{aligned} F_{RY} + F_{CY} &= F_g \\ 285,63 + F_{CY} &= 548,8 \end{aligned} \quad \checkmark \text{ any one/enige een}$$

$$F_{CY} = 263,17 \text{ N} \checkmark \text{ (upwards/opwaarts)}$$

Mark allocation: Puntetoekenning

- Calculating/Bereken F_{RY} ✓
 Calculating weight/Bereken gewig ✓
 Vector sum/vektorsom ✓
 Answer/Antwoord ✓

(4)

2.6 **POSITIVE MARKING FROM QUESTION 2.4 and 2.5**
POSITIEWE NASIEN VANAF VRAAG 2.4 en 2.5

$$\tan \theta = \frac{263,17}{200} \checkmark$$

$$\theta = 52,77^\circ \checkmark$$

(2)
[13]

QUESTION/VRAAG 3

3.1	Criteria for hypothesis/Riglyne vir hipotese State the relationship between the correct dependent and independent variables. Stel die verwantskap tussen die korrekte afhanklike en onafhanklike veranderlike. The controlled variable is stated as part of the hypothesis Die gekontroleerde veranderlike word genoem as deel van die hipotese Dependent variable/afhanklike veranderlike: acceleration/versnelling Independent variable/onafhanklike veranderlike: (net) force/(netto) krag
-----	---

Example/Voorbeeld:

The acceleration is directly proportional to (net) force ✓ if the mass of the trolley is kept constant ✓

Die versnelling is direk eweredig aan die (netto) krag ✓ indien die massa van die trollie konstant bly ✓

(2)

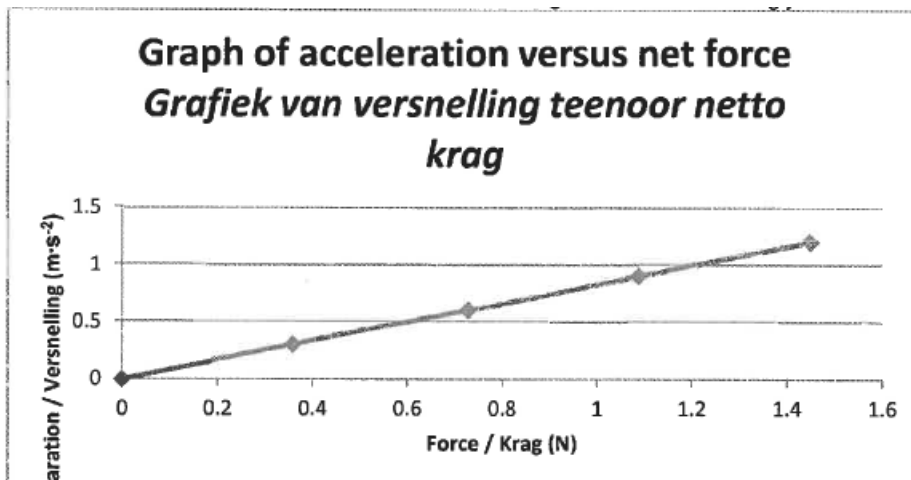
3.2.1 (Net) Force ✓
 (Netto) Krag ✓

(1)

3.2.2 Mass of trolley ✓
 Massa van die trollie ✓

(1)

3.3



Refer to back of memo for graph drawn to scale

Verwys na die laaste bladsy van memorandum vir skaalgrafiek

Marking criteria for graph Nasienkriteria vir grafiek	
Axes with correct/appropriate scale Asse met korrekte/toepaslike skaal	✓
3 or more coordinates correctly plotted 3 of meer koördinate korrek gestip If 2 coordinates correctly plotted - one mark Indien 2 koördinate korrek gestip – een punt	✓✓
Drawing a line of best fit through the origin Teken 'n lyn van beste passing deur die oorsprong	✓

(4)

3.4

Accept any set of coordinates from the graph, for example:

Aanvaar enige kombinasie van koördinate vanaf die grafiek, byvoorbeeld:

$$\text{gradient} = \frac{1,45 - 0,36}{1,2 - 0,3} \checkmark = 1,21 \checkmark$$

OR/OF

$$\text{gradient} = \frac{1,09 - 0}{0,9 - 0} \checkmark = 1,21 \checkmark$$

OR/OF

$$\text{gradient} = \frac{0,73 - 0}{0,6 - 0} \checkmark = 1,22 \checkmark$$

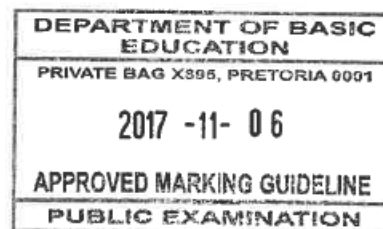
OR/OF

$$\text{gradient} = \frac{0,36 - 0}{0,3 - 0} \checkmark = 1,2 \checkmark$$

If the origin is used and zeros are not shown, max $\frac{2}{3}$

Indien die oorsprong gebruik word en nulwaardes word nie getoon, maks $\frac{2}{3}$

(3)



3.5

POSITIVE MARKING FROM QUESTION 3.4

POSITIEWE NASIEN VANAF VRAAG 3.4

$$\text{Gradient} = \frac{a}{F} = \frac{1}{m}$$

$$m = \frac{1}{1,21} \checkmark = 0,83 \text{ kg} \checkmark$$

(2)

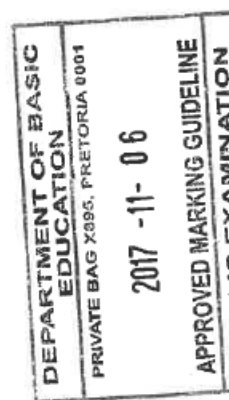
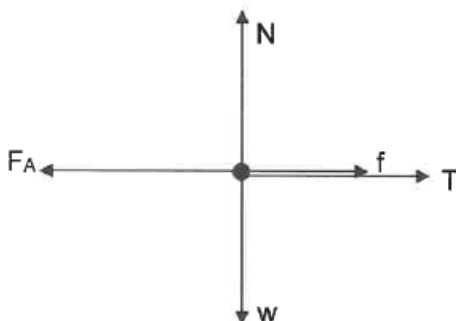
[13]

QUESTION/VRAAG 4

- 4.1 Frictional force is the force that opposes the motion of an object and which acts parallel to the surface. ✓✓
Wrywingskrag is die krag wat die beweging van 'n voorwerp teenstaan en ewewydig aan die oppervlak inwerk. ✓✓ (2)

- 4.2 (⊖) Newton's Third law: ✓
 When object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object A. ✓✓
 (⊖) *Newton se Derde wet: ✓*
 Wanneer voorwerp A 'n krag op voorwerp B uitoefen sal voorwerp B gelyktydig 'n krag van gelyke grootte in die teenoorgestelde rigting op voorwerp A uitoefen. ✓✓ (3)

4.3



Notes: Accepted Labels/Aanvaarbare Byskrifte		Mark/Punt
w	weight/gravitational force/ $F_G/F_g/12\ 740\ \text{N}$ <i>gewig/gravitasiekrag/swaartekrag/$F_G/F_g/12\ 740\ \text{N}$</i>	✓
T	Tension force / F_T <i>Spanningskrag/F_T</i>	✓
f	friction/ F_f <i>Wrywing/F_f</i>	✓
N	Normal/ $F_N/12\ 740\ \text{N}$ <i>Normaal/$F_N/12\ 740\ \text{N}$</i>	✓
F_A	Applied force/ $F_{\text{applied}}/F_{\text{engine}}/F$ <i>Toegepaste krag/$F_{\text{toegepas}}/F_{\text{engin}}/F$</i>	✓
	Any additional force: deduct 1 mark (maximum $\frac{4}{5}$) <i>Enige addisionele krag: trek 1 punt af (maksimum $\frac{4}{5}$)</i>	
	Lines must touch object otherwise (maximum $\frac{4}{5}$) <i>Lyne moet voorwerp raak anders (maksimum $\frac{4}{5}$)</i>	
	Subtract one mark if arrows are not shown <i>Trek een punt af indien pylpunte nie gewys word nie</i>	

- 4.4 4.4.1 $F_{\text{net}} = ma$ } ✓
 $F_{\text{engine}} - f - T = 0$
 $9\ 000 - 0,45(F_g) - T = 0$
 $9\ 000 \checkmark - 0,45(1\ 300)(9,8) \checkmark - T = 0 \checkmark$
 $T = 3\ 267\ \text{N} \checkmark$ (5)

4.4.2 **POSITIVE MARKING FROM QUESTION 4.4.1**
POSITIEWE NASIEN VANAF VRAAG 4.4.1

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ T - f_k = 0 \end{array} \right\} \checkmark \text{ Any one / enige een}$$

$$\begin{array}{l} 3\,267 - f_k = 0 \checkmark \\ f_k = 3\,267 \text{ N (backwards/terugwaarts)} \\ f_k = \mu_k N \checkmark \\ f_k = \mu_k mg \\ 3\,267 = \mu_k (950)(9,8) \checkmark \\ \mu_k = 0,35 \checkmark \end{array}$$

OR

$$\begin{array}{l} f_k = \mu_k N \checkmark \\ f_k = \mu_k mg \\ 3\,267 \checkmark = \mu_k (950)(9,8) \checkmark \\ \mu_k = 0,35 \checkmark \end{array}$$

(5)

4.5 Newton's second law $\checkmark$ the object experiences a net force slowing it down to stop $\checkmark\checkmark$

OR

Newton's first law, $\checkmark$ an object will continue moving at a constant velocity unless a non-zero net force acts on it. $\checkmark\checkmark$

Newton se tweede wet $\checkmark$ die voorwerp ervaar 'n netto krag wat dit laat stadiger beweeg totdat dit stop. $\checkmark\checkmark$

OF

Newton se eerste wet, $\checkmark$ sal 'n voorwerp aanhou beweeg teen 'n konstante snelheid tensy 'n nie-nul netto krag daarop inwerk. $\checkmark\checkmark$

(3)

4.6 **POSITIVE MARKING FROM QUESTION 4.4.1**
POSITIEWE NASIEN VANAF VRAAG 4.4.1

$$\begin{array}{l} F_{\text{net}} = ma \\ -3\,267 = 950a \checkmark \\ a = -3,44 \text{ m}\cdot\text{s}^{-2} \\ = 3,44 \text{ m}\cdot\text{s}^{-2} \checkmark \text{ backwards/to the right / terugwaarts/regs } \checkmark \end{array}$$

(3)
[26]

QUESTION/VRAAG 5

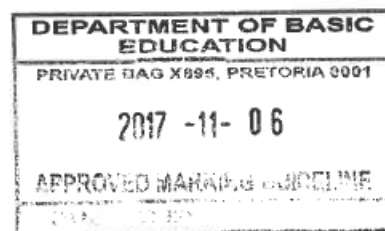
5.1 Weight is the gravitational force exerted on an object by the earth. $\checkmark$
Gewig is die gravitasiekrag wat die Aarde op 'n voorwerp uitoefen. $\checkmark$
Mass is the amount of matter in a body. $\checkmark$
Massa is die hoeveelheid materie in 'n liggaam. $\checkmark$

(2)

5.2 $g = \frac{GM}{r^2} \checkmark$

$$2,7 = \frac{6,67 \times 10^{-11} M}{\left(\frac{1}{3} \times 6,38 \times 10^6\right)^2} \checkmark$$

$$M = 1,83 \times 10^{23} \text{ kg } \checkmark$$



(4)

5.3 $\frac{9,8}{2,7} = 3,63 \text{ times smaller } \checkmark\checkmark \text{ on planet X than on Earth}$
3,63 keer kleiner op planeet X as op die Aarde

(2)
[8]