KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES

COMMON TEST

APRIL 2021

TIME: 2 hours

MARKS: 100

This question paper consists of 12 pages and two data sheets.

Page 15 is the answer sheet to question 2.2.3, which must be submitted with the answer book.

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.

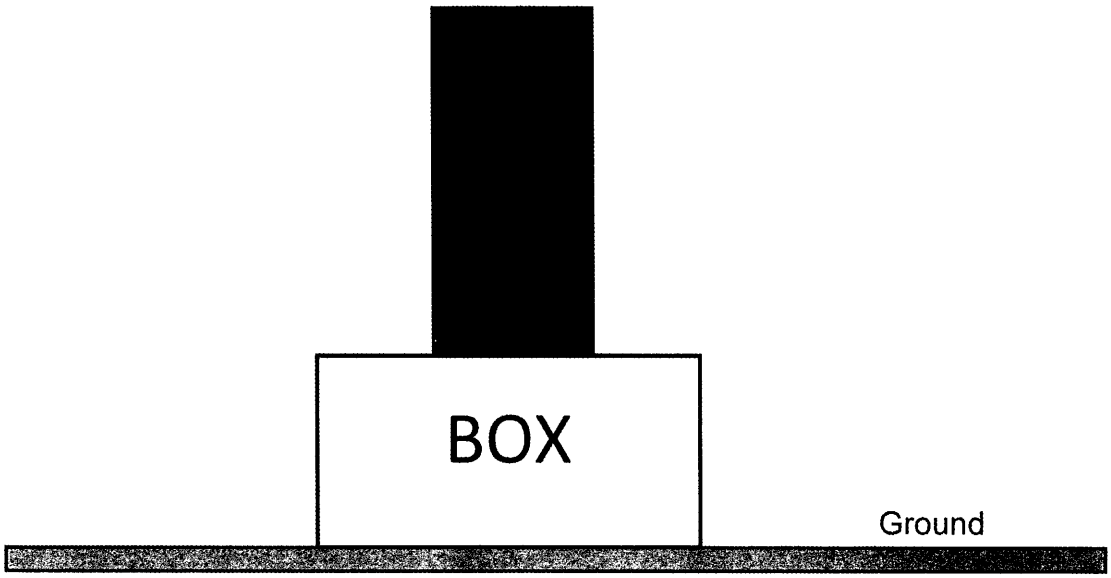
QUESTION 1: MULTIPLE CHOICE QUESTIONS

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 represents a VECTOR and a SCALAR in that order?

A Displacement and Velocity
B Acceleration and Force
C Work and Mass
D Weight and Time (2)

1.2 A man of mass m stands upright on a stationary wooden box placed on the ground.



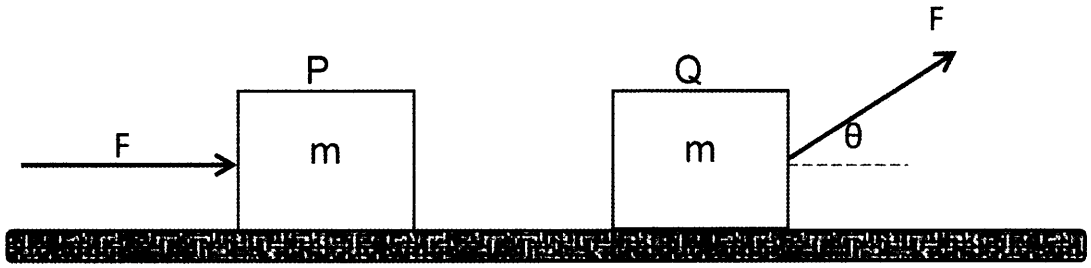
The weight of the box is W.
The NORMAL force acting on the box is equal to …

A W + m
B W — m
C W + mg
D W — mg (2)

1.3 Two bodies whose centres are "r" metres apart exert a gravitational force F on each other. If the distance between them is halved whilst their masses remain the same, the new force that they will exert on each other will be....

A 2 F
B 4 F
C ½ F
D ¼ F (2)

1.4 The same force, with magnitude F, is applied to two IDENTICAL blocks on the same surface as shown. Both blocks move to the right.



Which of the following is the same for both blocks?

A The acceleration.
B The kinetic frictional force.
C The ratio of the kinetic frictional force to the normal force.
D The normal force. (2)

1.5 Which ONE of the following pairs of molecules has a DOUBLE bond and a TRIPLE bond respectively?

A NH_3 and O_2
B F_2 and Cl_2
C H_2O and CH_4
D O_2 and N_2 (2)

1.6 For which ONE of the following bonds is the difference in electronegativity the GREATEST?

A C—O
B C—H
C C—Br
D H—Br (2)

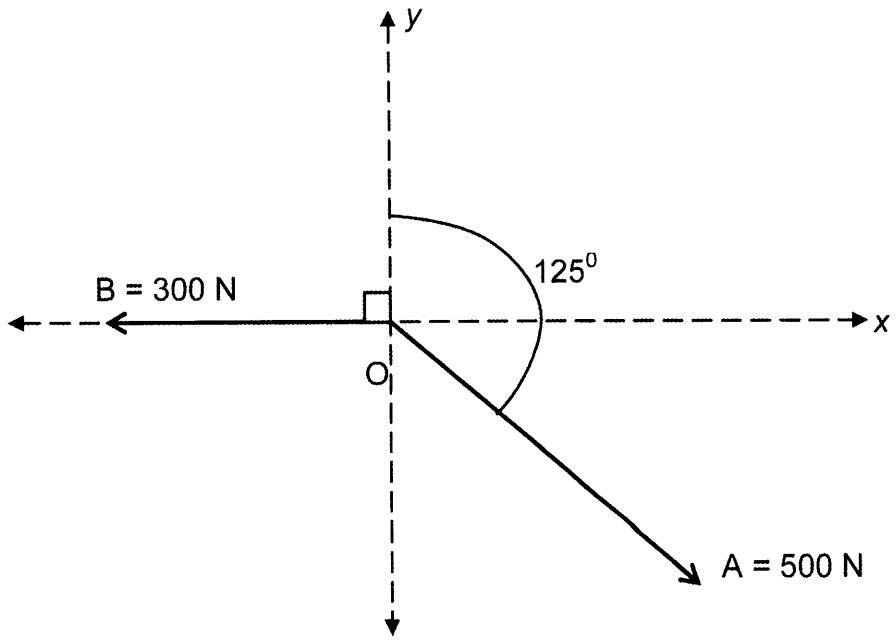
1.7 The shape of the water (H_2O) molecule is …

A angular
B tetrahedral
C trigonal planar
D trigonal bipyramidal (2)

[14]

QUESTION 2

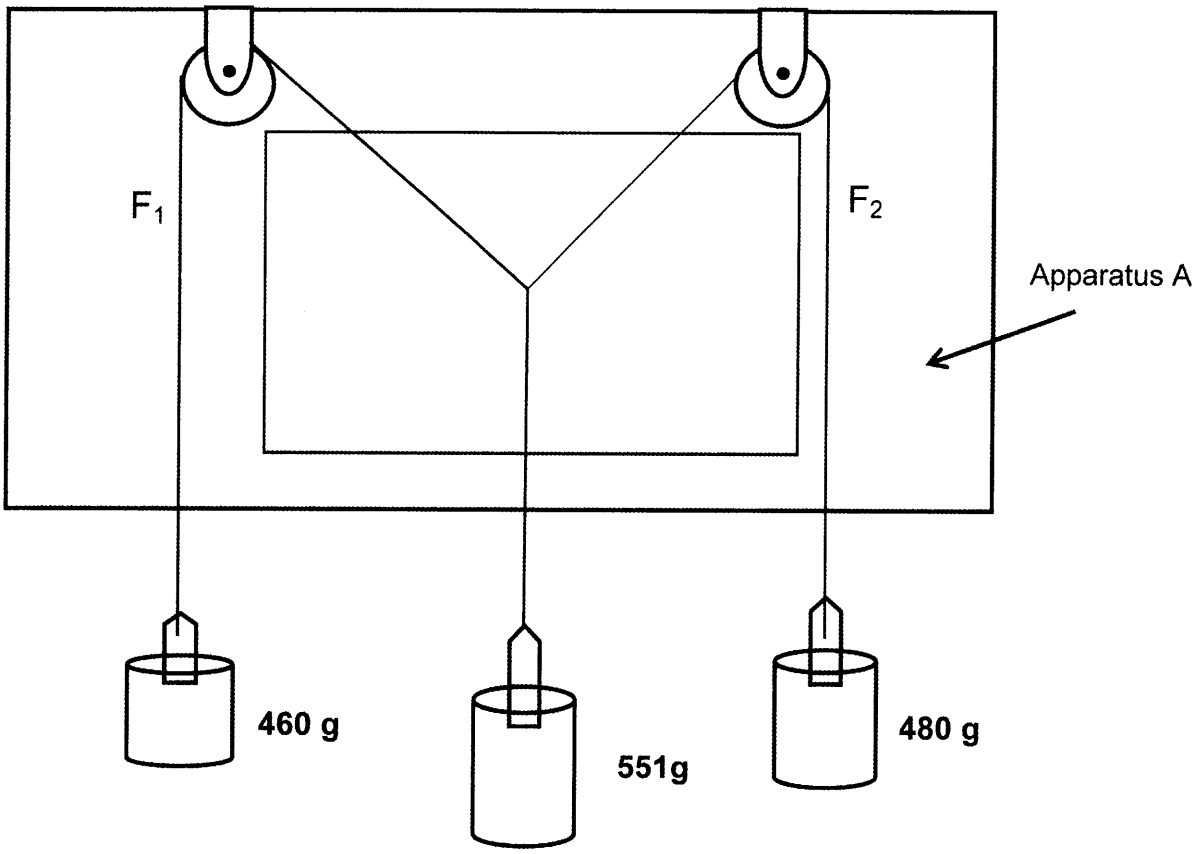
2.1 Two forces, A and B, of magnitudes 500 N and 300 N respectively act on a point O in the directions shown below. The forces act on the same plane and are NOT drawn to scale.



2.1.1 Define *resultant force*. (2)

2.1.2 Calculate the magnitude of the resultant force. (5)

2.2 The apparatus shown below is used to determine the resultant of two co-planar forces F_1 and F_2. The pulleys are frictionless.



2.2.1 Write down the name of apparatus A shown above. (1)

2.2.2 A mirror is used to plot the image of the string on the sheet of paper. Why is the use of the mirror recommended? (1)

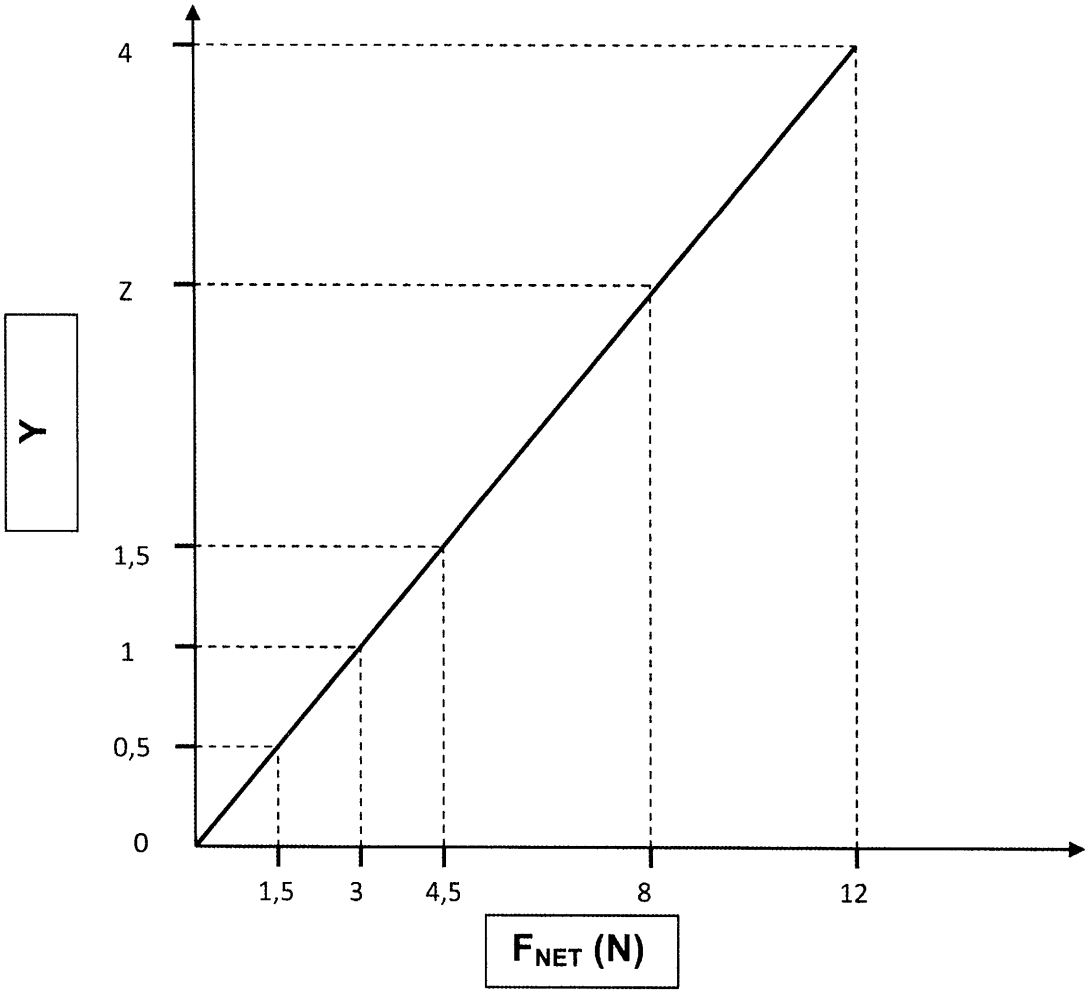
An incomplete diagram for the results of this investigation is given *on* ***page 15*** *of this question paper.*

2.2.3 Complete the diagram using the scale **10mm represents 1 N** and determine the magnitude of the resultant of F_1 and F_2.
YOU MUST SUBMIT THIS SHEET WITH YOUR ANSWER BOOK. (6)

2.2.4 The 551 g mass piece is now removed. How will this affect the magnitude and direction of the resultant force determined in Question 2.2.3?
Choose from INCREASES, DECREASES OR REMAINS THE SAME.
Give a reason for the answer. (2)
[17]

QUESTION 3

The graph below represents the data obtained in an experiment that aims to verify Newton's Second Law of motion.



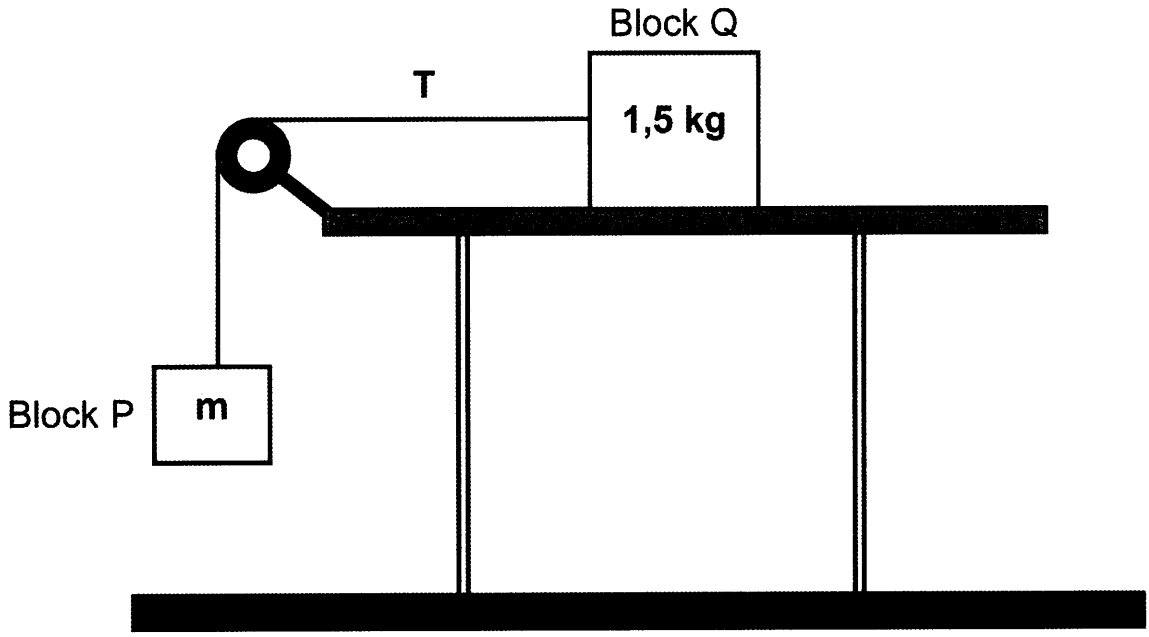
3.1.1 State Newton's Second Law of motion in words. (2)

3.1.2 Write down the quantity represented by Y with its correct units. (2)

3.1.3 Use the graph to calculate the mass of the trolley. (3)

3.1.4 Determine the value of Z. (3)

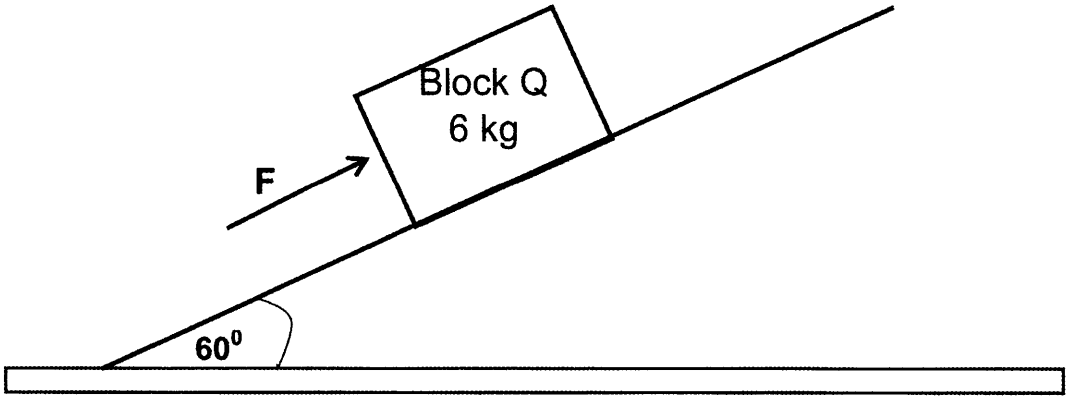
3.2 The sketch shows a block Q of mass 1,5 kg placed on a ROUGH horizontal surface. Block Q is attached to another block P of mass *m* by an inextensible cord that passes over a frictionless pulley. The blocks are stationary and the static frictional force between the surface and block Q is 15 N. The tension in the cord is T.



3.2.1 What is the magnitude of the tension T? (1)

3.2.2 *The mass of block P is now DOUBLED resulting in the 1,5 kg block accelerating to the left. The kinetic frictional force experienced by block Q is 14,75 N.*
By applying Newton's second law of motion SEPARATELY to each of the blocks, calculate the magnitude of the acceleration of block P. (6)

3.3 A constant force F is applied to a 6 kg block to move it up a rough surface inclined at 60^0 to the horizontal. Force F, which is parallel to the incline, moves the block up the incline at CONSTANT VELOCITY. The block experiences a constant kinetic frictional force of 12,25 N.



3.3.1 Draw a free body diagram showing all the forces acting on Block Q. (4)

3.3.2 Calculate the magnitude of force F. (4)

3.3.3 *The angle of the incline is now increased to 75^0.*
How will this affect the magnitude of the velocity of the block as it moves UP the incline, if the force F acting on it remains constant?
Choose from INCREASES, DECREASES OR REMAINS THE SAME. (2)

[27]

QUESTION 4

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

4.2 Earth has a mass of 6×10^{24} kg and an average radius of $6,4 \times 10^6$ m.
A communication satellite, mass 1500 kg, moves in a fixed circular orbit around the Earth. The 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 kilometres of the satellite from the surface of Earth. (6)

[8]

QUESTION 5

Consider the following molecules and answer the questions below:

CO_2 $HC\ell$ H_2O $BeC\ell_2$ N_2 NH_3 CO

5.1 Draw the Lewis structure for:

5.1.1 $BeC\ell_2$. (2)
5.1.2 NH_3 (2)

5.2 Indicate whether the COVALENT BONDS in the following molecules are POLAR or NON-POLAR.

5.2.1 $HC\ell$ (1)
5.2.2 N_2 (1)
5.2.3 CO_2 (1)

5.3 Define the term *dative covalent bond*. (2)

5.4 Explain why the hydronium ion (H^+) can form a dative covalent bond with NH_3. (2)

[11]

QUESTION 6

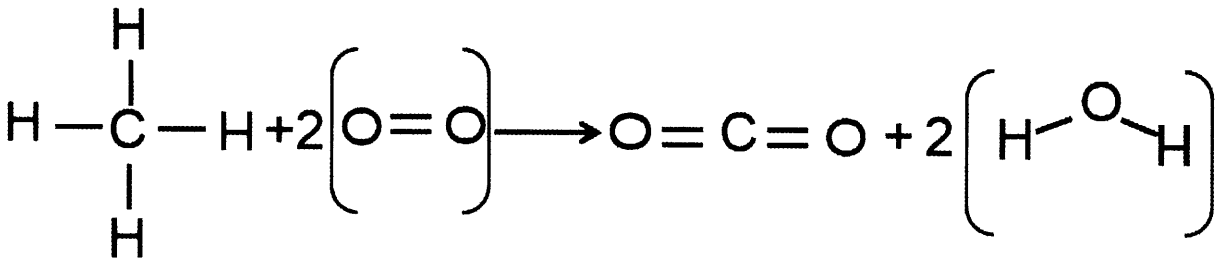
A group of learners decided to investigate the relationship between bond length and bond energy. The data collected theoretically is shown in the table below.

BOND	BOND LENGTH (pm)	BOND ENERGY ($kJ.mol^{-1}$)
C≡C	120	839
C=O	123	804
O=O	121	498
C–C	154	348
H–O	96	463
H–C	109	413

6.1 Write down an investigative question for this investigation. (2)

6.2 Apart from bond length, name TWO other factors that influence bond energy. (2)

6.3 In a combustion reaction, methane burns in oxygen to form carbon dioxide and water. The balanced reaction, showing the bonds, is given below.



Using the table above, determine whether there is a net release or a net absorption of energy in this reaction. (6)

6.4 Which ONE of the following bond energies is correct for the C=C bond?
Choose from **880 $kJ.mol^{-1}$**, **540 $kJ.mol^{-1}$** or **320 $kJ.mol^{-1}$**.
Explain the choice. (4)

[14]

QUESTION 7

7.1 Define the term *electronegativity*. (2)

7.2 Explain the difference between a polar and a non-polar molecule. (2)

7.3 The table below shows the properties of methane (CH_4) and chloromethane (CH_3Cl).

MOLECULE	STRUCTURE	SHAPE	TYPE
CH_4	H I H — C — H I H	Tetrahedral	Non-polar
CH_3Cl	H I H — C —Cl I H	Tetrahedral	Polar

7.3.1 Explain why the CH_4 molecule is non-polar. (2)

7.3.2 A chlorine (Cl) atom replaces one of the hydrogen (H) atoms in the methane (CH_4) molecule to form a chloromethane (CH_3Cl) molecule. Both molecules have the same shape.
Explain why the chloromethane (CH_3Cl) molecule that forms is polar. (3)

[9]

TOTAL: 100

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

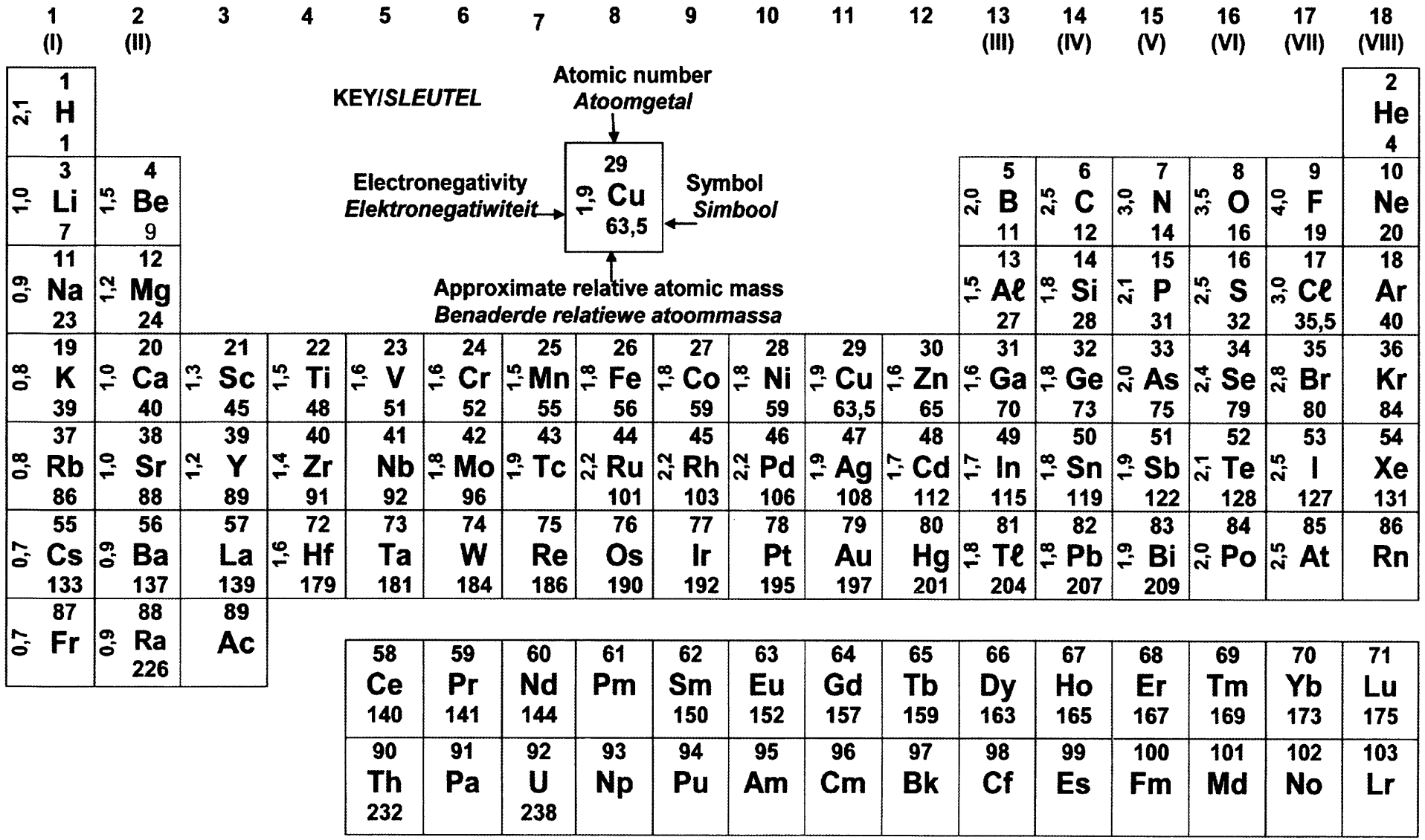
MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ 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



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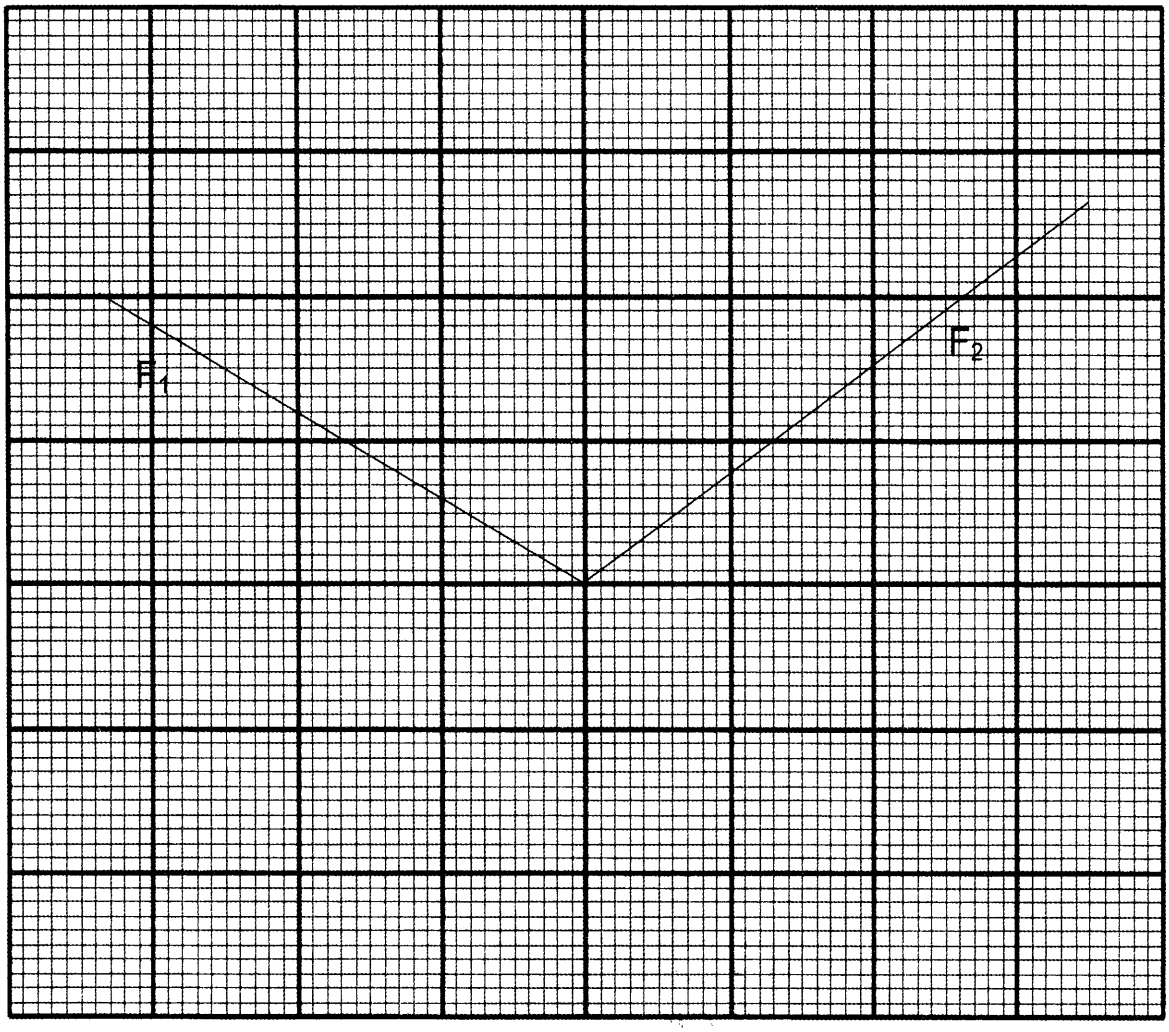
NAME OF LEARNER : _____

GRADE: 11 ____

Question 2.2.3



 PHSC GR11 & 10

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GRADE 11

PHYSICAL SCIENCES
COMMON TEST
MARCH 2021
MARKING GUIDELINES

NB: This marking guideline consists of 8 pages.

QUESTION ONE

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

7 x 2 = [14]

QUESTION TWO

2.1

2.1.1 That single force that has the same effect as two or more forces acting together. ✓✓ (2 or 0) (2)

2.1.2 $A_x = 500 \cos 35^0$ ✓ $= 409,58$ N
$A_Y = 500 \sin 35^0$ ✓ $= 286,79$ N

$B_x = -300$ N
AND $B_y = 0$ N (may be implied) ✓

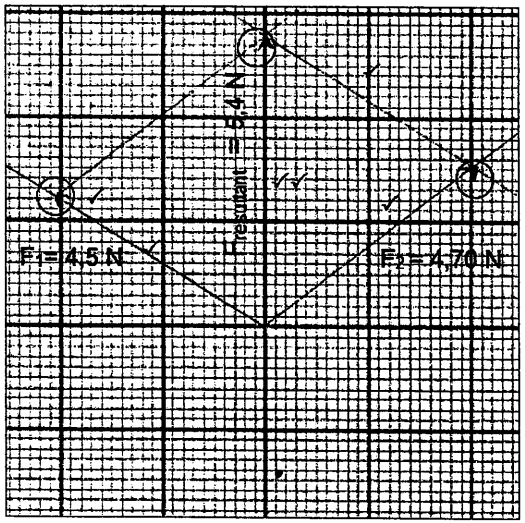
$R_{NET}^2 = R_X^2 + R_Y^2$
$= (109,58)^2 + (-286,79)^2$ ✓
$R_{NET} = 307,01$ N ✓ (5)

Marking Criteria: Question 2.1.2	
Criteria	Mark allocation
• Substitution in formula for x-component of A	1
• Substitution in formula for y-component of A	1
• Correct x and y components of B.(zero can be omitted)	1
• Substitution in formula for resultant force (Theorem of Pythagoras)	1
• Correct answer ($F_{NET} = 307,01$ N)	1

2.2

2.2.1 Force board✓
To avoid the error of parallex. ✓ OR (1)

2.2.2 To ensure that the position / direction of the string is accurately plotted. ✓ (1)



Marking Criteria : Vector Diagram	
Criteria	Mark allocation
Forces F_1 and F_2 correctly plotted using the given scale	2 x 1 = 2
Direction of all forces are correctly shown	1
Resultant force is correctly drawn by completing the parallelogram accurately.	2 x 1 = 2
Answer is correct (F_{NET} = 5,4 N) (Accept Range : 4,8 – 6 N)	1

(6)

2.2.4 REMAINS THE SAME. ✓ It is the equilibrant / Used to keep the system in equilibrium. ✓ (2)

[17]

QUESTION 3

3.1.1 Whenever a net force acts on an object, it produces an acceleration in the direction of the net force. This acceleration is directly proportional to the net force ✓and inversely proportional to the mass of the object. ✓ (2)
(Marks must only be awarded if the statement is in the correct context)

3.1.2 Y : Acceleration✓ $m \cdot s^{-2}$ ✓ (2)

3.1.3 Gradient : $\frac{1}{m} = \frac{\Delta y}{\Delta x}$

$= \frac{4-0}{12-0}$ ✓ ✓(or any other appropriate values from graph)

$= 0.33$

$m = 3{,}03$ kg✓ (3)

3.1.4 **POSITIVE MARKING FROM Q 3.1.3**

$\frac{z-0}{8-0}$ ✓$= 0{,}33$ ✓

Z = 2,64 ✓ (2,67) (3)

3.2.1 T = 15 N✓ (1)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1**

W =T= m.g

15 = m·9,8✓ m = 1,53 kg

Taking downward motion as positive

Block P

F_{NET} = ma
W + (–T) = ma ✓ any one

3,06(9,8) – T ✓ = 3,06 a ✓

T = 29,998 – 3,06 a

Block Q

F_{NET} = ma

T + ($-f_k$) = m·a

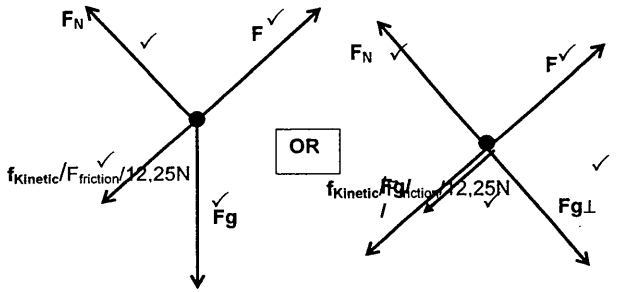
T – 14,75 = 1,5 a ✓

T = 1,5 a + 14,75

29,998 – 3,06 a = 1,5 a + 14,75

a = 3,34 $m \cdot s^{-2}$ ✓ (6)

3.3.1



1 mark for $F_{g//}$ and $F_{g\perp}$

(4)

1 mark for each force correctly drawn and labelled. (Ignore relative sizes)

3.3.2 $F_{g//} = mg\sin\theta = 6(9,8)(\sin 60^0)$
$= 50,922$ N

$F_{NET} = ma$
$F + (-F_{g//}) + (-f_K) = ma$ ✓ any one
$F - 50,922 - 12,25$ ✓ $= 0$ ✓
$F = 63,17$ N✓ (4)

3.3.3 DECREASES ✓✓ (2)
[27]

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 statement is in the correct context) (2)

4.2 $F = \frac{Gm_1m_2}{r^2}$✓

10500 ✓ $= \frac{6,67 \times 10^{-11} \times 1500 \times 6 \times 10^{24}}{r^2}$ ✓

$r = 7,561 \times 10^6$ m ✓

Distance = $7,561 \times 10^6$ (−) ✓ $6,4 \times 10^6$ (1 mark for subtraction of distances)
$= 1,16 \times 10^6$ m = 1161,18 km✓ (6)
[8]

QUESTION 5

5.1.1

✓✓ (2)

5.1.2

✓✓ (2)

5.2.1 Polar ✓ (1)

5.2.2 Non-polar✓ (1)

5.2.3 Polar✓ (1)

5.3 Type of covalent bond, where both the shared pair of electrons is given by one atom only. ✓✓ (2)

5.4 There is a lone pair of electrons on the central nitrogen (N) atom✓ of NH_3 and an empty orbital in the hydronium ion (H^+)✓ (2)

[11]

QUESTION 6

6.1 What is the relationship between bond energy and bond length? ✓✓ (2)
(Correctly identifying the 2 variables✓; phrasing into an appropriate question✓)

6.2 Size of atom ✓
Bond order ✓ (**Accept:** number of bonds) (2)

6.3 Energy absorbed = (4 x 413) ✓ + 2(1 x 498) ✓ = 2648 $kJ.mol^{-1}$

Energy released = (2 x 804) ✓+ (2 x 2 x 463) ✓ = 3460 $kJ.mol^{-1}$

Since Energy released > Energy absorbed✓
Net energy is released in this reaction ✓ (6)

6.4 540 $kJ.mol^{-1}$✓
The C=C bond is stronger than C-C✓, but weaker than C≡C, ✓ therefore energy required is greater than 348 but less than 839 $kJ.mol^{-1}$ ✓ (4)

[14]

QUESTION 7

7.1 Is the measure of the tendency of an atom in a molecule to attract bonding electrons. ✓✓ (2)

7.2 A polar molecule contains charge that is unevenly distributed and thus forms a dipole / has a net dipole moment **OR** a polar molecule has one end that is slightly positive, and an opposite end that is slightly negative.✓
A non-polar molecule has evenly distributed charge and does not form a dipole **OR** a non-polar molecule does not have distinct oppositely charged ends.✓ (2)

7.3.1 The CH_4 molecule has identical / symmetrical charge distribution **OR** the charge density is identical.✓ There is no distinct oppositely charged poles/ends. ✓ (2)

7.3.2 Chlorine is more electronegative than carbon, ✓ thus making chlorine slightly more negative. ✓ Since there are distinct positive and negative ends **OR** The charge distribution surrounding the central carbon atom is not identical, ✓ CH_3Cl is a polar molecule. (3)

[9]

TOTAL :100