higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(First Paper)
NQF LEVEL 4

(10021004)

12 March 2018 (Y-Paper)
13:00–16:00

Nonprogrammable calculators and appropriate mathematical instruments may be used.

This question paper consists of 13 pages and a data sheet of 3 pages.

TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write your EXAMINATION NUMBER and CENTRE NUMBER in the appropriate spaces on the ANSWER BOOK.
5. Approximate ALL final answers accurately to TWO decimal places.
6. Show the formulae and substitutions in ALL calculations.
7. Start each question on a NEW page.
8. Write neatly and legibly.

SECTION A

QUESTION 1

Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 A combination of a set of fixed pulleys with a set of moveable ones.

1.2 Circuit elements that store energy in a magnetic field.

1.3 An instrument used to measure radiation.

1.4 A measure of the shortest distance from the starting point to the end position.

1.5 A collision in which kinetic energy is conserved.

(5 × 1) **[5]**

QUESTION 2

Choose a term from COLUMN B that matches the description in COLUMN A. Write only the letter (A–J) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Resistors in series	A	kinetic energy
2.2	The rate at which mechanical energy is transferred	B	potential dividers
2.3	The type of energy an object has because of its position	C	gamma waves
2.4	Electromagnetic waves with the lowest frequency	D	Joule
2.5	The SI unit of energy	E	work done
		F	Newton
		G	power
		H	current dividers
		I	radio waves
		J	potential energy

(5 × 1) **[5]**

QUESTION 3

Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 Torque is the tendency to cause rotational motion.

3.2 In real life AMA is always greater than IMA.

3.3 The photoelectric effect is evidence of the particle nature of light.

3.4 Generators can produce both AC and DC current.

3.5 Inductance is measured in Farad.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 The net force acting on an object is directly proportional to the …

A mass of the object.

B acceleration of the object.

C change in momentum of the object.

D kinetic energy of the object.

4.2 A ball is thrown vertically upwards and reaches a maximum height. At the instant the ball changes direction, which one of the following physical quantities has a non-zero value:

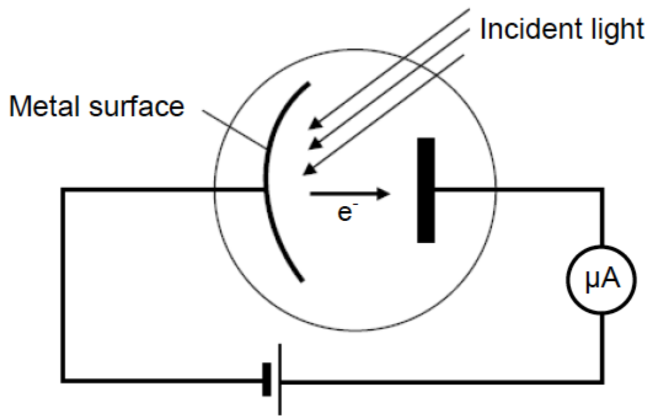
A Kinetic energy

B Momentum

C Velocity

D Acceleration

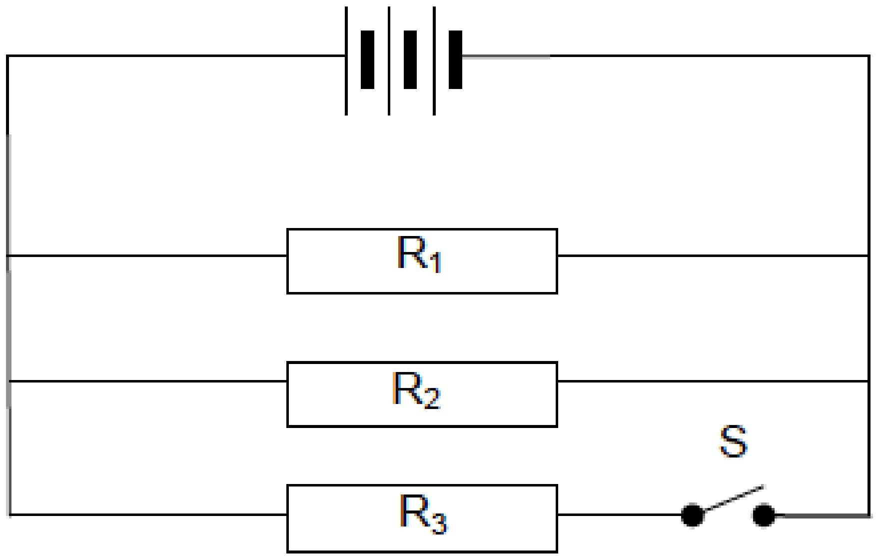
4.3 When light of a certain frequency is incident on the cathode of a photocell, the ammeter registers a reading.



The frequency of the incident light is now INCREASED while keeping the intensity of the incident light constant.
Which one of the following is a correct explanation for what happens to the reading on the ammeter?

	AMMETER READING	EXPLANATION FOR READING
A	Decreases	The number of photoelectrons emitted decreases
B	Remains the same	The number of photoelectrons emitted remains the same
C	Increases	The number of photoelectrons emitted increases
D	Increases	The speed of the photoelectrons emitted increases

4.4 Consider the circuit diagram below:



When switch **S** is closed, which one of the following correctly describes the change in total current and total resistance in the circuit?

	TOTAL CURRENT	TOTAL RESISTANCE
A	Decreases	Decreases
B	Increases	Decreases
C	Decreases	Increases
D	Increases	Increases

4.5 A hairdryer is marked 220 V, 50 Hz and 2 200 W. What current will flow through the hairdryer when it is in operation?

A 0,1 A

B 4,4 A

C 10 A

D 44 A

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5: MEASUREMENTS AND HAZARD SYMBOLS

Convert the following to the unit indicated:

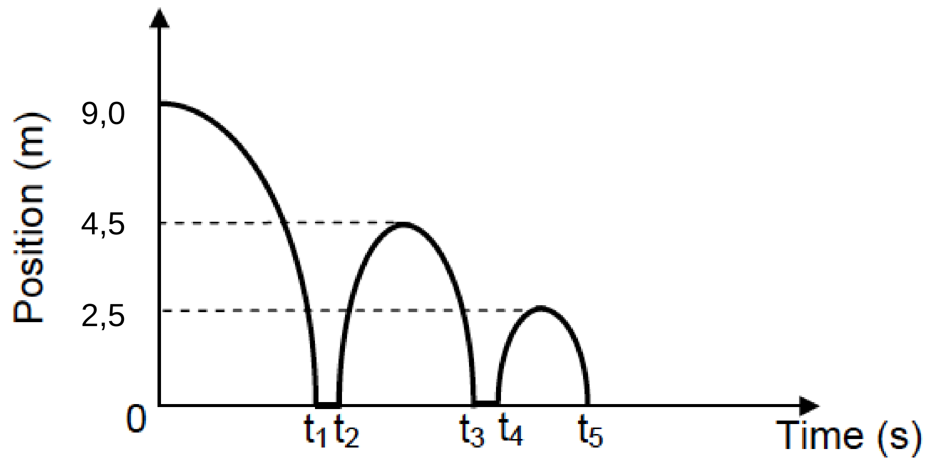
5.1 15 $m \cdot s^{-1}$ to $km \cdot h^{-1}$ (1)

5.2 0,1 g to kg (1)

5.3 25 m^3 to dm^3 (1)
[3]

QUESTION 6: FREE-FALLING BODIES

A tennis ball of mass 60 g is projected vertically downwards towards the ground from a height of 9,0 m. at a velocity of 3 $m \cdot s^{-1}$. The position-time graph for the motion of the tennis ball is shown in the graph below.



6.1 After the <u>second</u> bounce what is the maximum vertical height reached by the tennis ball. (1)

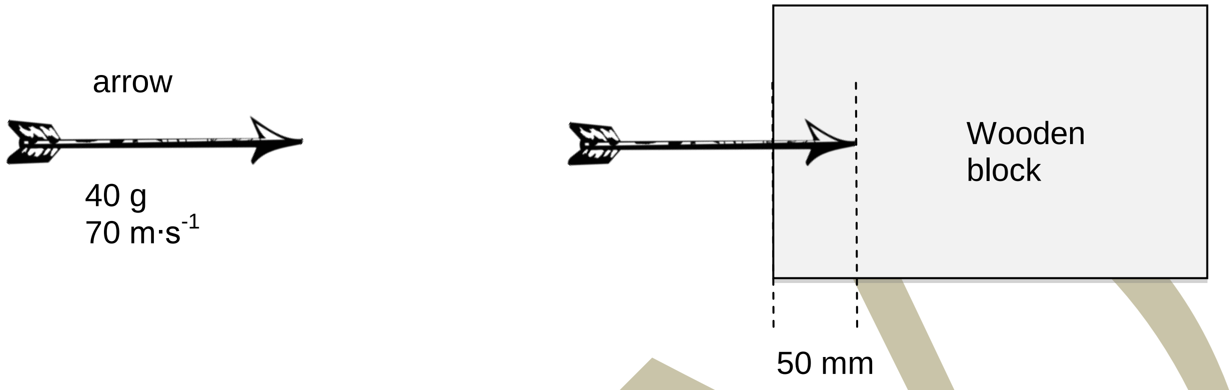
6.2 Calculate the time t_1 for the tennis ball to reach the ground for the first time. (5)

6.3 Calculate the velocity with which the ball rebounds from the ground during the first bounce. (4)

6.4 Each time the tennis ball strikes the ground, is it an example of an ELASTIC or INELASTIC collision? Explain the answer. (3)
[13]

QUESTION 7: MOMENTUM

An arrow, with a mass of 40 g, traveling at a velocity of 70 $m \cdot s^{-1}$, strikes a wooden target. The arrow penetrates 50 mm into the wood before coming to a stop.



Calculate the:

7.1 Momentum of the arrow just before striking the wooden block (3)

7.2 Change in kinetic energy of the arrow. (4)

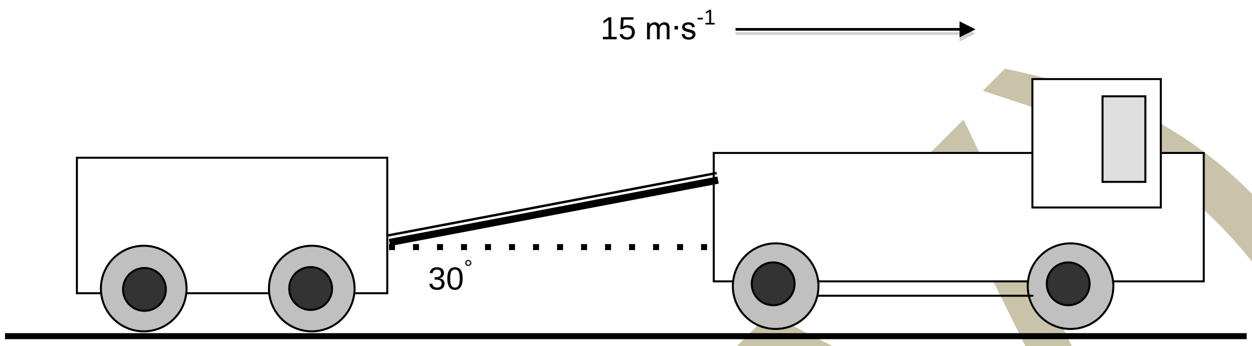
7.3 Impulse of the collision between the arrow and the wooden block (4)

7.4 Time taken for the arrow to stop. (3)

7.5 Magnitude of the force that stops the arrow. (4)
[18]

QUESTION 8: WORK, POWER AND ENERGY (Start on a new page)

A car is towed away from the scene of an accident at a constant horizontal speed of 15 $m \cdot s^{-1}$. The tow bar attached to the car applies a force of 1 500 N at an angle of 30^0 to the horizontal as shown in the diagram below.



8.1 Define *work*. (2)

8.2 Calculate the total work done on the car by the tow bar when the car is towed for a distance of 1,8 km. (4)

8.3 Define *power*. (2)

8.4 Calculate the rate at which the tow bar does work on the car over this distance of 1,8 km. (4)

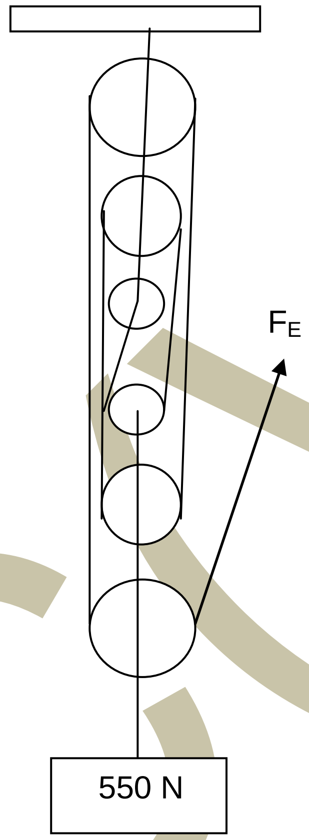
The road surface changes from tar to dirt. The magnitude of the forces acting on the car increases. The tow bar continues to apply a constant force of 1 500 N at an angle of 30° on the car. The car moves a further 250 m along the dirt road.

8.5 Consider how the change in the road surface will affect the total work done on the car by the tow bar over the 250 m. Is the total work done whilst travelling on the dirt road GREATER THAN, LESS THAN or EQUAL TO the total work done on the tar road? Explain the answer. (3)

[15]

QUESTION 9: MECHANICAL ADVANTAGE

The pulley system shown below is used to hoist a 550 N object through a vertical distance of 7,5 m, using an applied force of 150 N.



9.1 Determine the IMA of the system. (1)

9.2 Calculate the ideal force exerted by the system. (3)

9.3 Calculate the AMA. (3)

9.4 Determine the efficiency of the pulley system. (3)
[10]

QUESTION 10: WAVES, SOUND AND LIGHT

The whistle of a train emits sound waves of frequency 500 Hz. Brenda is standing on the platform of the station. Brenda measures the frequency of the sound waves emitted by the train as 520 Hz. The speed of sound in air is 340 $m \cdot s^{-1}$.

10.1 Name the phenomenon responsible for the observed change in frequency. (1)

10.2 Is the train moving AWAY FROM or TOWARDS Brenda? (1)

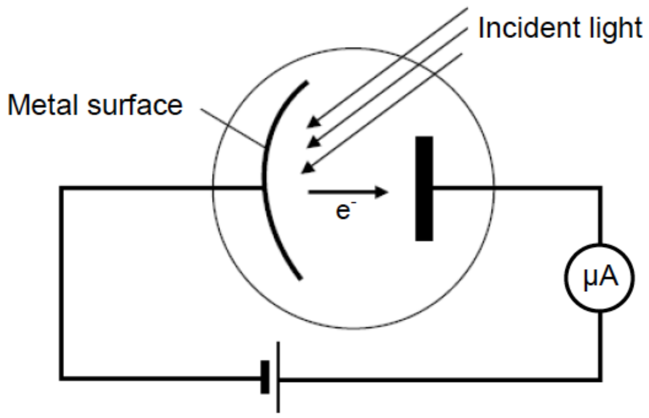
10.3 Calculate the speed of the train. (4)

10.4 Steven is sitting in the train. Will the frequency observed by Steven be GREATER THAN, EQUAL TO or SMALLER THAN 500 Hz? Explain the answer. (3)
[9]

QUESTION 11: PHOTOELECTRIC EFFECT

11.1 Define *photoelectric effect.* (2)

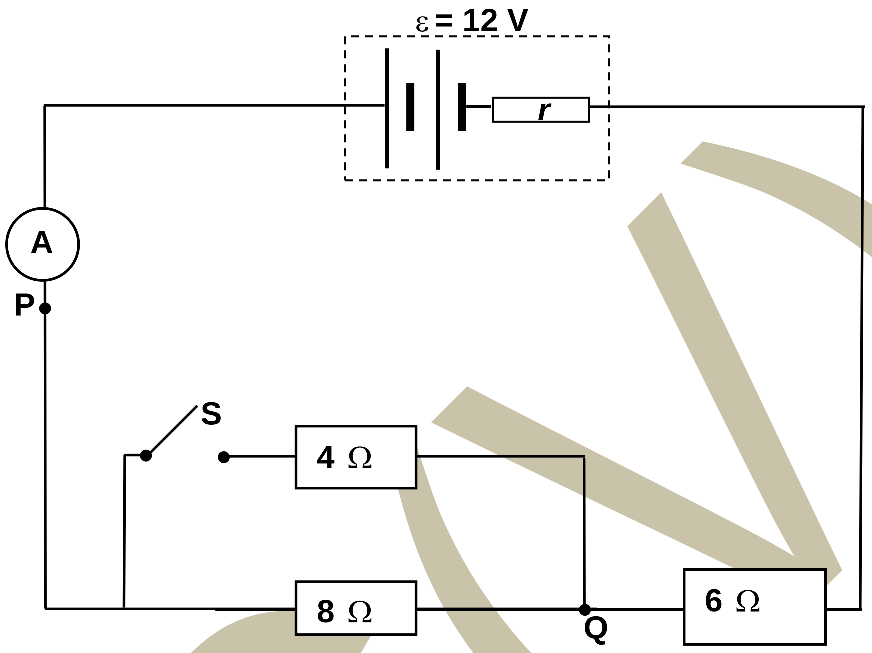
11.2 Incident light of 420 nm wavelength is shone on a metal surface. The minimum amount of energy required to emit an electron from the metal is 3×10^{-19} J.



Calculate the maximum energy of a photoelectron emitted from the metal. (6)
[8]

QUESTION 12: ELECTRICITY

The circuit diagram below represents a combination of resistors in series and parallel. The battery has an EMF of 12 V and an unknown internal resistance *r*.



With switch **S OPEN**, ammeter A gives a reading of 0,8 A.

12.1 Calculate the total resistance of the external circuit. (3)

12.2 Calculate the internal resistance of the battery. (4)

12.3 Calculate the energy dissipated in the 6 Ω resistor in 4 minutes. (3)

*Switch **S** is now closed.*

12.4 How will EACH of the following be affected when the switch is closed? Write down only DECREASES, REMAINS THE SAME or INCREASES.

12.4.1 The total resistance of the circuit. (2)

12.4.2 The reading on ammeter A. (2)

12.4.3 The internal resistance. (2)

12.5 A conducting wire of negligible resistance is now connected between points **P** and **Q**. What effect will this have on the temperature of the battery? Write down only DECREASES, REMAINS THE SAME or INCREASES. Explain how you arrived at the answer. (3)

[19]

QUESTION 13: ELECTRICITY

A transformer inside a cell phone charger has 1 100 turns on the primary coil and 25 turns on the secondary coil. The cell phone charger is plugged into a 220 V mains supply and the current in the secondary coil when the charger is turned on is 2 A.

13.1 Is the transformer in the cell phone charger an example of a STEP-UP or a STEP-DOWN transformer. Give a reason for the answer. (2)

13.2 Calculate the voltage across the secondary coil. (3)

13.3 Calculate the current in the primary coil. (3)

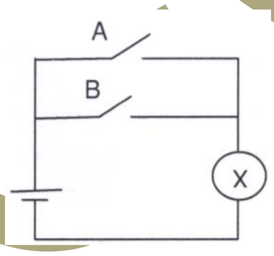
13.4 How much energy is transferred by the charger in 3 minutes? (3)
[11]

QUESTION 14: ELECTRONICS

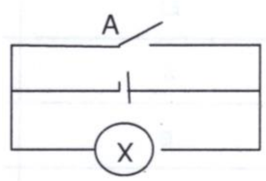
14.1 A capacitor with a capacitance of 24 μF is connected to a 12 V battery. Calculate the maximum charge that the capacitor can store. (3)

14.2 The following simple circuits illustrate the principle upon which logic gates work. For each of the circuits below state whether it is an OR gate, AND gate or NOT gate.

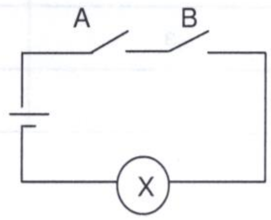
14.2.1



14.2.2



14.2.3



(3 × 2) (6)
[9]

TOTAL SECTION B: 115
GRAND TOTAL: 150

NATIONAL CERTIFICATE (VOCATIONAL)

NASIONALE SERTIFIKAAT (BEROEPSGERIG)

DATA FOR PHYSICAL SCIENCES P1 LEVEL 4

GEGEWENS VIR FISIESE WETENSKAPPE V1 VLAK 4

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Gravitational constant *Swaartekragkonstante*	G	$6,67 \times 10^{-11}\ N{\cdot}m^{2}{\cdot}kg^{-2}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N{\cdot}m^{2}{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e^{-}	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F{\cdot}m^{-1}$
Permeability of free space *Permeabiliteit van vry ruimte*	μ_0	$4\pi \times 10^{-7}\ T{\cdot}m{\cdot}A^{-1}$

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

FORCE/*KRAG*

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

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

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

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

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\lambda = \frac{h}{mv}$	$\sin\theta = \frac{m\lambda}{a}$
$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$	

MATTER AND MATERIALS/*MATERIE EN MATERIALE*

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

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

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

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$U = \frac{kQ_1Q_2}{r}$
$E = \frac{F}{q}$	$Q = It$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$R_s = R_1 + R_2 + \ldots$	emf/*emk* (ε) = $I(R + r)$