education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 17 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 sub questions, 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, etc. where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g.1.11 E.

1.1 Two objects of mass 2X and 3X respectively, where X is an unknown quantity, exert a force F on each other when they are a certain distance apart. What will be the force between two objects situated the same distance apart but having a mass of 5X and 6X respectively?

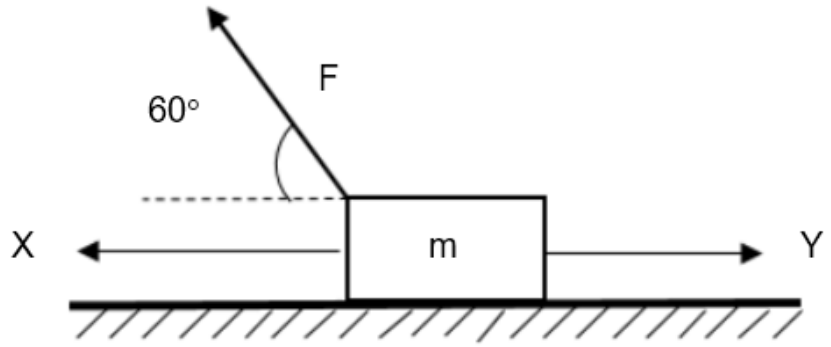
A 6F

B 30F

C 5F

D 2,2F (2)

1.2 A box, mass m, is at rest on a rough horizontal surface. A force of constant magnitude F is then applied on the box at an angle of 60° to the horizontal, as shown in the diagram below.



If the box has a uniform horizontal acceleration of magnitude, 'a', the frictional force acting on the box is ...

A Fsin60° - ma in the direction of X.

B Fsin60° - ma in the direction of Y.

C Fcos60° - ma in the direction of Y.

D Fcos60° - ma in the direction of X. (2)

1.3 The velocity of an object is doubled. If the mass of the object does not change, then its …

A momentum remains the same and its kinetic energy is doubled.

B momentum and kinetic energy are doubled.

C momentum and kinetic energy are quadrupled.

D momentum is doubled and its kinetic energy is quadrupled. (2)

1.4 A car is accelerating up an inclined slope. The non-conservative force(s) which do non-zero work on the car include …

(i) gravitational force.

(ii) normal force.

(iii) force of the engine.

(iv) frictional force.

Choose ONE of the following options:

A (i) only

B (i) and (ii)

C (iii) and (iv)

D (iii) only (2)

1.5 A body of mass 'm' moves at a constant velocity through a horizontal displacement 'y' against a constant frictional force 'F' in 't' seconds. What is the power required to keep this body moving constantly?

A 0

B $\frac{F\Delta y}{\Delta t}$

C $mg\Delta y$

D $\frac{1}{2}F\Delta y$ (2)

1.6 Which ONE of the following is the main principle applied in the flow meter which measures blood flow rate?

A Red shift

B Doppler effect

C Blue shift

D Diffraction (2)

1.7 Two identical point charges experience a certain electrostatic force when they are a distance 'r' apart. If the charge on both spheres is doubled and distance between them is doubled, the force experienced will …

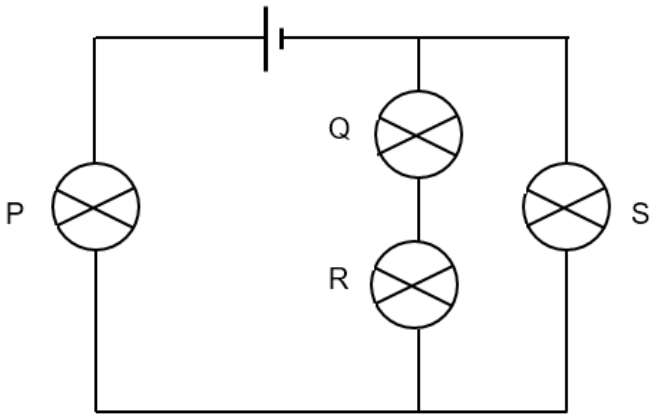
A remain the same.

B be doubled.

C be four times greater.

D be halved. (2)

1.8 In the circuit shown below, the bulbs have identical resistances and the battery has negligible internal resistance.



If the bulb Q burns out in the circuit, then …

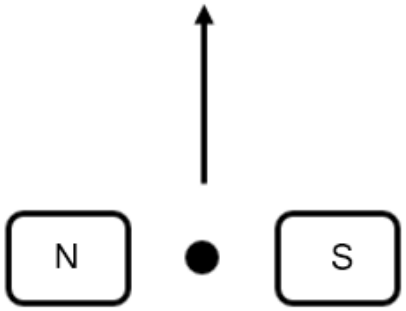
A all the remaining bulbs will burn equally bright.

B R and S will burn equally bright but less brighter than P.

C R and S will burn equally bright but brighter than P.

D S and P will burn equally bright. (2)

1.9 The diagram below shows a cross-section of a conducting wire placed between two opposite magnetic poles. The wire is moved through the magnetic field in the direction indicated by the arrow.



The current induced in the conductor will be …

A directed out of the page.

B directed in to the page.

C zero.

D increased as it moves upwards. (2)

1.10 The threshold frequency of a certain metal has a value of ' f ' and the frequency of incident light is '2f '. If the frequency of the incident light increases to '4f ', the resulting kinetic energy of the photo electrons emitted …

A is increased by factor of 3.

B is increased by factor of 2.

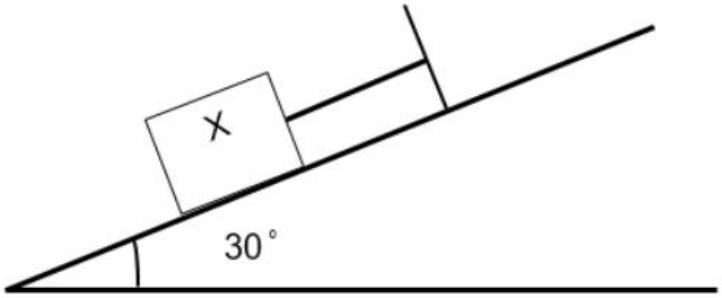
C remains the same.

D is increased by factor of 4. (2)

[20]

QUESTION 2 (Start on a new page.)

A block of mass X is held stationery by a rope of negligible mass. The block rests on a frictionless plane which is inclined at 30° to the horizontal.



2.1 Draw a labelled force diagram showing all the forces acting on the block. (3)

2.2 Calculate the mass of the block when the force by the rope is 8 N. (3)

2.3 A braking test is carried out on a car travelling at 20 $m \cdot s^{-1}$. A braking distance of 30 m is measured when a braking force of 6 000 N is applied to stop the car.

2.3.1 State Newton's Second Law of motion in words. (2)

2.3.2 Calculate the acceleration of the car when the braking force of 6 000 N applied. (3)

2.3.3 A trailer of mass 600 kg is attached to the car and the braking test is repeated from 20 $m \cdot s^{-1}$ using the same braking force.
How long will it take to stop the car? (2)

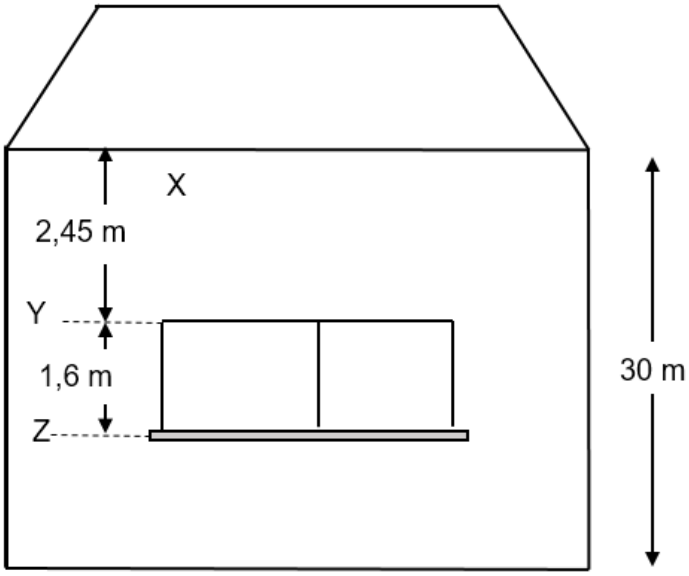
2.4 Patrick's mass is 60 kg at ground level. Does his weight change when he is 5 046 m high from the ground? Choose from LESS THAN or GREATER THAN or REMAINS SAME.

Justify the answer by means of suitable calculations. (5)
[18]

QUESTION 3 (Start on a new page.)

3.1 A painter is painting the tiles on the roof of a building. While painting, the roller he is using slips from his hand and falls from rest from the edge of the roof, which is 30 m above the ground, as shown in the diagram below

Ignore the effects of air friction.



3.1.1 What is the magnitude and direction of the acceleration of the roller at the moment it falls from the edge of the roof at point X? (1)

3.1.2 Calculate how long the roller took to fall from the roof at point X to the top of the window Y, which is 2,45 m below the roof. (3)

3.1.3 Calculate the speed with which the roller passes by the bottom of the window at point Z, if the height of the window is 1,6 m? (2)

3.1.4 A jogger running at a constant velocity of 7 $m \cdot s^{-1}$ on the ground below is 25 m away when the roller falls. Will the roller hit the jogger?

Use a calculation to support your answer. (4)

3.2 An object is projected upwards with a velocity of 14,7 $m \cdot s^{-1}$. It returns to its starting point after 3 s.

3.2.1 Draw a velocity time graph for the object's motion during the 3 s. Indicate the initial velocity, final velocity and times for entire motion on the graph. (2)

3.2.2 Use the graph, drawn for QUESTION 3.2.1, to determine the distance covered by the object over a 3 s period. (2)

[14]

QUESTION 4 (Start on a new page.)

At a crash test facility, a crash test dummy with a mass of 80 kg was used to investigate collisions at different impact speeds. A sensor on the dummy measured the time it takes to come to rest upon impact. The results were tabulated in a table below:

TEST NO	v_i (m·s^{-1})	t(s)	IMPULSE (N·s)
1	5	0,09	-400
2	10	0,18	**X**
3	15	0,27	-1200
4	20	0,36	-1600

4.1 What is the DEPENDENT and INDEPENDENT VARIABLE for this investigation? (2)

4.2 Complete the table by calculating the value of X. (3)

4.3 Draw a graph of impulse versus time for this investigation. (2)

4.4 Calculate the gradient of the graph in question 4.3. (2)

4.5 What does the gradient of this graph represent? (1)

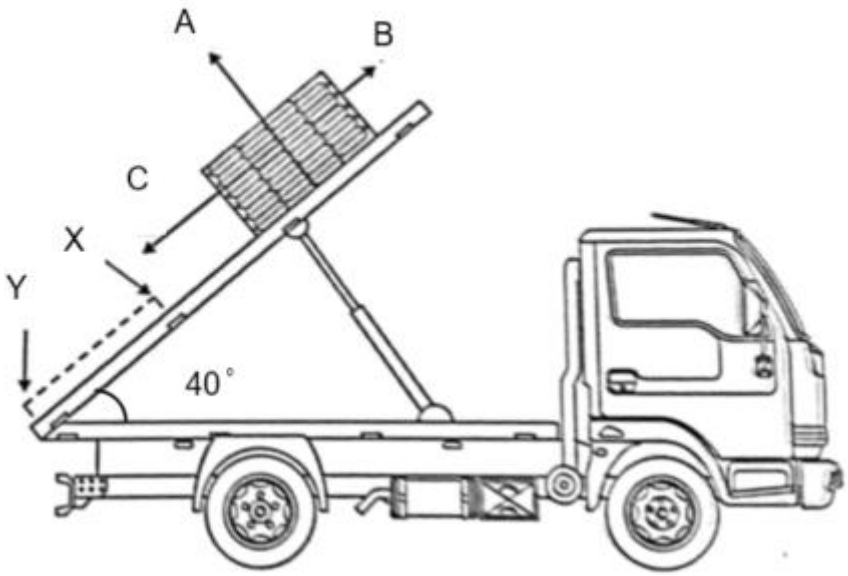
4.6 If an airbag was used in this investigation, would the impact force experienced by the test dummy INCREASE or DECREASE or REMAINS THE SAME.

Explain your answer. (2)
[12]

QUESTION 5 (Start on a new page.)

A dump truck tilts its bed to an angle of 40° with the horizontal in order to unload a 500 kg crate of cement bags, a frictional force of 1 000 N acts on the crate as it slides down the truck bed.

The motion of the crate is illustrated in the diagram below. The forces acting on the crate are represented by A, B and C.



5.1 Label the forces A, B and C. (3)

5.2 The crate passes point X at a speed of 2 $m \cdot s^{-1}$ and moves a distance of 1 m before reaching point Y, the end of the truck bed.

5.2.1 State the work-energy theorem in words. (2)

5.2.2 Calculate the net work done on the crate during its motion from point X to point Y. (3)

5.2.3 Use the work-energy theorem to calculate the speed of the crate at point Y. (3)
[11]

QUESTION 6 (Start on a new page)

A spectator on the grandstand at a Grand Prix motor racing event observes a change in the frequency of a racing car's engine as it speeds to the grandstand.

The frequency of the racing car's engine is 410 Hz when approaching the grandstand, and 305 Hz as it moves away. 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 velocity of the racing car as it passes the grandstand. (6)

6.3 Explain why the frequency of the racing car's engine is higher as it approaches the grandstand. (3)

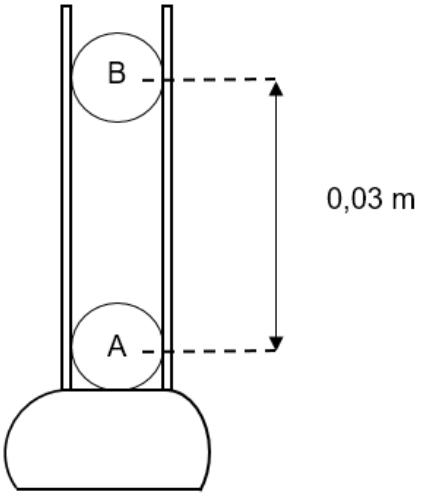
6.4 Astronomers have observed that light from distant galaxies is redshifted.

What does the redshift of light tell us about the universe? (2)
[13]

QUESTION 7 (Start on a new page.)

7.1 A neutral graphite ball A is placed in a glass cylinder. Graphite ball B which carries a positive electrostatic charge is dropped into the glass cylinder.
After making contact with A, ball B rises to a height of 0,03 m where it remains suspended, as shown in the diagram.

Both balls now carry a charge of 25 nC.



7.1.1 What was the original charge on ball B before it was dropped into the cylinder? (2)

7.1.2 Calculate the electrostatic force between the two charged balls. (3)

7.1.3 Explain why ball B remains suspended above ball A. (2)

7.2 A charged sphere K hangs from a horizontal beam at point P by an inelastic thread of negligible mass as shown in DIAGRAM 1 below. The length of the string is 0, 12 m. The sphere has a weight of 9,8 x 10^{-3} N.

DIAGRAM 1

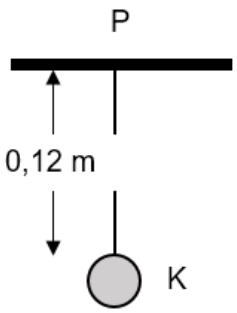
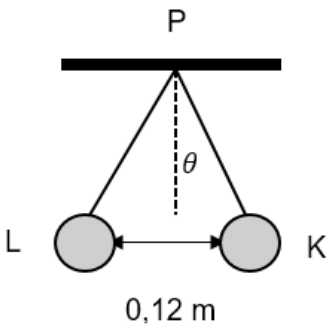


DIAGRAM 2



A second charged sphere L is attached to point P by an identical piece of inelastic thread. The two charged spheres do not touch and remain stationery when the distance between their centres is 0,12 m, as shown in DIAGRAM 2 above.

7.2.1 State Coulomb's law in words. (2)

7.2.2 Draw a labelled free-body diagram showing all the forces acting on the sphere K in DIAGRAM 2. (3)

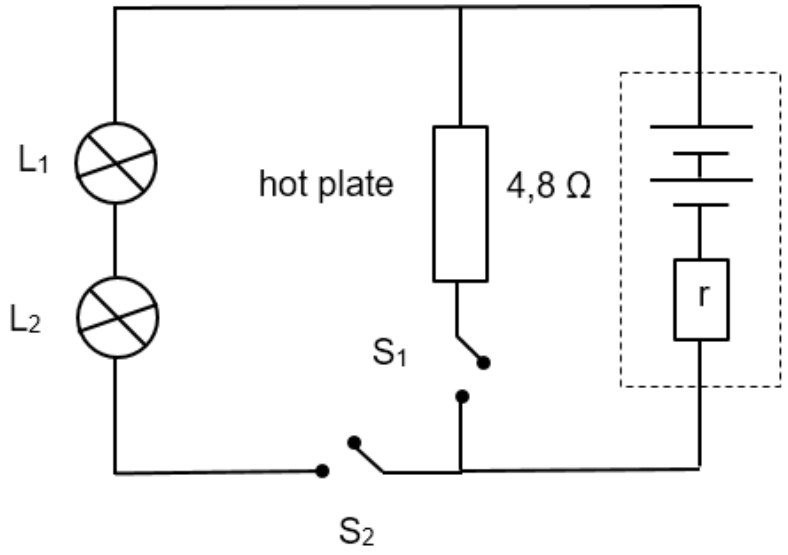
7.2.3 Calculate the angle θ. (2)

7.2.4 Calculate the tension in the thread. (2)

7.2.5 Calculate the magnitude of the electrostatic force that sphere L exerts on sphere K. (2)
[18]

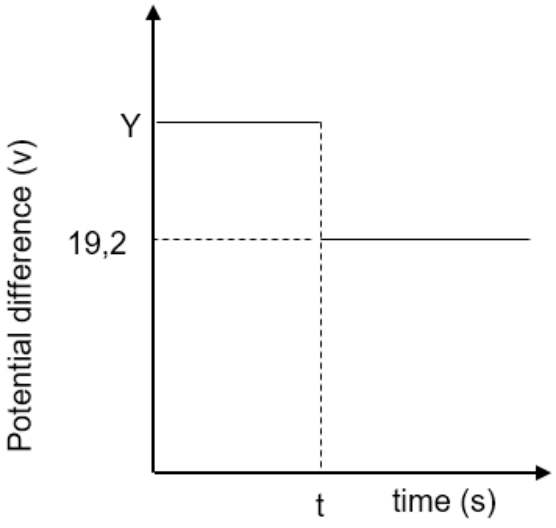
QUESTION 8 (Start on a new page.)

A holiday maker set up a circuit in his caravan. He uses two 12-volt cells of unknown internal resistance. He connects a hot plate and two light bulbs L_1 and L_2 to the cells, as shown in the circuit diagram below.



The hot plate has a resistance of 4,8 Ω and is controlled by switch S_1. The light bulbs L_1 and L_2 are controlled by switch S_2. The resistance of the connecting wires are negligible.

The graph below shows the potential difference across the terminals of the battery before and after switch S_1 is closed, while S_2 remains open. Switch S_1 is closed for t seconds.



8.1 What is the value of Y on the graph? (1)

8.2 Calculate the value of lost volt. (1)

8.3 What is the disadvantage of connecting L_1 and L_2, as shown on the circuit diagram above? (2)

8.4 When the switch S_1 is closed and S_2 remains open, calculate the following:

8.4.1 The current through the hot plate (3)

8.4.2 Internal resistance of the battery (2)

8.5 Both switches are now closed and the battery delivers a current of 8 A during this period.

8.5.1 Calculate resistance of each light bulb. (4)

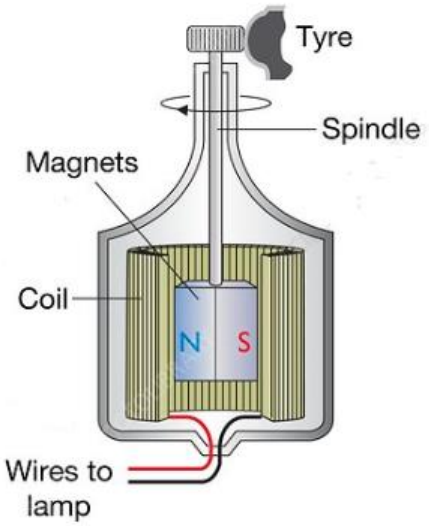
8.5.2 Will the potential difference across the cells INCREASE, DECREASE or REMAINS THE SAME if the hot plate burns out?

Explain your answer WITHOUT calculations. (3)
[16]

QUESTION 9 (Start on a new page.)

Tom used his basic knowledge of electricity and magnetism to make a small dynamo (electric generator) to power a lamp for his bicycle.

9.1 The diagram below illustrates how his dynamo works. The magnet rotates when the disc attached presses the tyre.



9.1.1 What energy conversion takes place in this device? (2)

9.1.2 Explain why Tom DID NOT need to use slip rings for this dynamo. (1)

9.1.3 Tom finds that the faster he pedals his bicycle, the brighter the lamp shines. Write an explanation for this. (3)

9.2 The peak value of the AC voltage across a speaker from a music system is 17 V and the speaker has a resistance of 10 Ω.

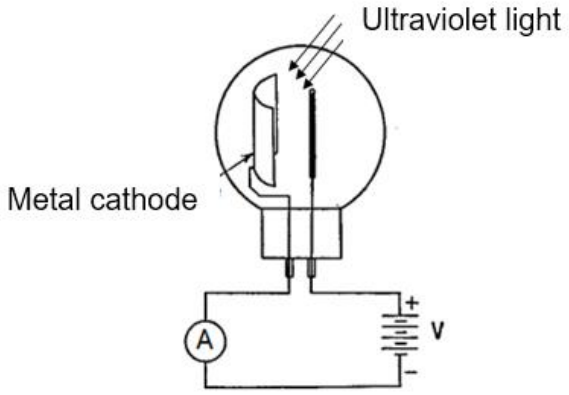
9.2.1 Calculate 'rms' voltage. (3)

9.2.2 Calculate the peak value for the current. (4)

9.2.3 Calculate average power dissipated in this circuit. (3)
[16]

QUESTION 10 (Start on a new page.)

Light incident on the cathode of a photoelectric cell connected to a battery and a sensitive ammeter is shown below.



10.1 Name the particle that carries the charge inside the photoelectric cell. (1)

10.2 Define the term *threshold frequency*. (2)

10.3 The frequency of the incident light on the metal plate is 6,16 x 10^{14} Hz. The released electrons have a kinetic energy of 5,6 x 10^{-20}J.

10.3.1 Calculate the energy of the incident photons. (3)

10.3.2 Calculate threshold frequency of the metal. (3)

10.4 Red light from a 50 W globe is shown on the cathode, there is a small reading on the ammeter. If 50 W globe is replaced by 100 W globe.
How will this change affect the reading on the ammeter?

Choose from INCREASE, DECREASE OR REMAINS THE SAME.

Explain your answer. (3)
[12]

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 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	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 the Earth *Massa van die Aarde*	M_E	5,98 x 10^{24} kg
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = W_0 + K_{max}$ 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*

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