GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2021

10841

PHYSICAL SCIENCES: PHYSICS

PAPER 1

TIME: 3 hours

MARKS: 150

14 pages + 3 data sheets

PHYSICAL SCIENCES: Paper 1

10841E

X05

P.T.O.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
2. You may use a non-programmable calculator.
3. You may use appropriate mathematical instruments.
4. You are advised to use the attached DATA SHEETS.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Start the answer to EACH question on a NEW PAGE.
7. Leave ONE line between two sub-questions, for example, between QUESTION 2.1 and QUESTION 2.2.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round-off your final numerical answers to a minimum of TWO decimal places where needed.
10. Give brief motivations, discussions, et cetera where required.
11. 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Inertia is a property of an object whereby the object …

A needs a force to accelerate.
B comes to rest when the force that has set it in motion is removed.
C has kinetic energy.
D is not able to move. (2)

1.2 A box, mass **m,** rests on the floor of a lift which is accelerating upwards. The lift's acceleration is **a** and the acceleration due to gravity is **g**. The net force on the box is equal to:

A ma
B -mg
C ma + (-mg)
D ma – (-mg) (2)

1.3 A learner drops an object from the 15th floor of a high building. One second later the learner drops another identical object from the same position. As both objects are in free fall, the distance between them will …

A increase.
B decrease.
C initially increase, then decrease.
D remain the same. (2)

1.4 A trolley with mass **m**, is moving with a constant horizontal velocity of **v**, on a frictionless track. A block with mass **m**, is dropped onto the trolley, from above. The final velocity of the trolley and block will be:

A 0

B v

C $\frac{v}{2}$

D $\frac{v}{4}$ (2)

1.5 An AC electric motor has a power rating of 1,2 kW. In ONE minute, the amount of work done by the motor (in Joule) is:

A 1 200
B 2 000
C 72
D 72 000 (2)

1.6 A car travels at a constant velocity towards a stationary listener. The car's hooter emits a sound of constant frequency as it approaches the listener.

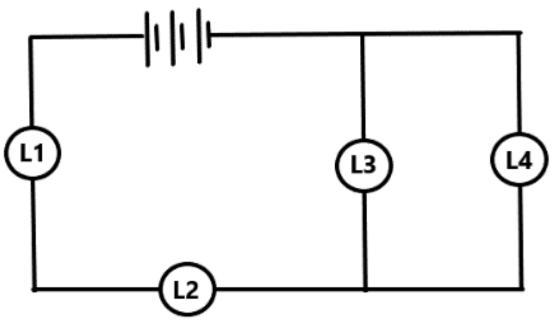
Which ONE of the following statements regarding the frequency and the wavelength of the sound of the hooter, as observed by the listener, is CORRECT?

A Both the frequency and the wavelength have decreased.
B Both the frequency and the wavelength have increased.
C The frequency has decreased while the wavelength has increased.
D The frequency has increased while the wavelength has decreased. (2)

1.7 The number of excess electrons which will cause a charge of -8µC on a sphere, is equal to:

A 5×10^{-13}
B 5×10^{13}
C 5×10^{14}
D 5×10^{-14} (2)

1.8 Four identical light bulbs are connected as shown in the diagram below.



How does the brightness and potential difference of **L4** compare with the brightness and potential difference of **L1**?

	BRIGHTNESS	POTENTIAL DIFFERENCE
A	LESS	LESS
B	LESS	THE SAME
C	THE SAME	LESS
D	THE SAME	THE SAME

(2)

1.9 Which ONE of the following devices cannot operate with both DC and AC currents?

A Electric kettle
B Transformer
C 240 V Light bulb
D Electric fan (2)

1.10 In an experiment on the photoelectric effect, a scientist shines a green light on a metal surface and observes that electrons are ejected from the metal surface. Later the scientist shines a blue light, with the same intensity as the green light, on the same metal surface.

Which ONE of the statements below will be the CORRECT observation as a result of this change?

A The number of ejected electrons per second will increase.
B The number of ejected electrons per second will decrease.
C The maximum kinetic energy of the ejected electrons will increase.
D The speed of the ejected electrons will decrease. (2)

[20]

QUESTION 2 (Start on a new page.)

An empty lift is supported by a steel cable. The lift moves upwards at a **constant speed** while an upward force of 2 500 N is applied by the cable. Ignore the mass of the cable and all frictional forces.

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

2.2 Draw a labelled free-body diagram indicating all the forces acting on the lift while it is travelling upwards at this constant speed. (2)

2.3 Write down the magnitude of the acceleration of the lift as it moves upwards. (1)

2.4 Calculate the mass of the empty lift. (3)

2.5 When the 2 500 N force of the cable is replaced by a force of 3 000 N, the lift accelerates upwards. Calculate the magnitude of this acceleration. (4)

2.6 Identify the force that forms a Newton III force pair with the weight of the empty lift. (2)

[14]

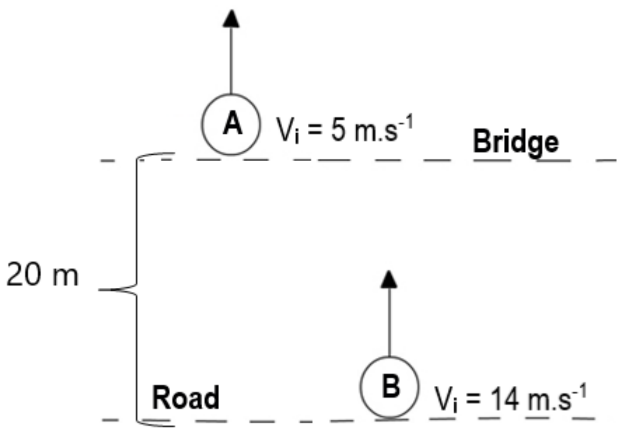
QUESTION 3 (Start on a new page.)

A boy standing on a bridge projects a **ball A** vertically upwards with an initial velocity of 5 m·s^{-1}. The height of the bridge is 20 m. Ignore air resistance.

3.1 Give the magnitude and direction of the acceleration of **ball A** as it leaves the boy's hand. (2)

3.2 Calculate the total time it will take **ball A** to reach the road. (4)

At the same instant that **ball A** is thrown upwards from the top of the bridge, another **ball B,** is projected up from the road. **Ball B** has an initial velocity of 14 m·s^{-1}.



3.3 Calculate how far apart **ball A** and **ball B** will be after 1,2 s. (6)

Tennis **ball A** hits the road below, stays in contact with the road for 0,2 seconds before it bounces up with a velocity of 14 m·s^{-1}.

3.4 Draw a velocity-time sketch graph for the motion of **ball A** from the time that it is projected up from the bridge until the time it rebounds to a maximum height.

Clearly indicate the following on your graph:

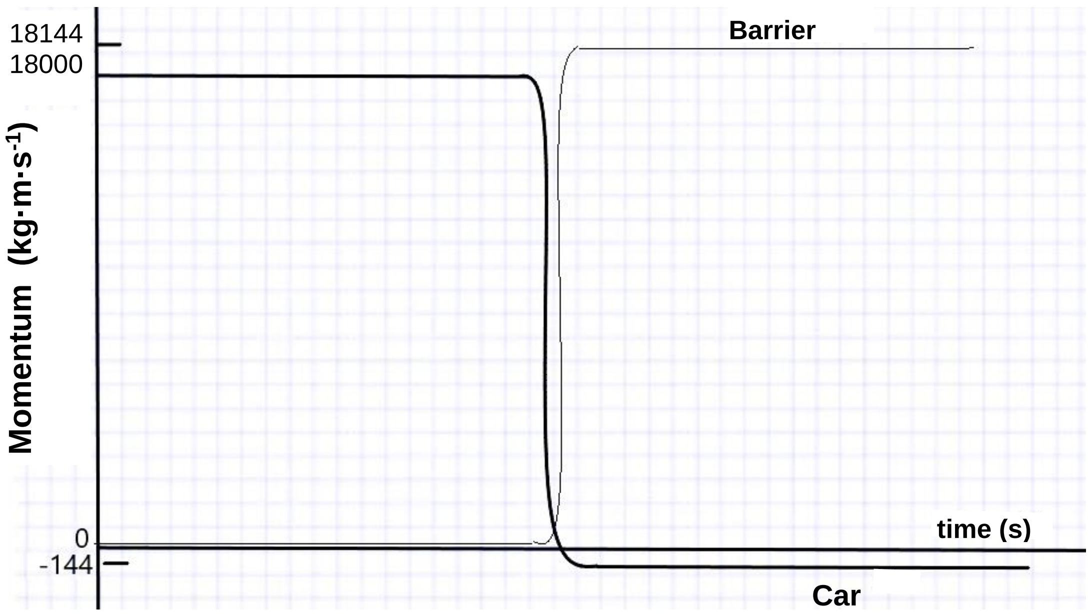
3.4.1 The initial velocity of the ball.
3.4.2 The time when the ball hits the road and is in contact with the road.
3.4.3 The velocity of the ball when it rebounds from the road. (4)

[16]

QUESTION 4 (Start on a new page.)

A car with a mass of 900 kg is moving east and collides with a free-standing barrier that has a mass of 3 200 kg.

Study the following momentum-time graph of the car and the barrier below and answer the questions that follow.



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

4.2 Use the information given on the graph and calculate the:

4.2.1 Final speed and direction of the car (4)

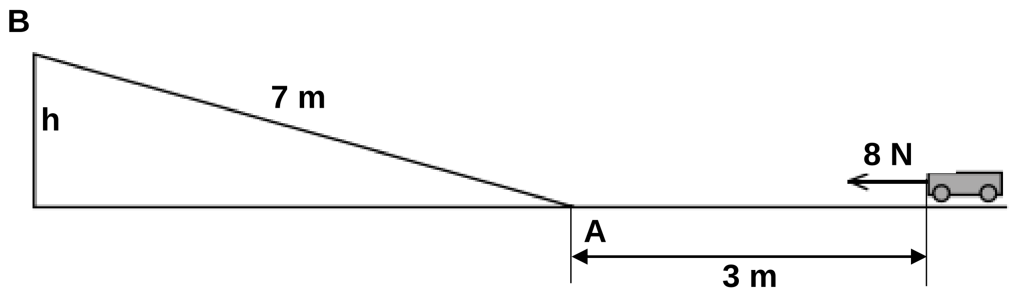
4.2.2 Impulse on the car (4)

4.3 Is this collision elastic or inelastic?

Use calculations to verify your answer. (5)
[15]

QUESTION 5 (Start on a new page.)

A 2 kg trolley is at rest on a horizontal frictionless surface. A constant horizontal force of 8 N is then applied to the trolley over a distance of 3 m.



At point **A**, in the diagram above, the force is removed. The trolley moves a distance of 7 m up the incline until it reaches a maximum height at point **B**. The trolley experiences a constant frictional force of **1,5 N** while moving up the incline.

5.1 Define a *non-conservative force*. (2)

5.2 Draw a labelled free-body diagram indicating all the forces acting on the trolley as it moves along the horizontal surface. (3)

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

5.4 Use energy principles to calculate the:

5.4.1 Speed of the trolley when it reaches point **A** (4)

5.4.2 Height, *h*, that the trolley reaches at point **B** (4)

[15]

QUESTION 6 (Start on a new page.)

A group of Grade 12 learners stand outside a fire station when a fire engine races past them on a call. The siren of the fire engine emits a sound with a frequency of 250 Hz while moving at a speed of 20 $m.s^{-1}$ past the learners with flashing red lights. <u>The group of learners notice that the sound of the siren changes as the fire engine moves away from them</u>. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1 Name the phenomenon described in the underlined sentence above. (1)

6.2 How would each of the following change as the fire engine moves away from the learners? Write only GREATER THAN, LESS THAN or STAYS THE SAME.

6.2.1 Frequency observed by the learners (1)

6.2.2 The speed of the sound in air (1)

6.3 Calculate the apparent frequency of the sound from the siren observed by the learners when the fire engine moves away from the learners at a speed of 20 $m.s^{-1}$. (4)

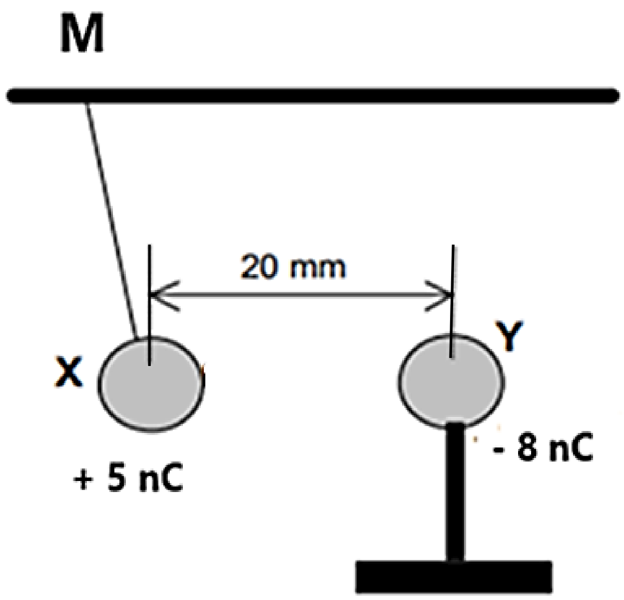
6.4 Draw a diagram to show the advancing wavefronts that are produced by the sound as the fire engine moves away from the learners. Clearly indicate the learners' position and the direction of the fire engine's velocity in the diagram. (2)

6.5 There is a noticeable change in the frequency of the sound, but no noticeable change in the colour of the flashing red light as the fire engine races past the learners. Explain these observations. (3)

[12]

QUESTION 7 (Start on a new page.)

A metal sphere **X**, with a charge of +5 nC is suspended by an inelastic thread of negligible mass which is tied to the ceiling at point **M**. Another metal sphere **Y**, on an insulated stand, has a charge of –8 nC and is brought closer to sphere **X** until their centres are 20 mm apart.



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

7.2 Calculate the magnitude of the electrostatic force that sphere **Y** exerts on sphere **X**. (4)

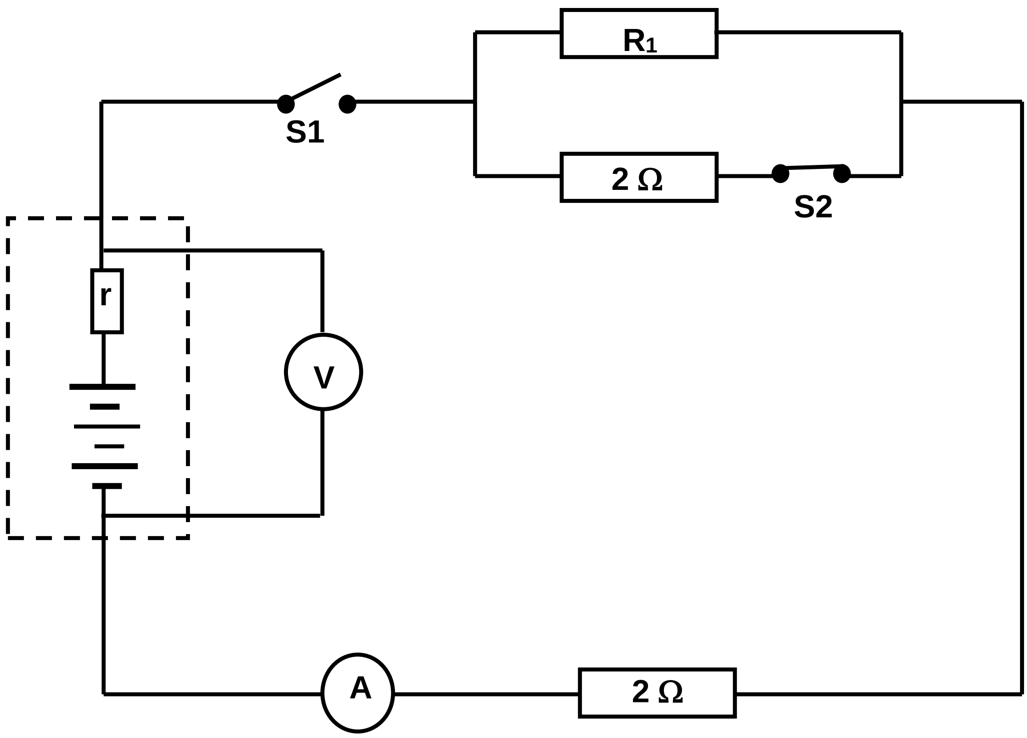
7.3 Draw the resultant electric field pattern produced by spheres **X** and **Y**. (3)

7.4 Sphere **Y** is now moved closer and makes contact with sphere **X** after which sphere **X** is repelled.

Calculate the new charge on sphere **X**. (3)
[12]

QUESTION 8 (Start on a new page.)

A battery with an emf of **8 V** and an internal resistance **r**, is connected in a circuit as shown below.



If switch **S₁** is closed, the reading on the voltmeter is **6,86 V** and on the ammeter is **2 A**.

8.1 Explain the meaning of an emf of **8 V**. (2)

8.2 Calculate the internal resistance **r**, of the battery. (3)

8.3 Calculate the value of the unknown resistor **R_1**. (5)

8.4 Define the term *power*. (2)

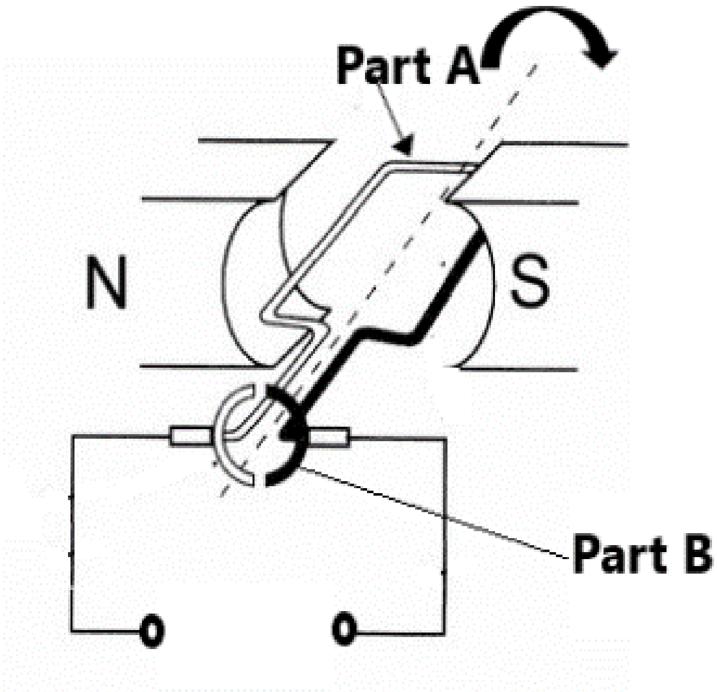
8.5 Switch **S_2** is now opened.

8.5.1 What effect will the power dissipated by **R_1** have? Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)

8.5.2 Explain your answer to QUESTION 8.5.1. (3)
[16]

QUESTION 9 (Start on a new page.)

The diagram below shows a simple generator.



9.1 Is this an AC or a DC generator? (1)

9.2 Give a reason for your answer to QUESTION 9.1. (2)

9.3 Write the name of **Part A**. (1)

9.4 Describe the energy conversion that takes place in the generator. (2)

9.5 The maximum emf generated is 15 V. Draw a sketch graph of emf-versus-time for ONE and a HALF cycles for this generator. (3)

9.6 The specifications of a professional hairdryer are as follows:

2 100 Watt, AC motor 240 V

9.6.1 Define *rms* for an *alternating voltage*. (2)

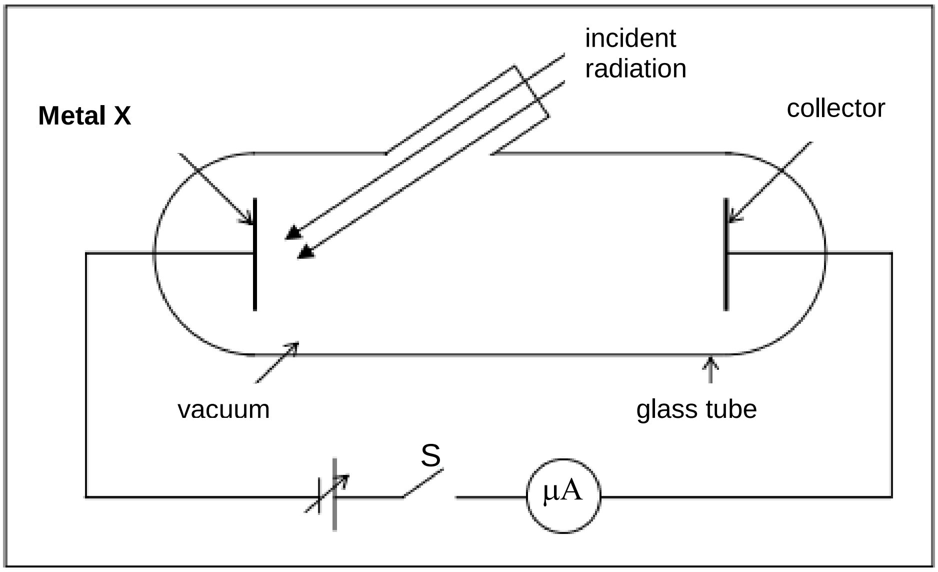
9.6.2 What is the rms voltage for this hairdryer? (2)

9.6.3 Calculate the maximum current that might flow through the hairdryer. (4)

[17]

QUESTION 10 (Start on a new page.)

The apparatus shown below allows for several variables in the investigation of the photoelectric effect. A learner sets up the apparatus and measures the maximum kinetic energy of photoelectrons emitted from the surface of metal **X**, using different frequencies of the incident radiation.



Metal	Work function (J)
Sodium	$3,65 \times 10^{-19}$
Magnesium	$5,92 \times 10^{-19}$
Aluminium	$6,53 \times 10^{-19}$
Zinc	$7,15 \times 10^{-19}$

10.1 Describe the term *photoelectric effect*. (2)

10.2 Light with different wavelengths is shone onto metal **X** and the kinetic energy is measured.

10.2.1 Name the independent, dependent and the controlled variables of this experiment. (3)

10.2.2 When ultraviolet light with a wavelength of 280 nm is shone onto metal **X**, the kinetic energy of the released electron is $5,74 \times 10^{-20}$ J. Identify metal **X** in the table given above. (5)

10.2.3 The maximum kinetic energy of the electrons ejected by this ultraviolet light is greater than the maximum kinetic energy of the electrons ejected by the bright blue light.
Explain why this is so. (3)
[13]

TOTAL: 150

END

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	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of the earth *Radius van die aarde*	R_E	$6,38 \times 10^{6}\ m$
Mass of the earth *Massa van die aarde*	M_E	$5,98 \times 10^{24}\ kg$
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	$9,11 \times 10^{-31}\ kg$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gem} = Fv_{gem}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

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*

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