education

Department:
Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION - 2006

PHYSICAL SCIENCE P1
PHYSICS

HIGHER GRADE

FEBRUARY/MARCH 2006

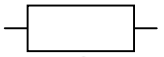
Marks: 200

2 Hours

This question paper consists of 16 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.

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.

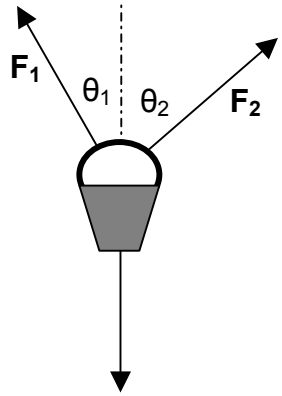
ANSWER:

A	B	C	D

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

QUESTION 1

1.1 A bucket of water is held **at rest** (in equilibrium) between Jack and Jill. The magnitude of the force that Jack exerts on the bucket is $\mathbf{F_1}$ and the force makes an angle θ_1 with the vertical. The magnitude of the force that Jill exerts on the bucket is $\mathbf{F_2}$ and the force makes an angle θ_2 with the vertical.



If θ_1 is **smaller** than θ_2, which one of the following statements concerning the magnitudes of the forces is **true**?

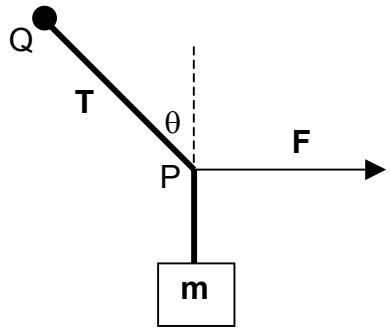
A $\mathbf{F_1 > F_2}$

B $\mathbf{F_1 = F_2}$

C $\mathbf{F_1 < F_2}$

D $\mathbf{F_1 + F_2}$ = weight of the bucket, but $\mathbf{F_1}$ and $\mathbf{F_2}$ are not known. (4)

1.2 An object of mass **m** is suspended by a light inelastic rope attached to the object and at Q. A horizontal force **F** is applied at P until equilibrium is reached. The tension in section PQ of the rope is equal to **T**.



If the mass of the object is increased while θ remains the same, …

A **T** will decrease and **F** will increase.

B **T** will increase and **F** will increase.

C **T** will decrease while **F** will remain constant.

D **T** will increase while **F** will remain constant. (4)

1.3 In an experiment to determine the acceleration of a trolley, the following ticker-tapes were obtained using the same ticker timer. Which one of the ticker-tapes represents uniform acceleration of the trolley? Tapes are not drawn to scale.

A . 660 mm . 540 mm . 420 mm . 300 mm .

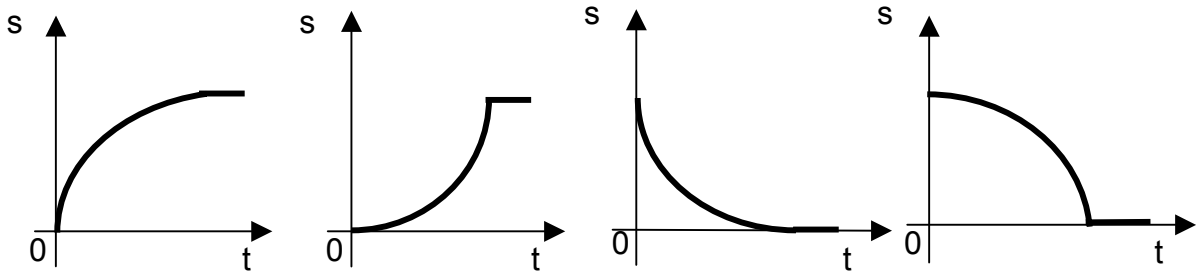
B . 1 140 mm . 660 mm . 420 mm . 300 mm .

C . 760 mm . 580 mm . 420 mm . 280 mm .

D . 2 400 mm . 1 200 mm . 600 mm . 300 mm .

(4)

1.4 Hebeth drops a ball of putty from the second floor of a building. The putty lands on the ground below and does not bounce up at all. Which one of the following displacement-time graphs best represents the displacement of the putty, from the moment it is dropped until it lands on the ground and remains stationary? The displacement is measured from the point of release on the second floor. Ignore the effects of air resistance.



(4)

1.5 The gravitational force that the earth exerts on a satellite is **F**. If the distance between the satellite and the centre of the earth is doubled, the gravitational force that the earth exerts on the satellite will be equal to …

A $\frac{1}{4}\mathbf{F}$.

B $\frac{1}{2}\mathbf{F}$.

C 2**F**.

D 4**F**. (4)

1.6 A fly hits the front windscreen of a moving car. Compared to the magnitude of the force the fly exerts on the windscreen, the magnitude of the force the windscreen exerts on the fly during the collision, is …

A zero.

B smaller, but not zero.

C bigger.

D the same. (4)

1. 7 A 4 kg mass falls at a **terminal velocity**. Which one of the following combinations, concerning the air resistance and the resultant force, is correct?

	Magnitude and direction of air resistance	**Magnitude of resultant force**
A	40 N down	40 N
B	40 N down	0 N
C	40 N up	40 N
D	40 N up	0 N

(4)

1.8 An exploding device is thrown vertically upwards. As it reaches its highest point, it explodes and breaks up into three pieces of **equal mass**. Which one of the following combinations is possible for the motion of the three pieces if they all move in a vertical line?

	Mass 1	**Mass 2**	**Mass 3**
A	v downwards	v downwards	v upwards
B	v upwards	2v downwards	v upwards
C	2v upwards	v downwards	v upwards
D	v upwards	2v downwards	v downwards

(4)

1.9 A trolley, R, of mass **m** is moving horizontally to the right at a constant velocity and has kinetic energy $\mathbf{E_k}$. If another trolley, S, also of mass **m** is dropped perpendicularly on top of trolley R, while trolley R is moving, the new kinetic energy of the combination will be …

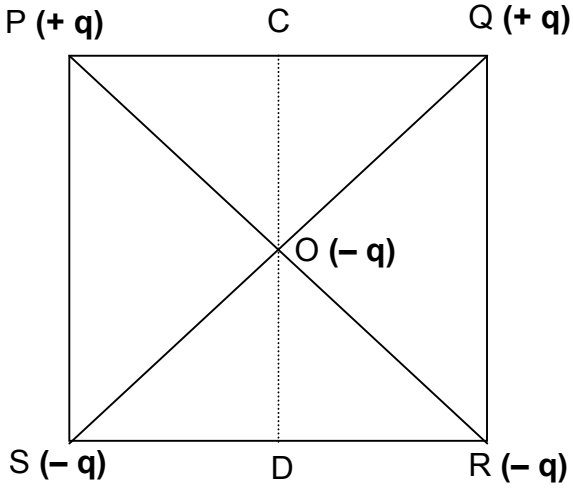
A $2\ \mathbf{E_k}$.

B $\sqrt{2}\ \mathbf{E_k}$.

C $\frac{1}{2}\mathbf{E_k}$.

D $\frac{1}{4}\mathbf{E_k}$. (4)

1.10 Five point charges, of magnitudes of either **+ q** or **– q**, are stationary at the four corners of a square PQRS and at its centre, O, as shown in the diagram below. The magnitude of the electrostatic force which the charge at P exerts on the charge at O is **F**.



The magnitude and direction of the resultant electrostatic force, experienced by the charge at O, the point of intersection of the diagonals of the square, is …

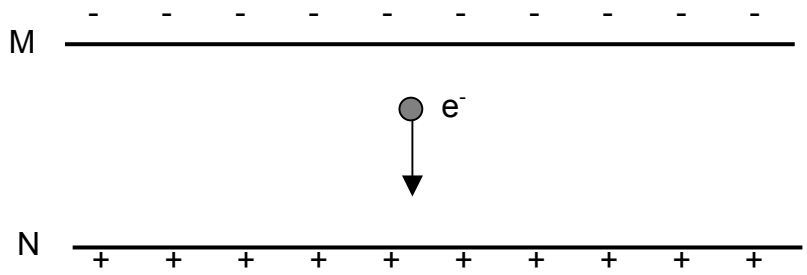
A 4**F** along OC.

B 4**F** along OD.

C $\sqrt{8}$ **F** along OC.

D $\sqrt{8}$ **F** along OD. (4)

1.11 An electron moves from a negatively charged plate M towards a positively charged plate N. The plates are parallel to each other.

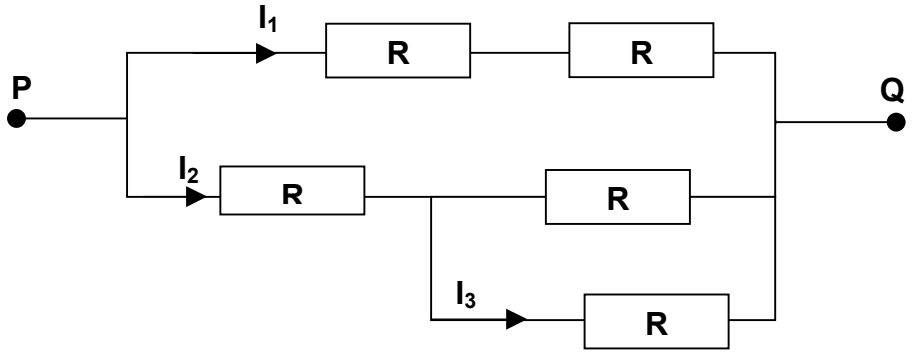


Which one of the following combinations, relating to the magnitude of the electrical force **F** exerted on the electron and the kinetic energy $\mathbf{E_k}$ of the electron, is correct?

	Magnitude of electrical force on electron (F)	**Kinetic energy of electron (E_k)**
A	decreases	increases
B	remains constant	increases
C	decreases	decreases
D	remains constant	decreases

(4)

1.12 A section of a circuit represented below, shows a network of five identical resistors, each of resistance **R**.



$\mathbf{I_1}$, $\mathbf{I_2}$ and $\mathbf{I_3}$ are currents in the different branches as shown in the diagram. Which one of the following statements is true of these currents?

A $I_2 > I_1 > I_3$

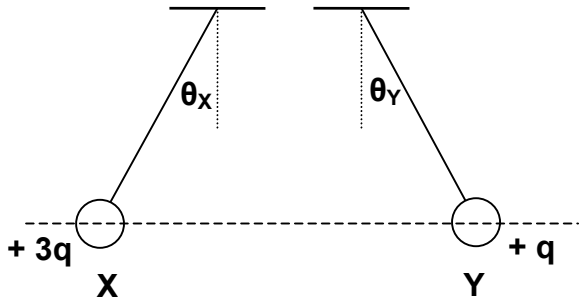
B $I_1 > I_2 > I_3$

C $I_2 > I_1$ and $I_2 < I_3$

D $I_1 = I_2$ and $I_2 > I_3$.

(4)

1.13 Two light, identical, conducting balls, X and Y, are suspended vertically by threads. When X and Y carry charges of **+ 3q** and **+ q** respectively, they move to new positions of equilibrium, with the respective threads forming angles θ_X and θ_Y with the vertical, as shown below (sketch not drawn to scale).



How do angles θ_X and θ_Y compare?

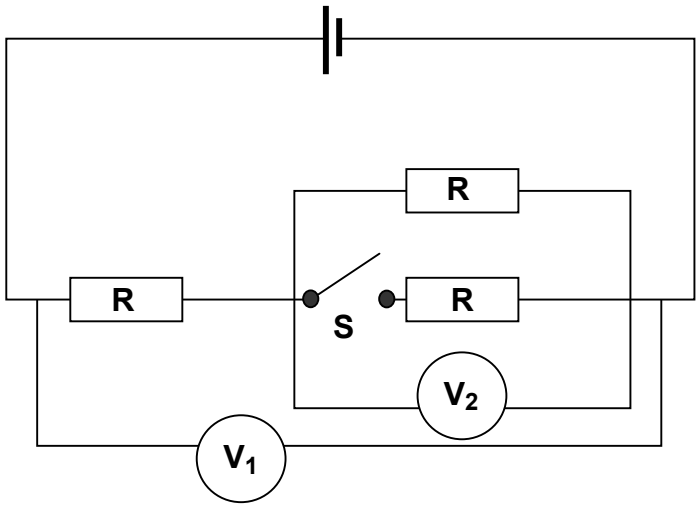
A $\theta_X = 3\,\theta_Y$

B $\theta_X = \frac{1}{3}\theta_Y$

C $\theta_X = 9\,\theta_Y$

D $\theta_X = \theta_Y$ (4)

1.14 In the circuit represented below, the three resistors are identical, each of resistance **R**. Switch S is open and the cell has negligible internal resistance.

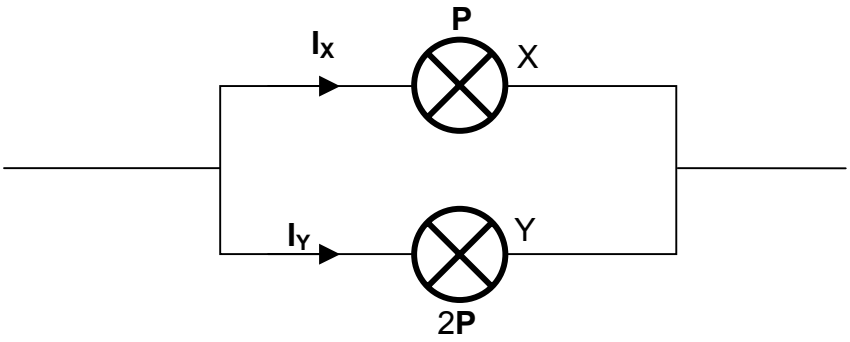


How will the readings on the voltmeters be influenced if switch S is closed?

	Voltmeter V_1	**Voltmeter V_2**
A	decreases	decreases
B	remains constant	increases
C	decreases	increases
D	remains constant	decreases

(4)

1.15 Two electric lamps, X and Y, dissipate power of **P** and 2**P** respectively, while connected in parallel to a 240 V supply. Their respective resistances are $\mathbf{R_X}$ and $\mathbf{R_Y}$, while the currents they carry are $\mathbf{I_X}$ and $\mathbf{I_Y}$ respectively.



Which one of the following sets of ratios is true for the two lamps?

	$\mathbf{R_X : R_Y}$	$\mathbf{I_X : I_Y}$
A	1 : 2	1 : 4
B	2 : 1	1 : 4
C	2 : 1	1 : 2
D	1 : 2	1 : 2

(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 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]

During a mountain climbing exercise, Sandra, mass 60 kg, is suspended from an inelastic piece of nylon rope, fixed to a vertical cliff at X. A light, strong rod is fixed to her middle and she pushes the rod against the cliff so that she can hang freely as indicated in Figure 1.

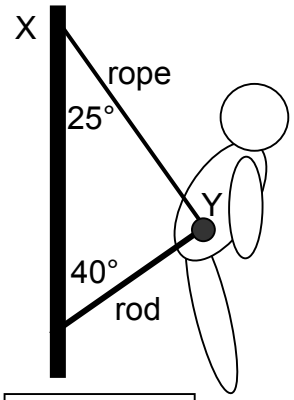


Figure 1

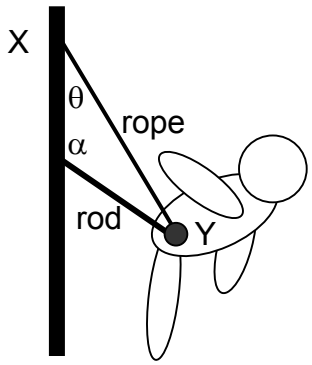


Figure 2

The forces act through point Y in all situations.

2.1 State, in words, the **triangle rule for forces in equilibrium**. (3)

2.2 (Refer to Figure 1) Determine, either by accurate scale drawing (1 cm represents 50 N; indicate at least 2 angles) or by means of a calculation (include a rough, labelled diagram), the **magnitude** of the force which the rope exerts on her, if the angle the rope makes with the cliff is 25°. The angle the rod makes with the cliff is 40°. (6)

Sandra leans back to hand another climber a piece of climbing equipment. In doing so, she moves the rod upwards against the cliff. When she is in equilibrium again, angle α, which the rod then makes with the vertical cliff, is more than 90° and the tension in the rope has changed (See Figure 2).

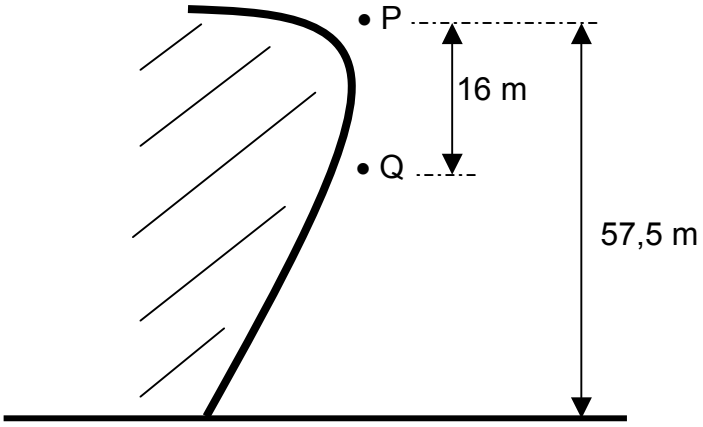
2.3 Is the tension in the rope **more than** or **less than** it was before in Figure 1? Explain your answer. (3)

2.4 The breaking strength of the rope is 800 N. Just before it breaks, the force the rod exerts, is 300 N. Determine, either by accurate scale drawing or by means of a calculation, the angle between the rope and the cliff. (4)

[16]

QUESTION 3 [START ON A NEW PAGE]

The height from which ball A is dropped from point P at the top of a cliff, is 57,5 m. At the instant ball A passes point Q, which is 16 m below point P, a second ball, B, is **thrown downwards** from the same height as point P. Ignore the effects of air resistance.



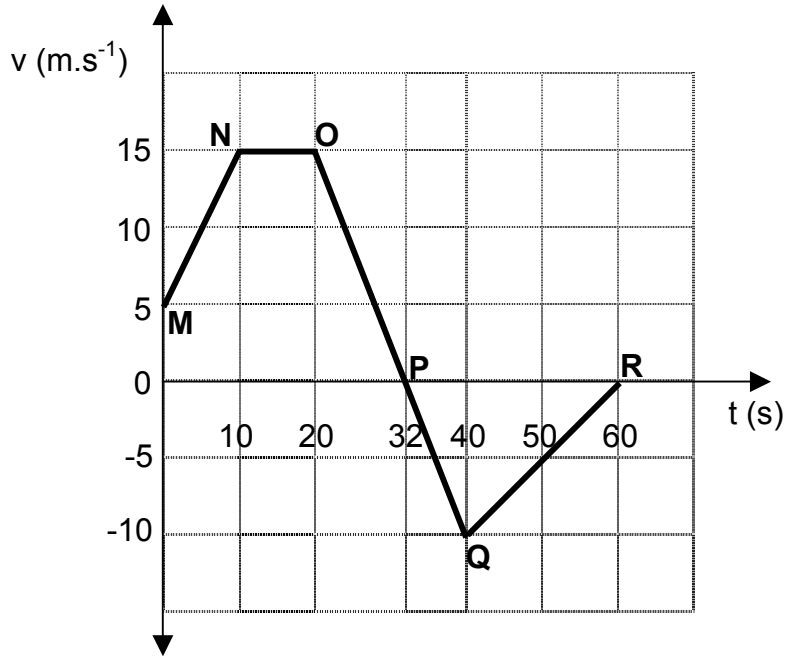
3.1 Calculate the time taken by ball A to fall from P to Q. (5)

3.2 Calculate the initial speed with which ball B has to be thrown downwards so that both balls reach the ground at the same instant. (8)

[13]

QUESTION 4 [START ON A NEW PAGE]

The following velocity-time graph represents the motion of a car during a journey along a straight road.



4.1 Define, in words, **acceleration**. (2)

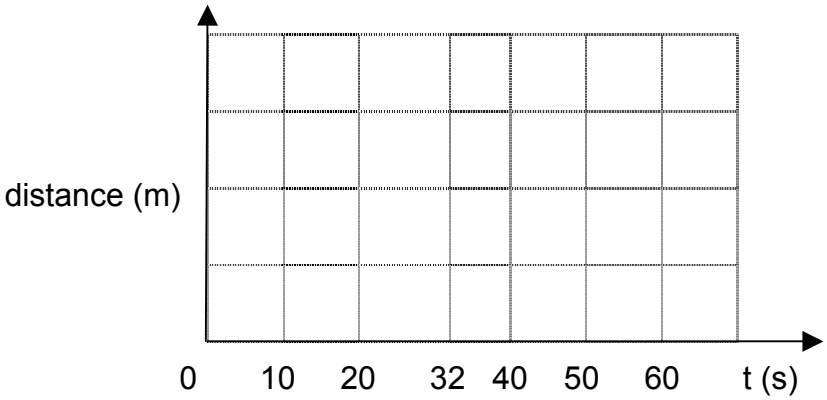
4.2 Using the graph, and without any calculations, **compare** the acceleration of the car represented by the sections:

4.2.1 MN and QR (3)
4.2.2 OP and PQ (2)

4.3 Describe the motion of the car immediately before and after point P in the graph. (4)

4.4 Determine the total **distance** travelled by the car for the time interval t = 0 s to t = 32 s. (5)

4.5 Copy the following system of axes and sketch a rough **distance-time graph** for the time interval t = 0 s to t = 60 s. Indicate all the relevant time values, however, it is not necessary to indicate the distance values.



(7)
[23]

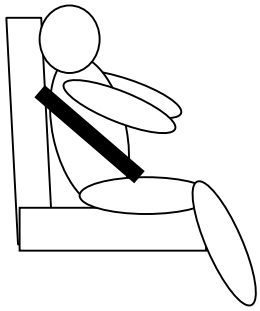
QUESTION 5 [START ON A NEW PAGE]

Akhona and Scelo had an argument about the importance of using a seat belt in a car. Scelo does not believe that it is necessary to use seat belts. Akhona takes Scelo to the Kyalami Race Track, where a safety test is performed on a car. During this test, a crash-test dummy is placed on the front seat, without a seat belt. At high speed, the brakes are applied very hard in an emergency situation.

5.1 Describe the motion that the dummy undergoes during the severe braking. (1)

5.2 Name and state, in words, the **law** of Physics which can be used to explain the motion of the dummy in this situation. (4)

The dummy of mass 60 kg is then secured with a seat belt. The car is involved in a collision which brings it to rest from a speed of 14 m.s^{-1}.

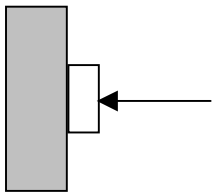


5.3 What is the relationship between **change in momentum** and **resultant force**? (2)

5.4 Calculate the force exerted by the seat belt on the dummy if the dummy comes to rest in 0,25 s. (6)
[13]

QUESTION 6 [START ON A NEW PAGE]

Sanet presses a book against a vertical wall as shown in the sketch.



6.1 Draw a labelled force diagram indicating **all** the forces acting on the book. (4)

6.2 State, in words, **Newton's Third Law of Motion**. (3)

6.3 Name the action-reaction pairs of forces acting in the **horizontal** plane. (4)
[11]

QUESTION 7 [START ON A NEW PAGE]

Two identical pendulums, comprising of iron balls P and Q, each of mass 1 kg, are suspended (hang downwards) from inelastic strings so that they just touch each other (Figure 1). The length of both pendulums, measured to the centre of the balls, is 1,5 m. P is pulled sideways so that the string forms an angle of 30° with the vertical and is then released (Figure 2). Ignore friction.

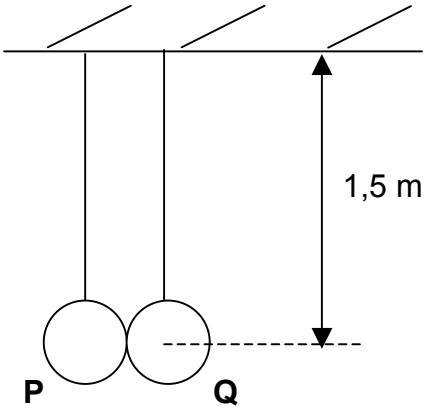


Figure 1

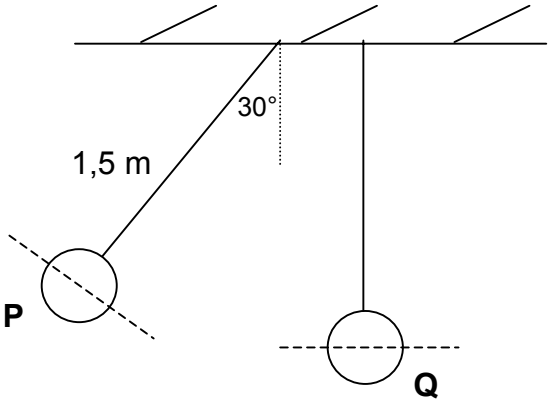


Figure 2

7.1 State, in words, the **law of conservation of mechanical energy**. (3)

7.2 Calculate the gravitational potential energy of ball P, relative to its lowest position, as shown in figure 2. (7)

7.3 Calculate the magnitude of the velocity of ball P just before it collides with ball Q. (5)

Ball P comes to rest immediately after colliding with ball Q.

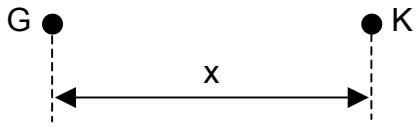
7.4 What will be the magnitude of the velocity of ball Q just after the collision? (2)

7.5 State, in words, the law used to answer QUESTION 7.4. (3)

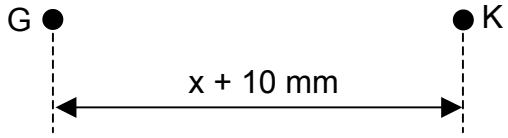
[20]

QUESTION 8 [START ON A NEW PAGE]

Two identical, positive point charges, G and K, are a distance **x** apart. The magnitude of the electrical force that G exerts on K, is 2×10^{-3} N.



When the charges are a further 10 mm apart, the force that G then exerts on K, is $1{,}25 \times 10^{-4}$ N.



8.1 State, in words, **Coulomb's law**. (4)

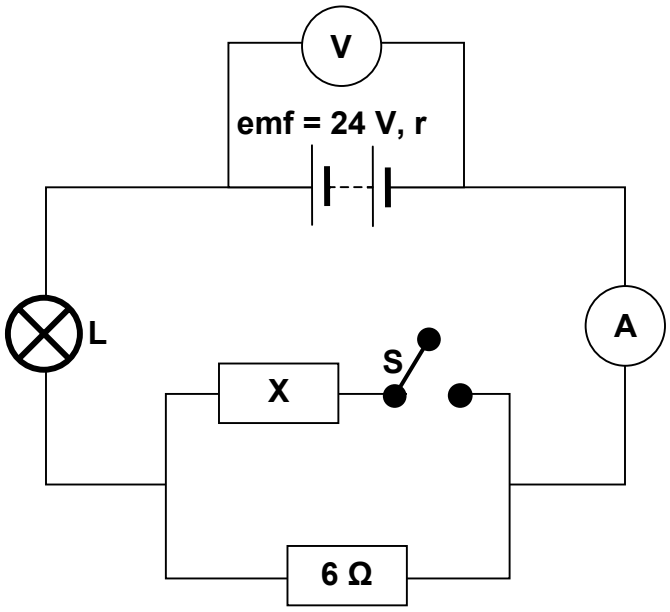
8.2 By which factor did the magnitude of the electrical force decrease? (2)

8.3 Formulate an equation which can be used to calculate the original distance, **x**, between the charges. The solution of the equation is not needed. (4)

8.4 Calculate the magnitude of the charge on each point charge if the original distance, **x**, between the charges was $3{,}3 \times 10^{-3}$ m. (5)
[15]

QUESTION 9 [START ON A NEW PAGE]

In the circuit represented below, the battery has an emf of 24 V and an unknown internal resistance, **r**. The resistance of resistor **X** is unknown.



9.1 Explain the term **emf** as applied to an electrical cell. (3)

When switch S is open, ammeter A has a reading of 1,5 A.

9.2 Calculate the resistance of lamp L if the power dissipated in it is 18 W. (4)

9.3 Calculate the internal resistance of the battery. (6)

When switch S is closed, ammeter A has a reading of 2,0 A.

9.4 Calculate the reading on voltmeter V. (4)

9.5 Calculate the resistance of resistor X. (8)

9.6 Calculate the energy transferred to lamp L in 2 minutes. (4)
[29]

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

DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS

SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

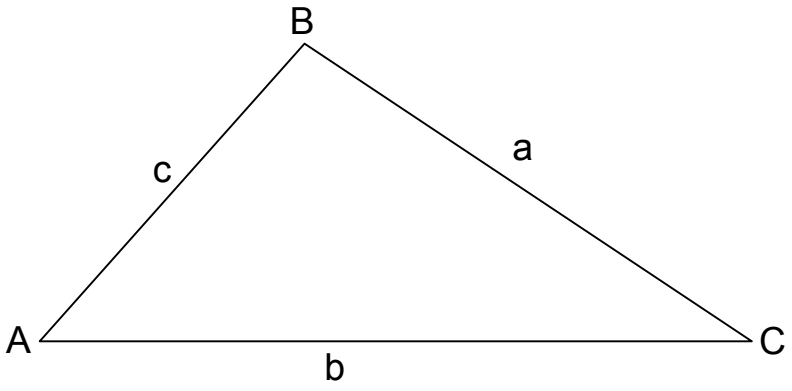
DATA FOR PHYSICAL SCIENCE
PAPER I (PHYSICS)

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	$10\ m.s^{-2}$
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/ANTWOORDBLAD

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	