KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES

COMMON TEST

MARCH 2023

TIME: 2 hours

MARKS: 100

This question paper consists of 13 pages, one data sheet and two answer sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK.**
2. This question paper consists of **SIX** 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.

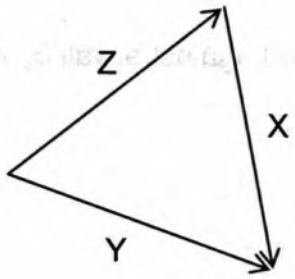
QUESTION 1 : MULTIPLE CHOICE QUESTIONS

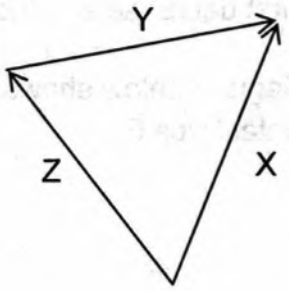
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A - D) next to the question number (1.1 —1.7) in the ANSWER BOOK, for example 1.8 D.

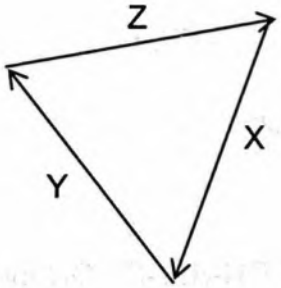
1.1 Which ONE of the following pairs of physical quantities consists of a vector and a scalar?

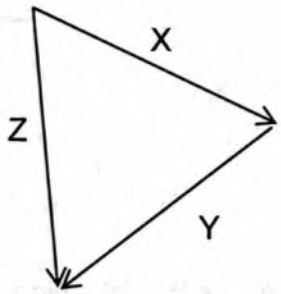
A Force and distance
B Force and acceleration
C Velocity and displacement
D Distance and speed (2)

1.2 Which ONE of the following diagrams is the best representation of the vector sum: X + Y= - Z?

A


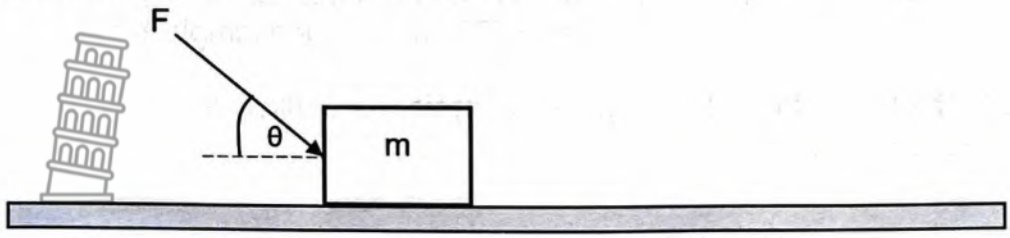
B


C


D


(2)

1.3 A crate of mass m is pushed across a horizontal surface by a force F acting at an angle θ to the horizontal as shown in the diagram below. The crate experiences a constant frictional force.

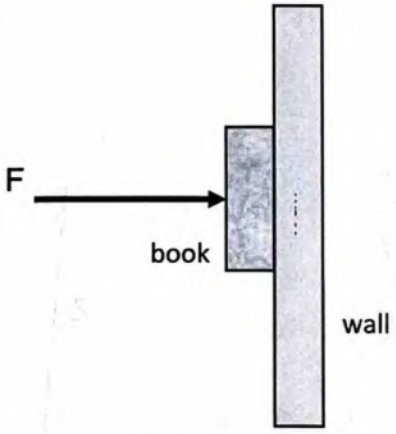


How will the magnitude of the frictional force be affected if the force F is INCREASED?

It will …

A decrease.
B increase.
C remain the same.
D first decrease and then increase. (2)

1.4 The diagram below shows a book which is pressed against a wall by a horizontal force F.



Which one of the following represents an ACTION-REACTION force pair according to Newton's third law?

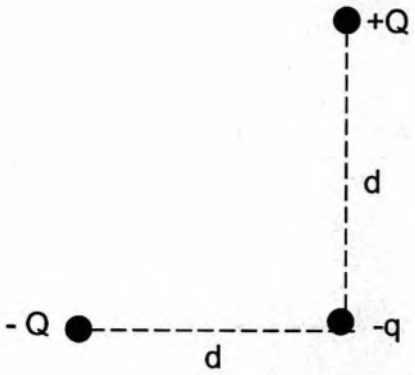
A The weight of the book and the force F on the book
B Force F on the book and the force of the book on the wall
C The weight of the book and the force that the book exerts on Earth
D The weight of the book and the friction between the book and the wall (2)

1.5 A satellite experiences a gravitational force of magnitude F on the surface of Earth. The radius of Earth is R. The satellite now orbits Earth at an unknown height above the surface of Earth and experiences a gravitational force of magnitude $\frac{1}{16}$ F.
This unknown height above the surface of Earth is ....

A R
B 2 R
C 3 R
D 4 R

(2)

1.6 Two charges, + Q and – Q, are placed the same distance d from a negative charge – q. The charges, + Q and – Q, are located along lines that are perpendicular to each other as shown in the diagram below.



Which ONE of the following vectors shows the correct direction of the NET FORCE acting on charge – q due to charges + Q and – Q?

A


B


C


D


(2)

1.7 Which one of the statements below does NOT represent the properties of electric field lines? They ....

A are always at right angles to a surface.

B can never intersect or touch one another.

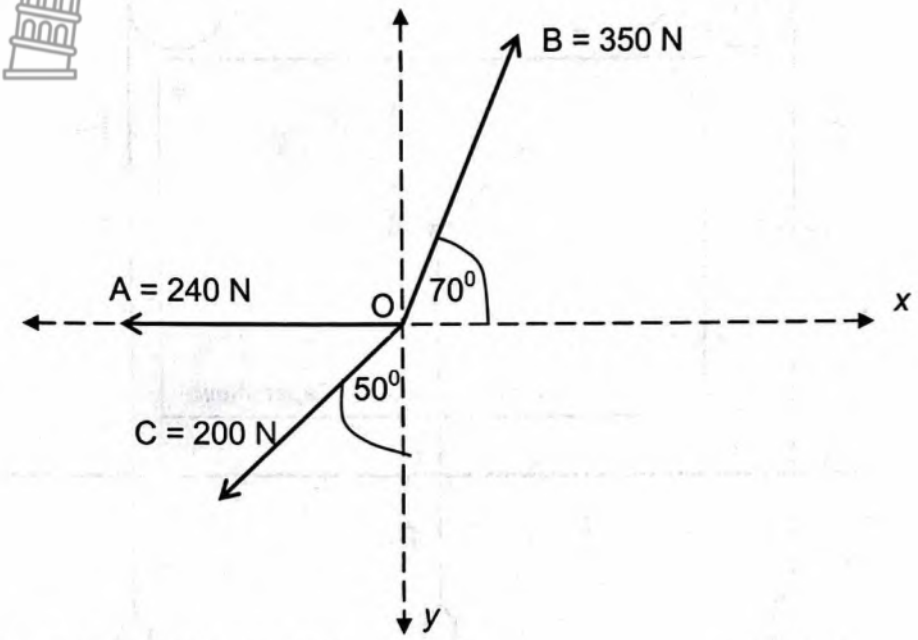
C are closest to one another where the electric field is the weakest.

D run parallel where the electric field is uniform. (2)

[14]

QUESTION 2 (Start on a new page)

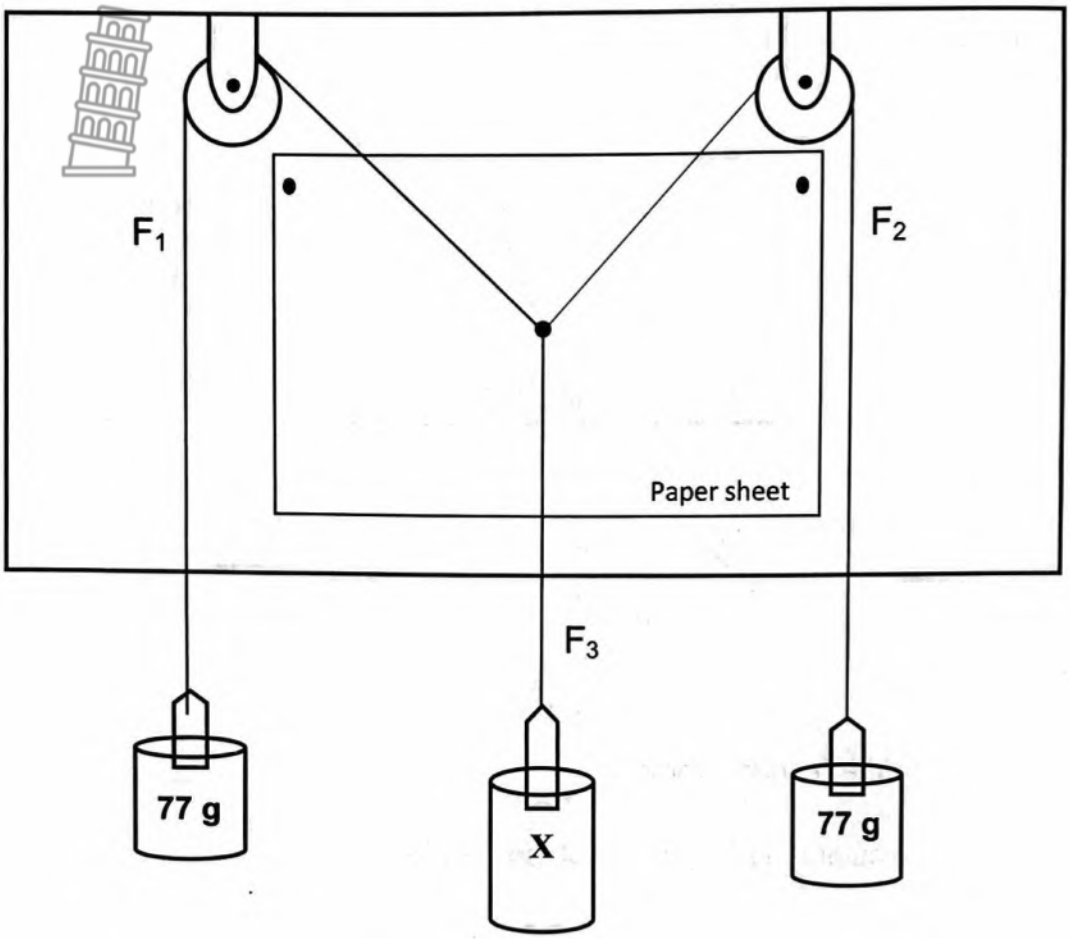
2.1 Three forces A, B and C of magnitudes 240 N ,350 N and 200 N respectively act on a point O in the directions as shown below.
The forces are NOT drawn to scale.



2.1.1 Define *resultant force* (2)

2.1.2 Calculate the magnitude of the resultant force (5)

2.2 The apparatus shown below was used to determine the resultant of two co-planar forces, F_1 and F_2.



2.2.1 Calculate the magnitude of the force F_1 (2)

2.2.2 A mirror is used to plot the images of the forces acting in the string. Give a reason why the mirror is used (2)

2.2.3 An INCOMPLETE diagram for the results of this investigation is given ON PAGE 15 OF THIS QUESTION PAPER.
Complete the diagram using a scale of 10 mm = 0,1 N and determine the magnitude of the resultant force.
BE SURE TO SUBMIT THIS SHEET WITH YOUR ANSWER BOOK. (4)

2.2.4 Hence calculate the mass of X (2)
[17]

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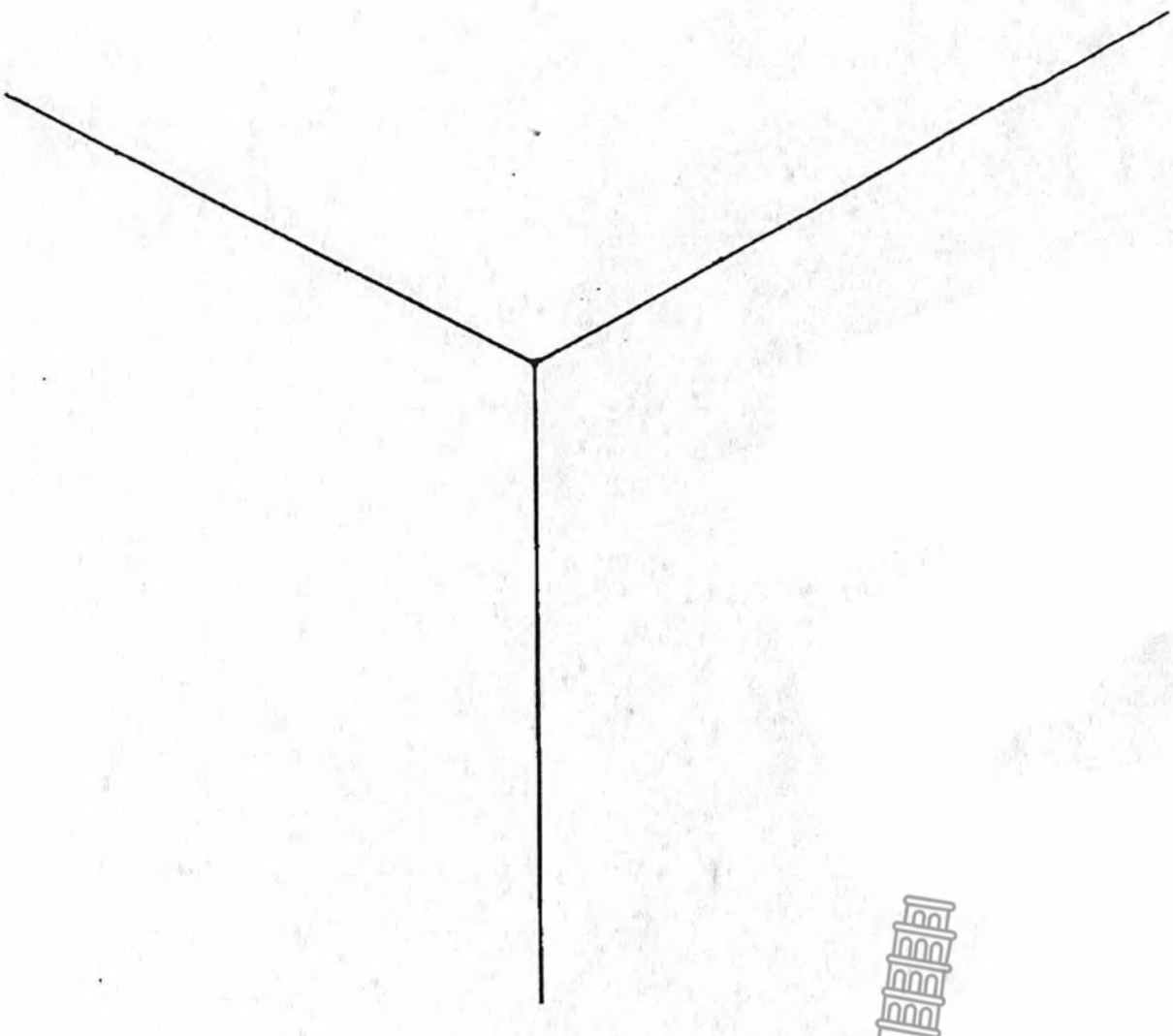
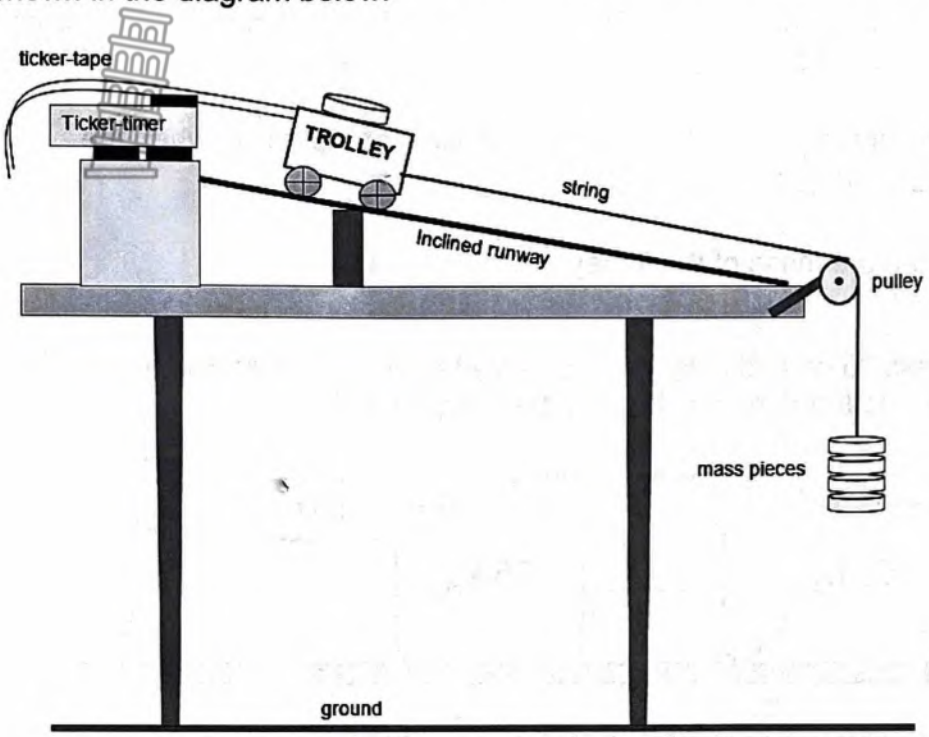
NAME OF LEARNER : _____

Question 2.2.3

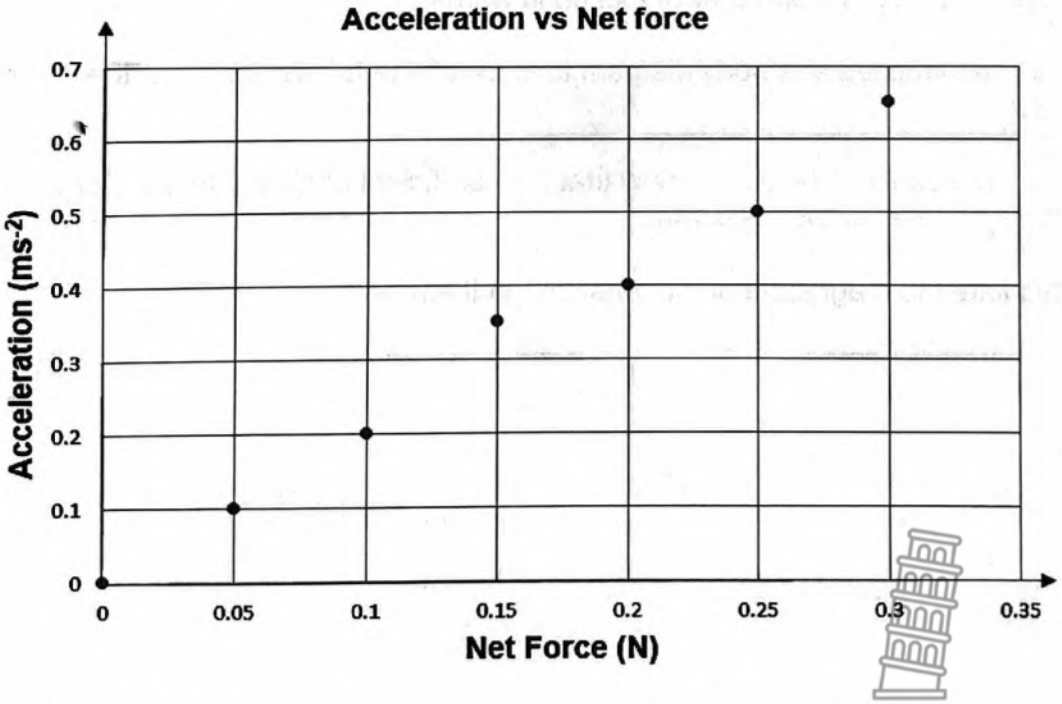


QUESTION 3 (Start on a new page)

3.1 The experiment below was used to verify a relationship between the acceleration produced and the net force acting on an object. Learners set up the apparatus as shown in the diagram below.



The results obtained are used to plot the INCOMPLETE graph shown.



3.1.1 Write down the name of the quantity that must be kept constant in this experiment (1)

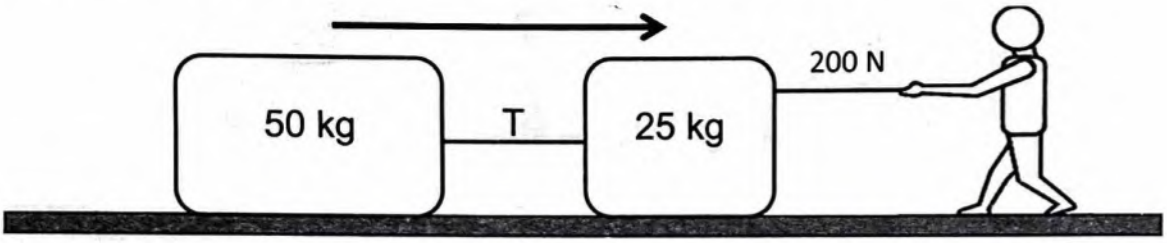
3.1.2 ON THE DIAGRAM SHEET provided on PAGE 16, draw the graph that can be expected.
BE SURE TO SUBMIT THIS SHEET WITH YOUR ANSWER BOOK. (1)

3.1.3 State in words the mathematical relationship between acceleration produced and the net force acting on an object. (1)

3.1.4 Use the graph to determine the acceleration of the trolley when the net force is 0,25 N. (2)

3.1.5 Calculate the mass of the trolley. (3)

3.2 Two crates of mass 25 kg and 50kg are connected by a light inextensible rope. A force of 200 N is applied to the right, as shown in the diagram below.



The crates move with an acceleration of 1,25 $m \cdot s^{-2}$ to the right across a rough horizontal surface. The coefficient of kinetic friction is the same for both crates.

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

3.2.2 Draw the labelled free body diagram to show all the forces acting on the 25 kg crate. (5)

3.2.3 Using relevant calculations, show that the coefficient of kinetic friction for the crates and the surface is 0,144. (6)

3.2.4 Calculate the magnitude of the tension T in the rope. (2)

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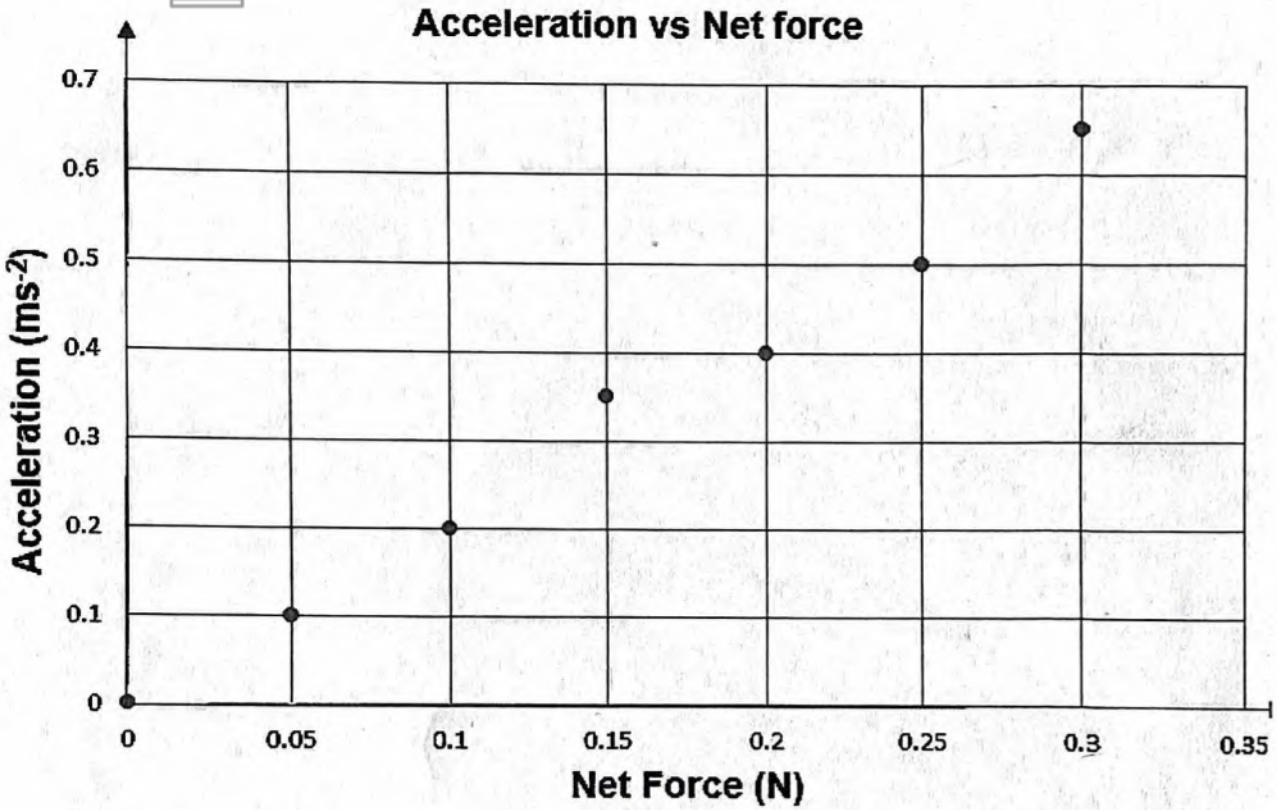
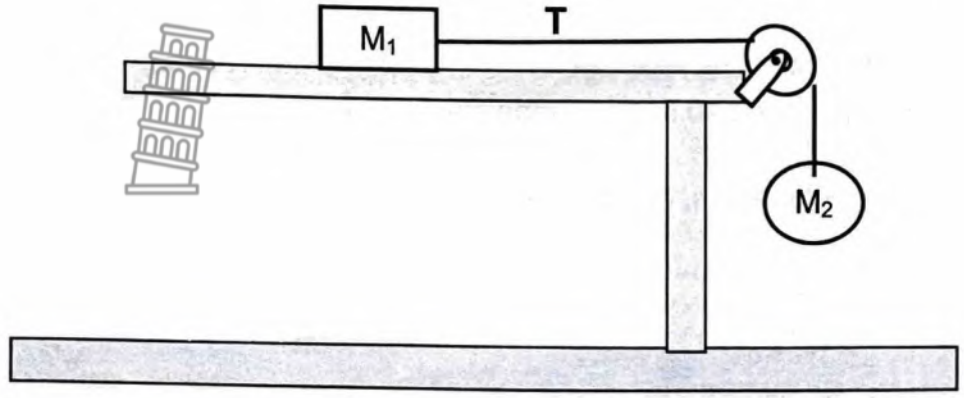
NAME OF LEARNER : _____

Question 3.1.2



3.3 A block of mass M_1 and a ball of mass M_2 are connected by a light inextensible string that passes over a frictionless pulley as shown below. The block is placed on a ROUGH horizontal surface.

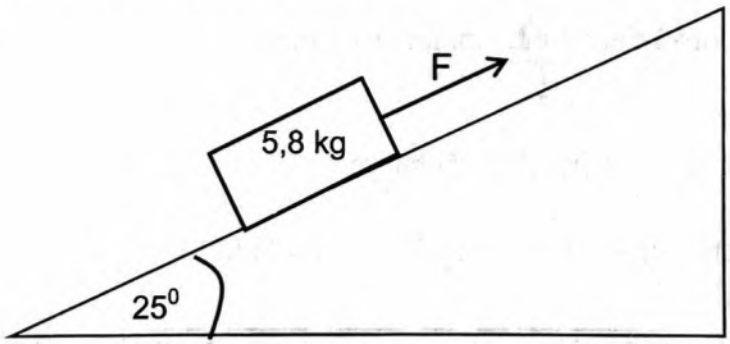


How will the acceleration of the blocks be affected when each of the following changes are made: (Choose from INCREASES, DECREASES, or REMAINS THE SAME)

3.3.1 The mass of the ball, M_2, is doubled? (1)

3.3.2 The mass of the block, M_1, is doubled? Fully explain the answer. (4)

3.4 A block of mass 5,8 kg is pulled up an incline at CONSTANT VELOCITY by a force F that makes an angle of 25^0 with the horizontal.
The kinetic frictional force between the block and the surface is 51,51 N.



3.4.1 Calculate the magnitude of force F (4)

3.4.2 The applied force F is now removed. Briefly describe the motion of the block immediately after F is removed (3)
[35]

QUESTION 4 (Start on a new page)

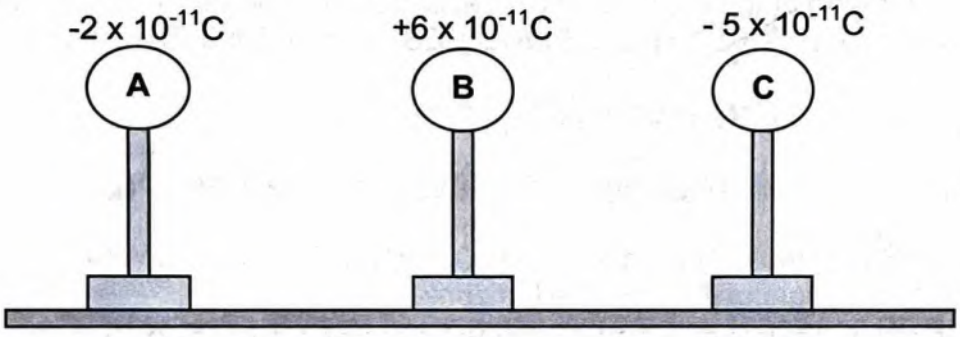
4.1 State *Newton's Law of Universal Gravitation* in words. (2)

4.2 A communications satellite of mass 1500 kg moves in a fixed orbit around Earth. Earth exerts a force of magnitude 10 500 N on the satellite in order to keep it in the specified orbit.
Calculate the distance, in kilometers, of the satellite above the surface of Earth. (5)

[7]

QUESTION 5 (Start on a new page)

5.1 Three identical metal spheres A, B and C carry charges of -2×10^{-11} C, $+6 \times 10^{-11}$ C and -5×10^{-11} C respectively.



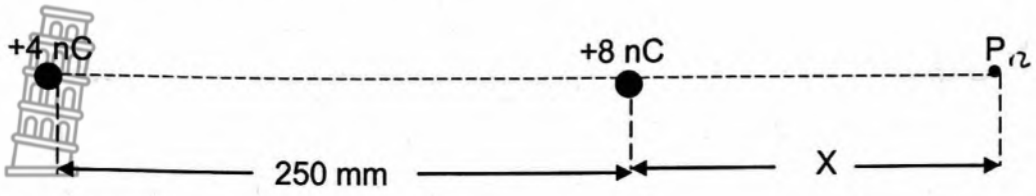
All three spheres are brought into contact with each other and then separated AT THE SAME TIME.

5.1.1 State the *Principle of conservation of charge*. (2)

5.1.2 Calculate the charge on each sphere after separation. (3)

5.1.3 By calculating the change in charge of sphere B, explain why sphere B becomes negatively charged after contact. (3)

5.2 Two point charges of magnitudes +4 nC and +8 nC are placed at a distance of 250 mm apart. P is a point on the line joining the two charges, a distance X mm from the +8 nC charge, as shown in the diagram below.



5.2.1 State *Coulomb's Law* in words. (2)

5.2.2 Calculate the magnitude of the force that the +4 nC charge exerts on the +8 nC charge. (4)

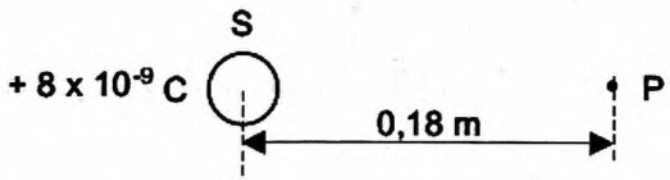
5.2.3 A third point charge of magnitude +12 nC is now placed at point P so that the resultant electrostatic force acting on the +8 nC charge is **zero**.
Calculate the distance X. (5)

[19]

QUESTION 6 (Start on a new page)

6.1 Define *electric field,* in words. (2)

6.2 S is a small, positively charged sphere carrying a charge of $+ 8 \times 10^{-9}$ C.
P is a point 0,18 m from the centre of S.



6.2.1 Draw the electric field pattern for S. (2)

6.2.2 Calculate the electric field at P. (4)

[8]

TOTAL : 100

DATA SHEET:

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m\cdot s^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of the Earth	R_E	$6,38 \times 10^{6}\ m$
Mass of the Earth	M_E	$5,98 \times 10^{24}\ kg$
Coulomb's constant	k	$9,0 \times 10^{9}\ N\cdot m^2\cdot C^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

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

FORCE

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

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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MARKING GUIDELINE

NB: This marking guideline consists of 8 pages.

QUESTION ONE

1.1 A ✓✓
1.2 C ✓✓
1.3 B ✓✓
1.4 D ✓✓
1.5 C ✓✓
1.6 D ✓✓
1.7 C ✓✓

7 x 2 = [14]

QUESTION TWO

2.1

2.1.1 It is a single force that can represent a number of forces acting on an object in both magnitude and direction. ✓✓ (2 or 0) (2)

2.1.2 **OPTION 1** : $\Sigma Rx = (-240) + (-200\cos 40^0) + (350\cos 70^0)$ ✓= - 273,502 N

OPTION 2 : $\Sigma Rx = (-240) + (-200\sin 50^0) + (350\sin 20^0)$ ✓= - 273,502 N

OPTION 3 : $\Sigma Rx = 240\cos 180^0 + 200\cos 220^0 + 350\cos 70^0$ ✓ = - 273,502 N

OPTION 1 : $\Sigma Ry = 350\sin 70^0 + (-200\sin 40^0)$ ✓= 200,335 N

OPTION 2 ; $\Sigma Ry = (350\cos 20^0) + (-200\cos 50^0)$ ✓= 200,335 N

OPTION 3 : $\Sigma Ry = 350\sin 70^0 + 200\sin 220^0$ ✓= 200,335 N

$R_{NET}^2 = R_X^2 + R_Y^2$

$= (-273{,}502)^2$ ✓+ $(200{,}335)^2$✓

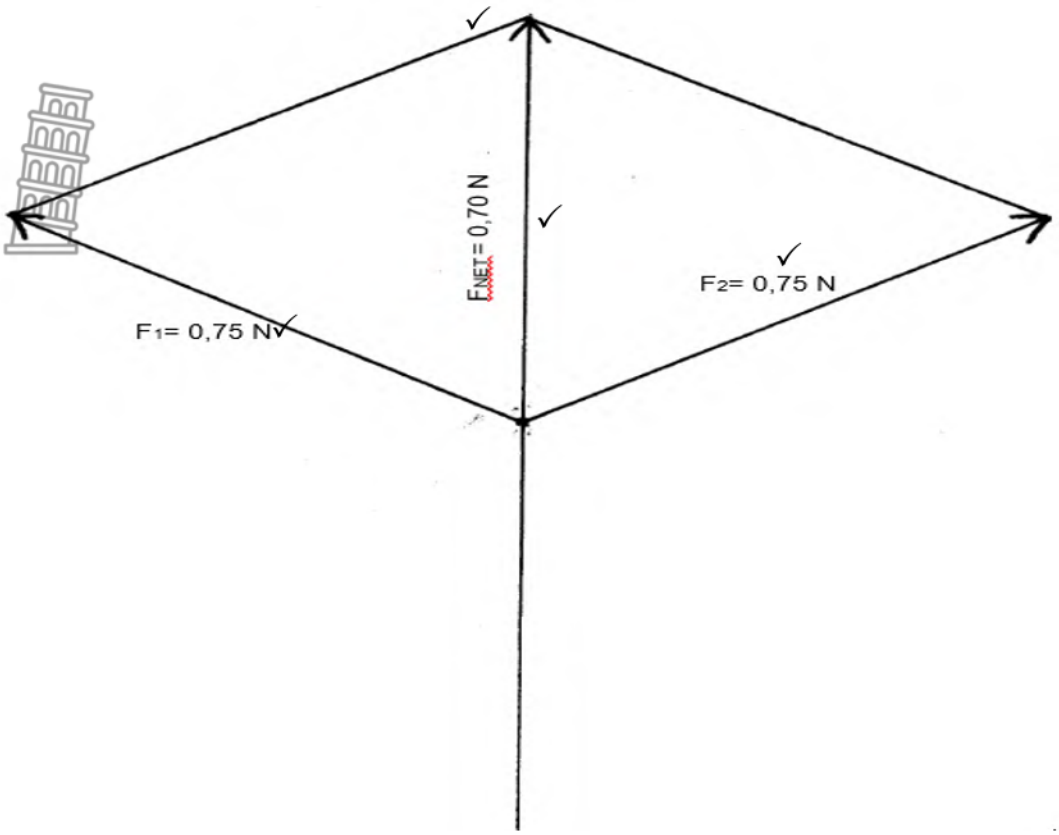
R_{NET} = 339,02 N ✓ (Accept 339,024 N) (5)

2.2

2.2.1 $F_1 = mg = (0{,}077)(9{,}8)$ ✓= 0,755 N✓ (2)

2.2.2 Using a mirror allows for a more accurate marking of the string. ✓ The shadow of the string (on the page) appears to change when viewed from different angles (Error of parallax) ✓. (2)

2.2.3



Marking Rubric : Force diagram	
Criteria	Mark allocation
Both forces F_1 and F_2 drawn correctly	2 mark
Parallelogram completed	1 mark
Resultant force drawn correctly (Range 6,8 -7,2)	1 mark

(4)

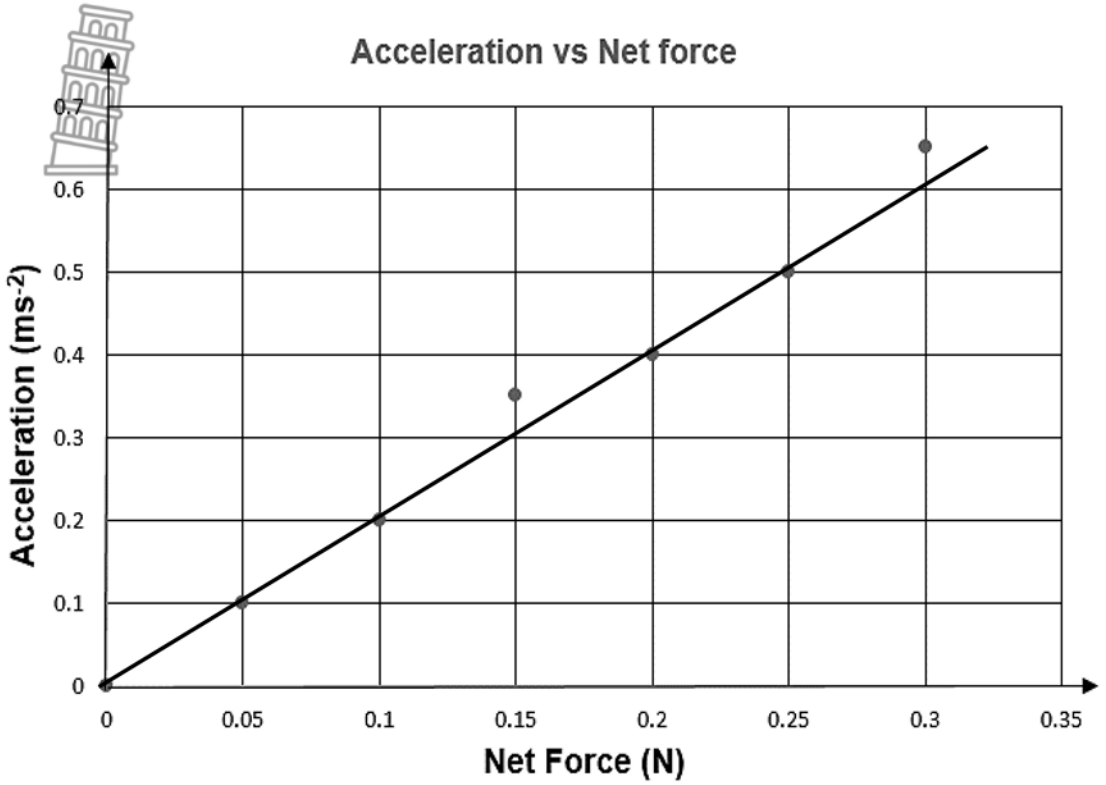
2.2.4 Mass of x = 0,086 kg✓✓ (2)

[17]

QUESTION 3

3.1.1 mass✓ (1)

3.1.2



Criteria	Mark allocation
line of best fit correctly drawn through the points	1

(1)

3.1.3 Directly proportional ✓ (1)

3.1.4 0,5 ms^{-2} ✓✓ (2)

3.1.5 $\frac{1}{m} = \frac{\Delta a}{\Delta F_{net}}$

$\frac{1}{m} = \frac{0,7 - 0}{0,35 - 0}$ ✓✓

m = 0,5 kg ✓

OR

$F_{NET} = ma$

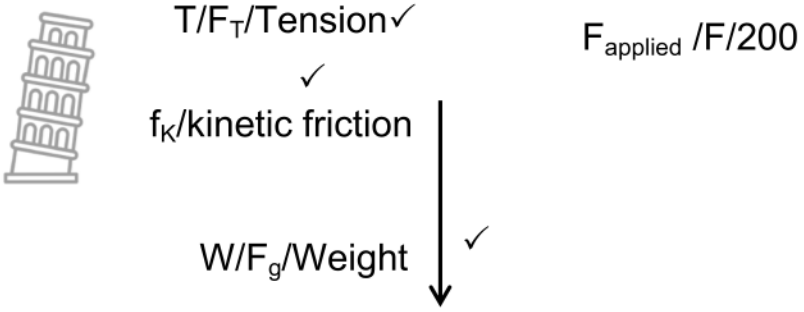
0,35 = m(0,7)

m = 0,5 kg

(3)

3.2.1 If a non zero <u>resultant force</u> acts on an object at rest, the object accelerates in the direction of the resultant force, this <u>acceleration is directly proportional to the force</u> ✓and <u>inversely proportional to the mass of the object.</u>✓ (2)

3.2.2



(5)

3.2.3

50 kg block		**25 kg block**
$F_{Net} = ma$ ✓		$F_{Net} = ma$
$F_T + (-f_k) = 50(1,25)$ ✓		$200 + (-½ f_k) + (-F_T) = 25(1,25)$
$F_T = 62,5 + f_k$ …..(1)		$200 - ½ f_k - F_T = 31,25$ ✓….(2)
Substitute (1) in (2)		
$200 - ½ f_k - (62,5 + f_k) = 31,25$	**OR**	$200 - ½ f_k - (62,5 + f_k) = 31,25$
$f_k = 70,833$ N		$f_k = 70,833$ N

$f_k = \mu_k F_N$ ✓
70,833✓ = μ_k (50)(9,8)✓
μ_k = 0,144

(6)

POSITIVE MARKING FROM Q 3.2.3

3.2.4

$F_T = 62,5 + f_k$	**OR**	$200 - ½ f_k - F_T = 31,25$
$= 62,5 + 70,833$ ✓		$200 - ½ (70,833) - F_T = 31,25$✓
$= 133,33$ N ✓		$F_T = 133,33$ N ✓

(2)

3.3.1 INCREASES✓ (1)

3.3.2 DECREASES ✓
Normal force increases✓
Frictional force increases✓
Net force decreases✓ (4)

POSITIVE MARKING from Q 3.3 to 3.4.1

3.4.1 $Fg_{//} = mg\sin\theta$
$= (5,8)(9,8)\sin 25^0$ ✓
$= 24,022$ N

$F_{Net} = ma$
$F + (-f_K) + (-Fg_{//}) = ma$
$F - (51,51) - (24,022)$✓ = 0 ✓
F = 75,53 N ✓

(4)

3.4.2 The block will <u>continue in its original direction of motion</u> ✓✓by virtue of its inertia. Thereafter it will come to rest ✓(since the kinetic friction is greater than the component of weight (Fg//) acting parallel and down the incline.) (3)

[35]

QUESTION 4

4.1 Every body in the universe attracts every other body with a gravitational force that is directly proportional to the product of their masses✓ and inversely proportional to the square of the distance between their centres. ✓
(Marks must only be awarded if the definition is in context with the gravitational law) (2)

4.2 $F = \frac{Gm_1m_2}{r^2}$✓

10500✓ $= \frac{6{,}67 \times 10^{-11} \cdot 6\,x10^{24} \cdot 1500}{(R)^2}$ ✓

R = 7,56 x 10^6 m

Distance above the surface of the Earth = 7,56 x10^6 – 6,38 x 10^6✓

= 1,18 x 10^6 m

= 1,18 x 10^3 km✓ (5)

[7]

QUESTION 5

5.1.1 Total charge in an isolated system remains constant (2)

5.1.2 $Q = \frac{Q_1+Q_2+Q_3}{3}$

$= \frac{(-2 \times 10^{-11}) + 6 \times 10^{-11} + (-5 \times 10^{-11})}{3✓\ (dividing\ by\ 3)}$✓

= – 3,33 X10 $^{-12}$ C✓ (3)

5.1.3 $6 \times 10^{-11} + x = -3{,}33 \times 10^{-12}$✓

x = – 6,33 x 10^{-11} C✓

During contact sphere B gains electrons (negative charge).✓ (3)

5.2.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges ✓and inversely proportional to the square of the distance (r) between them✓. (2)

5.2.2 $F = \frac{k Q_1 Q_2}{r^2}$ ✓

$= \frac{9 \times 10^9 \cdot 4 \times 10^{-9} \cdot 8 \times 10^{-9}}{(0,25)^2}$ ✓✓

$= 4,61 \times 10^{-6}$ N✓ (4)

5.2.3 **POSITIVE MARKING FROM Q5.2.3**

$F = \frac{k Q_1 Q_2}{r^2}$

$= \frac{9 \times 10^9 \cdot 12 \times 10^{-9} \cdot 8 \times 10^{-9}}{(x)^2}$ ✓

$F_{NET} = 0$ ✓

$4,61 \times 10^{-6}$ ✓ $- \frac{9 \times 10^9 \cdot 12 \times 10^{-9} \cdot 8 \times 10^{-9}}{(x)^2}$ ✓ $= 0$

$4,61 \times 10^{-6} = \frac{9 \times 10^9 \cdot 12 \times 10^{-9} \cdot 8 \times 10^{-9}}{(x)^2}$

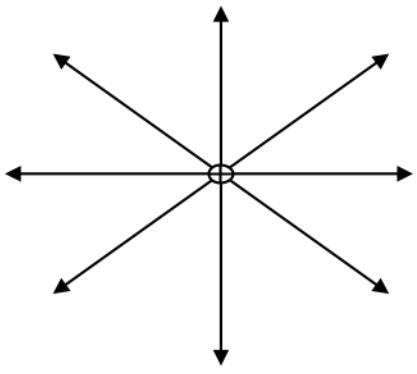
$x = 0,433$ m✓ (5)

[19]

QUESTION 6

6.1 Electric field is a region (in space)✓ where (in which) an (electric) charge experiences a (electric) force. ✓ (2)

6.2.1



Criteria	Mark allocation
All direction of arrows correctly drawn,field lines do not cross each other	1
Correct shape	1

(2)

6.2.2 $E = \frac{k \cdot Q}{r^2}$ ✓

$= \frac{9x10^{9} \cdot 8x10^{-9}}{(0,18)^2}$ ✓ ✓

$= 2222,22\ N \cdot C^{-1}$ ✓ (4)

[8]

TOTAL : 100