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Basic Education
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**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

TECHNICAL SCIENCES P1

NOVEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 2 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 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 between two subquestions, 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

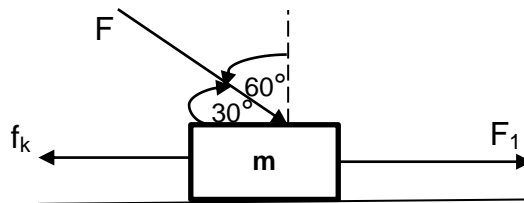
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Newton's First Law of Motion implies that an object will continue moving at constant velocity as long as the ...

- A sum of all forces acting on the object is zero.
- B net force experienced by the object is greater than zero.
- C net force experienced by the object is less than zero.
- D sum of all the forces acting on the object is greater than zero but less than one.

(2)

1.2 An object of mass **m** moves to the right with a non-zero acceleration under the influence of the forces as indicated in the diagram below.



Which ONE of the following equations CORRECTLY represents the diagram above?

- A $f_k = F_1 - F\sin 60^\circ$
- B $f_k = F_1 + F\cos 60^\circ$
- C $f_k = F_1 - F\cos 30^\circ - ma$
- D $f_k = F_1 + F\cos 30^\circ - ma$

(2)

1.3 A car experiences a constant net force of 500 N as it moves towards the west. The rate at which the momentum of the car changes during its motion is ...

- A equal to an impulse of the car.
- B equal to 500 N.
- C greater than the net force.
- D less than 500 N.

(2)

1.4 A ball with mass m strikes a wall with speed v . Assume that the collision is elastic. If the ball bounces back with the same speed v the magnitude of the change in momentum will be ...

A $2 mv$ in the opposite direction.

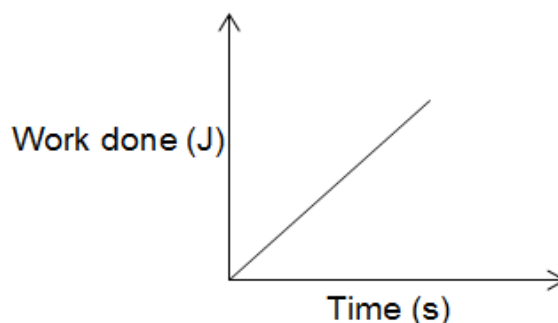
B mv in the opposite direction.

C $2 mv$ in the original direction.

D mv in the original direction.

(2)

1.5 The graph below represents the relationship between the work done on an object and the time taken.



The gradient of the graph represents ...

A momentum.

B kinetic energy.

C power.

D potential energy.

(2)

1.6 Which term best describes a force that is equal and opposite to the deforming force?

A Strain

B Stress

C Applied force

D Restoring force

(2)

- 1.7 Which ONE of the following statements represents Pascal's law?
- A The area is inversely proportional to the pressure in it if the temperature remains constant.
 - B The pressure exerted at any point of a continuous liquid at equilibrium is transmitted equally in all directions.
 - C The pressure is directly proportional to the volume if the temperature remains constant.
 - D Volume is inversely proportional to the pressure on it if the temperature remains constant. (2)
- 1.8 Which ONE of the following is equivalent to the unit of capacitance?
- A $C.V$
 - B $C.V^{-2}$
 - C $C.V^{-1}$
 - D $C.V^2$ (2)
- 1.9 Consider the straight current-carrying conductor below. The direction of the current in the conductor is indicated by the arrow.



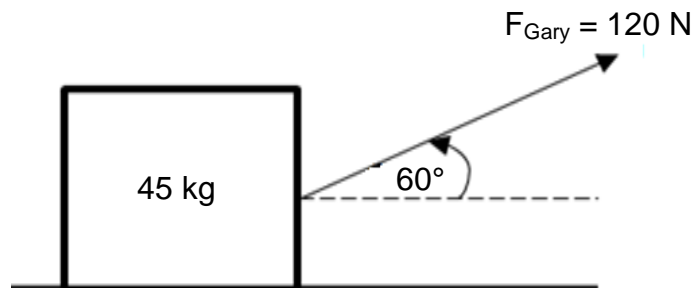
The direction of the magnetic field will be ...

- A to the left.
 - B to the right.
 - C clockwise.
 - D anticlockwise. (2)
- 1.10 Which ONE of the following is implied by Lenz's law? The induced ... that produced it.
- A emf always opposes the change in flux
 - B emf always opposes the flux
 - C emf always opposes the emf
 - D current always opposes the current (2)

[20]

QUESTION 2 (Start on a new page.)

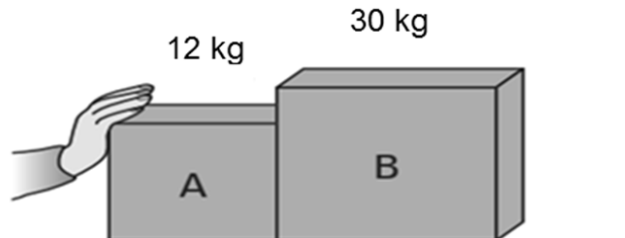
A toolbox with a mass of 45 kg rests on horizontal rough surface. Gary pulls the toolbox with a force of 120 N at an angle of 60° to the horizontal using a rope, as shown in the diagram below. The toolbox is not moving as he is pulling it.



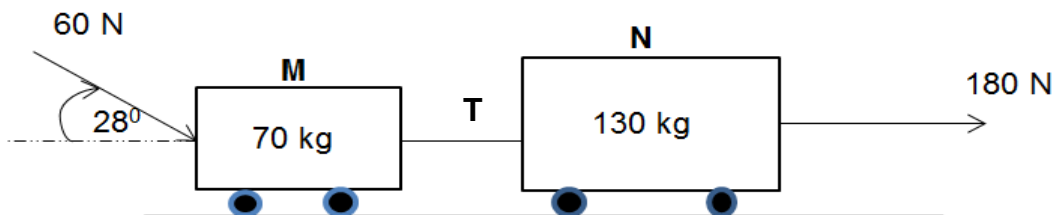
- 2.1 Draw a free-body diagram of all the forces acting on the toolbox. (4)
- 2.2 State a law of motion that can be used to explain why the toolbox is not moving. (2)
- 2.3 Use the law in QUESTION 2.2 to explain why the toolbox is not moving. (2)
- [8]**

QUESTION 3 (Start on a new page.)

- 3.1 Crate **A** and crate **B**, of different masses, are placed next to each other on a horizontal rough surface. A hand pushing crate **A** causes both crates to accelerate at $2,3 \text{ m}\cdot\text{s}^{-2}$ to the right. Crate **B** experiences a frictional force of $25,3 \text{ N}$.



- 3.1.1 State Newton's Third Law of Motion in words. (2)
- 3.1.2 Calculate the force exerted by crate **B** on crate **A**. (6)
- 3.2 Two workers, Paul and Martha, are moving two trolleys, **M** and **N**, connected by a light inextensible string, as shown in the diagram below. Paul pulls trolley **N** with a force of 180 N to the east. Martha pushes trolley **M** with a force of 60 N at an angle of 28° with the horizontal.

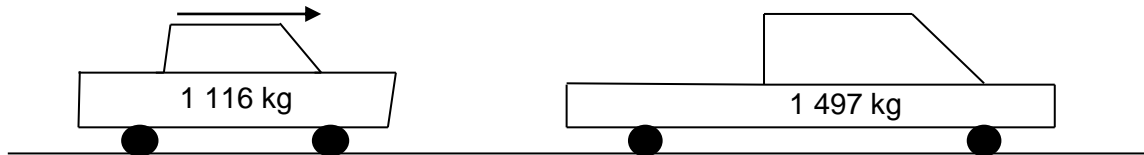


The frictional force experienced by trolley **M** is $6,4 \text{ N}$ and that of trolley **N** is $8,58 \text{ N}$.

- 3.2.1 State Newton's Second Law of Motion in words. (2)
- 3.2.2 If the system accelerates at $1,09 \text{ m}\cdot\text{s}^{-2}$, calculate the tension (**T**) in the string. (4)
- 3.2.3 If Paul's pulling force is now applied at an angle of 60° with the horizontal, what will happen to the frictional force experienced by trolley **N**? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 3.2.4 Explain your answer to QUESTION 3.2.3. (3)
- [18]**

QUESTION 4 (Start on a new page.)

A car of mass 1 116 kg was travelling at $30 \text{ m}\cdot\text{s}^{-1}$ towards the east when it collided with a stationary bakkie of mass 1 497 kg. After the collision the bakkie moved at $8 \text{ m}\cdot\text{s}^{-1}$ to the east.



Assume that the system is isolated.

- 4.1 Define the term *isolated system*. (2)
 - 4.2 Calculate the momentum of the car just before the collision. (3)
 - 4.3 Determine the magnitude of the car's velocity after the collision. (4)
 - 4.4 Name and state the principle used to answer QUESTION 4.3. (3)
 - 4.5 Without any calculation, determine how the final momentum of the car compares with the initial momentum. Write only GREATER THAN, SMALLER THAN or EQUAL TO. (1)
 - 4.6 Explain your answer to QUESTION 4.5. (2)
- [15]**

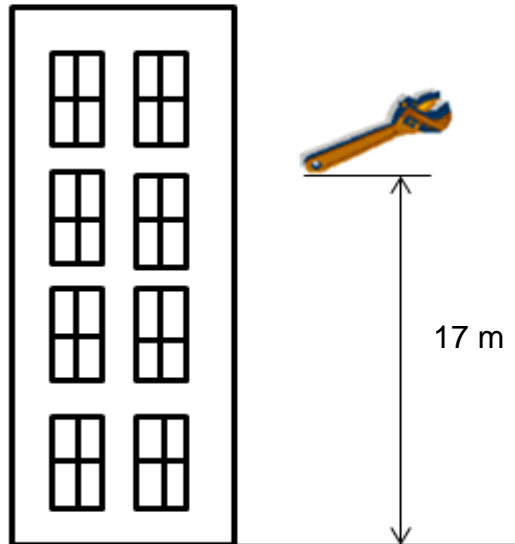
QUESTION 5 (Start on a new page.)

A construction vehicle hit a container of mass 80 kg which was left stationary on a frictionless floor. The vehicle exerted a force of 4,5 kN over $3 \times 10^{-2} \text{ s}$ on the container. The collision between the vehicle and the container was INELASTIC.

- 5.1 Explain the concept *inelastic collision*. (2)
 - 5.2 Define (*net*) force in terms of momentum. (2)
 - 5.3 Calculate the velocity of the container after the collision. (4)
- [8]**

QUESTION 6 (Start on a new page.)

- 6.1 A worker dropped a spanner from a building of a certain height. When the spanner reached a height of 17 m above the ground, the velocity was $3 \text{ m}\cdot\text{s}^{-1}$. The mass of the spanner was 0,15 kg. Assume all the effects of friction are negligible.



- 6.1.1 Define the term *mechanical energy*. (2)
- Calculate the:
- 6.1.2 Mechanical energy of the spanner 17 m above the ground (4)
- 6.1.3 Velocity of the spanner after it had fallen 11 m below the 17 m height (5)
- 6.1.4 Velocity with which the spanner hit the ground (4)
- 6.2 A worker applies a force of 60 N to lift a toolbox from the floor to a height of 0,5 m in 1,2 s. Assume that $1 \text{ hp} = 746 \text{ W}$.
- 6.2.1 Which formula can be used to calculate power when an object moves at constant velocity? (1)
- 6.2.2 Calculate the power of the worker. Express the worker's power in horsepower. (4)

[20]

QUESTION 7 (Start on a new page.)

7.1 A 2,02 m long steel wire with a cross-sectional area of $8,09 \times 10^{-3} \text{ m}^2$ hangs vertically with a 2,3 kN load attached to it. The load causes the length of the wire to increase by 21 mm.

7.1.1 Define the term *elasticity*. (2)

Calculate the:

7.1.2 Stress in the steel wire (3)

7.1.3 Strain caused by the load (3)

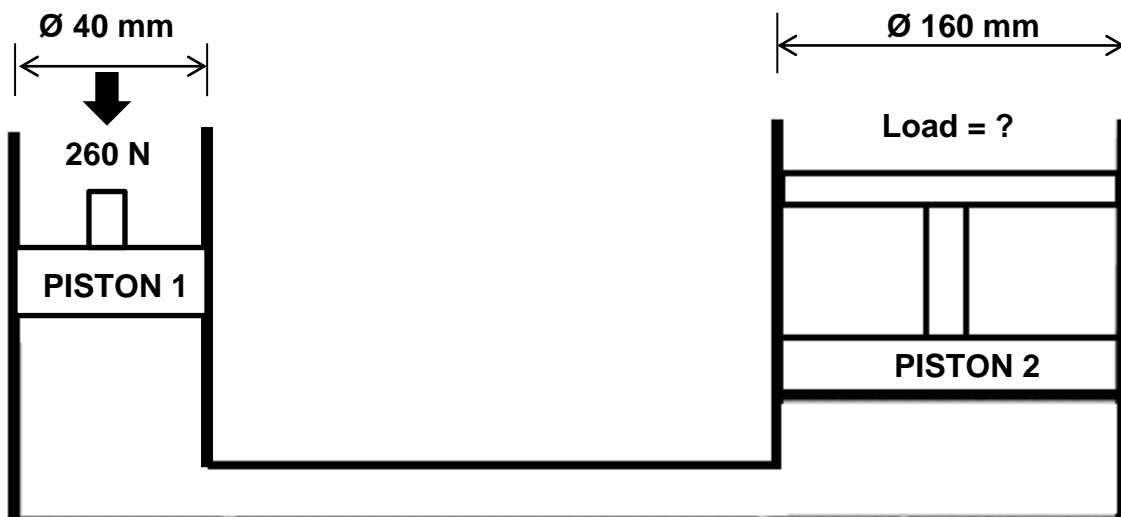
7.2 State Hooke's law. (2)

7.3 Give TWO examples of perfectly elastic substances. (2)

7.4 Define the term *viscosity*. (2)

7.5 State TWO applications of hydraulics systems. (2)

7.6 A recycling company uses a hydraulic system. Use the specifications in the diagram below to answer the questions that follow.



Calculate:

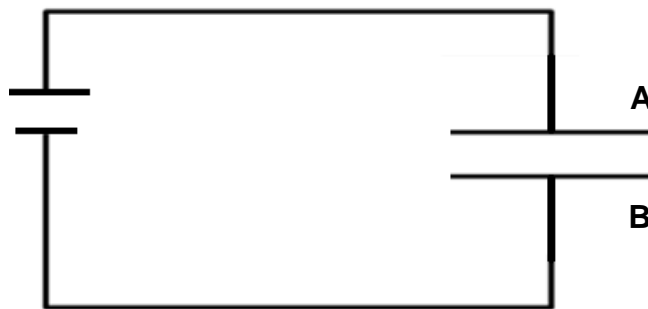
7.6.1 Fluid pressure in the hydraulic system while in equilibrium (4)

7.6.2 Force exerted by PISTON 2 (4)

[24]

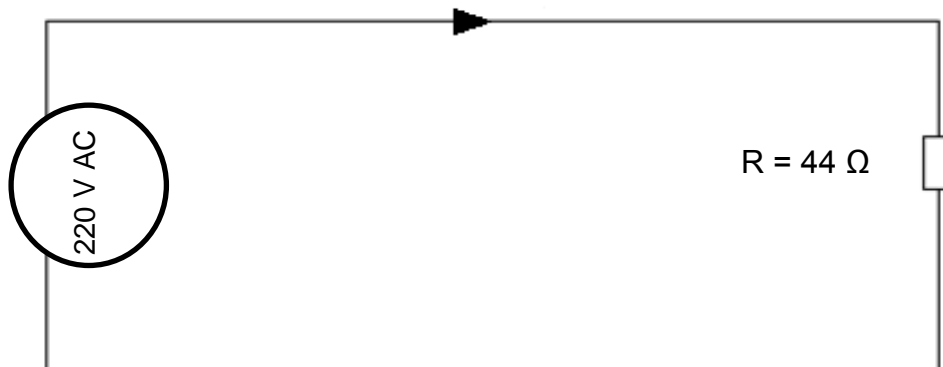
QUESTION 8 (Start on a new page.)

- 8.1 Define a *semiconductor*. (2)
- 8.2 What type of semiconductor is silicon? (1)
- 8.3 Phosphorus was added to silicon in small quantities. It was then found that the electrical conductivity of silicon has improved.
- 8.3.1 Identify the process which is described above. (1)
- 8.3.2 What type of semiconductor material (P-type or N-type) was formed during the process? Give a reason for your answer. (2)
- 8.4 Two parallel plates, **A** and **B**, in the diagram below form a capacitor. The plates of the capacitor are 3,28 mm apart, each with an area of 12,2 cm² and a charge of 0,435 nC. There is a vacuum between the plates. Answer the questions that follow.



- 8.4.1 Calculate the capacitance of this capacitor. (4)
- 8.4.2 If the distance between the plates is doubled, how will that impact on the value of the capacitance calculated in QUESTION 8.4.1? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 8.4.3 Explain your answer to QUESTION 8.4.2. (2)

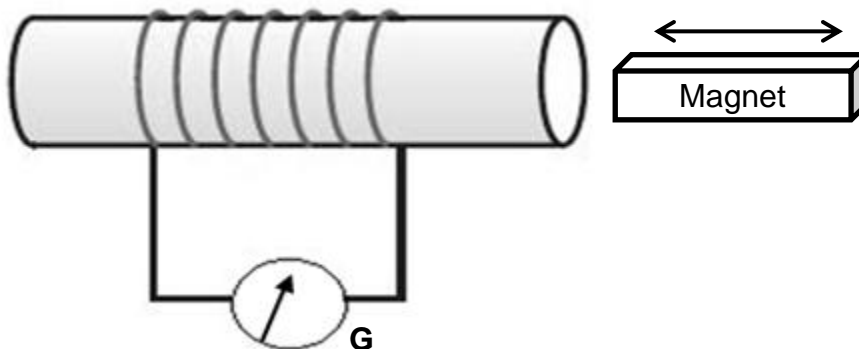
- 8.5 The circuit diagram below has a power source of 220 volts and a resistor with a resistance of 44 ohms. Study the circuit diagram below and answer the questions that follow.



- 8.5.1 Calculate the current in the circuit. (3)
- 8.5.2 Give the relationship between the current and the heat produced in the circuit. (2)
- 8.5.3 Name TWO appliances in which the heating effect of electric current is used. (2)
- [20]**

QUESTION 9 (Start on a new page.)

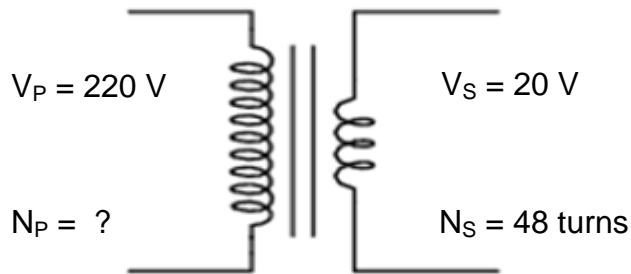
- 9.1 The sketch below is used to illustrate Faraday's law of electromagnetic induction.



- 9.1.1 State Faraday's law of electromagnetic induction in words. (2)
- 9.1.2 State TWO ways in which the deflection of the galvanometer needle could be increased. (2)
- 9.2 A coil with an area of $0,6 \text{ m}^2$ is held with its axis coinciding with the direction of a magnetic field of strength $0,4 \text{ T}$. Calculate the magnetic flux linkage. (3)
- [7]**

QUESTION 10 (Start on a new page.)

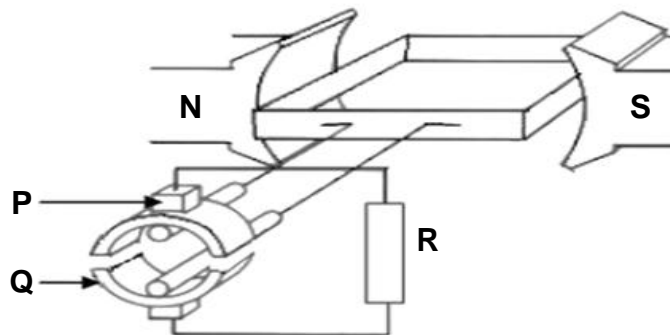
10.1 A diagram of a step-down transformer is shown below. Study the diagram and answer the questions that follow.



10.1.1 Define a *step-down transformer*. (2)

10.1.2 Calculate the number of primary windings. (3)

10.2 The diagram of a DC generator is shown below. Study the diagram and answer the questions that follow.



10.2.1 Label components **P** and **Q**. (2)

10.2.2 Which component enables the generator to produce DC voltage? Write **P** or **Q**. (1)

10.2.3 Differentiate between *AC generators* and *DC generators*. (2)

[10]

TOTAL: 150

**DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 1**

**GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 1**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ε ₀	8,85 x 10 ⁻¹² F.m ⁻¹

TABLE 2: FORMULAE/TABEL 2: FORMULES

FORCE/KRAG

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$

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 $E_k = \frac{1}{2} mv^2$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

**ELASTICITY, VISCOSITY AND HYDRAULICS/ELASTISITEIT, VISKOSITEIT EN
HIDROULIKA**

$\sigma = \frac{F}{A}$ / Stress = $\frac{\text{Force}}{\text{Area}}$ Druk = $\frac{\text{Krag}}{\text{Area}}$	$\epsilon = \frac{\Delta \ell}{L}$ / Strain = $\frac{\text{change in length}}{\text{original length}}$ Vervorming = $\frac{\text{verandering in lengte}}{\text{oorspronklike lengte}}$
$P = \rho gh$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{\sigma}{\epsilon} = K$ / modulus of elasticity = $\frac{\text{stress}}{\text{strain}}$ modulus van elastisiteit = $\frac{\text{spanning}}{\text{vervorming}}$	Pressure (P) = $\frac{\text{Force (F)}}{\text{Area}}$ Druk (P) = $\frac{\text{Krag (F)}}{\text{Area}}$

ELECTROSTATICS/ELEKTROSTATIKA

$C = \frac{Q}{V}$	$C = \frac{\epsilon_0 A}{d}$
-------------------	------------------------------

CURRENT ELECTRICITY/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$ $R_p = \frac{R_1 \times R_2}{R_1 + R_2}$	$q = I \Delta t$
$W = VQ$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/ELEKTROMAGNETISME

$\phi = BA$	$\epsilon = -N \frac{\Delta \phi}{\Delta t}$
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	