education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

PREPARATORY EXAMINATION

SEPTEMBER 2019

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 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. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. 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 The force or the component of a force which a surface exerts on an object with which it is in contact, and which is perpendicular to the surface is called the...

A normal force.

B frictional force.

C applied force.

D gravitational force. (2)

1.2 A satellite experiences a gravitational force of magnitude **F** on the surface of the earth. The radius of the earth is **R**.

The satellite now circles the earth at an unknown height ABOVE the surface of the earth and experiences a gravitational force of magnitude ¼ **F**. This unknown height above the surface of the earth is ....

A 4R

B 3R

C 2R

D R (2)

1.3 Which ONE of the following is the unit of measurement for the RATE OF CHANGE OF MOMENTUM?

A watt

B kilogram

C ohm

D newton (2)

1.4 A brick of mass **m** is thrown vertically upwards, from the ground, and reaches a maximum height *h* above the ground. Another brick of mass **2m** is also thrown vertically upwards, from the same point, and reaches the same maximum height *h*. Ignore all effects of friction.

A Both bricks have the same kinetic energy when they are thrown.

B Both bricks have the same velocity when they are thrown.

C Both bricks have the same momentum when they are thrown.

D The brick of mass **m** will take a shorter time to reach the maximum height. (2)

1.5 If the net work done on an object is negative (less than zero), then the ...

A kinetic energy of the object remains unchanged

B kinetic energy of the object is decreasing.

C kinetic energy of the object at the start is zero.

D kinetic energy of the object is increasing. (2)

1.6 An observer runs towards a stationary sound source. As the observer approaches the source, the observed pitch increases because the observed ...

A loudness increases.

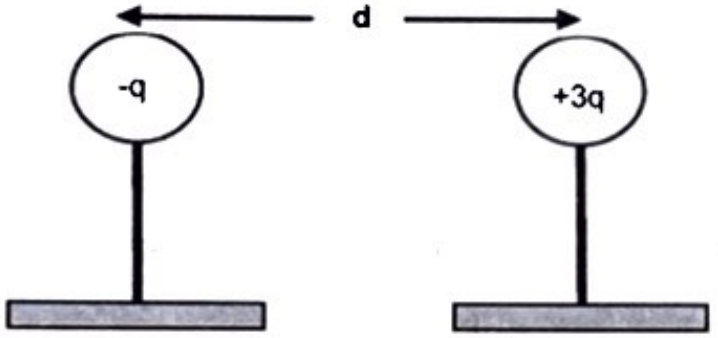
B wavelength increases.

C frequency increases.

D frequency decreases. (2)

1.7 Two small identical metal spheres, on insulated stands, carry charges -q and +3q respectively.

When the centres of the spheres are a distance **d** apart, the spheres exert an electrostatic force of magnitude ***F*** on each other.



The spheres are now made to touch and are brought back to the **same positions** as before.

The magnitude of the electrostatic force which the spheres now exert on each other, in terms of ***F***, is:

A $\frac{1}{2}F$

B $3F$

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

D $\frac{4}{3}F$

(2)

1.8 A certain conductor obeys Ohm's law.

Which ONE of the statements below regarding the resistance of the conductor is CORRECT?

The resistance of this conductor ...

A remains unchanged, even if its temperature changes.

B remains unchanged, even if the potential difference across it or current in it changes at constant temperature.

C changes as the potential difference across it changes at constant temperature.

D changes as the current passing through it changes at constant temperature.

(2)

1.9 A DC generator functions at a frequency of 80 Hz. The number of times the output voltage reaches a maximum in 1 second is ...

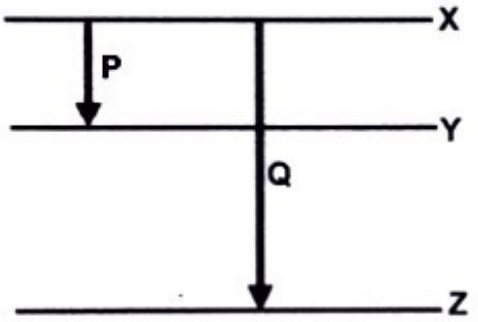
A 160

B 120

C 80

D 40 (2)

1.10 The diagram below represents 3 energy levels, **X**, **Y** and **Z**, in a certain atom. The energy difference between levels **Y** and **Z** is twice the energy difference between levels **X** and **Y**.



If the wavelength of a photon emitted as a result of transition **P**, from level **X** to **Y**, is λ, then what is the wavelength of the photon emitted during transition **Q**, from level **X** to **Z**?

A 2λ

B 3λ

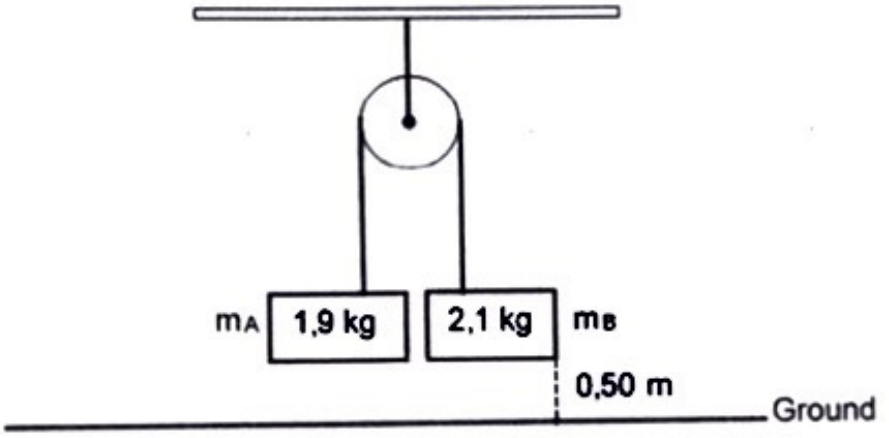
C $\frac{\lambda}{2}$

D $\frac{\lambda}{3}$

(2)
[20]

QUESTION 2 (Start on a new page)

The sketch bellow is a set-up which can be used to determine the gravitational acceleration, **g**. Two different masses m_A and m_B are attached to a light, inextensible cord which hangs over a frictionless pulley, as shown in the diagram below. The masses are initially held AT REST.



Ignore the effects of air friction, and masses of the cord and pulley.

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

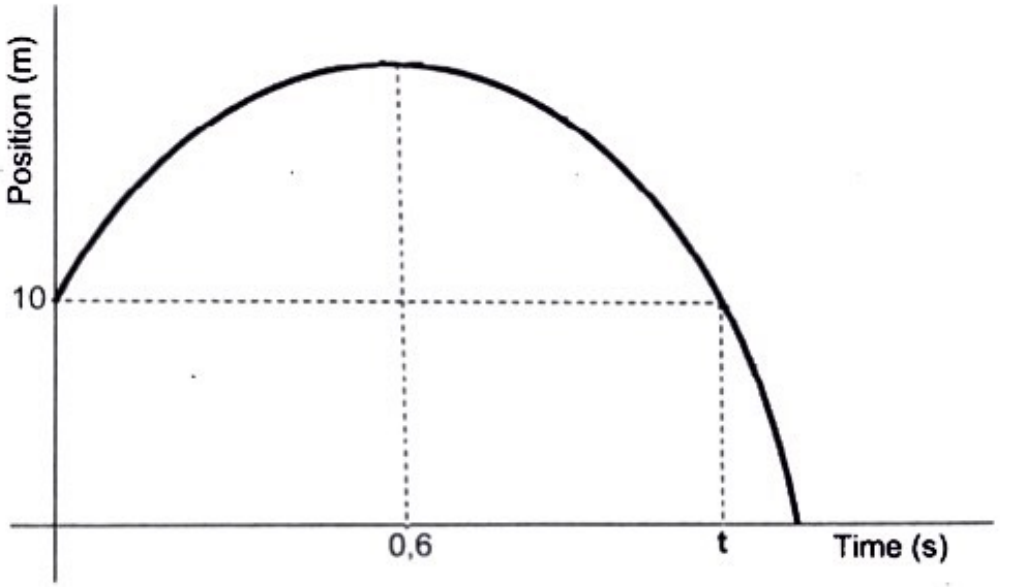
When the masses are released from rest, the system moves through a vertical distance of 0,50 m in 1,43 seconds.

2.2 Draw a labelled free-body diagram for mass m_A as it moves upwards. (2)

2.3 Calculate the value of the gravitational acceleration, **g**. (7)
[11]

QUESTION 3 (Start on a new page)

The sketch graph below shows the motion of a ball that is thrown vertically upwards from the balcony of a building. The ball takes 0,6 s to reach its highest point, after which it falls downwards, past the balcony, to the ground. Ignore the effects of air friction.



3.1 How high is the balcony above the ground? (1)

3.2 Write down the numerical value of time **t**. (1)

3.3 Define the term *projectile*. (2)

3.4 Calculate the initial velocity of the ball. (3)

3.5 Calculate the maximum height, above the ground, reached by the ball. (4)

3.6 Calculate the magnitude of the final velocity of the ball when it reaches the ground. (3)

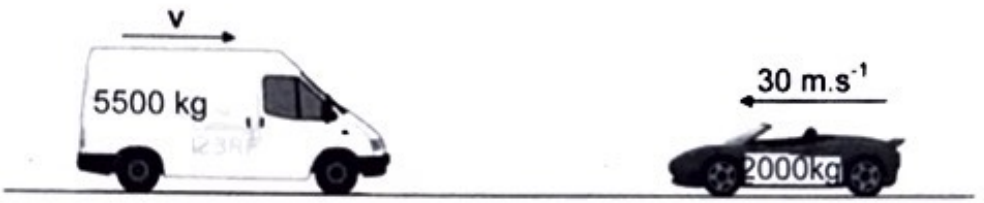
3.7 Draw a velocity versus time graph for the motion of the ball. Indicate the following on your graph:

- initial velocity
- final velocity
- time taken to reach maximum height (4)

[18]

QUESTION 4 (Start on a new page)

A delivery vehicle of mass 5 500 kg, moving at a velocity **v** to the right collides head on with a car of mass 2 000 kg moving at 30 $m \cdot s^{-1}$ in the opposite direction. Immediately after the collision, the car and the truck move at 10 $m \cdot s^{-1}$ and 6 $m \cdot s^{-1}$, respectively, to the right.



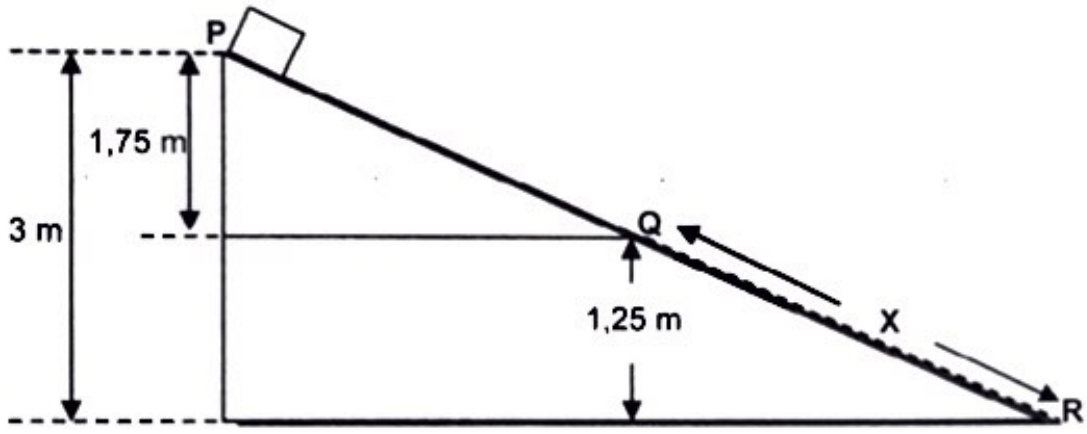
4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the magnitude of the velocity of the delivery vehicle before the collision. (4)

4.3 If the collision lasts 0,2 seconds, calculate the force the car exerts on the delivery vehicle during the collision. (4)
[10]

QUESTION 5 (Start on a new page)

A 4 kg box is held *stationary* at point **P**, the top of a plane PQR, inclined at an angle to the horizontal. The portion PQ of the plane is smooth while the portion QR is rough.



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

5.2 Determine the speed of the box at position **Q**. (4)

5.3 The box experiences a *kinetic frictional force* of 15 N as it moves with a CONSTANT VELOCITY, from **Q** to **R**, down the plane.

5.3.1 State the *Work-Energy Theorem* in words. (2)

5.3.2 Draw a labelled free-body diagram showing ALL forces acting on the box as it moves from **Q** to **R**. (3)

5.3.3 Use the ENERGY PRINCIPLES to calculate the distance **X**, between **Q** and **R**. (5)

5.4 The angle between the incline and the horizontal is now increased.

How will this increase affect the coefficient of kinetic friction of the box?

Write only INCREASE, DECREASE or REMAIN THE SAME. (1)
[17]

QUESTION 6 (Start on a new page)

An ambulance with its siren on, moves at constant velocity TOWARDS a person standing next to the road. The person measures a frequency which is 110% of the frequency of the sound emitted by the siren of the ambulance.

6.1 Name and state the phenomenon observed above. (3)

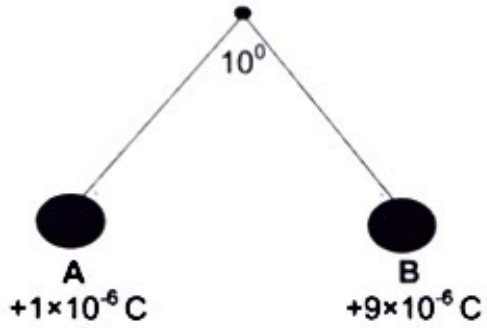
6.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the speed of the ambulance. (5)

6.3 How will the frequency measured by the person be affected if the speed of the ambulance is increased?

Write only INCREASE, DECREASE or REMAIN THE SAME. (1)
[9]

QUESTION 7 (Start on a new page)

Two positively charged identical metal spheres, **A** and **B**, each with a mass of 4 g are suspended from the same point by light, inextensible strings of equal length. The strings make an angle of 10° with each other as shown in the diagram below.



Before contact

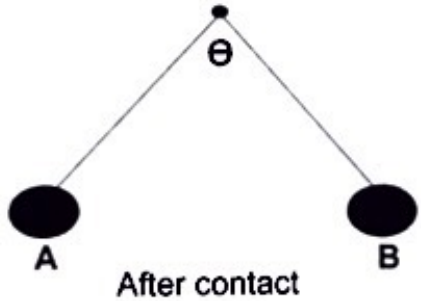
7.1 State *Coulomb's Law* in words. (2)

7.2 Draw a labelled free-body diagram of the forces acting on sphere **B**. (3)

7.3 Calculate the magnitude of the electrostatic force of repulsion between charge **A** and **B**. (4)

7.4 Hence, calculate the distance between the two charges. (4)

The spheres are now BROUGHT INTO CONTACT with each other and allowed to separate, making a new angle θ between them as shown in the diagram below:



After contact

7.5 Sketch the combined electric field pattern between charges **A** and **B** (3)

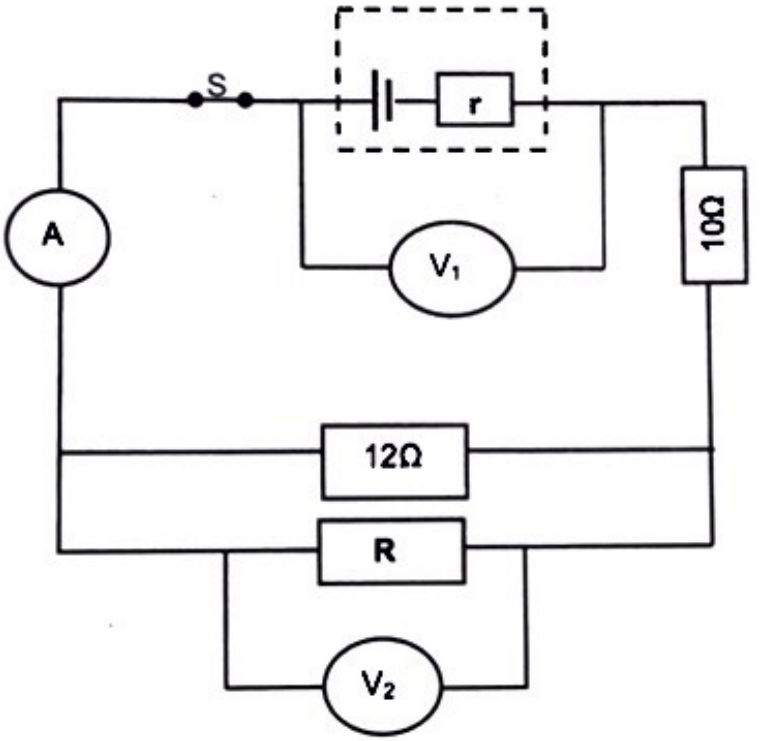
7.6 Calculate the new charge on each sphere. (2)

7.7 Were electrons transferred from **A** to **B** or **B** to **A** during contact? (1)

7.8 Determine the number of electrons transferred during contact. (2)
[21]

QUESTION 8 (Start on a new page)

The battery in the circuit, represented in the diagram below, has an internal resistance **r**. When switch **S** is closed the reading on voltmeter V_2 is 18 V and resistor **R** dissipates 13,5 W.



8.1 Calculate the resistance of resistor **R**. (3)

8.2 Calculate the reading on the ammeter. (5)

8.3 Explain, in words, what is meant by the term *internal resistance*. (2)

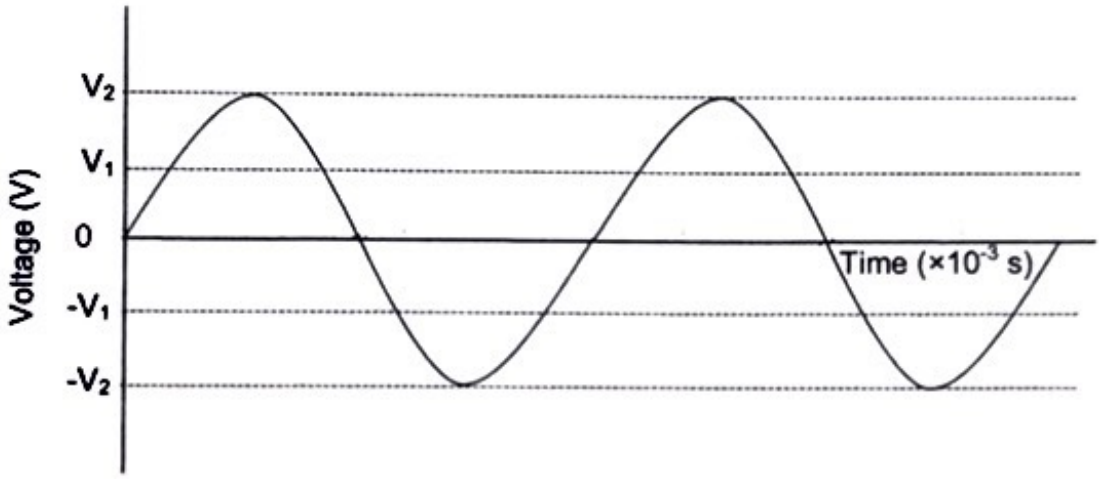
8.4 Calculate the potential difference across the 10 Ω resistor. (3)

8.5 When switch **S** is opened, voltmeter V_1 reads 45,9 V. Hence, calculate the internal resistance of the battery. (5)

8.6 Does the external resistance in the circuit INCREASE, DECREASE or REMAIN THE SAME when the resistor **R** is removed? (1)
[19]

QUESTION 9 (Start on a new page)

The diagram below shows a sketch graph of output voltage versus time for an AC generator which is used to supply power to a building. The home owner plugs a kettle into a 220 V socket.



9.1 Write down the NAME of the principle on which the generator functions. (1)

9.2 Define, in words, the term *root- mean square (rms)* of the alternating current. (2)

9.3 Which ONE of the voltages (V_1 or V_2) is the root-mean square (rms) output of the generator? (1)

9.4 Write down, the FORMULA in terms of V_1 and V_2, that expresses the relationship between V_1 and V_2. (1)

9.5 Calculate the value of V_2. (3)

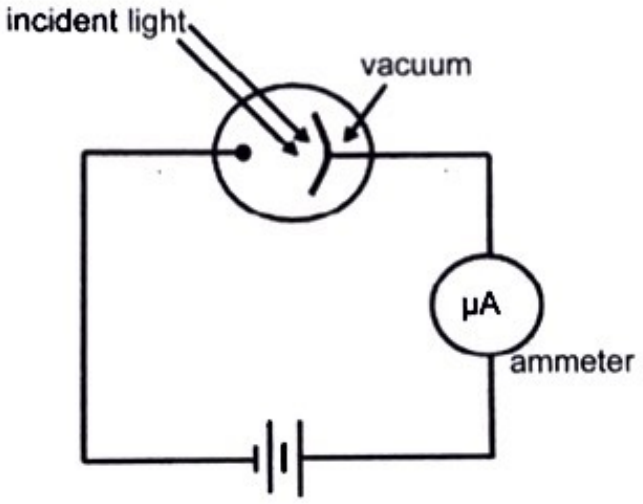
The power of the kettle is 1 200 W.

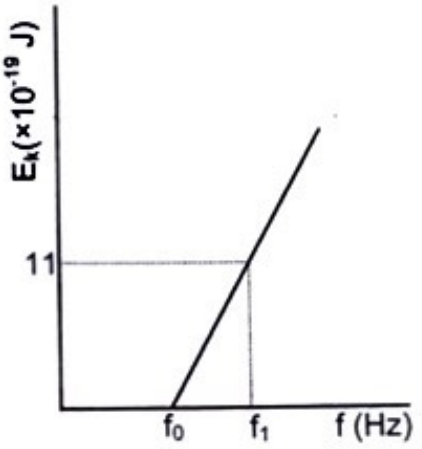
9.6 Calculate the peak (maximum) current of the kettle. (3)

9.7 State ONE advantage of using AC instead of DC for long distance transmission of electrical power. (1)
[12]

QUESTION 10 (Start on a new page)

A learner investigates the relationship between the maximum kinetic energy of photo-electrons and frequency of light when light is incident on a metal surface of a photo-cell. The graph obtained by the learner was found to cut the x-axis at $f_0 = 5 \times 10^{14}$ Hz.





10.1 Is the electrode, on which the light is incident the CATHODE or ANODE of the photo-cell? (1)

10.2 Write down the name of the physical quantity represented by f_0. (1)

10.3 Define the term *work function*. (2)

10.4 Calculate the work function of the metal. (3)

10.5 Calculate frequency, f_1, shown on the graph. (5)

10.6 How will the value of f_0 be affected if light of different frequencies are incident on the same metal surface?

Choose from INCREASE, DECREASE or REMAIN THE SAME (1)

[13]

TOTAL MARKS: 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 electron*	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

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

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 $E_{k(max)} = \frac{1}{2}mv_{max}^2$ 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)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT / WISSELSTROOM

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