higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(First Paper)
NQF LEVEL 4

(10021004)

27 November 2018 (Y-Paper)
13:00–16:00

Nonprogrammable calculators and appropriate mathematical instruments may be used.

This question paper consists of 13 pages, 1 data sheet and a formula sheet of 2 pages.

TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Give brief motivations or explanations where required.
5. ALL final answers must be accurately approximated to TWO decimal places.
6. Write neatly and legibly.

SECTION A

QUESTION 1

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 A collision in which kinetic energy is conserved

1.2 A grooved wheel that turns readily on an axle and is supported in a frame

1.3 A circuit component that converts AC to DC

1.4 A device that produces electrical energy from mechanical energy

1.5 The energy transferred per unit electric charge in a circuit

(5 × 1) **[5]**

QUESTION 2

Choose an item from COLUMN B that best matches a description in COLUMN A. Write only the letter (A–J) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	The condition in the investigation that is changed	A	Watt
		B	dependent variable
2.2	The ability of a body to do work	C	Joule
2.3	Two carbon blocks pressed lightly against the split rings	D	power
2.4	A particle of electromagnetic radiation	E	proton
2.5	SI unit of measurement of energy	F	commutators
		G	independent variable
		H	energy
		I	brushes
		J	photon

(5 × 1) **[5]**

QUESTION 3

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 The Doppler effect is a change in observed frequency due to the relative motion of a source and an observer.

3.2 The tendancy of an object to remain at rest or to continue in its uniform motion in a straight line is known as Newton's Third Law.

3.3 In a series circuit, a 5 ohm resistor will have less current passing through it than through a 2 ohm resistor.

3.4 The shift of spectral lines toward the red end of the visible spectrum, provides evidence that the universe is expanding.

3.5 When two cars collide, the heavier car exerts a greater force on the lighter car.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 The mass of a satellite on Earth is M. At a height equal to three times the radius of the Earth, the **mass** of the satellite will be…

A 3M
B ⅓M
C 1/9M
D M

4.2 In an explosion a stationary body breaks up into two unequal masses **m** and **M**. They move in a straight line in opposite directions. If mass **m** has a velocity v then the velocity of **M** is …

A $\frac{-mv}{M}$

B v

C $\frac{-M}{mv}$

D - mv

4.3 The siren of an ambulance travelling at a constant speed towards a stationary observer produces sound waves of a frequency of 400 Hz.

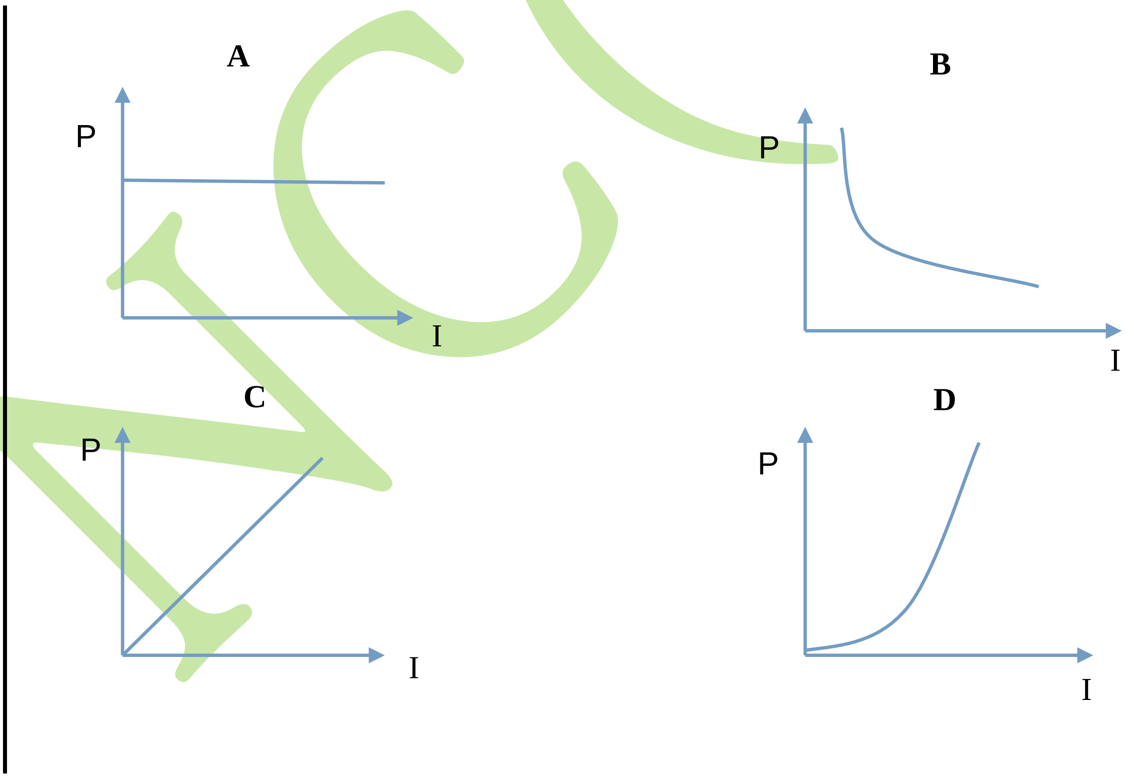
Which ONE of the following frequencies, in hertz, is most likely heard by the observer?

A 350
B 400
C 380
D 480

4.4 Which ONE of the following changes may lead to an increase in the emf of an AC generator without changing the generator's frequency?

A Decrease the speed of rotation
B Increase the area of the coil
C Increase the resistance of the coil
D Decrease the resistance of the coil

4.5 Graph … best represents the relationship between the electrical power and the current in an ohmic conductor.



(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS AND INFORMATION

1. The formula and substitutions must be shown in ALL calculations.

2. Round off your final answers to TWO decimal places.

QUESTION 5: MEASUREMENTS

5.1 Write the SI unit that would be used for each of the following quantities:

5.1.1 Frequency

5.1.2 Momentum

(2 × 1) (2)

5.2 Convert the following:

5.2.1 30 cm^3 into dm^3

5.2.2 650 μm into m

(2 × 1) (2)
[4]

QUESTION 6: FREE-FALLING BODIES

6.1 A building is 10 m tall. Stone **A** is dropped from the top of the building. The initial speed of stone **A** is 0 m·s^{-1}. When stone **A** is 5 m from the ground, stone **B** is thrown straight downward from the same height. Stone **B** is thrown with an unknown speed, v. The two stones strike the ground simultaneously. Ignore the effects of air resistance.

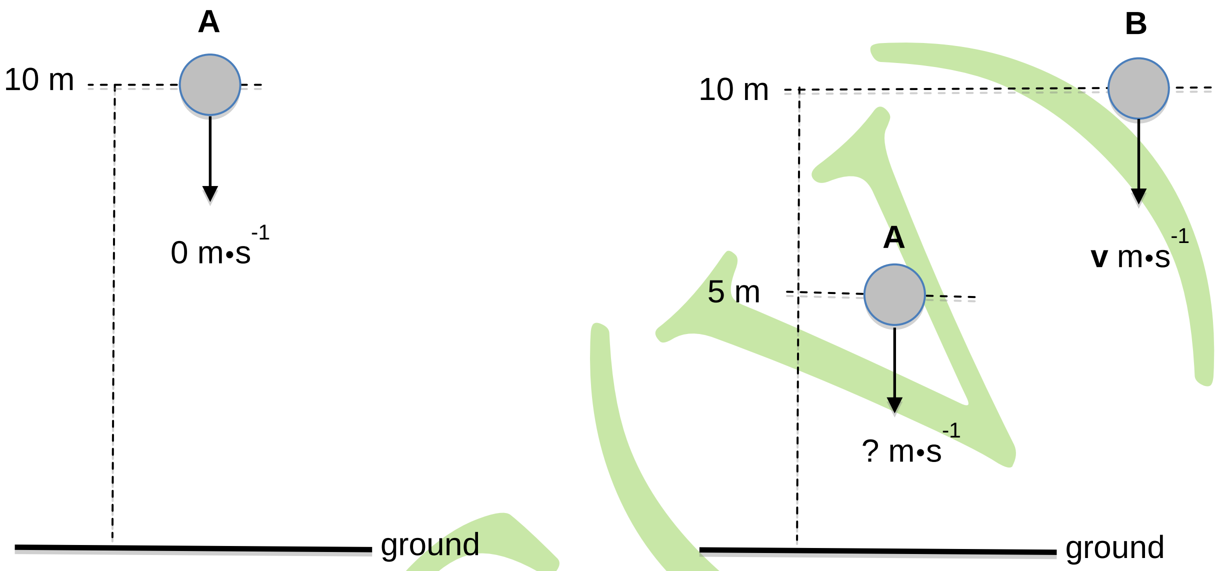


DIAGRAM 1 DIAGRAM 2

Calculate:

6.1.1	Speed of stone **A** when it is 5 m from the ground.	(3)
6.1.2	Time taken by stone **B** to strike the ground.	(6)
6.1.3	Initial speed of stone **B**.	(3)
6.1.4	Final speed of stone **B** as it strikes the ground.	(3)

6.2 Draw a rough position-time graph in the ANSWER BOOK for the motion of stone **B** and indicate all the relevant values on the graph. (3)

[18]

QUESTION 7: MOMENTUM

A 0,05 kg tennis ball travelling horizontally strikes a tennis racket with a speed of 50 m·s^{-1}. The ball is returned with a speed of 70 m·s^{-1} in the opposite direction.

Calculate:

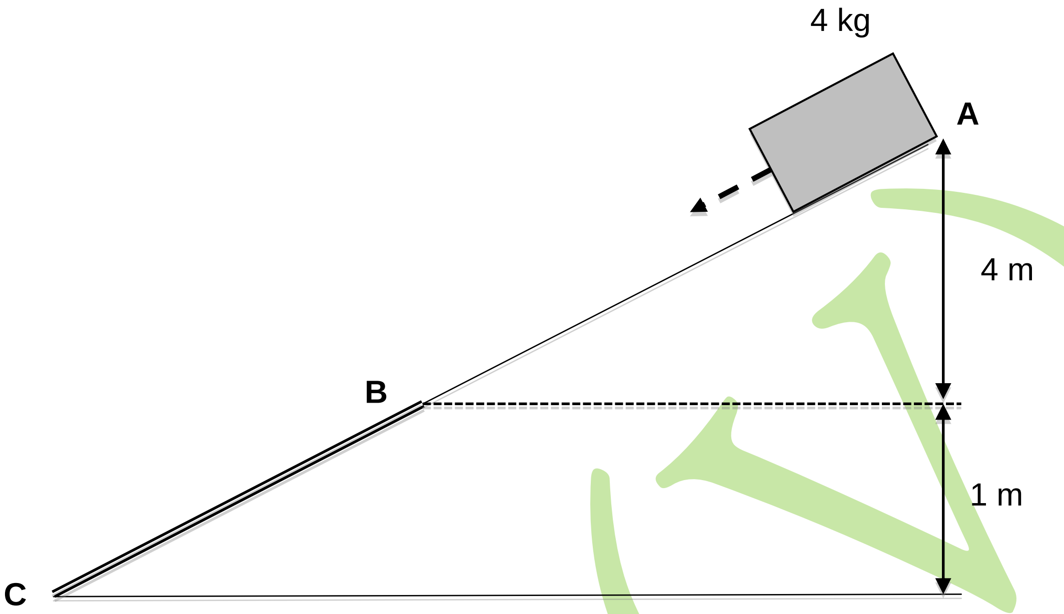
7.1 The impulse delivered to the ball by the racket. (4)

7.2 The force exerted on the ball by the racket if the contact time is 0,02 s. (3)

[7]

QUESTION 8: WORK, POWER AND ENERGY

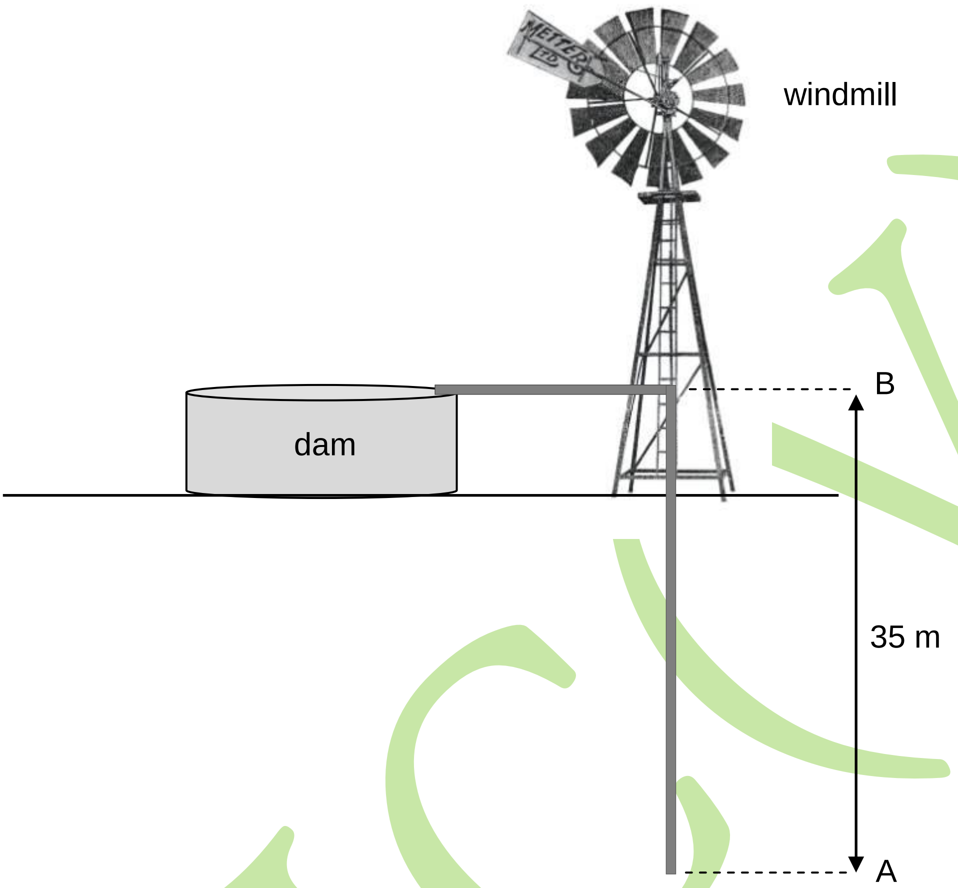
8.1 A 4 kg object moves from rest down an inclined path **ABC** as shown below. Section AB of the path is frictionless.



8.1.1 Calculate the mechanical energy of the object at **A**. (3)

8.1.2 Use the principle of conservation of mechanical energy to calculate the speed of the object at **B**. (5)

8.2 On a farm, a windmill is used to pump stationary water from a well point through a vertical height of 35 m. By measuring the amount of water being collected in the dam, the farmer calculates that 150 L of water are pumped every 1,5 minutes. The density of the water is taken as 1 g/cm^3.



8.2.1 Calculate the work done to lift one litre of water from A to B. (4)

8.2.2 Calculate the *power* delivered by the pump. (4)
[16]

QUESTION 9: MECHANICAL ADVANTAGE

A pulley system lifts a 2 500N load with an effort of 500 N.

Calculate:

9.1 The mechanical advantage of the system. (3)

9.2 The effort force required to lift a load of 700 N. (3)
[6]

QUESTION 10: WAVES, SOUND AND LIGHT

10.1 A fire engine is moving towards Patrick, who is standing by the side of the road. The fire engine is moving at a constant speed of 25 $m \cdot s^{-1}$. The siren of the fire engine emits sound waves having a wavelength of 0,23 m. The speed of sound in air is 340 $m \cdot s^{-1}$.

10.1.1 Calculate the frequency of the sound waves emitted by the siren as heard by the fire engine driver. (3)

10.1.2 Calculate the frequency of the sound waves emitted by the siren as heard by Patrick. (5)

10.1.3 How would the answer to QUESTION 10.1.2 change if the speed of the fire engine decreased to 20 $m \cdot s^{-1}$.
Write down only INCREASES, DECREASES or REMAINS THE SAME. (2)

10.2 Consider the following electromagnetic radiations and answer the questions.

microwaves X-rays radio waves unltraviolet waves gamma waves

10.2.1 Give TWO characteristics that these radiations have in common. (2)

10.2.2 Which ONE of the types of radiation mentioned in the list above has the highest penetrative ability? (2)

10.2.3 Which one of the listed radiations has the longest wavelength? (2)

[16]

QUESTION 11: PHOTOELECTRIC EFFECT

A group of learners perform an experiment to investigate the photoelectric effect. They irradiate a metal disc M with three light sources of different wavelengths and note the ejection of the photoelectrons from the metal.

The results obtained are shown in the following table:

LIGHT SOURCE	**WAVELENGTH ($\times 10^{-9}$ m)**	**EJECTION OF PHOTOELECTRONS**
A	480	Electrons ejected and moving away from the metal
B	620	No electrons ejected
C	570	Electrons ejected and NOT moving away from the metal

11.1 Define the *photoelectric effect* in words. (2)

11.2 Explain why light source **A** will eject electrons from the metal disc M, but light source **B** will not eject electrons. (2)

11.3 Calculate the *work function* of the metal M. (3)

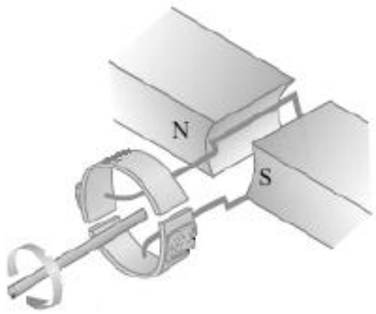
11.4 Calculate the speed with which the electrons will move away from the metal disc M when it is irradiated with light source **A**. (5)

11.5 Light source **A** is BLUE light and light source **B** is ORANGE light.
Which colour is possibly light source **C**?
Choose only between VIOLET, GREEN or RED. (2)

[14]

QUESTION 12: ELECTRICITY

12.1 A generator is shown below. Assume that the coil is in a vertical position.

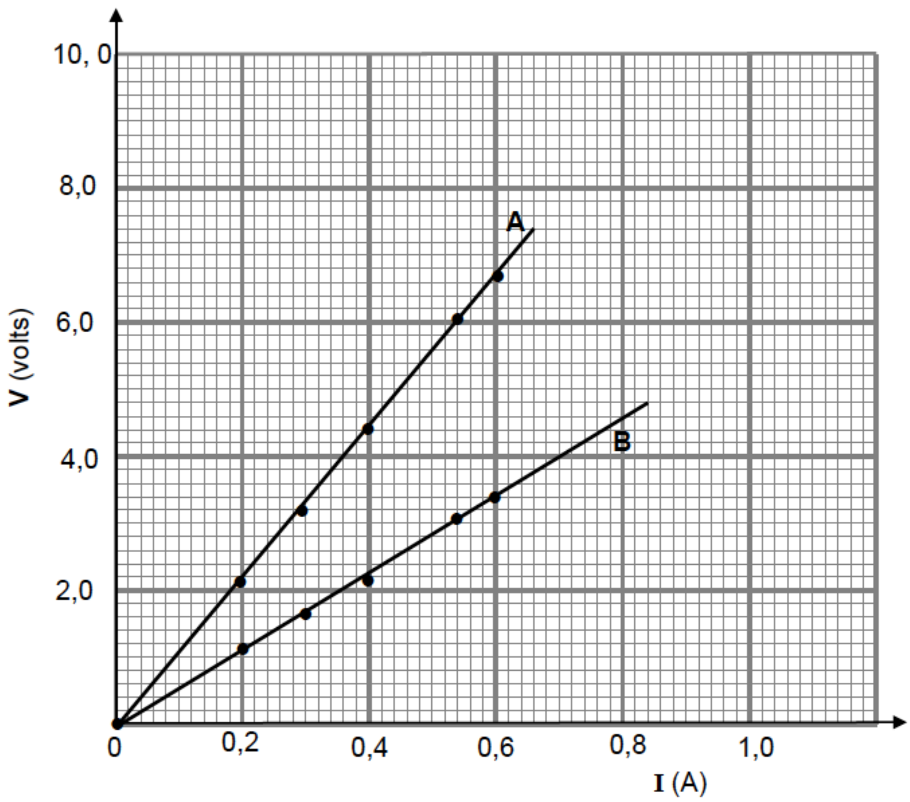


12.1.1 Is this an AC or DC generator? Give a reason for the answer. (2)

12.1.2 The coil starts turning from the vertical position. Sketch an induced emf vs time graph for TWO complete rotations of the coil. (3)

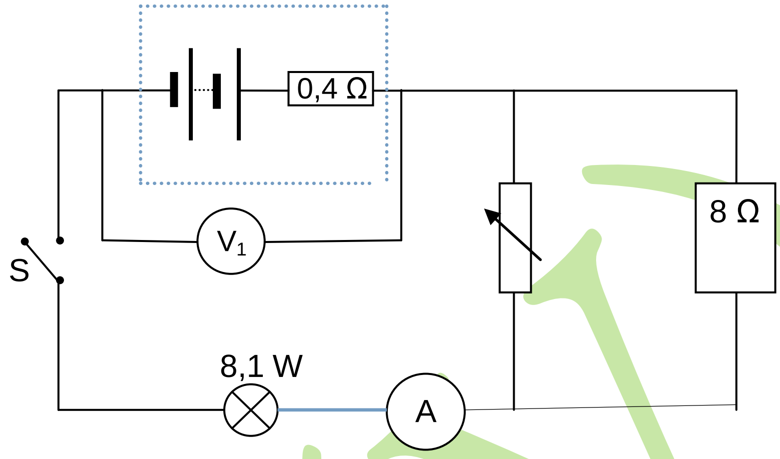
12.2 Bontle and her friends wish to establish which resistance wire (**A** or **B*)*** will heat a quantity of water faster. They obtain the following results from their experimentation:

Graph of V versus I for resistors A and B



Assuming that Bontle and her friends keep all relevant factors constant, which wire, **A** or **B**, will be a more suitable heater of water? Use calculations to show how you arrived at the answer. (7)

12.3 A resistor, a light bulb and a rheostat are connected to an 8,4 V battery, with an internal resistance of 0,4 Ω, as shown in the diagram below. The power of the light bulb is 8,1 W. The rheostat is changed until the ammeter shows a reading of 1,5 A when the switch **S** is closed.



12.3.1 Calculate the resistance of the light bulb. (3)

12.3.2 Calculate the resistance of the rheostat when the reading on the ammeter is 1,5 A. (6)

12.4 The rheostat is changed so that the resistance of the rheostat substantially increases.
How will the following readings be influenced? Write only INCREASES, DECREASES or REMAINS THE SAME.

12.4.1 The total resistance in the circuit.

12.4.2 The EMF of the battery.

12.4.3 The reading on V_1.

(3 × 2) (6)
[27]

QUESTION 13: ELECTRONICS

13.1 State THREE factors on which the inductance of an inductor depends. (3)

13.2 A parallel plate capacitor consists of two metal plates, each of area 150 cm^2. They are separated by a vacuum gap 0,60 cm thick.

What is the capacitance of this device? (4)
[7]

TOTAL SECTION B: 115
GRAND TOTAL: 150

DATA SHEET

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m\cdot s^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J\cdot s$
Gravitational constant	G	$6{,}67 \times 10^{-11}\ N\cdot m^{2}\cdot kg^{-2}$
Coulomb's constant	k	$9{,}0 \times 10^{9}\ N\cdot m^{2}\cdot C^{-2}$
Charge on electron	e^{-}	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$
Permittivity of free space	ε_0	$8{,}85 \times 10^{-12}\ F\cdot m^{-1}$
Permeability of free space	μ_0	$4\pi \times 10^{-7}\ T\cdot m\cdot A^{-1}$

FORMULA SHEET

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* $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ 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* $K_{max} = \frac{1}{2}mv_{max}^2$	

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*

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