EXAMINATION	NATIONAL SENIOR CERTIFICATE
GRADE	12
DATE	JUNE 2024
SUBJECT	PHYSICAL SCIENCES
PAPER	1
MARK TOTAL	150
DURATION (HOURS)	3
NUMBER OF PAGES	24

SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

SUID-AFRIKAANSE KOMPREHENSIEWE ASSESSERINGSINSTITUUT

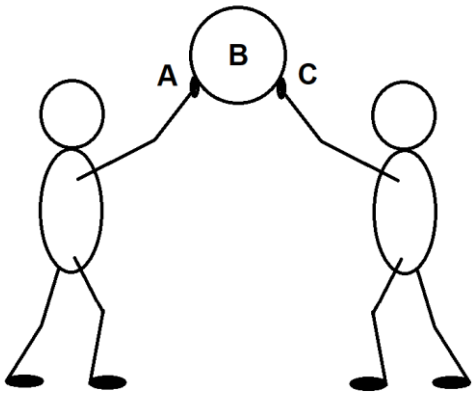
INSTRUCTIONS AND INFORMATION

1. Answer all questions in the **ANSWER BOOK**.
2. You may use a non-programmable calculator.
3. You may use appropriate mathematical instruments.
4. Number the answers correctly according to the numbering system used in this question paper.
5. **YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS**.
6. Give brief motivations, discussions, et cetera, where required.
7. Start **EVERY** question on a NEW page.
8. Leave a line open between sub questions, e.g. QUESTION 2.1 and QUESTION 2.2
9. Show the formulae and substitutions in **ALL** calculations.
10. Round the final value of the numerical answers off to **TWO** decimal places.
11. Only write in **BLUE** pen.

QUESTION 1

You have four 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) on your answer sheet (e.g., 1.11 D).

1.1 Two learners (A and C) push against the same ball (B) as shown in the diagram below.

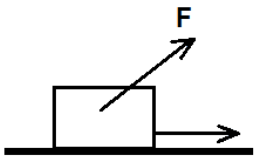


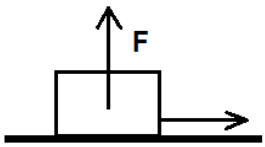
In the table below, identify which one of the force pairs can be regarded as action-reaction pairs and which one of Newton's laws can be used to describe them.

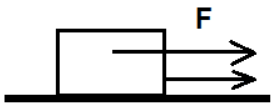
	Action-reaction pair	**Newton's Law**
A	A on C and C on A	Newton's first law
B	A on B and B on A	Newton's first law
C	C on B and B on A	Newton's third law
D	C on B and B on C	Newton's third law

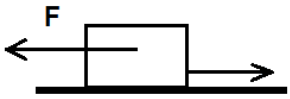
(2)

1.2 Each of the following diagrams shows a force of magnitude F being applied to a box which is being displaced to the right.

P 

Q 

R 

S 

(2)

In which one of the above diagrams is the force F doing negative work on the box?

A P
B Q
C R
D S

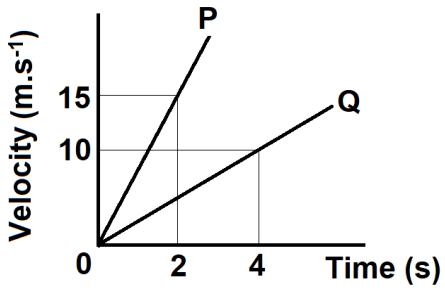
(2)

1.3 A block is moving along a rough horizontal surface. Which one of the descriptors for the kinetic frictional force acting on the block is correct? The kinetic frictional force is ___.

	Normal force	**Area**	**Velocity**
A	directly proportional to the normal force	independent of the area of contact	dependent on the velocity of motion
B	directly proportional to the normal force	dependent on the area of contact	independent of the velocity of motion
C	inversely proportional to the normal force	dependent on the area of contact	dependent on the velocity of motion
D	directly proportional to the normal force	independent of the area of contact	independent of the velocity of motion

(2)

1.4 The graph below shows the relationship between velocity and time for the motion of two objects, P and Q.



If the acceleration of object Q is x, then the acceleration of object P is___.

A ⅓ x
B x
C 2 x
D 3 x (2)

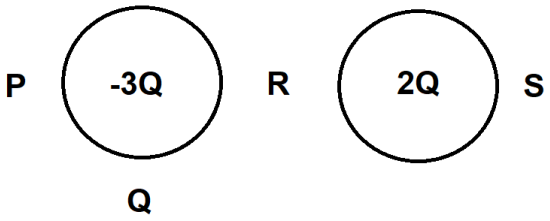
1.5 Learners observe the motion of two clay balls moving towards each other on a horizontal surface and the balls thereafter colliding. After colliding with each other, the two balls stick to each other and move off as one. All frictional effects are ignored.
Concerning the system made up of the two balls, the learners concluded that ____.

A both total momentum and total kinetic energy are conserved.
B both total momentum and total energy are conserved.
C total momentum is conserved but total energy is not conserved.
D total energy is conserved but total momentum is not conserved. (2)

1.6 A source of sound and an observer are moving towards each other. The frequency of the sound detected by the observer is NOT dependent on the ____.

A speed of the source
B speed of the observer
C frequency of the source
D distance between the observer and the source (2)

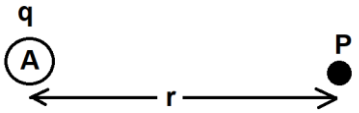
1.7 Two point charges (-3Q and 2Q) are placed close to each other. P, Q, R and S are regions in the electric fields of the charges, as shown in the diagram below.

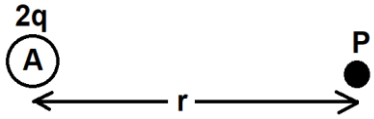


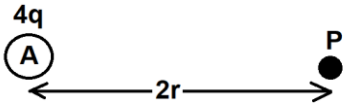
In which one of the regions will a negative test charge experience a zero net electrostatic force?

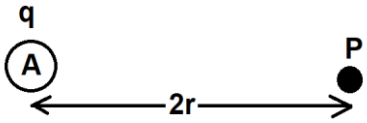
A. P
B. Q
C. R
D. S (2)

1.8 The following diagrams show a point P at a certain distance away from a charged sphere A. In which one of the diagrams will the magnitude of the electric field at point P be the greatest?

A 

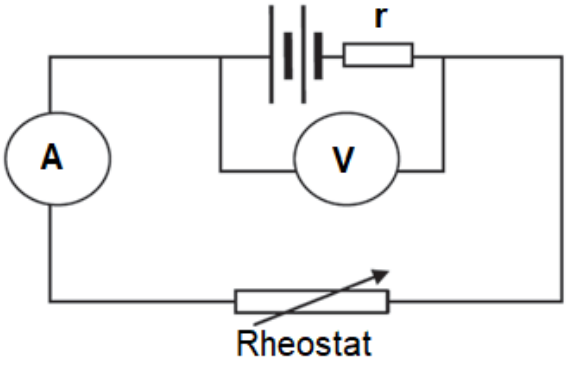
B 

C 

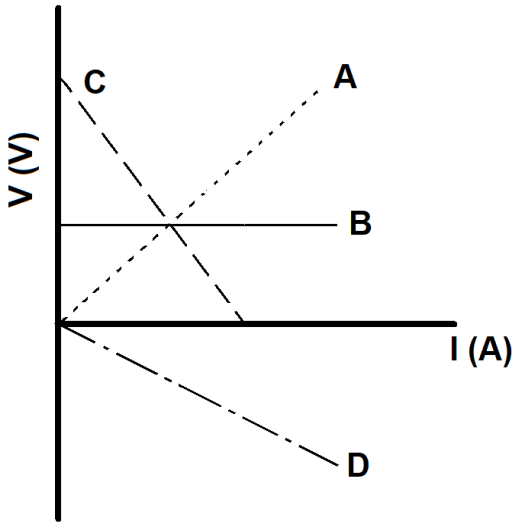
D 

(2)

1.9 In order to determine the internal resistance of a battery, learners construct a circuit using the following circuit diagram.

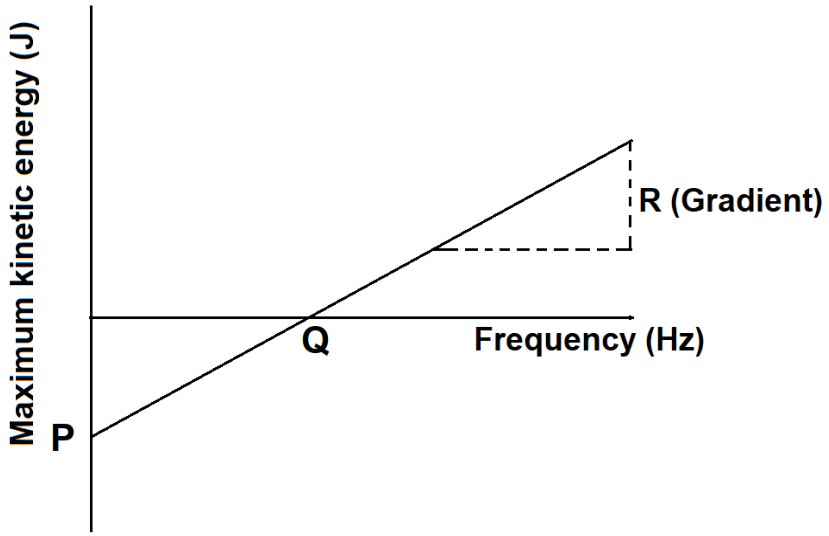


The values of the terminal potential difference (V) and the current (I) are measured by changing the readings on the rheostat.
Which one of the following graphs of V vs I can be used to calculate the internal resistance of the battery?



(2)

1.10 In a photoelectric experiment, light of different frequencies is radiated on the surface of a metal strip. The maximum kinetic energy of the electrons ejected from the surface of the metal for each frequency of light is then determined, and a graph is drawn as shown below.



P and Q are points on the straight line while R is the gradient of the line.
Correctly identify what is represented by P, Q and R.

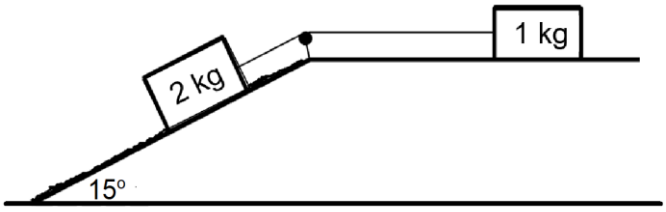
	P	Q	R
A	Planck's constant	threshold frequency	work function
B	work function	threshold frequency	Planck's constant
C	threshold frequency	work function	Planck's constant
D	threshold frequency	Planck's constant	work function

(2)

[20]

QUESTION 2

Two blocks (of masses 1 kg and 2 kg each) are connected to one another with a light inextensible string passing over a frictionless pulley as indicated in the diagram below. The diagram is not drawn to scale.



The **2 kg block moves on a rough slope** which makes an angle of 15° with the horizontal. The coefficient of kinetic friction between the 2 kg block and the surface of the slope is 0,1. The **1 kg block moves on a smooth, frictionless, horizontal surface**.

2.1 State *Newton's second law* in words. (2)

2.2 Draw a labelled free-body diagram of all the forces acting on the **2 kg-block**. (4)

2.3 Calculate the magnitude of the kinetic frictional force acting on the **2 kg-block** while it is sliding down the slope. (3)

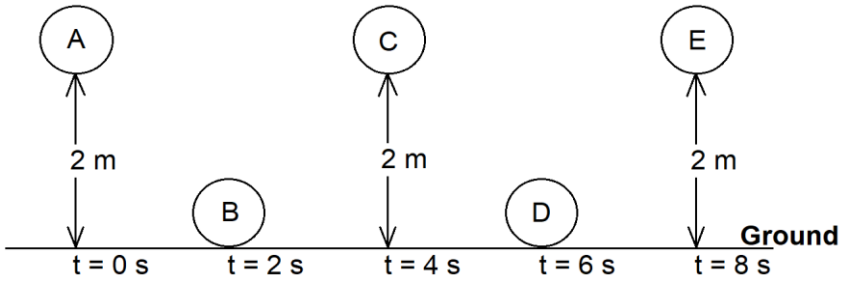
2.4 Calculate the magnitude of the acceleration of the **1 kg-block.** (5)

2.5 How will the magnitude of the kinetic frictional force which acts on the 2 kg block change if the angle of the slope is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (4)

[18]

QUESTION 3

A hard rubber ball was dropped from a height of 2 m above the ground. The ball hit the ground and bounced up and down on the same spot. After every bounce the ball reached a height of 2 m before dropping back to the ground. The diagram below, not drawn to scale, shows the positions of the ball at different time intervals.



Ignore the effects of air resistance.

3.1 Explain what is meant by a *free-falling body*. (2)

Take upwards to be the POSITIVE direction of motion.

3.2 What is the magnitude of the acceleration experienced by the ball at each of the following points?

3.2.1 C (1)

3.2.2 D (1)

3.3 Draw a sketch graph to show how the displacement of the ball changed with time from t = 0 s till t = 8 s. Take the ground as zero reference point. (3)

3.4 Calculate the speed at which the ball was moving at the 3rd second. (3)

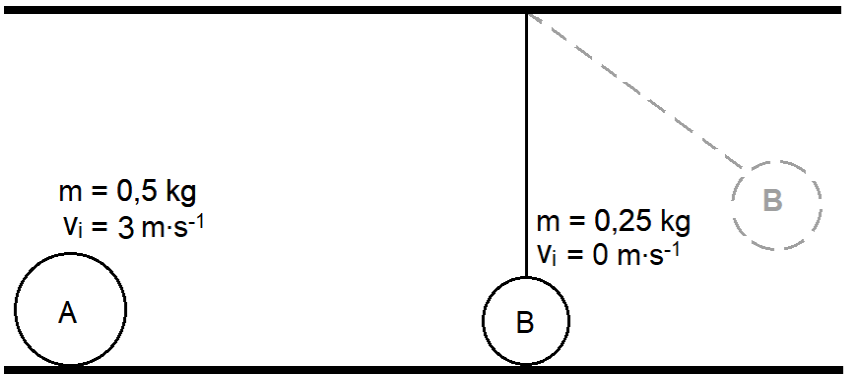
3.5 Was the collision of the ball with the ground elastic or inelastic? Give reasons for the answer. (3)

[13]

QUESTION 4

Ball A, with a mass of 0,5 kg moving with a velocity of 3 $m \cdot s^{-1}$ to the right, collides with a stationary ball B, mass = 0,25 kg.

The stationary ball is connected to a light inextensible string. After the collision ball B swings upward to a maximum height as indicated in the diagram below.
Ignore the effects of air resistance.



4.1 Define the term *momentum.* (2)

4.2 Calculate the momentum that **ball A** had before the collision. (3)

After the collision ball A continues to move to the right with a reduced velocity of 1,6 $m \cdot s^{-1}$.

4.3 State the *principle of conservation of linear momentum*. (2)

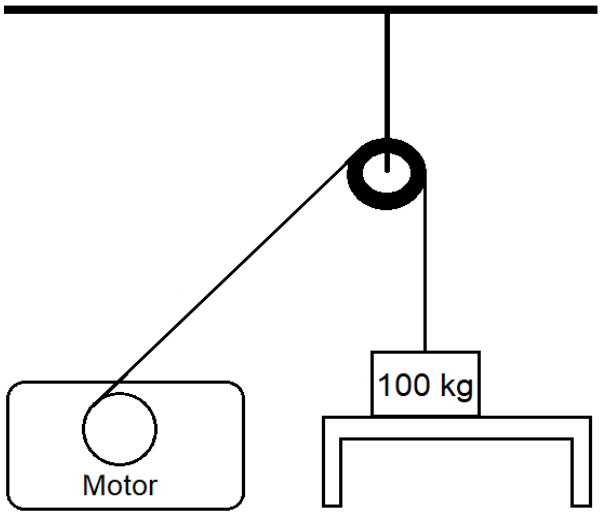
4.4 Calculate the magnitude of the velocity that **ball B** had immediately after the collision. (4)

4.5 Determine the maximum height reached by **ball B** after the collision. (4)

[15]

QUESTION 5

A block of mass 100 kg is at rest on a table. A motor is used to lift the block vertically upwards by connecting the block to the motor by means of a light inextensible string passing over a frictionless pulley. See diagram below.



When the block is 2,5 m above the table, its velocity is 0,8 $m \cdot s^{-1}$.

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

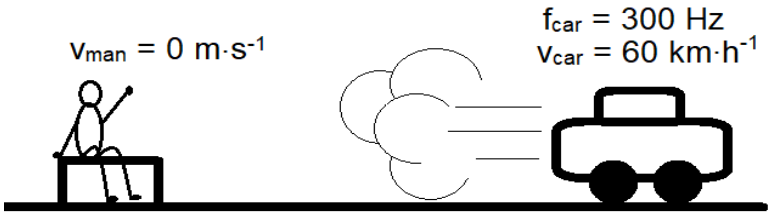
5.2 Make use of the **work-energy theorem** to calculate the energy needed to lift the block to the height of 2,5 m. (3)

5.3 Calculate the force exerted by the motor to lift the block. (4)

[9]

QUESTION 6

A man sitting on a bench near the road waved to his friend who is hooting while driving a car. The frequency of the sound of the car's hooter is 300 Hz. The car goes past the man travelling at a constant velocity of 60 km·h^{-1}.



6.1 State the *Doppler effect* in words. (2)

6.2 What is the observed frequency of the car's hooter the moment the car is next to the man? (1)

6.3 How will the frequency observed by the man change if the car moves away from him? Choose from INCREASES, DECREASES or REMAIN THE SAME.
Make use of the property of sound waves to support the answer. (3)

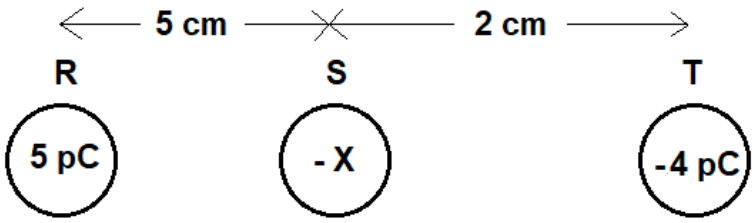
6.4 Draw a sketch graph to show the relationship between observed frequency of the hooter (f_L) and the time taken (t) as the car moves past the man and then away from him. (3)

6.5 On the **same set of axis used in question 6.4**, make use of a **dotted line (- - - -)** to indicate how the graph would change if the car moved at a higher speed past the man and then away from him. (3)

[12]

QUESTION 7

7.1 The diagram below shows three point charges R, S and T situated along a horizontal line. Point charges R and T carry charges of 5 pC and -4 pC respectively. Point charge S has an unknown **negative** charge X.

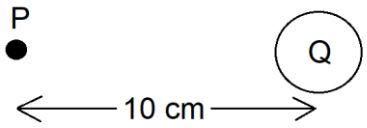


7.1.1 State *Coulomb's law* in words. (2)

7.1.2 The net electrostatic force on point charge **S** is 1,728 x 10^{-10} N directed towards R. Calculate the value of X, the charge on **S**. (7)

7.1.3 Calculate the new charge on **S if it was allowed to touch R and then separated again.** (3)

7.2 Point P is 10 cm away from a neutral sphere Q.



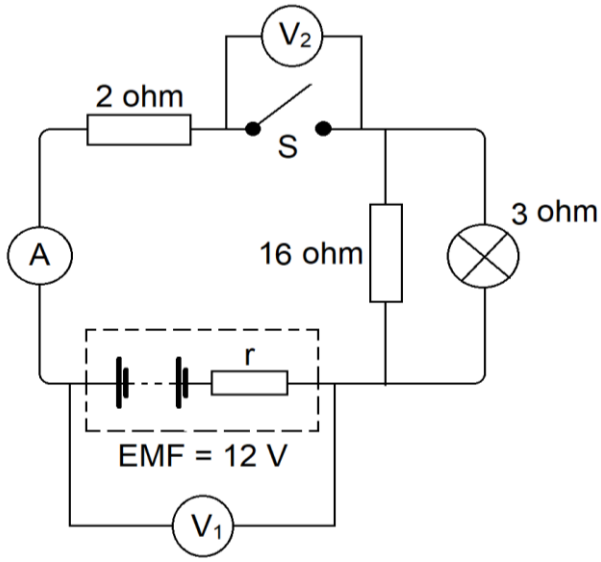
7.2.1 Calculate the number of electrons that must be removed from sphere Q so that the magnitude of the electric field at point P is 2,7 x 10^{3} N·C^{-1}. (5)

7.2.2 What will be the direction of the electric field at P after the sphere Q has become charged? Choose from LEFT or RIGHT. (1)

[18]

QUESTION 8

The battery in the circuit diagram below has an emf of 12 V and an unknown internal resistance r. Two high resistance voltmeters (V_1 and V_2) are connected across the battery and across the switch S. An ammeter, two resistors of 16 Ω and 2 Ω each and a light bulb of resistance 3 Ω are connected as shown. The resistance of the connecting wires and the ammeter is negligible.



Switch S is OPEN.

8.1 How does the reading on V_1 compare to the reading on V_2? Choose from SAME or DIFFERENT. Give a reason for the answer. (2)

Switch S is now CLOSED. The reading on the voltmeter (V_1) across the battery changes to 9 V.

8.2 What will be the new reading on V_2? (1)

8.3 Calculate the total external resistance of the circuit. (3)

8.4 Calculate the internal resistance, r, of the battery. (4)

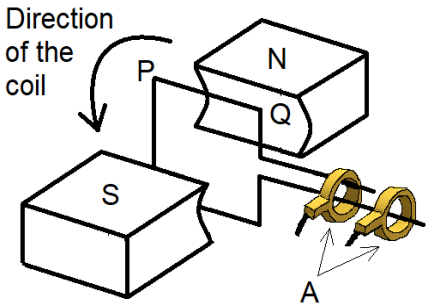
8.5 Calculate how much electric charge will pass through the light bulb in 3 minutes. (5)

8.6 How will the brightness of the light bulb change if the 16 Ω resistor was removed from the circuit?
Choose from INCREASES, DECREASES or REMAIN THE SAME.
Give an explanation for the answer. (4)

[19]

QUESTION 9

Learners wanted to investigate the working of an AC generator. They set up their investigation according to the diagram below. The coil rotates in an anticlockwise direction.



9.1 Name the energy conversion that takes place in a generator. (2)

9.2 Name the component marked A in the diagram. (1)

9.3 In which direction does the current flow in the coil? Choose from **P to Q** or **Q to P**. Name the rule you applied to arrive at the answer. (3)

9.4 Sketch a graph of induced emf versus time for one complete rotation of the coil. Start your graph with the coil in the position shown above. (3)

9.5 State ONE way in which the induced emf can be increased without changing the components of the generator above. (1)

Their generator has a coil with a large number of turns and it produces a rms potential difference of 240 V.

9.6 The generator above is connected across an appliance rated at 2000 W. Calculate the rms current passing through the appliance. (3)

[13]

QUESTION 10

Your teacher wants to demonstrate the photoelectric effect and decides to shine light of different wavelengths onto a metal surface of a photoelectric cell.

The maximum kinetic energy ($E_{k(max)}$) of the emitted electrons was determined for the various wavelengths (λ) and recorded in the table below. Note that the inverse of the wavelength ($\frac{1}{\lambda}$) was used in the table**.**

Inverse of wavelength $\frac{1}{\lambda}$ (x 10^6 m^{-1})	**Maximum kinetic energy $E_{k\ (max)}$ (x 10^{-19}J)**
4,0	4,49
3,3	3,09
2,9	1,89
2,5	1,34
2,2	0,07
2,0	0,31

10.1 Define the term *photoelectric effect* in words. (2)

10.2 Use the table above to draw an accurate graph of $E_{k\ (max)}$ versus $\frac{1}{\lambda}$ on the graph sheet provided. **Remove the graph sheet and place it inside the cover of your answer book after completing this question.** (6)

10.3 Use the graph to determine the threshold frequency of the metal in the photoelectric cell. (4)

10.4 How would the slope of the graph change if the intensity of the light being radiated on the photoelectric cell was larger than that used by the teacher. Choose from INCREASES, DECREASES or REMAIN THE SAME. (1)

[13]

GRAND TOTAL: 150

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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 gravitasie konstante*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	6,35 x 10^6 m
Mass of the Earth *Massa van die Aarde*	M_E	5,98 x 10^{24} kg
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·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 or q_e	-1,6 x 10^{-19} C
Electron mass *Elektron massa*	m_e	9,11 x 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* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{GmM}{d^2}$	$f_s^{max} = \mu_s N$ $f_k = \mu_k N$

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* $W_{net} = \Delta E_k$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$P_{ave} = Fv_{ave}$	$P = \frac{W}{\Delta t}$

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* $E = h\frac{c}{\lambda}$
$E = W_o + K_{max}$ or/*of* $E = W_o + E_{k\,(max)}$	
$E = hf$ and/*en* $W_o = hf_o$ and/*en* $K_{max} = \frac{1}{2}mv_{max}^2$ or/*of* $E_{k(max)} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$R_s = R_1 + R_2 + \ldots$	emf (ε) = I(R + r)
$q = I\,\Delta t$	emk (ε) = I(R + r)
$P = \frac{W}{\Delta t}$	$W = Vq$
$P = VI$	$W = VI\Delta t$
$P = I^2R$	$W = I^2R\Delta t$
$P = \frac{V^2}{R}$	$W = \frac{V^2\Delta t}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ *or/of* $P_{gem} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = I_{rms}^2R$ *or/of* $P_{gem} = I_{wgk}^2R$
	$P_{ave} = \frac{V_{rms}^2}{R}$ *or/of* $P_{gem} = \frac{V_{wgk}^2}{R}$

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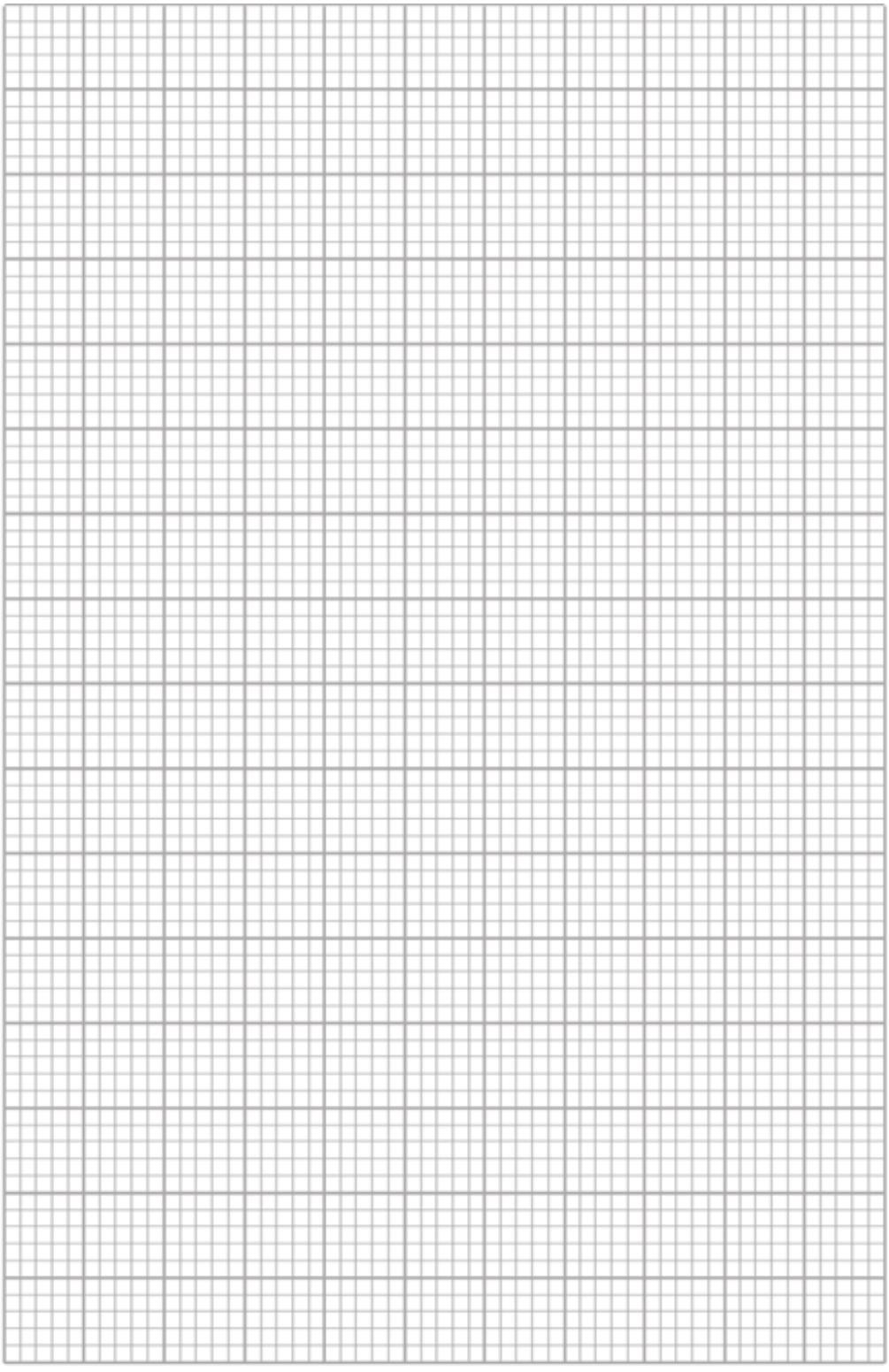
STUDENT NUMBER												

Place this sheet inside the cover of your answer book after you finish this question.

QUESTION 10.2



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