# basic education

Department:
Basic Education
**REPUBLIC OF SOUTH AFRICA**

## NATIONAL
## SENIOR CERTIFICATE

## GRADE 12

**PHYSICAL SCIENCES:  PHYSICS (P1)**

**NOVEMBER 2011**

**MARKS:  150**

**TIME:  3 hours**

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

**INSTRUCTIONS AND INFORMATION**

1.  Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2.  This question paper consists of TWO sections:

    SECTION A     (25)
    SECTION B     (125)

3.  Answer ALL the questions in the ANSWER BOOK.

4.  You may use a non-programmable calculator.

5.  You may use appropriate mathematical instruments.

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

7.  YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

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

9.  Round off your final numerical answers to a minimum of TWO decimal places.

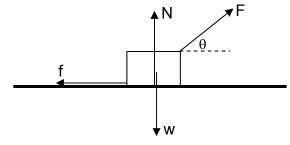          

## SECTION A

## 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) in the ANSWER BOOK.

1.1      The rate at which work is done                                                (1)

1.2      The term that describes two sources that produce waves that have a constant phase relationship to each other                                            (1)

1.3      The general name given to the insulating material between the plates of capacitors                                                                       (1)

1.4      The type of current produced by an electric generator which has slip rings      (1)

1.5      The unit of measurement of electric field                                      (1)
                                                                                        **[5]**

## QUESTION 2:  MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.
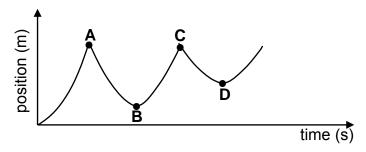
2.1       Impulse is equal to the …

          A      initial momentum of a body.

          B      final momentum of a body.

          C      change in momentum of a body.

          D      rate of change in momentum of a body.                                  (2)

2.2       An object is pulled along a straight horizontal road to the right without being lifted. The force diagram below shows all the forces acting on the object.



          Which ONE of the above forces does POSITIVE WORK on the object?

          A      w

          B      N

          C      f

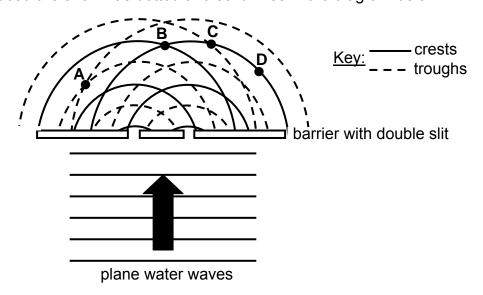          D      F                                                                      (2)

2.3     A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. The position-time graph below represents the motion of the bouncing ball from the instant it is released from rest.



Neglecting air resistance, which point (**A**, **B**, **C** or **D**) on the graph represents the position-time coordinates of the maximum height reached by the ball after the SECOND bounce?

A     A

B     B

C     C

D     D                                                                                          (2)


2.4     Water waves pass through a double slit. The resulting circular wavefronts produced are shown as dotted and solid lines in the diagram below.



Which ONE of the points (**A**, **B**, **C** or **D**) lies on a nodal line?

A     A

B     B

C     C
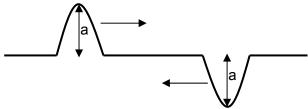
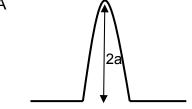D     D                                                                                          (2)

2.5    The diagram below represents two pulses, each of amplitude *a*, travelling in opposite directions along a slinky coil.
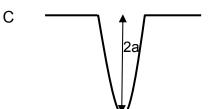


Which ONE of the following represents the resultant amplitude at the instant that these two pulses meet?

A                                                        B



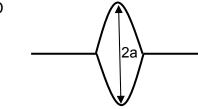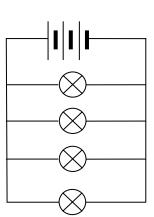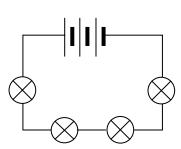C                                                        D



(2)

2.6    A set of identical light bulbs are connected as shown in the circuit diagrams below. The internal resistance of the battery is negligible.

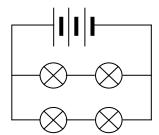In which ONE of these circuits will the light bulbs glow the brightest?

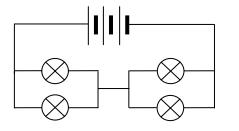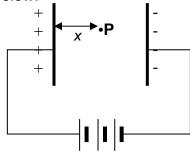A                                                        B



C                                                        D



(2)

2.7     The unit of measurement of THE RATE OF FLOW OF CHARGE in a conductor is …

        A     watt.

        B     volt.

        C     ampere.

        D     coulomb.                                                                (2)

2.8     Point **P** is a distance $x$ from the positive plate of a parallel-plate capacitor as shown in the diagram below.



        The magnitude of the electric field at **P** is $E$. At a distance $\frac{1}{2}x$ from the positive plate, the magnitude of the electric field will be …

        A     $\frac{1}{4}E$

        B     $\frac{1}{2}E$

        C     $E$

        D     $2E$                                                                    (2)

2.9     Which ONE of the following descriptions best explains the formation of a line emission spectrum?

        A line emission spectrum is formed when …

        A     white light passes through a cold gas.

        B     white light passes through a triangular prism.

        C     electrons in the ground state move to a higher energy level.

        D     electrons in the excited state move to a lower energy level.           (2)

2.10    Which ONE of the following electromagnetic waves has the shortest wavelength?

        A     Radio waves

        B     Gamma rays

        C     Infrared rays

        D     Ultraviolet rays                                                       (2)
                                                                                    **[20]**
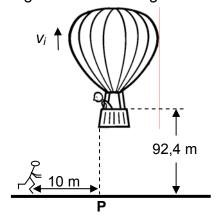
                                                         **TOTAL SECTION A:     25**

**SECTION B**

**INSTRUCTIONS AND INFORMATION**

1.      Start EACH question on a NEW page.

2.      Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3.      Show the formulae and substitutions in ALL calculations.

4.      Round off your final numerical answers to a minimum of TWO decimal places.

**QUESTION 3   (Start on a new page.)**

A hot-air balloon is moving vertically upwards at a constant speed. A camera is accidentally dropped from the balloon at a height of 92,4 m as shown in the diagram below. The camera strikes the ground after 6 s. Ignore the effects of friction.



3.1      At the instant the camera is dropped, it moves upwards. Give a reason for this observation.                                                                                                       (1)

3.2      Calculate the speed $v_i$ at which the balloon is rising when the camera is dropped.                                                                                                                   (4)

3.3      Draw a sketch graph of velocity versus time for the entire motion of the camera.

         Indicate the following on the graph:

         • Initial velocity
         • Time at which it reaches the ground                                                   (4)

3.4      If a jogger, 10 m away from point **P** as shown in the above diagram and running at a constant speed of 2 m·s⁻¹, sees the camera at the same instant it starts falling from the balloon, will he be able to catch the camera before it strikes the ground?

         Use a calculation to show how you arrived at the answer.                    (5)

                                                                                                          **[14]**

**QUESTION 4   (Start on a new page.)**

A patrol car is moving on a straight horizontal road at a velocity of 10 m·s⁻¹ east. At the same time a thief in a car ahead of him is driving at a velocity of 40 m·s⁻¹ in the same direction.

$v_{PG}$ = 10 m·s⁻¹                    $v_{TG}$ = 40 m·s⁻¹

$v_{PG}$: velocity of the **p**atrol car relative to the **g**round
$v_{TG}$: velocity of the **t**hief's car relative to the **g**round

4.1     Write down the velocity of the thief's car relative to the patrol car.                    (2)

A person in the patrol car fires a bullet at the thief's car. The bullet leaves the gun with an initial horizontal velocity of 100 m·s⁻¹ relative to the patrol car. Ignore the effects of friction.

4.2     Write down the initial velocity of the **b**ullet relative to the **t**hief's car.                    (2)

While travelling at 40 m·s⁻¹, the thief's car of mass 1 000 kg, collides head-on with a truck of mass 5 000 kg moving at 20 m·s⁻¹. After the collision, the car and the truck move together. Ignore the effects of friction.

20 m·s⁻¹

40 m·s⁻¹

4.3     State the *law of conservation of linear momentum* in words.                    (2)

4.4     Calculate the velocity of the thief's car immediately after the collision.                    (6)

4.5     Research has shown that forces greater than 85 000 N during collisions may cause fatal injuries. The collision described above lasts for 0,5 s.
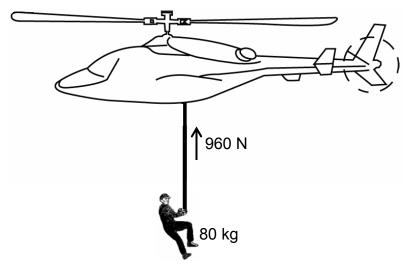
        Determine, by means of a calculation, whether the collision above could result in a fatal injury.                    (5)

                                                                                            **[17]**

## QUESTION 5   (Start on a new page.)

A rescue helicopter is stationary (hovers) above a soldier. The soldier of mass 80 kg is lifted vertically upwards through a height of 20 m by a cable at a CONSTANT SPEED of 4 m·s$^{-1}$. The tension in the cable is 960 N. Assume that there is no sideways motion during the lift. Air friction is not to be ignored.



960 N

80 kg

| | | |
|---|---|---|
| 5.1 | State the work-energy theorem in words. | (2) |
| 5.2 | Draw a labelled free-body diagram showing ALL the forces acting on the soldier while being lifted upwards. | (3) |
| 5.3 | Write down the name of a non-contact force that acts on the soldier during the upward lift. | (1) |
| 5.4 | Use the WORK-ENERGY THEOREM to calculate the work done on the soldier by friction after moving through the height of 20 m. | (5) |

**[11]**

## QUESTION 6   (Start on a new page.)

A train approaches a station at a constant speed of 20 m·s$^{-1}$ with its whistle blowing at a frequency of 458 Hz. An observer, standing on the platform, hears a change in pitch as the train approaches him, passes him and moves away from him.

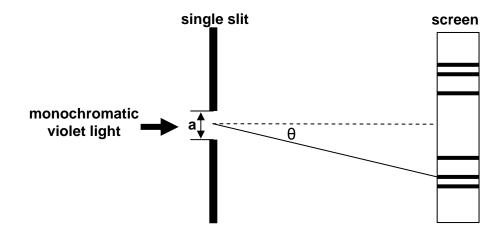| | | |
|---|---|---|
| 6.1 | Name the phenomenon that explains the change in pitch heard by the observer. | (1) |
| 6.2 | Calculate the frequency of the sound that the observer hears while the train is approaching him. Use the speed of sound in air as 340 m·s$^{-1}$. | (4) |
| 6.3 | How will the observed frequency change as the train passes and moves away from the observer? Write down only INCREASES, DECREASES or REMAINS THE SAME. | (1) |
| 6.4 | How will the frequency observed by the train driver compare to that of the sound waves emitted by the whistle? Write down only GREATER THAN, EQUAL TO or LESS THAN. Give a reason for the answer. | (2) |

**[8]**

**QUESTION 7   (Start on a new page.)**

A learner investigates the change in broadness of the central bright band in a diffraction pattern when light passes through single slits of different widths. She uses monochromatic violet light of wavelength 4 x 10$^{-7}$ m. The apparatus is set up as shown in the diagram below.



| 7.1 | Define the term *monochromatic light*. | (2) |
|---|---|---|
| 7.2 | Write down the investigative question for this investigation. | (2) |
| 7.3 | Write down TWO variables that are kept constant during this investigation. | (2) |

7.4    The learner now uses a narrower slit.

How will the broadness of the central bright band change? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give an explanation. (2)

7.5    Calculate the angle θ at which the second minimum is formed if a slit of width 2,2 x 10$^{-6}$ m is used. (5)

**[13]**

## QUESTION 8   (Start on a new page.)

Two metal spheres, **P** and **T**, on insulated stands, carry charges of +3 x 10$^{-9}$ C and -6 x 10$^{-9}$ C respectively.

+3 x 10$^{-9}$ C  **P**        **T**  -6 x 10$^{-9}$ C

The spheres are allowed to touch each other and are then placed 1,5 m apart as shown below.

1,5 m

**P**                    **T**

8.1     In which direction will electrons flow while spheres **P** and **T** are in contact? Write down only FROM **P** TO **T** or FROM **T** TO **P**.                                                             (1)

8.2     Calculate the net charge gained or lost by sphere **P** after the spheres have been in contact.                                                                                                              (3)

8.3     Calculate the number of electrons transferred during the process in QUESTION 8.2.                                                                                                                        (2)

8.4     A third sphere **R,** carrying a charge of -3 x 10$^{-9}$ C, is NOW placed between **P** and **T** at a distance of 1 m from **T**.

        Calculate the net force experienced by sphere **R** as a result of its interaction with **P** and **T**.                                                                                                   (6)
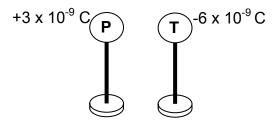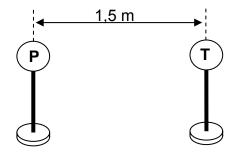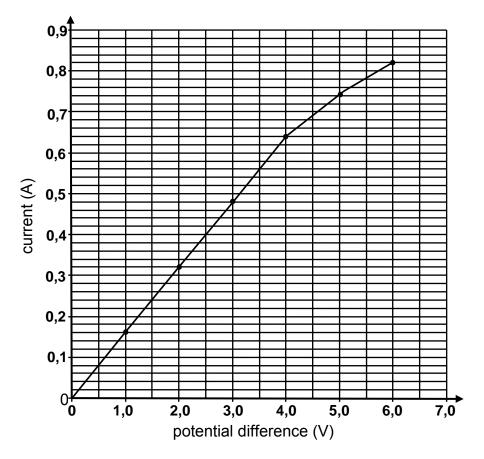                                                                                                                                                                                                                  **[12]**

**QUESTION 9   (Start on a new page.)**

Learners conduct an investigation to verify Ohm's law. They measure the current through a conducting wire for different potential differences across its ends. The results obtained are shown in the graph below.



9.1    Which ONE of the measured quantities is the dependent variable?                    (1)

9.2    The graph deviates from Ohm's law at some point.

       9.2.1    Write down the coordinates of the plotted point on the graph
                beyond which Ohm's law is not obeyed.                                        (2)

       9.2.2    Give a possible reason for the deviation from Ohm's law as shown
                in the graph. Assume that all measurements are correct.                      (2)

9.3    Calculate the gradient of the graph for the section where Ohm's law is
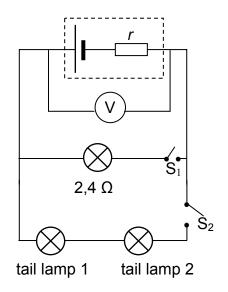       obeyed.

       Use this to calculate the resistance of the conducting wire.                          (4)
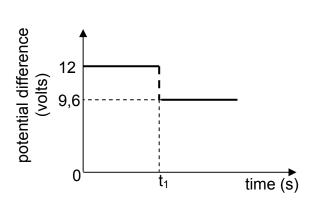
                                                                                            **[9]**

**QUESTION 10   (Start on a new page.)**

The headlamp and two IDENTICAL tail lamps of a scooter are connected in parallel to a battery with unknown internal resistance as shown in the simplified circuit diagram below. The headlamp has a resistance of 2,4 Ω and is controlled by switch $S_1$. The tail lamps are controlled by switch $S_2$. The resistance of the connecting wires may be ignored.

The graph alongside shows the potential difference across the terminals of the battery before and after switch $S_1$ is closed (whilst switch $S_2$ is open). Switch $S_1$ is closed at time $t_1$.



10.1    Use the graph to determine the emf of the battery.                                                    (1)

10.2    WITH ONLY SWITCH $S_1$ CLOSED, calculate the following:

      10.2.1    Current through the headlamp                                                          (3)

      10.2.2    Internal resistance, $r$, of the battery                                            (3)

10.3    BOTH SWITCHES $S_1$ AND $S_2$ ARE NOW CLOSED. The battery delivers a current of 6 A during this period.

      Calculate the resistance of each tail lamp.                                                  (5)

10.4    How will the reading on the voltmeter be affected if the headlamp burns out? (Both switches $S_1$ and $S_2$ are still closed.)

      Write down only INCREASES, DECREASES or REMAINS THE SAME.

      Give an explanation.                                                                        (3)
                                                                                                            **[15]**
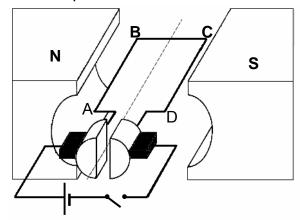
**QUESTION 11   (Start on a new page.)**

Diesel-electric trains make use of electric motors as well as generators.

11.1     The table below compares a motor and a generator in terms of the type of energy conversion and the underlying principle on which each operates. Complete the table by writing down only the question number (11.1.1–11.1.4) in the ANSWER BOOK and next to each number the answer.
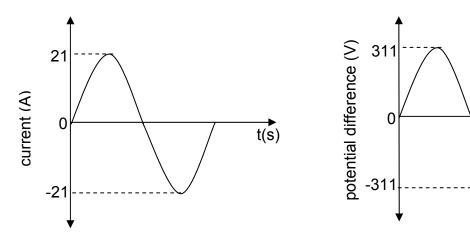
|  | TYPE OF ENERGY CONVERSION | PRINCIPLE OF OPERATION |
|---|---|---|
| **Motor** | 11.1.1 | 11.1.3 |
| **Generator** | 11.1.2 | 11.1.4 |

(4)

The simplified diagram below represents an electric motor.



11.2     Give a reason why the section of the coil labelled **BC** in the above diagram does not experience a magnetic force whilst the coil is in the position as shown. (2)

11.3     Graphs of the current and potential difference outputs of an AC generator are shown below.



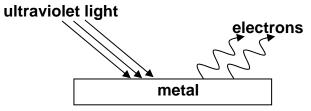Calculate the average power output of this generator. (6)

**[12]**

**QUESTION 12   (Start on a new page.)**

A metal surface is illuminated with ultraviolet light of wavelength 330 nm. Electrons are emitted from the metal surface.

<u>The minimum amount of energy required to emit an electron from the surface of this metal</u> is $3,5 \times 10^{-19}$ J.



| 12.1 | Name the phenomenon illustrated above. | (1) |
|---|---|---|

| 12.2 | Give ONE word or term for the underlined sentence in the above paragraph. | (1) |
|---|---|---|

| 12.3 | Calculate the frequency of the ultraviolet light. | (4) |
|---|---|---|

| 12.4 | Calculate the kinetic energy of a photoelectron emitted from the surface of the metal when the ultraviolet light shines on it. | (4) |
|---|---|---|

12.5     The intensity of the ultraviolet light illuminating the metal is now increased. What effect will this change have on the following:

| 12.5.1 | Kinetic energy of the emitted photoelectrons (Write down only INCREASES, DECREASES or REMAINS THE SAME.) | (1) |
|---|---|---|

| 12.5.2 | Number of photoelectrons emitted per second (Write down only INCREASES, DECREASES or REMAINS THE SAME.) | (1) |
|---|---|---|

12.6     Overexposure to sunlight causes damage to skin cells.

| 12.6.1 | Which type of radiation in sunlight is said to be primarily responsible for this damage? | (1) |
|---|---|---|

| 12.6.2 | Name the property of this radiation responsible for the damage. | (1) |
|---|---|---|

**[14]**

**TOTAL SECTION B:      125**
**GRAND 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<br>*Swaartekragversnelling* | $g$ | $9{,}8 \ \text{m·s}^{-2}$ |
| Speed of light in a vacuum<br>*Spoed van lig in 'n vakuum* | $c$ | $3{,}0 \times 10^{8} \ \text{m·s}^{-1}$ |
| Planck's constant<br>*Planck se konstante* | $h$ | $6{,}63 \times 10^{-34} \ \text{J·s}$ |
| Coulomb's constant<br>*Coulomb se konstante* | $k$ | $9{,}0 \times 10^{9} \ \text{N·m}^2\text{·C}^{-2}$ |
| Charge on electron<br>*Lading op elektron* | $e$ | $-1{,}6 \times 10^{-19} \ \text{C}$ |
| Electron mass<br>*Elektronmassa* | $m_e$ | $9{,}11 \times 10^{-31} \ \text{kg}$ |
| Permittivity of free space<br>*Permittiwiteit van vry ruimte* | $\varepsilon_0$ | $8{,}85 \times 10^{-12} \ \text{F·m}^{-1}$ |

      

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

## FORCE/*KRAG*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $F_{net}\Delta t = \Delta p$ <br> $\Delta p = mv_f - mv_i$ | $w = mg$ |

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

| | |
|---|---|
| $W = F\Delta x\cos\theta$ | $U = mgh$    or/*of*    $E_P = mgh$ |
| $K = \dfrac{1}{2}mv^2$    or/*of*    $E_k = \dfrac{1}{2}mv^2$ | $W_{net} = \Delta K$    or/*of*    $W_{net} = \Delta E_k$ <br><br> $\Delta K = K_f - K_i$    or/*of*    $\Delta E_k = E_{kf} - E_{ki}$ |
| $P = \dfrac{W}{\Delta t}$ | $P = Fv$ |

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

| | |
|---|---|
| $v = f\lambda$ | $T = \dfrac{1}{f}$ |
| $f_L = \dfrac{v \pm v_L}{v \pm v_s}f_s$    or/*of*    $f_L = \dfrac{v \pm v_L}{v \pm v_b}f_b$ | $E = hf$ <br> $E = h\dfrac{c}{\lambda}$ |
| $\sin\theta = \dfrac{m\lambda}{a}$ | $E = W_o + E_k$ <br><br> where/*waar* <br><br> $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \dfrac{1}{2}mv^2$ |

      

## ELECTROSTATICS/*ELEKTROSTATIKA*

| | |
|---|---|
| $F = \dfrac{kQ_1Q_2}{r^2}$ | $E = \dfrac{kQ}{r^2}$ |
| $E = \dfrac{V}{d}$ | $E = \dfrac{F}{q}$ |
| $U = \dfrac{kQ_1Q_2}{r}$ | $V = \dfrac{W}{q}$ |
| $C = \dfrac{Q}{V}$ | $C = \dfrac{\varepsilon_0 A}{d}$ |

## ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

| | |
|---|---|
| $R = \dfrac{V}{I}$ | emf $(\varepsilon) = I(R + r)$ <br><br> emk $(\varepsilon) = I(R + r)$ |
| $R_s = R_1 + R_2 + ...$ <br> $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + ...$ | $q = I\,\Delta t$ |
| $W = Vq$ <br><br> $W = VI\,\Delta t$ <br><br> $W = I^2R\,\Delta t$ <br><br> $W = \dfrac{V^2 \Delta t}{R}$ | $P = \dfrac{W}{\Delta t}$ <br><br> $P = VI$ <br><br> $P = I^2R$ <br> $P = \dfrac{V^2}{R}$ |

## ALTERNATING CURRENT/*WISSELSTROOM*

| | |
|---|---|
| $I_{rms} = \dfrac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \dfrac{I_{maks}}{\sqrt{2}}$ <br><br> $V_{rms} = \dfrac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \dfrac{V_{maks}}{\sqrt{2}}$ | $P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ <br><br> $P_{average} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$ <br><br> $P_{average} = \dfrac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \dfrac{V_{wgk}^2}{R}$ |