education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2023

MARKS: 150

TIME: 3 hours

12841E

X10

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line open between two sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, etc. where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g.1.11 E.

1.1 If the distance of an object above the surface of the Earth is increased, the weight of this object …

A increases.

B decreases.

C remains same.

D increase then suddenly decrease. (2)

1.2 A constant, resultant force acts on a body which is moving freely in a straight line. Which PHYSICAL QUANTITY will remain constant?

A Velocity

B Momentum

C Acceleration

D Kinetic energy (2)

1.3 Which one of the following DOES NOT represent the units of a vector?

A N

B $N \cdot C^{-1}$

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

D $J \cdot m^{-1}$ (2)

1.4 A car is moving on a straight, frictionless and horizontal road at CONSTANT velocity. When the car enters on to a rough surface **Q**, the speed decreases and the car comes to rest.

Which ONE of the following statements about the car, after passing point **Q** is true?

A The kinetic energy of the car remains constant.

B The mechanical energy of the car is conserved.

C The potential energy of the car is converted to kinetic energy.

D The kinetic energy of the car is used to do work against friction. (2)

1.5 Light of wavelength 680 nm coming from a receding distant galaxy is observed by an astronomer on the Earth. The wavelength observed by the astronomer will most likely be ...

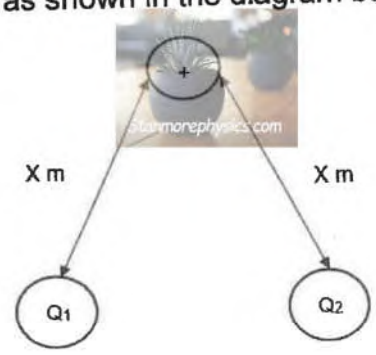
A 700 nm.

B 680 nm.

C 600 nm.

D 630 nm. (2)

1.6 A positive test charge is placed in the electric field of two identical positively charged objects Q_1 and Q_2 as shown in the diagram below.



The net force experienced by the test charge will be:

A zero

B upwards

C downwards

D to the left (2)

1.7 Power may be defined as:

A force per unit displacement

B energy exchange

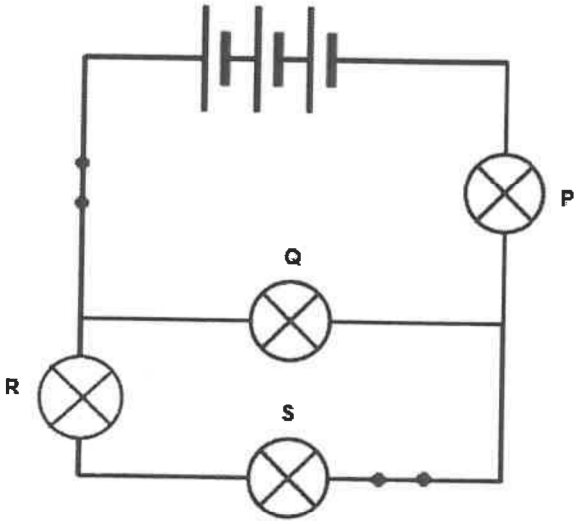
C rate of transfer of energy

D product of work done and time

(2)

1.8 In the circuit shown below, the battery lights up all four identical bulbs **P**, **Q**, **R** and **S**.

Which one of the statements correctly describes the comparative brightness of bulbs **P**, **Q**, **R** and **S**?



A **P** and **Q** glow equally bright and are brighter than **R** and **S**.

B **P**,**R** and **S** are of equal brightness and glow brighter than **Q**.

C **P** and **R** are of equal brightness and glow brighter than **Q** and **S**.

D **P** glows the brightest followed by **Q** and then by **R** and **S**, which are of the same brightness.

(2)

1.9 One difference between a DC generator and an AC generator is that a DC generator ...

A generates a lower current than an AC generator.

B has slip ring and an AC generator has split ring commutator.

C has split ring commutator and an AC generator has slip rings.

D generates electrical energy where the AC generator generates mechanical energy. (2)

1.10 An absorption spectrum is the result of the ...

A material's absorption of red light.

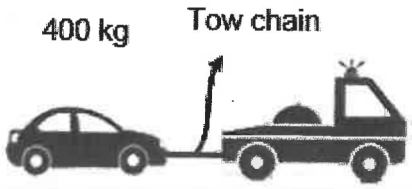
B emission of specific frequencies of light when a gas is heated.

C atoms of a cold, dilute gas absorbing photons of certain frequencies of white light.

D radiation of distinct lines of different frequencies when a low-density gas is electrolysed. (2)
[20]

QUESTION 2 (Start on a new page.)

A tow truck attempts to tow a broken down car of mass 400 kg. The coefficient of static friction is 0,60 and the coefficient of kinetic (dynamic) friction is 0,4. A tow chain connects the tow truck to the car as shown in the diagram below.

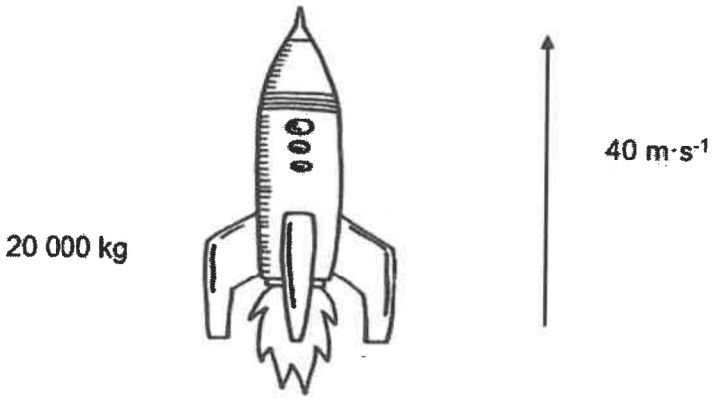


2.1 Calculate the force required to:

2.1.1 Just move the car if the rope is parallel to the road (3)

2.1.2 Keep the car moving at CONSTANT speed (2)

2.2 A rocket of mass of 20 000 kg moves vertically upwards with a uniform acceleration from rest to a velocity of 40 $m \cdot s^{-1}$ in 1.6 s.
Ignore the effects of friction.



2.2.1 State Newton's Third Law of Motion in words. (2)

2.2.2 Draw a labelled free-body diagram of all the forces acting on the rocket. (2)

2.2.3 What is the magnitude and direction of the total force exerted on the rocket during first 1,6 s? (4)

2.2.4 An astronaut of mass 80 kg is carried in the space capsule. Determine the resultant force acting on him during the first 1,6 s? (2)
[15]

QUESTION 3 (Start on a new page.)

A helicopter moves vertically upwards at a constant velocity, releases a package. It takes 6 s for the package to reach the ground. The package strikes the ground with a velocity of 49,8 $m \cdot s^{-1}$. Ignore effects of air friction.

3.1 Define the term *free fall*. (2)

3.2 Why does the package rise before falling to the ground? (1)

3.3 If the time taken for the package to reach the maximum height is 0,8 s, calculate the velocity of the helicopter. (3)

3.4 Calculate the height of the package above the ground at the moment it is released from the helicopter. (3)

3.5 Draw a velocity-time graph that represents the motion of the package until it reaches the ground.

Indicate the initial velocity, final velocity and times for entire motion on the graph. (3)

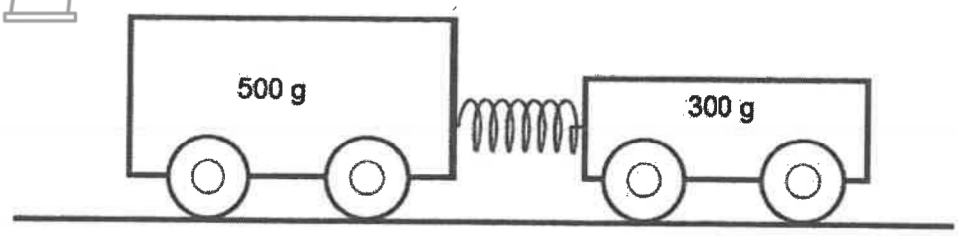
3.6 Use the graph, drawn for question **3.5**, to determine the maximum height reached by the package above its point of release. (2)

3.7 After releasing the package, the helicopter continue to move vertically upwards with the same constant velocity. Calculate how much higher the helicopter moves, from the time it releases the package until the time that the package reaches the ground. (2)

[16]

QUESTION 4 (Start on a new page.)

Two trolleys are placed on a frictionless track in a Physics laboratory. A compressed spring is placed between the two stationary trolleys. Trolley 1 has a mass of 500 g and trolley 2 has a mass of 300 g. The spring is released and trolley 1 moves away with a velocity of 2,4 $m \cdot s^{-1}$.



4.1 State the law of *conservation of momentum*. (2)

4.2 Calculate the velocity of trolley 2 after the spring is released. (3)

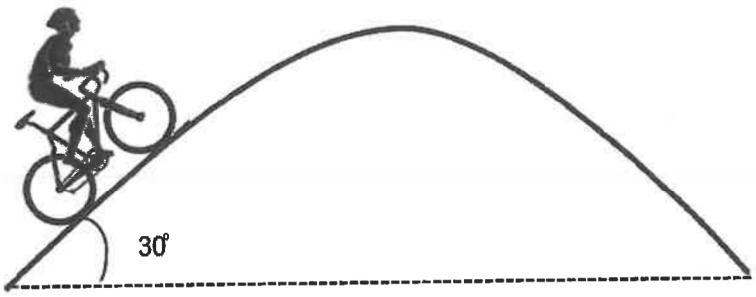
4.3 If the release of the spring takes 0,12 s. Calculate the force which the spring exerts on each of the trolleys. (3)

4.4 Describe how the acceleration of the trolleys would be affected if the masses of the trolleys were doubled.

Choose from INCREASE, DECREASE OR REMAINS THE SAME.
Explain your answer. (2)
[10]

QUESTION 5 (Start on a new page.)

A cyclist cycles up to the top of a hill with a length of 50 m at a CONSTANT velocity. The force of kinetic friction that the bike encounters is 55 N. The combined mass of the cyclist and the bicycle is 70 kg. The slope forms an angle of 30 ° with the horizontal.



5.1 Draw a labelled free-body diagram to show all the forces acting on the bicycle when the cyclist pedals up the slope. (4)

5.2 When the bicycle in going up the slope, calculate work done by the:

5.2.1 Force of friction (3)

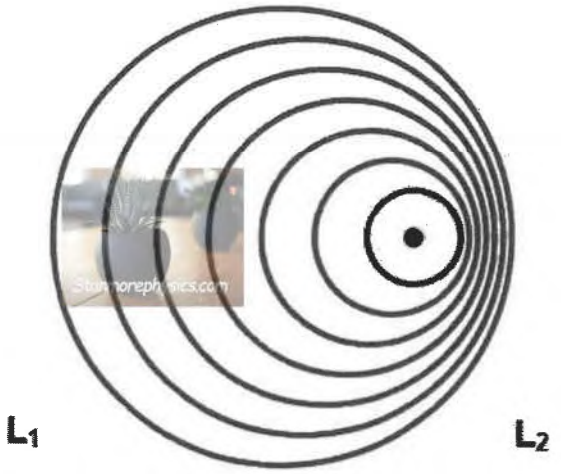
5.2.2 Gravitational force (3)

5.2.3 Applied force (4)

5.3 Determine magnitude of the applied force (2)
[16]

QUESTION 6 (Start on a new page)

6.1 Diagram below represents sound waves which are emitted by the siren of a police car. The speed of the police car is 100 km·h^{-1} and frequency of sound waves emitted is 800 Hz. The points L_1 and L_2 represents the stationery listeners standing on the road.



6.1.1 State the *Doppler effect* in words. (2)

6.1.2 What is the name of the instrument used to measure the rate of blood flow in the arteries of a human being? (1)

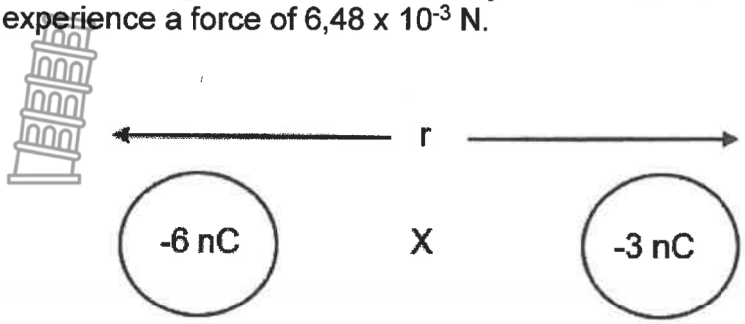
6.1.3 Will the frequency of the sound heard by listener L_1 be greater or less than 800 Hz? Explain the answer. (3)

6.1.4 Calculate the frequency of sound heard by the listener L_1. (4)

6.2 Galaxy **A** is 1 500 million and Galaxy **B** 5 000 million light years away from Earth. Light from which galaxy will have greater red shift?
Explain your answer. (3)
[13]

QUESTION 7 (Start on a new page.)

Two dust particles are floating in the air. One dust particle carries a charge of -6 nC and other carries a charge of -3 nC. When they are a certain distance **r** from each other, they experience a force of $6,48 \times 10^{-3}$ N.



7.1 Write down the name of the force that exists between these two particles and state the effect they have on each other. (2)

7.2 Suggest ONE way in which the particles could have acquired their charge. (1)

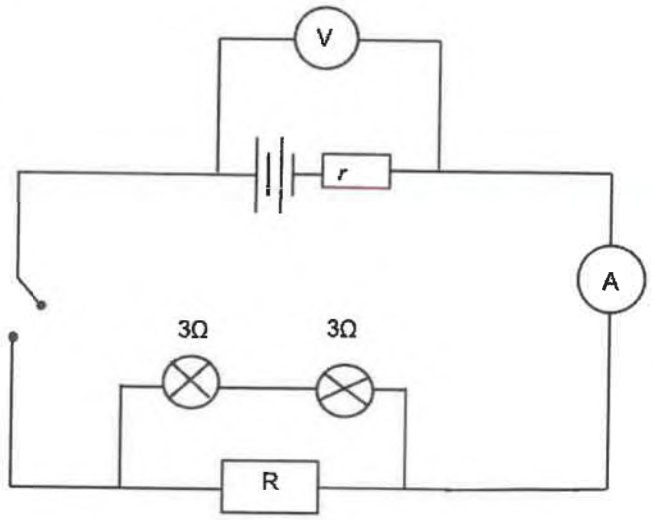
7.3 Draw the electric field pattern, which exists between the two particles. (2)

7.4 Calculate the distance **r** between the particles. (4)

7.5 Calculate the magnitude and direction of net electric field at a point **X** which is exactly halfway between the particles, when they are at distance **r** apart. (5)
[14]

QUESTION 8 (Start on a new page.)

Two 9 V batteries are connected in a circuit with an ammeter, a switch, a voltmeter, two 3 Ω light bulbs and a resistor **R** as shown in the circuit diagram below. The battery has an internal resistance **r.**



8.1 When the switch is open, what will the reading be on the:

8.1.1 Voltmeter (1)

8.1.2 Ammeter (1)

8.2 When the switch is closed, voltmeter reading drops by 0,72 V and ammeter reads 7,2 A.

8.2.1 Explain why the voltmeter reading drops. (3)

8.2.2 Calculate the internal resistance **r** of the battery. (3)

8.2.3 Calculate the resistance of the resistor **R** (5)

8.3 If the resistor **R** is removed from the circuit, would the power dissipated in the light bulbs INCREASE, DECREASE or REMAINS SAME. Explain your answer without calculations. (3)
[16]

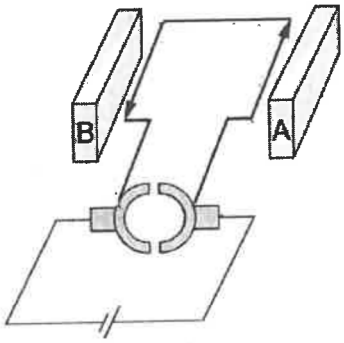
QUESTION 9 (Start on a new page.)

A company that manufactures electrical appliances has produced a new cordless electric drill, which is operated by a 9 V battery.

9.1 State the principle on which an electric motor works. (2)

9.2 Does the drill have a direct or alternating current motor? (1)

The diagram below shows a simplified version of structure of a motor.
The coil is placed between the opposite poles of two magnets.



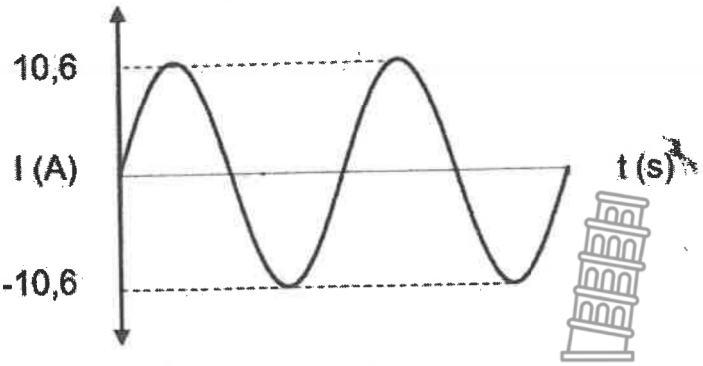
9.3 Name the structure that ensures the coil rotates in one direction only. (1)

9.4 If the current is flowing in the coil as indicated in the diagram, the coil is undergoing anticlockwise rotation.

Is the magnetic field direction from **B to A** or from **A to B**? (1)

9.5 Peter has an electric drill, which operates from an alternating current supply.
The drill has the following markings on it: 240 V,1800 W, 50 Hz

The current passing through the drill while operating is represented in the graph below:



9.5.1 The current passing through the drill changes within every cycle.
How long does it take to complete a cycle? (1)

9.5.2 Calculate the **rms** current the drill draws when operating. (3)

9.5.3 What is the resistance of the drill? (4)

9.6 Small electric motors are used in remote controlled toy cars.

9.6.1 Write down two modifications that can be made to increase toy car's speed. (2)

9.6.2 As the motor turns, the wheels of the car rotates in one direction, moving it forwards.

Write down TWO modifications to the motor that could make the car to move in reverse direction. (2)
[17]

QUESTION 10 (Start on a new page.)

A scientist was investigating certain material for possible use in a solar cell. Firstly the scientist uses a source of blue light with wavelength 460 nm to produce photo electrons. The kinetic energy of photo electron is $1,6 \times 10^{-19}$ J. The scientist then carries an experiment to find out whether light of other wavelengths also emits electrons from the material. He used red light with wavelength 700 nm in this experiment.

10.1 What type of energy conversion is taking place in a solar cell? (2)

10.2 What is the aim of his investigation? (2)

10.3 Show by calculation whether red light will be able to emit electrons from the material? (7)

10.4 Is the material used in this investigation suitable for making solar cells? Explain your answer. (2)
[13]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of the Earth *Massa van die Aarde*	M_E	5,98 x 10^{24} kg
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r) emk (ε) = I(R + r)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$	/	$I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$	/		$P_{ave} = I^2_{rms}R$ / $P_{gemiddeld} = I^2_{wgk}R$
$V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$			$P_{ave} = \frac{V^2_{rms}}{R}$ / $P_{gemiddeld} = \frac{V^2_{wgk}}{R}$