GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2023

11101

TECHNICAL SCIENCES

(PAPER 1)

TIME: 3 hours

MARKS: 150

13 pages + 3 data sheets

11101E

X05

INSTRUCTIONS AND INFORMATION

1. Write your name in 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 subsections, 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, et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter (A – D) next to the question numbers (1.1 to 1.10) in your ANSWER BOOK.

1.1 The force that the Earth exerts on any object on or near its surface is called ...

A normal force.
B applied force.
C gravitational force.
D tension force. (2)

1.2 When a car moves at a constant velocity, the resultant force acting on the body is zero. This phenomenon is best explained by ...

A Newton's First Law.
B Newton's Second Law.
C Newton's Third Law.
D gravitational acceleration. (2)

1.3 The net force exerted on an object is equal to the ...

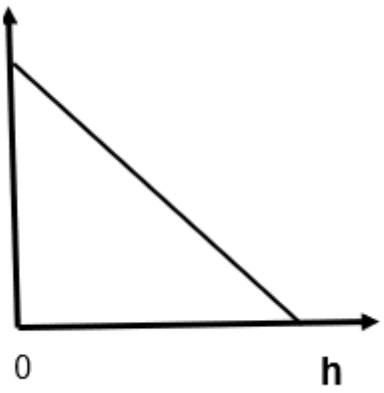
A rate of change in velocity.
B rate of change in momentum.
C impulse exerted on the object.
D change in momentum of the object. (2)

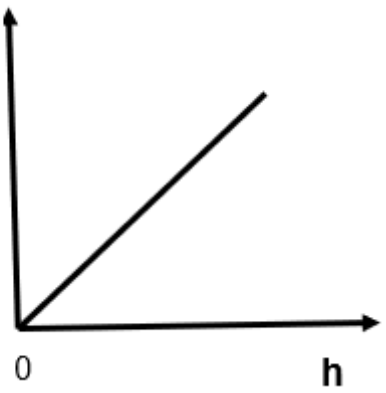
1.4 Which of the following is the unit of impulse?

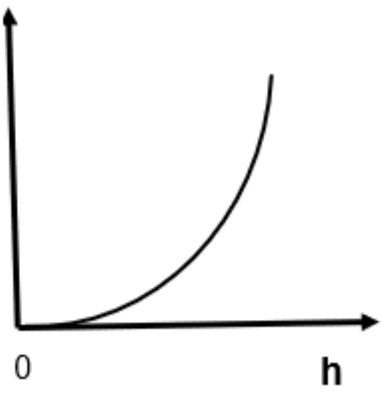
A Ampere (A)
B Coulomb (C)
C Newton-second (N·s)
D Newton (N) (2)

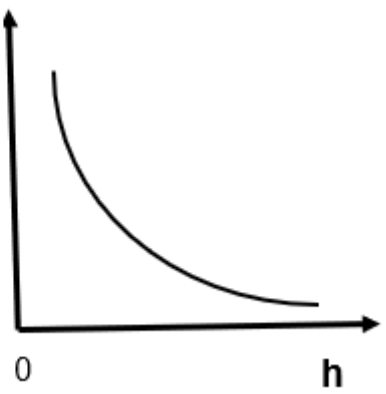
1.5 An object is dropped from a height, **h**, above ground level. Ignore the effects of air resistance.

Which of the following graphs BEST represents the relationship between its kinetic energy, **K** and its height, **h** above ground level?

A 

B 

C 

D 

(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 The device that can convert electrical energy to mechanical energy is called a ...

A dynamo.
B alternator.
C electric motor.
D generator. (2)

1.8 Consider the following four variables:

(i) Current between plates
(ii) Distance between plates
(iii) Type of dielectric material
(iv) Total surface area of plates

Which of these factors affects the capacitance of a capacitor?

A (iii), (ii) & (i)
B (iv), (iii) & (ii)
C (iv), (ii) & (i)
D (iv), (iii) & (i) (2)

1.9 Which of the following terms BEST explains why a pencil in a glass of water appears to be cut in half?

A Reflection
B Interference
C Diffraction
D Refraction (2)

1.10 The period of a wave is the:

A Number of completed waves that passes a point in one second
B Time it takes for one wave to travel past a point
C Distance the wave travels in one second
D Number of times the wave is repeated in one second (2)

[20]

QUESTION 2: MATCHING ITEMS

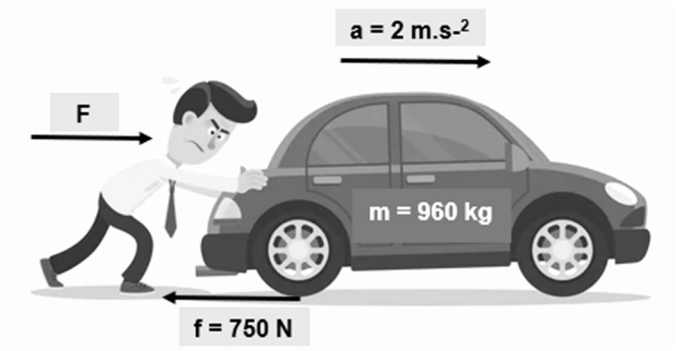
Match the terms in COLUMN B with the descriptions in COLUMN A. Write only the letter (A – H) next to the question numbers (2.1 to 2.8) in the ANSWER BOOK, e.g. 2.9 I

COLUMN A		COLUMN B	
2.1	The perpendicular force exerted by a surface on an object that lies on that surface	A	Kinetic energy
2.2	The product of the mass of an object and its velocity	B	Dielectrics
2.3	The energy of an object due to its motion	C	Focal point
2.4	A body that does not show a tendency to regain its original shape and size when the deforming force is removed	D	Normal force
2.5	The capacitor comprises two plates separated by material	E	Electromagnetic induction
2.6	The rate of flow of charge	F	Perfectly plastic body
2.7	The point in space where parallel light rays meet after passing through the lense	G	Current
2.8	The production of an electromotive force (emf) or voltage across an electrical conductor due to relative motion between the conductor and magnetic field	H	Momentum

(8 x 1) **[8]**

QUESTION 3 (Start on the new page.)

3.1 In the diagram below a learner is pushing the car of 960 kg mass, with force **F** on a rough surface with the acceleration of 2 $m \cdot s^{-2}$. The frictional force between the car's tyres and the surface is 750 N.



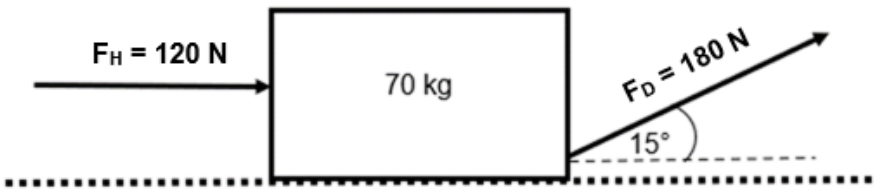
3.1.1 Define the term *frictional force*. (2)

3.1.2 Draw the free-body diagram of ALL the forces acting on the car. (4)

3.1.3 Calculate the applied force exerted by the learner on the car. (4)

3.1.4 Calculate the weight of the car. (2)

3.2 Two learners are helping each other to move a big box of 70 kg mass from one corner of the room to the other corner. One of the learners is pushing the box with force $\mathbf{F_H}$ of 120 N and the other learner is pulling the same box with a diagonal force $\mathbf{F_D}$ of 180 N at an angle of 15° to the horizontal surface. The box experiences the kinetic frictional force of 100 N across the flow.



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

3.2.2 From the diagram above, how many forces are acting on the object in total? (1)

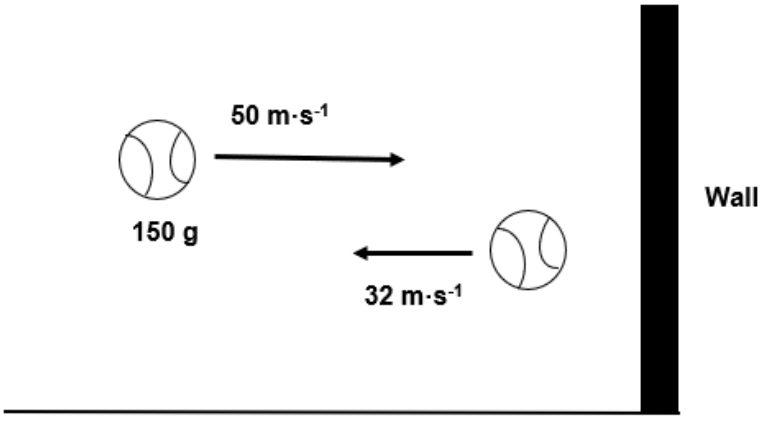
3.2.3 Calculate the acceleration of the box. (4)

3.2.4 If the angle of the force $\mathbf{F_D}$ increases, what will happen to the kinetic frictional force? Write only INCREASES, DECREASES OR REMAINS THE SAME. (1)

[20]

QUESTION 4 (Start on the new page.)

4.1 A ball of mass 150 g is thrown against a wall at a velocity of 50 $m \cdot s^{-1}$. The ball bounces back towards the hand of the thrower at a velocity of 32 $m \cdot s^{-1}$ as illustrated in the diagram below.



4.1.1 Define the term *impulse*. (2)

4.1.2 Convert the mass of the ball from grams to kilograms (kg). (2)

4.1.3 Will the net force exerted by the ball on the wall INCREASE, DECREASE or REMAIN THE SAME if the time of contact between the ball and the wall increases? (1)

4.1.4 Calculate the net force exerted by the wall on the ball if the contact time between the wall and the ball is 0,012 s. (4)

4.2 Modern vehicles use airbags as a protection system to reduce the risk of death or injury during a collision. These airbags inflate at the moment of collision to reduce the risk of death or injury.



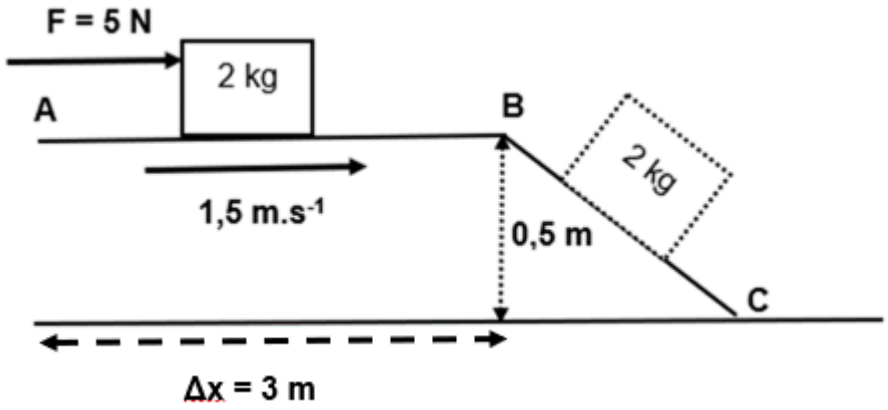
4.2.1 Use momentum principles to explain how airbags serve as a protection system against injuries. (2)

4.2.2 How will the increased change in velocity of the car affect the impulse of the car? (2)

[13]

QUESTION 5 (Start on the new page.)

A 2 kg crate is at rest on a frictionless horizontal surface. The crate is then pushed by a constant force **F** of magnitude 5 N to the right. The crate moves at a constant velocity of 1,5 $m \cdot s^{-1}$ on the horizontal surface to cover the distance of 3 m from point **A** to point **B**. When the force is removed at point **B**, the crate slides down the slope from a height of 0,5 m to point **C** at the ground. Ignore the effects of friction. Consider the diagram below and answer the questions that follow.



5.1 Define the term *work*. (2)

5.2 Calculate the net work done on the crate as it moves from point **A** to point **B**. (3)

5.3 Consider the motion from point **B** to point **C** on the ground.

5.3.1 State the *principle of conservation of mechanical energy* in words. (2)

5.3.2 Calculate the kinetic energy of the crate at point **B**. (3)

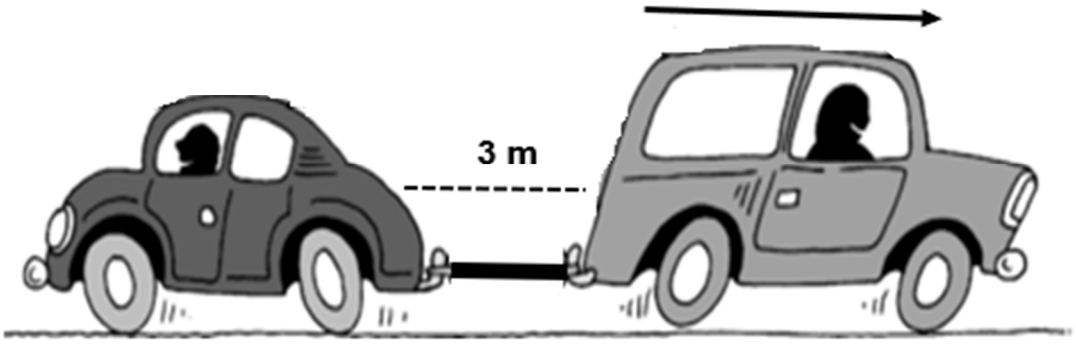
5.3.3 Calculate the gravitational potential energy of the crate at point **B**. (3)

5.3.4 Use the principle of conservation of mechanical energy to calculate the speed at which the crate hits the ground. (5)

[18]

QUESTION 6 (Start on a new page.)

6.1 A minicar and an SUV are connected to each other with a solid steel rod. The solid steel rod is 3 m long and has a radius of 0,03 m. The SUV pulls with a force of 6 000 N to stretch the solid steel rod by 0,01 m to the right.



6.1.1 Define the term *deforming force*. (2)

6.1.2 Calculate the cross circle area of the solid steel rod. (3)

6.1.3 Calculate the stress experienced by the solid steel rod. (3)

6.1.4 Calculate the strain experienced by the solid steel rod. (3)

6.1.5 State Hooke's Law in words. (2)

6.1.6 Calculate the Young's modulus of elasticity for the solid steel rod. (4)

6.2 When the temperature of a fluid increases, its viscosity decreases. Liquids that are used as lubricating fluids and for several other applications must be selected correctly in relation to operating temperatures. The diagram below shows two different engine oils of different grades.



6.2.1 Define the term *viscocity*. (2)

6.2.2 Which of the two oils shown in the diagram above will thicken more in cold weather? (1)

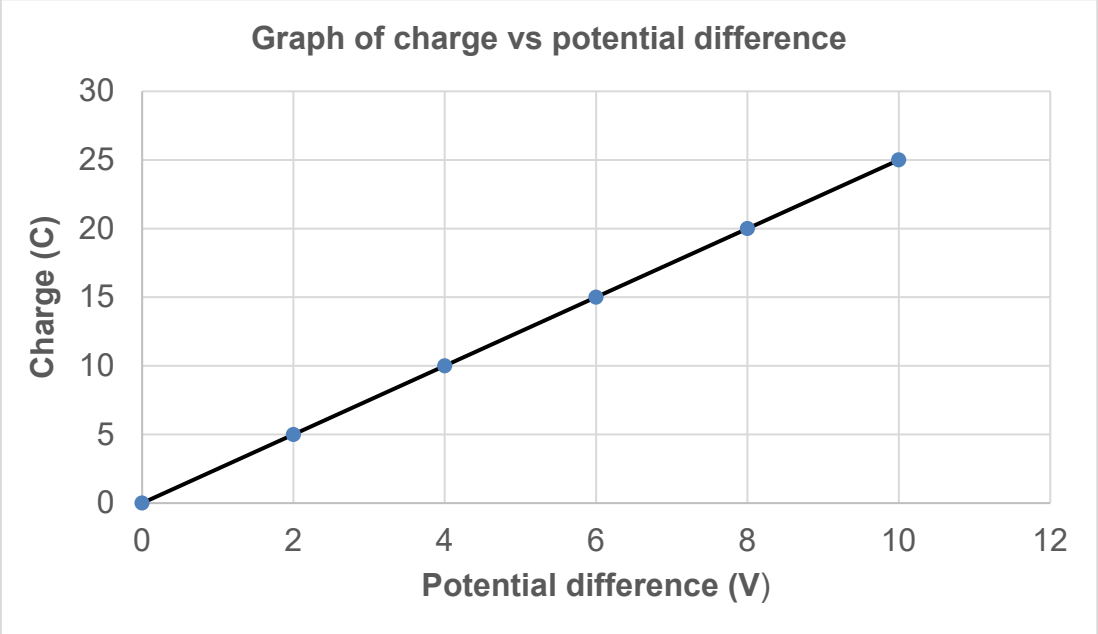
6.2.3 Give a reason for your answer in QUESTION 6.2.2. (1)

6.2.4 Which oil can be used during winter, and for cars in cooler regions to keep the engine functioning optimally? (1)

6.2.5 State ONE function of motor oil. (1)
[23]

QUESTION 7 (Start on a new page.)

The graph below represents the results of an experiment that was conducted by a learner using a capacitor. The learner measures the charge stored in the different potential differences.



7.1 Define the term *capacitance*. (2)

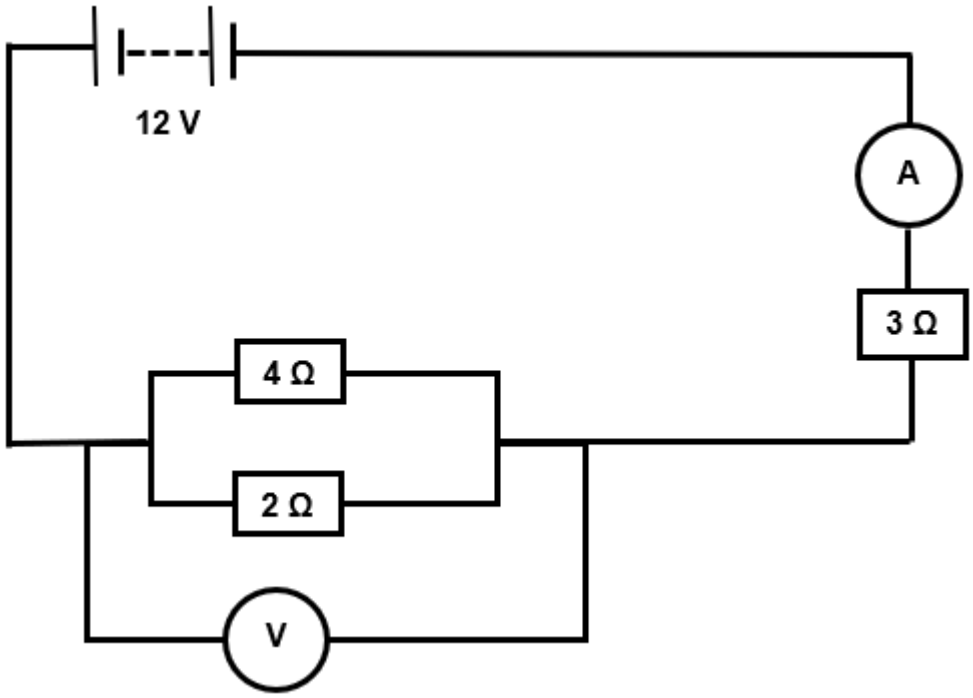
7.2 Use the results on the graph to calculate the capacitance of the capacitor in this experiment. (3)

7.3 What is the relationship between the charge and the potential difference in this experiment? (2)

7.4 Give TWO examples of capacitors that are used in technology. (2)
[9]

QUESTION 8 (Start on a new page.)

In the circuit diagram below, the battery has an emf of 12 V. Ignore the internal resistance of the battery.



8.1 State Ohm's Law in words. (2)

8.2 Calculate the:

8.2.1 Total resistance of the circuit (4)

8.2.2 The reading on the ammeter (3)

8.2.3 The reading on the voltmeter (3)

8.2.4 The power in the 3 Ω resistor (4)

8.3 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 3 Ω resistor is removed? Give a reason for your answer. (2)

[18]

QUESTION 9 (Start on a new page.)

When a surface is shiny and smooth, like a mirror, light will be reflected.

9.1 Draw a ray diagram and indicate the following labels:

- Angle of incidence
- Angle of reflection
- Normal
- Incident ray
- Reflection ray
- Mirror (5)

9.2 Define the term *critical angle*. (2)

9.3 Define the term *dispersion*. (2)

9.4 How are the wavelength, frequency and speed of light affected as light travels from air to water? (3)

[12]

QUESTION 10 (Start on a new page.)

In Physics, electromagnetic radiation refers to the waves of the electromagnetic field propagating through space-time carrying electromagnetic radiant energy.

10.1 Define an *electromagnetic wave*. (2)

10.2 Name FOUR properties of electromagnetic waves. (4)

10.3 Explain where in the medical world we use electromagnetic waves. (1)

10.4 Explain the use of the waves as mentioned in QUESTION 10.3. (2)

[9]

TOTAL: 150

END

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 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasie konstante*	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 Earth *Massa van Aarde*	M	5,98 x 10^{24} kg
Radius of Earth *Radius van Aarde*	R_E	6,38 x 10^3 km

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*

$F_{net} = ma$	$p = mv$
$\mu_k = \frac{f_k}{N}$	$\mu_s = \frac{f_{s(max/maks)}}{N}$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P_{av} = Fv_{av}$ $P_{gemid} = Fv_{gemid}$
$P = \frac{W}{\Delta t}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\,\Delta t$
W = Vq W = VI Δ 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*

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