education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

SEPTEMBER 2019

MARKS: 150

TIME: 3 HOURS

This question paper consists of 14 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of 10 questions. Answer ALL 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket 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 where applicable.

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

12. Write neatly and legibly.

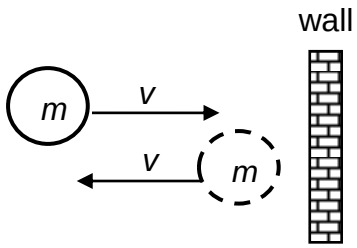
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write down only the letter (A–D) next to the question number (1.1–1.10) in your ANSWER BOOK, for example 1.11 D.

1.1 Which one of the following quantities is a measure of the *inertia* of a body?

A mass
B net force
C velocity
D impulse (2)

1.2 A ball of mass *m* strikes a wall perpendicularly at a speed *v*. The ball bounces back with the same speed **v**, as shown in the diagram below.

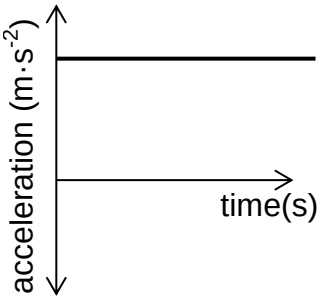


The magnitude of the change in momentum of the ball is …

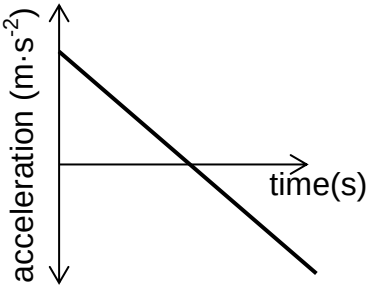
A 0.
B mv.
C 2mv.
D 3mv. (2)

1.3 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following acceleration-versus-time graphs best represents the complete motion of the stone? Ignore the effects of air resistance.

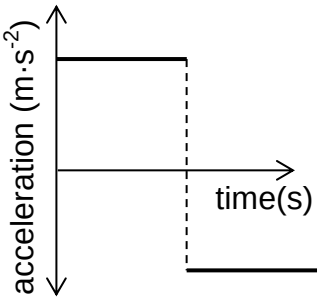
A



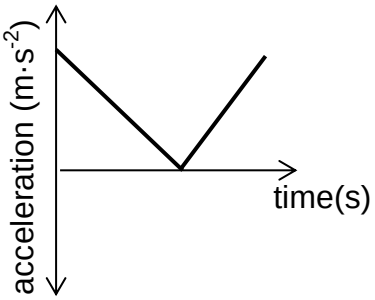
B



C



D



(2)

1.4 An object moving at a constant velocity suddenly encounters a rough horizontal surface. The object continues to move over this rough surface.

The net work done on the object during the motion over the rough surface is …

A zero.

B positive.

C negative.

D constant. (2)

1.5 A ball is dropped from a height *h*. After falling a distance *x*, the kinetic energy of the ball will be …

A mg*(h + x).*

B mg*(h – x).*

C mg*x.*

D $\frac{mgh}{2}$. (2)

1.6 The Doppler effect is observed …

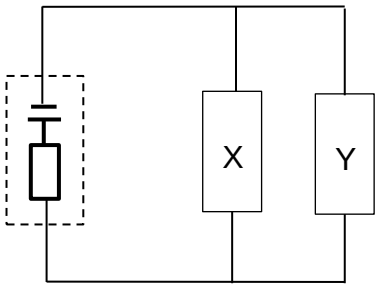
A only with sound waves.

B only with light waves.

C with both sound and light waves.

D neither with light nor sound waves. (2)

1.7 In the circuit below the resistance of Y is twice that of X.



If the power dissipated in X is *P*, then the power dissipated in Y will be …

A $\frac{P}{4}$.

B $\frac{P}{2}$.

C $2P$.

D $4P$. (2)

1.8 Two charged spheres on insulating stands carrying charges Q_1 and Q_2 are kept a distance *r* apart.

Each sphere exerts an electrostatic force of magnitude *F* on the other. The distance between the spheres is now DOUBLED and the charge on one sphere is HALVED. The magnitude of the new electrostatic force on a sphere is …

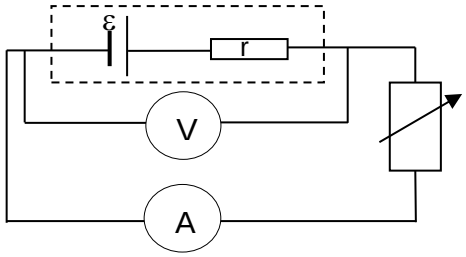
A F.

B $\frac{F}{2}$.

C $\frac{F}{4}$.

D $\frac{F}{8}$. (2)

1.9 In the circuit shown below, a variable resistor is used.



The resistance of the variable resistor is *decreased*. Which ONE of the following combinations of changes will occur in the voltmeter and ammeter readings?

	Voltmeter reading	**Ammeter reading**
A	Unchanged	Unchanged
B	Decreases	Increases
C	Decreases	Unchanged
D	Increases	Increases

(2)

1.10 The wavelength of a monochromatic light source **P** is half that of a monochromatic light source **Q**. The energy of a photon from source **P** is E.

What will be the energy of a photon from source **Q**?

A $\frac{E}{4}$

B $\frac{E}{2}$

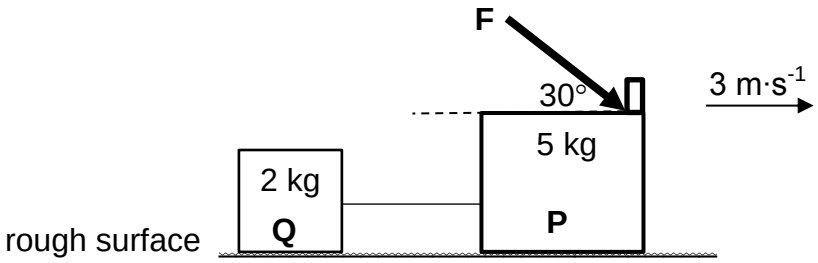
C E

D 2E (2)

[20]

QUESTION 2 (Start on a new page.)

Two blocks, **P** and **Q**, resting on a rough horizontal surface, are connected by a light inextensible string. The blocks have masses 5 kg and 2 kg respectively. A constant force **F**, acting at an angle of 30° to the horizontal, is applied to the 5 kg block, as shown below.



The two blocks now move to the *right* at a CONSTANT SPEED of 3 m·s^{-1}.

2.1 State Newton's First Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram for block **P**. (5)

Block **P** and **Q** experience constant frictional forces of 2,5 N and 1 N respectively.

2.3 Calculate the magnitude of force **F**. (6)

The string connecting **P** and **Q** suddenly breaks while force **F** is still being applied.

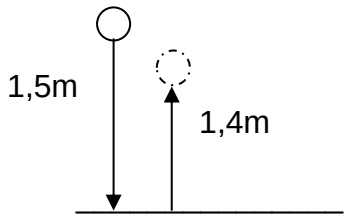
2.4 Is the direction of the acceleration of block **Q** now towards LEFT or RIGHT? Explain your answer. (3)

2.5 How will the net force acting on the block **P** be affected. Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[17]

QUESTION 3 (Start on a new page.)

A ball of mass 0,5 kg that is dropped onto a hard floor from a height of 1,5 m rebounds vertically to a height of 1,40 m. Ignore the effects of friction.



Here the ball is considered as a projectile.

3.1 Explain the term *projectile*. (2)

3.2 Calculate the speed of the ball when it makes contact with the floor after it has been dropped. (3)

3.3 Write down the magnitude and direction of the acceleration of the ball while moving upwards after it has bounced from the floor. (2)

3.4 Is the collision of the ball with the floor elastic or inelastic? (1)

3.5 Calculate the change in kinetic energy of the ball due to collision with the floor. (4)

3.6 Draw a velocity-time graph for the motion of the ball from the moment it is dropped till it reaches the maximum height of 1,4 m after it has bounced.

On the graph indicate the velocity with which the ball makes contact with the floor. (3)

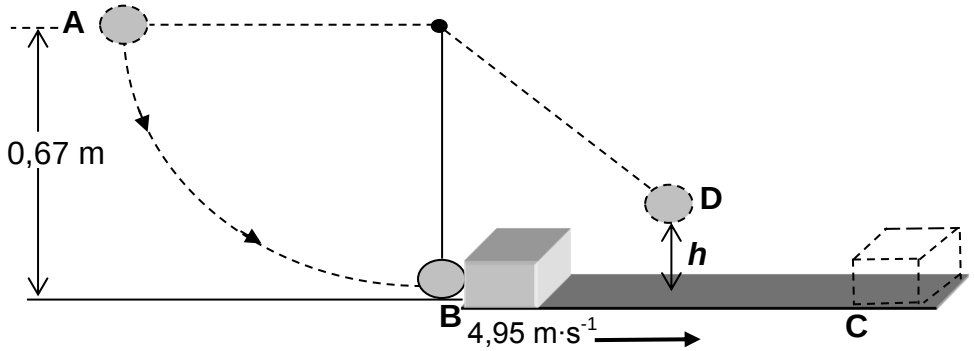
[15]

QUESTION 4 (Start on a new page.)

The diagram below shows a steel ball of mass 5 kg, suspended from a string of negligible mass released from rest at point **A** 0,67 m from its lowest point, **B**. As the steel ball swings through its lowest position at point **B**, it collides with a stationary block of mass 2 kg.

Immediately after the collision, the block moves to the right with a velocity of 4,95 m·s^{-1} on frictionless track **BC**.

Ignore frictional effects and assume no loss of mechanical energy occurs during the collision.



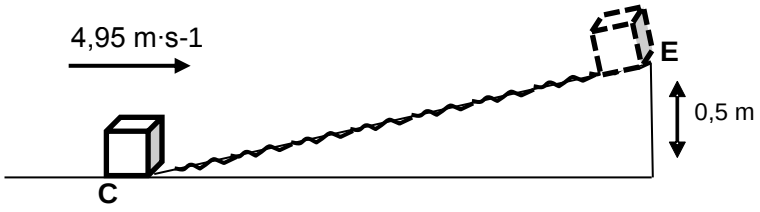
4.1 Explain what is meant by *isolated system*. (2)

4.2 Calculate the velocity of the steel ball immediately after collision. (7)

4.3 Calculate the maximum height, ***h***, the steel ball reached at point **D** after collision. (5)

4.4 Give a reason why the ball is NOT reaching its original height of 0,67 m. (2)

The block moves from point **C** at a speed of 4,95 m·s^{-1} up a rough inclined plane to point **E** which is 0,5 m above the horizontal as shown in the diagram below.



4.5 State *work-energy theorem* in words. (2)

4.6 The block reaches point **E** with a speed of 2 m·s^{-1}. Use energy principles to calculate the work done by the frictional force when the 2 kg block moves from point **C** to point **E**. (4)

[22]

QUESTION 5 (Start on a new page.)

A police car is travelling down a road at a constant speed of 16 $m \cdot s^{-1}$, emits sound waves from its siren. A man sitting on the side of the road with a detector which registers sound waves at a frequency of 440,74 Hz as the police car *approaches* him.

After passing him and moving *away* at the same constant speed, sound waves of frequency 401,12 Hz are registered.

5.1 State the Doppler effect in words. (2)

5.2 Calculate the:

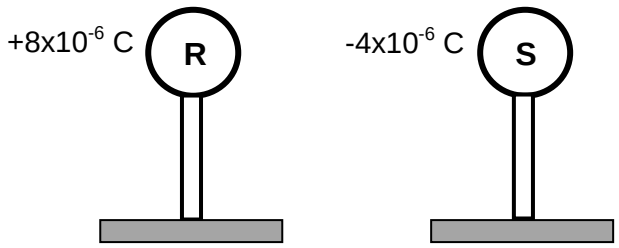
5.2.1 Speed of the sound waves. (6)

5.2.2 Frequency at which the siren emits the sound waves. (2)

[10]

QUESTION 6 (Start on a new page.)

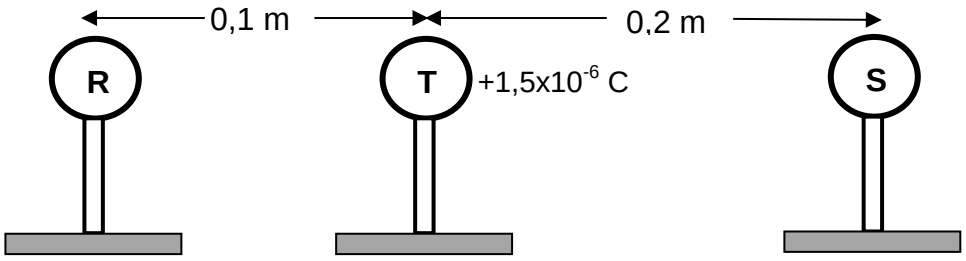
The diagram below shows two small identical metal spheres, **R** and **S**, each placed on isolated stands. Spheres **R** and **S** carry charges of $+8x10^{-6}$ C and $-4x10^{-6}$ C respectively.



Spheres **R** and **S** are brought into contact for a while and then separated by a small distance.

6.1 Calculate the net charge on each of the spheres. (2)

After R and S have been in contact and separated, a third sphere, **T**, of charge + $1,5x10^{-6}$ C is now placed between them as shown in the diagram below.

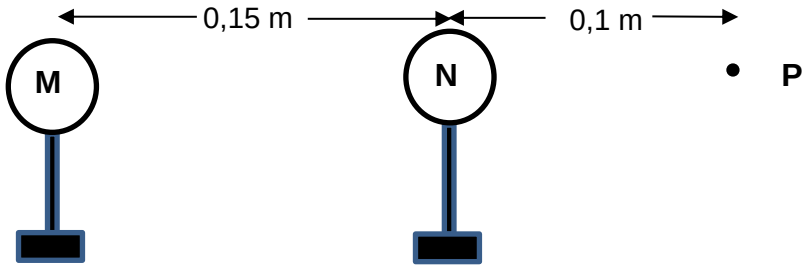


6.2 Draw a free-body diagram showing the electrostatic forces experienced by sphere **T** due to spheres **R** and **S**. (2)

6.3 Calculate the net electrostatic force experienced by sphere **T** due to spheres **R** and **S**. (6)
[10]

QUESTION 7 (Start on a new page.)

Two charged spheres, **M** and **N**, on insulating stands are separated by a distance of 0,15 m. Charge on sphere **M** is $+6 \times 10^{-12}$ C and sphere **N** carries 5×10^{6} excess electrons. **P** is a point 0,1 m to the right of sphere **N** as shown below.



7.1 Calculate the charge on sphere **N.** (3)

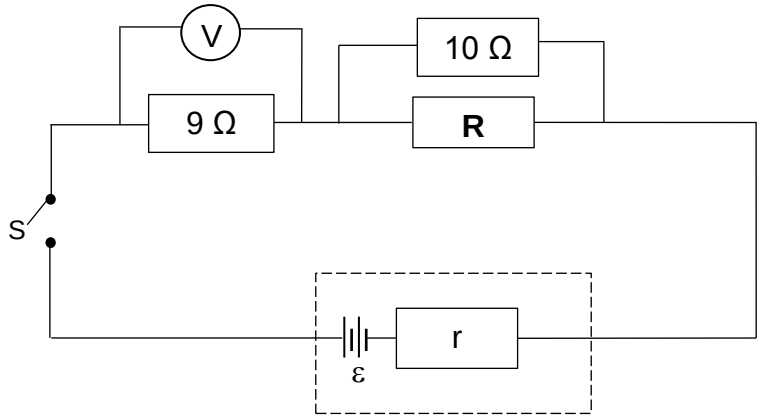
7.2 Define the electric field at a point. (2)

7.3 Draw the electric field pattern due to the charged spheres **M** and **N**. (3)

7.4 Calculate the magnitude of the net electric field a point **P**. (5)
[13]

QUESTION 8 (Start on a new page.)

In the circuit below the battery can supply a maximum of 12 J of energy per 1 coulomb of charge. The resistances of the connecting wires are negligible. The internal resistance of EACH CELL in the battery is 0,2 Ω.



8.1 State *Ohm's law* in words. (2)

8.2 Give the phrase for the underlined words. (1)

Switch **S** is now closed. The voltmeter measures 6,75 V.

8.3 Calculate the:

8.3.1 Current in the battery. (3)

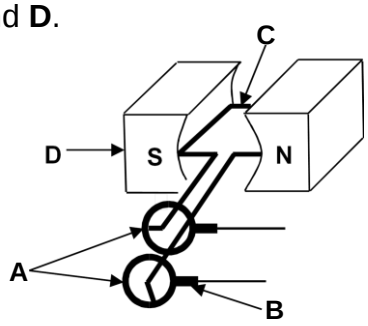
8.3.2 Resistance of resistor **R**. (7)

8.4 It is very common to connect many appliances to a multiplug which results in overheating. Modern multiplugs have a cut-off switch built in to avoid this overheating.

Use the knowledge of parallel circuits, explain why this cut-off switch is important. (3)
[16]

QUESTION 9 (Start on a new page.)

A simplified AC generator is shown in the diagram below. The main components are labelled **A**, **B**, **C** and **D**.



9.1 Name the principle on which the generator operates. (1)

9.2 Write down the NAME of the component labelled:

9.2.1 **A** (1)

9.2.2 **B** (1)

9.3 Will the induced emf be a MAXIMUM or a MINIMUM as component **C** is in position shown above? (1)

9.4 An AC supply is connected to a light bulb. The light bulb lights up with the same brightness as it does when connected to a 15 V battery.

9.4.1 Write down the rms voltage of the AC supply. (1)

9.4.2 If the power rating of the bulb is 60 W, calculate the peak current through the light bulb. (5)

9.5 AC generators can be converted into DC generator.

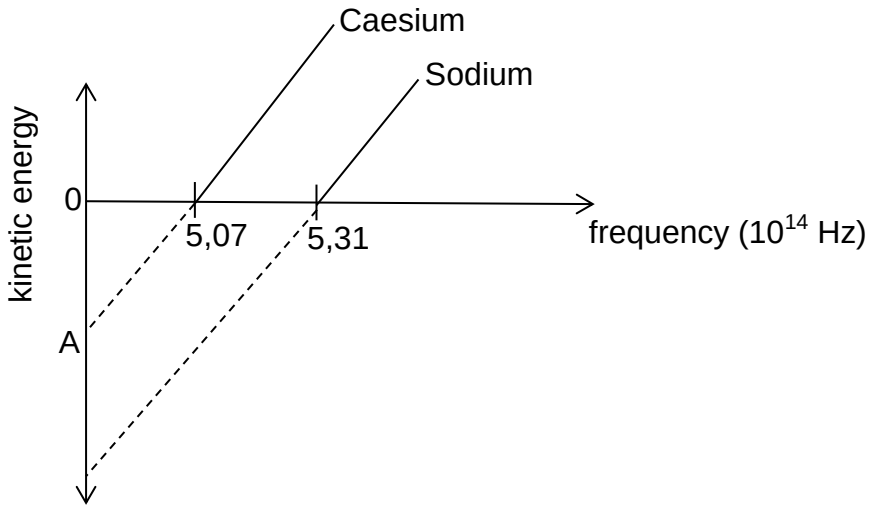
9.5.1 Name the component needed to effect the above conversion. (1)

9.5.2 Sketch an induced emf versus time graph for a DC generator for one complete rotation of component **C**. (2)

[13]

QUESTION 10 (Start on a new page.)

In an experiment, light of different frequencies is shone onto two photocells, one with caesium cathode and the other one with sodium cathode. The sketch graph of frequency versus kinetic energy of the emitted electrons is shown below.



10.1 Define the term *threshold frequency (cut-off frequency)*. (2)

10.2 Which photocell will, for the same frequency of light, emit photoelectrons of higher kinetic energy? Choose from caesium or sodium. (1)

10.3 Name the energy value shown as **A**. (1)

10.4 Write down the name of the quantity represented by the gradient of this graph. (1)

For a certain frequency of light, the maximum kinetic energy of a photoelectron from sodium cathode is $2,03 \times 10^{-19}$ J.

10.5 Calculate the wavelength of the light used. (5)

10.6 What influence will the following changes in the incident light have on the maximum kinetic energy of the photo electrons emitted?
Choose from INCREASES, DECREASES or STAYS THE SAME.

10.6.1 An increase in the wavelength of light used. Give a reason for your answer. (2)

10.6.2 An increase in the intensity of light used. Give a reason for your answer. (2)

[14]

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GGEWENS 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 *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-1}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^{6}\ m$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$

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*

$F_{net} = ma$	$p = mv$
$f_s^{\ max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$
	$P_{ave} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$