Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: PHYSICS (P1)

COMMON TEST

MARCH 2017

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 50

TIME : 1 hour

This question paper consists of 6 pages and a 1-page data sheet.

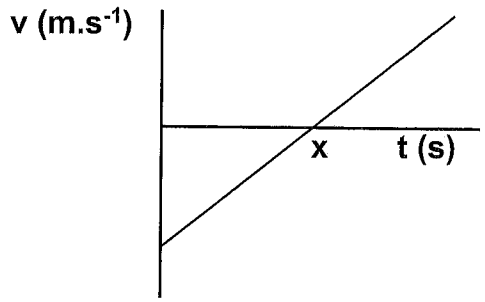
INSTRUCTIONS AND INFORMATION TO CANDIDATES

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 subsections, 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.

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 – 1.3) in the ANSWER BOOK, for example 1.4 D.

1.1 A velocity versus time graph below shows the vertical motion of an object.



Which of the following correctly describes the displacement (Δy) and acceleration of the object at point **x** indicated on the graph?

	Displacement (m)	Acceleration ($m.s^{-2}$)
A	Zero	-9.8
B	Δy	Zero
C	-Δy	9.8
D	Δy	9.8

(2)

1.2 A ball of mass m is thrown towards a wall with speed v and it rebounds with the same speed v. The force that ball exerts on the wall is of magnitude F. If the collision lasts for "t" seconds, what is the magnitude of the force that the wall exerts on the ball?

A F B mvt C $\frac{mv}{t}$ D $\frac{\frac{1}{2}mv}{t}$ (2)

1.3 The weight of a man on the surface of the earth is *w*. If the man is in a spaceship whose distance from the surface of the earth is equal to the diameter of the earth, then the gravitational force of the earth on the man will be …

A $\frac{w}{9}$ B $\frac{w}{\sqrt{3}}$ C $9w$ D $\frac{w}{2}$ (2)

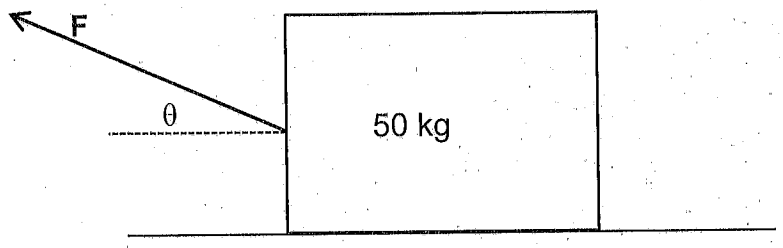
1.4 A spacecraft, consisting of two parts A and B, with mass m and 2m respectively, is moving with a velocity **v** in an easterly direction. After an explosion, part A breaks away from part B with a velocity of **3v** in a westerly direction. The velocity of part B after explosion will be:

A v B 2v C 3v D 6v (2)

[8]

QUESTION 2 (Start on a new page)

A constant pulling force F is applied on a heavy block of mass 50 kg as shown in the diagram below. The coefficient of static friction between the block and the rough floor surface is 0,34. The magnitude of the static frictional force is 120 N.



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

2.2 State, in words, *Newton's Second Law of Motion*. (2)

2.3 Calculate the magnitude of the vertical component of the applied force. (5)

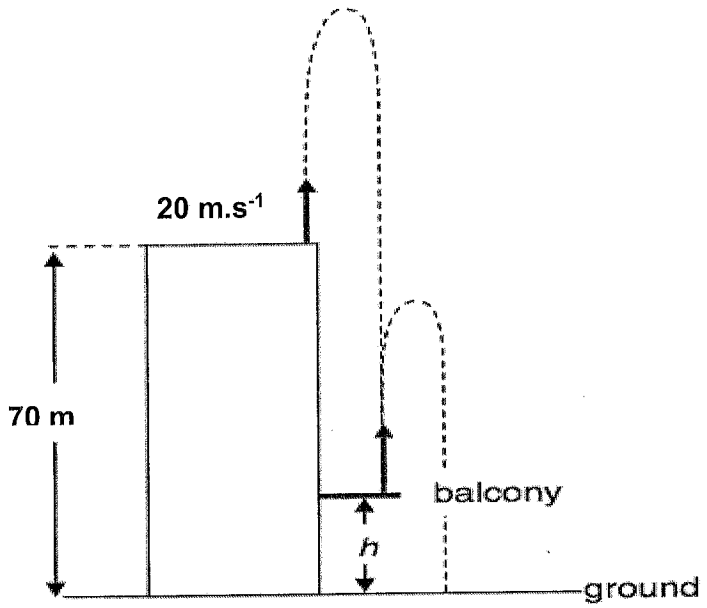
2.4 The applied force is now increased. Under the action of this new constant force, the block begins to move horizontally along the table.

2.4.1 How will the magnitude of the normal force change as the block moves across the table surface? State only INCREASES, DECREASES or REMAINS THE SAME. (1)

2.4.2 Explain your answer to QUESTION 2.4.1. (2)
[14]

QUESTION 3 (Start on a new page)

A boy standing on the top of a 70 m high building throws a ball vertically upwards at 20 $m.s^{-1}$. The ball strikes the balcony below after 5 s. The ball then bounces off the balcony and lands on the ground as illustrated in the diagram.



3.1 Define the term *free fall.* (2)

3.2 Determine the time taken by the ball to reach the maximum height. (3)

3.3 Calculate the velocity of the ball as it strikes the balcony. (3)

3.4 Calculate the height, h, of the balcony above the ground. (4)

3.5 Sketch the velocity versus time graph for the ball from the moment it was thrown from the top of the building until it hit the balcony.

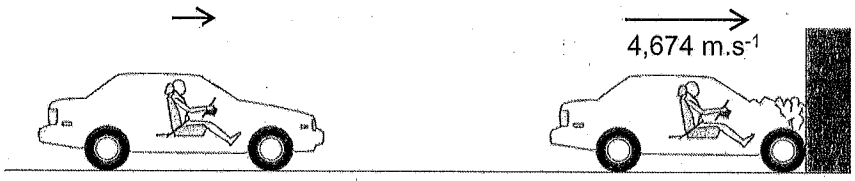
Indicate the following on the graph:

- Initial velocity of the ball
- Time to reach the maximum height
- Velocity of the ball on hitting the balcony (4)

[16]

QUESTION 4 (Start on a new page)

A car is travelling eastwards along a straight road. The driver sees an obstacle across the road, and then applies the brakes. Once applied, the brakes allow the car to slow down. Unfortunately, this is not sufficient, and the car crashes into the obstacle. The car hits the obstacle with a speed of 4,674 $m.s^{-1}$ and it takes 0,2 s for the car to come to a stop. The mass of the car and its driver is 1100 kg.



4.1 Define the term impulse. (2)

4.2 Calculate the change in momentum that the car experiences. (4)

4.3 Calculate the resultant force on the car during the collision. (3)

Luckily the driver is not injured in the collision. He is wearing a seatbelt, and as the car crashes into the obstacle, its airbags are deployed.

4.4 Using laws of Physics, explain how airbags can help to reduce the chance of injury in collisions such as this one. (3)

[12]

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 *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

MEMORANDUM

COMMON TEST

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NATIONAL SENIOR CERTIFICATE

GRADE 12

N.B. This memorandum consists of 5 pages including this page.

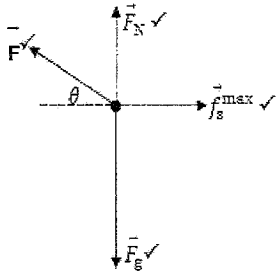
PHYSICS

QUESTION 1

1.1 C✓✓ (2)
1.2 D✓✓ (2)
1.3 A✓✓ (2)
1.4 C/D ✓✓ (2)
[8]

QUESTION 2

2.1



1 mark per arrow and label
subtract 1 mark for each of the following errors:

- F shown with its components (unless components in dashed lines)

- Block representation of the body will be accepted if: All forces are drawn correctly, starting from the surface of the block

(4)

2.2 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. ✓ (Part marks) (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. (2 or 0). (2)

2.3

$f_s = \mu_s F_N$ ✓
$120 = (0,34)F_N$✓
$F_N = 352,94$ N

Vertical forces : taking up as positive
$F_{net,y} = 0$
$F_y + F_N + F_g = 0$
$F_y + F_N - mg = 0$
$F_y + 352,94$✓ $- (50)(9,8)$ ✓ $=0$
$F_y = 137,06$ N✓ (5)

2.4.1 DECREASES✓ (1)

2.4.2 $F_N + F_y = F_g$✓, F_y increases✓ and normal force decreases in magnitude (2)

OR

The parcel will not push as hard into the table surface✓✓ so the normal force will decrease in magnitude. (2)

[14]

QUESTION 3

3.1 The motion of an object under the influence of gravity/weight/gravitational force only. (2 or 0). (2)

3.2

Upward positive	Downward positive
$v_f = v_i + a\Delta t$✓ $0 = 20 + (-9,8)\ \Delta t$✓ $\Delta t = 2,04$ s✓	$v_f = v_i + a\Delta t$✓ $0 = -20 + (9,8)\ \Delta t$✓ $\Delta t = 2,04$ s✓

(3)

3.3 **OPTION 1**

Upward positive	Downward positive
$v_f = v_i + a\Delta t$✓ $= 20 + (-9,8)\ (5)$✓ $= 29,00 m.s^{-1}$, downwards✓	$v_f = v_i + a\Delta t$✓ $= -20 + (9,8)\ (5)$✓ $= 29,00 m.s^{-1}$, downwards✓

Note: 1 Mark for both magnitude and direction (3)

OPTION 2

Upward positive	Downward positive
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= (20)(5) + \frac{1}{2}(-9,8)(5)^2$ $= -22,50$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= (-20)(5) + \frac{1}{2}(9,8)(5)^2$ $= 22,50$ m
$v_f^2 = v_i^2 + 2a\Delta y$ $= (20)^2 + 2(-9,8)(-22,5)^2$ ✓ $v_f = 29,00 m.s^{-1}$, downwards✓	$v_f^2 = v_i^2 + 2a\Delta y$ $= (-20)^2 + 2(9,8)(22,5)^2$ ✓ $v_f = 29,00 m.s^{-1}$, downwards✓

Note: 1 Mark for both magnitude and direction (4)

3.4 **OPTION 1**

Upward positive	Downward positive
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (20)(5) + \frac{1}{2}(-9,8)(5)^2$ ✓ $= -22,50$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (-20)(5) + \frac{1}{2}(9,8)(5)^2$ ✓ $= 22,50$
$h = 70 + (-22,50)$ ✓	$h = -(-70 + 22,50)$✓

(4)

OPTION 2

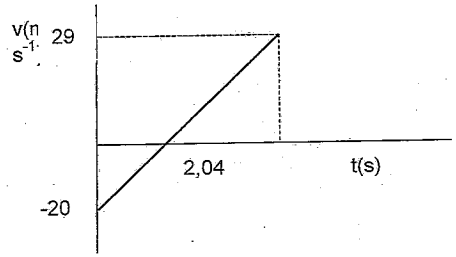
POSITIVE MARKING FROM QUESTION 3.3

Upward positive	Downward positive
$v_f^2 = v_i^2 + 2a\Delta y$✓ $(-29)^2 = (20)^2 + 2(-9,8)\ \Delta y$ ✓ $\Delta y = -22,50$	$v_f^2 = v_i^2 + 2a\Delta y$✓ $(29)^2 = (-20)^2 + 2(9,8)\ \Delta y$ ✓ $\Delta y = 22,50$
$h = 70 + (-22,50)$ ✓ $= 47,50$ m✓	$h = -(-70 + 22,50)$✓ $= 47,50$ m✓

(4)

3.5

Downward is positive

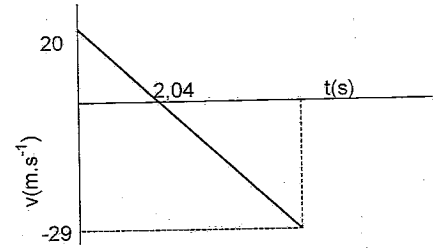


Marking criteria

Shape✓
Graph starts at -20 $m.s^{-1}$✓
Graph intercept at 2,04 s ✓
Graph ends at 29 $m.s^{-1}$✓

(4)

Upward is positive



Marking criteria

Shape✓
Graph starts at 20 $m.s^{-1}$✓
Graph intercept at 2,04 s ✓
Graph ends at -29 $m.s^{-1}$✓

QUESTION 4

4.1 Product of the net force acting on an object and the time the net force acts on the object. ✓✓ (2)

4.2

Take eastwards as positive	Take eastwards as negative
$\Delta p = mv_f - mv_i$✓ = (1100)(0) ✓ – (1100)(4,674) ✓ = -5141,40 = 5141,40 kg.m.s^{-1}, westwards✓	$\Delta p = mv_f - mv_i$✓ = (1100)(0) ✓ – (1100)(-4,674) ✓ = 5141,40 kg.m.s^{-1}, westwards✓

(4)

4.3 **POSITIVE MARKING FROM QUESTION 4.2**

Take eastwards as positive	Take eastwards as negative
$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{-5141,4}{0,2}$ ✓ = -25707,00 = 25 707,00 N (westwards) ✓	$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{5141,4}{0,2}$ ✓ = 25 707,00 N (westwards) ✓

(3)

4.4 $F_{net} = \frac{\Delta p}{\Delta t}$ ✓ OR $F_{net} \alpha \frac{1}{\Delta t}$ ✓

Airbags increase contact time during collision. ✓ This causes the impact force experienced by the driver to be decreased, ✓hence less injuries. (3)

[16]

TOTAL: 50