

DEPARTMENT OF EDUCATION REPUBLIC OF SOUTH AFRICA

## SENIOR CERTIFICATE EXAMINATION - 2005

## PHYSICAL SCIENCE P1

 PHYSICSSTANDARD GRADE
FEBRUARYIMARCH 2005

Marks: 150

2 Hours
This question paper consists of 13 pages, 2 data sheets and 1 multiple-choice answer sheet.


## 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:

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

## QUESTION 1

## INSTRUCTIONS

1. Answer this question on the specially printed ANSWER SHEET. [NOTE: The answer sheet may be either a separate sheet provided as part of your question paper, or printed as part of the answer book.] Write your EXAMINATION NUMBER (and centre number if applicable) in the appropriate spaces, if a separate answer sheet is used.
2. 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 mark the appropriate block on the ANSWER SHEET with a cross ( $X$ ).
3. 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.
4. If more than one block is marked, no marks will be awarded for that answer.

PLACE THE COMPLETED ANSWER SHEET INSIDE THE FRONT COVER OF YOUR ANSWER BOOK, IF A SEPARATE ANSWER SHEET HAS BEEN USED.

## EXAMPLE

QUESTION: The symbol for the SI unit of time is ...

| A | t. |
| :--- | :--- |
| B | h. |
| C | S. |
| D | m. |

ANSWER:

[NOTE: This layout may vary, depending on the type of answer sheet used by the province.]

## QUESTION 1

1.1 A car moves horizontally at a constant velocity of $60 \mathrm{~km} \cdot \mathrm{~h}^{-1}$, in the direction shown.


Which ONE of the following vector diagrams indicates the forces acting on the car?

A

B

C

D
1.2 Two unequal forces act simultaneously on a body. The resultant force ...

A is the same as the equilibrant.
B keeps the body in equilibrium.
C has the same effect as the two forces acting together.
D always has a magnitude which is equal to the sum of the magnitudes of the two individual forces.
1.3 A stone falls freely from rest and reaches a velocity $\mathbf{v}$ after undergoing a displacement $\mathbf{x}$. Ignore the effects of friction. The stone will reach a velocity $2 \mathbf{v}$ after undergoing a displacement ...

A $4 \mathbf{x}$.
B $\quad 2 x$.
C $\quad \sqrt{2} \mathbf{x}$.
D $\quad \sqrt{2 x}$.
1.4 A truck driver is travelling along a straight, horizontal road in his empty truck. He applies his brakes as hard as possible (maximum) and brings the truck to rest. Later in the day he is driving along the same road but is carrying a full load. He applies the brakes the same as before. How will the new braking distance and braking time compare with the previous ones?

|  | New braking distance | New braking time |
| :---: | :---: | :---: |
| A | is greater | is the same |
| B | is the same | is the same |
| C | is greater | is greater |
| D | is the same | is greater |

1.5 An acceleration of $5 \mathrm{~m} . \mathrm{s}^{-2}$ can be explained as follows:

A The velocity changes by $5 \mathrm{~m} \cdot \mathrm{~s}^{-1}$ every second.
B The velocity changes by $5 \mathrm{~m} \cdot \mathrm{~s}^{-1}$ every successive, equal time interval.
C The velocity changes by $5 \mathrm{~m} . \mathrm{s}^{-1}$ every successive, decreasing time interval.

D The velocity changes by $5 \mathrm{~m} \cdot \mathrm{~s}^{-1}$ every successive, increasing time interval.
1.6 Jakes lifts a mass of 200 kg , with uniform velocity, through a certain height in 2 s . What is the magnitude of the force that he exerts on the mass?

A $\quad 4000 \mathrm{~N}$
B $\quad 2000 \mathrm{~N}$
C $\quad 1000 \mathrm{~N}$
D $\quad 400 \mathrm{~N}$
1.7 The gravitational force which the earth exerts on the moon is ...

A directly proportional to the distance between their centres.
B inversely proportional to the mass of the moon.
C inversely proportional to the product of the mass of the earth and the mass of the moon.

D inversely proportional to the square of the distance between their centres.
1.8 A pendulum swings from point $P$ through $Q$ to point $R$. At point $Q$, the pendulum has a gravitational potential energy of 20 J , relative to its lowest point (point R ), and kinetic energy of 5 J .


If the effects of air resistance are ignored, the kinetic energy of the pendulum at R , the lowest point of its motion, will be equal to ...

A 5 J .
B $\quad 15 \mathrm{~J}$.
C 20 J .
D 25 J .
1.9 Ammaar is riding his bicycle on a horizontal road. The bicycle hits a rock and he falls over the handlebars. This is because of his ...

A inertia.
B weight.
C kinetic energy.
D gravitational potential energy.
1.10 Which ONE of the following has the same unit as that of energy?

A W. $\mathrm{s}^{-1}$
B W.s
C N.m ${ }^{-1}$
D N.m ${ }^{-2}$
1.11 Two identical, positive point charges are placed a distance apart.

Which ONE of the following diagrams best represents the resultant electric field pattern which will be obtained due to these two charges?
A




(3)
1.12 Potential difference can best be defined as ...

A the work done in moving a positive charge from a point of low potential to a point of high potential in an electric field.

B the force applied in moving a positive charge from a point of low potential to a point of high potential in an electric field.

C the work done in moving a positive unit charge from a point of low potential to a point of high potential in an electric field.

D the force applied in moving a positive unit charge from a point of low potential to a point of high potential in an electric field.
1.13 The south pole of a magnet is placed on the left-hand side and the north pole of another magnet on the right-hand side. A conductor, placed between the two magnetic poles, carries conventional current into the plane of the page, as shown in the diagram below.

$\otimes$ Into the plane of the page, away from observer.

The conductor would experience a force ...
A towards J, downwards.
B towards K, upwards.
C to the right (the north pole of the magnet).
D to the left (the south pole of the other magnet).
1.14 Two conductors, $X$ and $Y$, carry electric currents in four different arrangements, in the directions as shown. In which ONE of the following cases will conductor $X$ experience a force of attraction due to conductor $Y$ ?
A

$\mathrm{B} \longrightarrow \mathrm{X}$

C

D

1.15 Three identical bulbs, A, B and C, are connected to a battery. Assume the battery has negligible internal resistance.


Which ONE of the following combinations correctly represents the brightness of bulbs $A$ and $B$, compared to their original brightness, if bulb $C$ is removed?

|  | New brightness of bulb A | New brightness of bulb B |
| :---: | :---: | :---: |
| A | dimmer | dimmer |
| B | brighter | dimmer |
| C | brighter | brighter |
| D | dimmer | brighter |

## ANSWER QUESTIONS 2 TO 8 IN THE ANSWER BOOK.

## INSTRUCTIONS

1. Start each question on a NEW PAGE in the ANSWER BOOK.
2. Leave a line between subsections, for example 2.1 and 2.2.
3. Show ALL the formulae, as well as calculations, including substitutions.
4. Number the answers exactly as the questions are numbered.

## QUESTION 2

[START ON A NEW PAGE]
A railway truck, fully laden with mealies (total mass 5000 kg ), rests on a horizontal track with the handbrake engaged (Figure 1). In order to offload the mealies from the truck, the track is tilted at an angle to the horizontal (Figure 2).


When the track is tilted $20^{\circ}$ to the horizontal, the tailgate can be opened and the mealies can be released while the truck remains stationary.
2.1 Draw a labelled force vector diagram (not a triangle of forces) which shows the gravitational force of the earth acting on the truck and its components parallel and perpendicular to the inclined track. Also indicate at least ONE angle in your vector diagram.
2.2 Determine, either by accurate construction ( 1 cm represents 10000 N ) or by calculation, the magnitude and direction of the frictional force which prevents the truck from sliding down the slope. (Handbrake still engaged and mealies not offloaded.)

## QUESTION 3

[START ON A NEW PAGE]
A man, standing on a bridge, is 20 m above the level at which the captain of an approaching boat must catch a package. The man drops the package from the side of the bridge (see diagram) when the captain is 12 m away from point $P$, directly below the package. The boat travels at a constant velocity of $4 \mathrm{~m} . \mathrm{s}^{-1}$ while the captain remains stationary relative to the boat. Ignore the effects of air resistance.

3.1 Calculate the time taken for the package to reach point $P$.
3.2 Calculate the magnitude of the velocity of the package at point $P$.
3.3 The captain, however, will not reach point $P$ in time. Explain this by means of a calculation.

In order for the package to be caught, the captain needs to accelerate the boat from the instant the package is dropped.
3.4 Calculate the magnitude of the acceleration of the boat in order for the captain to catch the package.

## QUESTION 4

[START ON A NEW PAGE]
A helicopter on a fire-fighting mission, lifts a bag of water with the help of a rope vertically upwards at a constant acceleration of $0,4 \mathrm{~m} \cdot \mathrm{~s}^{-2}$. The mass of the water and the bag together is 750 kg .

### 4.1 State Newton's Second Law of Motion in words.

4.2 Calculate the magnitude of the resultant force on the bag of water.
4.3 Calculate the magnitude of the force which the rope exerts on the bag of water while it is accelerating upwards.
4.4 After the bag of water has been lifted, the helicopter accelerates vertically downwards. State whether the force exerted by the rope on the bag will increase, decrease or remain the same.

## QUESTION 5

[START ON A NEW PAGE]
A toy engine of mass 2 kg is designed to run down and along a track as shown below.


The engine is released at point $P$, height 1,5 m above ground level, and it travels along the track to point Q at ground level.
5.1 State, in words, the principle of conservation of mechanical energy.
5.2 Calculate the gravitational potential energy of the engine at point $P$, relative to ground level.
5.3 Using the principle of conservation of mechanical energy, what would be the kinetic energy at Q ?
5.4 However, it is found that the kinetic energy at point $Q$ is actually less than this value given in QUESTION 5.3.
5.4.1 Explain why the kinetic energy is less.
5.4.2 Is the principle of conservation of mechanical energy therefore valid in this situation?

## QUESTION 6

[START ON A NEW PAGE]
A toy cannon (gun), mass $0,4 \mathrm{~kg}$, is resting on a horizontal table. The cannon shoots out a solid rubber ball, mass $0,025 \mathrm{~kg}$, horizontally. Immediately after firing the shot, the cannon rolls back with a velocity of $0,2 \mathrm{~m} . \mathrm{s}^{-1}$ and then comes to rest.

6.1 Name and state, in words, the principle which will enable you to calculate the velocity with which the rubber ball is fired.
6.2 Calculate the magnitude of the velocity with which the ball is fired.
6.3 In which direction will the acceleration of the cannon be, after the ball has been fired, while it is rolling backwards (to the right)?
6.4 If the magnitude of the acceleration of the cannon, after firing the rubber ball, is $0,05 \mathrm{~m} . \mathrm{s}^{-2}$, calculate the magnitude and direction of the frictional force which the table exerts on the wheels of the cannon.

## QUESTION 7

[START ON A NEW PAGE]
Two identical, very small, charged spheres, X and Y , on insulated stands, are placed 20 cm apart, as indicated in the diagram. $X$ has a charge of $+8 \times 10^{-9} \mathrm{C}$ and $Y$ has a charge of $-4 \times 10^{-9} \mathrm{C}$.


### 7.1 State Coulomb's law in words.

7.2 Calculate the magnitude and direction of the electrostatic force that $X$ exerts on Y .
7.3 Calculate the magnitude of the electric field strength that sphere $Y$ sets up at the point where sphere $X$ is positioned.

The charged sphere $Y$ is brought closer towards $X$ and is made to touch $X$. Sphere $Y$ is then moved back to its original position which is 20 cm from $X$.
7.4 Calculate the new charges on $X$ and $Y$ after they have made contact and been separated again.

## QUESTION 8

[START ON A NEW PAGE]
In the circuit represented below, the battery has an emf of 12 V and negligible internal resistance. Voltmeter $V_{1}$ is connected across the battery and voltmeter $V_{2}$ is connected across the open switch S . The resistance of the connecting wires and the ammeter can be ignored.


Switch S is open.
8.1 What is the reading on $\mathrm{V}_{1}$ ?
8.2 What is the reading on $V_{2}$ ?

Switch S is then closed.
8.3 Voltmeters $\mathrm{V}_{1}$ and $\mathrm{V}_{2}$ can register either $\mathbf{0} \mathbf{V}, \mathbf{1 2} \mathrm{V}$ or a reading somewhere between 0 V and 4 V . Choose ONE of these possible readings and give an explanation for your choice of the reading on:
8.3.1 $\mathrm{V}_{1}$
8.3.2 $\mathrm{V}_{2}$
8.4 Calculate the effective resistance of the parallel combination of resistors.
8.5 Calculate the reading on the ammeter.
8.6 Calculate the energy transferred in the $1 \Omega$ resistor in 1,5 minutes.

# DEPARTMENT OF EDUCATION DEPARTEMENT VAN ONDERWYS 

## SENIOR CERTIFICATE EXAMINATION SENIORSERTIFIKAAT-EKSAMEN

## DATA FOR PHYSICAL SCIENCE PAPER I (PHYSICS)

## GEGEWENS VIR NATUUR- EN SKEIKUNDE VRAESTEL I (FISIKA)

TABLE 1: PHYSICAL CONSTANTS
TABEL 1: FISIESE KONSTANTE

| NAME/NAAM | SYMBOL/SIMBOOL | VALUE/WAARDE |
| :---: | :---: | :---: |
| Acceleration due to gravity Swaartekragversnelling | $g$ | $10 \mathrm{~m} . \mathrm{s}^{-2}$ |
| Gravitational constant Swaartekragkonstante | $\underline{\mathbf{G}}$ | 6,7 $\times 10^{-11} \mathrm{~N} . \mathrm{m}^{2} . \mathrm{kg}^{-2}$ |
| Charge on electron Lading van elektron | $\mathbf{e}^{-}$ | $-1,6 \times 10^{-19} \mathrm{C}$ |
| MATHEMATICAL AIDS/WIS $\begin{aligned} & \frac{\sin A}{a}=\frac{\sin B}{b}=\frac{\sin C}{c} \\ & c^{2}=a^{2}+b^{2}-2 a b \cos C \end{aligned}$ | GE HULPMIDDELS <br> a <br> C |  |

## TABLE 2: FORMULAE

TABEL 2: FORMULES
MOTION/BEWEGING

| $v=u+a t$ | $s=u t+\frac{1}{2} a t^{2}$ |
| :--- | :--- |
| $v^{2}=u^{2}+2 a s$ | $s=\left(\frac{u+v}{2}\right) t$ |

## FORCE/KRAG

| $F_{\text {res }}=m a$ | $p=m v$ |
| :--- | :--- |
| $F=\frac{G m_{1} m_{2}}{r^{2}}$ | $F \Delta t=\Delta p=m v-m u$ |

WORK, ENERGY AND POWERIARBEID, ENERGIE EN DRYWING

| $W=F s$ | $E_{p}=m g h$ |
| :--- | :--- |
| $P=\frac{W}{t}$ | $E_{k}=\frac{1}{2} m v^{2}$ |

ELECTROSTATICS/ELEKTROSTATIKA

| $F=\frac{k_{1} Q_{2}}{r^{2}}$ | $\left(k=9 \times 10^{9} \mathrm{~N} \cdot \mathrm{~m}^{2} \cdot \mathrm{C}^{-2}\right)$ | $V=\frac{W}{\mathrm{Q}}$ |
| :--- | :--- | :--- |
| $E=\frac{\mathrm{F}}{\mathrm{q}}$ | $\mathrm{W}=\mathrm{QEs}$ |  |
| $E=\frac{\mathrm{kQ}}{\mathrm{r}^{2}}$ | $\left(\mathrm{k}=9 \times 10^{9} \mathrm{~N} \cdot \mathrm{~m}^{2} \cdot \mathrm{C}^{-2}\right)$ | $\mathrm{E}=\frac{\mathrm{V}}{\mathrm{d}}$ |

## CURRENT ELECTRICITYISTROOMELEKTRISITEIT

| $\mathrm{Q}=\mathrm{It}$ | emf/emk $=\mathrm{I}(\mathrm{R}+\mathrm{r})$ |
| :--- | :--- |
| $\mathrm{R}=\mathrm{r}_{1}+\mathrm{r}_{2}+\mathrm{r}_{3}+\ldots$ | $\mathrm{F}=\frac{\mathrm{kl} \mathrm{I}_{2} \ell}{\mathrm{~d}} \quad\left(\mathrm{l}=2 \times 10^{-7} \mathrm{~N} . \mathrm{A}^{-2}\right)$ |
| $\frac{1}{\mathrm{R}}=\frac{1}{\mathrm{r}_{1}}+\frac{1}{\mathrm{r}_{2}}+\frac{1}{\mathrm{r}_{3}}+\ldots$ | $\mathrm{W}=\mathrm{VIt}=\mathrm{I}^{2} \mathrm{Rt}=\frac{\mathrm{V}^{2} \mathrm{t}}{\mathrm{R}}$ |
| $\mathrm{R}=\frac{\mathrm{V}}{\mathrm{I}}$ | $\mathrm{P}=\mathrm{VI}=\mathrm{I}^{2} \mathrm{R}=\frac{\mathrm{V}^{2}}{\mathrm{R}}$ |

ANSWER SHEETIANTWOORDBLAD

| Examination number <br> Eksamennommer |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

## DEPARTMENT OF EDUCATION

DEPARTEMENT VAN ONDERWYS
SENIOR CERTIFICATE EXAMINATION/SENIORSERTIFIKAAT-EKSAMEN
PHYSICAL SCIENCE STANDARD GRADE FIRST PAPER (PHYSICS)/ NATUUR- EN SKEIKUNDE STANDAARDGRAAD EERSTE VRAESTEL (FISIKA)


| For the use of the marker |  |
| :--- | :--- |
| Vir die gebruik van die nasiener |  |$|$| Marks obtained <br> Punte behaal |
| :--- |
| Marker's <br> initials <br> Nasiener <br> Se paraaf |
| Marker's <br> number <br> Nasiener <br> se nommer |

