



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 11**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2017**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 15 pages, 2 data sheets and 1 answer sheet.**



**INSTRUCTIONS AND INFORMATION**

1. Write your name and class (for example 11A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK, except QUESTION 3.3 which has to be answered on the attached ANSWER SHEET.
3. Hand in the ANSWER SHEET together with the ANSWER BOOK.
4. Start EACH question on a NEW page in the ANSWER BOOK.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. You are advised to use the attached DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your final numerical answers to a minimum of TWO decimal places.
12. Give brief motivations, discussions et cetera where required.
13. Write neatly and legibly.



**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

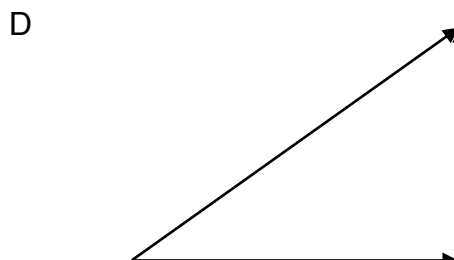
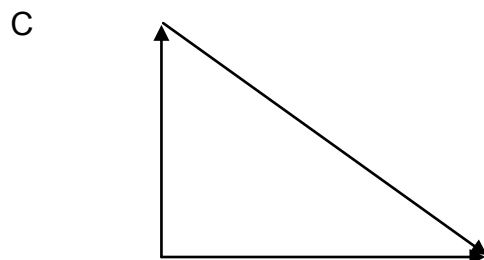
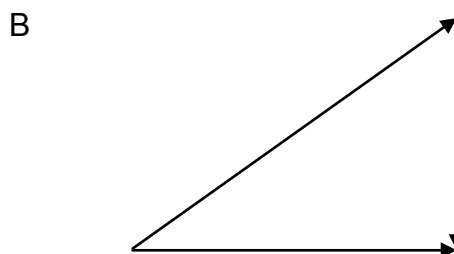
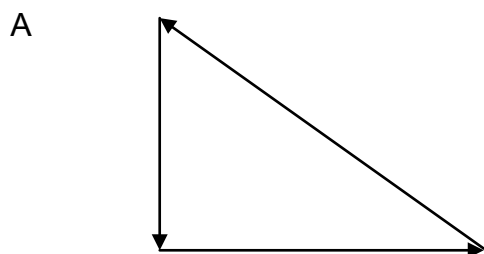
Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following pairs of physical quantities is vector quantities?

- A Force and distance
- B Velocity and speed
- C Charge and electric field
- D Electric field and force

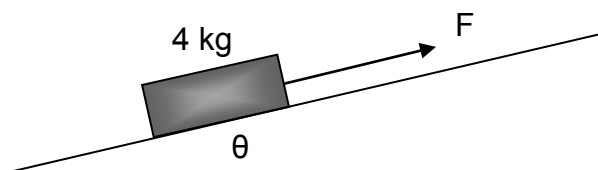
(2)

1.2 Which ONE of the following vector diagrams represents three forces acting on an object simultaneously while the object moves at CONSTANT VELOCITY?



(2)

- 1.3 A block with a mass of 4 kg is pulled upwards along a frictionless slope, inclined at an angle  $\theta$ , with a force  $F$ , as shown in the sketch below.



Which ONE of the following equations can be used to calculate the magnitude of the normal force ( $N$ )?

- A  $N = (4)(9,8)\sin\theta$
- B  $N = F - (4)(9,8)\cos\theta$
- C  $N = F + (4)(9,8)\cos\theta$
- D  $N = (4)(9,8)\cos\theta$  (2)

- 1.4 A satellite orbits Earth at a height where the gravitational force is a quarter ( $\frac{1}{4}$ ) of the force it experiences on the surface of the Earth. If the radius of Earth is  $R$ , the height of the satellite ABOVE THE SURFACE of Earth is ...

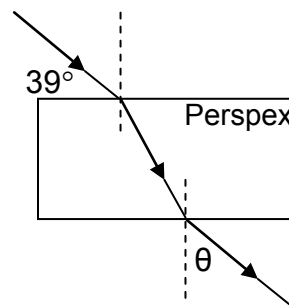
- A  $4R$
- B  $2R$
- C  $R$
- D  $\frac{1}{2}R$  (2)

- 1.5 A light ray passes from glass to air. The angle of incidence is  $35^\circ$ . The critical angle of glass is  $38^\circ$ .

The light ray will undergo ...

- A diffraction.
- B refraction and bend away from the normal.
- C total internal reflection.
- D refraction and bend towards the normal. (2)

- 1.6 The path of a light ray passing from air through a rectangular Perspex block is shown below.



The magnitude of angle  $\theta$  will be ...

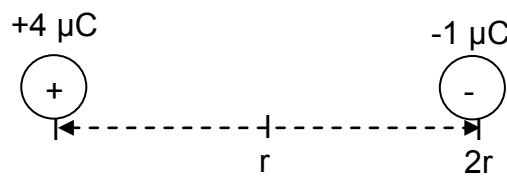
- A less than  $39^\circ$ .
- B equal to  $39^\circ$ .
- C equal to  $51^\circ$ .
- D equal to  $90^\circ$ . (2)

- 1.7 A monochromatic red light ray passes through a single slit of width  $d$ . The diffraction pattern is projected on a screen. The red light is then replaced with monochromatic blue light and passed through the same single slit.

The degree of diffraction will ...

- A increase because the degree of diffraction is directly proportional to wavelength.
- B decrease because blue light has a shorter wavelength than red light.
- C increase because blue light has a longer wavelength than red light.
- D decrease because the degree of diffraction is inversely proportional to wavelength. (2)

- 1.8 A negative charge of  $1\ \mu\text{C}$ , which is free to move, is placed at a distance  $2r$  from a positive charge of  $4\ \mu\text{C}$ .



Which ONE of the following statements regarding the  $-1\ \mu\text{C}$  charge, when it is at distance  $r$ , is CORRECT?

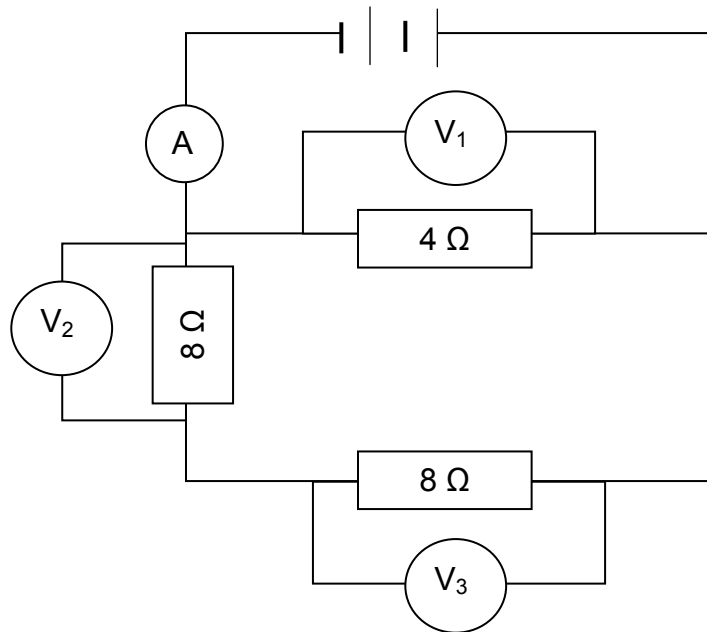
The electrostatic force experienced by the  $-1\ \mu\text{C}$  charge will ...

- A remain the same.
- B be halved.
- C be doubled.
- D increase four times. (2)

- 1.9 A circular coil is placed inside a magnetic field and rotated clockwise to induce an emf. Which ONE of the following changes will increase the induced emf?

- A Rotating the coil slower
- B Decreasing the number of turns/windings of the coil
- C Increasing the speed of rotation of the coil
- D Changing the polarity of the magnets (2)

- 1.10 In the circuit diagram below, the battery has negligible internal resistance. The resistance of the ammeter and wires may also be ignored.



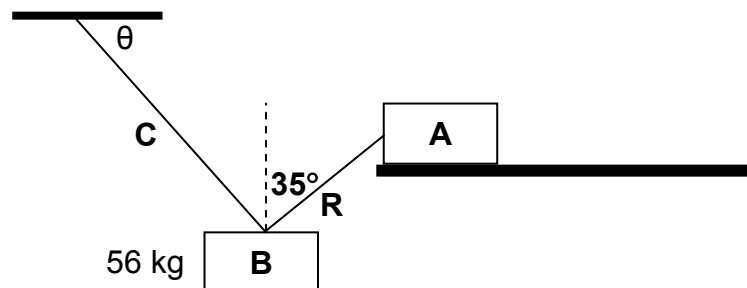
The reading on voltmeter  $V_3$  will be equal to ...

- A  $V_1$
- B  $\frac{1}{2} V_1$
- C  $V_1 + V_2$
- D  $V_2 - V_1$

(2)  
[20]

**QUESTION 2 (Start on a new page.)**

Block **A**, which is at rest on a horizontal rough surface, is used as an anchor to hold block **B**, with a mass of 56 kg, in the air at a certain height above the ground. The two blocks are connected with rope **R**, which makes an angle of  $35^\circ$  with the vertical. Block **B** is suspended from the ceiling with cable **C**. Refer to the diagram below.



Block **A** experiences a frictional force of magnitude 200 N. The system is stationary.

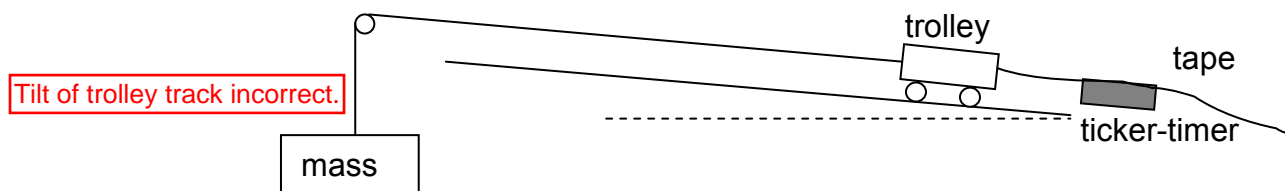
- 2.1 Define the term *resultant vector*. (2)
- 2.2 What is the magnitude of the resultant force acting on block **B**? (1)
- 2.3 Draw a labelled free-body diagram indicating all the forces acting on block **B**. (3)
- 2.4 Determine the horizontal component of the force in rope **R**. (1)
- 2.5 Calculate the vertical component of the force in cable **C**. (4)
- 2.6 Calculate the angle  $\theta$  between the cable and the ceiling. (2)

**[13]**



**QUESTION 3 (Start on a new page.)**

Learners investigate the relationship between net force and acceleration by pulling a trolley across a surface which is slightly inclined to compensate for friction. The trolley is connected to different masses by a string of negligible mass. The string passes over a frictionless pulley. Refer to the diagram below.



Ticker-tape attached to the trolley passes through the ticker-timer. The acceleration of the trolley is determined by analysing the ticker-tape. The results of the net force produced by the different masses and the acceleration of the trolley were recorded in the table below.

NET FORCE (N)	$a \text{ (m}\cdot\text{s}^{-2}\text{)}$
0,3	0,36
0,6	0,73
0,9	1,09
1,2	1,45

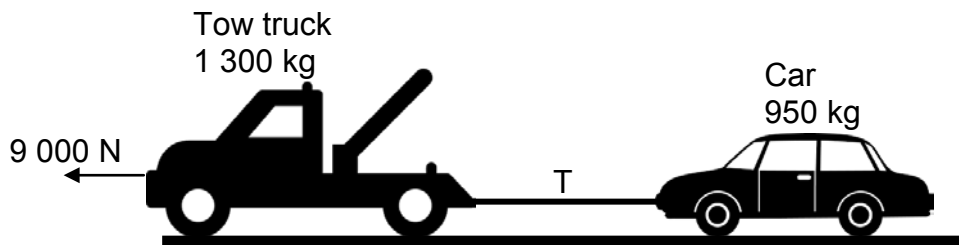
- 3.1 Write down a hypothesis for this experiment. (2)
- 3.2.1 Identify the *independent variable*. (1)
- 3.2.2 Identify the *controlled variable*. (1)
- 3.3 Use the graph paper on the ANSWER SHEET and draw a graph of the acceleration versus net force. (4)
- 3.4 Calculate the gradient of the graph. (3)
- 3.5 Use the gradient of the graph calculated in QUESTION 3.4 to determine the mass of the trolley. (2)
- [13]**

This question raised a lot of concerns. Due to the rotation of the wheels, two frictional forces are present. The engine's force is practically applied via a frictional force to the left on the driving wheels. The other set of wheels experience a frictional force to the right. This type of situation is courting danger.

#### QUESTION 4 (Start on a new page.)

A tow truck pulls a car along a gravel road.

The force applied by the engine of the tow truck is 9 000 N. The mass of the tow truck is 1 300 kg and the mass of the car is 950 kg. The vehicles are connected to each other by an inelastic tow bar of negligible mass. See the diagram below.



The tow truck and car move at a CONSTANT VELOCITY.

- 4.1 Define the term *frictional force*. (2)
- 4.2 NAME AND STATE the law that explains why the force exerted by the tow truck on the car is the same as the force exerted by the car on the tow truck. (3)
- 4.3 Draw a labelled free-body diagram indicating all the forces acting on the tow truck. (5)
- 4.4 If the coefficient of kinetic friction between the tow-truck tyres and the road surface is 0,45, calculate the:
  - 4.4.1 Magnitude of the tension in the tow bar (5)
  - 4.4.2 Coefficient of kinetic friction between the CAR tyres and the road surface (5)

Suddenly the tow bar between the car and the tow truck disconnects and the car comes loose.

- 4.5 Using a relevant law of motion, explain why the car continues moving forward for a short distance. (3)
  - 4.6 Calculate the acceleration of the car as it comes to a stop after a short distance. (3)
- [26]**

**QUESTION 5 (Start on a new page.)**

The acceleration due to gravity on planet X is  $2,7 \text{ m}\cdot\text{s}^{-2}$ . The radius of this planet is a third ( $\frac{1}{3}$ ) of the radius of Earth.

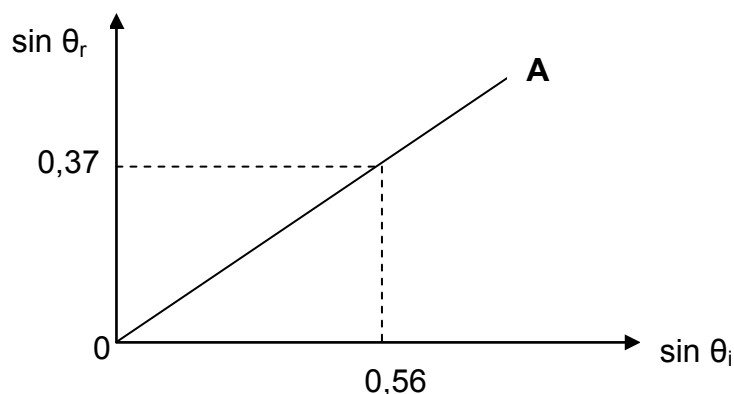
- 5.1 Explain the difference between *weight* and *mass*. (2)
- 5.2 Calculate the mass of planet X. (4)
- 5.3 Determine the factor by which the weight of an object on planet X will differ from the weight of the same object on Earth. (2)
- [8]**

**QUESTION 6 (Start on a new page.)**

Experiments are performed to compare the refractive indices of different materials.

In one experiment a light ray passes from air to material **A** and the angles of incidence and refraction are measured. The refractive index for air is 1.

The graph below was drawn using the results of material **A**.



- 6.1 Define the term *angle of incidence*. (2)
- 6.2 Calculate the refractive index of material **A** using the data in the graph. (3)
- 6.3 Calculate the speed of the light through material **A**. (3)
- 6.4 If material **A** is replaced by material **B**, the angle of refraction is  $31^\circ$  when the angle of incidence is  $40^\circ$ .
- 6.4.1 Calculate the refractive index of material **B**. (4)
- 6.4.2 Redraw the graph of material **A**, and on the same set of axis, draw the graph you expect for material **B**. Label the graphs of material **A** and material **B** clearly. (2)

6.5 Total internal reflection occurs when a light ray passes from material **A** to material **B**. The critical angle of material **A** is  $49^\circ$ .

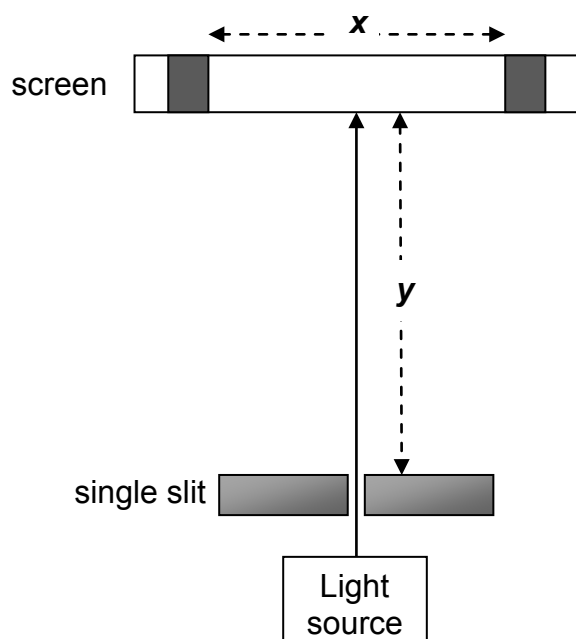
6.5.1 Which range of angles will make it possible for total internal reflection to occur? (2)

6.5.2 What OTHER condition is necessary for total internal reflection to take place? (2)

**[18]**

**QUESTION 7 (Start on a new page.)**

An experiment is set up, as shown below, to investigate the effect of slit width on the degree of diffraction. Distance **y** on the diagram represents the distance between the screen and the single slit. Distance **x** on the diagram represents the width of the central bright band.



7.1 Write down an investigative question for this experiment. (2)

7.2 State *Huygens' principle* in words. (2)

7.3 How will distance **x** be affected if the slit width is increased? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

7.4 Explain the answer to QUESTION 7.3. (2)

7.5 How will distance **x** be affected if distance **y** is increased? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

**[8]**

**QUESTION 8 (Start on a new page.)**

Two IDENTICAL point charges, **X** and **Y**, are placed 2 mm apart. Point **P** is 3 mm to the right of charge **Y**. The net electric field at point **P** is  $5,44 \times 10^6 \text{ N}\cdot\text{C}^{-1}$  to the left.



- 8.1 Define the term *electric field* at a point. (2)
- 8.2 Are the charges NEGATIVE or POSITIVE? (1)
- 8.3 Draw the resultant electric field pattern for charges **X** and **Y**. (3)
- 8.4 Calculate the magnitude of the charge **X**. (5)
- 8.5 Charge **Y** is now replaced by an identical oppositely charged point charge.

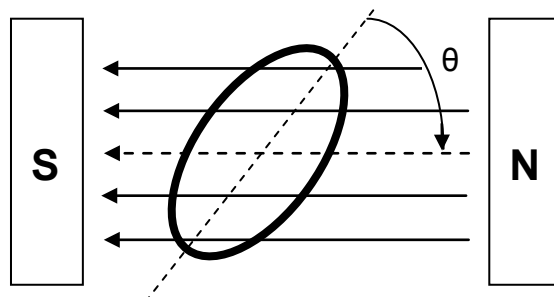
How will the magnitude of the net electric field at point **P** be affected?  
Choose from INCREASE, DECREASE or REMAIN THE SAME.

Give a reason for the answer.

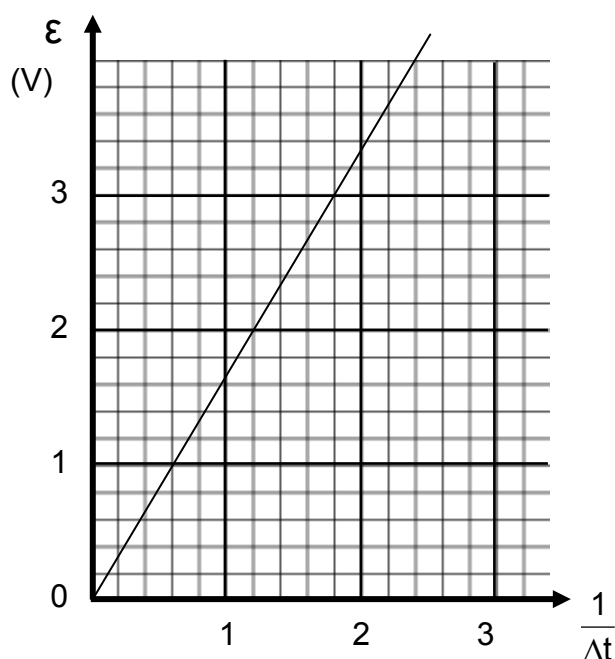
(2)  
**[13]**

**QUESTION 9 (Start on a new page.)**

An induction coil of area  $48,6 \text{ cm}^2$  and 200 windings is rotated clockwise in a constant magnetic field of magnitude  $2,4 \text{ T}$ . Refer to the diagram below.



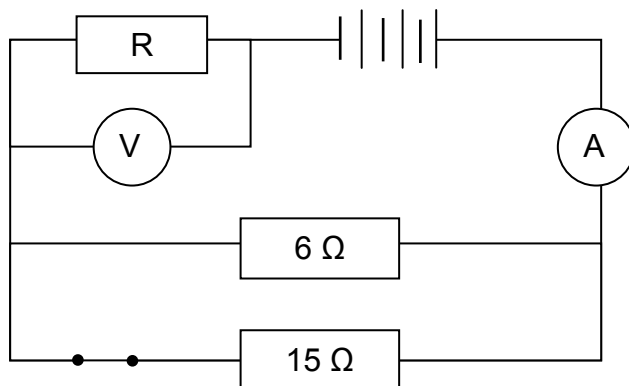
The graph below shows how the induced emf varies with the inverse of time.



- 9.1 State *Faraday's law* in words. (2)
- 9.2 Use the information in the graph to calculate the change in magnetic flux. (5)
- 9.3 The coil rotates through an angle  $\theta$  to a position where the magnetic flux becomes zero. Calculate angle  $\theta$ . (4)
- [11]**

**QUESTION 10 (Start on a new page.)**

- 10.1 The circuit below consists of a  $6\ \Omega$  and  $15\ \Omega$  resistor connected in parallel and an unknown resistor  $R$ , in series. An ammeter, a high-resistance voltmeter, a closed switch and battery are connected, as shown. The resistance of the battery and wires can be ignored.



The total power dissipated in the parallel part of the circuit is 50 W.

- 10.1.1 Define the term *power*. (2)
- 10.1.2 Calculate the effective resistance of the parallel combination. (2)
- 10.1.3 Calculate the potential difference across the resistors in parallel. (3)
- 10.1.4 Calculate the current through resistor  $R$ . (3)

The switch in the circuit is now OPENED.

- 10.1.5 How will the reading on the voltmeter (V) be influenced? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)
- 10.1.6 Explain the answer to QUESTION 10.1.5. (3)
- 10.2 A geyser, labelled 2 000 W, is used for an average of 5 hours per day. The cost of electricity is 80 cents per kWh.
- 10.2.1 Calculate the energy used by the geyser for 5 hours per day. (4)
- 10.2.2 Calculate the cost of electricity to operate the geyser for a month with 30 days. (2)

**[20]**

**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 <i>Swaartekragversnelling</i>	g	9,8 m·s <sup>-2</sup>
Gravitational constant <i>Swaartekragkonstante</i>	G	6,67 x 10 <sup>-11</sup> N·m <sup>2</sup> ·kg <sup>-2</sup>
Radius of Earth <i>Straal van Aarde</i>	R <sub>E</sub>	6,38 x 10 <sup>6</sup> m
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 <sup>9</sup> N·m <sup>2</sup> ·C <sup>-2</sup>
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	3,0 x 10 <sup>8</sup> m·s <sup>-1</sup>
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 <sup>-19</sup> C
Electron mass <i>Elektronmassa</i>	m <sub>e</sub>	9,11 x 10 <sup>-31</sup> kg
Mass of the earth <i>Massa van die Aarde</i>	M	5,98 x 10 <sup>24</sup> 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**

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



**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**

$F = \frac{kQ_1Q_2}{r^2}$ ( $k = 9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$ )	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$ ( $k = 9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$ )	$n = \frac{Q}{e}$

**ELECTROMAGNETISM/ELEKTROMAGNETISME**

$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$	$\Phi = BA \cos \theta$
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**ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE**

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



**ANSWER SHEET****HAND IN THIS ANSWER SHEET TOGETHER WITH THE ANSWER BOOK.****NAME:** \_\_\_\_\_ **CLASS:** \_\_\_\_\_**QUESTION 3.3**