education

Department:
Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2009

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages, 3 data sheets and 1 answer sheet.

INSTRUCTIONS AND INFORMATION

1.   Write your examination number (and centre number if applicable) in the appropriate spaces on the ANSWER SHEET and ANSWER BOOK.

2.   Answer ALL the questions.

3.   This question paper consists of TWO sections:

       SECTION A (35 marks)
       SECTION B (115 marks)

4.   Answer SECTION A on the attached ANSWER SHEET.

5.   Answer SECTION B in the ANSWER BOOK.

6.   Non-programmable calculators may be used.

7.   Appropriate mathematical instruments may be used.

8.   Number the answers correctly according to the numbering system used in this question paper.

9.   Data sheets are attached for your use.

10.   Give brief motivations, discussions, et cetera where required.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1	The force that acts on a body in free fall	(1)
1.2	The ability to do work	(1)
1.3	The phenomenon observed when a wave bends around the edges of an obstacle	(1)
1.4	The law that describes the interaction between two point charges at rest	(1)
1.5	Electromagnetic radiation with the shortest wavelength	(1)

[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

| COLUMN A		COLUMN B	
2.1	A collision during which the kinetic energy changes	A	elastic
		B	wavefront
2.2	A unit of measure equal to the watt	C	low frequency electromagnetic waves
2.3	The imaginary line joining points in phase on a wave	D	$N \cdot m \cdot s^{-1}$
2.4	Energy of a charge due to its location in an electric field	E	inelastic
		F	amplitude
2.5	Radio waves	G	electric potential energy
		H	sound waves
		I	$J \cdot s$
		J	potential difference

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1   When a child exerts a horizontal force on a heavy crate, the crate does not move because the crate exerts an equal but opposite force on the child.   (2)

3.2   The net (total) work done on a body that travels at constant speed is zero.   (2)

3.3   As a source moves towards a stationary observer, the frequency of the source and the observed frequency changes.   (2)

3.4   Current in a given conductor at constant temperature is inversely proportional to the potential difference across its ends.   (2)

3.5   Sodium produces an emission spectrum that is different from its absorption spectrum.   (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1   The diagram below shows two trucks, P and Q, travelling in opposite directions along a straight level road. Truck P travels at 15 $m \cdot s^{-1}$ and truck Q travels at 10 $m \cdot s^{-1}$.
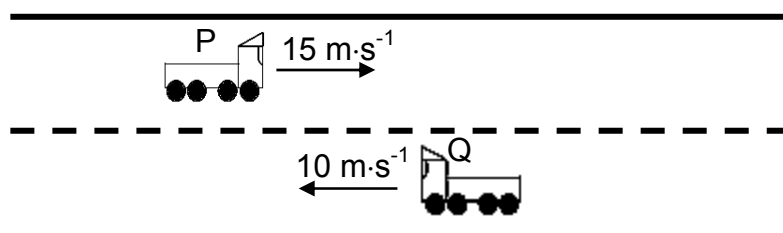
A passenger on truck P will observe truck Q travelling at …

A   5 $m \cdot s^{-1}$

B   10 $m \cdot s^{-1}$

C   15 $m \cdot s^{-1}$

D   25 $m \cdot s^{-1}$ (3)

4.2   The engine of a car does work, *W,* to increase the velocity of the car from
        0 to *v*.   The work done by the engine to increase the velocity from **_v to 2v_**,
        is:

        A   *W*

        B   2*W*

        C   3*W*

        D   4*W*   (3)

4.3   The siren of a police car, travelling at a speed *v*, emits sound waves of
        frequency *f*.

        Which ONE of the following best describes the frequency that will be
        observed by a passenger in a car following right behind the police car at a
        speed *v*?

        A   Zero

        B   Smaller than *f*

        C   Equal to *f*

        D   Greater than *f*   (3)

4.4   A negatively charged plastic comb is brought close to, but does not touch, a
        small piece of paper. If the comb and the paper are now attracted to each
        other, the original charge on the paper was …

        A   negative.

        B   positive.

        C   negative or neutral.

        D   positive or neutral.   (3)

4.5   Which ONE of the following best describes the difference between laser
        light and fluorescent light?

        A   Laser light consists of more frequencies than fluorescent light.

        B   Laser light is coherent, monochromatic and collimated, while
              fluorescent light has none of these properties.

        C   Laser light is coherent and collimated, while fluorescent light is
              monochromatic.

        D   Fluorescent light is coherent and laser light is not.   (3)
                                                                                            [15]

                                                    TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS AND INFORMATION

1.   Answer this section in the ANSWER BOOK.

2.   The formulae and substitutions must be shown in ALL calculations.

3.   Round off your answers to TWO decimal places where applicable.

QUESTION 5

The roof of a tall building is 25 m above the ground. A rigid ball of mass 0,3 kg falls freely when dropped from the roof. It strikes the concrete floor on the ground with velocity v_1. It bounces to a maximum vertical height of 6 m.

The ball was in contact with the floor for 0,9 s.   Ignore the effects of friction.
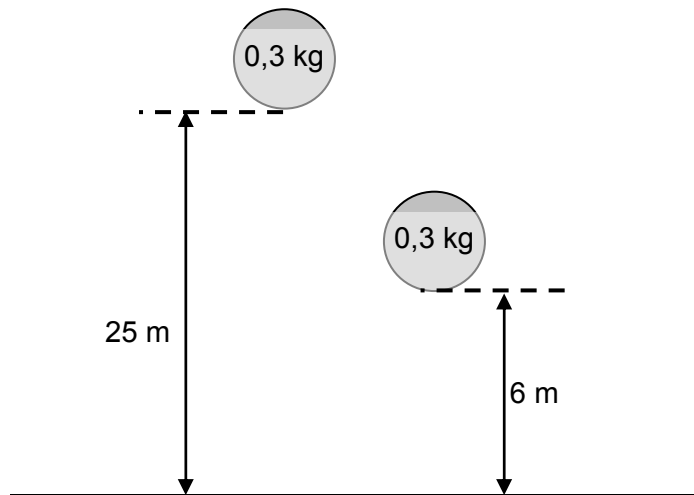
5.1   Calculate the velocity v_1 when the ball first hits the floor.   (3)

5.2   Calculate the impulse of the ball as a result of the collision.   (7)

5.3   Calculate the magnitude of the net force exerted on the ball.   (3)

5.4   Using the ground as zero reference, draw a sketch graph of position (displacement) versus time for the motion of the ball from its original height until it reaches its second maximum height. Indicate the relevant position values on the y-axis.   (4)

5.5   The rigid ball is now replaced with a softer ball of the same mass and volume as the rigid ball. It is then dropped from the same height onto the concrete floor.

   Will the ball reach the SAME, GREATER or LESSER height compared to the previous ball? Use principles of physics to explain your answer.   (3)
                                                                                                                      [20]

QUESTION 6

In South Africa the transportation of goods by trucks adds to the traffic problems on our roads.

A 10 000 kg truck travels up a straight inclined road of length 23 m at a constant speed of 20 km·h^{-1}. The total work done by the engine of the truck to get there is 7×10^5 J. The work done to overcome friction is $8,5 \times 10^4$ J.
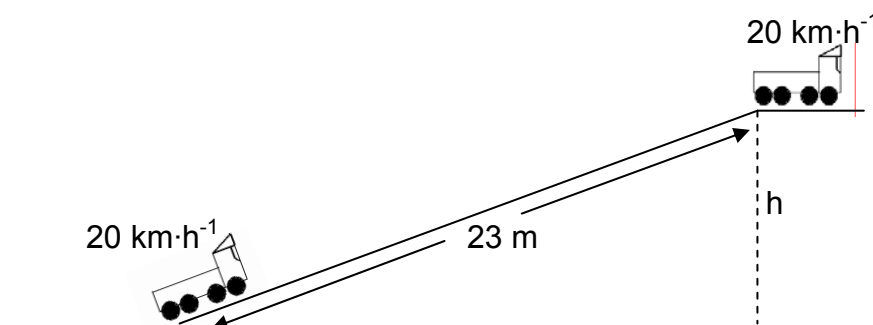
6.1   Calculate:

    6.1.1   The height, h, reached by the truck at the top of the road   (6)

    6.1.2   The instantaneous power delivered by the engine of truck   (6)

6.2   Arrestor beds are constructed as a safety measure to allow trucks to come to rest when their brakes fail whilst going downhill. Write down TWO design features of such arrestor beds.   (2)

[14]

QUESTION 7

Dolphins use ultrasound to scan their environment.

When a dolphin is 100 m from a rock, it emits ultrasound waves of frequency 250 kHz whilst swimming at 20 m·s^{-1} towards the rock. Assume that the speed of sound in water is 1 500 m·s^{-1}.

7.1   Calculate the frequency of the sound waves detected by a detector on the rock. (4)

7.2   When the dolphin is 50 m from the rock, another ultrasound wave of 250 kHz is emitted.

How will the frequency of the detected sound waves compare with the answer calculated in QUESTION 7.1? Write down only HIGHER, LOWER or REMAINS THE SAME. Explain your answer. (2)

[6]

QUESTION 8

8.1   The diagram below shows the three primary colours of light. Each of D, E and F in the diagram below is obtained by adding a pair of primary colours. This is the basis of how technology may use colour to produce desired colour effects as is done in the television.
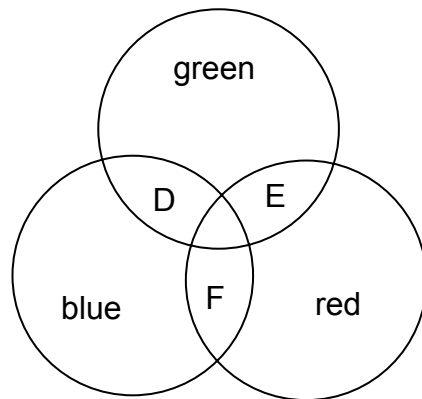
8.1.1   Which THREE colours are represented by the letters D, E and F respectively?   (3)

8.1.2   Why are the colours red, blue and green referred to as primary colours?   (2)

8.2   White light passes through a yellow filter, which is in turn followed by a cyan filter as shown in the diagram below.
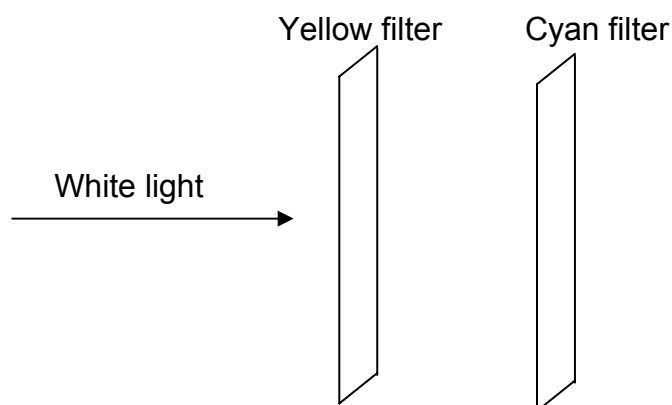
8.2.1   Identify the colour that emerges from the cyan filter.   (1)

8.2.2   Explain your answer to QUESTION 8.2.1.   (4)

8.2.3   The cyan filter is now replaced with a magenta filter. What colour will emerge from the magenta filter?   (1)

[11]

QUESTION 9

Huygens's principle is used to explain the wave phenomena, interference and diffraction.

9.1   State Huygens's principle.   (2)

9.2   Use Huygens's principle to explain the diffraction of water waves in a ripple tank as they pass through a narrow opening in a barrier.   (3)

9.3   A single slit of unknown width is illuminated with red light of wavelength 650 nm.

        Calculate the width of the slit for which the first dark band will appear at 15°.   (3)

                                                                              [8]
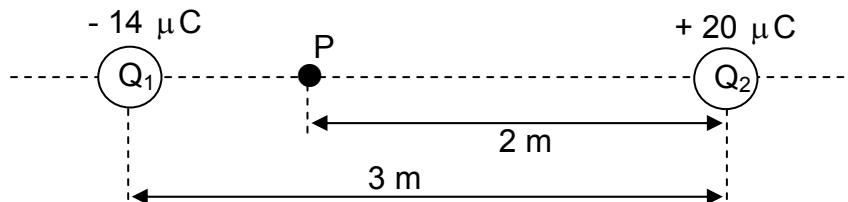
QUESTION 10

Each plate of a parallel plate capacitor has an area of 40 cm^2. The plates are 1 cm apart. The capacitor is connected to a 12 V DC supply.

10.1   Calculate the magnitude of the charge on each plate.   (5)

10.2   By which factor will the charge calculated in QUESTION 10.1 change if the area of each parallel plate is changed to 20 cm^2?

        Explain your answer in terms of physics principles and the charge stored in the capacitor. (NO calculations needed.)   (3)

10.3   What is the net charge on the capacitor?   (1)

10.4   Capacitors are used in flash cameras. Give a reason for this use.   (1)

                                                                              [10]

QUESTION 11

Two point charges, Q_1 and Q_2, a distance 3 m apart, are shown below. The charge on Q_1 is - 14 μC and the charge on Q_2 is + 20 μC.

11.1   Define the *electric field* at a point in space.   (2)

11.2   Draw the electric field pattern due to these two charges.   (3)

11.3   Calculate the net electric field at point P situated 2 m from Q_2.   (5)
[10]

QUESTION 12

The battery in the circuit below has an emf of 12 V and an internal resistance of 0,2 Ω. The resistance of the connecting wires can be ignored.
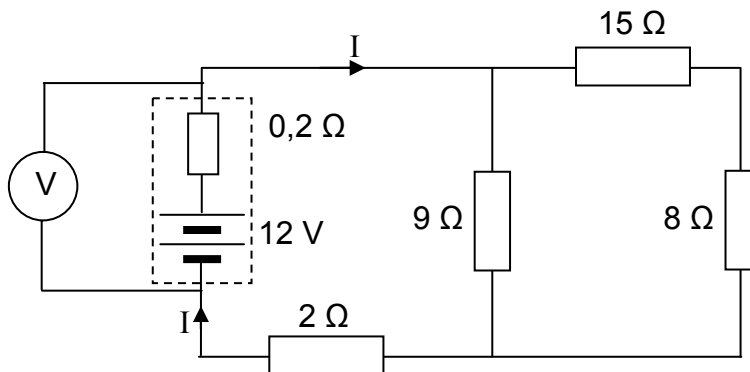
12.1   Calculate the current, I, that flows through the battery.   (6)

12.2   How will the reading on the voltmeter be affected if the 9 Ω resistor is removed and replaced with a conducting wire of negligible resistance? Explain your answer.   (4)
[10]

QUESTION 13

13.1   Electric motors are used in pumps, fans and compressors. Electric motors can be either AC or DC. The diagram below illustrates one of these types of electric motors.
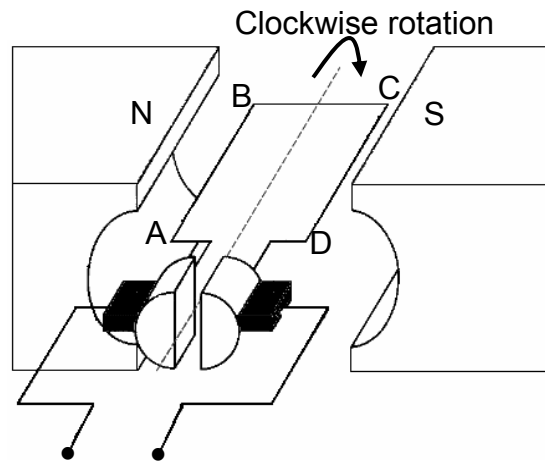
13.1.1   What type of electric motor (AC or DC) is illustrated in the diagram?

Give a reason for your answer.   (2)

13.1.2   If the loop turns in a clockwise direction, in what direction is the current in section AB of the loop flowing in the above diagram? Write down from A to B, or from B to A only.   (1)

The motor in the diagram is now changed to operate as a generator.

13.1.3   On what principle does a generator operate?   (1)

13.1.4   Draw a sketch graph of the potential difference versus time for this generator while it is functioning.   (2)

13.2   The diagram below shows a dynamo attached to the wheel of a bicycle. When riding a bicycle, the wheel rotates a magnet near a coil.
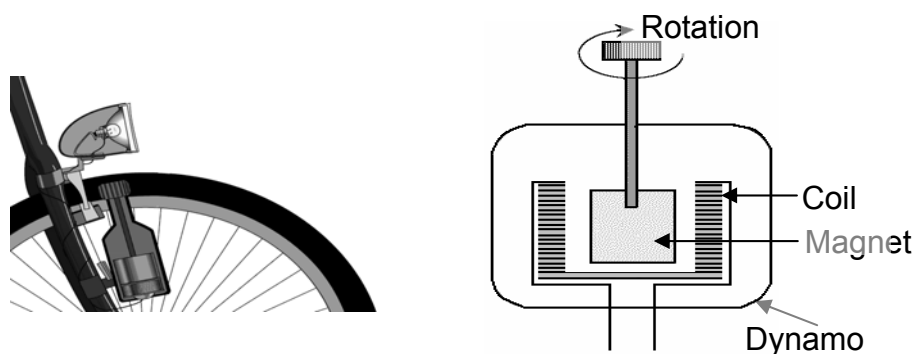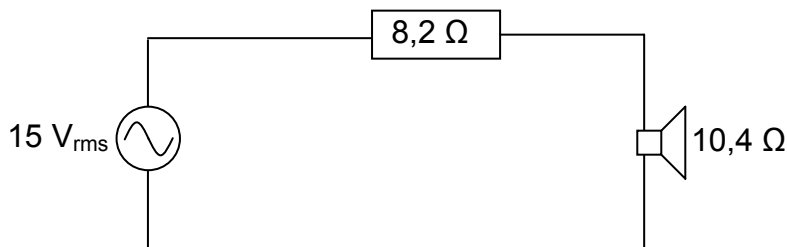

Explain how a current is induced in the coil.   (2)

[8]

QUESTION 14

14.1   In the circuit below the AC source delivers alternating voltages at audio frequency to the speaker.

14.1.1   What is the peak voltage that the source can deliver? (2)

14.1.2   Calculate the average power delivered to the speaker. (6)

14.2   Alternating current is generated at power stations.

Name TWO advantages of AC transmission over long distances. (2)

[10]

QUESTION 15

The work function of three metals is shown in the table below.

METAL	WORK FUNCTION (W_0) in J
Aluminium	$6{,}54 \times 10^{-19}$
Zinc	$6{,}89 \times 10^{-19}$
Silver	$7{,}58 \times 10^{-19}$

15.1   Give a reason why different metals have different work functions. (1)

15.2   Light of wavelength $2{,}3 \times 10^{-7}$ m is shone onto a metal X. The average speed of the emitted electrons is $4{,}78 \times 10^5 \, \text{m·s}^{-1}$.

Identify metal X by performing a relevant calculation. (6)

15.3   What conclusion about the nature of light is drawn from the photo-electric effect? (1)

[8]

TOTAL SECTION B: 115

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES P1 GRADE 12

GEGEWENS VIR FISIESE WETENSKAPPE V1 GRAAD 12

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8 \ \text{m·s}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8} \ \text{m·s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \ \text{J·s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9} \ \text{N·m}^{2}\text{·C}^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19} \ \text{C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \ \text{kg}$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12} \ \text{F·m}^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/*of* $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p = mv_f - mv_i$	$F_g = mg$

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

$W = F\Delta x \cos\theta$	$U = E_P = mgh$
$K = E_k = \dfrac{1}{2}mv^2$	$W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \dfrac{W}{\Delta t}$	$P = Fv$

WAVES, LIGHT AND SOUND/*GOLWE, LIG EN KLANK*

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \dfrac{1}{f}$ or/*of* $T = \dfrac{1}{\nu}$
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\dfrac{c}{\lambda}$
$\lambda = \dfrac{h}{mv}$	$\sin\theta = \dfrac{m\lambda}{a}$
$hf = W_0 + \dfrac{1}{2}mv^2$	

MATTER AND MATERIALS/*MATERIE EN MATERIALE*

$F = k\Delta x$	Stress/*Spanning* $= \dfrac{F}{A}$
Strain/*Vervorming* $= \dfrac{\Delta x}{\ell}$	

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

$I_{rms} = \dfrac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \dfrac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \dfrac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \dfrac{V_{maks}}{\sqrt{2}}$	$\varepsilon = -N\dfrac{\Delta\Phi}{\Delta t}$
$\Phi = BA$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = \dfrac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \dfrac{V_{wgk}^2}{R}$ $P_{average} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \dfrac{kQ_1 Q_2}{r^2}$	$E = \dfrac{kQ}{r^2}$
$E = \dfrac{V}{d}$	$U = \dfrac{kQ_1 Q_2}{r}$
$E = \dfrac{F}{q}$	$Q = It$
$C = \dfrac{Q}{V}$	$C = \dfrac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \dfrac{V}{I}$	$\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + ...$
$R_s = R_1 + R_2 + ...$	emf/*emk* $(\varepsilon) = I(R + r)$

EXAMINATION NUMBER/
EKSAMENNOMMER:

ANSWER SHEET/*ANTWOORDBLAD*

QUESTION 1/*VRAAG 1*

1.1 _____ (1)

1.2 _____ (1)

1.3 _____ (1)

1.4 _____ (1)

1.5 _____ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 _____ (1)

2.2 _____ (1)

2.3 _____ (1)

2.4 _____ (1)

2.5 _____ (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 _____

_____ (2)

3.2 _____

_____ (2)

3.3 _____

_____ (2)

3.4 _____

_____ (2)

3.5 _____

_____ (2)
[10]

QUESTION 4/*VRAAG 4*

4.1 A	B	C	D
4.2 A	B	C	D
4.3 A	B	C	D
4.4 A	B	C	D
4.5 A	B	C	D

(5 x 3) [15]

TOTAL SECTION A/*TOTAAL AFDELING A*: 35