KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES

COMMON TEST

MARCH 2024

TIME: 2 hours

MARKS: 100

This question paper consists of 15 pages including TWO data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

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

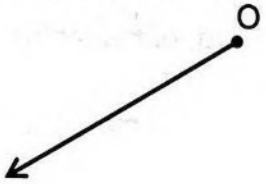
QUESTION 1

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 1.8E

1.1 Which of the following pairs of physical quantities are BOTH vectors?

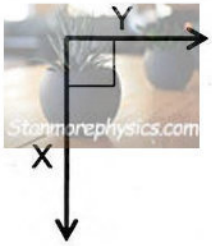
A Displacement and speed
B Acceleration and force
C Force and mass
D Distance and electric field (2)

1.2 The resultant of two forces, X and Y acting at a common point O is shown below. The angle between the two forces is 90^0.

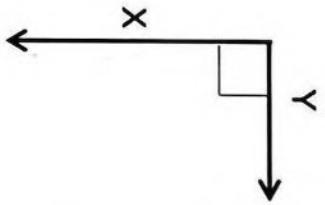


Which ONE of the following vector diagrams, not drawn to scale, is the correct representation of the directions of X and Y?

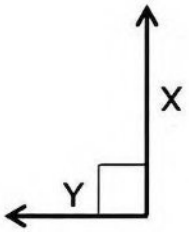
A



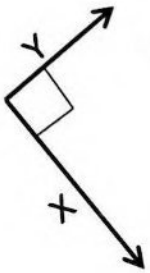
B



C

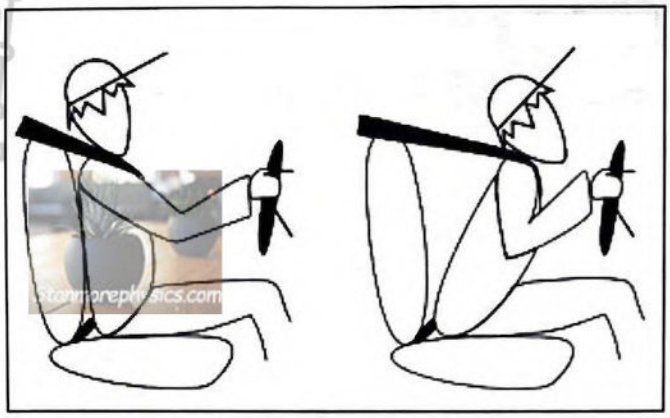


D



(2)

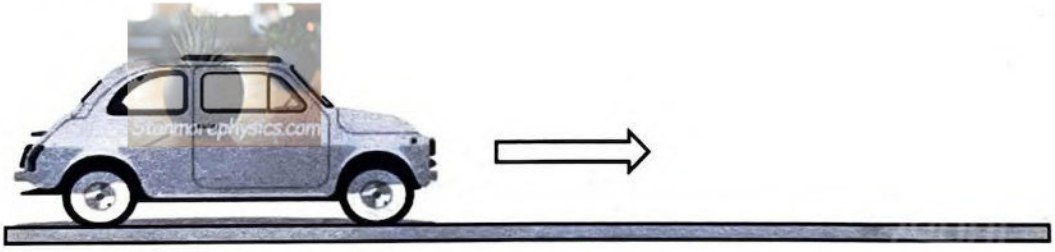
1.3 The diagram below shows the motion of the driver of a car when he stops the car suddenly. The driver is wearing a seat belt.



When the brakes are applied, the driver moves forward, but is restricted by the seat belt.
How does the force that the driver exerts on the seatbelt compare to the force that the seatbelt exerts on the driver?

A Greater than and in the same direction.
B Greater than and in the opposite direction.
C Equal to and in the same direction.
D Equal to and in the opposite direction. (2)

1.4 The diagram below shows a car covering equal displacements in equal time intervals.



Which ONE of the following statements is true for the motion of the car?

A The car speeds up uniformly.
B The car slows down uniformly.
C The car is travelling at constant velocity.
D A net force acts on the car in the forward direction. (2)

1.5 A body of mass ***m*** is in a state of *weightlessness*. Which ONE of the following statements concerning the weight and inertia of the body is TRUE?

A The body has weight and experiences inertia.
B The body has no weight and does not experience inertia.
C The body has weight and does not experience inertia.
D The body has no weight and experiences inertia. (2)

1.6 The electrostatic force that two charged spheres exert on each other is ***F*** when they are placed a distance ***r*** metres apart. The charge on each sphere is now tripled and the distance between them is ½ ***r***. The force that the spheres exert on each other will now be …

A 9 ***F***
B 18 ***F***
C 27 ***F***
D 36 ***F*** (2)

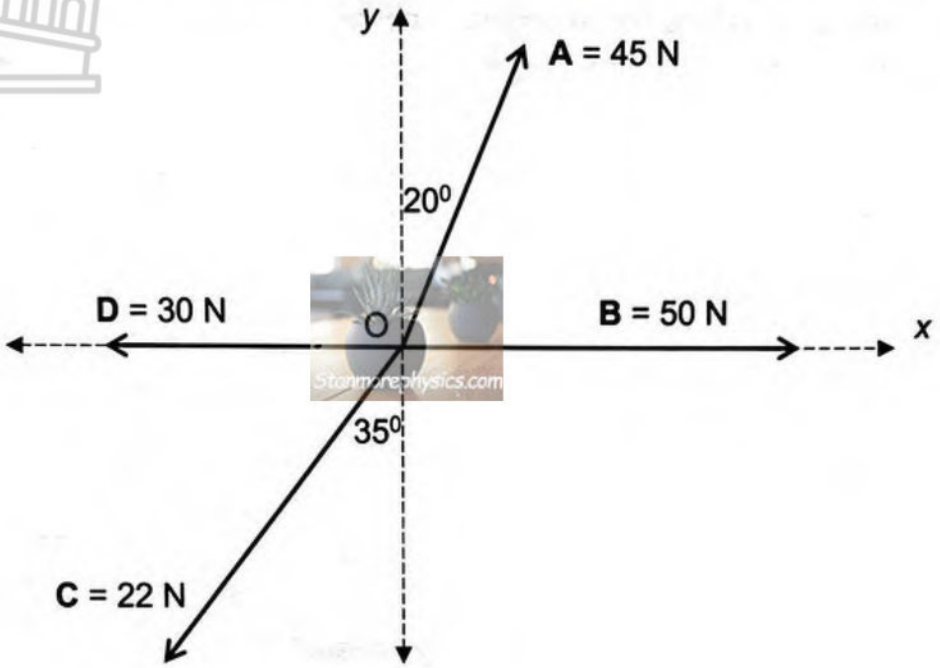
1.7 A test charge is placed at point P in an electric field generated by a point charge. The magnitude of the electric field at point P is given by:

A The ratio of the force experienced by the test charge to the magnitude of the test charge.
B The product of the force experienced by the test charge and the magnitude of the test charge.
C The ratio of the force experienced by the test charge to the magnitude of the point charge.
D The product of the force experienced by the test charge and the magnitude of the point charge. (2)

[14]

QUESTION 2

Four forces **A**, **B**, **C** and **D** of magnitudes 45 N ,50 N, 22 N and 30 N respectively, act on a point **O** in the directions shown below. The forces are NOT drawn to scale.



2.1 Define the term *resultant* vector. (2)

2.2 Calculate:

2.2.1 the vector sum of the HORIZONTAL components of the forces. (2)

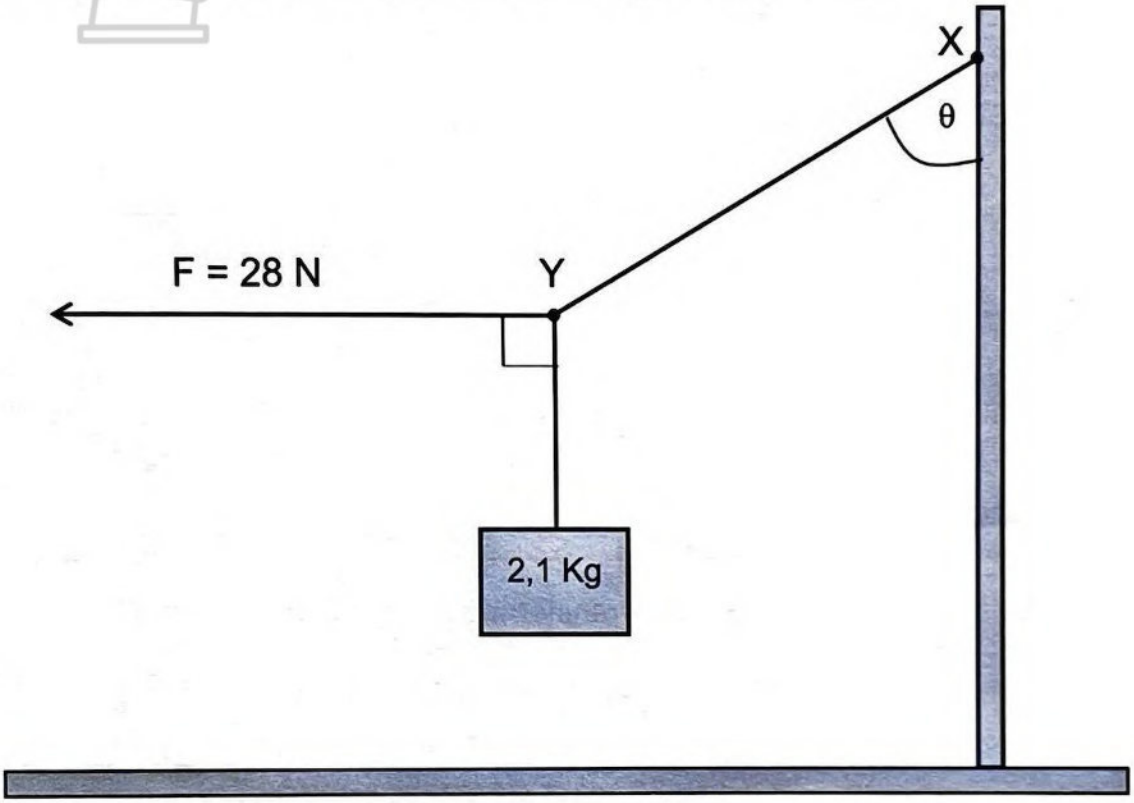
2.2.2 the vector sum of the VERTICAL components of the forces. (2)

2.3 Using your answers to questions 2.2.1 and 2.2.2 above, draw a labelled vector diagram. Show the resultant force on this diagram. (Do not draw to scale) (3)

2.4 Calculate the magnitude and direction of the resultant force acting at point **O**. (5)
[14]

QUESTION 3

A light, inextensible rope is attached to a vertical wall at point X.
A block of mass 2,1 kg is attached to the other end of the rope. The rope is pulled to the left by a horizontal force F of magnitude 28 N, applied at point Y, as shown in the diagram below. The rope makes an angle θ with the wall.



3.1 Draw a closed vector diagram to show ALL the forces acting at point Y. Include at least one angle in your diagram. (4)

3.2 Calculate:

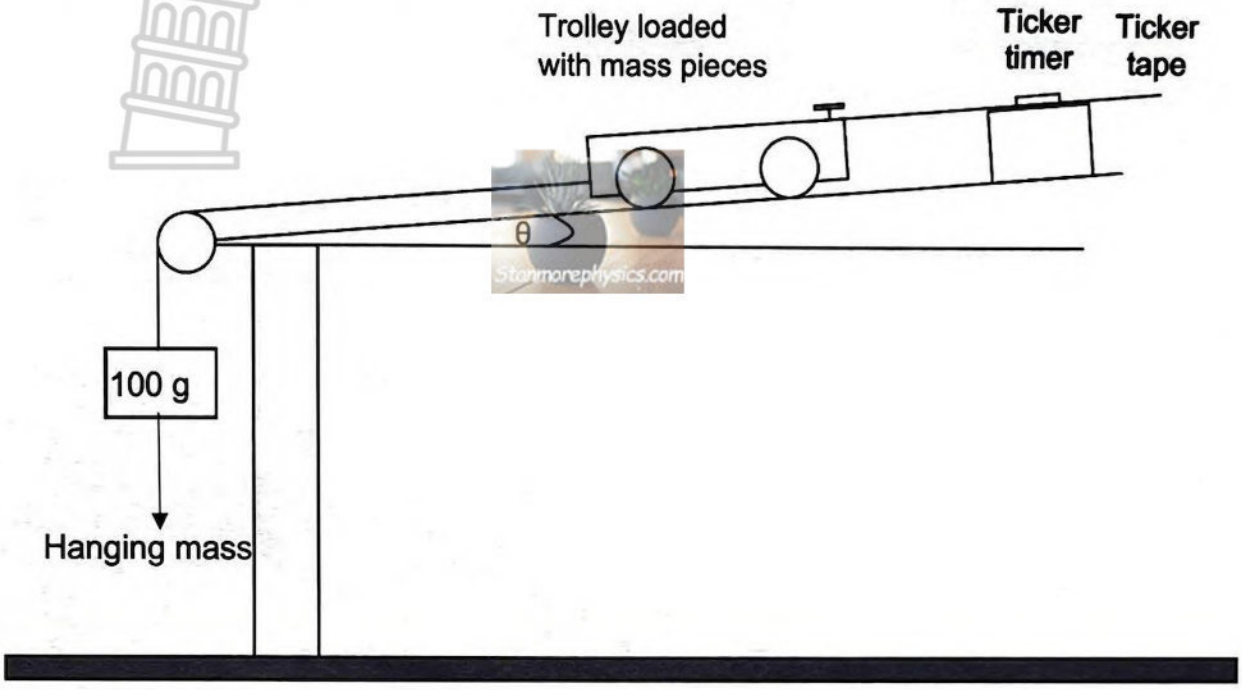
3.2.1 the tension in the rope (3)

3.2.2 angle θ (2)

[9]

QUESTION 4

A Physical Sciences class sets up an experiment to investigate Newton's Second Law of motion. They set up the apparatus as shown below.



The net force acting on the trolley was increased by transferring mass pieces from the trolley to the hanging mass.
The experiment was done five times, and the data collected is shown below.

Readings	Hanging mass(g)	Net Force(N)	Acceleration(ms^{-2})
1	100	0.98	0,5
2	200	1.96	1,0
3	300	2.94	1,5
4	400	3.92	2,0
5	500	X	Y

4.1 State *Newtons Second Law of motion* in words. (2)

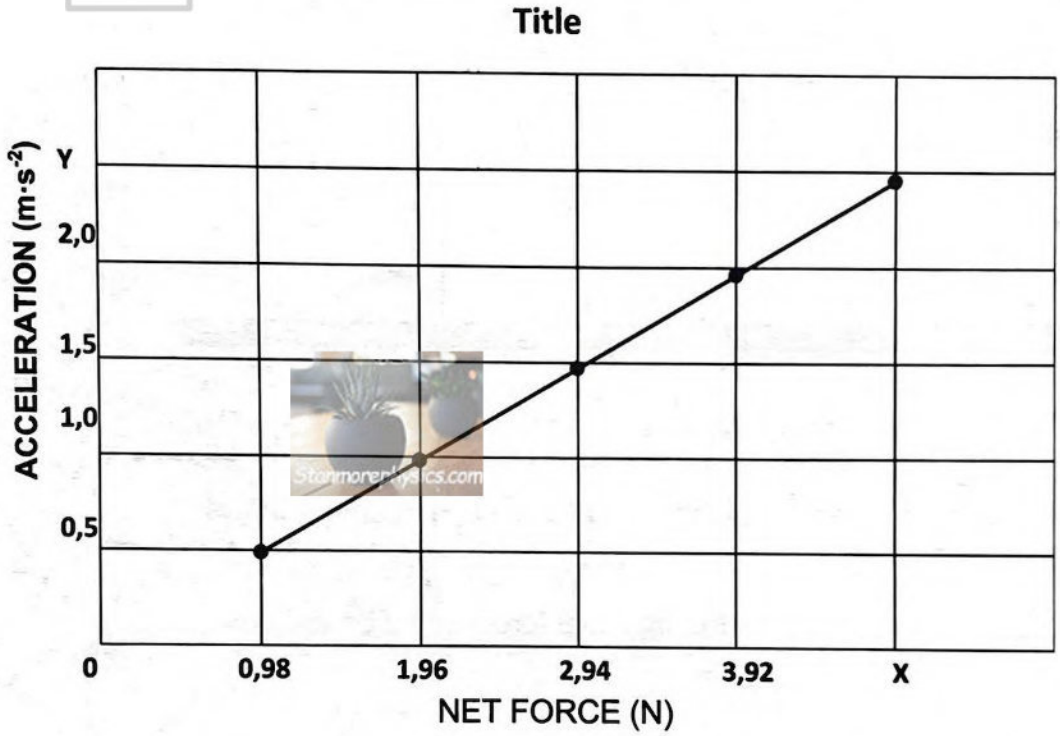
4,2 Write down an investigative question for this experiment. (2)

4.3 State one variable that should be kept constant during the experiment. (1)

4.4 Write down the numerical values of X and Y given in the table. (2)

4.5 The track along which the trolley moves is CORRECTLY inclined to compensate for friction. If the track makes an angle of 8° with the horizontal, calculate the coefficient of kinetic friction for the surface. (4)

4.6 The graph below was plotted using the data from the table.



4.6.1 Calculate the gradient of the graph. (3)

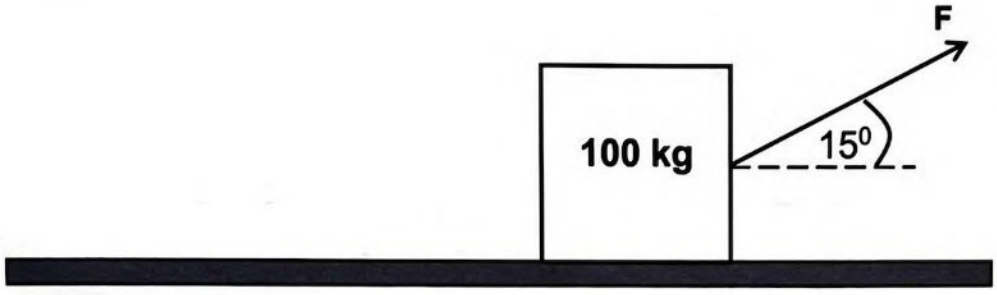
4.6.2 What quantity does the gradient of the graph represent? (2)

4.6.3 Calculate the mass of the system. (2)

[18]

QUESTION 5

5.1 A box of mass 100 kg is at rest on a rough horizontal surface. When a force of magnitude **F** is applied to the box at an angle of 15° to the horizontal, as shown in the diagram below, the box moves to the right at CONSTANT VELOCITY.



The co-efficient of kinetic friction between the box and the surface is 0,5.

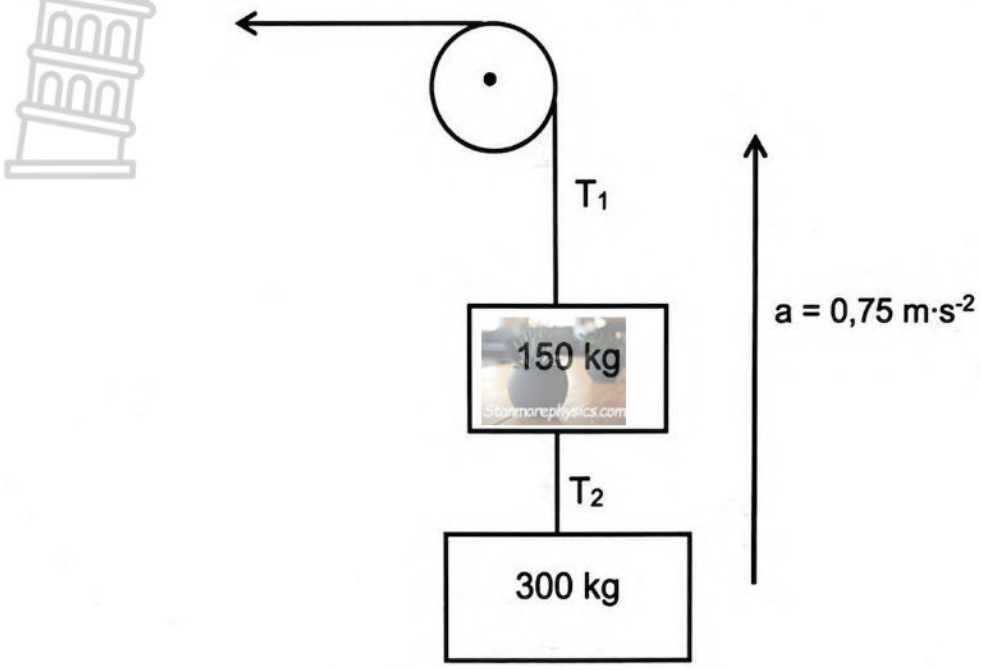
5.1.1 Show that the magnitude of the normal force acting on the box is given by 980 – 0,259 **F**. (2)

5.1.2 Calculate the magnitude of the frictional force acting on the box in terms of **F**. (2)

5.1.3 Hence calculate the magnitude of **F**. (3)

5.1.4 How will the magnitude of the frictional force change if the size of the angle is doubled?
Choose from INCREASES, DECREASES OR REMAINS THE SAME. (1)

5.2 A crane lifts two blocks of masses of 150 kg and 200 kg as shown in the diagram below. The 150 kg block accelerates upwards at 0,75 m·s^{-2}.



5.2.1 Draw a labelled free body diagram to show all the forces acting on the 150 kg block. (3)

5.2.2 Calculate the magnitude of the tension T_1. (5)

5.3 An object falling freely near the surface of planet Mars experiences a gravitational acceleration of 3,8 m·s^{-2}. The mass of Mars is 6,4 x 10^{23} kg.

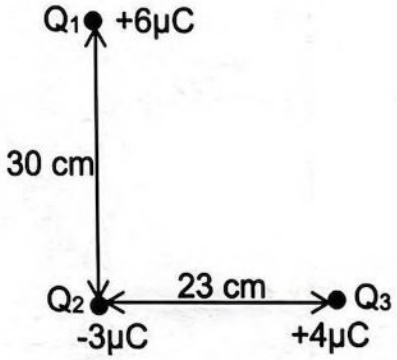
5.3.1 State *Newton's law of universal gravitation* in words. (2)

5.3.2 Calculate the radius of Mars. (4)

5.3.3 What is the weight of the object on Earth's surface if it has a mass of 6,45 kg? (2)
[24]

QUESTION 6

Three point charges, Q_1, Q_2 and Q_3 are placed in a vacuum.
The charges on Q_1, Q_2 and Q_3 are +6 µC, -3µ C and +4 µC respectively. The spheres are arranged so that Q_1 and Q_2 are 30 cm apart, and Q_3 is 23 cm away from Q_2 as shown in the diagram. The line joining Q_1 and Q_2 is perpendicular to the line joining Q_2 and Q_3.



6.1 State *Coulombs Law of Electrostatics* in words. (2)

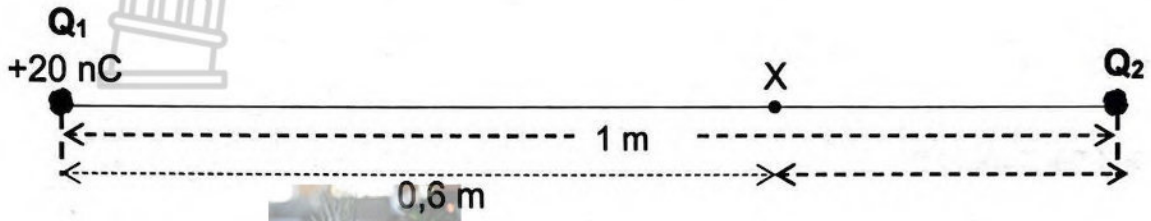
6.2 Draw a FORCE diagram showing the electrostatic forces exerted by charges Q_1 and Q_3 on Q_2. (2)

6.3 Calculate the magnitude of the net electrostatic force exerted on charge Q_2 by charges Q_1 and Q_3. (5)

[9]

QUESTION 7

Two point charges Q_1 and Q_2 are placed 1 m apart. The magnitude of Q_1 is +20 nC and is placed 0,6 m from point **X** as shown in the diagram below.



7.1 DESCRIBE an *electric field*. (2)

7.2 If the net electric field at point X is 1300 $N \cdot C^{-1}$ to the right, determine the MAGNITUDE and SIGN of the charge on Q_2. (5)

7.3 Charge Q_1 is now removed. Draw the electric field pattern for Q_2. (2)

7.4 Calculate the magnitude of the net electrostatic force that an electron would experience if it is placed at point X. (3)
[12]

TOTAL : 100 MARKS

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	$6,4 \times 10^{6}\ m$
Mass of the Earth	M_E	$5,98 \times 10^{24}\ kg$
Charge on the electron	e	$-1,6 \times 10^{-19}\ C$

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 $n=\frac{Q}{q_e}$	

Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

MARKING GUIDELINES

COMMON TEST

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GRADE 11

NB: This memorandum consists of 7 pages.

QUESTION ONE

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

7 x 2 = [14]

QUESTION TWO

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

2.2.1 **OPTION 1** : Σ Rx = (–30) +(50) + (-22cos55^0)+(45 cos70^0) ✓= 22,772 N✓

OPTION 2 : Σ Rx = (–30) + (50) +(-22sin35^0)+(45sin20^0) ✓= 22,772 N✓

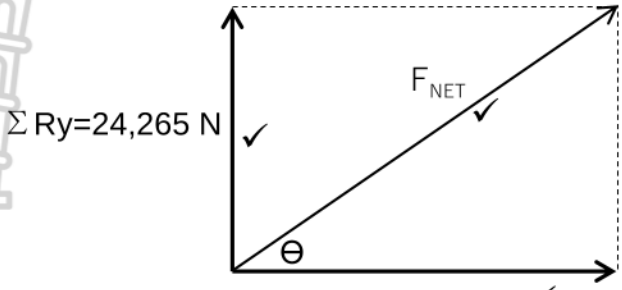
OPTION 3 : Σ Rx = 50cos0^0+30 cos180^0 + (45cos70^0)+22cos235^0 ✓ = 22,772 N ✓ (2)

2.2.2 **OPTION 1** : Σ Ry = 45 sin 70^0 + (– 22sin55^0) ✓= 24,265 N ✓

OPTION 2 ; Σ Ry = (45 cos 20^0) +(– 22cos35^0) ✓= 24,265 N✓

OPTION 3 : Σ Ry = 45 sin 70^0 + 22 sin 235^0 ✓= 24,265 N✓ (2)

2.3 **Positive marking from Question 2.2**



2.3 ΣRx =22,772 N ✓

Marking Rubric : Force diagram	
Criteria	Mark allocation
Force ΣRx drawn correctly	1 mark
Force ΣRy drawn correctly	1 mark
Resultant force drawn correctly	1 mark

(3)

2.4

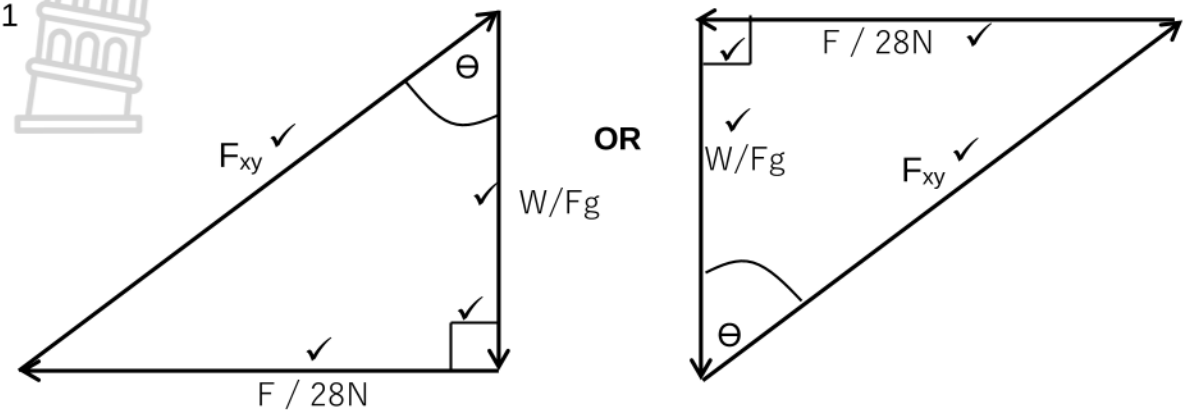
$$R_{NET}^2 = R_X^2 + R_Y^2$$
$$= (22,772)^2 \checkmark + (24,265)^2 \checkmark$$
$$R_{NET} = 33,28\ N \checkmark$$
$$\text{Tan } \Theta = \frac{24,265}{22,772} \checkmark$$
$$\Theta = 46,82° \checkmark \text{ (North of East)} \quad \text{OR at a bearing of } 43,18°$$

(5)

[14]

QUESTION 3

3.1



Marking Rubric : Force diagram	
Criteria	Mark allocation
Three forces drawn correctly and labelled.	3 x 1 mark
At least one angle correctly drawn	1 mark

(4)

3.2.1 $F_{xy}^2 = (28)^2$✓ + $(20,58)^2$✓
$= 34,7$ N✓ (3)

3.2.2 $\tan \Theta = \frac{28}{20,58}$✓
$\Theta = 53,68^0$✓ (2)

[9]

QUESTION 4

4.1 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)

4.2 What is the relationship <u>between the acceleration of the trolley and the net forced exerted on it?</u> ✓✓ (2)

4.3 The mass of the system, the gradient of the track, the frequency of the timer, The friction experienced by the trolley along the track. (Accept any one) ✓ (1)

4.4 X : <u>4,9</u> N✓
Y: <u>2,5</u> ms^{-2}✓ (2)

4.5 $F_{g//} = f_k$
$mg \sin\theta$ ✓ = $\mu_k mg \cos\theta$✓
$\mu_k = \frac{sin\theta}{cos\theta} = \frac{\sin 8°}{cos8°}$✓
μ_k = 0,14✓ (4)

4.6.1 Gradient/m = $\frac{\Delta a}{\Delta Fnet}$
$= \frac{1,5-0}{2,94-0}$✓ ✓ (or any other set of values from the graph)
= 0,51✓(kg^{-1})
(3)

4.6.2 Inverse of mass✓✓ (2)

4.6.3 **Positive marking from question 4.6.1**
$\frac{1}{m}$ = 0,51✓
m = 1,96 kg✓ (2)

[18]

QUESTION 5

5.1
5.1.1 $F_N + F\sin\theta = F_g$
$F_N = F_g - F\sin\theta$ } Any 1✓
$= \underline{100(9,8) - F\sin15°}$✓
= 980 - 0,259 F (2)

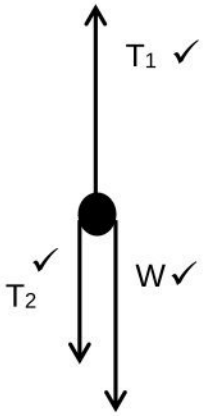
5.1.2 $f_k = \mu_k F_N$ ✓
$= \underline{0,5(980 - 0,259F)}$
f_k = + 490 - 0,129F✓ (2)

5.1.3 $F\cos15^0 + (-f_k) = 0$
$F\cos15^0 = f_k$ } Any 1✓
$\underline{0,966\ F = 490 - 0,129F}$ ✓
F= 447,49 N✓ (3)

5.1.3 Decreases✓ (1)

5.2.1

15 kg



(3)

5.2.2 **150 kg** **300 kg**

$F_{Net} = ma$
$T_1+(-T_2)+(-W_{15kg})= ma$ ✓ any one

$F_{Net} = ma$
$T_2 + (-300 \times 9,8) = 300(0,75)$

$T_2 = 3165$ N

$\underline{T_1+(-3165)+[-(150\times9,8)]}$ ✓ $= \underline{150(0,75)}$ ✓

$T_1 = 4747,5$ N ✓

(5)

OR

5.2.2 **150 kg** **200 kg**

$F_{Net} = ma$
$T_1+(-T_2)+(-W_{15kg})= ma$ ✓ any one

$F_{Net} = ma$
$T_2 + (-200 \times 9,8) = 200(0,75)$

$T_2 = 2110$ N

$\underline{T_1+(-2110)+(-(150\times9,8))}$ ✓ $= \underline{150(0,75)}$ ✓

$T_1 = 3692,5$ N ✓

(5)

5.3.1 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)

5.3.2 $a = \frac{Gm}{r^2}$ ✓

$3{,}8$ ✓ $= \dfrac{6{,}67 \times 10^{-11} \cdot 6{,}4 \times 10^{23}}{r^2}$ ✓

$r = 3{,}35\ x10^{6}\ m$ ✓ (4)

5.3.3 W=mg

= (6,45 x 9,8) ✓

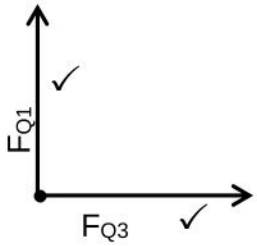
= 63,21 kg ✓ (2)

[24]

QUESTION 6

6.1 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)

6.2



(2)

6.3 $F_{Q3 \rightarrow Q2}$

$$F = \frac{kQ_1Q_2}{r^2} \quad \checkmark$$

$$= \frac{9\times10^9(3\times10^{-6})(4\times10^{-6})}{(0,23)^2} \checkmark$$

$$= 2,04 \text{ N}$$

$F_{Q1 \rightarrow Q2}$

$$F = \frac{kQ_1Q_2}{r^2}$$

$$= \frac{9\times10^9(6\times10^{-6})(3\times10^{-6})}{(0,3)^2} \checkmark = 1,80 \text{ N}$$

$$F_{NET}^2 = (F_{Q3})^2 + (F_{Q1})^2$$

$$= (2,04)^2 + (1,8)^2 \checkmark$$

$$F_{NET} = 2,72 \text{ N} \checkmark$$

(5)

[9]

QUESTION 7

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

7.2 $E = \frac{kQ}{r^2}$ ✓

$= \frac{9\times10^{9}\,(20\times10^{-9})}{(0,6)^2}$ ✓

$= 5\,00\ N\cdot C^{-1}$

$E_{NET} = E_{Q1} + E_{Q2}$

$1300 = 500 + E_{Q2}$ ✓

$E_{Q2} = 800\ N\cdot C^{-1}$

$E = \frac{kQ}{r^2}$

$800 = \frac{9\times10^{9} \times Q_2}{(0,4)^2}$ ✓

$Q_2 = 1,42 \times 10^{-8}\ C$ negative ✓ (5)

7.3 Positive marking from question 7.2

- Correct pattern✓
- Arrow direction✓

(2)

7.4 $F = q_eE$ ✓

$= (1,6 \times 10^{-19})(1300)$ ✓

$= 2,08 \times 10^{-16}\ N$ ✓ (3)

[12]

TOTAL : 100 MARKS