LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF EDUCATION

MOPANI EAST DISTRICT

NATIONAL
SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES
CONTROLLED TEST 1
MARCH 2023

MARKS : 100
TIME : 2 Hours

This question paper consists of 9 pages including this cover page.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.

2. This question paper consists of 4 questions. Answer ALL the questions.

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

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

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. Show ALL formulae and substitutions in ALL calculations.

8. Round off your FINAL numerical answers to **TWO** decimal places.

9. Diagrams are NOT necessarily drawn to scale.

10. Write neatly and legibly.

QUESTION 1

Four options are provided as possible answers to the following questions. Each question has only one correct answer. Write down ONLY the letter (A-D) next to the question number.

1.1 Choose the set of physical quantities which are vectors only.

A work, energy, weight, distance
B force, mass, time, power
C force, displacement, velocity, acceleration
D force, distance, speed, acceleration (2)

1.2 When resolving the vector into horizontal component, which one of the following is relevant?

A $R_y = R\sin\theta$ for the resultant component
B $R_y = R\cos\theta$ for the resultant component
C $R_x = R\cos\theta$ for the resultant component
D $R_x = R\sin\theta$ for the resultant component (2)

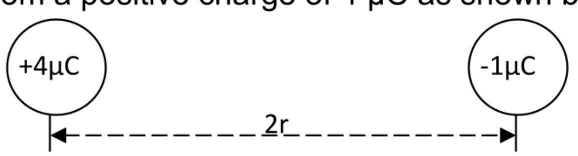
1.3 Which of the following forces is equal but in opposite direction to the normal?

A $F_{g\perp}$ to the surface
B $F_{g\parallel}$ to the surface
C Applied force
D Frictional force (2)

1.4 Frictional force is:

A inverse to normal
B inverse to applied force
C proportional to applied force
D proportional to the normal force (2)

1.5 A negative charge of 1μC which is free to move is placed a distance 2r from a positive charge of 4 μC as shown below:

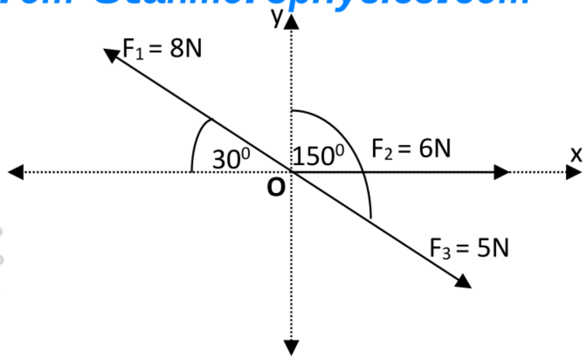


Which one of the following statements regarding the -1μC charge, when it is at distance r is correct:
The electrostatic force experienced by the -1μC charge will:

A remain the same
B be halved
C be doubled
D increase four times (2)

[10]

QUESTION 2



Three forces F_1, F_2 and F_3 act at a common point O as shown in the diagram above.

The magnitude of vector F_1 = 8 N, F_2 = 6 N and F_3 = 5 N.

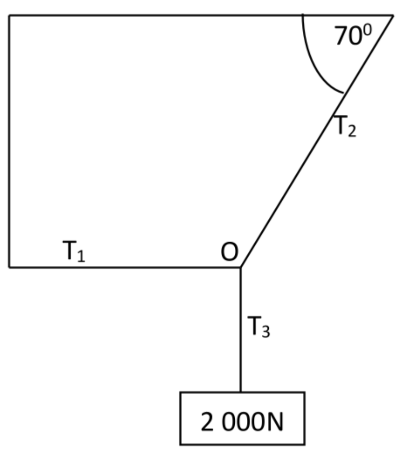
2.1 Define the term resultant of a vector. (2)

2.2 Use calculations to determine the following:

2.2.1 The vertical and the horizontal components of vector F_1. (4)

2.2.2 The resultant force acting at point O. (9)

2.3 The structure below shows a system that is in an equilibrium state. The strings with forces T_1, T_2 and T_3 are joined at point O. The weight of the block suspended from T3 is 2 000N.



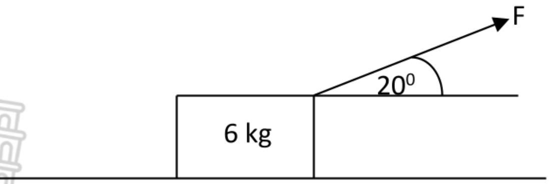
2.3.1 Explain the meaning of a closed vector diagram. (2)

2.3.2 Draw a labelled closed vector diagram of forces showing all the forces acting on the point. Indicate at least one angle in your diagram. (2)

[19]

QUESTION 3

A crate of mass 2kg is pulled to the right across a rough horizontal surface by a constant force **F**. This constant force **F** is applied at an angle of 20^0 to the horizontal as shown in the diagram below.



3.1 State Newton's first law of motion. (2)

3.2 Draw a free body diagram, showing al the forces acting on the crate. (4)

3.3 A constant frictional force of 3N acts between the surface and the crate. The coefficient of kinetic friction between the crate and the surface is 0.12. Calculate the magnitude of:

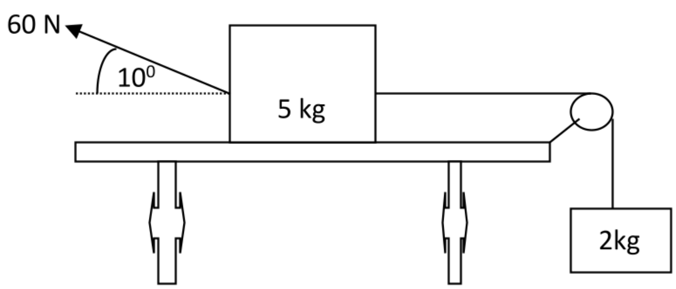
3.3.1 Normal force acting on the crate. (3)

3.3.2 force F. (4)

3.3.3 acceleration of the crate. (4)

3.4 A 5 kg block, resting on a rough horizontal table is connected by a light inextensible string passing over a frictionless pulley, is connected to another block of mass 2 kg hanging vertically as shown in the diagram below:

A force of 60 N is applied to the 5 kg block at an angle of 10^0 with the horizontal, thus making the block to accelerate to the left.



The coefficient of kinetic friction between the 5 kg block and the surface of the table is 0.5. Ignore the effects of air friction.

3.4.1 Draw the free body diagram, showing ALL the forces acting on the 5 kg block. (4)

3.4.2 State Newton's Second Law of motion in words. (2)

3.4.3. Calculate the vertical component of the 60 N force. (3)

3.4.4 Calculate the horizontal component of the 60 N force. (3)

3.4.5 Calculate the normal force acting on the 2 kg block. (2)

3.4.6 Calculate the tension force connecting the two blocks. (5)

3.5 A massive rock from outer space is moving towards the Earth.

3.5.1 State Newton's Law of Universal Gravitation in words. (2)

3.5.2 How does the magnitude of the gravitational force exerted by the Earth on the rock changes as the distance between the rock and the Earth becomes smaller? (2)

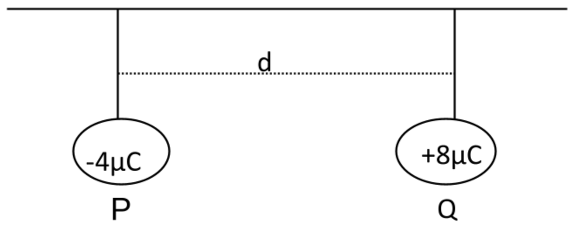
Choose from INCREASES, DECREASES or REMANS THE SAME.

Give a reason for your answer.

[40]

QUESTION 4

4.1 Two identical metal spheres, sphere P and sphere Q, are at a distance ***d*** apart and are suspended from an insulated rigid wooden bar as shown in the diagram below. The charges on the spheres are -4μC and +8μC respectively.



Sphere Q experiences an electrostatic force.

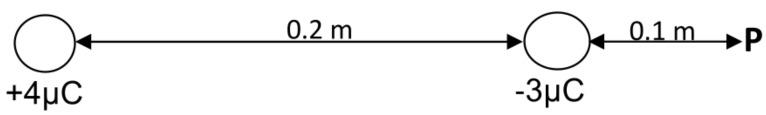
4.1.1 Define electric field. (2)

4.1.2 In which direction will sphere Q move? Write down only TO THE LEFT or TO THE RIGHT. (1)

4.1.3 The spheres are now made to touch and then separated. Were electrons REMOVED FROM or TRANSFERRED TO **P?** Give a reason for your answer. (2)

4.1.4 Calculate the distance d between the two spheres if the force experienced by P is 0.8 N. (4)

4.2. Charges of +4μC and -3μC are placed at a distance of 0.2 m apart on a straight line as shown below. Point P is located 0.1m to the right of the -3μC charge.

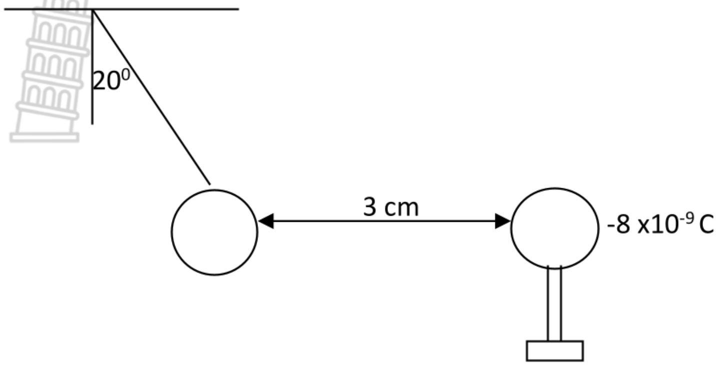


Calculate the:

4.2.1 net electric field at point P (5)

4.2.2 mass of a +6μC charge placed at P that will experience an acceleration of magnitude 5 x10^2 m.s^{-2}. (3)

4.3. A small isolated sphere A, with a mass of 0.2 g carrying a charge of +7 $x10^{-9}$ C, is suspended from a horizontal surface by a string of negligible mass. A second sphere B, carrying a charge of -8 $x10^{-9}$ C, on an isolated stand, attracts sphere A, so that the string forms an angle of 20^0 with the vertical. The horizontal distance between the centres of the two is 3cm. Refer to the diagram below:



4.3.1 State Coulomb's law in words. (2)

4.3.2 Draw a vector diagram of the force acting on sphere A and indicate at least ONE angle. (4)

4.3.3 Calculate the magnitude of the electrostatic force that sphere B exerts on sphere A. (4)

4.3.4 Calculate the magnitude of the tension force in the string. (4)

[31]

TOTAL= 100 MARKS

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 1 (FISIKA)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9{,}8 \text{ m}\cdot\text{s}^{-2}$
Gravitational constant *Swaartekragkonstante*	G	$6{,}67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of Earth *Straal van Aarde*	R_E	$6{,}38 \times 10^{6} \text{ m}$
Coulomb's constant *Coulomb se konstante*	K	$9{,}0 \times 10^{9} \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3{,}0 \times 10^{8} \text{ m}\cdot\text{s}^{-1}$
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31} \text{ kg}$
Mass of the earth *Massa van die Aarde*	M	$5{,}98 \times 10^{24} \text{ kg}$

FORCE/*KRAG*

$F_{net} = ma$	$w = mg$
$F = \dfrac{Gm_1m_2}{r^2}$	$\mu_s = \dfrac{f_{s(max)}}{N}$
$\mu_k = \dfrac{f_k}{N}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \frac{c}{v}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$ $(k = 9{,}0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2})$	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$ $(k = 9{,}0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2})$	$n = \frac{Q}{e}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots$	$R = r_1 + r_2 + r_3 + \ldots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

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PHYSICAL SCIENCES

MEMORANDUM FOR CONTROLLED TEST 1

MARCH 2023

MARKS : 100

This memorandum consists of pages including this cover page.

QUESTION 1

1.1 C √√ (2)
1.2 C √√ (2)
1.3 A √√ (2)
1.4 D √√ (2)
1.5 D √√ (2)

[10]

QUESTION 2

2.1 A single vector having the same effect as two or more vectorsacting together. √√ (2)

2.2.1 **Option 1** (4)

$F_{1x} = F_1\cos30^0$ √
$= 8\cos30^0$
$= 6.93$ N √

$F_{1y} = F_1\sin30^0$ √
$= 8\sin30^0$
$= 4.0$ N √

Option 2

$F_{1x} = F_1\sin60^0$ √
$= 8\sin60^0$
$= 6.93$ N √

$F_{1y} = F_1\cos60^0$ √
$= 8\cos60^0$
$= 4.0$ N √

2.2.2 Horizontal vectors (9)

$F_{1x} = -6.93$ N
$F_{2x} = +6$ N
$F_{3x} = F_3\cos60^0$ or $F_{3x} = F_3\sin30^0$
$= 5\cos60^0$ √ $= 5\sin30^0$ √
$= 2.5$ N $= 2.5$ N

$F_{Rx} = -6.93 + 6 – 2.5$
$= -3.43$ N
$= 3.43$ N to the left √

Vertical forces
$F_{1y} = F_1\sin30^0$
$= 8\sin30^0$ √
$= 4.0$ N

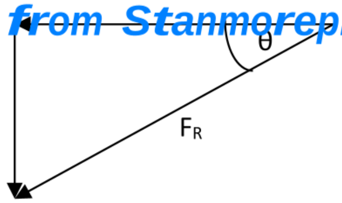
$F_{2y} = 0$ N

$F_{3y} = F_3\sin60^0$ or $F_{3y} = F_3\cos30^0$
$= 5\sin60^0$ √ $= 5\cos30^0$ √
$= 4.33$ N $= 4.33$ N

$F_{Ry} = 4 – 4.33$
$= -0.33$ N $= 0,33$ N downwards √

F_{Rx}

F_{Ry}



$F_R = \sqrt{(F_{Rx})^2 + (F_{Ry})^2}$ √

$= \sqrt{(3.43)^2 + (0.33)^2}$

$= 3.45$ N √

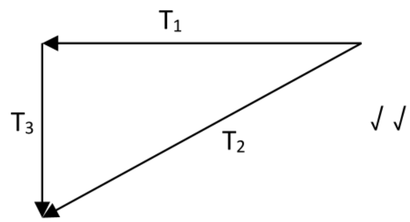
$\tan\theta = \dfrac{0.33}{3.43}$ √

$\theta = 5.50^0$

So F_R = 3.45 N at the bearing of 264.50^0 √ $(270^0 – 5,50^0)$

2.3.1 A closed vector diagram is a set of vectors drawn on the cartesian plane using the tail-to-head method and that has a resultant with a magnitude of zero, √ √ (2)

2.3.2. (2)

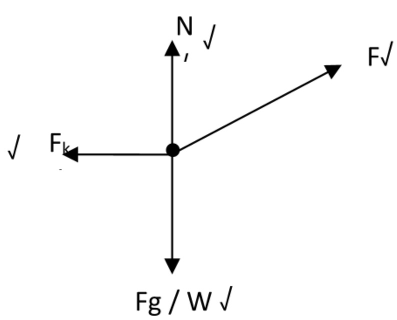


[19]

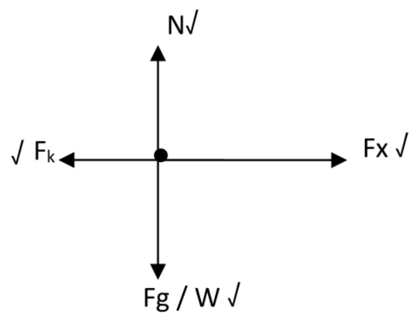
QUESTION 3

3.1. An object will continue in its atate of rest / uniform motion unless a resultant force acts on it. √ √ (2)

3.2. (4)



OR



3.3.1 $F_k = \mu_k N$ √ (3)

$3 = (0.12)(N)$ √

$N = 15$ N √

3.3.2 **Fnet = ma** √ (4)

N + Fy – W = 0

15 + Fsin20⁰√ –(6)(9.8) √ = 0

F = 128.06 N √

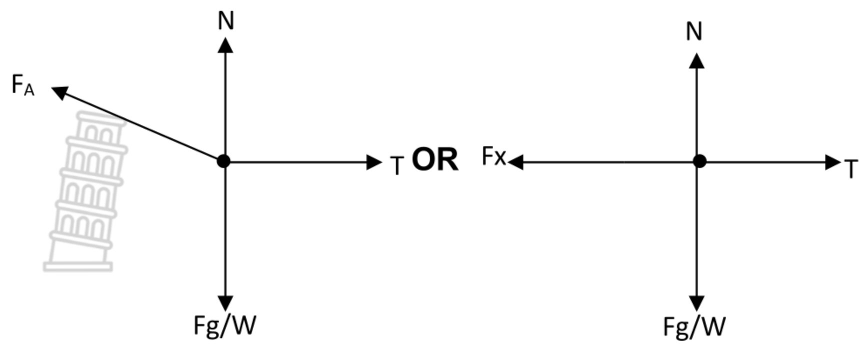
3.3.3 **Fnet = ma** √ (4)

$F\cos 20^0 - F_k = ma$

$128.06 \cos 20^0$ √ – 3 = 6a √

a = 19.56 m.s^{-2} √

3.4.1 (4)



Marking guidelines

W / Weight/ Fg √
T / Tension √
F_A / Applied force / F_X √
N / Normal force √

3.4.2 When force is applied on an object it produces acceleration in the direction of the force and this acceleration is directly proportional to the applied force and inversely proportional to the mass of the object. √ √ (2)

3.4.3 $Fx = F\cos 10^0$ √ (3)
$= 60\cos 10^0$ √
$= 59.1$ N √

3.4.4 $Fy = F\cos 10^0$ √ (3)
$= 60\sin 10^0$ √
$= 10.4$ N √

3.4.5 $Fy + N = W$ √ (2)
$10.4 + N = 5(9.8)$
$N = 38.6$ N √

3.4.6 Fnet = ma √ (5)
For the 5kg block
Fx – T = ma
59.1 - T = 5a √
T = 59.1 – 5a ……………….(1)

For the 2kg block
Fnet = ma
T – W = ma
T – (2)(9,8) = 2a √
T = 19.6 + 2a ……………….(2)
Equating (1) and (2)
59.1 – 5a = 19.6 + 2a
a = 5.64 m,s^{-2} √
substituting a = 5.64 m,s^{-2} in either (1) or (2) gives:
T = 30.88 N √

3.5.1 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. √√ (2)

3.5.2 Increases √ (2)

$F \propto \frac{1}{r^2}$ √

[40]

QUESTION 4

4.1.1. Electric field is a region in space where wherein an electric charge experiences a force. √ √ (2)

4.1.2 To the left √ (1)

4.1.3 Removed √ (2)

The charge on P is positive √

4.1.4 $F = \frac{kQ_1Q_2}{d^2}$ √ (4)

$0{,}8$ √ $= \frac{(9 \times 10^9) \times (2 \times 10^{-6}) \times (2 \times 10^{-6})}{d^2}$ √

$d = 0{,}21$ m √

4.2.1 $E = \frac{kQ}{r^2}$ √ (5)

$E_4 = (9 \times 109) \times \frac{(4 \times 10^{-6})}{(0.3)^2}$ √

$= 4 \times 10^5$ N,C^{-1} to the left

$E_3 = (9 \times 109) \times \frac{(3 \times 10^{-6})}{(0.1)^2}$ √

$= 2.7 \times 10^6$ N,C^{-1} to the left

$E_P = E_4 + E_3$

$= (0.4 - 2.9) \times 10^6$ N.C^{-1} √

$= 2{,}3 \times 10^6$ N.C^{-1} to the left √

4.2.2 $F = ma$ √ (3)

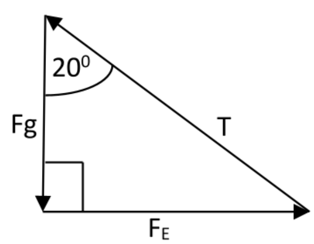
$QE = ma$

$m = \frac{(6 \times 10^{-6})(2{,}3 \times 10^6)}{(5 \times 10^2)}$ √

$= 2.76 \times 10^{-2}$ kg √

4.3.1 The magnitude of the electrostatic force exerted by two charges on each other is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. (2)

4.3.2 (4)



Marking guidelines

W / Weight/ Fg √

T / Tension √

FE/ Electrostatic force √

Angle indicated √

4.3.3 $F = \frac{kQ_1Q_2}{r^2}$ √ (4)

$= \frac{(9 \times 10^{9})(8 \times 10^{-9})(7 \times 10^{-9})}{(0{,}03)^2}$ √ √

$= 5{,}60 \times 10^{-4}$ N √

4.3.4 Fg = mg (4)

$= (2{,}0 \times 10^{-4})(9.8)$ √

$= 1.96 \times 10^{-3}$ N √

$T^2 = Fg^2 + F_E^2$

$= (1.96 \times 10^{-3})^2 + (5{,}6 \times 10^{-4})^2$ √

$= 2.04 \times 10^{-3}$ N √

[31]

TOTAL = 100 MARKS