GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2024

TECHNICAL SCIENCES

(PAPER 1)

TECHNICAL SCIENCES P1

C2101E

TIME: 3 hours

MARKS: 150

12 pages + 2 data sheets

X05

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space in the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions.
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. 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 Which physical quantity is a measure of the inertia of a body?

A Force
B Mass
C Weight
D Momentum (2)

1.2 A force **F**, is applied on an object of mass **m**, and the object accelerates with the acceleration **a**. If the mass is tripled and the force remains the same, what will be the new acceleration?

A $3\mathbf{a}$
B $\frac{1}{6}\mathbf{a}$
C $\frac{1}{3}\mathbf{a}$
D $\mathbf{a}$ (2)

1.3 The rate of change of momentum is equivalent to:

A Net force
B Impulse
C Change in momentum
D Force applied (2)

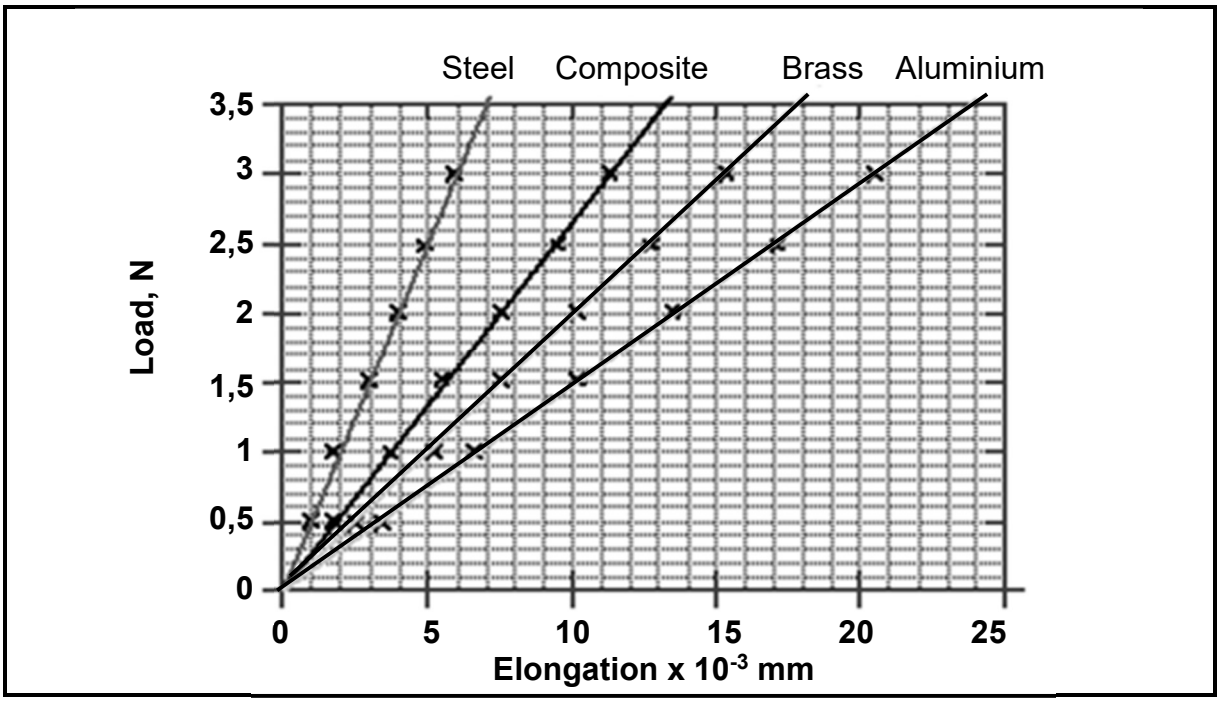
1.4 A ray of light strikes a mirror at an angle of incidence that is equal to 39°. According to the law of reflection, the angle of reflection, is …

A equal to 39°.
B greater than 39°.
C less than 39°.
D Insufficient information given. (2)

1.5 The SI unit of stress is equivalent to:

A 1 $kg \cdot m \cdot s^{-1}$.
B 1 $N \cdot m^{-2}$.
C 1 J·s.
D 1 W (2)

1.6 Consider the graph below which shows the Load versus Elongation for different materials.



Which of the following materials has the greatest modulus of elasticity?

A Aluminium
B Brass
C Composite
D Steel (2)

1.7 With a decrease in temperature, the viscosity ...

A of gases increases.
B of liquids increases.
C of liquids decreases.
D depends on the surface area of the liquid. (2)

1.8 Which of the following statements is INCORRECT?

A All liquids are generally incompressible.
B The pressure of a liquid increases with depth.
C The fluid pressure exerted by a static fluid depends only upon the depth and the density of the fluid.
D Fluid pressure only depends upon the total mass or total volume of the liquid. (2)

1.9 A block of mass 200 kg on a horizontal surface is moved by a 50 N force over a distance of 2 m. The work done by the gravitational force on the object is:

A 100 J
B –100 J
C 3 920 J
D 0 J (2)

1.10 Which of the following is CORRECT about an object falling from rest in an isolated system?

i. Kinetic energy of the object increases.
ii. Gravitational potential energy of the object increases.
iii. Mechanical energy remains the same.

A i only
B i and iii
C ii and iii
D i, ii and iii (2)

[20]

QUESTION 2 (Start on a new page.)

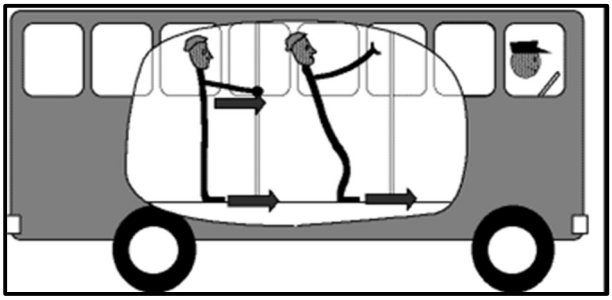
Choose a term from COLUMN B that matches the statement in COLUMN A. Write only the letter (A – E) next to the question numbers (2.1 to 2.5) in the ANSWER BOOK, e.g. 2.6 F.

COLUMN A		COLUMN B	
2.1	A field in applied sciences and engineering dealing with the mechanical properties of liquids	A	An isolated system
2.2	A system on which the net external force acting on the system is zero	B	Optic axis
2.3	The central horizontal line that passes through the centres of curvature of a lens surface	C	Perfectly elastic body
2.4	The energy that an object has because of its position relative to the surface of the Earth	D	Hydraulics
2.5	A body which regains its original shape and size completely when the deforming force is removed	E	Gravitational potential energy

[5]

QUESTION 3 (Start on a new page.)

3.1 The picture below shows a person standing inside a stationary bus. When the driver of the bus suddenly accelerates, the person falls backwards.

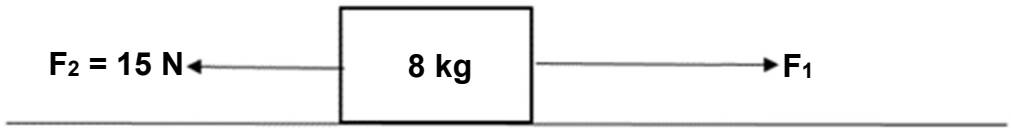


3.1.1 Which term is used to explain the resistance of an object to any change in its state of motion or rest? (1)

3.1.2 What is the relationship between mass and the concept mentioned in QUESTION 3.1.1? (2)

3.1.3 Use Newton's First Law of Motion to explain why the person falls backward. (3)

3.2 An 8 kg block is being pulled by two forces in opposite directions, $\mathbf{F_2}$ of 15 N to the left and a constant force $\mathbf{F_1}$. The block moves on a rough horizontal surface at CONSTANT VELOCITY to the right.



3.2.1 State Newton's Second Law of Motion. (2)

3.2.2 Draw a labelled free-body diagram of ALL the forces acting on the block. (5)

The coefficient of kinetic friction between the block and the surface is 0,3.

3.2.3 Write down the magnitude of the net force acting on the block. (1)

3.2.4 Calculate the frictional force acting on the block. (5)

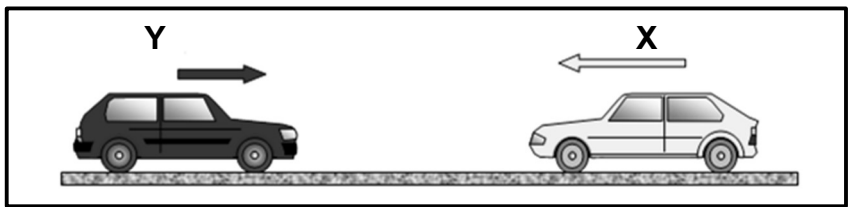
3.2.5 Calculate the magnitude of force $\mathbf{F_1}$. (3)

3.2.6 Force $\mathbf{F_1}$ is now applied at an angle θ above the horizontal. How does this influence the normal force acting on the block? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[23]

QUESTION 4 (Start on a new page.)

Two cars, **X** and **Y**, of identical mass **m** are travelling in opposite directions along the same straight line and collide head on. Initially car **X** has a velocity of 25 $m \cdot s^{-1}$ west and car **Y** has a velocity of 10 $m \cdot s^{-1}$ east. After the collision, the two cars move together.



4.1 State the principle of conservation of linear momentum in words. (2)

4.2 Calculate the velocity of the two cars after the collision. (4)

4.3 A bystander watching the collision claims that this was an inelastic collision.

Explain in words what is meant by an *inelastic collision*. Refer to momentum and energy. (2)

4.4 A truck weighing 5 000kg is moving down a steep road at 60 $km \cdot h^{-1}$ when suddenly the brakes fail. The driver loses control, and the truck hits a big pole next to the road, coming to a complete stop in 0,03 seconds.



4.4.1 Define the term *impulse*. (2)

4.4.2 Calculate the force exerted by the pole on the truck. (6)

4.4.3 What is the magnitude and direction of the force exerted by the truck on the pole? (1)

4.4.4 NAME and STATE in words Newton's law of motion used to answer QUESTION 4.4.3. (3)

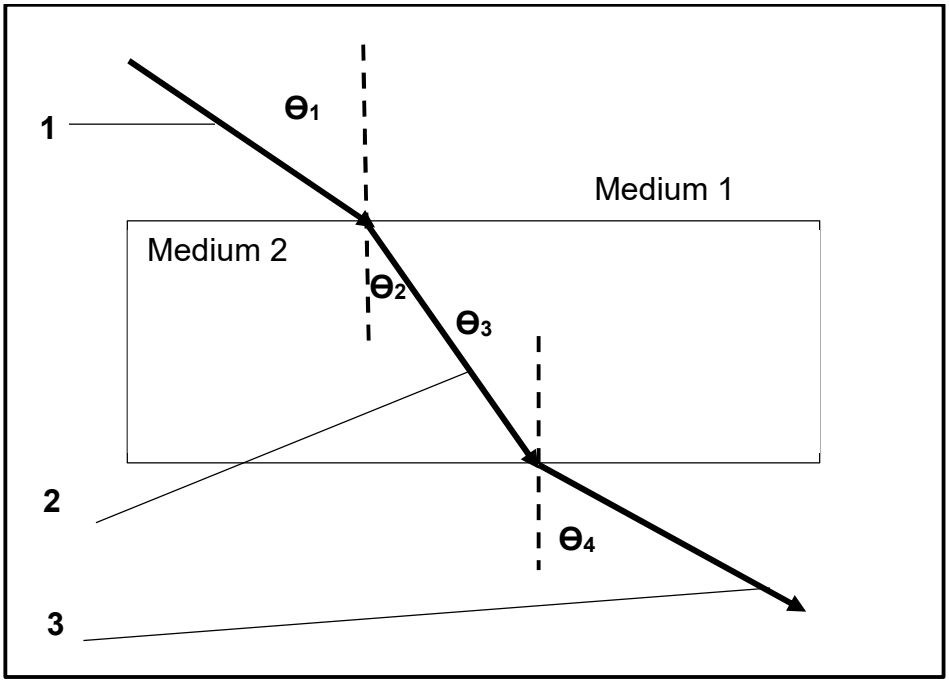
4.4.5 Explain how an inclusion of an arrestor bed on this steep road could make it safer for truck drivers. (3)

[23]

QUESTION 5 (Start on a new page.)

5.1 Define the term *refraction of a wave*. (2)

5.2 Study the ray diagram below and answer the questions that follow.

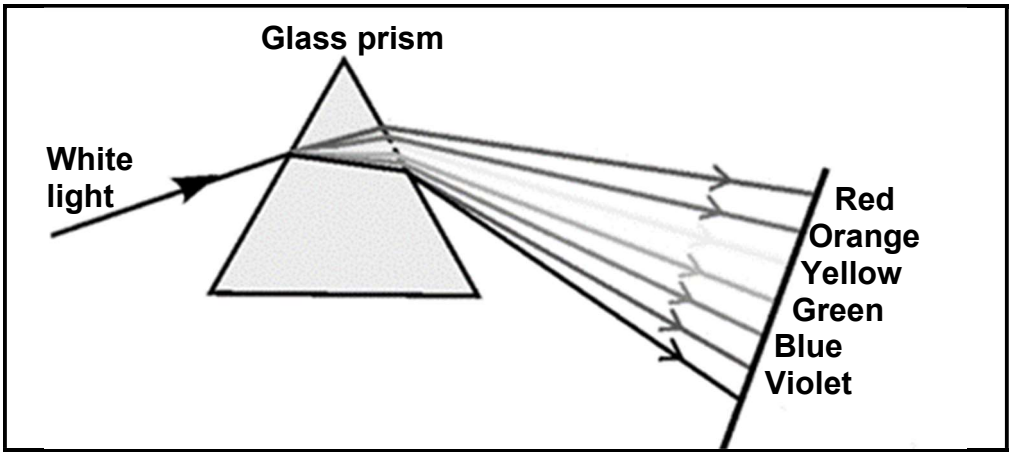


5.2.1 Write down labels for light rays numbered **1** – **3**. (3)

5.2.2 Write down the names of the angles numbered Θ_1, Θ_2 and Θ_4. (3)

5.2.3 How does the value of Θ_1 compare to that of Θ_4? Write down SMALLER THAN, EQUAL TO or GREATER THAN. (1)

5.3 The diagram below shows how the colours of a rainbow are formed when sunlight passes through a prism.



5.3.1 Name and define the physical phenomenon illustrated in the diagram above. (3)

5.3.2 Explain how the phenomenon mentioned in QUESTION 5.3.1 affects violet light and red light?

Explain why these waves are affected differently. (2)

5.4 Electromagnetic waves are formed by mutually inducing electric and magnetic fields, around a moving electric charge, that are perpendicular to each other and perpendicular to the direction of propagation of the wave.

Write down TWO properties of electromagnetic waves. (2)
[16]

QUESTION 6 (Start on a new page.)

In a building, a vertical steel beam with a square cross-sectional area supports a load of 4×10^4 N. The length of the beam is 4 m and the side of the cross-sectional area is $54{,}78 \times 10^{-3}$ m.

6.1 Define the term *elastic limit*. (2)

6.2 Calculate the stress within the steel beam. (5)

6.3 Young's modulus for steel is 2×10^{11} Pa. Calculate the (compressive) strain in the beam. (3)

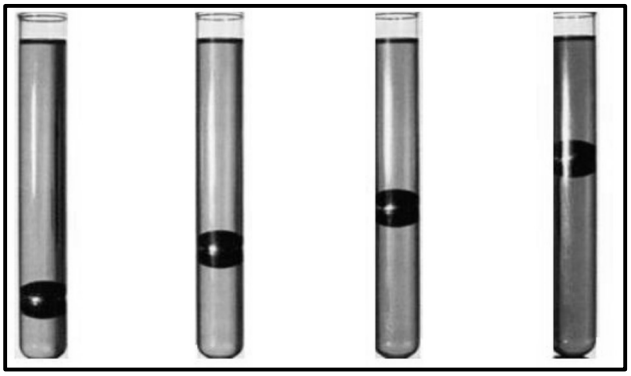
6.4 If the ultimate stress of steel is $5{,}0 \times 10^8$ Pa, calculate the maximum mass that the beam can support. (5)
[15]

QUESTION 7 (Start on a new page.)

7.1 Define the *thrust* of a liquid. (2)

7.2 Explain how extreme cold weather affects the viscosity of monograde oil. (2)

7.3 Steel balls of equal masses are dropped into test tubes with motor oils of different viscosities at the same time. Which one of the following has the lowest viscosity? Explain your answer. (3)



Test tube A | Test tube B | Test tube C | Test tube D

7.4 Study the picture of the can of engine oil below and answer the questions that follow.



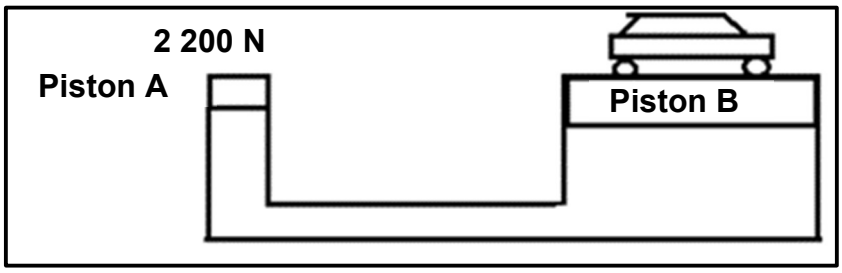
7.4.1 For what does the W in 20W/50 stand? (1)

7.4.2 Interpret the meaning of the grading 20W50 SAE on the can of engine oil. (2)

[10]

QUESTION 8 (Start on a new page.)

A hydraulic system is used to lift a vehicle of mass **m** in an auto garage. The vehicle sits on a piston **B** of area 0,5 m^2, and a force of 2 200 N is applied to a piston **A** of area 0,03 m^2.



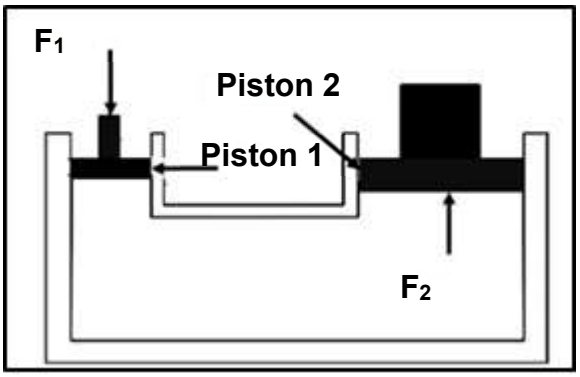
8.1 State Pascal's law in words. (2)

8.2 Calculate the force applied to lift the vehicle. (3)

8.3 List TWO uses of hydraulic lifts in technology. (2)

8.4 What property of fluids makes it possible for the hydraulic lift to operate? (1)

8.5 The diagram below shows a hydraulic system. A force of 300 N, F_1, is exerted on piston 1 with a radius of 20 mm. Piston **2** has an area of 2,83 x 10^{-3} m^2.



8.5.1 Calculate the radius of **piston 2**. (3)

8.5.2 If the distance between piston 1 and piston 2 is increased, how would it affect the answer to QUESTION 8.5.1? Write only INCREASE, DECREASE or STAY THE SAME. (1)

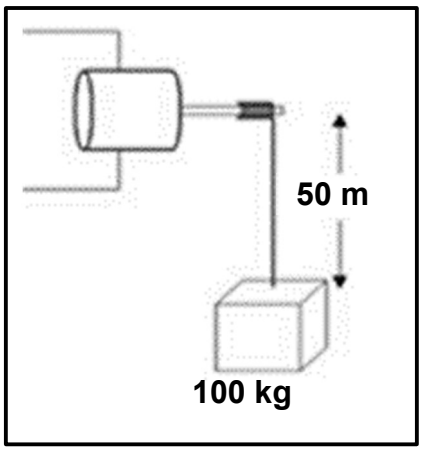
8.6 The pressure of a dam which is 5 m deep, is 49 000 Pa.

Determine the change in pressure from 5 m to the bottom of the dam if the dam is 20 m deep. Take the density of water as 1 000 kg·m^{-3}. (5)

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QUESTION 9 (Start on a new page.)

An electric motor lifts a 100 kg mass vertically upwards to a height of 50 m, at a constant speed of 8 $m \cdot s^{-1}$.



9.1 Define *work done*. (2)

9.2 Draw a force diagram representing all the forces acting on the mass while it moves upwards. (2)

9.3 Calculate the work done to lift the 100 kg mass upwards. (3)

9.4 The motor malfunctions and stops, while the mass is halfway through the movement. The cable breaks and the mass falls to the ground. Ignore the effects of air resistance.

9.4.1 State the principle of conservation of mechanical energy. (2)

9.4.2 Calculate the gravitational potential energy gained by the mass when the motor malfunctions and stops working. (3)

9.4.3 Calculate the velocity with which the mass hits the ground. (4)

9.5 Calculate the average power generated by the motor while it was working, in horsepower. (5)

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TOTAL: 150

DATA FOR TECHNICAL SCIENCES GRADE 12
JUNE EXAMINATION

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
JUNIE EKSAMEN

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} $J \cdot s$
Standard pressure *Standaarddruk*	p°	1,01 x 10^5 Pa
Standard temperature *Standaardtemperatuur*	T°	273 K
Permittivity of free space *Permittiwiteit van vrye spasie*	ε_o	8,85 $\times 10^{-12}$ $F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

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

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* $E_k = \frac{1}{2}mv^2$	$\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$M_E = E_k + E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemiddeld} = Fv_{gemiddeld}$	

ELASTICITY, VISCOSITY & HYDRAULICS
ELASTISITEIT, VISKOSITEIT & HIDROULIKA

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

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

$v = f\lambda$	$T = \frac{1}{f}$
$E = hf$ or/*of* $E = h\frac{c}{\lambda}$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{\kappa \varepsilon_o A}{d}$ and/*en* $C = \frac{\varepsilon_o A}{d}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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