education

Department:
Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION - 2006

PHYSICAL SCIENCE P1
PHYSICS

HIGHER GRADE

OCTOBER/NOVEMBER 2006

MARKS: 200

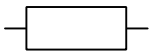
TIME: 2 hours

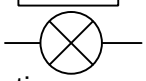
This question paper consists of 16 pages, a data sheet consisting of 4 pages and 1 multiple-choice answer sheet.

NOTE: QUESTION 8.1 SHOULD BE ANSWERED ON THE GRAPH PAPER WHICH IS 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. Answer this question on the specially printed ANSWER SHEET. [NOTE: The answer sheet may either be 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 SI unit of time is ...

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

ANSWER:

A	B	~~C~~	D

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

QUESTION 1

1.1 Which ONE of the following combinations of base units represents **change in momentum**?

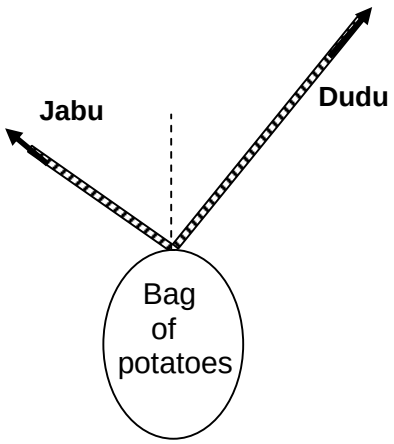
A $kg.m.s^{-1}$

B $kg.m.s^{-2}$

C $kg.m^2.s^{-2}$

D $kg.m^2.s^{-3}$ (4)

1.2 Jabu and her sister Dudu hold a bag of potatoes **at rest**, using two ropes tied to the top of the bag as shown. The magnitude of the force which Dudu applies on the rope is greater than the magnitude of the force which Jabu applies on her rope.



Which ONE of the following statements is true with reference to the magnitudes of the vertical or horizontal components of the forces applied by Jabu and Dudu?

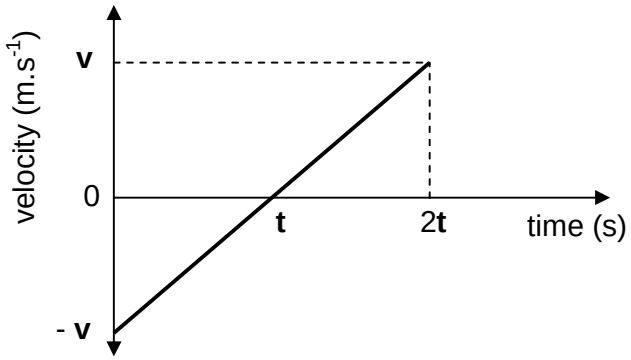
A $F_{Jabu/Horizontal} < F_{Dudu/Horizontal}$

B $F_{Jabu/Horizontal} = F_{Dudu/Horizontal}$

C $F_{Jabu/Vertical} = F_{Dudu/Vertical}$

D $F_{Jabu/Vertical} > F_{Dudu/Vertical}$ (4)

1.3 The graph below shows the variation of velocity with time of a body moving under the influence of the force of gravity. Downward is taken as positive.



What is the total displacement of the body, in m, in time 2**t**?

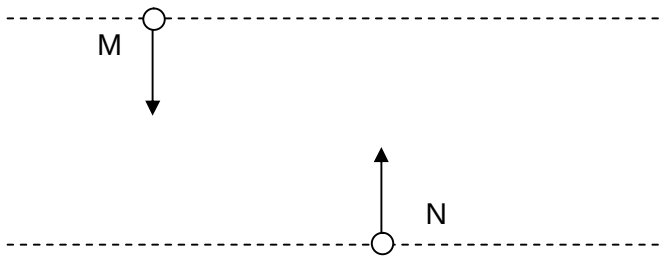
A $5\mathbf{t}^2$

B 2**vt**

C **vt**

D zero (4)

1.4 The instant a steel ball M is dropped from rest from a certain height, another steel ball N is projected vertically upward from ground level. The maximum height which N reaches is the same as the height from which M is dropped. M does not bounce when it strikes the ground.

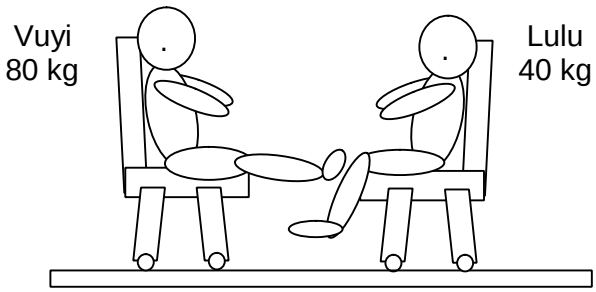


Consider the motion of N only for its rise upward. Which ONE of the following pairs of statements, regarding the speed and acceleration of the balls, is true when they reach the halfway mark of their separate motions? The effect of air resistance is negligible.

	Speed	**Acceleration**
A	speed of M < speed of N	The directions of the accelerations of M and N are both downward.
B	speed of M = speed of N	The directions of the accelerations of M and N are both downward.
C	speed of M > speed of N	The direction of the acceleration of M is downward and that of N is upward.
D	speed of M = speed of N	The direction of the acceleration of M is downward and that of N is upward.

(4)

1.5 Vuyi, mass 80 kg, and Lulu, mass 40 kg, sit on identical office chairs (fitted with rollers) facing each other. Vuyi places her feet against Lulu's knees and pushes her away.



Which ONE of the following is correct regarding the magnitude of the force exerted by Lulu on Vuyi?

A $\mathbf{F}_{\text{Lulu on Vuyi}} = \frac{40}{120}\mathbf{F}_{\text{Vuyi on Lulu}}$

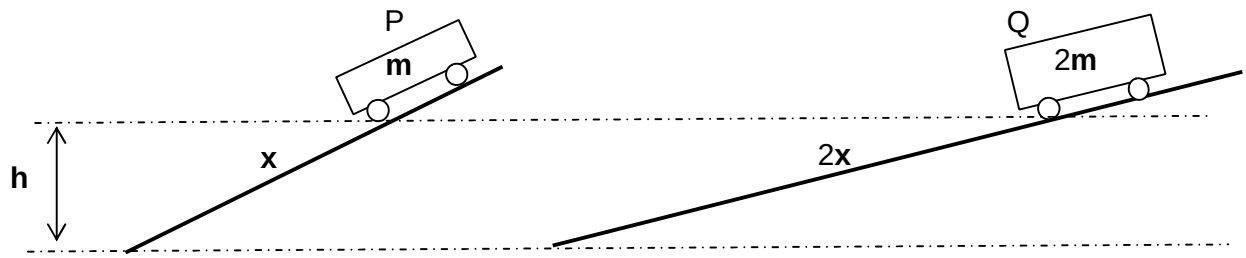
B $\mathbf{F}_{\text{Lulu on Vuyi}}$ = zero

C $\mathbf{F}_{\text{Lulu on Vuyi}} = \mathbf{F}_{\text{Vuyi on Lulu}}$

D $\mathbf{F}_{\text{Lulu on Vuyi}} = \frac{40}{80}\mathbf{F}_{\text{Vuyi on Lulu}}$

(4)

1.6 Trolley P, mass **m**, and another trolley Q, mass 2**m**, are released from rest from the same vertical height **h** and run down two tracks of length **x** and 2**x** respectively. Disregard all frictional forces.



What is the speed of Q at the bottom of its slope if P has a speed of **v** at the bottom of its slope?

A 4**v**

B 2**v**

C $\sqrt{2}\,\mathbf{v}$

D **v**

(4)

1.7 An electric motor lifts a load of mass **m** through a vertical height **h** at a constant speed **v** in a time Δ**t**. Which ONE of the following expressions can be used to calculate the rate at which work is done on the load while it is being lifted at a constant speed?

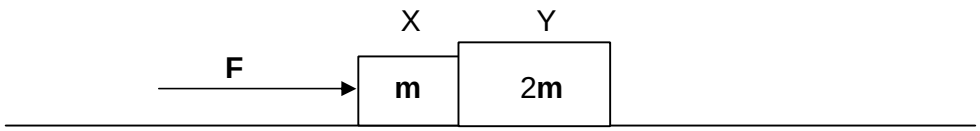
A $\mathbf{mgh\Delta t}$

B $\dfrac{\mathbf{mgh}}{\Delta \mathbf{t}}$

C $\left(\mathbf{mgh} + \dfrac{\mathbf{mv}^2}{2}\right) \div \Delta \mathbf{t}$

D $\dfrac{\mathbf{mv}^2}{2\Delta \mathbf{t}}$ (4)

1.8 Two blocks, X and Y, masses **m** and 2**m** respectively, are in contact with each other. The blocks are accelerated by a horizontal force **F** along a frictionless, horizontal surface.



What is the magnitude of the force that Y exerts on X?

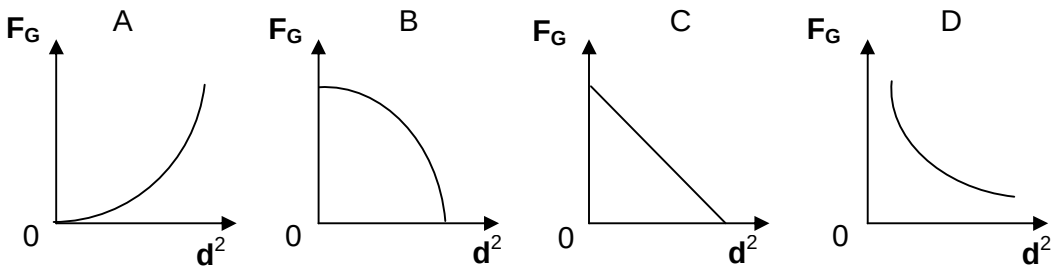
A 2**F**

B **F**

C $\frac{2}{3}$**F**

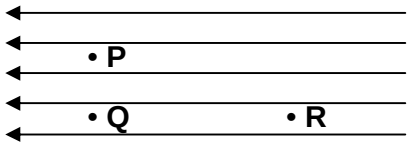
D $\frac{1}{3}$**F** (4)

1.9 Which ONE of the following graphs is the best representation of the relationship between the gravitational force $\mathbf{F_G}$, which one particle exerts on another particle, and the distance **d** between them?



(4)

1.10 P, Q and R are three points in a uniform electric field. A line drawn from Q to R is parallel to the field, while a line drawn from P to Q is perpendicular to the field.



Between which two points is the potential difference zero?

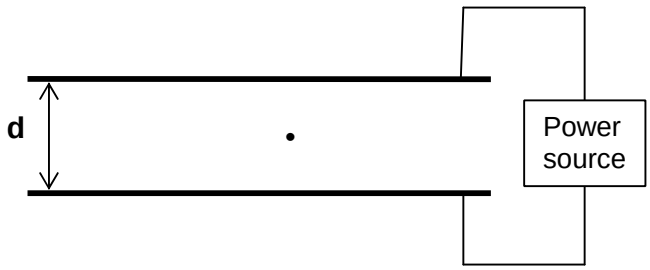
A P and Q

B P and R

C Q and R

D None of the above-mentioned points (4)

1.11 In a Millikan-type experiment, a constant potential difference **V** is applied by a power source which is connected across two oppositely charged, parallel plates. When the plates are a distance **d** apart, an oil drop is at rest between them.

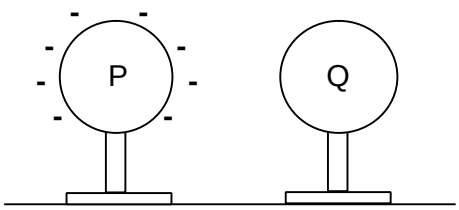


The distance between the plates is increased to 2**d**. Which ONE of the following combinations best explains the magnitudes of the two forces acting on the oil drop and the direction of the resultant force now experienced by the oil drop?

	Magnitude of the force of the earth on the oil drop	**Magnitude of the force of the electric field on the oil drop**	**Direction of the resultant force on the oil drop**
A	remains unchanged	increases	upwards
B	increases	increases	upwards
C	increases	decreases	downwards
D	remains unchanged	decreases	downwards

(4)

1.12 Two metal spheres, P and Q, are mounted on insulated stands. Sphere P is negatively charged while sphere Q is neutral.



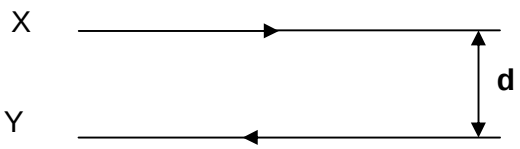
Sphere P is brought closer to sphere Q so that the spheres touch each other. They are then moved back to their original positions.

Which ONE of the following pairs of statements is true about the electrostatic force of sphere P on sphere Q, before touching and after touching?

	Before touching	**After touching**
A	P has no effect on Q	P repels Q
B	P has no effect on Q	P attracts Q
C	P attracts Q	P repels Q
D	P attracts Q	P attracts Q

(4)

1.13 Two long, parallel conductors, X and Y, placed a distance **d** apart, carry currents of $\mathbf{I_X}$ and $\mathbf{I_Y}$ respectively. The magnitude of the magnetic force that conductor X exerts on conductor Y is **F**.



The current in X is increased to $3\mathbf{I_X}$ and the distance between the conductors is halved. What is the magnitude of the force that X now exerts on Y?

A $12\mathbf{F}$

B $6\mathbf{F}$

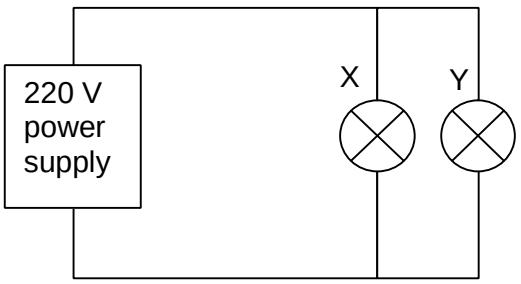
C $\frac{3}{2}\mathbf{F}$

D $\frac{3}{4}\mathbf{F}$

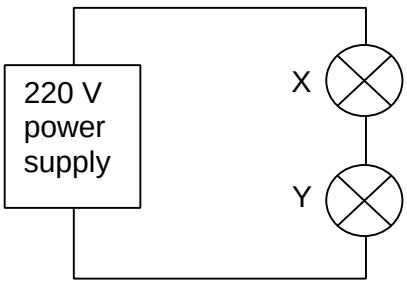
(4)

1.14 Thabo has two light bulbs, X and Y, marked 100 W and 60 W respectively. He first connects them in parallel (circuit 1) and then in series (circuit 2) in order to compare their brightness in each circuit.

Circuit 1



Circuit 2

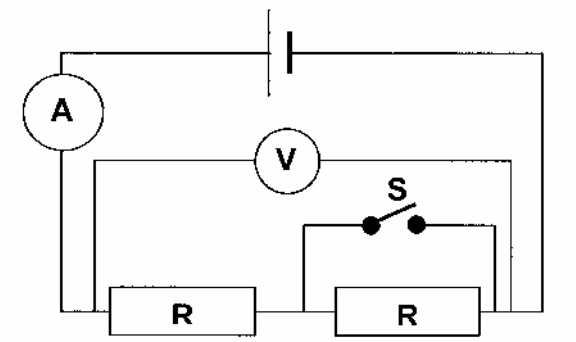


Which light bulb, X or Y, glows brighter in each circuit?

	Bulb that glows brighter in circuit 1	**Bulb that glows brighter in circuit 2**
A	X	X
B	Y	X
C	X	Y
D	Y	Y

(4)

1.15 In the circuit represented below, switch S is open. The internal resistance of the cell CANNOT be ignored.



Which ONE of the following combinations correctly represents the change in the readings on the ammeter and the voltmeter when switch S is closed?

	Ammeter reading	**Voltmeter reading**
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

(4)

15 x 4 = [60]

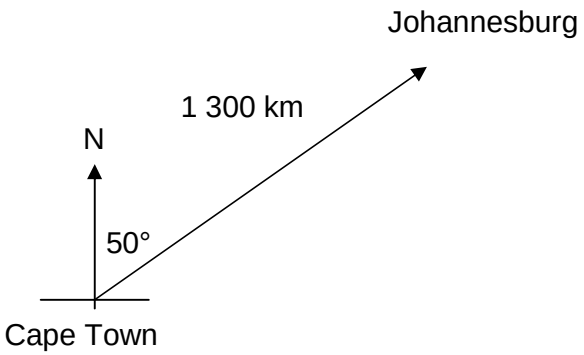
ANSWER QUESTIONS 2 TO 9 IN THE ANSWER BOOK.

INSTRUCTIONS

1. Start each question on a NEW PAGE in the ANSWER BOOK.
2. Leave a line between subsections, for example 2.1 and 2.2.
3. Show ALL the 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]

An aeroplane travels from Cape Town International Airport and the pilot must reach Johannesburg International Airport, which is situated 1 300 km from Cape Town on a bearing of 050°, in 4 hours. At the height at which the plane flies, a wind is blowing at 150 km.h^{-1} on a bearing of 315° for the whole trip.



2.1 Calculate the magnitude of the average resultant velocity of the aeroplane, in km.h^{-1}, if it is to get to its destination on time. (4)

2.2 Calculate the **magnitude** and **direction** of the average velocity, in km.h^{-1}, in which the aeroplane should be pointed in order to reach Johannesburg International Airport in the prescribed 4 hours. A labelled, rough sketch must be included as part of your answer. (The question must NOT be answered by using a scale drawing.) (11)

2.3 After 2,5 hours the control tower at Johannesburg Airport already has the plane 'in sight' on the radar screen.

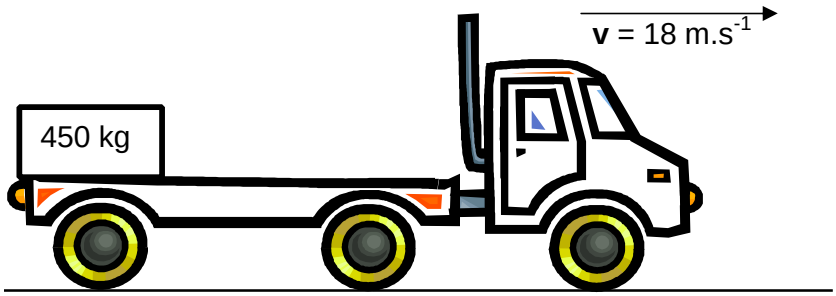
2.3.1 Calculate the distance of the plane from Johannesburg Airport at this point, assuming the wind has been constant for the whole trip. (3)

2.3.2 What is the direction of the plane as observed from the control tower? (2)

[20]

QUESTION 3 [START ON A NEW PAGE]

A truck, moving at a constant speed of 18 $m.s^{-1}$ on a straight, horizontal road, carries a box of mass 450 kg. The driver brakes suddenly to avoid hitting a sheep which runs across the road. The truck stops 6 s after the brakes are applied. Assume that the acceleration is uniform during braking.

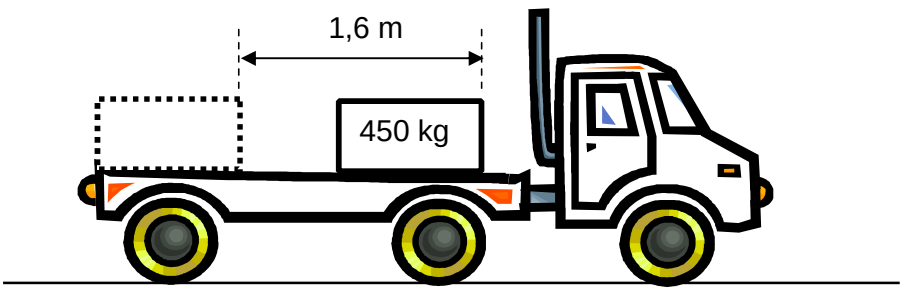


Calculate:

3.1 The acceleration of the truck (6)

3.2 The distance travelled by the truck from when the brakes are applied until it stops (5)

Later, during the journey, the truck is travelling at a speed of 6 $m.s^{-1}$ when it collides with a concrete wall and immediately comes to rest. The box on the back of the truck slides forward through a distance of 1,6 m on the back of the truck before coming to rest.

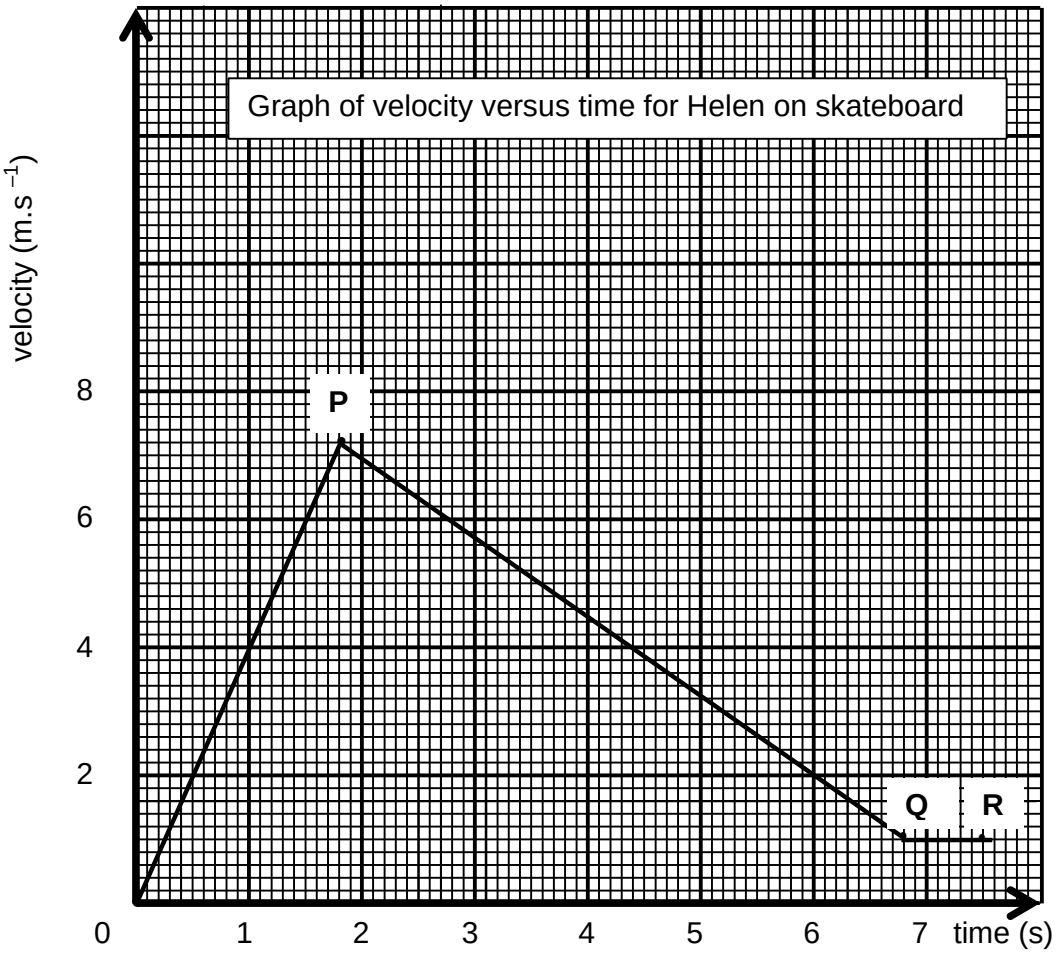


3.3 Name, and explain in words, the property of the box that causes it to slide forward on the back of the truck. (4)

3.4 Calculate the **magnitude** and **direction** of the average frictional force which brings the box to rest. (8)
[23]

QUESTION 4 [START ON A NEW PAGE]

Helen, on a skateboard, starts from rest without pushing herself forward and moves along a track that is not horizontal for her entire motion. During her entire motion she keeps both her feet on the skateboard. The graph below is a representation of how her velocity changes with time. Ignore all types of friction.



4.1 Without doing any calculations, comment on the **speed** and **acceleration** in each of the following sections:

4.1.1 From the start to P (2)

4.1.2 From P to Q (2)

4.2 Calculate the **magnitude** of her acceleration between points P and Q. (4)

4.3 Compare the accelerations of the two sections up to point Q without doing any further calculations. (2)

4.4 Compare the shape of the track for the two sections up to point Q. (4)

4.5 Calculate, by using the graph and not any equation of motion, the distance she skates up to point P. (4)

4.6 What is the resultant force on Helen between points Q and R? Explain why the resultant force has this value. (3)

[21]

QUESTION 5 [START ON A NEW PAGE]

Galileo showed experimentally that the acceleration due to gravity on Earth is the same for all falling bodies and Isaac Newton formulated the laws which help to explain this.

5.1 State, in words, **Newton's Law of Universal Gravitation**. (4)

5.2 Use relevant formulae to show that the acceleration due to gravity on Earth (**g**) does not depend on the mass of the falling body, but only on the mass of the earth ($\mathbf{M_E}$) and the radius of the earth ($\mathbf{R_E}$). (4)

5.3 Calculate the magnitude of the acceleration due to gravity on the planet Mercury, given the following:

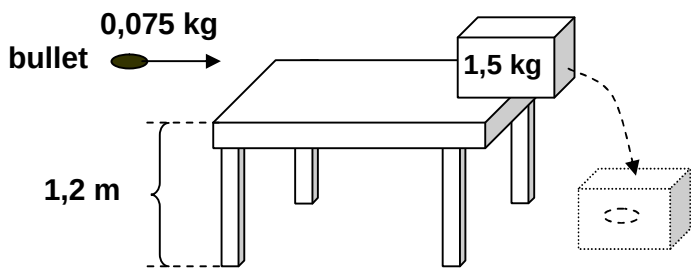
The mass of Mercury = $2,99 \times 10^{23}$ kg

The radius of Mercury = $2,42 \times 10^{6}$ m

(4)
[12]

QUESTION 6 [START ON A NEW PAGE]

A 1,5 kg block of wood is placed on the edge of a table 1,2 m above the floor. The block is struck by a bullet, mass 0,075 kg, moving at an unknown, horizontal velocity. After the impact, the bullet is embedded in the block, which falls to the floor. The block strikes the floor with a **speed** of 8 $m.s^{-1}$. Ignore all types of friction.



Calculate:

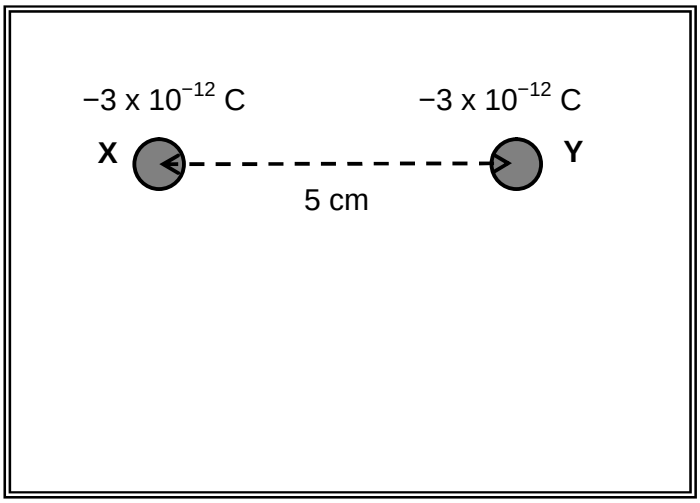
6.1 The magnitude of the velocity with which the block leaves the table (7)

6.2 The magnitude of the velocity with which the bullet strikes the block (7)

6.3 The magnitude of the impulse of the bullet during the impact (5)
[19]

QUESTION 7 [START ON A NEW PAGE]

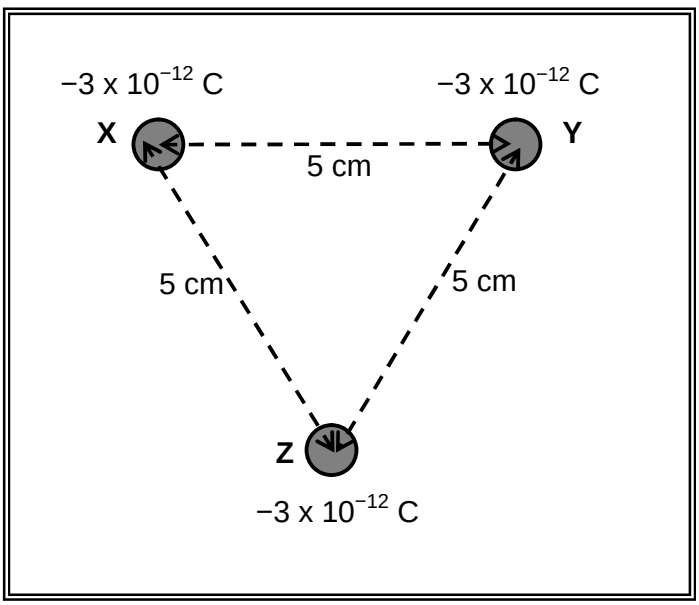
Two identical, light, metal balls, X and Y, each carrying a charge of -3×10^{-12} C, are fixed on a frictionless, horizontal, insulated surface as shown in the diagram. The distance between the centres of X and Y is 5 cm.



7.1 Draw the resultant electric field pattern produced by X and Y, assuming the surface does not affect the field in any way. (4)

7.2 Calculate the **magnitude and direction** of the force that X exerts on Y. (6)

A third ball, Z, identical to X and Y, also with a charge of -3×10^{-12} C, is placed on the frictionless surface such that the distance between the centres of all the balls is 5 cm.



7.3 As ball Z is released, it accelerates in the direction of the resultant force acting on it. State whether the magnitude of the acceleration of Z **increases**, **decreases** or **remains the same** as it moves. Explain your answer. (3)

[13]

QUESTION 8 [START ON A NEW PAGE]

Learners in a school are required to perform an experiment in order to obtain the relationship between the potential difference across an unknown resistor and the current in the resistor.

Azeez and Ziyanda connected the apparatus correctly and obtained the following results:

Current in ampere	**Potential difference in volt**
0	0
0,26	1,5
0,60	3,2
0,72	4,2
0,96	5,4

8.1 Use a suitable scale to draw and label a system of axes, with potential difference on the vertical (dependent) axis and current on the horizontal (independent) axis, on the graph paper **provided on the back of the answer sheet of QUESTION 1 or as a separate sheet**. Plot the points and draw the straight-line graph. (6)

8.2 State the relationship between the potential difference across the unknown resistor and the current in the resistor. (2)

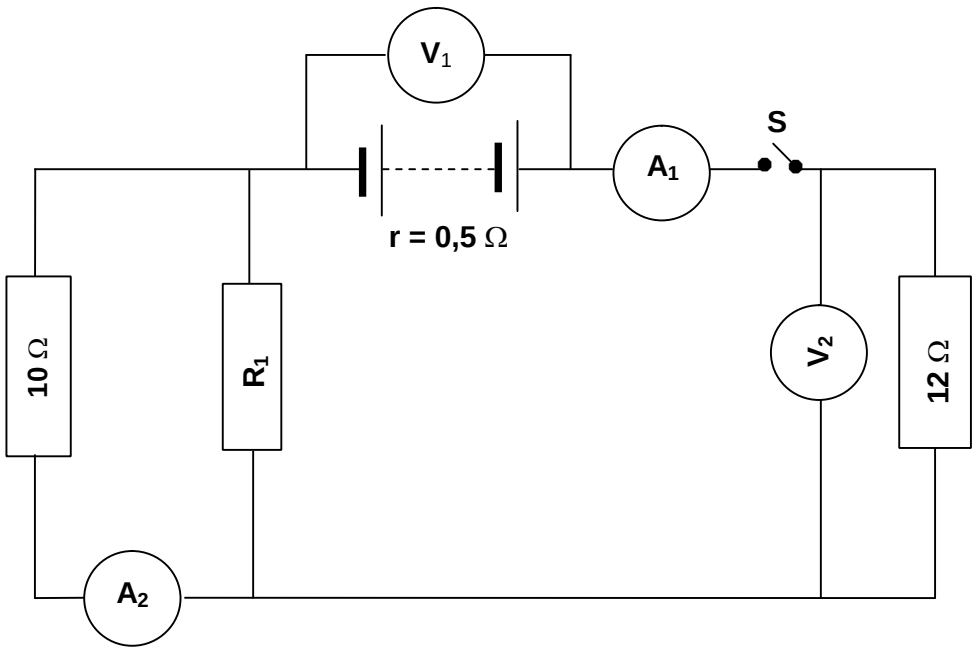
8.3 Calculate the gradient of the graph. (4)

8.4 What physical quantity does the gradient of this graph represent? (2)

8.5 This experiment forms the basis of an important law. Name this law. (2)
[16]

QUESTION 9 [START ON A NEW PAGE]

In the circuit represented below, the resistance of R_1, which is connected in parallel with the 10 Ω resistor, is unknown. When switch S is open, the reading on V_1 is 45 V. The battery has an internal resistance of 0,5 Ω.



When switch S is closed, the reading on V_1 is 43,5 V.

Calculate:

9.1 The reading on A_1 (5)

9.2 The reading on V_2 (3)

9.3 The reading on A_2 (4)

9.4 The resistance of R_1 (4)
[16]

TOTAL QUESTION 1 : 60
TOTAL QUESTIONS 2 – 9 : 140
GRAND TOTAL : 200

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DEPARTEMENT VAN ONDERWYS

SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

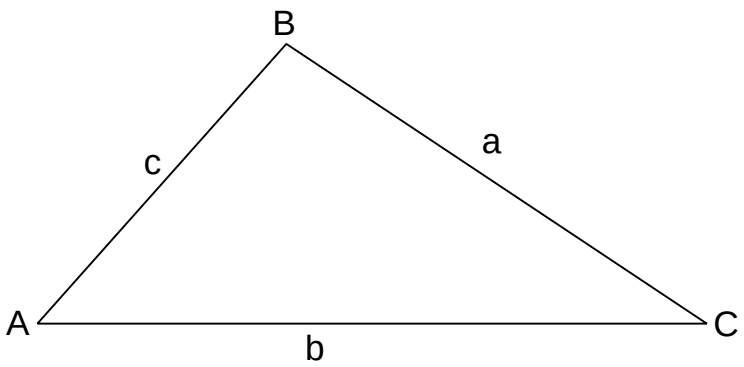
DATA FOR PHYSICAL SCIENCE
PAPER I (PHYSICS)

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	$10\ m.s^{-2}$
Gravitational constant *Swaartekragkonstante*	G	$6{,}7 \times 10^{-11}\ N.m^2.kg^{-2}$
Charge on electron *Lading van elektron*	e^-	$-1{,}6 \times 10^{-19}\ C$

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*

$v = u + at$	$s = ut + \frac{1}{2}at^2$
$v^2 = u^2 + 2as$	$s = \left(\frac{u+v}{2}\right)t$

FORCE/*KRAG*

$F_{res} = ma$	$p = mv$
$F = \frac{Gm_1m_2}{r^2}$	$F\Delta t = \Delta p = mv - mu$

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

$W = Fs$	$E_p = mgh$
$P = \frac{W}{t}$	$E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$ $(k = 9 \times 10^9\ N.m^2.C^{-2})$	$V = \frac{W}{Q}$
$E = \frac{F}{q}$	$W = QEs$
$E = \frac{kQ}{r^2}$ $(k = 9 \times 10^9\ N.m^2.C^{-2})$	$E = \frac{V}{d}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$Q = It$	emf/emk $= I(R + r)$
$R = r_1 + r_2 + r_3 + \ldots$	$F = \frac{kI_1I_2\ell}{d}$ $(k = 2 \times 10^{-7}\ N.A^{-2})$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots$	$W = VIt = I^2Rt = \frac{V^2t}{R}$
$R = \frac{V}{I}$	$P = VI = I^2R = \frac{V^2}{R}$

ANSWER SHEET FOR QUESTION 1/*ANTWOORDBLAD VIR VRAAG 1*

Examination number *Eksamennommer*													

DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS

SENIOR CERTIFICATE EXAMINATION/*SENIORSERTIFIKAAT-EKSAMEN*

PHYSICAL SCIENCE HIGHER GRADE FIRST PAPER (PHYSICS)/
NATUUR- EN SKEIKUNDE HOËR GRAAD EERSTE VRAESTEL (FISIKA)

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D
1.11	A	B	C	D
1.12	A	B	C	D
1.13	A	B	C	D
1.14	A	B	C	D
1.15	A	B	C	D

For the use of the marker *Vir die gebruik van die nasiener*	
Marks obtained *Punte behaal*	
Marker's initials *Nasiener se paraaf*	
Marker's number *Nasiener se nommer*	

15 x 4 = [60]

QUESTION 8.1/*VRAAG 8.1*

Examination number *Eksamennommer*													

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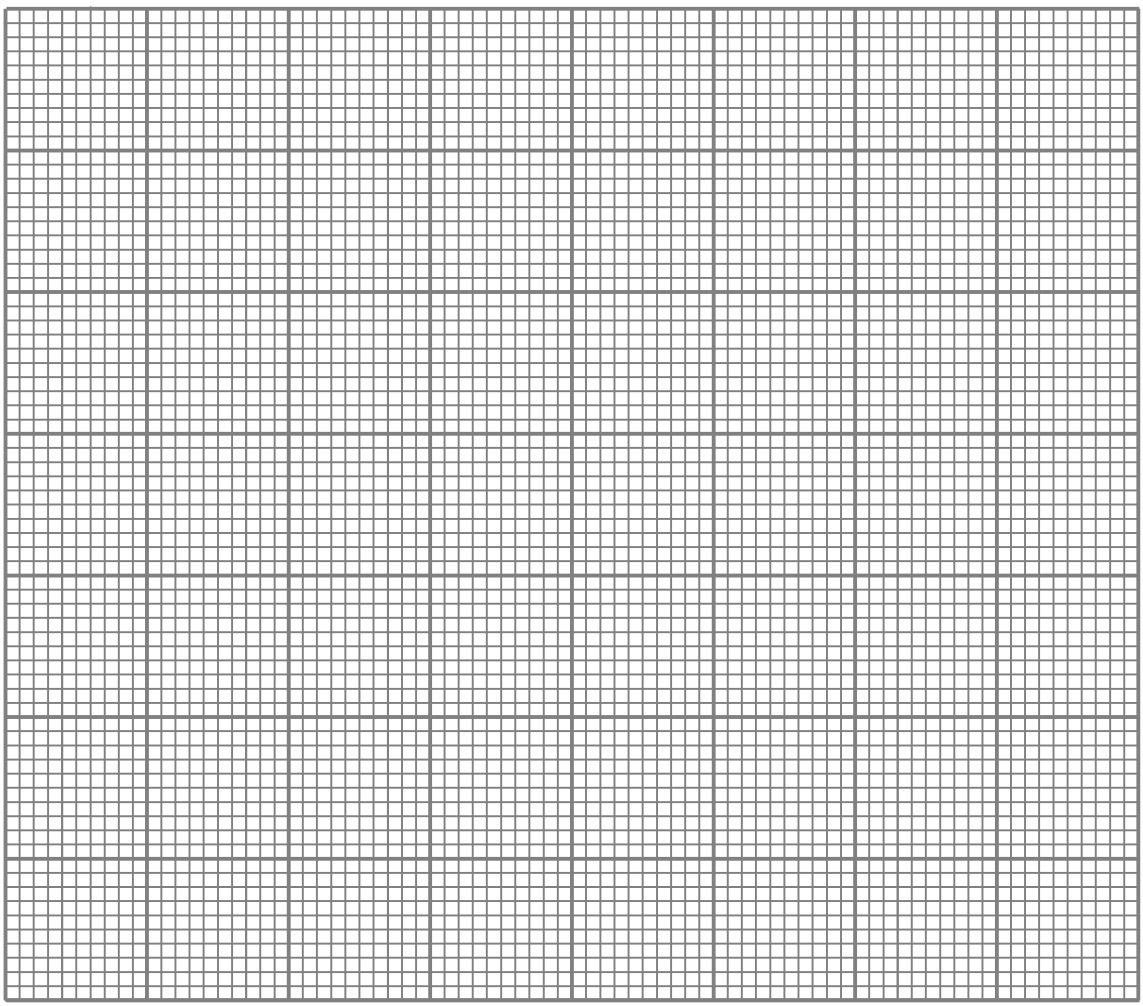

Place the graph paper in your answer book.
Plaas die grafiekpapier in jou antwoordeboek.