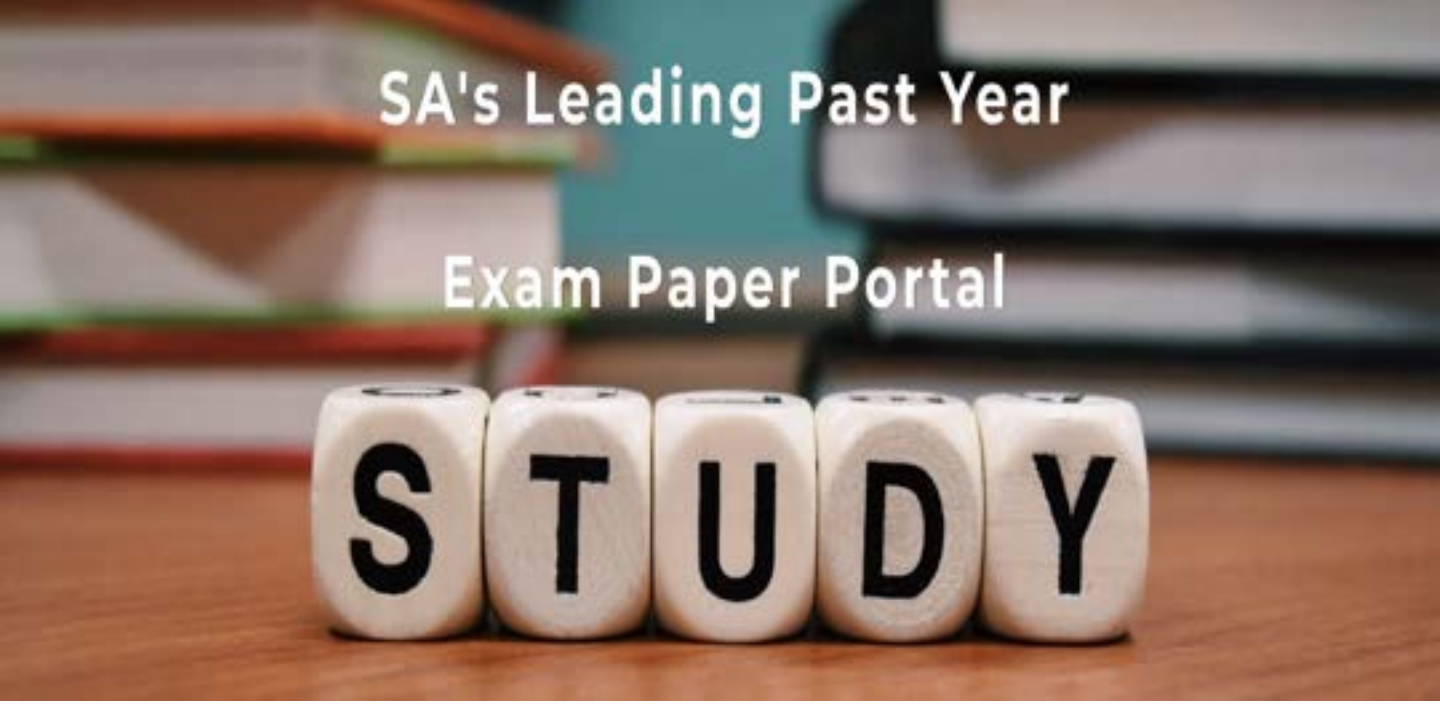

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GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION.

1. Write your name 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, for example 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 needed.
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 only the letter (A-D) next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following forces always acts vertically downwards on an object?

A Normal force

B Frictional force

C Applied force

D Gravitational force (2)

1.2 Two objects experience an INELASTIC collision in a closed system. Which ONE of the following combinations regarding the momentum and kinetic energy is correct?

	MOMENTUM	KINETIC ENERGY
A	Is not conserved	Is conserved
B	Is conserved	Is not conserved
C	Is not conserved	Is not conserved
D	Is conserved	Is conserved

(2)

1.3 The siren of a stationary train delivers sound waves of frequency 800 Hz. The train starts moving in such a way that the WAVELENGTH of the sound waves that reaches a stationary listener, INCREASES. The frequency that the stationary listener hears, could possibly be...

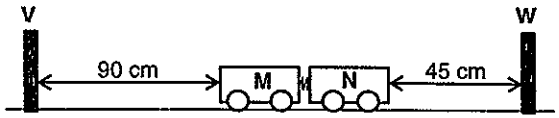
A 750 Hz

B 800 Hz

C 850 Hz

D 1000 Hz (2)

1.4 Two trolleys **M** and **N** are at rest on a frictionless surface. The compressed spring between the two trolleys is released and the trolleys move away from each other. The trolleys reach the buffers **V** and **W** SIMULTANEOUSLY. Which ONE of the following states the correct relationship between the magnitudes of the force on the two trolleys, change in momentum and acceleration of the two trolleys?

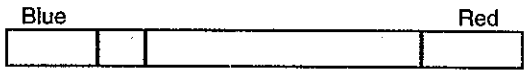


	Magnitude of force	Magnitude of change in momentum	Magnitude of acceleration
A	$F_M = F_N$	$\Delta p_M = \Delta p_N$	$a_M > a_N$
B	$F_M > F_N$	$\Delta p_M > \Delta p_N$	$a_M < a_N$
C	$F_M < F_N$	$\Delta p_M < \Delta p_N$	$a_M < a_N$
D	$F_M = F_N$	$\Delta p_M > \Delta p_N$	$a_M = a_N$

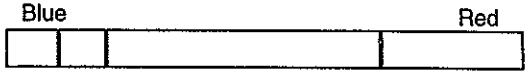
(2)

1.5 Astronomers obtained the following spectral lines of an element:

Spectrum of element in laboratory:



Spectrum of element from distant star:



This observation confirms that the ...

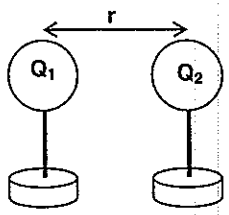
A star is moving towards the earth.

B star is moving away from the earth.

C universe enlarges.

D star is undergoing no relative movement. (2)

1.6 Two identical charges Q_1 and Q_2 are placed a distance **r** apart. The charges experience an electrostatic force **F**.

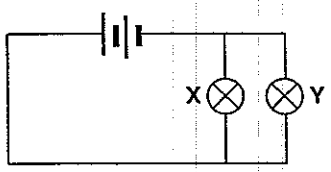


Which ONE of the following combinations will result in an electrostatic force of 16F between the charges?

	Charge Q_2	Distance r
A	½ Q_2	2r
B	4 Q_2	½ r
C	2 Q_2	½ r
D	8 Q_2	2r

(2)

1.7 In the circuit below the resistance of **X** is equal to R and the resistance of **Y** is equal to 3R.



If the power delivered by **X** is equal to P, what is the power delivered by Y?

A 3P

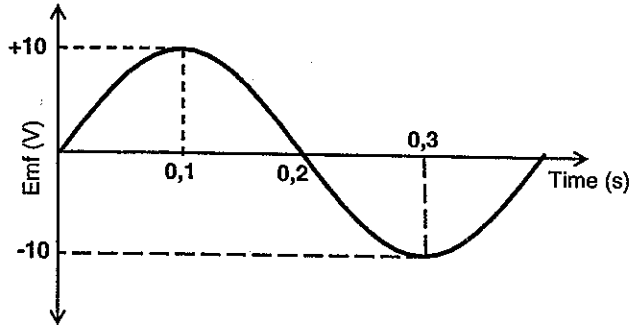
B $\frac{1}{9}$P

C $\frac{1}{3}$P

D 9P

(2)

1.8 The graph below shows the change in the emf versus time generated by a generator.



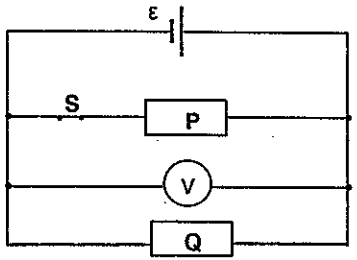
If the rotation speed of the generator is DOUBLED, how will this change affect the emf and period represented by the graph?

	Emf	Period
A	Larger than 10 V	0,2 s
B	Larger than 10 V	0,1 s
C	10 V	0,1 s
D	Smaller than 10 V	0,4 s

(2)

1.9 Two identical resistors **P** and **Q** are connected in the circuit as shown below. The cell has an emf ε and negligible internal resistance. The switch is initially CLOSED.

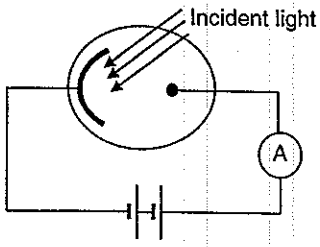
Switch S is now OPENED. Which ONE of the following combinations of changes will occur in **Q** and **V**?



	CURRENT IN Q	VOLTMETER V
A	Increases	Increases
B	Remains the same	Remains the same
C	Decreases	Remains the same
D	Remains the same	Decreases

(2)

1.10 The diagram below shows light incident on the cathode of a photocell. The ammeter registers a reading.



The intensity of the incident light is now changed.

Which ONE of the following correctly describes the relationship between the intensity of the incident light and the ammeter reading?

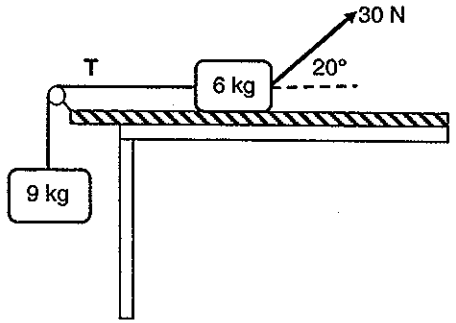
	INTENSITY	AMMETER READING
A	Increases	Increases
B	Increases	Remains the same
C	Increases	Decreases
D	Decreases	Increases

(2)
[20]

QUESTION 2 (Start on a new page)

A block of mass 6 kg rests on a rough horizontal table. It is connected by a light inextensible string **T** which passes over a light frictionless pulley to another block of mass 9 kg hanging vertically as shown below.

When a 30 N force is applied to the 6 kg block at an angle of 20° to the horizontal, the 6 kg block accelerates at 3,35 $m \cdot s^{-2}$ TO THE LEFT.



The coefficient of kinetic friction between the 6 kg block and the surface of the table is μ_k. Ignore the effects of air friction.

2.1 Draw a labelled free-body diagram that shows ALL the forces acting on the **6 kg block**. (5)

2.2 Write down Newton's SECOND law in words. (2)

Calculate the:

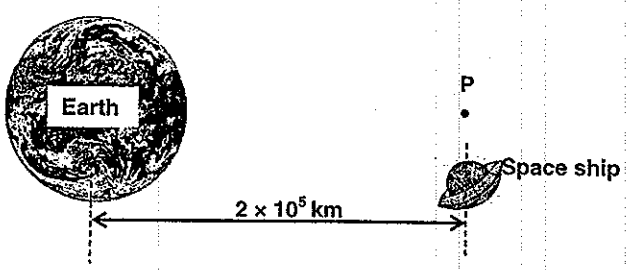
2.3 Normal force on the 6 kg block. (3)

2.4 Tension in string **T**. (2)

2.5 Coefficient of kinetic friction (μ_k) between the 6 kg block and the table. (5)
[17]

QUESTION 3 (Start on a new page)

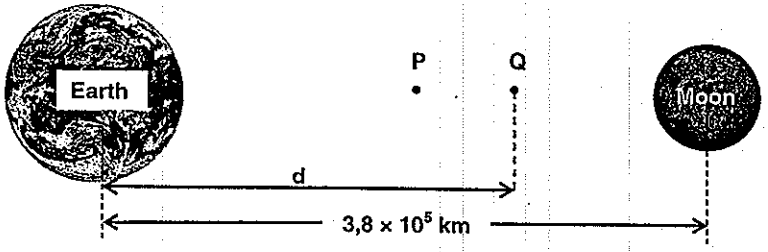
A space ship, mass 3 500 kg, is at rest at point P, 2×10^5 km from the centre of the earth.



3.1 State Newton's Law of Universal Gravitation in words. (2)

3.2 Calculate the magnitude of the gravitational force that the space ship experiences at point P. (4)

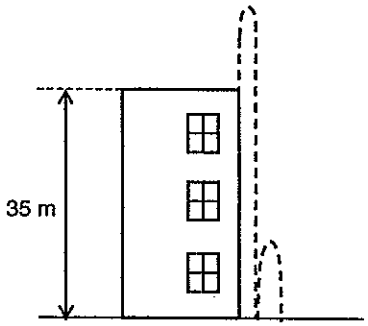
Point Q is a point on a straight line between the moon and the earth. Point Q is a distance d from the centre of the earth. The space ship experiences a ZERO net force when it is at rest at point Q.
The mass of the moon is $7{,}35 \times 10^{22}$ kg and it is at average $3{,}8 \times 10^5$ km from the earth.



3.3 Calculate the distance between points P and Q. (5)
[11]

QUESTION 4 (Start on a new page)

A ball is projected vertically upwards from the roof of a 35 m high building at a velocity of 15 $m \cdot s^{-1}$. The ball reaches the ground and bounces back.



4.1 Define the term *projectile*. (2)

4.2 Calculate the:

4.2.1 Maximum height the ball reaches above the ground. (4)

4.2.2 Time taken by the ball to reach the ground for the first time. (4)

4.3 Sketch a velocity-time graph for the motion of the ball, from the time it was projected untill it reaches the ground after the bounce.

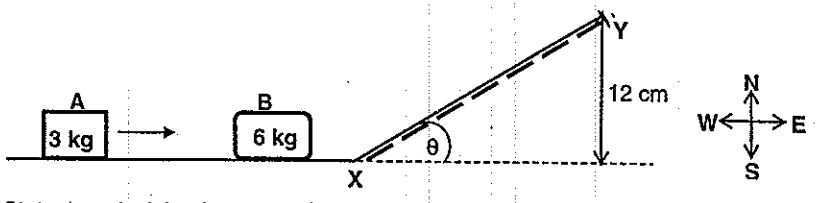
Show the following clearly on the graph:

a) The initial velocity of the ball.

b) The time taken to reach the ground for the first time. (4)
[14]

QUESTION 5 (Start on a new page)

Block **A** with a mass of 3 kg moves eastwards at a constant velocity on a horizontal frictionless surface. It collides with a stationary block **B** of mass 6 kg. Immediately after the collision block **A** moves at 0,5 $m \cdot s^{-1}$ to the west and block **B** at 2,25 $m \cdot s^{-1}$ to the east.



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

5.2 Calculate the speed of block **A** before the collision. (4)

After the collision, block **B** moves up a rough incline **XY**. A constant frictional force of 10 N acts on the block and causes it to come to rest at point **Y**.

5.3 Draw a labelled free-body diagram for block **B** on the incline. (3)

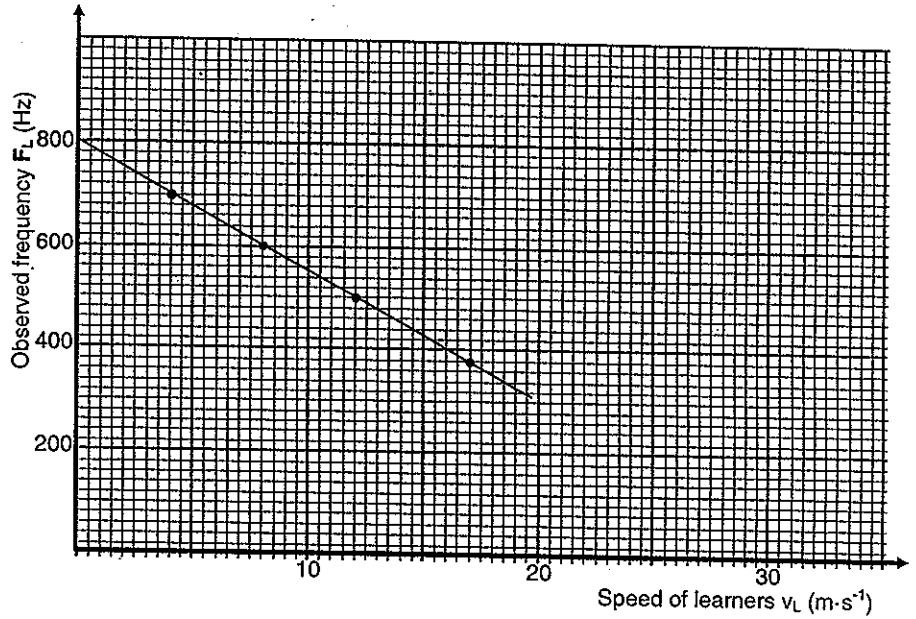
5.4 In which direction is the net force on block **B** on the incline?
Choose either FROM **X** TO **Y** or FROM **Y** TO **X**. (1)

5.5 Write the NAME of a non-conservative force that is acting on block **B** as it moves from **X** to **Y**. (1)

5.6 Use ENERGY PRINCIPLES only to calculate the angle θ of the incline. (6)
[17]

QUESTION 6 (Start on a new page)

During an experiment learners move at different velocities away from a stationary sound source. The learners write down the observed frequency F_L for each of the different velocities and obtain the following graph. Ignore the effect of wind.



6.1 Write down an investigative question for this experiment. (2)

6.2 State the Doppler effect in words. (2)

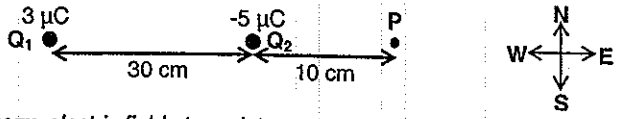
6.3 Use the graph and write down the value of the frequency of the sound source. Give a reason for the answer. (2)

6.4 Calculate the gradient of the graph. (2)

6.5 Use the gradient of the graph as calculated in Question 6.4 to calculate the speed of sound in air. (3)
[11]

QUESTION 7 (Start on a new page)

Two charged particles Q_1 and Q_2 are placed 30 cm apart as shown in the diagram below. Point **P** is 10 cm east of charge Q_2.



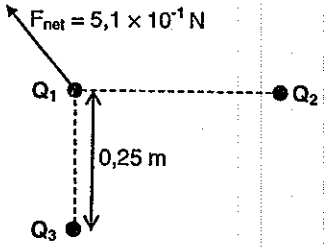
7.1 Define the term *electric field at a point.* (2)

7.2 Calculate the magnitude and direction of the net electric field at point **P**. (6)

The two charges are brought into contact with each other and placed at their original positions.

7.3 Calculate the charge on each of the particles after contact. (2)

After Q_1 and Q_2 were brought into contact, a charge Q_3 is placed 0,25 m due south of Q_1. Charge Q_1 experiences a net force of magnitude $5{,}1\times10^{-1}$ N due to the other two charges as shown in the diagram.

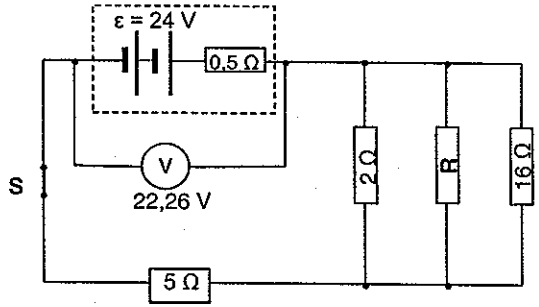


7.4 What is the nature of the charge on Q_3? Choose from POSITIVE or NEGATIVE. (1)

7.5 Calculate the magnitude of the charge on Q_3. (5)
[16]

QUESTION 8 (Start on a new page)

A battery with an internal resistance of 0,5 Ω and an emf (ε) of 24 V is connected in a circuit, as shown below. With switch **S** closed, the high-resistance voltmeter (V) has a reading of 22,26 V.



8.1 Explain the concept *emf of 24 V* in terms of work done. (2)

Calculate the:

8.2 Ammeter reading (3)

8.3 Power dissipated in the 16 Ω resistor. (4)

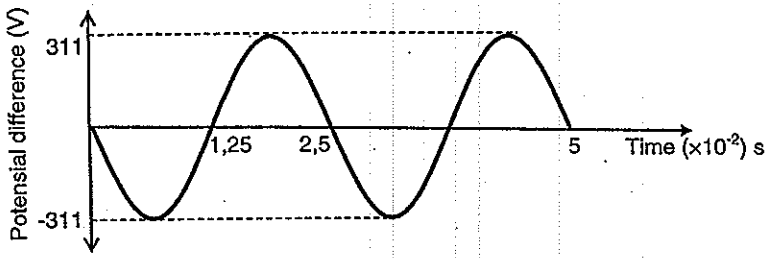
8.4 Current passing through resistor **R**. (4)

Resistor **R** is removed from the circuit.

8.4 Will the power dissipated in the 16 Ω resistor INCREASE, DECREASE or REMAIN CONSTANT? Explain the answer without doing any calculations. (5)
[18]

QUESTION 9 (Start on a new page)

A generator is used to deliver current through a 120 W bulb. The graph below shows the change in potential difference against time in the bulb.



9.1 What type of generator is used? Choose from ALTERNATING CURRENT (AC) or DIRECT CURRENT (DC). (1)

9.2 Write down the energy conversion that takes place in the bulb. (2)

9.3 Write down the name of the principle on which the functioning of the generator is based. (1)

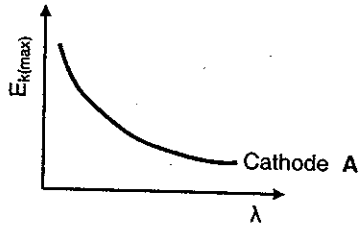
9.4 Calculate the frequency of the current. (2)

9.5 Calculate the rms-current through the bulb. (4)

9.6 Calculate the resistance of the bulb. (3)
[13]

QUESTION 10 (Start on a new page)

Light of different wavelengths is used to investigate the maximum kinetic energy of photoelectrons ejected from a specific type of cathode (**A**). The following graph is drawn from the results.



10.1 Define the term *threshold frequency* in words. (2)

10.2 Write down the mathematical relationship between the wavelength (λ) of the light and the maximum kinetic energy ($E_{k(max)}$) of the photoelectrons. (2)

10.3 How will an increase in the intensity of the light influence the maximum kinetic energy of the photoelectrons? Choose from INCREASES, DECREASES, or REMAINS THE SAME. Give a reason for the answer. (2)

10.4 The threshold frequency of cathode **A** is $1{,}18 \times 10^{15}$ Hz. Calculate the maximum speed of an emitted photoelectron if cathode **A** is irradiated with light of wavelength 160 nm. (5)

10.5 The photoelectric cell is replaced with one which has a cathode **B** of LOWER THRESHOLD FREQUENCY and the experiment is repeated.

Redraw the above graph of $E_{k(max)}$ versus λ for cathode **A** and on the same system of axes use a dotted line to draw the graph for cathode **B**. (2)
[13]

TOTAAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS 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	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	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	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
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 Earth *Massa van Aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6{,}38 \times 10^{6}\ m$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F{\cdot}v_{ave}$ / $P_{gemid} = F{\cdot}v_{gemid}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ 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 $W_o = hf_o$ 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 $(\varepsilon) = I(R + r)$ emk $(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT / WISSELSTROOM

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