GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PROVINCIAL EXAMINATION

JUNE 2018

GRADE 11

PHYSICAL SCIENCES: PHYSICS

PAPER 1

TIME: 3 hours

MARKS: 150

15 pages + 2 data sheets and 1 answer sheet

P.T.O.

GAUTENG DEPARTMENT OF EDUCATION
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PHYSICAL SCIENCES: PHYSICS (Paper 1)

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INSTRUCTIONS AND INFORMATION:

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL questions in the ANSWER BOOK except QUESTION 7.4 which has to be answered on the graph paper attached to this question paper. Write your name in the appropriate space on the graph paper.
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 subquestions, 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 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, et cetera where required.
12. Write neatly and legibly.

SECTION A

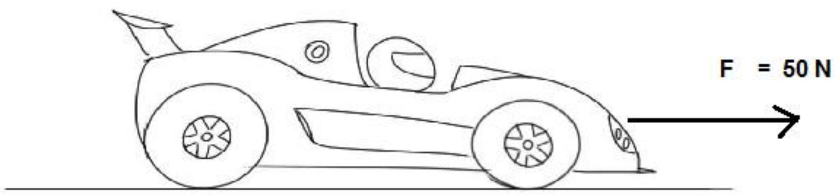
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number **(1.1 – 1.10)** in the ANSWER BOOK, for example **1.11 A**.

1.1 Which ONE of Newton's Laws is in control of a spacecraft traveling through space without using fuel?

A Newton's First Law
B Newton's Second Law
C Newton's Third Law
D Newton's Law of Universal Gravitation (2)

1.2 A toy racing car of weight 30 N is moving on a straight level road with a rough surface at a **constant velocity**. The force of the engine of the car is 50 N. Which one of the following is the resultant force acting on the car?



A 50 N to the right
B 50 N to the left
C 0 N
D 30 N (2)

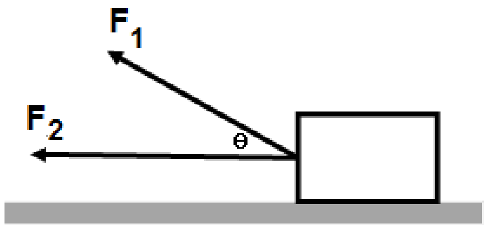
1.3 The best definition of reflection is …

A changing direction when crossing a boundary.
B changing speed at a boundary.
C passing through a boundary.
D bouncing off a boundary. (2)

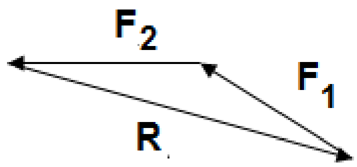
1.4 A car of mass **m** collides head-on with a truck of mass 2 m. If the car exerts a force of magnitude **F** on the truck during the collision, the magnitude of the force that the truck exerts on the car is …

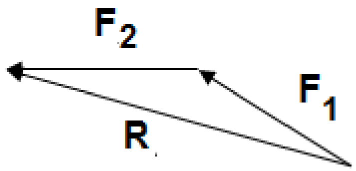
A ½ F
B F
C 2 F
D 4 F (2)

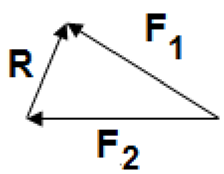
1.5 Two forces act on a crate to pull it to the left. The crate lies on a horizontal frictionless surface as shown in the diagram.

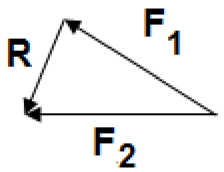


Which vector diagram correctly shows how the resultant force **R** on the crate can be determined?

A


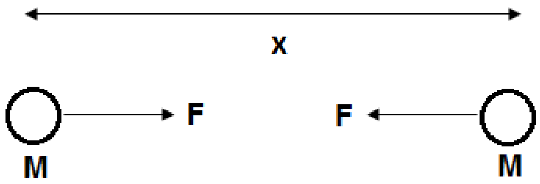
B


C


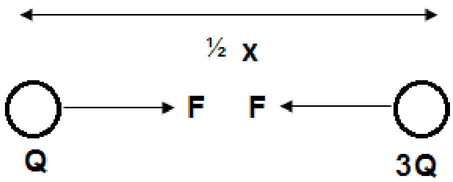
D


(2)

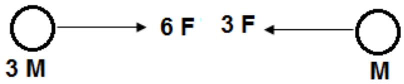
1.6 The gravitational force **F**, exerted on each other by two identical metal spheres, each with a mass **M** and separated by a distance x, can be represented as in the diagram below.

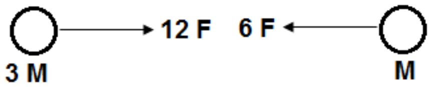


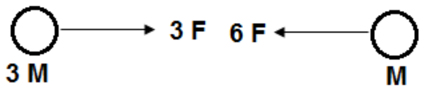
Two other metal spheres with masses of M and 3M respectively are ½ x apart.

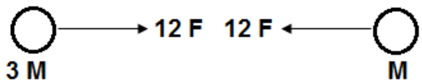


Which ONE of the following diagrams best represents the new forces which these two spheres experience?

A


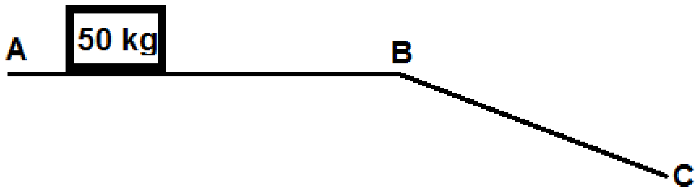
B


C


D


(2)

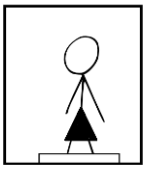
1.7 A crate moves at a **constant velocity** *v* across a horizontal surface AB, after which it slides down the slope BC. The coefficient of kinetic friction is the same throughout ABC.



Which ONE of the following statements is true?

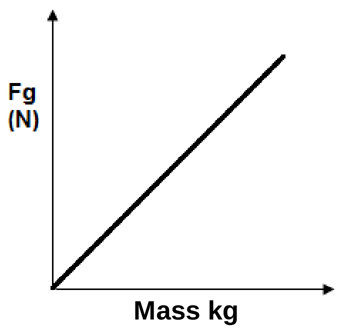
A f_k(slope) < f_k(horizontal)
B f_k(slope) > f_k(horizontal)
C f_k(slope) = f_k(horizontal)
D $\mu_k N$(slope) > $\mu_k N$(horizontal) (2)

1.8 A girl, mass 50 kg stands on a bathroom scale in a lift. If the reading on the scale is 560 N, then …



A the lift moves upwards at a constant velocity.
B the lift moves upwards at a constant acceleration.
C the lift moves downwards at a constant velocity.
D the lift moves downwards at a constant acceleration. (2)

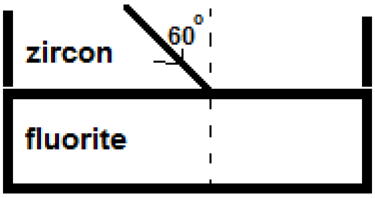
1.9 The following graph shows the relationship between gravitaional force and the mass of the object near the suface of the earth.



The gradient of the graph represents ...

A mass of the earth.
B radius of the earth.
C gravitation acceleration of the earth.
D weight of the object. (2)

1.10 When a light ray passes from zircon (n = 1,923) into fluorite (n = 1,434) at an angle of 60˚, its path is …



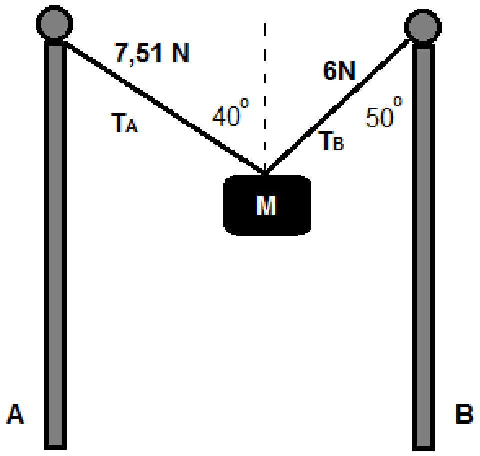
A parallel to the normal.
B reflected internaly in the zircon.
C bent towards the normal.
D bent away from the normal. (2)

TOTAL SECTION A: (10x2) [20]

SECTION B

QUESTION 2: (START ON A NEW PAGE)

Heavy rain caught a learner on his way back home from school. On reaching home, he emptied his backpack and hung his backpack on the washing line between two vertical parallel poles. The bag remains in equilibrium. He realised that the angle between the washing line and pole B is 50°. On further investigation he noted that force on the washing line between his bag and pole A is 7,51 N as shown in the diagram below:



2.1 Draw a vector diagram showing at least one angle and all forces acting on the bag. (4)

2.2 Write down the magnitude of the resultant of all forces acting on the bag. (2)

2.3 Name and explain the principle you used to answer question 2.2 (2)

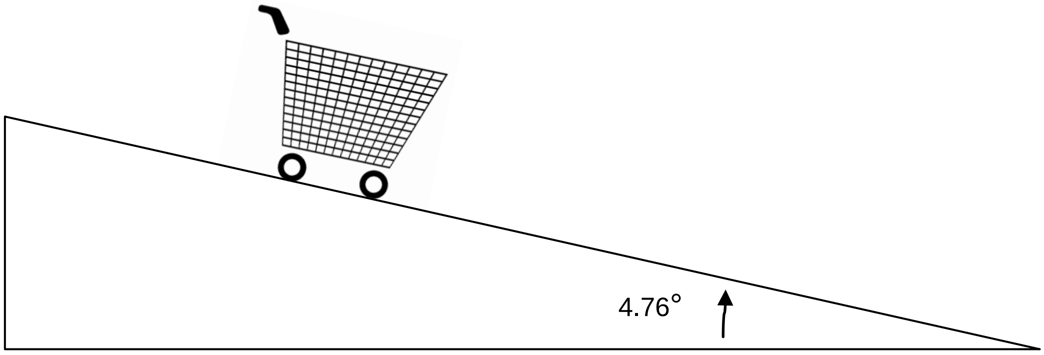
2.4 Calculate the mass of this “wet bag” if the force on the washing line between the bag and pole A is 7,51 N (5)

2.5 When the bag is completely dry, the washing line becomes more contracted (more horizontal). How would the magnitude of F_B change? Only write down INCREASE, DECREASE or REMAINS THE SAME. (2)

[15]

QUESTION 3: (START ON A NEW PAGE)

National Building Regulations recommended specifications for trolley and wheelchair ramps specifies that a ramp must be 6 m in length, while the angle of the ramp must equal 4.76°. The combined mass of the trolley and its contents is 80 kg. The coefficient of static friction between the wheels of the trolley and the ramp is 0.1 which drops to 0.09 once the trolley is moving.



3.1 Define the term **static friction**. (2)

3.2 Draw a labelled diagram showing all the forces acting on the trolley. (3)

3.3 While the trolley is at the top of the ramp:

- 3.3.1 Calculate the normal force. (3)
- 3.3.2 Calculate the maximum force of static friction. (2)
- 3.3.3 Explain, with the aid of a calculation, whether the trolley will start to roll down the ramp on its own or not. (4)

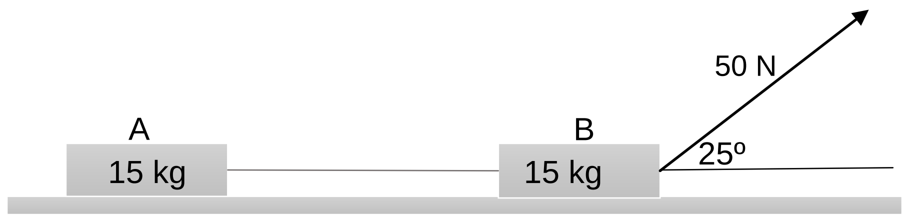
3.4 If the ramp is longer than 6 m, a less steep gradient is required. For a ramp of a less steep gradient, state whether the following would **increase**, **decrease** or **remain the same**.

- 3.4.1 The angle of the ramp (1)
- 3.4.2 The coefficient of friction (1)
- 3.4.3 The force of kinetic friction (1)
- 3.4.4 Refer to a relevant Physics principle, law or equation(s) to explain your answer to Question 3.4.3. (2)

[19]

QUESTION 4: (START ON A NEW PAGE)

Two identical wooden crates of equal masses, A and B are joined together with a string. They are used on a carrot farm to collect the harvest to carry to the storeroom. Each crate carries a mass of 15 kg and they are dragged across level rough surface by a force 250 N on crate B that forms an angle 25º with the horizontal. There is a frictional force of 11 N working in on each crate.



4.1 State Newton's second law of motion in words. (2)

4.2 Calculate the …

4.2.1 magnitude of the tension in the string. (8)

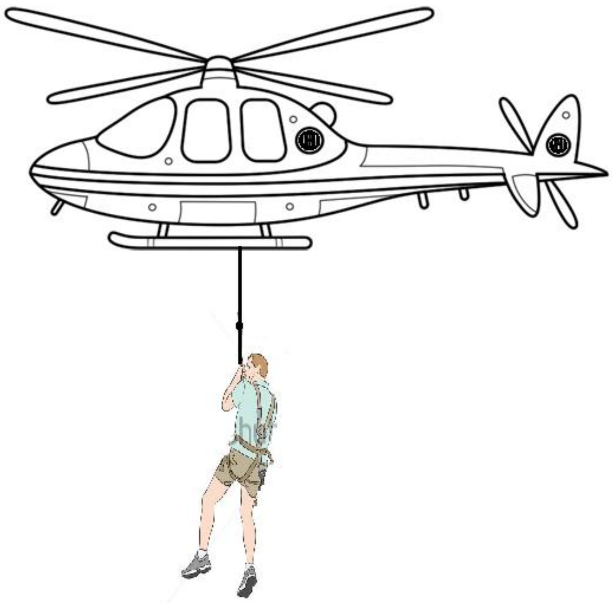
4.2.2 coefficient of kinetic friction on crate B. (4)

4.3 If a 2 kg bag of carrots is loaded to crate B without any other change made, explain what will happen to the system. (3)

[17]

QUESTION 5: (START ON A NEW PAGE)

The actor, Christian Bale, performed his most dangerous stunt in the movie, *Rescue Dawn*. Bale had to hang on a rope below a helicopter as he was lifted from an open space in the forest.
The system, comprising of the helicopter (mass 2 tons), and Bale, hanging stationary, is represented below:



The mass of Bale is 80 kg. Rope A connects Bale to the helicopter and there is a tension of 920 N in the rope. The rope does not stretch and the mass of the rope can be ignored.

5.1 Draw a labelled free-body diagram showing all the forces acting on Bale. (3)

5.2 Why does Bale remain stationary despite the tension being greater than his weight? (2)

When they have cleared the forest, a winch inside the helicopter starts to lower Bale downwards, onto a boat, with an acceleration of 0,18 $m.s^{-2}$ while the helicopter remains in its position, with the rotor blades still moving at the same speed.

5.3 Calculate the tension in the rope while Bale is being lowered. (5)

5.4 State Newton's third law of motion. (2)

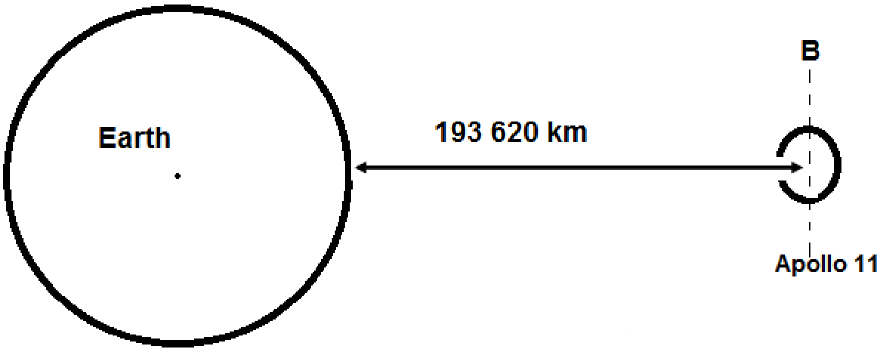
5.5 Identify an action-reaction force pair working in on Bale. (2)

5.5 Indicate the magnitude of the force of Bale on the rope. (1)

[15]

QUESTION 6: (START ON A NEW PAGE)

Apollo 11, with a mass of 300 kg, was the first manned spaceship to travel to and land on the moon. The Earth has a mass of $6,0 \times 10^{24}$ kg while the Moon has a mass of $7,3 \times 10^{22}$ kg.



6.1 State *Newton's Law of Universal Gravitation*. (2)

6.2 At some position between the Earth and the Moon, Apollo 11 would have experienced a resultant force of zero. Explain how this is possible. (2)

6.3 Calculate the magnitude of the gravitational force of attraction that Apollo 11 will experience at point B. (5)

6.4 An Astronaut has to go for a spacewalk to do some repairs. Why does the astronaut appear weightless? (2)

Curiosity is a car-sized robotic rover exploring the Gale Crater on Mars as part of NASA's Mars Science Laboratory mission. The rover was first tested on the Moon.

Curiosity has a mass of 899 kg including 80 kg of scientific instruments. The rover is 2.9 m long by 2.7 m wide by 2.2 m in height.

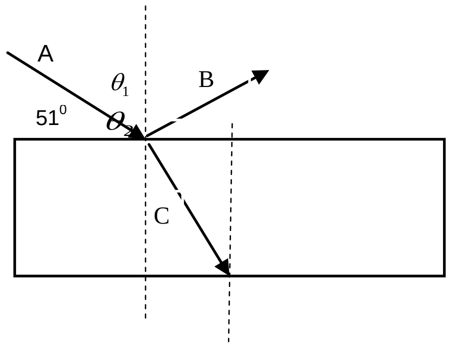
6.5 If the moon has a mass of 600×10^{21} kilograms and a radius of 1 737 kilometres, what is the weight (gravitational force) of *Curiosity* on the surface of the moon? (4)

6.6 How would the force of gravity on *Curiosity* change on a planet with half the mass and three times the radius of the moon? (2)

[17]

QUESTION 7: (START ON A NEW PAGE)

When white light is shone onto a rectangular prism, the following happens:



7.1 Define *refraction*. (2)

7.2 Name the labels **A**, **B** and **C**. (3)

In an experiment to verify Snell's law, a learner measured the angle of incidence *i* and the angle of refraction *r* for a ray of light entering a substance. The experiment was repeated for different values of the angle of incidence and the following data was recorded.

***i* (˚)**	30	40	50	55	60	65	70
sin *i*	0,50	0,64	0,77	0,82	0,87	0,91	0,94
***r* (˚)**	19	26	30	33	36	38	40
sin *r*	0,33	0,44	0,50	0,54	0 59	0,62	0,64

7.3 Explain why it was necessary to repeat the experiment so many times. (2)

7.4 Draw a graph of sin *i* vs sin *r* on the graph paper provided. (5)

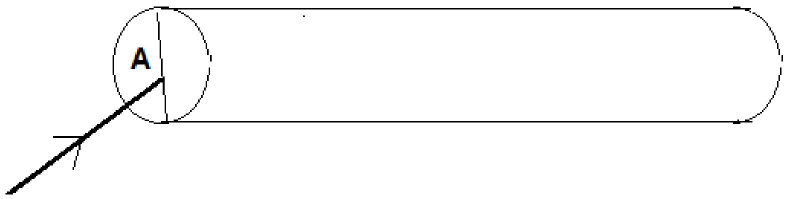
7.5 Explain how the graph verifies Snell's law. (3)

7.6 From the graph calculate the refractive index of the substance. (4)

[19]

QUESTION 8: (START ON A NEW PAGE)

Light travels from air into an optical fibre with an index of refraction of 1.44.

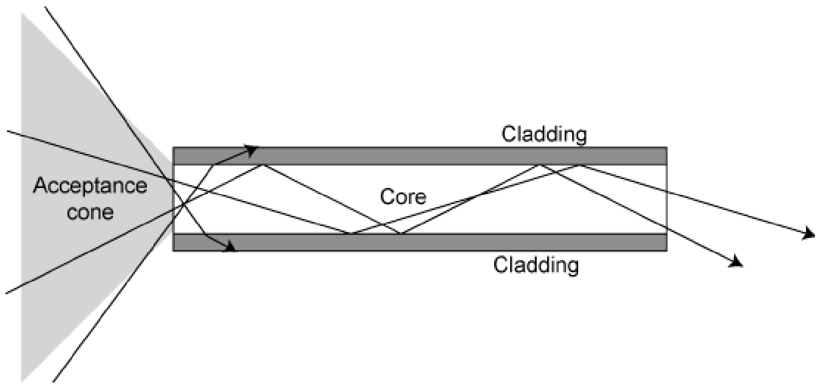


8.1 In which direction does the light bend? (2)

8.2 If the angle of incidence on the end of the fibre is 22^{o}, what is the angle of refraction inside the fibre, at point A? (4)

8.3 Redraw the diagram as shown above and sketch the path of light as it changes media, at point A. (3)

The definition of an optical fibre is a thin flexible fibre with a glass core through which light signals can be sent with very little loss of strength.



8.4 Define the term *Total Internal Reflection*. (TIR) (2)

8.5 Calculate the critical angle of an optical fibre …

8.5.1 without cladding if the glass has a refractive index of 1.56. (3)

8.5.2 when cladding is added of n = 1.49. (2)

8.6 What advantage does the adding of a cladding to the optical fibre have on the speed of light in the fibre? (2)

[18]

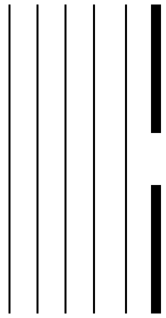
QUESTION 9: (START ON A NEW PAGE.)

9.1 State **Huygen's principle**. (2)

9.2 Describe how a transverse wave with a straight wavefront can be produced in a dam or pool. (2)

9.3 Explain how the wavelength of a wave could be shortened. (2)

The diagram below shows straight water waves in a ripple tank approaching a narrow gap, the size of which is approximately the same as the wavelength of the waves.



9.4 Redraw the diagram and sketch the diffraction pattern of the wave fronts emerging from the gap. (2)

9.5 Describe how the pattern of the wave fronts emerging from the gap would change if the size of the gap were significantly increased. Only state INCREASE, DECREASE or REMAIN THE SAME. (2)

[10]

TOTAL SECTION B 80

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 11 PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11 VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$
Gravitational constant *Swaartekragkonstante*	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of Earth *Straal van Aarde*	R_E	$6,38 \times 10^6\ m$
Coulomb's constant *Coulomb se konstante*	K	$9,0 \times 10^9\ N\cdot m^2\cdot C^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8\ m\cdot s^{-1}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Mass of the earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$

TABLE 2: FORMULAE / *TABEL 2: FORMULES*

MOTION / *BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE / *KRAG*

$F_{net} = ma$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$\mu_s = \frac{f_{s(max)}}{N}$
$\mu_k = \frac{f_k}{N}$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \frac{c}{v}$

ELECTROSTATICS / *ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$ (k = 9,0 x 10^9 N·m^2·C^{-2})	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$ (k = 9,0 x 10^9 N·m^2·C^{-2})	$V = \frac{W}{Q}$

ELECTROMAGNETISM / *ELEKTROMAGNETISME*

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

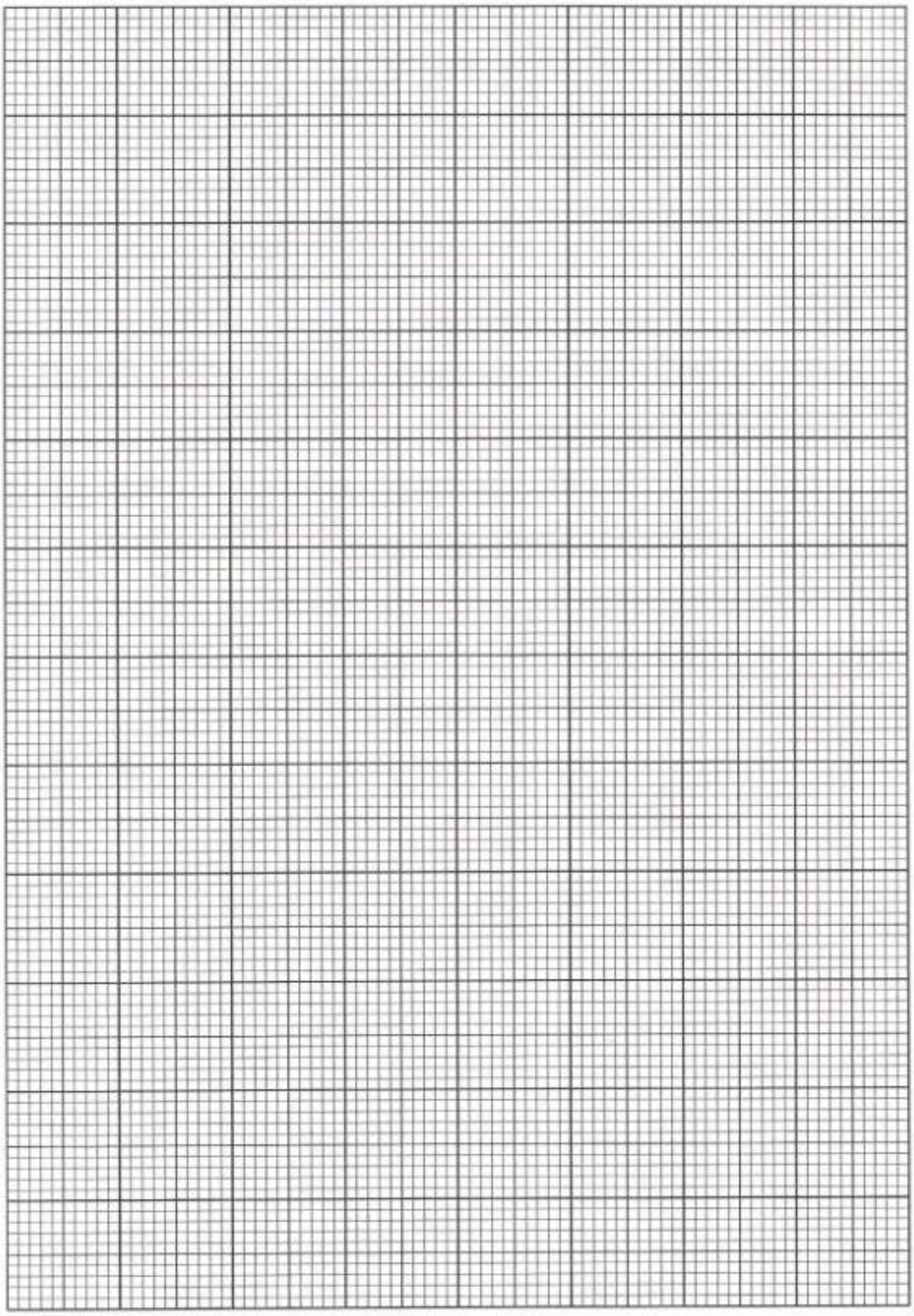
CURRENT ELECTRICITY / *STROOMELEKTRISITEIT*

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + ...$	$R = r_1 + r_2 + r_3 + ...$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

QUESTION 7.4:

NAME OF LEARNER:________________________

sin *i*



0

sin *r*

END