KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

PREPARATORY EXAMINATION

SEPTEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

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 sub questions, 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 SHEET.

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

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 number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following physical quantities is a measure of the inertia of a body?

A Mass.
B Velocity.
C Energy.
D Acceleration. (2)

1.2 The distance between the centres of two planets, **P** and **Q** is **r**. The mass of **P** is TWICE that of **Q**.

Consider the following statements regarding the gravitational force exerted by the planets.

(i) The force will always be attractive.
(ii) The force exerted by **P** on **Q** is twice that exerted by **Q** on **P**.
(iii) The force that the bodies exert on each other is independent of their masses.
(iv) The force exerted by **P** on **Q** is equal in magnitude but opposite in direction to the force exerted by **Q** on **P**.

Which statement(s) is/are TRUE?

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

1.3 A ball is thrown vertically upwards and it returns to the starting point.

Which ONE of the following statements regarding the *rate of change of velocity* of the ball is TRUE?

A Its direction for the upward and downward motions are different.
B It is always directed downwards during the motion.
C It is zero at the maximum height reached.
D It is in the same direction as the velocity of the ball. (2)

1.4 A vehicle is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is **K** and the magnitude of the momentum is **p**. The speed of the vehicle can be given as:

A $\frac{K}{p}$

B $\frac{p}{K}$

C $\frac{K}{2p}$

D $\frac{2K}{p}$ (2)

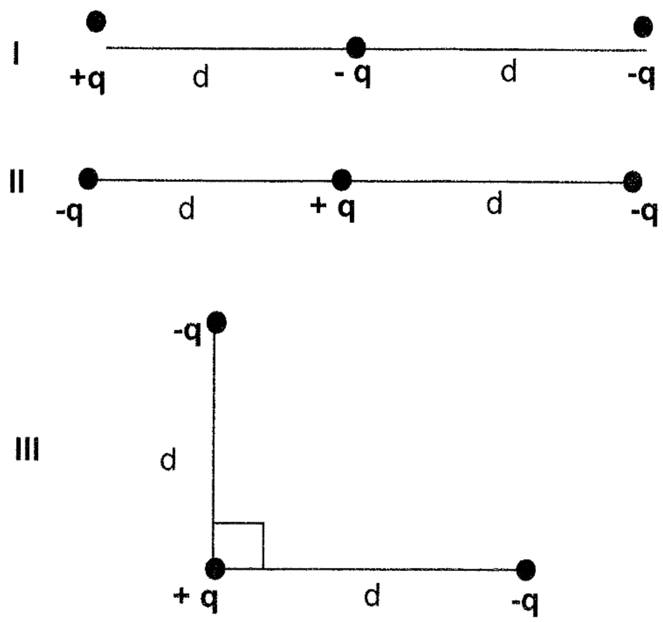
1.5 The engine of a car does work, W, to increase its velocity from 0 to *v*.
The work done by the engine to increase the velocity from ***v* to 2*v***, is

A W
B 2W
C 3W
D 4W (2)

1.6 A taxi sounds it hooter whilst it is moving at a constant velocity ***away*** from a stationary listener. Compared to the sound waves detected by the taxi driver, the sound waves detected by the observer has a greater …

A wavelength.
B frequency.
C energy.
D speed. (2)

1.7 Sketches **I**, **II** and **III**, not drawn to scale, are different ways in which three point charges are arranged. The charges are identical in MAGNITUDE and the distance 'd' between the charges is the same.

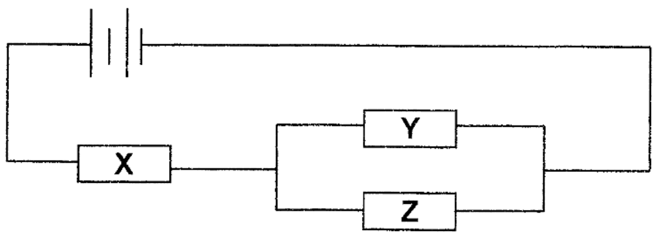


In which of these sketches will the magnitude of the NET electrostatic force experienced by the **+ q** charge be LARGEST and SMALLEST respectively?

	LARGEST NET FORCE on +q	SMALLEST NET FORCE on +q
A	I	II
B	II	III
C	III	I
D	III	II

(2)

1.8 Three identical resistors **X**, **Y** and **Z** are connected as shown in the circuit below.



If the power in **X** is P, then the power in **Y** is ...

A 2P

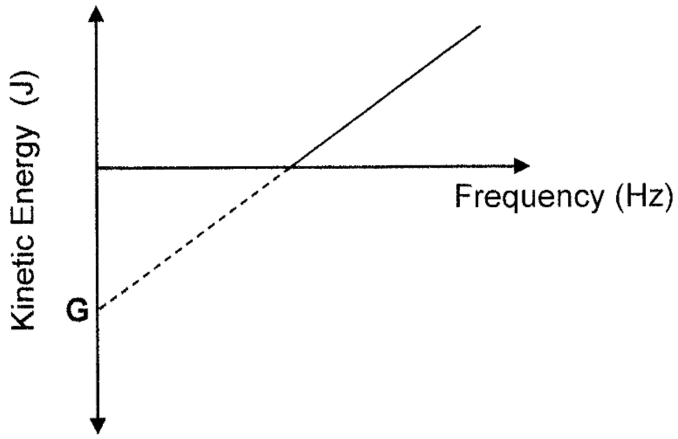
B $P/4$

C P

D $P/2$

(2)

1.9 The graph below shows the relationship between maximum kinetic energy (K_{max}) of the photoelectrons and frequency of incident photons during an experiment on the photoelectric effect.

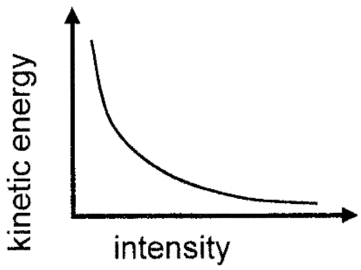


The point labelled **G** on the graph represents the …

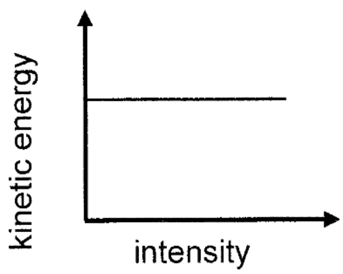
A threshold wavelength.
B maximum frequency.
C threshold frequency.
D work function. (2)

1.10 Which ONE of the following graphs best represents the relationship between the maximum kinetic energy of the emitted photoelectrons and the intensity of the incident light when light is shown on a metal surface?

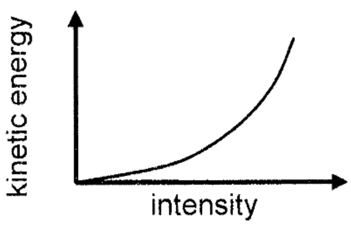
A



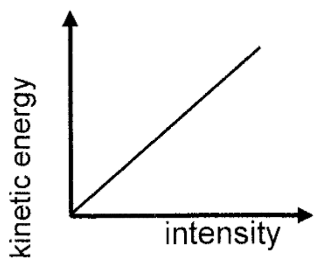
B



C



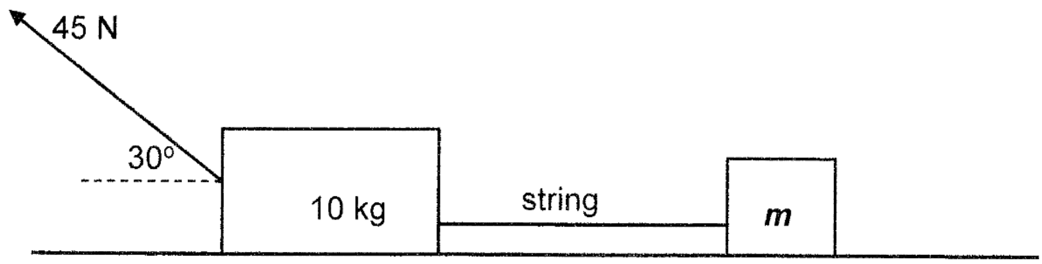
D



(2)
[20]

QUESTION 2

A 10 kg block is connected to another block of unknown mass '***m***' by a light inextensible string. The blocks are placed on a rough horizontal surface. When a force of 45 N is applied to the 10 kg at an angle of 30° to the horizontal, as shown in the sketch below, the blocks accelerate at 2,5 $m{\cdot}s^{-2}$ to the LEFT.



The block of mass ***m*** kg experiences a constant frictional force of magnitude 1 N whilst moving.

2.1 Draw a labelled free body diagram indicating ALL the forces acting on the 10 kg block while it is accelerating. (5)

2.2 Define the term *normal force*. (2)

2.3 Calculate the magnitude of the normal force acting on the 10 kg block. (4)

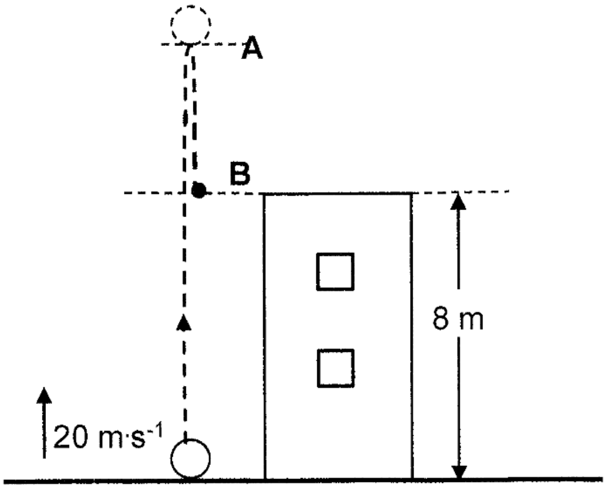
The co-efficient of kinetic friction (μ_k), between the 10 kg block and the surface is 0,125.

2.4 Calculate the unknown mass '***m***'. (6)

[17]

QUESTION 3

A small stone is projected vertically upwards from the ground with a speed of 20 m·s^{-1}. It passes the roof of an 8 m tall building on its way up and reaches its maximum height at **A**. On its way down, the stone passes the roof at point **B** as shown in the diagram below. Ignore the effects of air friction.



3.1 Write down the acceleration of the stone at point **A**. (2)

3.2 Using equations of motion, calculate the:

3.2.1 Time it takes for the stone to reach point **A** (3)

3.2.2 Magnitude of the velocity of the stone at the instant it reaches point **B** (3)

3.2.3 Total time it takes for the stone to move from the ground until it reaches point **B** on its way down (4)

3.3 Sketch a velocity – time graph for the motion of the stone from the instant it is projected until it reaches point **B** on its way down.

Indicate the following in your graph:

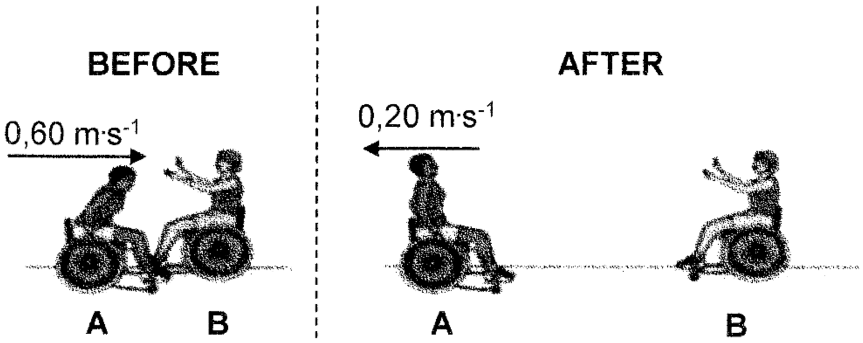
- Initial velocity
- Time taken to reach maximum height
- The final velocity at point **B** (4)

[16]

QUESTION 4

Two friends on wheel chairs are playing on a surface that has NEGLIGIBLE friction. The combined mass of girl **A** and her wheelchair is 60 kg whilst that of girl **B** and her wheelchair is 85 kg.

Girl **A** moves to the right at a velocity of 0,60 $m \cdot s^{-1}$ and collides with girl **B**, who is stationary. After the collision, girl **A** and her wheelchair move with a velocity of 0,20 $m \cdot s^{-1}$ to the left in the same straight line.



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

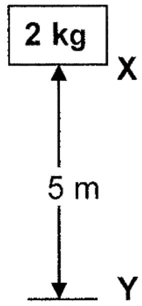
4.2 Calculate the velocity of the friend on wheelchair **B** immediately after the collision? (5)

4.3 Determine by means of a relevant calculation whether the collision was ELASTIC or INELASTIC. (5)

[12]

QUESTION 5

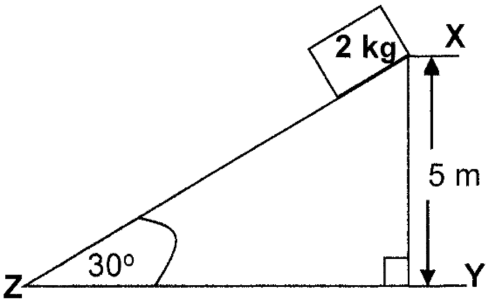
A block of mass 2 kg was dropped from point **X** and reaches point **Y**. Neglect friction.



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

5.2 Use the principle of conservation of mechanical energy to calculate the speed of the block when it reaches point **Y**. (4)

The same block was then released from **X** again, but travelled along a path **XZ** which is frictionless, as shown below



5.3 State the *work – energy theorem* in words (2)

5.4 Use the work – energy theorem to calculate the speed of block when it reaches point **Z**. (4)

5.5 How should the answers of QUESTIONS 5.2 and 5.4 compare according to physics principles?
Choose from: EQUAL or UNEQUAL

Explain the answer. (3)

[15]

QUESTION 6

A policeman with a speed detector is standing on a straight section of a road where the speed limit is 80 $km \cdot h^{-1}$. The hooter of a car moving on this section of the road with a constant UNKNOWN speed emits sound waves of frequency 400 Hz.

The wavelength of the sound waves detected by the police man is 0,80 m.
The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1 State the *Doppler Effect in words*. (2)

6.2 Calculate the frequency of the sound wave detected by the policeman. (3)

6.3 Determine, with the aid of a suitable calculation, whether the car is EXCEEDING the speed limit or not. (5)

6.4 How would your answer to QUESTION 6.2 be affected if the car travels at a LOWER constant speed? Choose from GREATER THAN, LESS THAN or THE SAME AS. (1)

6.5 State two uses of the Doppler effect in medicine (2)

[13]

QUESTION 7

In FIGURE 1 below, two IDENTICAL, negative point charges are placed a distance **X** metres apart. The charges exert an electrostatic force of magnitude 1984 N on each other.

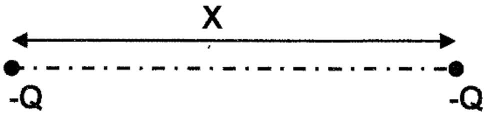


Figure 1

In FIGURE 2, the charges are separated a further 0,8 m. The electrostatic force the charges now exert on each other is of magnitude 124 N.

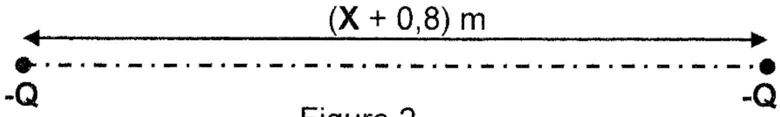


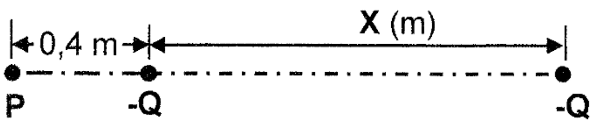
Figure 2

7.1 State *Coulomb's Law* in words. (2)

7.2 Calculate the distance **X**. (4)

7.3 Calculate the magnitude of the charges. (3)

7.4 The charges are returned to their original positions as in FIGURE 1 (**X** metres apart). A **proton** is now placed at point **P** which is 0,4 m to the left of **-Q** as shown below.



7.4.1 Define *electric field at a point* in words. (2)

Calculate the magnitude of the:

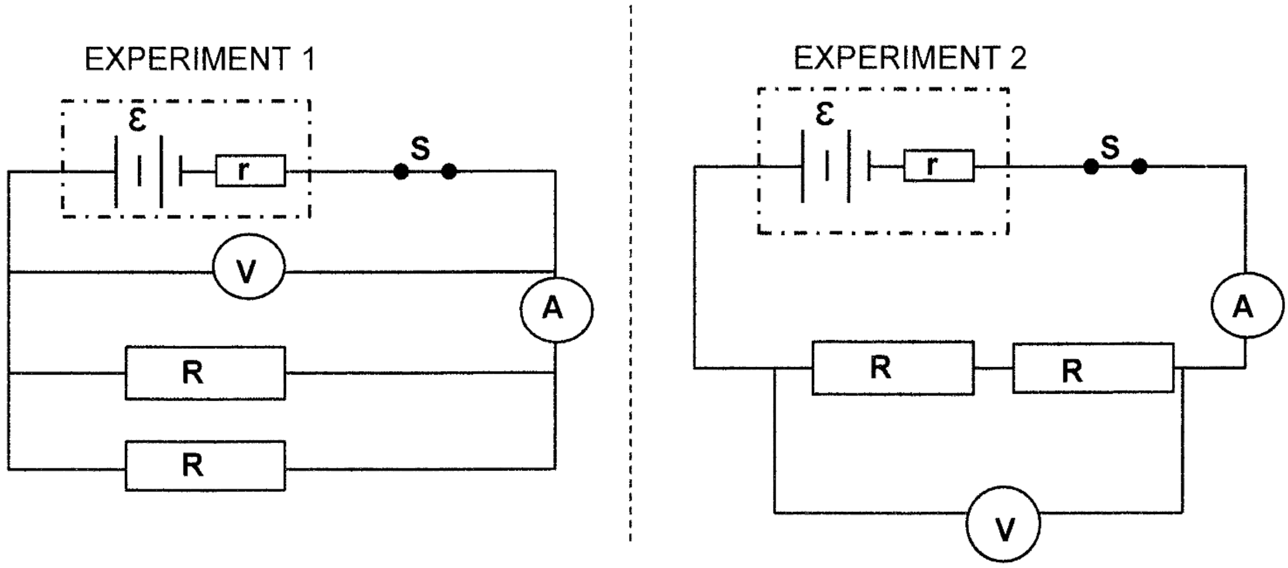
7.4.2 NET electric field at point **P** (5)

7.4.3 NET force experienced by the proton at **P** (3)

[19]

QUESTION 8

8.1 A battery is connected to two IDENTICAL resistors, R, in two separate experiments as shown below.



The internal resistance and emf of the battery are UNKNOWN. The ammeter and voltmeter readings in both experiments are shown in the table below.

	AMMETER READING (A)	VOLTMETER READING (V)
EXPERIMENT 1	6,13	18,40
EXPERIMENT 2	1,78	20,58

8.1.1 Define *emf* in words. (2)

8.1.2 Calculate the emf of the battery (5)

8.1.3 Calculate the resistance of R (3)

8.1.4 One of the resistors in EXPERIMENT 1 is now disconnected. How will this affect the power dissipated by the battery?

Choose from: INCREASE, DECREASE or REMAIN THE SAME.

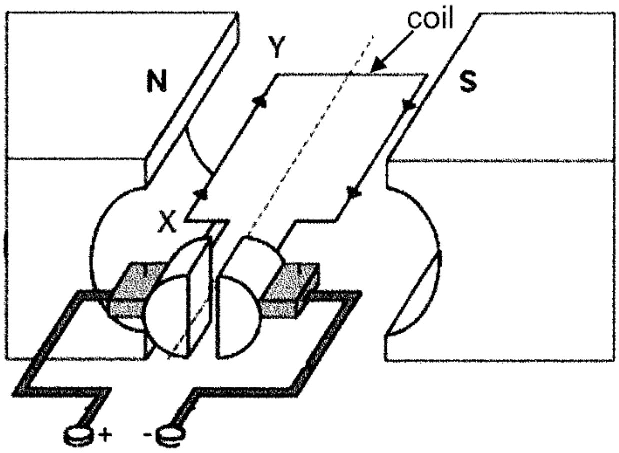
Explain the answer by making reference to a suitable formula for power. (4)

8.2 A current of 4,4 A passes through an oven of resistance 50 Ω. Calculate the cost of electricity consumed by the oven for 6 hours if the price of electricity is R1,69 per kWh. (3)

[17]

QUESTION 9

9.1 The sketch below represents a simplified version of a DC electric motor.

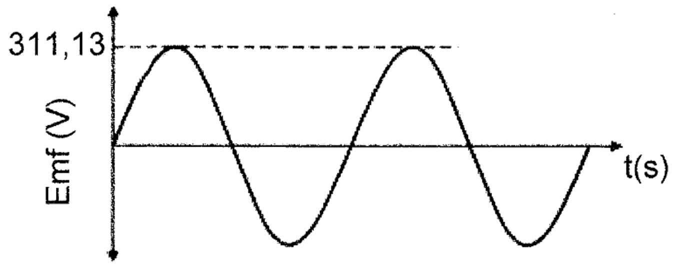


9.1.1 Name the component that ensures that the coil (armature) rotates continuously in the SAME direction. (1)

9.1.2 In which direction does the coil rotate? Choose from: CLOCKWISE or ANTICLOCKWISE. (2)

9.1.3 Write down the energy conversion that occurs in a motor. (2)

9.2 The above motor is CONVERTED to operate as an ac generator and the output of the generator is shown in the sketch graph below.



9.2.1 Write down TWO changes that need to be made for the above conversion. (2)

9.2.2 Calculate the rms voltage. (3)

[10]

QUESTION 10

The work functions of two metals are listed in the table below.

Metal	Work function (J)
Sodium	$2,46 \times 10^{-19}$
Platinum	$6,35 \times 10^{-19}$

10.1 Define *work function.* (2)

The sodium surface is illuminated with light having a wavelength of 400×10^{-9} m.

10.2 Calculate the energy of a photon of the incident light. (3)

10.3 Calculate the maximum speed of the ejected electrons. (4)

10.4 The same light is now incident on a platinum metal.

Will electrons be ejected from the platinum metal?
Choose from: YES or NO

Write down a reason for your answer (2)

[11]

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

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

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

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

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 $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or/of $K_{(max)} = \frac{1}{2}mv^2_{max}$	

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

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