LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

MOGALAKWENA DISTRICT

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES
TERM 1 TOPIC TEST 2026
NEWTON'S LAWS

MARKS: 50

DURATION: 1.5 HOURS

INSTRUCTIONS AND INFORMATION

1. Answer all the questions in each section.

2. Non-programmable calculators may be used.

3. Number the answers correctly according to the numbering system used in the question paper.

4. Appropriate mathematical instruments may be used.

5. Give motivations and discussions where required.

6. Round off your FINAL numerical answer to **ONLY TWO** decimal place.

7. Show the formulae and substitutions in ALL calculations.

This question paper consists of 7 pages including this cover sheet.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 A constant net force is applied to a block. Which ONE of the following statements is CORRECT?

The block will move with a …

A   constant velocity.

B   Constant acceleration.

C   Constantly increasing acceleration.

D   Constantly decreasing acceleration. (2)

1.2 A crate of mass m is stationary on a plane inclined at an angle θ with the horizontal.
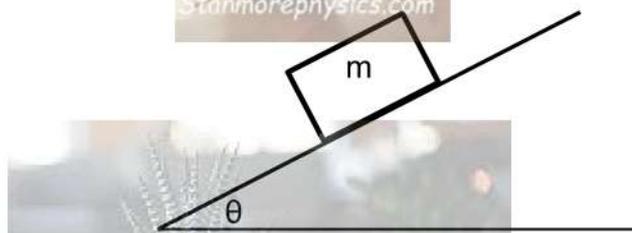
Which ONE of the following statements regarding the magnitude of the frictional force acting on the crate is CORRECT?

The magnitude of the frictional force acting on the crate is …

A   equal to the component of the weight of the crate which is parallel to the plane.

B   Larger than the component of the weight of the crate which is parallel to the plane.

C   Equal to the component of the weight of the crate which is perpendicular to the plane.

D   Larger than the component of the weight of the crate which is perpendicular to the plane. (2)

**[4]**

2

QUESTION 2 (Start on a new page.)

In an experiment, a crate of mass 8,5 kg, lying stationary on a rough horizontal table, is connected to a mass hanger by means of a light inextensible string passing over a frictionless pulley, as shown in the diagram below. Mass pieces are added to the mass hanger and the acceleration of the crate is measured. The experiment is repeated several times by adding different masses to increase the hanging mass each time.

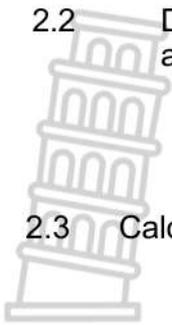Ignore the effects of air friction.
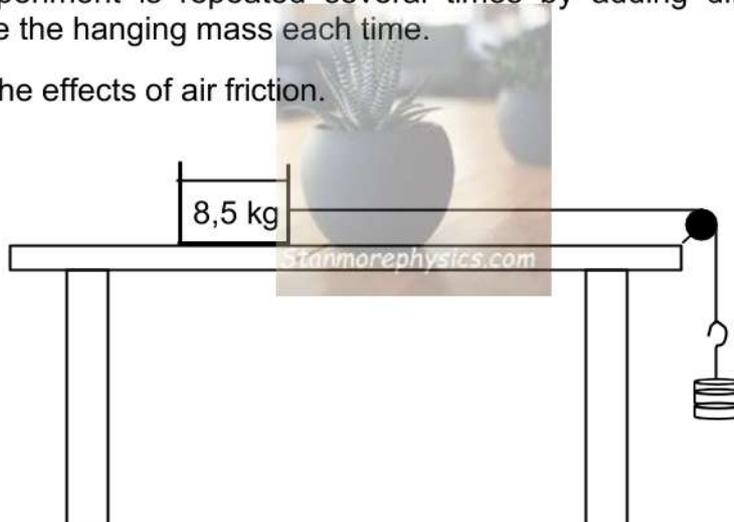
Mass hanger with massless pieced
The results obtained were used to draw the sketch graph below.
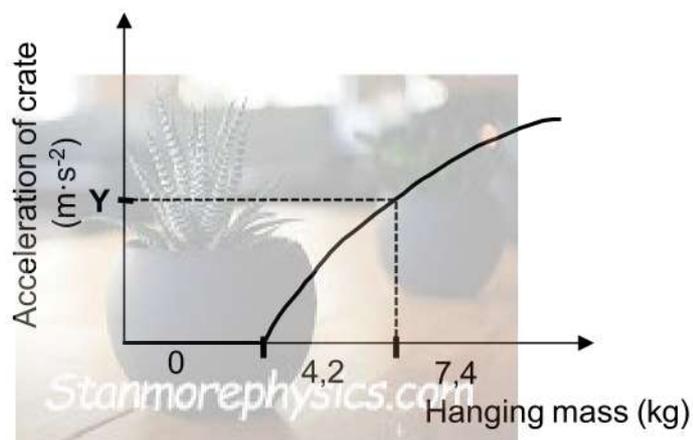
2.1   Define the term *static friction*.   (2)

2.2 Draw a labelled free-body diagram showing ALL the HORIZONTAL forces acting on the crate JUST BEFORE it starts moving. (2)

2.3 Calculate the:

2.3.1 Coefficient of static friction (μs) (4)

2.3.2 Magnitude of the acceleration represented by **Y** on the graph if the coefficient of kinetic friction between the crate and the table is 0,40 (5)

2.4 A 5 kg block is now placed inside the crate and the experiment is repeated. How will this affect the maximum static frictional force now experienced by the crate? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)
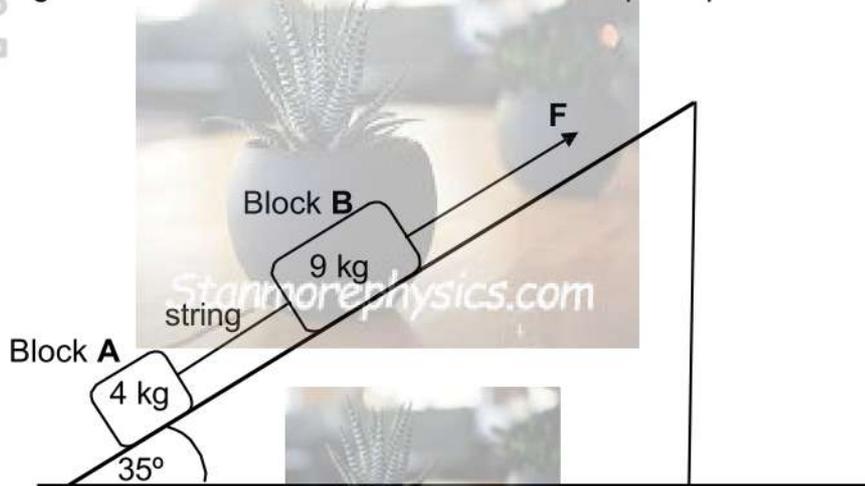
[15]
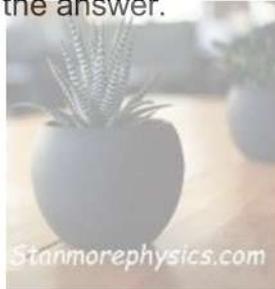
QUESTION 3 (start on a new page)

wo blocks, **A**, of mass 4 kg, and **B**, of mass 9 kg, are connected by a light inextensible string. The blocks are held at rest on a plane which is inclined at an angle of 35º with the horizontal.

A constant force, **F**, acting parallel to the plane, is applied to block **B**, as shown in the diagram below. The blocks now accelerate up the plane at 2 m·s^{-2}.

3.1   State Newton's Second Law of Motion in words.   (2)

The kinetic frictional forces acting on blocks **A** and **B** are 5,88 N and 13,23 N respectively.

3.2   Draw a labelled free-body diagram showing all the forces acting on block **A**.   (4)

3.3   Calculate the magnitude of:

      3.3.1   The tension in the string   (4)

      3.3.2   Force **F**   (3)

3.4   The angle that the plane makes with the horizontal is now decreased.

   3.4.1   How will this change the kinetic frictional force acting on block **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME.   (1)

      3.4.2   Explain the answer to QUESTION 2.4.1.   (2)

[16]

QUESTION 4 (Start on a new page.)

Block **A** of mass **m** is connected to block **B** of mass 7,5 kg by a light inextensible rope passing over a frictionless pulley. Block **B** is initially held at a height of 1,5 m above the ground, while block **A** is initially stationary on the ground, as shown in the diagram below.
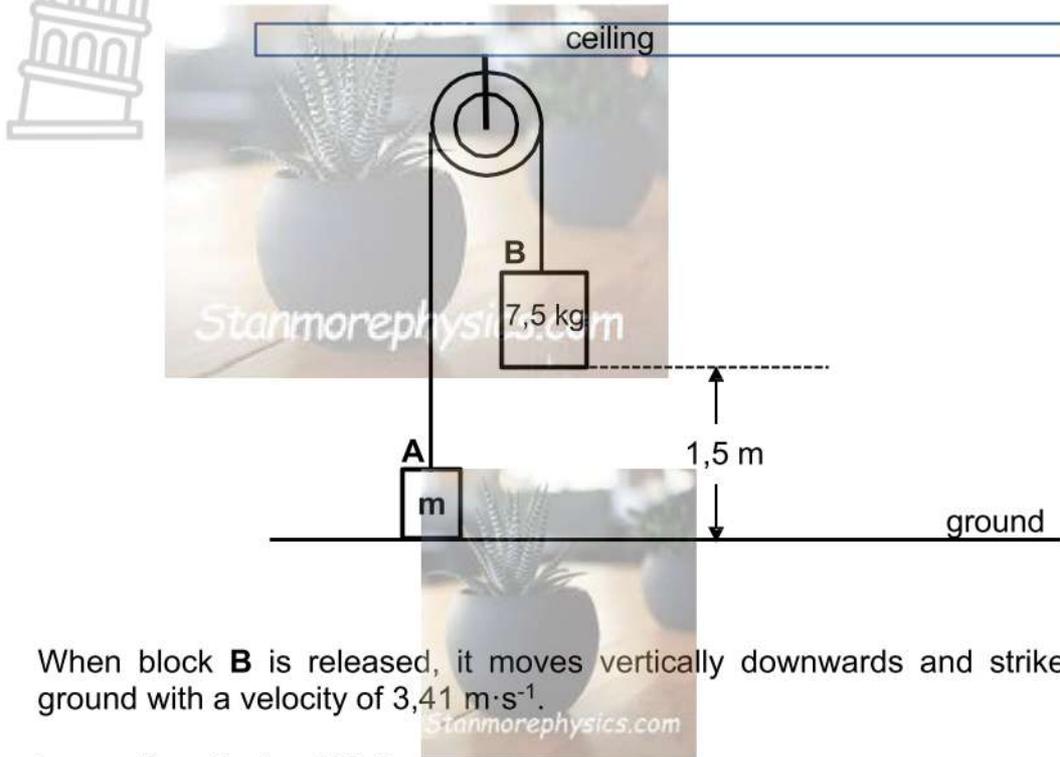
When block **B** is released, it moves vertically downwards and strikes the ground with a velocity of 3,41 m·s⁻¹.

Ignore the effects of friction.

4.1   Show, by means of a calculation, that the magnitude of the acceleration of block **B** was 3,88 m·s⁻² while the block was moving vertically downwards.   (3)

4.2   Draw a labelled free-body diagram showing ALL the forces acting on block **B** immediately after it was released.   (2)

4.3   Calculate the value of **m** by applying Newton's Second Law to EACH BLOCK while they are in motion.   (5)

4.4   Calculate the maximum height above the ground reached by block **A**.   (5)

[15]

DATA FOR PHYSICAL SCIENCES
GRADE 12 PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8 \text{ m·s}^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11} \text{ N·m}^2\text{·kg}^{-2}$
Radius of the Earth	R_E	$6{,}38 \times 10^6 \text{ m}$
Mass of the Earth	M_E	$5{,}98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum	c	$3{,}0 \times 10^8 \text{ m·s}^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34} \text{ J·s}$
Coulomb's constant	k	$9{,}0 \times 10^9 \text{ N·m}^2\text{·C}^{-2}$
Charge on electron	e	$-1{,}6 \times 10^{-19} \text{ C}$
Electron mass	m_e	$9{,}11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 \text{ or/of } \Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x \text{ or/of } v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t \text{ or/of } \Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\dfrac{m_1 m_2}{d^2} \quad \text{or/of} \quad F = G\dfrac{m_1 m_2}{r^2}$	$g = G\dfrac{M}{d^2} \quad \text{or/of} \quad g = G\dfrac{M}{r^2}$
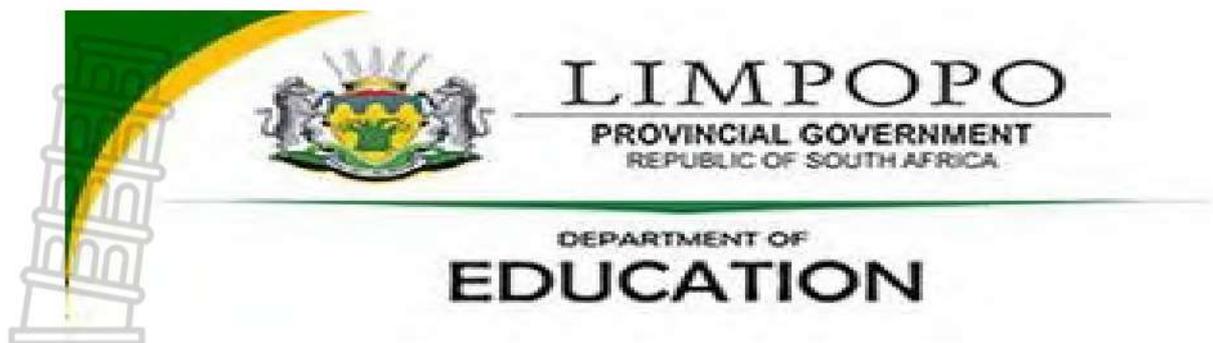
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GRADE 12

PHYSICAL SCIENCES TERM 1
TOPIC TEST 2026
NEWTON'S LAWS
MARKING GUIDELINE

MARKS: 50   **DURATION: 1.5 HOURS**

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1   B ✓✓   (2)

1.2   A ✓✓   (2)
                                                                                                              [4]

QUESTION 2 (Start on a new page.)

2.1

| **Marking criteria** |
| If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./ |

The <u>force that opposes the tendency of motion of a stationary object relative/parallel to a surface</u> ✓✓.

(2)

2.2

Accept

	Accepted labels
f_s	static friction/ f / F_f /F_w
T	F_T/F_{string}/tension

Notes
- Do not penalize if vertical forces (w, N) are shown
- Mark is awarded for label <u>and</u> arrow.
- Do not penalize for length of arrows
- If arrows do not touch the dot: Max $^1/_2$
- Any other additional force(s) except w and N: *Max* $^1/_2$
- If everything correct, but no arrows: Max/*Maks* $^1/_2$

(2)

2.3.1

OPTION 1	**OPTION 2**
For hanging m: $F_{net} = ma$ $mg - T = 0$ or $T - mg = 0$ $T = mg$ $T = 4,2(9,8)$ ✓ $= 41,16$ N **For crate:** $F_{net} = ma$ $T - f_s^{max} = ma$ $T - \mu_s mg = ma$ $T - f_s^{max} = 0$ $f_s^{max} = T$ $\mu_s N = T$ $f_s^{max} = \mu_s N$ ⎱ ✓Any one / $\mu_s(8,5)(9,8)$ ✓ $= 41,16$ $\mu_s = 0,49$ ✓	$f_s^{max} = T = w_{hanging}$ $f_s^{max} = m_{hanging}g$ $\mu_s N = m_{hanging}g$ ⎱ ✓Any one $\mu_s m_{crate}.g = m_{hanging}g$ $f_s^{max} = \mu_s N$ $\mu_s(8,5)(9,8)$ ✓ $= 4,2(9,8)$ ✓ **OR** $\mu_s(8,5) = 4,2$ $\mu_s = 0,49$ ✓

(4)

5
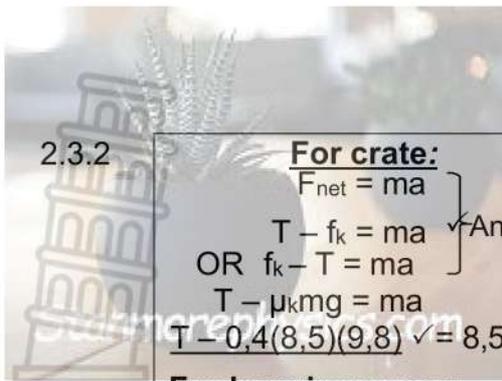
2.3.2

For crate:
$F_{net} = ma$
$T - f_k = ma$ ✓Any one
OR $f_k - T = ma$
$T - \mu_k mg = ma$
$T - 0,4(8,5)(9,8)$ ✓ $= 8,5a$ .... Eqn (1)

For hanging mass:
$F_{net} = ma$
$mg - T = ma$
$7,4(9,8) - T$ ✓ $= 7,4a$ ....Eqn (2)

✓Any one

$Y = a = 2,47 \ (m \cdot s^{-2})$ ✓

NOTE: T can be calculated first (54,32 N)

(5)

2.4   INCREASES ✓ $f_s^{max} \ \alpha \ N$ **OR** $f_s^{max} \ \alpha \ m$ **OR** $f_s^{max} = \mu_s N$ **OR** the normal force acting on the crate increases **OR** increase in mass/weight of crate (increases the normal force) ✓

(2)
[15]

QUESTION 3 (start on a new page)
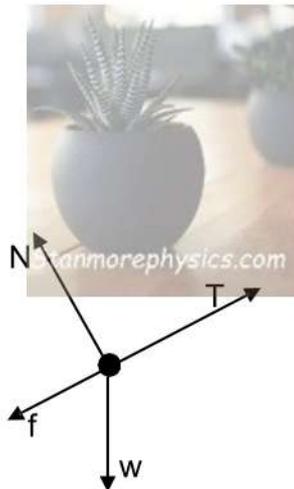
3.1

> **Marking criteria**
> If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark

When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The <u>acceleration is directly proportional to the resultant/net force</u> and <u>inversely proportional to the mass of the object</u>. $\checkmark\checkmark$.
OR
The <u>resultant/net force</u> acting on an object is <u>equal to the rate of change of momentum of the object in the direction of the resultant/net force</u>. (2 or 0)

(2)

3.2

		Accepted labels
	N	F_N/Normal/F_{normal}/F_{normal}
	f	(kinetic) friction/5,88 N /F_f/f_k /F_w
	w	F_g/F_w/weight/mg/39,2 N/gravitational force
		F_g/F_w/mg/39,2 N
	T	F_T/F_{string}/tension/*spanning*

Notes
- Mark is awarded for label <u>and</u> arrow.
- Do not penalise for length of arrows.
- If w is not shown but $w_∥$ and $w_⊥$ are shown, give 1 mark for both.
- If arrows do not touch the dot: Max/*Maks* $\frac{3}{4}$
- Any other additional force(s)*): Max/Maks* $\frac{3}{4}$
- If everything correct, but no arrows:
  Max/*Maks* $\frac{3}{4}$

(4)

4

3.3.1

For block A:
UP THE INCLINE AS POSITIVE/

$$F_{net} = ma$$
$$T - f_k - w_{\parallel} = ma$$ ✓Any one
$$T - f_k - mgsin\theta = ma$$
$$\underline{T - 5,88 - 4(9,8)sin35°} ✓ = \underline{4(2)} ✓$$
$$T = 36,36 \text{ N} ✓$$

DOWN THE INCLINE AS POSITIVE/

$$F_{net} = ma$$
$$-T + f_k + w_{\parallel} = ma$$ ✓Any one
$$-T + f_k + mgsin\theta = ma$$
$$\underline{-T + 5,88 + 4(9,8)sin35°} ✓ = \underline{4(-2)} ✓$$
$$T = 36,36 \text{ N} ✓$$

(4)

3.3.2 **POSITIVE MARKING FROM QUESTION 2.3.1**

NOTE: If systems approach is used, learner gets mark for the answer only.

For block B:
UP THE INCLINE AS POSITIVE/

$$F_{net} = ma \quad F$$
$$-T - f_k - w_{\parallel} = ma$$
$$F - T - f_k - mgsin\theta = ma$$
$$\underline{F - 36,36 - 13,23 - 9(9,8)sin35°} ✓ = \underline{(9)(2)} ✓$$
$$F = 118,18 \text{ N} ✓$$

DOWN THE INCLINE AS POSITIVE/

$$F_{net} = ma$$
$$-F + T + f_k + w_{\parallel} = ma$$
$$-F + T + f_k + mgsin\theta = ma$$
$$\underline{-F + 36,36 + 13,23 + 9(9,8)sin35°} ✓ = \underline{(9)(-2)} ✓$$
$$F = 118,18 \text{ N} ✓$$

(3)

3.4.1   INCREASES ✓   (1)

3.4.2
- Since   and m are constant, as   decreases, <u>normal force/$w_{\perp}$/mgcos   will increase.</u> ✓

    OR
    $N = mgcos$

- Frictional force is directly proportional to normal force/ ✓

(2)
[16]

QUESTION 4 (Start on a new page.)

4.1

Marking criteria
- Formula to calculate a. ✓
- Correct substitution to calculate a. ✓✓

OPTION 1: DOWNWARDS AS POSITIVE	**UPWARDS AS POSITIVE**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(3,41)^2$ ✓ $= (0)^2 + (2)a(1,5)$ ✓ $a = 3,88 \text{ m·s}^{-2}$	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-3,41)^2$ ✓ $= (0)^2 + (2)a(-1,5)$ ✓ $a = -3,88$ $a = 3,88 \text{ m·s}^{-2}$

OPTION 2 DOWNWARDS AS POSITIVE

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

$$1,5 = \left(\frac{0 \quad 3,41}{2}\right)\Delta t$$

$\Delta t = 0,88 \text{ s}$

$v_f = v_i + a\Delta t$ ✓
$-3,41$ ✓ $= (0) + a(0,88)$ ✓
$a = -3,88$
$a = 3,88 \text{ m·s}^{-2}$

OR/OF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-1,5$ ✓ $= (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓
$a = -3,88$
$a = 3,88 \text{ m·s}^{-2}$

UPWARDS AS POSITIVE

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

$$-1,5 = \left(\frac{0 \quad 3,41}{2}\right)\Delta t$$

$\Delta t = 0,88 \text{ s}$

$v_f = v_i + a\Delta t$ ✓
$3,41$ ✓ $= (0) + a(0,88)$ ✓
$a = 3,88 \text{ m·s}^{-2}$

OR/OF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$1,5$ ✓ $= (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓
$a = 3,88 \text{ m·s}^{-2}$

(3)

4.2

ACCEPT

	Accepted symbols
w ✓	F_g/F_w/weight/mg/gravitational force/$F_{Earth\ on\ block}$/ /73,5N
T ✓	Tension/$F_{Tension}$/F_{rope}//F_T/F

Notes:
- Mark awarded for label <u>and</u> arrow.
- Do not penalise for length of arrows since drawing is not to scale.
- Any other additional force(s):   *Max* $\frac{1}{2}$

(2)

4.3

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an <u>acceleration that is directly proportional to the</u> <u>force</u> and <u>inversely proportional to the mass of the object</u>. ✓✓
.

OR
The resultant/net force acting on an object is <u>equal to the rate of change of</u> <u>momentum of the object</u> in the direction of the resultant/net force.

(2)

4.4

Marking criteria
- Any correct formula. ✓
- Correct substitution to calculate tension ✓✓
- Correct substitution to calculate mass of block A. ✓
- Correct final answer: 3,25 kg ✓

Calculation of tension (Block B) 3 marks:	Calculation of mass (Block A) 2 marks:

DOWNWARDS POSITITIVE

$$F_{net} = ma$$
$$+ T = ma$$ ✓Any one/ F_g
$$T = ma$$ *Enige een* mg –
$$7,5(9,8) – T\, ✓= 7,5(3,88)\, ✓$$
$$T = 44,40\ N$$

UPWARDS POSITIVE

$$F_{net} = ma$$
$$T – F_g = ma$$ ✓Any one/
$$T – mg = ma$$ *Enige een*
$$T – 7,5(9,8)\, ✓= 7,5(-3,88)\, ✓$$
$$T = 44,40\ N$$

UPWARDS POSITIVE

$$F_{net} = ma$$
$$T – F_g = ma$$
$$T – mg = ma$$
$$44,40 – m(9,8) = m(3,88)\,✓$$
$$m = 3,25\ kg\,✓$$

DOWN POSITIVE

$$F_{net} = ma$$
$$mg – T = ma$$
$$m(9,8) - 44,40 = m(-3,88)\,✓$$
$$m = 3,25\ kg\ ✓$$

(5)

4.5	**Marking criteria** • Any correct formula. ✓ • Correct substitution of v_i and v_f. ✓ • Correct substitution of 9,8 m·s⁻². ✓ • Adding 1,5 m to calculated Δy. ✓ • Correct final answer: 2,09 m ✓
	OPTION 1 **UPWARDS AS POSITIVE** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(0^2) = (3,41)^2$ ✓ $+ (2)(-9,8)\Delta y$ ✓ $\Delta y = 0,59$ m Maximum height = 0,59 + 1,5 ✓ $\qquad\qquad\qquad = 2,09$ m ✓ **DOWNWARDS AS POSITIVE** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(0^2) = (-3,41)^2$ ✓ $+ (2)(9,8)\Delta y$ ✓ $\Delta y = -0,59$ $\Delta y = 0,59$ m Maximum height = 0,59 + 1,5 ✓ $\qquad\qquad\qquad = 2,09$ m ✓
	OPTION 2 **UPWARDS AS POSITIVE** $v_f = v_i + a\Delta t$ $0 = 3,41 + (-9,8)\Delta t$ $\Delta t = 0,35$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\qquad = (3,41)(0,35)$ ✓ $+ \frac{1}{2}(-9,8)(0,35)^2$ ✓ $\qquad = 0,59$ m Maximum height = 0,59 + 1,5 ✓ $\qquad\qquad\qquad = 2,09$ m ✓ **DOWNWARDS AS POSITIVE** $v_f = v_i + a\Delta t$ $0 = -3,41 + (9,8)\Delta t$ $\Delta t = 0,35$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\qquad = (-3,41)(0,35)$ ✓ $+ \frac{1}{2}(9,8)(0,35)^2$ ✓ $\qquad = -0,59$ $\Delta y = 0,59$ m Maximum height = 0,59 + 1,5 ✓ $\qquad\qquad\qquad = 2,09$ m ✓

OPTION 3: UPWARDS AS

$v_f = v_i + a\Delta t$

$0 = 3,41 + (-9,8)\Delta t$

$\Delta t = 0,35$ s

$\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\dfrac{3,41 + 0}{2}\right)$ ✓ $(0,35)$ ✓

$\quad = 0,59$ m

Maximum height $= 0,59 \underline{+ 1,5}$ ✓
$\quad\quad\quad\quad\quad\quad = 2,09$ m ✓

DOWNWARDS AS POSITIVE

$v_f = v_i + a\Delta t$

$0 = -3,41 + (9,8)\Delta t$

$\Delta t = 0,35$ s

$\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\dfrac{-3,41 + 0}{2}\right)$ ✓ $(0,35)$ ✓

$\quad = -0,59$ m

Maximum height $= 0,59 \underline{+ 1,5}$ ✓
$\quad\quad\quad\quad\quad\quad = 2,09$ m ✓

Note:
OPTION 4 TO 5
Substitution of incorrect mass:
max: $^3/_5$

OPTION 4

$(E_{mech})_{top} = (E_{mech})_{bottom}$

$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ ⎫
$(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$ ⎬ ✓Any one

$\underline{(9,8)(h) + (0)}$ ✓ $= \underline{(0) + \frac{1}{2}(3,41)^2}$ ✓
$\quad\quad\quad h = 0,59$ m

Maximum height $= 0,59 \underline{+ 1,5}$ ✓
$\quad\quad\quad\quad\quad\quad = 2,09$ m ✓

OPTION 5

$W_{nc} = \Delta K + \Delta U$ ⎫

$W_{nc} = \Delta K + mg(h_f - h_i)$ ⎬ ✓Any one

$\quad 0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ ⎭

$\quad (0) = \underline{(0) - \frac{1}{2}(3,41)^2}$ ✓ $+ \underline{(9,8)(h)}$ ✓
$\quad\quad h = 0,59$ m

Maximum height $= 0,59 \underline{+ 1,5}$ ✓
$\quad\quad\quad\quad\quad\quad = 2,09$ m ✓

OPTION 6

$W_{net} = \Delta E_k$ ⎫

$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎬ ✓Any one

$\underline{(9,8)(\Delta y)\cos 180°}$ ✓ $= \underline{0 - \frac{1}{2}(3,41)^2}$ ✓
$\quad\quad\quad \Delta y = 0,59$ m

Maximum height $= 0,59 \underline{+ 1,5}$ ✓
$\quad\quad\quad\quad\quad\quad = 2,09$ m ✓

(5)

[17]

*******************************LEAVING NO CHILD BEHIND***