
**GERT SIBANDE DISTRICT**

**MSTA SUB HUB**

# GRADE 12

# PHYSICAL SCIENCES TOPIC TEST

## TOPIC: ELECTROSTATICS

## MAY 2022

## QUESTION PAPER

**MARKS: 50**

**TIME: 1: 00 HOUR**

**This question paper consists of 7 pages including the data sheet**

**INSTRUCTIONS**

1. Attempt ALL questions.
2. Round off the final answers to a minimum of TWO decimal places.
3. You're advised to use the attached data sheet.
4. Write neatly and legibly.

**QUESTION 1**

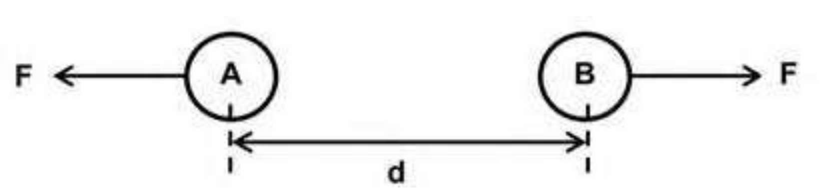
Four options (A–D) are given as possible answers to the following questions. Choose the answer and write only the letter (A – D ) next to the question number (1.1 – 1.2).

1.1 Two charged spheres of magnitudes $\mathbf{Q_1}$ and $\mathbf{Q_2}$ respectively are placed a distance **r** apart on insulating stands.
Which one of the following will INCREASE the magnitude of electrostatic force **F** between $\mathbf{Q_1}$ and $\mathbf{Q_2}$?

A Decrease the magnitude of $\mathbf{Q_1}$ and $\mathbf{Q_2}$.
B Increase the distance **r**.
C Decrease the distance **r**.
D Increase the magnitude of $\mathbf{Q_1}$, $\mathbf{Q_2}$ and the distance **r**. (2)



1.2 Two identical insulated conducting spheres **A** and **B** carry equal charges. They are separated by a distance **d** and exert a force with magnitude **F** on each other, as shown in the diagram below.



A third identical UNCHARGED sphere **C** touches **A**, and is then removed.

If the distance between spheres **A** and **B** remains the same, then the magnitude of the electrostatic force exerted on sphere **B** is now:

A 2**F**

B $\frac{1}{4}$**F**

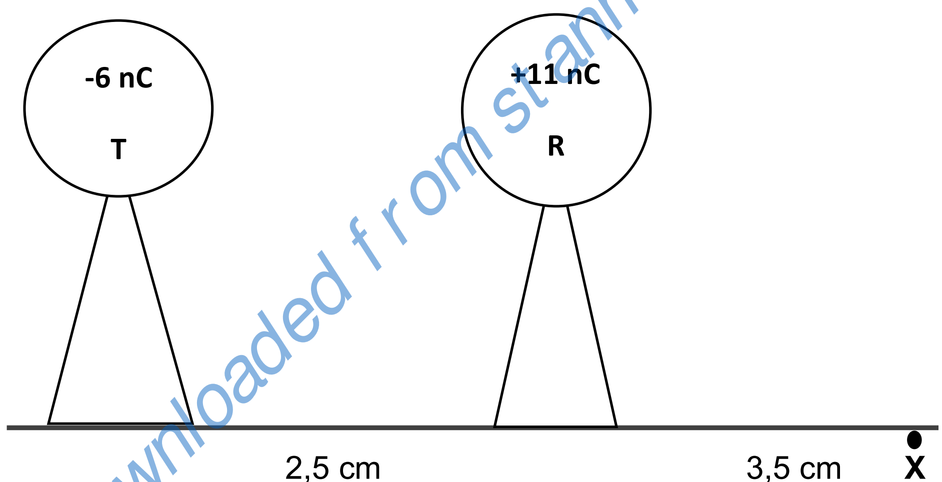
C 4**F**

D $\frac{1}{2}$**F** (2)

**[4]**

**QUESTION 2**

The diagram below shows two identical metal spheres **T** and **R**, placed on the wooden stands and each carrying a charge of -6 nC and +11 nC respectively. The two spheres are separated by a distance of 2, 5 cm, and point **X** is 3, 5 cm away from sphere **R**.



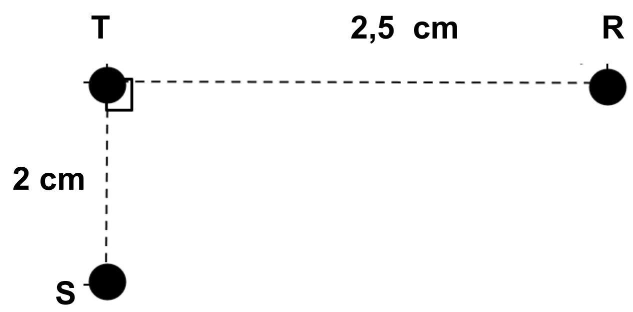



2.1 State Coulomb's law in words. (2)

2.2 Draw electric field pattern due to the two spheres T and R. (3)

2.3 Calculate the magnitude and direction of electric field at point **X** due to the presence of the charged spheres T and R. (5)

2.4 A third point charge **S**, carrying a charge of +5 nC, is now added to spheres **T** and **R** as shown in the diagram below, such that the distance between **T** and **S** is 2 cm.

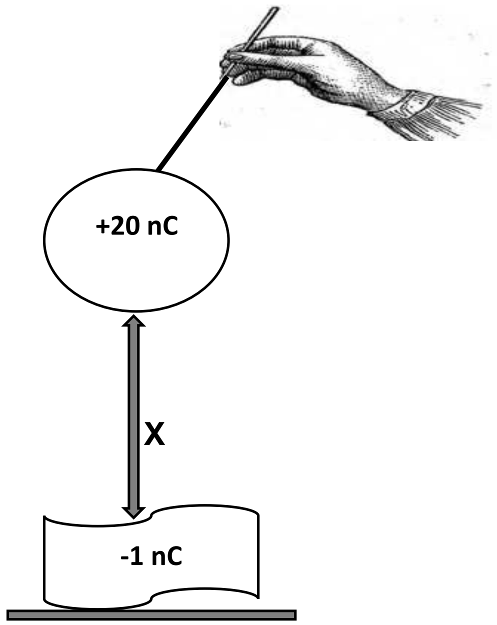



Calculate the magnitude of the net force acting on charge **T** due to the presence of the charges **R** and **S**. (6)

**[16]**

**QUESTION 3**

A charged sphere at the end of a wooden handle has a mass of 40 g and carries a charge of +20 nC. A learner brings the sphere close to a piece of tissue paper of mass 0,5 g and charge of -1 nC. The electrostatic force experienced between the sphere and the tissue paper is 0,0049 N.




3.1 Give a reason why the sphere is attached at the end of a palstic handle instead of a metalic handle. (1)

3.2 Calculate the maximum distance **X** at which the sphere will be able to pick up the tissue paper. (3)

3.3 Calculate the gravitational force of attraction between the sphere and the tissue paper. (3)

3.4 The spheres and the tissue paper are made to be in contact for some time and then separated by the original distance of **X** m. Calculate;

3.4.1 The net charge on the sphere and tissue paper after they have been in contact. (2)

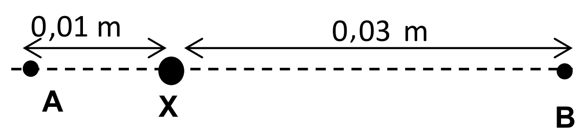
3.4.2 The number of electrons transferred when the sphere and the tissue paper were in contact. (3)

3.5 Sketch a graph of electrostatic force between the sphere and the tissue paper versus the distance between them. (2)

**[14]**

**QUESTION 4**

The diagram below shows a small sphere **X** from which 938 electrons were removed and two points **A** and **B** at different distances from the sphere **X.**




4.1 What is the nature of the charge on sphere **X**? Choose from POSITIVE or NEGATIVE. (1)

4.2 Calculate the magnitude of the charge on sphere **X**. (3)

4.3 Define the term *electric field at a point* in words. (2)

4.4 Draw the electric field pattern around sphere **X.** (2)

4.5 At what point, **A** or **B,** is the magnitude of the electric field due to the charged sphere **X** greater? Explain the answer. (3)

4.6 A negative point charge **Y** with charge $-2,8 \times 10^{-16}$ C is NOW placed at point **B** and a point charge **Z** with charge $+3,2 \times 10^{-16}$ C is placed at point **A.** Calculate the net electrostatic force on sphere **X.** (5)

**[16]**

**TOTAL: 50**

# DATA FOR PHYSICAL SCIENCES GRADE 12 PAPER 1 (PHYSICS)

## TABLE 1: PHYSICAL CONSTANTS

| NAME | SYMBOL | VALUE |
|---|---|---|
| Acceleration due to gravity | g | 9,8 m·s$^{-2}$ |
| Universal gravitational constant | G | 6,67 × 10$^{-11}$ N·m$^2$·kg$^{-2}$ |
| Coulomb's constant | k | 9,0 x 10$^9$ N·m$^2$·C$^{-2}$ |
| Electron mass | $m_e$ | 9,11x10$^{-31}$ Kg |
| Charge on electron | $e^-$ | -1,6 x 10$^{-19}$ C |

## TABLE 2: FORCES

| | |
|---|---|
| $F_{net} = ma$ | $w = mg$ |
| $F = \frac{Gm_1m_2}{r^2}$ | $g = \frac{Gm}{r^2}$ |

## TABLE 3: ELECTROSTATICS

| | |
|---|---|
| $F = \frac{kQ_1Q_2}{r^2}$ | $E = \frac{kQ}{r^2}$ |
| $V = \frac{W}{q}$ | $E = \frac{F}{q}$ |
| $n = \frac{Q}{e}$ **or** $n = \frac{Q}{q_e}$ | |

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**GRADE 12**

**PHYSICAL SCIENCES TOPIC TEST**

**TOPIC: ELECTROSTATICS**

**MAY 2022**

**MEMORANDUM**


**MARKS: 50**

**This memorandum consists of 6 pages**

**QUESTION 1**

1.1 C✓✓ (2)

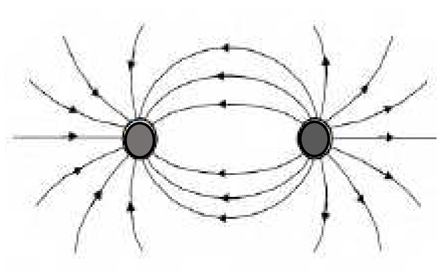
1.2 D✓✓ (2)

**[4]**

**QUESTION 2**

2.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them.✓ ✓ **[ 2 or 0 mark]** (2)

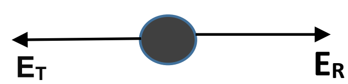
2.2



| Marking criteria for q 2.2 | Marks |
|---|---|
| Correct direction of field patterns from/towards the spheres. | ✓ |
| Correct shape of field pattern. | ✓ |
| Field lines not crossing/ not drawn inside the sphere. | ✓ |

(3)

2.3




**Right is positive**


$$E_R = \frac{kQ}{r^2}\ ✓$$

$$E_R = \frac{(9\times10^9)(11\times10^{-9})}{(0.035)^2}\ ✓$$

$E_R$= 80816,33 $N$ Right

$$E_T = \frac{(9\times10^9)(6\times10^{-9})}{(0,06)^2}\ ✓$$

$E_T = 15000\ N\cdot C^{-1}$ Left

$E_{net} = E_R + E_T$

= 80816,33 +(- 15000) ✓

$E_{net}$ = 65816,33 N.C$^{-1}$ right ✓

(5)

2.4 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{R\ on\ T} = \frac{(9\times10^9)(6\times10^{-9})(11\times10^{-9})}{(2,5\times10^{-2})^2}$ ✓

$F_{R\ on\ T} = 9,5 \times 10^{-4}$ N right (attractive) ✓**(both)**

$F_{S\ on\ T} = \frac{(9\times10^9)(6\times10^{-9})(5\times10^{-9})}{(2\times10^{-2})^2}$ ✓

$F_{S\ on\ T} = 6,75 \times 10^{-4}$ N downwards (attractive)

$F_{net} = \sqrt{(F_{R\ on\ T})^2 + (F_{S\ on\ T})^2}$

$F_{net} = \sqrt{(9,5 \times 10^{-4})^2 + (6,75 \times 10^{-4})^2}$ ✓

$F_{net} = 1,165 \times 10^{-4}$ N ✓ (6)

**[16]**

## QUESTION 3

3.1 To avoid leakage of charge. ✓
**OR:** Un like a metal, a wood does not conduct the charges/ does not allow the charges to pass through. (1)

3.2 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$0,0049 = \frac{(9\times10^9)(1\times10^{-9})(20\times10^{-9})}{r^2}$ ✓

r = 0,0061 m ✓ (3)

3.3 **POSITIVE MARKING FROM Q 3.2**

$F = \frac{Gm_1m_2}{r^2}$ ✓

$F = \frac{(6,7\times10^{-11})(0,5\times10^{-3})(40\times10^{-3})}{(0.0061)^2}$ ✓

F = 3,60 X 10 $^{-11}$ N ✓ (3)

3.4.1 $Q_{net} = \frac{Q1+Q2}{2}$

$Q_{net} = \frac{(-1\times10^{-9})+(20\times10^{-9})}{2}$ ✓

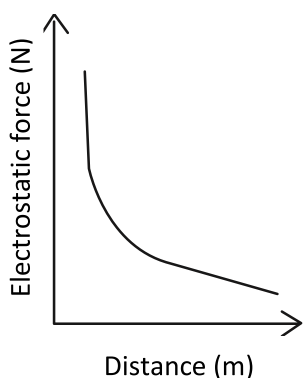
$Q_{net} = 9{,}5\text{x}10^{-9}$ C ✓ (2)

3.4.2

| **Option 1** | **Option 2** |
|---|---|
| $n = \frac{Q}{e}$ ✓<br>$n = \frac{(9{,}5\times10^{-9})-(-1\times10^{-9})}{(1{,}6\text{x}10^{-9})}$ ✓<br>n = 6,563 electrons ✓ | $n = \frac{Q}{e}$ ✓<br>$n = \frac{(9{,}5\times10^{-9})-(20\times10^{-9})}{(-1{,}6\text{x}10^{-9})}$ ✓<br>n = 6,563 electrons ✓ |

(3)

3.5




| **Marking criteria for the graph** | |
|---|---|
| Shape of the graph. | ✓ |
| Labelling of the axes. | ✓ |

(2)
**[14]**

## QUESTION 4

4.1 Positive✓ (1)

4.2 $n = \frac{Q}{e}$ ✓

$938 = \frac{Q}{(1,6x10-^{9})}$ ✓

$Q_x = 1,50\times10^{-16}$ C✓

**OR:**

Q = ne

$Q = 938(1,6 \times 10^{-19})$

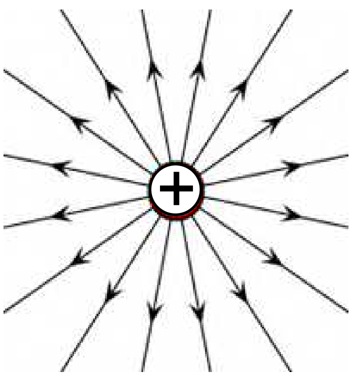
$Q_x = 1,50\times10^{-16}$ C

(3)

4.3 The electrostatic force experienced per unit positive charge placed at that point. ✓✓ (2)

**[2 OR O MARKS]**

4.4



| Marking criteria | |
|---|---|
| Shape | ✓ |
| Correct direction | ✓ |

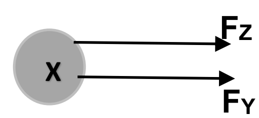
(2)

4.5 At **A**.✓ The distance from A to the charged sphere **X** is smaller than the distance from **B** to the charged sphere **X** ✓and the electric field at a point due to a point charge is inversely proportional to the square distance between the point and the charge✓ (3)

$\left( E \propto = \frac{1}{r^2} \right)$

4.6 **OPTION 1**

**POSITIVE MARKING FROM Q 4.2**




$F_{Y on X} = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{Y on X} = \frac{(9\times10^9)(1,5\times10^{-16})(2,8\times10^{-16})}{(0,03)^2}$ ✓

$F_{Y\ on\ X} = 4,2\times10^{-19}$ N

$F_{Z\ on\ X} = \frac{kQ_1Q_2}{r^2}$

$$F_{Z\,on\,X} = \frac{(9\times10^{9})(1{,}5\times10^{-16})(3{,}2\times10^{-16})}{(0{,}01)^2}✓$$

$F_{Z\ on\ X} = 43{,}2\times10^{-16}$ N

**If right is positive**

$F_{net} = F_{Y\ on\ X} + F_{Z\ on\ X}$

$F_{net} = 4{,}2\times10^{-19} + 43{,}2\times10^{-19}$ ✓

$F_{net} = 47{,}4\times10^{-19}$ N.to the right ✓

**OR:** $F_{net} = 4{,}74\times10^{-18}$ N to the right

**If left is positive**

$F_{net} = F_{Y\ on\ X} + F_{Z\ on\ X}$

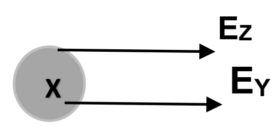
$F_{net} = -4{,}2\times10^{-19} + (-43{,}2\times10^{-19})$

$F_{net} = -47{,}4\times10^{-19}$ N.

$F_{net} = 47{,}4\times10^{-19}$ N to the right

**OR:** $F_{net} = 4{,}74\times10^{-18}$ N to the right

**OPTION 2**




$E = \frac{KQ}{r^2}$ ✓

$E_Z = 9\times10^9 \times \frac{(3{,}2\times10^{-16})}{(0{,}01)^2}$ ✓

$E_Z = 28{,}8\times10^{-3}\ N\cdot C^{-1}$

$E_Y = 9\times10^9 \times \frac{(2{,}8\times10^{-16})}{(0{,}03)^2}$ ✓

$E_Y = 2{,}8\times10^{-3}\ N\cdot C^{-1}$

**If right is positive**

$E_{net} = E_Z + E_Y$

$E_{net} = 28{,}8\times10^{-3} + 2{,}8\times10^{-3}$

$E_{net} = 31{,}6\times10^{-3}\ N\cdot C^{-1}$ to the right

**If left is positive**

$E_{net} = E_Z + E_Y$

$E_{net} = -28{,}8\times10^{-3} - 2{,}8\times10^{-3}$

$E_{net} = -31{,}60\times10^{-3}\ N\cdot C^{-1}$

$\vec{E}_{net} = 31{,}60\times10^{-3}\ N\cdot C^{-1}$ *to the right*

**POSITIVE MARKING FROM Q 4.2**

$F = qE$

$F = 1{,}5\times10^{-16}\times31{,}60\times10^{-3}$ ✓

$F = 47{,}4\times10^{-19} N$ *to the right* ✓

**OR:** $F = 4{,}74\times10^{-18} N$ *to the right*

(5)

**TOTAL: 50** **[16]**