KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES

COMMON TEST

MARCH 2022

TIME: 1,5 hours

MARKS: 75

This question paper consists of 10 pages, two data sheets and a detachable answer sheet for question 2.2.3

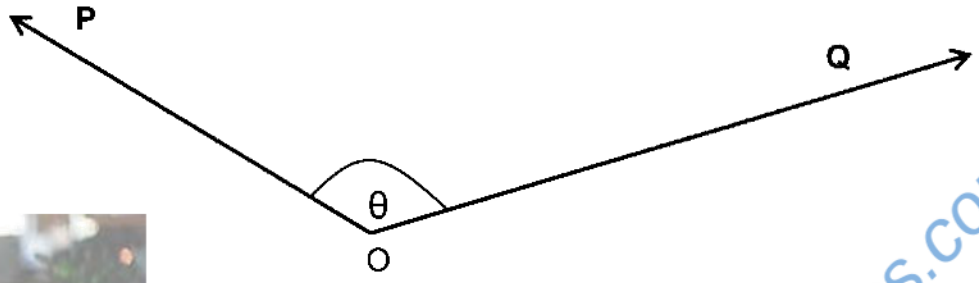
INSTRUCTIONS AND INFORMATION TO CANDIDATES

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 —1.5) in the ANSWER BOOK, for example 1.6 D.

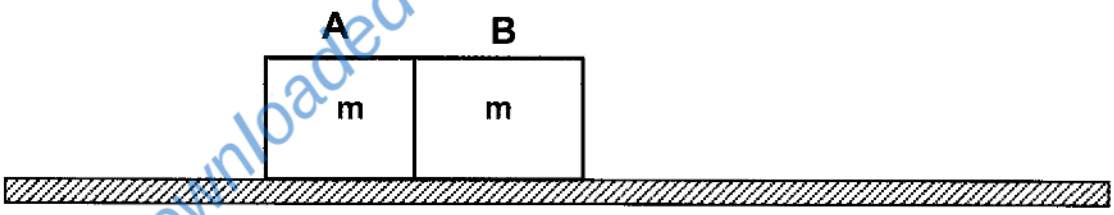
1.1 Two forces P and Q act at the same point O as shown in the sketch below.



When the angle θ between the forces changes, the resultant force obtained is 12 N .If the magnitude of force P is 4 N,which of the forces given below CANNOT be the magnitude of force Q?

A 8 N
B 11,31 N
C 2 N
D 10 N (2)

1.2 Two blocks A and B of identical mass **m** are in contact with each other on a rough surface. Block B is pushed to the left so that it exerts a force F on block A.



The force that block A exerts on block B, in terms of F, is…

A F, to the left
B ½ F, to the left
C ½ F, to the right
D F, to the right (2)

1.3 The gravitational force of attraction between two large masses is F. If the distance between the centres of the masses is doubled, the force between them will be

A ¼ F
B 2 F
C 4 F
D ½ F (2)

1.4 Which ONE of the following has a dative covalent bond?

A NH_3
B H_2O
C OH^-
D NH_4^+ (2)

1.5 Which one of the following combinations is correct if the number of bonding electron pairs between two identical atoms is increased?

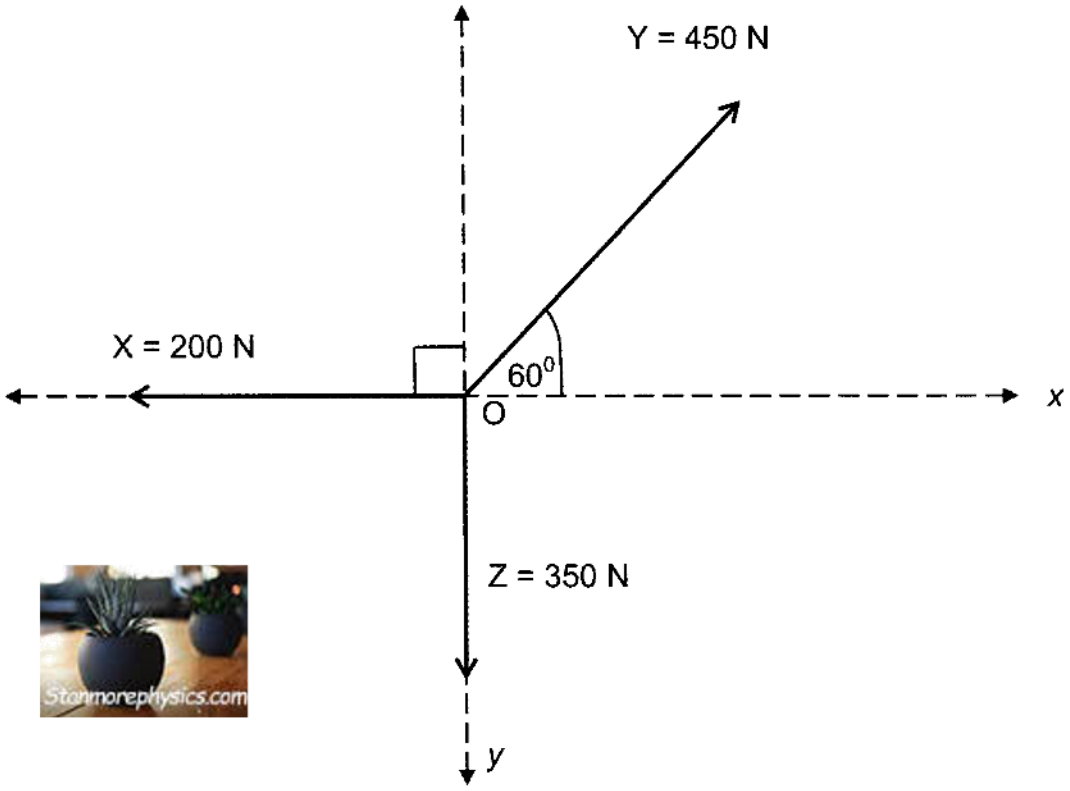
	Bond Length	Bond Energy
A	increases	increases
B	decreases	decreases
C	decreases	increases
D	increases	decreases

(2)

[10]

QUESTION 2

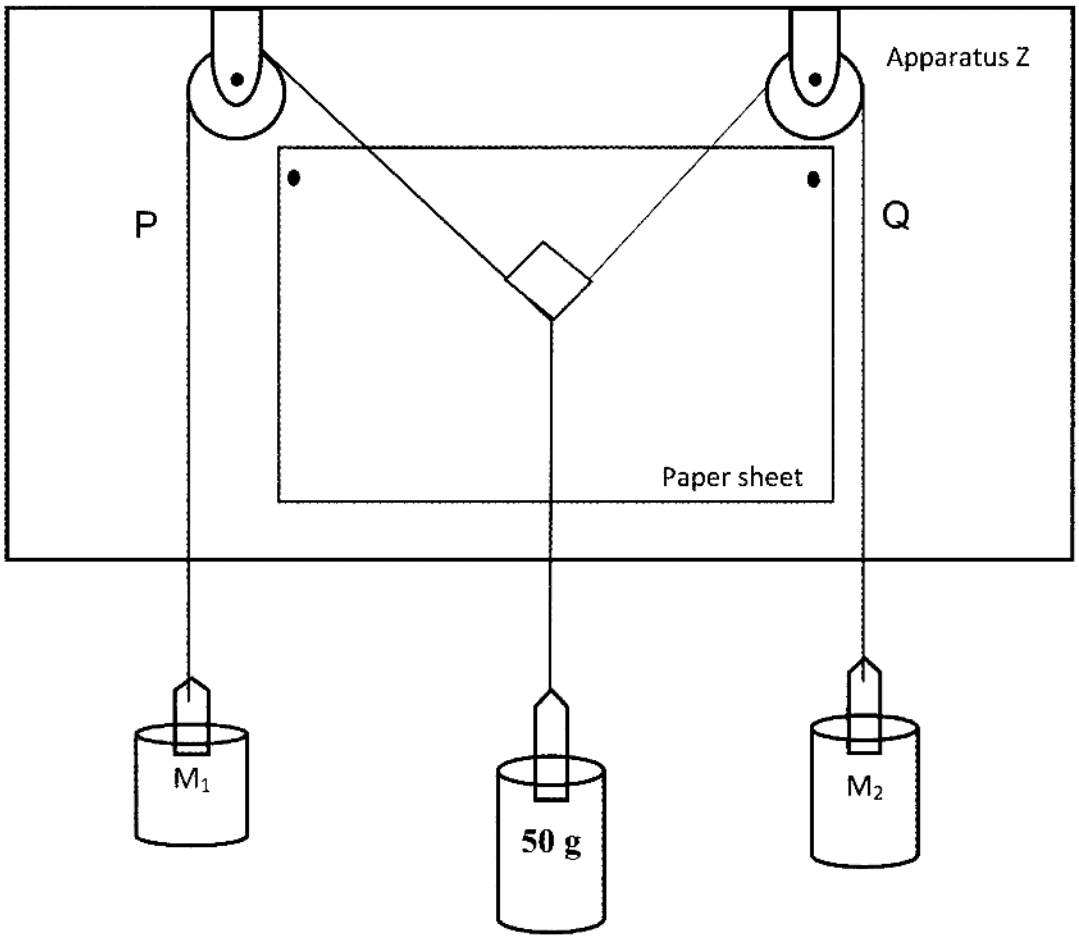
2.1 Three forces X, Y and Z of magnitudes 200 N ,450 N and 350 N respectively, act at a point O in the directions shown below. The forces are NOT drawn to scale.



2.1.1 Define *resultant force.* (2)

2.1.2 Calculate the magnitude of the resultant force of these three forces. (5)

2.2 The apparatus shown below was used to determine the resultant of two co-planar forces P and Q.



The angle between the forces P and Q is 90^0 and the masses M_1 and M_2 are identical.

2.2.1 Name the apparatus, Z, to which the paper sheet is attached. (1)

2.2.2 A learner states that the system is in a state of static equilibrium. State two conditions necessary for this system to remain in this state. (2)

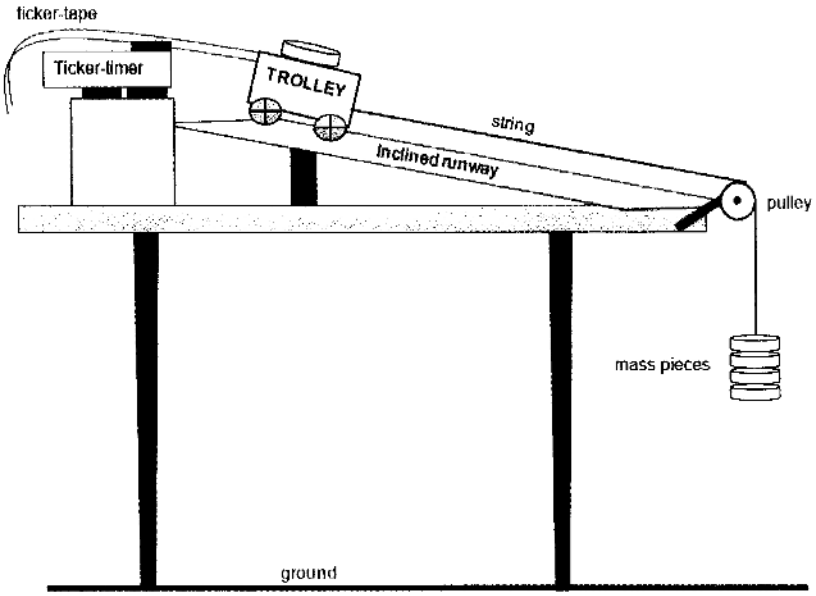
2.2.3 ***An incomplete diagram for the results of this investigation is given on page 14 of this question paper.***
Complete the diagram using a scale of 10mm = 0,1 N and determine the magnitude of the forces P and Q. (4)

2.2.4 The 50 g mass piece is now replaced by an 80 g mass piece. How will this affect the magnitude of the resultant force of P and Q when the system re-establishes a state of static equilibrium?
Choose from INCREASES, DECREASES OR REMAINS THE SAME. (2)
Give a reason for the answer.

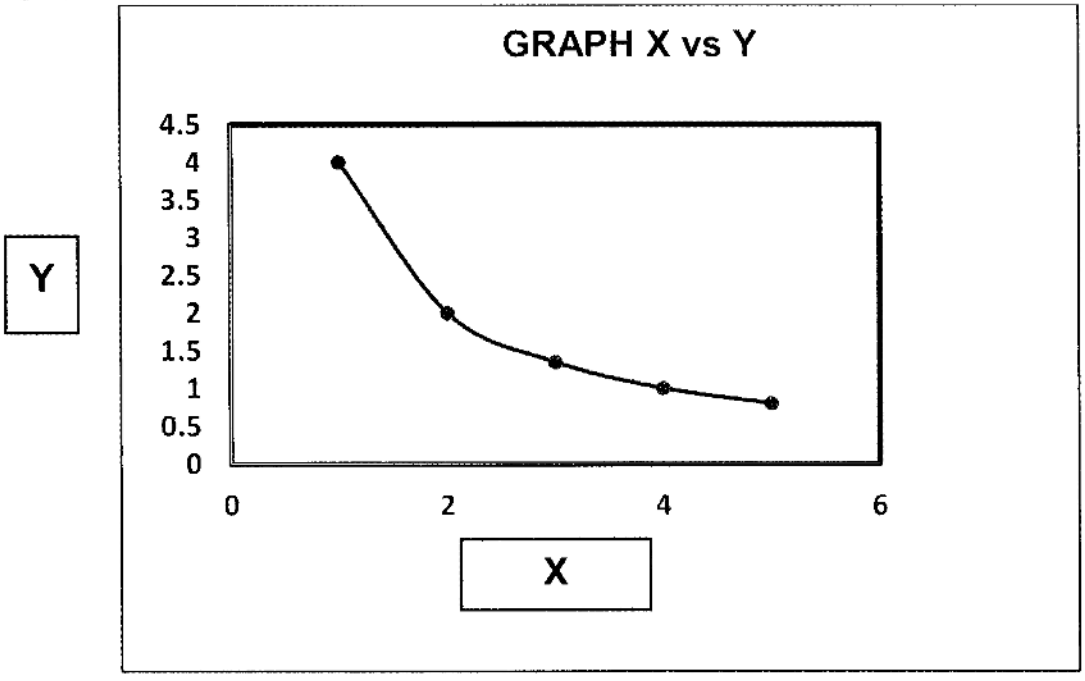
[16]

QUESTION 3

The experiment below was used to verify the relationship between acceleration and the mass of an object. Learners set up the apparatus as shown in the diagram below.



The runway was gently tilted as individual mass pieces were added onto the trolley whilst a constant force acted on the system. The results obtained were used to plot the graph shown.



3.1 A learner uses ticker tape to test whether the runway is tilted so that it compensates for friction.
How should the spacing of the dots appear on this ticker tape? (1)

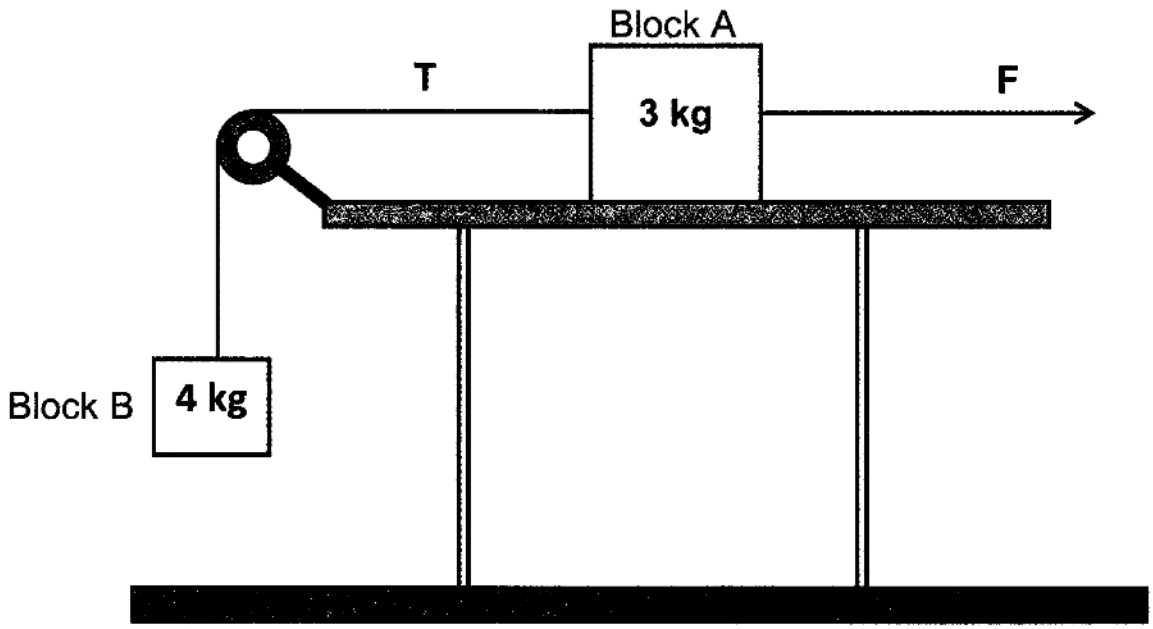
3.2 Write down the headings with relevant units for labels X and Y. (2)

3.3 Determine the constant net force used in this experiment. (3)

3.4 State in words the mathematical relationship between the variables X and Y. (1)

3.5 Sketch a graph of Y verses $\frac{1}{X}$. (no values are needed) (2)

3.6 Two blocks, A and B, of masses 3 kg and 4 kg respectively, are attached to each other by means of an inextensible cord. Block A is placed on a rough horizontal surface, while block B hangs over a frictionless pulley. When a horizontal force F is applied to block A, as shown, block A accelerates to the right.



The net force acting on block A is 6 N and the coefficient of kinetic friction for the surface and the block A is 0,025. The tension in the cord is T.

3.6.1 Draw a labelled free body diagram for block A. (5)

3.6.2 Calculate the magnitude of the acceleration of block B. (3)

3.6.3 Calculate the magnitude of force F (6)

[23]

QUESTION 4

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

4.2 Calculate the magnitude of the gravitational force that the Moon exerts on the Earth if the distance between their centres is 3.86×10^8 m. The Moon has a mass of 7.34×10^{22} kg. (4)

[6]

QUESTION 5

Consider the following molecules and answer the questions that follow:

A	B	C	D	E
SO_2	**HCl**	**H_2**	**HOCl**	**H_2O**

5.1 Consider molecule **A**:

5.1.1 Draw the Lewis Dot structure. (2)

5.1.2 Name the type of bonding between the atoms of molecule A. Give a reason for the answer. (2)

5.2 Write down the NAME or FORMULA of a non-polar molecule from the list above. (1)

5.3 Is the bond in molecule **B** POLAR or NON-POLAR? Explain your answer with the aid of a relevant calculation. (3)

5.4 For molecule **D** state the total number of:

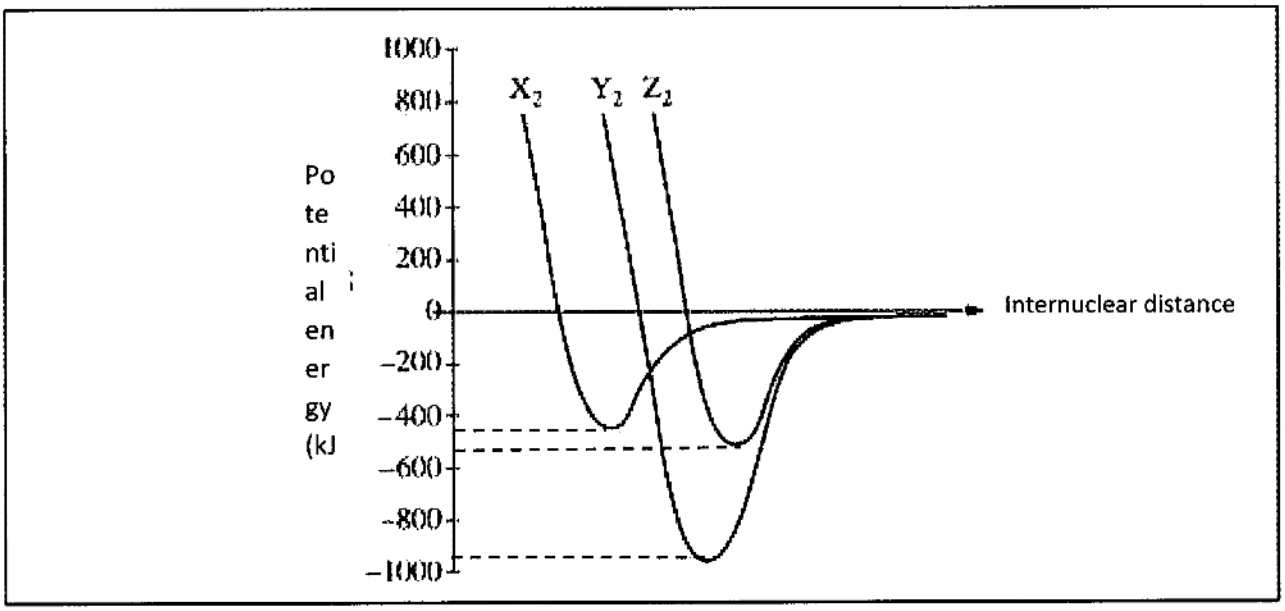
5.4.1 bonding electron pairs (1)

5.4.2 lone pairs (1)

[10]

QUESTION 6

The following graphs represent bond formation in diatomic molecules N_2, O_2 and H_2 in random order. Study the graphs below and answer the questions that follow.



6.1 Define the term *bond energy*. (2)

6.2 Identify the graph that represents the N_2 molecule. Choose form X_2, Y_2 or Z_2. (1)

6.3 Explain the answer to question 6.2. (3)

6.4 Write down the value of the bond energy for the H_2 molecule. (1)

6.5 Which molecule has the longest bond length? Choose form X_2, Y_2 or Z_2. (1)

6.6 Arrange molecules X_2, Y_2 and Z_2 in terms of increasing bond order. (2)

[10]

TOTAL :75

DATA SHEET

PHYSICS:

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	$5,98 \times 10^{24}\ kg$

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 $g = G\frac{M}{r^2}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

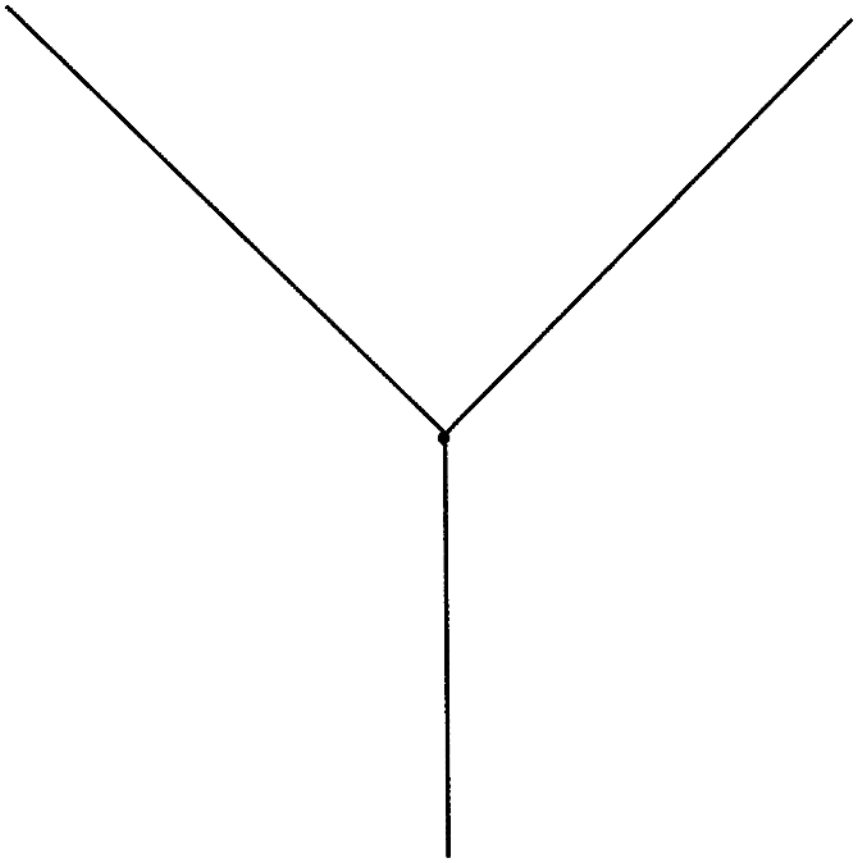
Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

DETACH THIS PAGE

NAME OF LEARNER : _____

Question 2.2.3



Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

MARKING GUIDELINE

COMMON TEST

MARCH 2022

NATIONAL
SENIOR CERTIFICATE

GRADE 11

NB: This marking guideline consists of 6 pages.

QUESTION ONE

1.1 C ✓✓
1.2 D ✓✓
1.3 A ✓✓
1.4 D ✓✓
1.5 C ✓✓

5 x 2 = [10]

QUESTION TWO

2.1

2.1.1 It is a single force that has the same effect as a number of forces acting on an object in both magnitude and direction. ✓✓ (2 or 0) (2)

2.1.2 $\Sigma Rx = (-200) + (450 \cos 60^0)$ ✓$= 25$ N

OR

$\Sigma Rx = (-200) + (450 \sin 60^0)$ ✓$= 25$ N

OR

$\Sigma Rx = 200 \cos 180^0 + 450 \cos 60^0$ ✓ $= 25$ N

$\Sigma Ry = 450 \sin 60^0 + (-350)$ ✓$= 39{,}71$ N

OR

$\Sigma Ry = (450 \cos 30^0) + (-350)$ ✓$= 39{,}71$ N

OR

$\Sigma Ry = 450 \sin 60^0 + 350 \sin 270^0$ ✓$= 39{,}71$ N

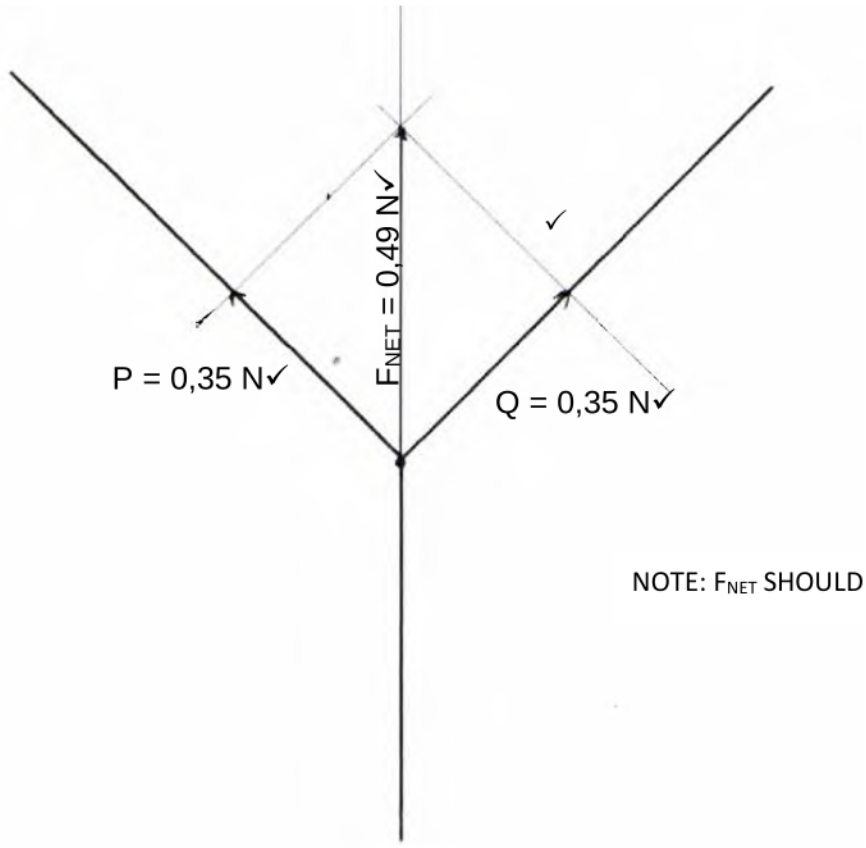
$R_{NET}^2 = R_X^2 + R_Y^2$
$= (25)^2$ ✓$+ (39{,}71\text{ N})^2$✓
$R_{NET} = 46{,}92$ N ✓ (5)

2.2

2.2.1 Force board✓ (1)

2.2.2 The system must be stationary, ✓ and the net force must be zero. ✓ (2)

2.2.3



NOTE: F_{NET} SHOULD BE 49 mm

Marking Rubric : Scale Diagram	
Criteria	Mark allocation
Resultant force is correctly drawn.	1
Completes the parallelogram to determine P and Q	1
Answer for Forces P and Q correctly plotted using the given scale with directions	2 x 1 = 2

(4)

2.2.4 INCREASES. ✓ The force balancing P and Q increases. ✓ (2)

[16]

QUESTION 3

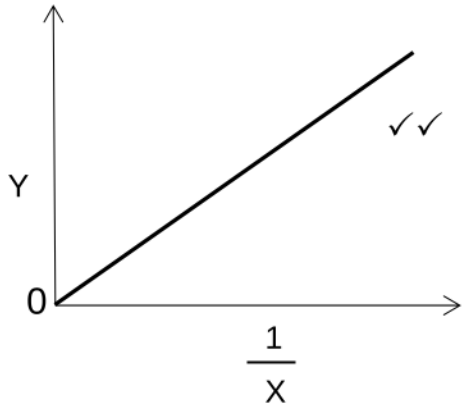
3.1 The dots shown on the tape will be equally spaced.✓ (1)

3.2 X : Acceleration($m \cdot s^{-2}$) ✓
Y : Mass (kg)✓ (2)

3.3 $F_{NET} = X \cdot Y$ ✓
= 4x1✓ [or using the coordinates of any point on the graph]
= 4 N ✓ Accept (range 3,5 – 4,2) (3)

3.4 X is inversely proportional to Y ✓ (1)
Accept: X α 1/Y

3.5

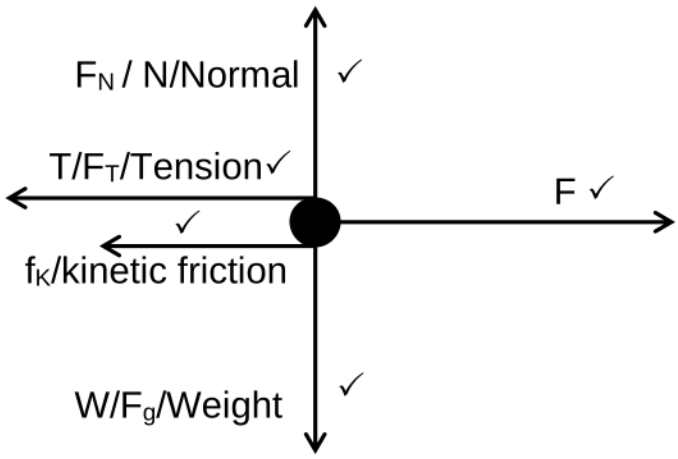


Criteria	Mark allocation
Line of direct proportion correctly drawn from origin (Shape)	2

(2)

3.6

3.6.1



(5)

3.6.2 Consider block A

$F_{NET} = m.a$✓
$\underline{6 = 3 \cdot a}$✓
$a = 2\ ms^{-2}$ ✓ (3)

3.6.3 Taking upward motion as positive

Block B

$f_k = \mu_k \cdot N$
$= 0,025(3)(9,8)$ ✓
$= 0,735$ N

Positive marking from Q 3.6.2

$F_{NET} = m \cdot a$
$T+(-W) = ma$ ✓ any one
$T - 4(9,8) = 4(2)$ ✓
$T = 47,2$ N

Block A

$F+ (-T) + (-f_k) = F_{net}$ ✓
$\underline{F - 47,2 - 0,735 = 6}$ ✓ (Award 2 ticks here if $F+ (-T) + (-f_k) = F_{net}$ is omitted above)
$F = 53,935$ N / 53,94 N ✓ (6)

[23]

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)

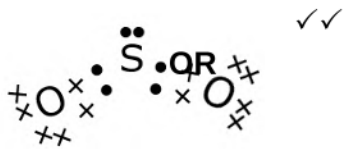
4.2

$$F = \frac{Gm_1m_2}{r^2}\checkmark$$
$$= \frac{6,67 \times 10^{-11} \cdot 7,34x10^{22} \cdot 5,98x10^{24}\checkmark}{(3.86\ x10^8)^2\checkmark}$$
$= 1,965 \times 10^{20}$ N ✓ (Accept $1,97 \times 10^{20}$ N) (4)

[6]

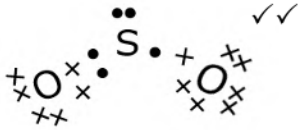
QUESTION 5

5.1.1

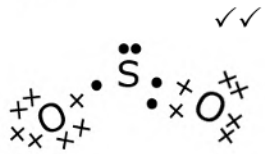


✓✓

OR



✓✓



✓✓

(2)

Ignore the shape of the molecule.

5.1.2 Covalent bond. ✓
Sharing of electrons when orbitals overlap. ✓ (2)

5.2 H_2 /Hydrogen✓ (1)

5.3 Polar.✓ ΔEN = 3,0 – 2,1✓ (3)
= 0,9 ✓

5.4.1 2✓ (1)

5.4.2 5✓ (1)

[10]

QUESTION 6

6.1 Bond energy of a compound is the energy needed to break one mole of its molecules into separate atoms. ✓ OR (2)
Bond energy is the energy required to break a bond, or the energy released when the bond is formed ✓✓ (for 1 mole of each atom forming the bond).

6.2 Y_2 ✓ (1)

6.3 N_2 has the highest bond order / a triple bond between the N atoms. ✓
The more bonds there are between two atoms, the shorter the bond length✓
(thus stronger the bond), therefore higher bond energy. ✓ (3)

6.4 430 ✓ ($kJ.mol^{-1}$). (Accept range 420 - 440 $kJ.mol^{-1}$) (1)

6.5 Z_2 or O_2. ✓ (1)

6.6 $X_2 < Z_2 < Y_2$ or $H_2 < O_2 < N_2$ ✓ (2)

[10]

TOTAL : 75