This question paper consists of 16 pages including this cover page, a data sheet consisting of 2 pages and 1 sheet of graph paper.

NOTE: QUESTION 3.4 MUST BE ANSWERED ON THE GRAPH PAPER PROVIDED.
GENERAL INSTRUCTIONS

1. Write your examination number (and centre number if applicable) in the appropriate spaces on the answer book.
2. Answer ALL the questions.
3. Non-programmable calculators may be used.
4. Appropriate mathematical instruments may be used.
5. A data sheet is attached for your use.
6. NOTE! The following circuit diagram symbols are used in this paper:

   Resistor:  instead of  
   Bulb:  instead of  

7. Marks may be forfeited if instructions are not followed.

QUESTION 1

INSTRUCTIONS

1. Four possible answers, indicated by A, B, C and D, are supplied with each question. Each question has only ONE correct answer. Choose only that answer which, in your opinion, is the correct or best one and indicate your choice by making a cross (X) on the answer sheet on the inside cover of your answer book.

2. Do NOT make any other marks on the answer sheet. Any calculations or writing that may be necessary when answering this question should be done in the answer book and must be deleted clearly by means of a diagonal line drawn across the page.

3. If more than one block is marked, no marks will be awarded for that answer.

EXAMPLE

QUESTION: The SI unit of time is ...

   A   t.
   B   h.
   C   s.
   D   m.

   ANSWER:  

   [A] [B] [X] [D]
QUESTION 1

1.1 Two forces of 20 N and 60 N act at a point.

As the angle $\theta$ between the forces varies between 0° and 180°, the magnitude of the resultant force $F_{\text{res}}$ ...

A is always less than 20 N.
B is always more than 60 N.
C varies between 40 N and 80 N.
D varies between 20 N and 60 N.  

1.2 Which ONE of the following physical quantities is the same as the 'change in momentum'?

A Impulse
B Resultant force
C Acceleration
D Work

1.3 A body starts from rest and is accelerated uniformly in a straight line to reach a velocity $v$ after a distance $s$.

What would its velocity be after travelling a distance of 2s from rest, if the body has the same acceleration?

A $4v$
B $2v$
C $\sqrt{2}v$
D $\sqrt{2}v$
1.4 The velocity-time graph below represents the motion of a car during a time interval from 0 to 3t seconds.

What is the resultant displacement over the period 0 to 3t?

A \[2vt\]
B \[vt\]
C \[\frac{1}{2}vt\]
D \[-\frac{1}{2}vt\] 

1.5 A parachutist falls from a hot-air balloon which is stationary at a certain height. She reaches terminal velocity after time T. Which ONE of the following displacement-time graphs best represents her motion?
1.6 A 2 kg mass piece is placed on a stationary 2 kg trolley, which is on a frictionless, horizontal surface. When a force \( F \) is applied to the trolley, it has an acceleration \( a \) (situation 1). An additional 1 kg mass piece is then placed on the trolley as well, and the same force \( F \) is applied to the trolley (situation 2).

![Diagram of two situations](image)

What is the acceleration of the trolley in situation 2?

A \[ \frac{1}{4}a \]

B \[ \frac{2}{3}a \]

C \[ \frac{4}{5}a \]

D \[ \frac{5}{4}a \]

(4)

1.7 A body slides along a frictionless, horizontal surface at constant velocity. For which ONE of the following pairs are the magnitudes of both physical quantities zero?

A Displacement and momentum

B Acceleration and momentum

C Displacement and resultant force

D Acceleration and resultant force

(4)
1.8 A man exerts a force on an inelastic rope and pulls a crate along a straight, horizontal floor.

Which ONE of the following is the reaction force to the force that the man exerts on the rope?

A The force of the rope on the crate
B The force of the crate on the man
C The force of the rope on the man
D The force of the crate on the rope

1.9 Bongi, standing on level ground, looks up and sees a bird that flies overhead in a straight line on a bearing of 310° (50° W of N). There is a steady wind blowing from west to east. In the vector diagrams below P, Q and R represent the following:

P is the velocity of the bird relative to the air.
Q is the velocity of the wind relative to the ground.
R is the resultant velocity of the bird relative to the ground.

Which ONE of the following vector diagrams correctly represents these three velocities?
1.10 A car has kinetic energy $E_k$ when it is travelling at a velocity $v$. Which ONE of the following expressions represents the magnitude of the car’s momentum?

A $\frac{E_k}{2v}$

B $\frac{E_k v}{2}$

C $\frac{2v}{E_k}$

D $\frac{2E_k}{v}$

(4)

1.11 R and S are two identical metal spheres on insulated stands. Sphere R is positively charged and S is neutral. They are brought into contact (FIGURE 1) and then separated again (FIGURE 2).

Which ONE of the following combinations correctly represents the charges on R and S after the separation?

<table>
<thead>
<tr>
<th></th>
<th>Charge on R</th>
<th>Charge on S</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>B</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>C</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>D</td>
<td>Neutral</td>
<td>Positive</td>
</tr>
</tbody>
</table>

(4)
1.12 A point charge, \( Q_2 \), is placed a distance \( 3x \) from a positive point charge \( Q_1 \). The resultant electric field strength at point \( P \), a distance \( x \) from \( Q_1 \), is zero.

Which ONE of the following combinations concerning \( Q_1 \) and \( Q_2 \) is correct?

<table>
<thead>
<tr>
<th></th>
<th>Charge on ( Q_2 )</th>
<th>Magnitude of the charges on ( Q_1 ) and ( Q_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Positive</td>
<td>Charge on ( Q_2 ) &gt; charge on ( Q_1 )</td>
</tr>
<tr>
<td>B</td>
<td>Negative</td>
<td>Charge on ( Q_2 ) &gt; charge on ( Q_1 )</td>
</tr>
<tr>
<td>C</td>
<td>Positive</td>
<td>Charge on ( Q_2 ) &lt; charge on ( Q_1 )</td>
</tr>
<tr>
<td>D</td>
<td>Negative</td>
<td>Charge on ( Q_2 ) &lt; charge on ( Q_1 )</td>
</tr>
</tbody>
</table>

(4)

1.13 In the diagram below the straight copper, current-carrying conductor, \( G \), experiences a downward force when placed between the two permanent bar magnets, \( F \) and \( H \).

Which ONE of the following combinations of directions of the relevant physical quantities is correct?

<table>
<thead>
<tr>
<th></th>
<th>Direction of magnetic field due to ( F ) and ( H )</th>
<th>Direction of current in ( G )</th>
<th>Direction of concentric magnetic field produced by current in ( G )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>H to F</td>
<td>Into the paper, away from the reader</td>
<td>Clockwise</td>
</tr>
<tr>
<td>B</td>
<td>H to F</td>
<td>Out of the paper, towards the reader</td>
<td>Anti-clockwise</td>
</tr>
<tr>
<td>C</td>
<td>F to H</td>
<td>Out of the paper, towards the reader</td>
<td>Clockwise</td>
</tr>
<tr>
<td>D</td>
<td>F to H</td>
<td>Into the paper, away from the reader</td>
<td>Anti-clockwise</td>
</tr>
</tbody>
</table>

(4)
1.14 A cell is connected in a closed circuit. Which ONE of the following is the correct explanation for the emf of the cell?

A  It is the work done to pass one coulomb of charge through the external resistance of the circuit only.

B  It is the work done to pass one coulomb of charge through the whole circuit.

C  It is the force required to pass one coulomb of charge through the external resistance of the circuit only.

D  It is the force required to pass one coulomb of charge through the whole circuit.

(4)

1.15 In the circuit represented below, a battery of emf \( E \) and internal resistance which is not negligible, is connected to two resistors in parallel. The resistance of one of the resistors is twice that of the other. The total current in the circuit is \( I \).

![Circuit Diagram]

Which ONE of the following combinations is correct for the readings on the ammeter and the voltmeter?

<table>
<thead>
<tr>
<th>Ammeter reading ( A )</th>
<th>Voltmeter reading ( V )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{3} I )</td>
<td>Less than ( E )</td>
</tr>
<tr>
<td>( \frac{2}{3} I )</td>
<td>Less than ( E )</td>
</tr>
<tr>
<td>( \frac{1}{3} I )</td>
<td>Equal to ( E )</td>
</tr>
<tr>
<td>( \frac{2}{3} I )</td>
<td>Equal to ( E )</td>
</tr>
</tbody>
</table>

(15 x 4)  

[60]
ANSWER QUESTIONS 2 TO 9 IN THE ANSWER BOOK.

INSTRUCTIONS

1. Start each question on a NEW PAGE in the ANSWER BOOK.

2. Leave a line between subsections of questions, for example 2.1 and 2.2.

3. Show ALL formulae, as well as the calculations, including substitutions.

4. Number the answers exactly as the questions are numbered.

QUESTION 2 [START ON A NEW PAGE]

Ziyanda keeps a wooden pole, PQ, vertically upright by two support wires, M and N, attached to its top end at P. In order to keep P stationary, support wire M, which makes an angle of 70° with the horizontal, exerts a force of 50 N on P. Support wire N makes an angle of 30° with the horizontal. The support wires and the pole are in the same vertical plane.

2.1 Calculate the **magnitude** and **direction** of the horizontal component of the force that support wire M exerts on P. (4)

2.2 State what is the **magnitude** and **direction** of the horizontal component of the force exerted by support wire N on point P, if the pole is to remain stationary. Give a reason for your answer. (3)

2.3 Calculate the **magnitude** of the vertical component of the force exerted on point P by:

   2.3.1 Support wire N (3)

   2.3.2 Support wire M (2)

2.4 Calculate the magnitude of the resultant force which the lower end of the pole, Q, exerts on the ground if the mass of the pole is 8 kg. (3) [15]
QUESTION 3

Millicent and Jabu are two students running in a 5 000 m race. The distance versus time graph of Millicent’s race is given below. Four points, O, M, N and P, are marked on the graph.

3.1 Between which two points does Millicent run the fastest? (2)

3.2 Give a reason for your answer to QUESTION 3.1 above. (2)

3.3 Calculate the average speed at which Millicent runs the race between points N and P. (4)

3.4 Jabu starts the race 250 s after Millicent and completes the race at the same time as Millicent. Use the graph paper, which is provided with the answer sheet, to draw a graph to represent the race of Jabu, assuming Jabu runs at a constant rate throughout the race. (3)

3.5 From the graph, write down the distance and time co-ordinates of the point where Jabu overtakes Millicent. (3)

3.6 How does the speed of each of the girls compare at the point where Jabu overtakes Millicent? Explain. (2)
QUESTION 4 [START ON A NEW PAGE]

Azeez connects two blocks, X and Y, masses 1 kg and 2 kg respectively, with a light, inelastic string. He places them on a horizontal floor and pulls the 2 kg block to the right with a force of 8 N. As the blocks are moving the 1 kg block experiences a frictional force of 0.75 N and the 2 kg block a frictional force of 1.25 N.

4.1 State, in words, Newton's Second Law of Motion. (3)

4.2 Draw TWO separate force diagrams, with labels, showing the horizontal forces acting on blocks X and Y. (4)

4.3 Calculate the magnitude of the acceleration of the blocks AND the magnitude of the tension in the string that connects X and Y. (9)

4.4 The applied force of 8 N is now applied at an acute angle with respect to the horizontal. State whether the magnitude of each of the following quantities increases, decreases or remains the same:

4.4.1 The acceleration of the blocks (2)

4.4.2 The tension in the connecting string (2 [20]

QUESTION 5 [START ON A NEW PAGE]

Hendrik, of mass 65 kg, on roller-skates, holds an iron bar of mass 5 kg in his hands. He is moving forward on a frictionless, horizontal track at a speed of 1 m.s⁻¹. In order to slow himself down, he throws the iron bar away from himself at a speed of 4 m.s⁻¹. Ignore the effects of all types of friction.

5.1 State, in words, the Principle of Conservation of Momentum. (3)

5.2 In which direction should Hendrik throw the iron bar to get the maximum decrease in his velocity? (2)

5.3 Calculate the magnitude and direction of Hendrik's velocity immediately after he has thrown the iron bar to get the maximum decrease in his velocity. (7 [12]
QUESTION 6

[START ON A NEW PAGE]

Ammaar, standing on the ground, throws a package, mass 500 g, vertically upwards to Isha, who is on the second-floor balcony of a building. At a height of 1.5 m above the ground (point Q), the package leaves his hand at a speed of 10 m.s\(^{-1}\). At a height of 3.5 m above the ground, the package accidentally passes through a thin layer of branches of a tree, but still continues vertically upwards. Ignore the effects of air resistance.

6.1 Calculate the maximum height above point Q that the package could have reached, if the branches had not been in the way.  

6.2 State, in words, the Law of Conservation of Mechanical Energy.  

6.3 Without using the kinematic equations of motion, calculate the speed of the package just as it reaches the branches.  

The package, on its way upward, leaves the branches at a velocity of 5 m.s\(^{-1}\) at a height of 3.60 m above the ground.

6.4 Calculate the work done by the package in passing through the branches.  

6.5 Calculate whether Isha, who must catch the package on the balcony at a height of 4.9 m above the ground, will be successful.  

[25]
QUESTION 7  [START ON A NEW PAGE]

A Millikan-type experiment is done to confirm that all charges are integer multiples of the basic charge on an electron. Two oppositely charged, parallel plates are set up in an evacuated container with the top plate being positively charged, while the bottom plate is negatively charged. A potential difference of 1500 V is applied across the plates which are 15 mm apart. An oil drop $X$, of mass $9.6 \times 10^{-15}$ kg, was found to be stationary between the plates.

7.1 Define electric field strength. (2)

7.2 Calculate the magnitude of the electric field strength between the plates. (4)

7.3 Draw a labelled force diagram showing the forces acting on $X$. The lengths of the vectors should be an indication of their respective magnitudes. (3)

7.4 Calculate the magnitude of the charge on $X$. (6)

7.5 Calculate the number of excess electrons on $X$. (2)

7.6 A neutral oil drop combines with $X$. What changes, if any, need to be made to keep the new combined drop stationary? Explain your answer. (4)

[21]
QUESTION 8  [START ON A NEW PAGE]

Peter opens the door of his car and the inside light is activated. The car battery has an emf of 12 V and an internal resistance of 0.45 Ω. The inside light is rated 10 V, 8 W.

8.1 State the relationship between power and electric current.  

8.2 Calculate the resistance of the inside light when it operates at a constant potential difference of 10 V.  

He observes that the cabin light in his car dims when the car is started. He decides to investigate the circuit involved in his motorcar to explain the dimming of the light. He draws the following circuit diagram showing how the different parts are connected.

8.3 Explain why the inside light dims if the car is started or, as indicated in the diagram, the switch $S_2$ is closed.  

8.4 Calculate the current at which the inside light operates if the total current in the circuit is 10 A when switch $S_2$ is closed.  

[15]
QUESTION 9

In the circuit represented below, the battery has an emf of 12 V and an unknown internal resistance. The resistance of resistor $R_3$ is also unknown. Voltmeters $V_1$ and $V_3$ have readings of 10 V and 6 V respectively.

9.1 Calculate the current in the circuit.

9.2 Calculate the current in resistor $R_2$.

9.3 Calculate the resistance of resistor $R_3$.

9.4 Calculate the internal resistance of the battery.

TOTAL QUESTION 1: 60
TOTAL QUESTIONS 2 – 9: 140
GRAND TOTAL: 200
TABLE 1: PHYSICAL CONSTANTS
TABEL 1: FISIESE KONstantes

<table>
<thead>
<tr>
<th>NAME/NAAM</th>
<th>SYMBOL/SIMBOOL</th>
<th>VALUE/WAARDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration due to gravity</td>
<td>g</td>
<td>10 m.s(^{-2})</td>
</tr>
<tr>
<td>Swaartekragversnelling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravitational constant</td>
<td>G</td>
<td>(6.7 \times 10^{-11}) N.m(^2).kg(^{-2})</td>
</tr>
<tr>
<td>Swaartekragkonstante</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge on electron</td>
<td>e(^-)</td>
<td>(-1.6 \times 10^{-19}) C</td>
</tr>
<tr>
<td>Lading van elektron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATHEMATICAL AIDS/WISKUNDIGE HULPMIDDELS

\[
\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}
\]

\[c^2 = a^2 + b^2 - 2ab \cos C\]
### TABLE 2: FORMULAE
### TABEL 2: FORMULES

#### MOTION/BEWEGING

<table>
<thead>
<tr>
<th>Formula</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v = u + at )</td>
<td>( s = ut + \frac{1}{2}at^2 )</td>
</tr>
<tr>
<td>( v^2 = u^2 + 2as )</td>
<td>( s = \left( \frac{u + v}{2} \right) t )</td>
</tr>
</tbody>
</table>

#### FORCE/KRAG

<table>
<thead>
<tr>
<th>Formula</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{\text{res}} = ma )</td>
<td>( p = mv )</td>
</tr>
<tr>
<td>( F = \frac{Gm_1m_2}{r^2} )</td>
<td>( F \Delta t = \Delta p = mv - mu )</td>
</tr>
</tbody>
</table>

#### WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

<table>
<thead>
<tr>
<th>Formula</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( W = Fs )</td>
<td>( E_p = mgh )</td>
</tr>
<tr>
<td>( P = \frac{W}{t} )</td>
<td>( E_k = \frac{1}{2}mv^2 )</td>
</tr>
</tbody>
</table>

#### ELECTROSTATICS/ELEKTROSTATIKA

<table>
<thead>
<tr>
<th>Formula</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F = \frac{kQ_1Q_2}{r^2} ) ((k = 9 \times 10^9 \text{ N.m}^2\text{.C}^{-2}))</td>
<td>( V = \frac{W}{Q} )</td>
</tr>
<tr>
<td>( E = \frac{F}{q} )</td>
<td>( W = QEs )</td>
</tr>
<tr>
<td>( E = \frac{kQ}{r^2} ) ((k = 9 \times 10^9 \text{ N.m}^2\text{.C}^{-2}))</td>
<td>( E = \frac{V}{d} )</td>
</tr>
</tbody>
</table>

#### CURRENT ELECTRICITY/STROOMELEKTRISITEIT

<table>
<thead>
<tr>
<th>Formula</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q = \text{lt} )</td>
<td>( \text{emf/emk} = I(R + r) )</td>
</tr>
<tr>
<td>( R = r_1 + r_2 + r_3 + \ldots )</td>
<td>( F = \frac{kl_1l_2\ell}{d} ) ((k = 2 \times 10^{-7} \text{ N.A}^{-2}))</td>
</tr>
<tr>
<td>( \frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots )</td>
<td>( W = Vlt = l^2Rt = \frac{V^2t}{R} )</td>
</tr>
<tr>
<td>( R = \frac{V}{I} )</td>
<td>( P = VI = l^2R = \frac{V^2}{R} )</td>
</tr>
</tbody>
</table>
QUESTION 3.4/VRAAG 3.4

Hand in this graph paper with your answer book and ensure that your examination number is entered in the appropriate spaces at the top of this page!

Lever hierdie grafiekpapier saam met jou antwoordeboek in en maak seker dat jou eksamennommer in die toepaslike spacies boaan hierdie bladsy geskryf is!