Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2023

TECHNICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

This paper consists of 17 pages, including 3 data sheets.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. You may use a non-programmable calculator.
5. LEAVE a line open between subsections, for example QUESTION 2.1 and QUESTION 2.2.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, et cetera where required.
10. 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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 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 the impulse of the car.

B equal to 500 N.

C greater than the net force

D less than 500 N (2)

1.2 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)

1.3 One of the properties of action-reaction pairs is that…

A they have the same magnitude.

B they act towards the same direction.

C their net force is always zero.

D they act on the same object. (2)

1.4 A learner drops his book from his desk to the floor. The mechanical energy at the top of the desk, from where the book was dropped will be …

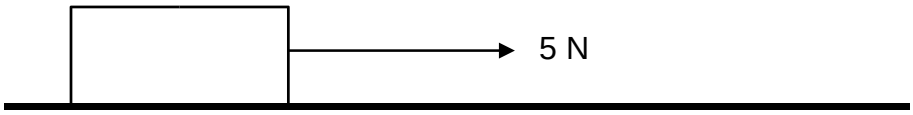
A equal to zero.

B equal to kinetic energy.

C equal to the gravitational potential energy.

D None of the above. (2)

1.5 An object moves with a **constant velocity** along a rough surface when a horizontal force of 5 N acts on it.



The magnitude of the kinetic frictional force is …

A equal to 0.

B equal to 5 N.

C greater than 5 N.

D less than or equal to 5 N. (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 A bricklayer wants to displace an object through a horizontal distance of 5 m. He applies a force of 10 N, but the object **remains at rest.**
Work done by the bricklayer on the object (in Joule) is …

A 0.

B 5.

C 10.

D 50. (2)

1.8 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)

1.9 Strain is defined as the …

A force acting per unit area.

B internal restoring force per unit area.

C force that changes the shape of an object.

D ratio of change in dimension to the original dimension. (2)

1.10 The pressure at a point in a liquid DOES NOT depend on the ...

A area.

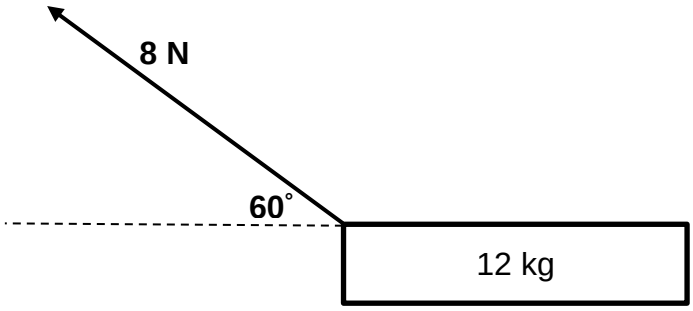
B depth.

C density.

D gravitational acceleration. (2)
[20]

QUESTION 2 (Start on a new page.)

A learner is pulling a block of mass 12 kg at a force of 8 N left at an angle of 60° to the horizontal. The block experiences a frictional force of 0,3 N parallel to the surface as shown in the diagram below.



2.1 Define the term *acceleration* in words. (2)

2.2 Use the diagram above to answer the questions below.

2.2.1 Calculate the magnitude and the direction of the net force. (5)

2.2.2 Calculate the magnitude of the acceleration of the block. (3)

2.2.3 Write down the NAME of the law that can be used to explain the movement of the block. (2)

2.2.4 State the law identified in QUESTION 2.2.3 in words. (2)

2.2.5 Draw a free-body diagram of all the forces acting on the block. (4)

2.3 Another block of same mass is placed on top of the block and pulled at the same angle. How will the following be influenced by the increase of mass?

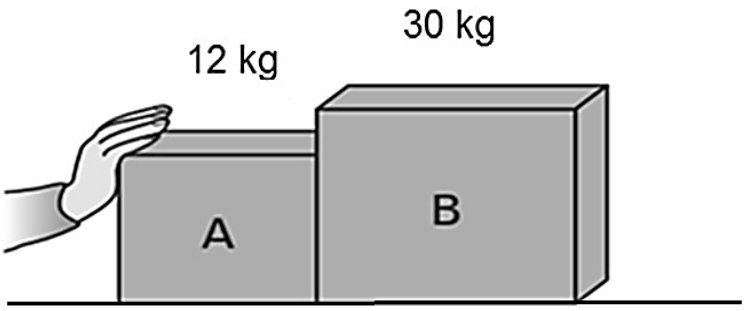
State only, INCREASES, DECREASES or REMAINS THE SAME.

2.3.1 Frictional force (1)

2.3.2 Acceleration (1)
[20]

QUESTION 3 (Start on a new page.)

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 $m.s^{-2}$ to the right. Crate **B** experiences a frictional force of 25,3 N.

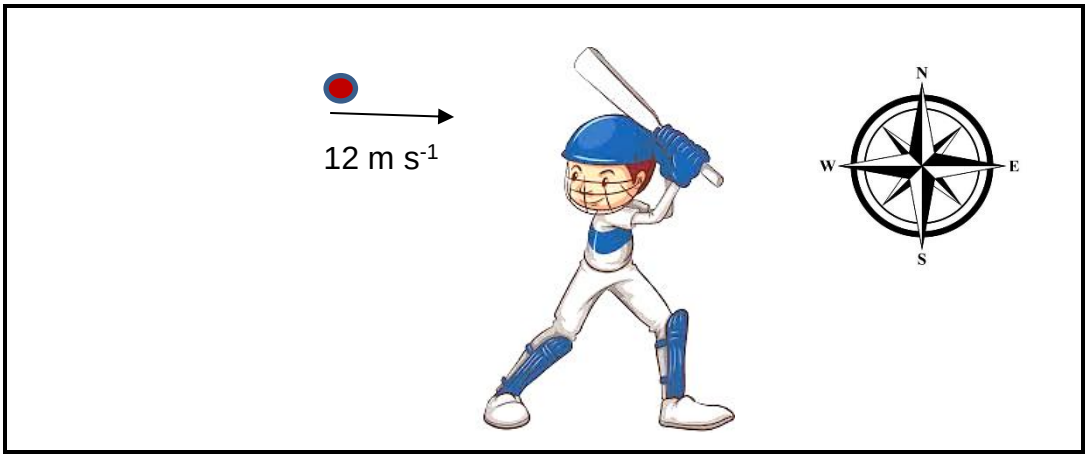


3.1 State Newton's Third Law of Motion in words. (2)

3.2 Calculate the force exerted by crate **B** on crate **A**. (6)
[8]

QUESTION 4 (Start on a new page.)

4.1 A cricket ball, of mass 175 g, is thrown directly towards a batsman at a horizontal velocity of 12 $m \cdot s^{-1}$ east. It is hit back in the opposite direction with a velocity of 30 $m \cdot s^{-1}$ west. The ball is in contact with the bat for a period of 0,05 s.



4.1.1 Give the definition of the term *impulse* in words. (2)

4.1.2 Calculate the change in the momentum of the ball in magnitude and direction. (5)

4.1.3 Calculate the magnitude of the force exerted by the bat on the ball. (3)

4.1.4 Modern cars use crumple zones on the front and the sides as a safety measure to reduce injuries during a collision. Explain, by using the concept of impulse, how crumple zones reduce injuries. (4)

4.2 Block **X**, of mass 2 kg, slides at 3 $m \cdot s^{-1}$ to the right and collides with a stationary block **Y**, of mass 3,5 kg. Block **X** rebounds at a velocity of 1 $m \cdot s^{-1}$ to the left.

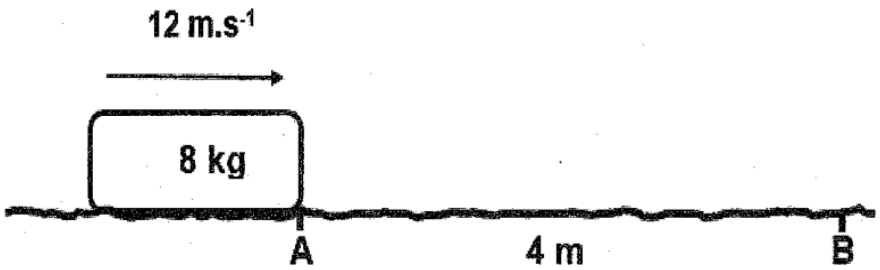
4.2.1 Write down the principle of conservation of linear momentum in words. (2)

4.2.2 Calculate the velocity of block **Y** after the collision. (5)

[21]

QUESTION 5 (Start on a new page.)

A block of mass 8 kg moves to the right over a rough horizontal surface from point **A** to point **B**. Point **B** is situated 4 m away from point **A** as shown in the diagram below. The coefficient of friction (μ_k) between the block and the surface **AB** is 0,14.



5.1 Define the term *work done* in words. (2)

5.2 Calculate:

5.2.1 The magnitude of the kinetic frictional force on the block while moving from point **A** to point **B** (3)

5.2.2 The work done by the kinetic frictional force from point **A** to point **B** (3)

5.3 What would the work done by gravitational force be equal to? (1)

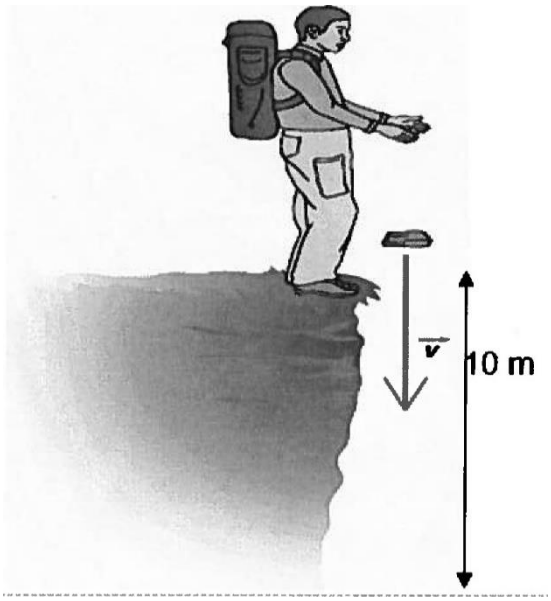
5.4 The amount of work done by a truck of mass 3 000 kg moving on a horizontal road in 30 s, is 480 000 J.

5.4.1 Define the term *power*. (2)

5.4.2 Calculate the power of the truck in horsepower. (5)
[16]

QUESTION 6 (Start on a new page.)

A hiker is standing on top of a cliff. The hiker drops a parcel with a mass of 8 kg, 10 m above the ground.



6.1 State the principle of Conservation of Mechanical Energy in words. (2)

6.2 Calculate the total mechanical energy of the parcel at the top of the cliff. (4)

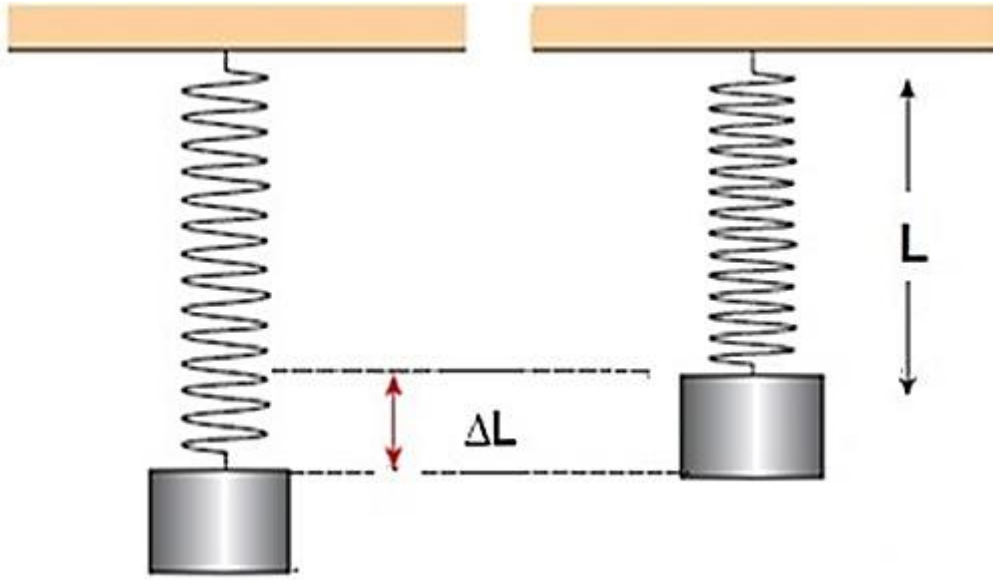
6.3 Another hiker, at the bottom of the cliff, picks up the parcel and walks 0,5 m on a horizontal surface with it.

6.3.1 Is there work done on the parcel after the second hiker has walked 0,5 m with it? Answer YES or NO. (1)

6.3.2 Explain your answer to QUESTION 6.3.1. (2)
[9]

QUESTION 7 (Start on a new page.)

A compressive force causes internal stress of 1 MPa in a SPRING made of an unknown metal. The resistance area of the round SPRING is 2×10^{-3} m^2 and its original length is 50 mm. The force causes the round SPRING to increase by 1×10^{-3} mm.



7.1 Define the term *strain* in words. (2)

7.2 State *Hooke's Law* in words. (2)

7.3 Calculate the:

7.3.1 *Force* that causes the SPRING to stretch (4)

7.3.2 *Strain* in the metal caused by the force (3)

7.3.3 *Elasticity modulus* for this metal (3)
[14]

QUESTION 8 (Start on a new page.)

The table below shows different types of motor oils and their gradings, used in different temperature regions, in different seasons.

Motor Oil	Type of Oil	Grading
A	Low viscosity	5W-30
B	High viscosity	5W-40

8.1 Define the term *viscosity*. (2)

8.2 What does 5W-30 represent on the label of a motor oil container? (2)

8.3 Use the information given in the table above to choose which motor oil (**A** or **B**) will be suitable for use in summer as compared to winter. (2)

8.4 Explain your answer to QUESTION 8.3 above in terms of viscosity and temperature. (2)

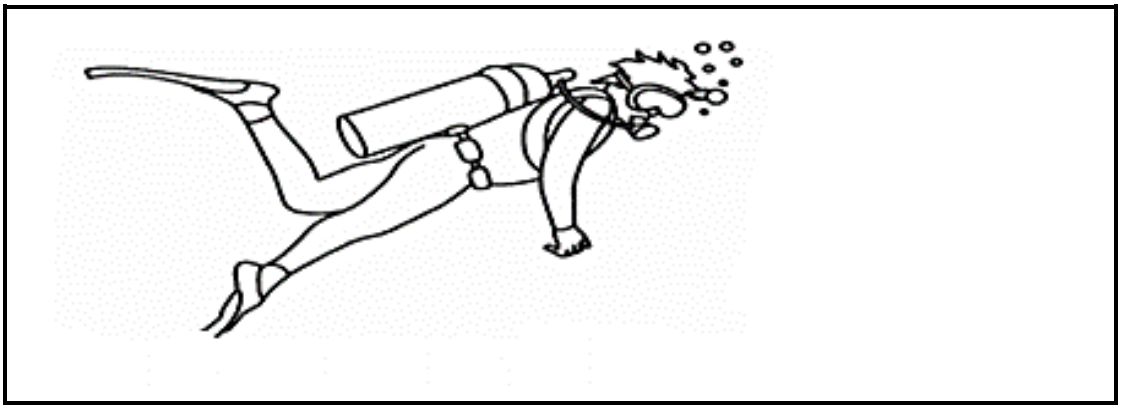
8.5 Distinguish between *single/mono-grade* and *multi-grade motor oils*. (4)
[12]

QUESTION 9 (Start on a new page.)

9.1 Explain the term *hydraulics*. (2)

9.2 Write down TWO applications of hydraulic systems. (2)

9.3 In the diagram below, a diver is seen swimming under water. The pressure acting on the diver's forehead is 1,2 x 10^5 Pa, and the surface area at the back of his head is 8,4 x 10^{-3} m^2.

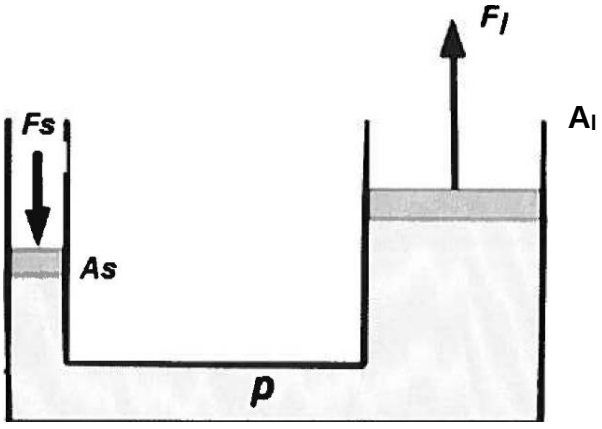


9.3.1 Define the term *pressure.* (2)

9.3.2 Calculate the magnitude of the force that acts on the diver's head. (3)

9.3.3 State the direction of the force of the water acting on the diver. (1)

9.4 The diagram below represents a simple hydraulic system that is used to lift cars. The force applied by $\mathbf{F_S}$ is 130 N downwards. The surface area of $\mathbf{A_S}$ is 0,002 m^2. The surface area of $\mathbf{A_I}$ is 0,025 m^2.

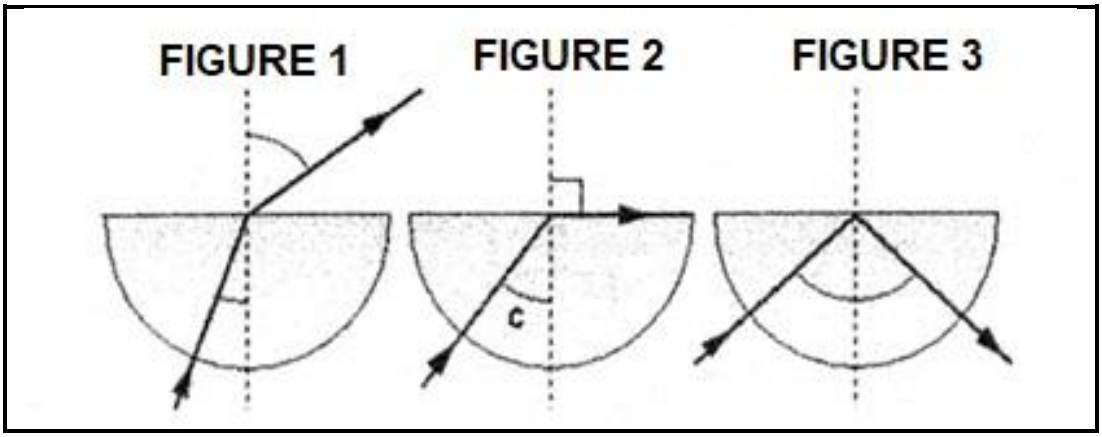


Calculate the force $\mathbf{F_I}$ due to pressure exerted by force **Fs**. (3)

[13]

QUESTION 10 (Start on a new page.)

10.1 Light moves through a semi-circular glass prism as indicated below.



10.1.1 Give ONE word that describes the phenomenon taking place in **FIGURE 1**. (1)

10.1.2 Give the name of angle C in **FIGURE 2**. (1)

10.1.3 Identify the phenomenon taking place in **FIGURE 3**. (1)

10.1.4 Give TWO conditions for the phenomenon in **FIGURE 3**. (2)

10.1.5 List THREE applications where the phenomenon in **FIGURE 3** is used in optical equipment. (3)

10.2 A radio station broadcasts an FM radio signal at 99,5 MHz.

10.2.1 Convert 99,5 MHz to Hz. (2)

10.2.2 Calculate the wavelength of this radio signal. (3)

10.2.3 The frequency of another radio station is 108 MHz.

Is the wavelength SHORTER THAN, the SAME AS or LONGER THAN the one calculated in QUESTION 10.2.2?

Give a reason for your answer. (4)

[17]

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 *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
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·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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$
Torque $= F \times r_\perp$	$MA = \frac{L}{E} = \frac{e}{l}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

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

$\sigma = \frac{F}{A}$	$\varepsilon = \frac{\Delta \ell}{L}$
$\frac{\sigma}{\varepsilon} = K$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$Q = \frac{Q_1 + Q_2}{2}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_o A}{d}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\Delta\Phi = BA$	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	