KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2023

MARKS: 150

TIME: 3 hours

Stanmorephysics

This question paper consists of 15 pages and 2 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 9 questions. Answer ALL the questions in the ANSWER BOOK.
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.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the correct 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 D.

1.1 Which ONE of the following is an example of a CONTACT force?

A Magnetic force.

B Frictional force.

C Electrostatic force.

D Gravitational force. (2)

1.2 The mass of an astronaut on EARTH is M. At a height above the Earth equal to twice the radius of the Earth, the mass of the astronaut will be . . .

A M

B $\frac{1}{4}$ M

C 2 M

D $\frac{1}{9}$ M (2)

1.3 A spaceship moves at CONSTANT VELOCITY. Which ONE of the following is a NON-ZERO quantity?

A Acceleration of the spaceship.

B Net force acting on the spaceship.

C Kinetic energy of the spaceship.

D Change in kinetic energy of the spaceship. (2)

1.4 A boy, mass *2m*, and a girl, mass *m*, are facing each other on roller skates. With their hands, they push off against one another. The boy experiences a force *F* and an acceleration *a* to the left.



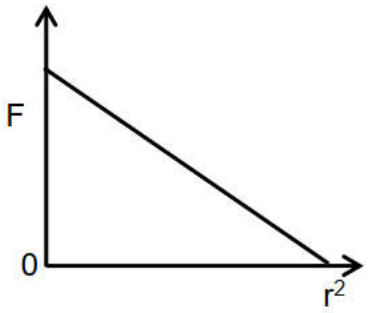
Which ONE of the following best describes the magnitudes of the force and acceleration experienced by the girl? Ignore the effects of friction.

	FORCE	ACCELERATION
A	F	a
B	F	½ a
C	F	2a
D	2F	½ a

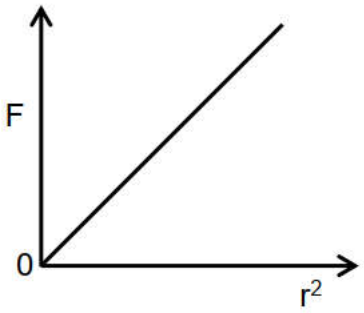
1.5 Two charged particles are placed a distance, r, apart. The electrostatic force exerted by one charged particle on the other is F.

Which ONE of the following graphs CORRECTLY represents the relationship between the electrostatic force (F), and the square of the distance (r^2) between the two charged particles?

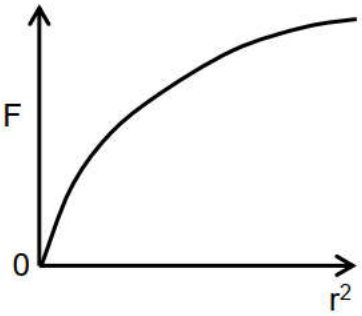
A



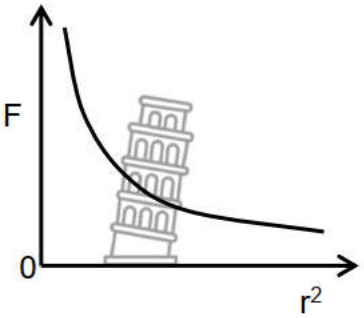
B



C

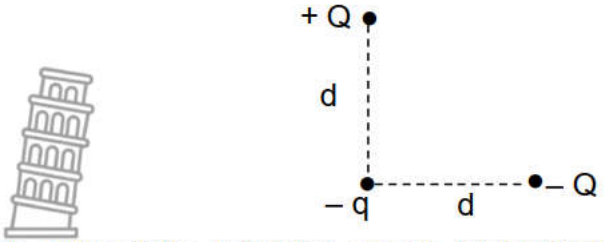


D



(2)

1.6 Two charges, + Q and – Q, are placed a distance d from a NEGATIVE CHARGE q. The charges, + Q and – Q, are located along lines that are perpendicular to each other as shown in the diagram below.

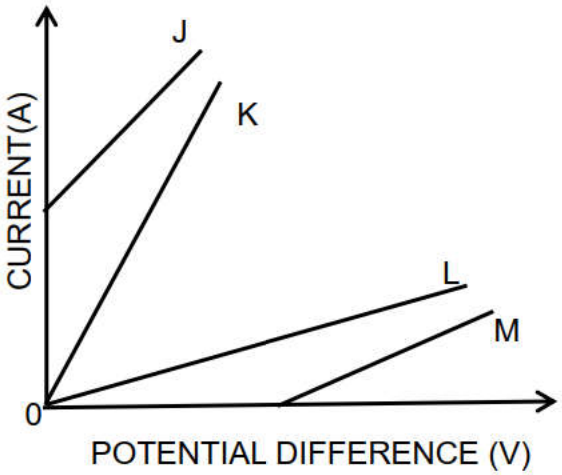


Which ONE of the following arrows CORRECTLY shows the direction of the NET ELECTROSTATIC FORCE acting on charge – q due to charges + Q and – Q?

A	
B	
C	
D	

(2)

1.7 The graph of CURRENT versus POTENTIAL DIFFERENCE obtained for four different resistors, J, K, L and M is shown below.



The resistor with the LARGEST resistance is . . .

A J

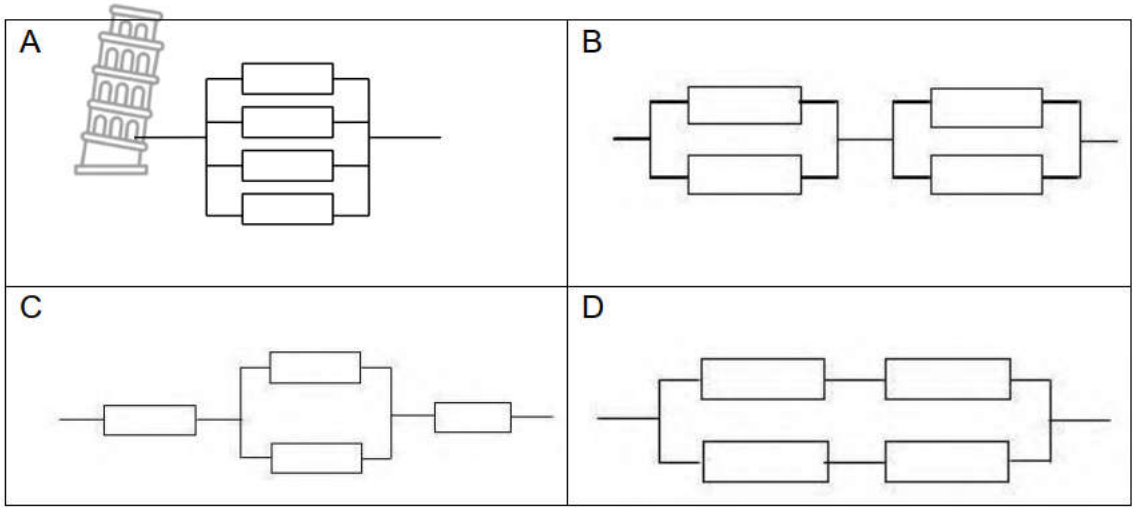
B K

C L

D M

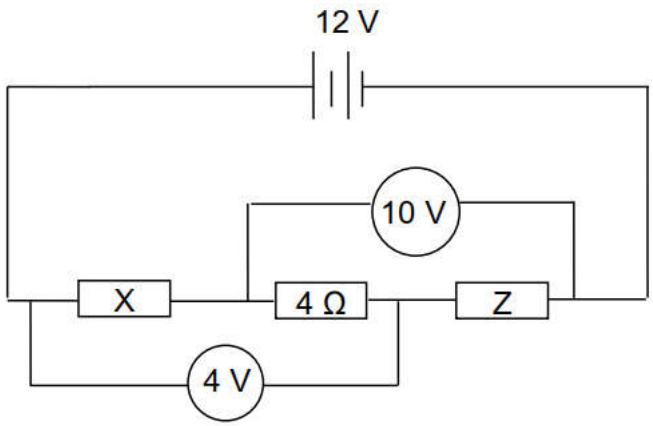
(2)

1.8 Different combinations of the same four identical resistors are shown below. Which ONE of the following combinations will have the HIGHEST resistance?



(2)

1.9 A circuit is set up as shown in the diagram below. The emf of the battery is 12 V. The voltmeters read 4 V and 10 V as shown.



The battery has no internal resistance and the resistance of the conducting wires can be ignored.

The value of resistor X is . . .

A 2 Ω

B 4 Ω

C 6 Ω

D 8 Ω

(2)

1.10 When a current passes through a straight conductor a field is generated around the conductor.
Which ONE of the following combinations is correct for the NATURE OF THE FIELD, and the ORIENTATION OF THE FIELD?

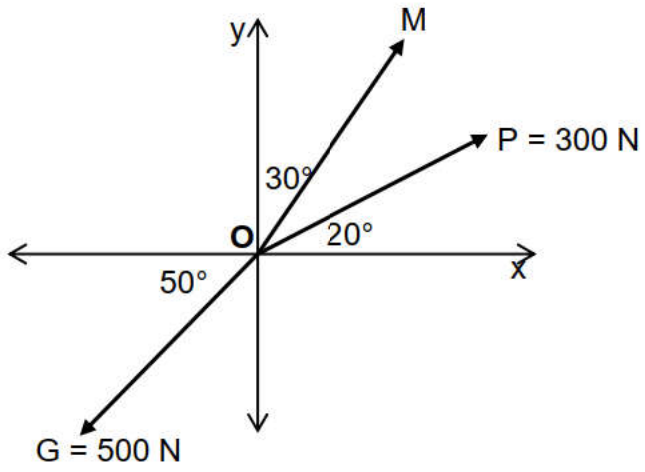
	NATURE OF THE FIELD	ORIENTATION OF THE FIELD
A	Magnetic	Perpendicular to the conductor
B	Electric	Perpendicular to the conductor
C	Magnetic	Parallel to the conductor
D	Electric	Parallel to the conductor

(2)

[20]

QUESTION 2 (Start on a new page.)

Three forces M, P and G act on point O, located at the origin of the Cartesian plane. The forces act in the directions shown in the diagram below and are NOT drawn to scale.



The magnitudes of P and G are 300 N and 500 N respectively.

2.1 Give a reason why forces are classified as vectors. (2)

2.2 Calculate the magnitude of the HORIZONTAL COMPONENT for force:
2.2.1 P (3)
2.2.2 G (2)

The resultant of the horizontal components of the forces M, P and G is 266,94 N.

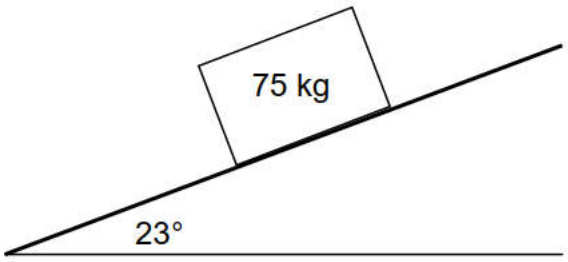
2.3 Calculate the magnitude of force M. (3)

2.4 Define *resultant* force. (2)

2.5 Calculate the magnitude of the resultant force acting at point O. (5)
[17]

QUESTION 3 (Start on a new page.)

A box of mass 75 kg lies on a rough surface inclined at an angle of 23° to the horizontal. The box is stationary on the incline as shown in the diagram below.



3.1 Define the term *static frictional force*. (2)

3.2 Draw a labelled free-body diagram indicating all the forces acting on the box while it is stationary. (3)

3.3 Calculate the:

3.3.1 Magnitude of the static frictional force (3)

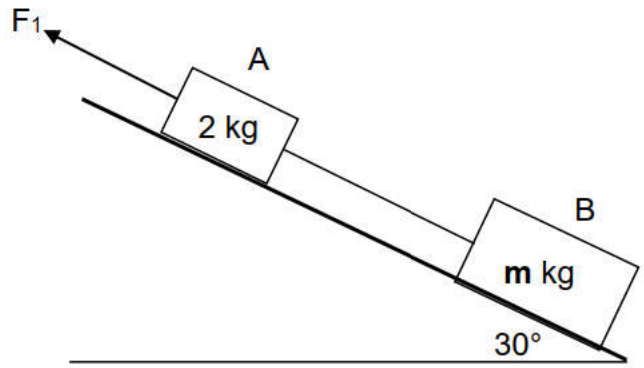
3.3.2 Coefficient of static friction between the rough surface and the box. (3)

3.4 The rough surface is now tilted at an angle of 18° to the horizontal. How will the magnitude of the static frictional force now compare to the value calculated in question 3.2.1? Choose from GREATER THAN, EQUAL TO or LESS THAN (1)

[12]

QUESTION 4 (Start on a new page.)

A light inelastic string connects two blocks A and B of mass of 2 kg and **m** kg respectively. The blocks are pulled up an inclined plane that makes an angle of 30° with the horizontal by a force of magnitude F_1, as shown in the diagram below.



The coefficients of kinetic friction for block A and block B are 0,15 and 0,45 respectively.

4.1 Draw a labelled free-body diagram indicating all the forces acting on block B as it moves up the inclined plane. (4)

4.2 State *Newton's Second Law of Motion* in words. (2)

The blocks accelerate up the incline at 5,72 $m \cdot s^{-2}$ and the tension in the string joining the two blocks is 18N.

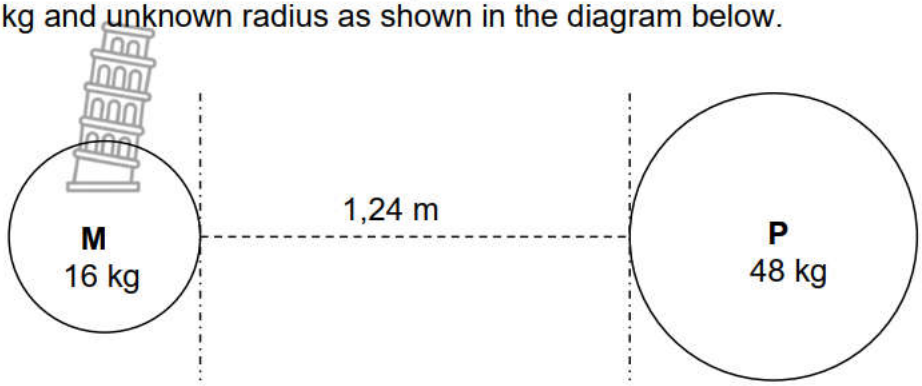
4.3 Calculate the numerical value of **m**. (5)

The magnitude of force F_1 is now changed to F_2 so that the blocks move up the inclined plane at CONSTANT VELOCITY.

4.4 Calculate the magnitude of F_2. (6)
[17]

QUESTION 5 (Start on a new page.)

A body **M** of mass 16 kg and radius 0,10 m is placed 1,24 m from another body, **P**, of mass 48 kg and unknown radius as shown in the diagram below.



5.1 State *Newton's Law of Universal Gravitation* in words. (2)

It is observed that body **M** exerts a force of magnitude 2,30 x 10^{-8} N on body **P** when placed as shown in the sketch above.

5.2 Describe the nature of this force. Choose from ATTRACTIVE or REPULSIVE. (1)

5.3 How does the magnitude of the force that body **M** exerts on body **P** compare to the magnitude of the force that body **P** exerts on body **M**? Choose from EQUAL TO, GREATER THAN or LESS THAN. (1)

5.4 Name and state the relevant Physics law to substantiate the answer to question 5.3 (3)

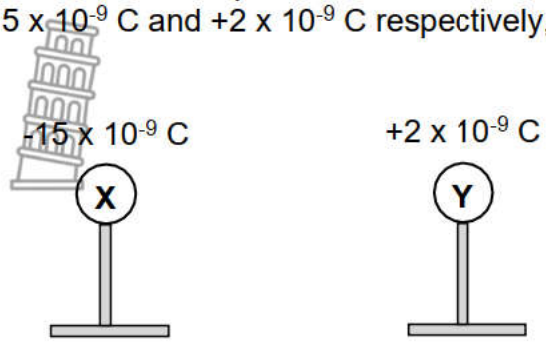
5.5 Calculate the radius of body **P**. (5)

Body **P** is now replaced by body **G** which has a mass of 64 kg and the same radius as body **P**.

5.6 Write down the magnitude of the force now experienced by body **M**. (2)
[14]

QUESTION 6 (Start on a new page.)

Two small identical metal spheres, **X** and **Y**, on identical insulated stands, carry charges of -15 x 10^{-9} C and +2 x 10^{-9} C respectively, as shown below.

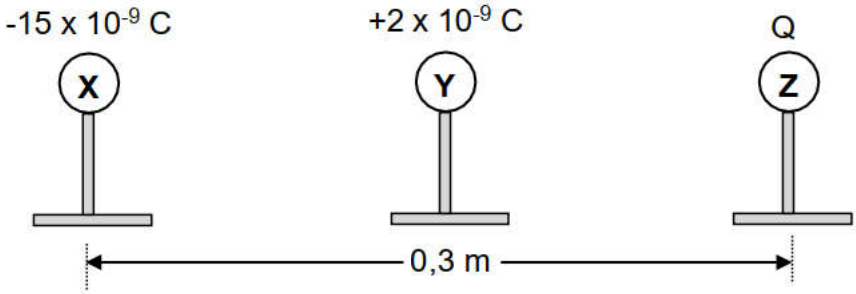


Before they were given their respective charges, both spheres were neutral. One of the charged spheres experienced a very small increase in mass after it was charged.

6.1 Which sphere, **X** or **Y**, experienced this very small increase in mass? (1)

6.2 Calculate the increase in the mass of the sphere referred to in question 6.1 (4)

A third identical sphere **Z** on an identical insulated stand, carrying an unknown charge Q, is placed so that the three spheres lie on the same horizontal line. The distance between the centres of spheres **X** and **Z** is 0,3 m as shown in the diagram below.



The charged spheres are now brought together so that all three spheres touch each other at the same time. They are then separated and returned to the positions shown above. The charge on each sphere after separation is -3 x 10^{-9} C.

6.3 Determine the magnitude of Q. (2)

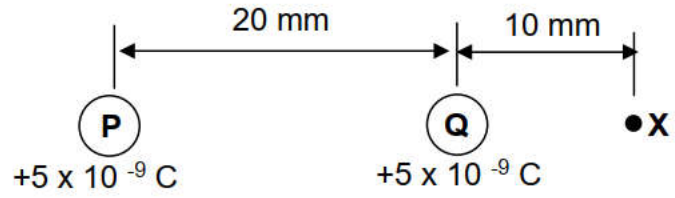
6.4 State *Coulomb's Law* in words. (2)

6.5 If, after separation of the charges, the net electrostatic force acting on sphere **Y** is 0 newtons, calculate the net electrostatic force acting on sphere **Z**. (5)

[14]

QUESTION 7 (Start on a new page.)

Two identical metal spheres **P** and **Q**, each carrying a charge of +5 x 10 $^{-9}$ C, lie on a flat wooden surface with their centres 20 mm apart. **X** is a point 10 mm from sphere **Q**, as shown in the diagram below. The centres of spheres **P** and **Q** and point X lie on the same straight line.



7.1 Define the term *electric field* at a point. (2)

7.2 Draw the resulting electric field pattern surrounding spheres **P** and **Q**. (3)

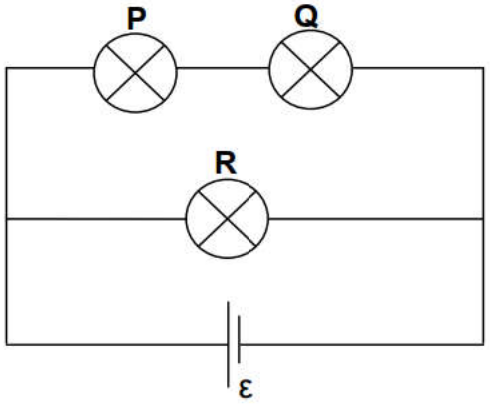
7.3 Calculate the magnitude of the net electric field at point **X**. (5)

7.4 Hence, calculate the magnitude of the electrostatic force that an electron will experience when placed at point **X**. (3)

[13]

QUESTION 8 (Start on a new page.)

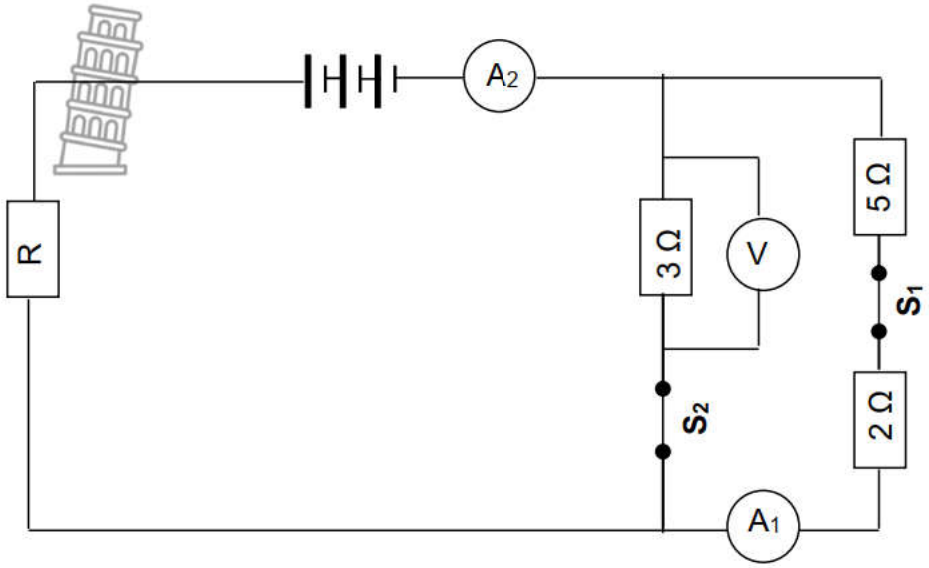
8.1 **P**, **Q** and **R** are light bulbs with the same resistance. They are connected to a battery with emf ε and negligible internal resistance, as shown in the ccircuit diagram below.



8.1.1 How does the brightness of bulb **P** compare with that of bulb **Q**?
Choose from EQUAL TO, GREATER THAN or LESS THAN
Give a reason for the answer. (2)

8.1.2 How does the brightness of bulb **P** compare with that of bulb **R**?
Choose from EQUAL TO, GREATER THAN or LESS THAN
Give a reason for the answer. (2)

8.2 A battery with an unknown emf and negligible internal resistance is connected to four resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



Both switches **S1** and **S2** are CLOSED. The reading on ammeter A_1 is 1,2 A.

Calculate the:

8.2.1 Reading on the voltmeter (3)
8.2.2 Reading on ammeter A_2 (4)
8.2.3 Power dissipated in the 3 Ω resistor (3)

Switch **S1** is now OPENED, while switch **S2** remains CLOSED. The reading on ammeter A_2 is now 3,48 A.

8.2.4 Calculate the emf of the battery. (6)

Switch **S2** is now OPENED, while switch **S1** is CLOSED.

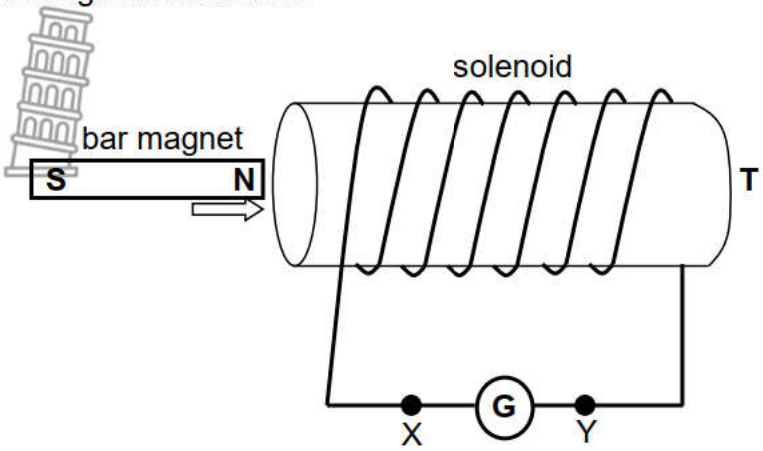
8.2.5 How will the reading on ammeter A_1 change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer. (3)

8.3 An electric heater draws 4,4 A from a 220 V source. Calculate the cost of using the heater for 30 days if the heater is used for 3 hours per day. The electricity tariff is R1,83 per kWh. (4)
[27]

QUESTION 9 (Start on a new page.)

9.1 The setup of the apparatus below was used to demonstrate Faraday's law of electromagnetic induction.



9.1.1 State *Faraday's Law of Electromagnetic induction* in words. (2)

9.1.2 Write down the polarity (North pole or South pole) established at point **T** as the bar magnet approaches the solenoid. (1)

9.1.3 What will be observed on the galvanometer when the bar magnet is held stationary inside the solenoid?
Give a reason for the answer. (2)

9.1.4 What is the direction of the induced current through the galvanometer? CHOOSE from X to Y or from Y to X. (2)

9.2 A magnetic field with a field strength of 0,5 T passes through a conducting loop of area 10 cm^2 in such a way that the field lines are at 70° to the plane of the loop.

9.2.1 Calculate the magnetic flux linkage. (3)

9.2.2 Calculate the average emf that will be induced across the ends of the coil if it is removed from the field in 0,2 s. (4)

9.3 A circular coil is placed inside a magnetic field and rotated clockwise to induce an emf.

How will the following changes influence the magnitude of the induced emf? Choose from INCREASES, DECREASES or REMAINS THE SAME.

9.3.1 Changing the polarity of the magnets. (1)

9.3.2 Increasing the speed of rotation of the coil. (1)

[16]

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	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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	$9{,}11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6{,}38 \times 10^{6}\ m$

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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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

ELECTROSTATICS & ELECTROMAGNETISM / *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* $n = \frac{Q}{q_e}$	$\phi = BA\cos\theta$ $\quad \varepsilon = \frac{-N\Delta\phi}{\Delta t}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$V = IR$	
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$Q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

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