education

Department:
Education
PROVINCE OF KWAZULU-NATAL

**GRADE 12**

# NATIONAL SENIOR CERTIFICATE

## PHYSICAL SCIENCES P1 (PHYSICS)

## COMMON TEST

## MARCH 2020

**MARKS : 50**

**TIME : 1 hour**

**This question paper consists of 6 pages and 1 data sheet.**

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## INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.

2. This question paper consists of FOUR questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

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

5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEET.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your final numerical answers to a minimum of TWO decimal places.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.4) in the ANSWER BOOK, for example 1.5 C.

1.1 If the net force acting on a object is ZERO, the object will …

A experience a constant increase in velocity.
B accelerate in the direction of the largest force.
C move at constant velocity or remain at rest.
D experience a constant decrease in velocity. (2)

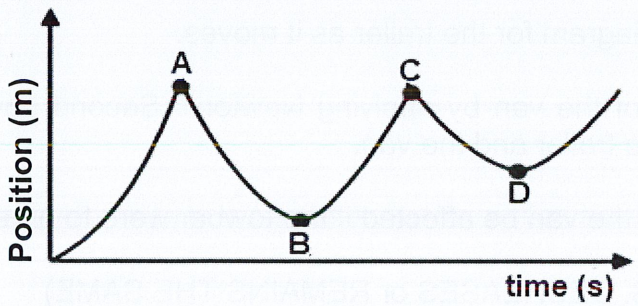
1.2 If the radius of the Earth were to shrink (become smaller) and its mass were to remain the same, the acceleration due to gravity on the surface of the Earth would …

A. increase
B. decrease
C. remain the same
D. be reduced to zero (2)

1.3 A car of mass **M**, traveling at a speed **v**, stops in a time **t** when a maximum braking force is applied. If the same braking force is now applied to stop a car of mass **2M** traveling at speed **v**, the time taken to achieve this will be…

A ½ **t**
B **t**
C √2 **t**
D 2 **t** (2)

1.4 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. The position-time graph below represents the motion of the bouncing ball from the instant it is released.




Neglecting air resistance, which point (**A**, **B**, **C** or **D**) on the graph represents the position-time coordinates for the moment the ball hits the ground for the **SECOND** time?

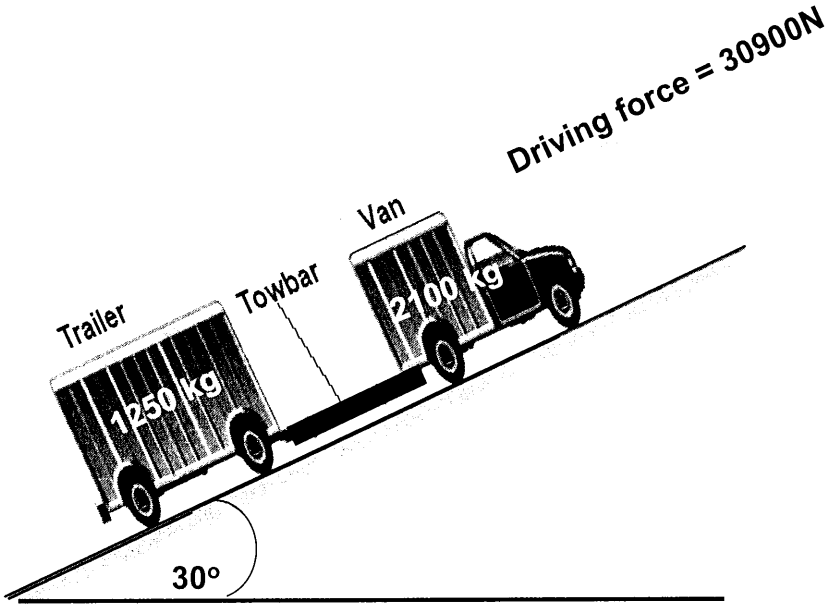
A **A**
B **B**
C **C**
D **D**

(2)
2 x 4 =**[8]**

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## QUESTION 2

The diagram below, not drawn to scale shows a van, mass **2100 kg**, pulling a trailer of mass **1250 kg** up a tar road that is inclined at 30° to the horizontal. The van a driving force of **30900 N**.




The coefficient of kinetic friction for the road and the vehicles is **0,3**.

2.1 State Newton's Second Law in words. (2)

In answering the following questions, ignore the rotational motion of the wheels of the van and trailer and the mass of the towbar.

2.2 Draw a labelled free body diagram for the trailer as it moves. (4)

2.3 Calculate the acceleration of the van by applying Newton's Second Law of Motion SEPARATELY to the trailer and the van. (6)

2.4 How will the acceleration of the van be affected if the towbar were to break?

(Choose from: INCREASES, DECREASES or REMAINS THE SAME)

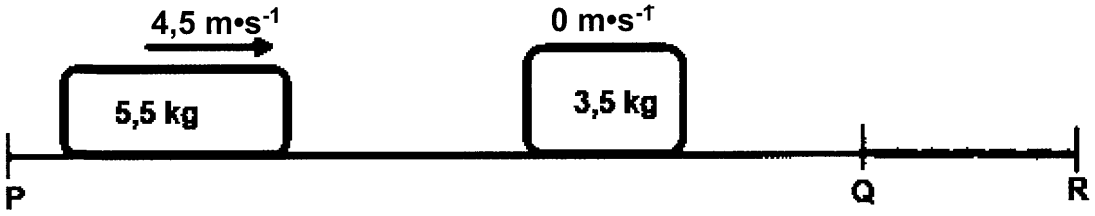
Give a reason. (2)

**[14]**

## QUESTION 3

The diagram below shows two sections, PQ and QR, of a horizontal, flat surface. Section PQ is SMOOTH, while section QR is ROUGH.

A 5,5 kg block, moving with a velocity of 4,5 $m \cdot s^{-1}$ to the right, collides head-on with a stationary 3,5 kg block. After the collision the two blocks stick together and move to the right past point Q. The combined blocks travel for 0,6 s from point Q before coming to a stop at point R.




3.1 State the Law of conservation of momentum in words (2)

3.2 Calculate the magnitude of the velocity of the combined blocks at point Q. (4)

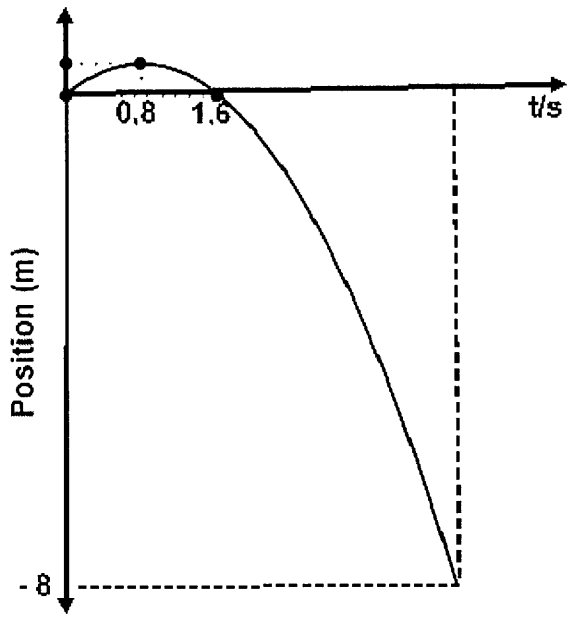
3.3 Use a calculation to prove that the collision between the two blocks is inelastic (4)

3.4 Calculate the magnitude of the net force acting on the combined blocks when they move through section QR. (4)

**[14]**

## QUESTION 4

A tennis ball is thrown vertically upwards from a window that is 8m above the ground. The ball takes 0,8 s to reach its maximum height, after which it lands on the ground below.
The graph below, not drawn to scale, represents the motion of the ball.
Ignore air resistance




4.1 Calculate:

4.1.1 The initial velocity of the ball. (3)

4.1.2 The maximum height above the ground that the ball reaches (4)

4.1.3 The time for the entire motion of the ball. (3)

4.2 Sketch a velocity - time graph for the entire motion of the ball. In the sketch indicate the following:

- Initial velocity of the ball
- Time to reach maximum height
- Time for the entire motion of the ball (4)

**[14]**

**TOTAL: 50**

# DATA FOR PHYSICAL SCIENCES (PHYSICS) GRADE 12

## *GEGEWENS VIR FISIESE WETENSKAPPE (FISIKA) GRAAD 12*

### TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

| NAME/*NAAM* | SYMBOL/*SIMBOOL* | VALUE/*WAARDE* |
|---|---|---|
| Acceleration due to gravity<br>*Swaartekragversnelling* | g | 9,8 $m \cdot s^{-2}$ |
| Universal gravitational constant | G | 6,67 x $10^{-11}$ $N.m^2.kg^{-2}$ |

### TABLE 2: FORMULAE/*TABEL 2: FORMULES*

### MOTION/*BEWEGING*

| | |
|---|---|
| $v_f = v_i + a\Delta t$ | $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ |
| $v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$ | $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ |
| $K = E_k = \frac{1}{2}mv^2$ | |

### FORCE/*KRAG*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $F_{net}\Delta t = \Delta p = mv_f - mv_i$ | $F_g = mg$ |
| $F = \frac{Gm_1m_2}{r^2}$ | |
| $f_s^{max} = \mu_s N$ | $f_k = \mu_k N$ |

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# PHYSICAL SCIENCES P1

# MARKING GUIDELINE

## MARCH 2020

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MARKS : 50**

**This marking guideline consists of 6 pages.**

Moderator
T.D. NGOBO
13/02/2020

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## SECTION A

## QUESTION 1: MULTIPLE CHOICE

1.1 C ✓✓

1.2 A ✓✓

1.3 D ✓✓

1.4 C ✓✓

2 x 4 = [8]

## SECTION B

## QUESTION 2

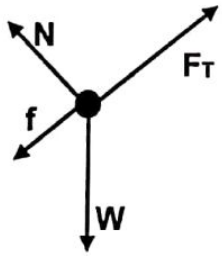
2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓ (2)

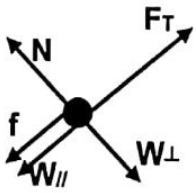
**OR**

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

**NOTE**: -1 mark for each key word/phrase omitted in the correct context

2.2




Accept if candidates drew a box instead of a dot.

| | Accept the following symbols |
|---|---|
| N✓ | $F_N$/Normal/Normal force/10608,91N |
| f✓ | Kinetic friction force/$f_K$/$F_f$/$f_r$ |
| $F_T$✓ | T/$F_{towbar}$ |
| W✓ | $F_g$/12250 N |

**Notes**
- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with body/dot : *Max:3/4*
- If arrows missing but labels are there: *Max:3/4*

T.D.N

(4)



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2.3 **For the Van**

✓ $F_{net} = ma$
$F_d + (-W_{||}) + (-f_k) + (-F_T) = ma$
$F_d - (W_{||} + f_k + F_T) = ma$
$30900$✓ $- (2100)(9,8)\sin 30° - 0,3(2100)(9,8)\cos 30°$✓ $- F_T = 2100a$✓
$30900 - 10290 - 5346,84 - F_T = = 2100a$

$15263,16 - F_T = 2100a$ ..... (1)

**For the Trailer**
$F_T + (-f_k) + (-W_{||}) = ma$
$F_T - (f_k + W_{||}) = ma$
$F_T - 0,3(1250)(9,8)\cos 30° - (1250)(9,8)\sin 30°$✓ $= 1250a$

$F_T - 9307,64 = 1250a$ ..... (2)

$5955,52 = 3350a$
$a = 1,78\ m\cdot s^{-2}$✓ (6)

2.4 Increase✓

If the Towbar breaks, the trailer will be left behind and therefore the net force acting on the van increases ✓ (2)
**[14]**

**QUESTION 3**

3.1 The total linear momentum in an isolated/closed system is constant.✓✓ (2)
**OR**
In an isolated/closed system, total linear momentum before collision is equal to total linear momentum after collision. ✓✓

**NOTE**: -1 mark for each key word/phrase omitted in the correct context

3.2 $\Sigma p_i = \Sigma p_f$ ✓
$m_A v_{Ai} + m_B v_{Bi} = (m_A + m_B) v_f$
$(5,5)(4,5) + (3,5)(0)$ ✓$= (5,5 + 3,5)\ v_f$✓
$v_f = 2,75\ m\cdot s^{-1}$✓ (4)

If zero is missing do not penalise

3.3 $K = \frac{1}{2}mv^2$✓

$\Sigma K_i = \frac{1}{2} m_A v_{Ai}^2 + \frac{1}{2} m_B v_{Bi}^2$
$= \frac{1}{2}(5,5)(4,5)^2 + 0$✓
$= 55,69$ J

$\Sigma K_f = \frac{1}{2}(m_A + \frac{1}{2}m_B) v_B^2$
$= \frac{1}{2}(5,5 + 3,5)(2,75)^2$✓
$= 34,03$ J

T.D.N.

$\Sigma K_i \neq \Sigma K_f$✓ (4)

If zero is missing do not penalise



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3.4 **OPTION 1**

$F_{net} \cdot \Delta t = \Delta p$
$F_{net} \cdot \Delta t = mv_f - mv_i$ ✓
$F_{net}(0,6)$ ✓ $= \underline{(5,5 + 3,5)(0) - (5,5 + 3,5)(2,75)}$ ✓
$F_{net} = -41,25$ N✓

**OPTION 2**

$v_f = v_i + a\Delta t$
$\underline{0 = 2,75 + a(0,6)}$ ✓
$a = -4,58\ m \cdot s^{-2}$

$F_{net} = ma$✓
$= \underline{(5,5 + 3,5)(-4,58333333333)}$ ✓
$= -41,25$ N✓ (4)

**[14]**

**QUESTION 4**

4.1

4.1.1

| **UPWARDS IS POSITIVE** | **UPWARDS IS NEGAITIVE** |
|---|---|
| $v_f = v_i + a\Delta t$✓<br>$\underline{0 = v_i + (-9,8)(0,8)}$ ✓<br>$v_i = 7,84\ m \cdot s^{-1}$<br>∴ initial velocity is 7,84 $m \cdot s^{-1}$ upwards✓ | $v_f = v_i + a\Delta t$✓<br>$\underline{0 = v_i + (9,8)(0,8)}$ ✓<br>$v_i = -7,84\ m \cdot s^{-1}$<br>∴ initial velocity is 7,84 $m \cdot s^{-1}$ upwards✓ |

(3)

4.1.2 **POSITIVE MARKING FROM 4.1.1**

**OPTION 1**

| **UPWARDS IS POSITIVE** | **UPWARDS IS NEGATIVE** |
|---|---|
| $v_f^2 = v_i^2 + 2a\Delta y$✓<br>$\underline{0 = 7,84^2 + 2(-9,8)\Delta y}$✓<br>$\Delta y = 3,136$m<br>∴Maximum height = 8+✓3,136 = 11,136m✓ | $v_f^2 = v_i^2 + 2a\Delta y$✓<br>$\underline{0 = (-7,84)^2 + 2(9,8)\Delta y}$✓<br>$\Delta y = -3,136$m<br>∴Maximum height = 8 +✓3,136 = 11,136m✓ |

(4)

T.D.N.



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**OPTION 2**

| UPWARDS IS POSITIVE | UPWARDS IS NEGATIVE |
|---|---|
| $\Delta y = (\frac{v_i+v_f}{2})\Delta t$✓ | $\Delta y = (\frac{v_i+v_f}{2})\Delta t$✓ |
| $[\Delta y = (\frac{7,84+0}{2})0,8]$ ✓ | $[\Delta y = (\frac{-7,84+0}{2})0,8]$✓ |
| Δy = 3,136m | Δy = -3,136m |
| ∴Maximum height = 8+✓3,136 = 11,136m✓ | ∴Maximum height = 8+✓3,136 = 11,136m✓ |

**OPTION 3**

| UPWARDS IS POSITIVE | UPWARDS IS NEGATIVE |
|---|---|
| $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ | $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ |
| $\Delta y = (7,84)(0,8) + \frac{1}{2}(-9,8)(0,8)^2$✓ | $\Delta y = (7,84)(0,8) + \frac{1}{2}(-9,8)(0,8)^2$✓ |
| Δy = 3,136m | Δy = -3,136m |
| ∴Maximum height = 8+✓3,136 = 11,136m✓ | ∴Maximum height = 8+✓3,136 = 11,136m✓ |

**OPTION 4**

$(K + U)_1 = (K + U)_2$✓
$(\frac{1}{2}mv^2 + mgh)_1 = (\frac{1}{2}mv^2 + mgh)_2$
$\frac{1}{2}m(7,84)^2 + m(9,8)(8)$ ✓ = $\frac{1}{2}m(0)^2 + m(9,8)(h)$ ✓
h = 11,136m✓

If zero is missing do not penalise

4.1.3 **POSITIVE MARKING FROM 4.1.1**

**OPTION 1**

**FROM STARTING POINT DOWNWARDS**

| UPWARDS IS POSITIVE | UPWARDS IS NEGATIVE |
|---|---|
| $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ | $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ |
| $-8 = (7,84)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$✓ | $8 = (-7,84)\Delta t + \frac{1}{2}(9,8)\Delta t^2$✓ |
| Δt = 2,31s✓ | Δt = 2,31s✓ |

(3)

**POSITIVE MARKING FROM 4.1.2**

**OPTION 2**

**FROM MAXIMUM HEIGHT DOWNWARDS**

| UPWARDS IS POSITIVE | UPWARDS IS NEGATIVE |
|---|---|
| $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ | $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ |
| $-11,136m = (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ | $11,136m = (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ |
| Δt = 1,51s | Δt = 1,51s |
| ∴total time = 1,51 +✓0,8 = 2,31s✓ | ∴total time = 1,51 +✓0,8 = 2,31s✓ |

T A. N



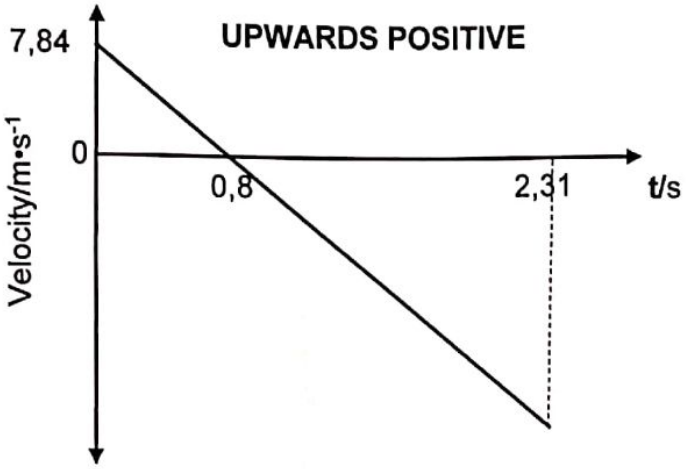
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**OPTION 3**

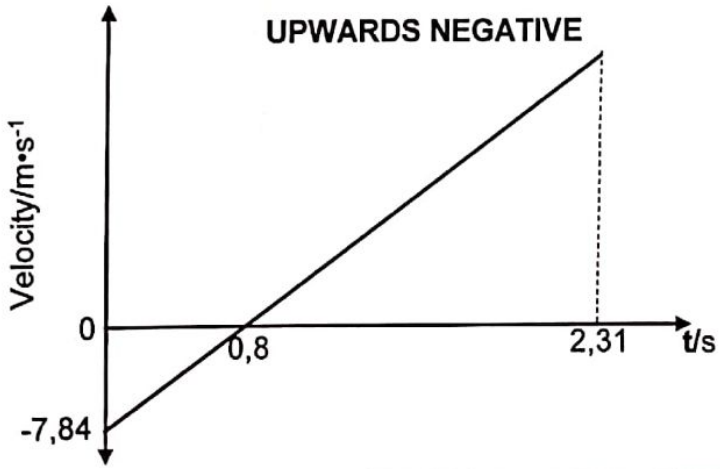
**FROM STARTING POINT DOWNWARDS**

| UPWARDS IS POSITIVE | UPWARDS IS NEGATIVE |
|---|---|
| $v_f^2 = v_i^2 + 2a\Delta y$ | $v_f^2 = v_i^2 + 2a\Delta y$ |
| $v_f^2 = (7,84)^2 + 2(-9,8)(-8)$<br>$v_f = -14,77\ m\cdot s^{-1}$ | $v_f^2 = (-7,84)^2 + 2(9,8)(8)$<br>$v_f = 14,77\ m\cdot s^{-1}$ |
| $v_f = v_i + a\Delta t$ ✓ | $v_f = v_i + a\Delta t$ ✓ |
| $-14,77 = 7,84 + (-9,8)\Delta t$ ✓ | $14,77 = -7,84 + (9,8)\Delta t$ ✓ |
| $\Delta t = 2,31\ s$ ✓ | $\Delta t = 2,31\ s$ ✓ |

4.2 **POSITIVE MARKING FROM 4.1.1 and 4.1.3**




**OR**




| CRITERIA FOR MARKING OF GRAPH | |
|---|---|
| Correct shape (line after 0,8 s is longer than before) | ✓ |
| Indication of initial velocity | ✓ |
| Indication of the time for the entire motion | ✓ |
| Indication of time to reach maximum height. | ✓ |

(4)
**[14]**

T.A.N.

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