education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

# NATIONAL SENIOR CERTIFICATE

## GRADE 12

## PHYSICAL SCIENCES: PHYSICS (P1)

## SEPTEMBER 2017

**MARKS: 150**

**TIME: 3 hours**

**This paper consists of 16 pages, a graph paper and 3 data sheets.**

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## INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of ELEVEN 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 open 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

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 your ANSWER BOOK, for example 1.11 E.

1.1 Which one of the following physical quantities is equal to the product of the mass and the velocity of an object?

A Power

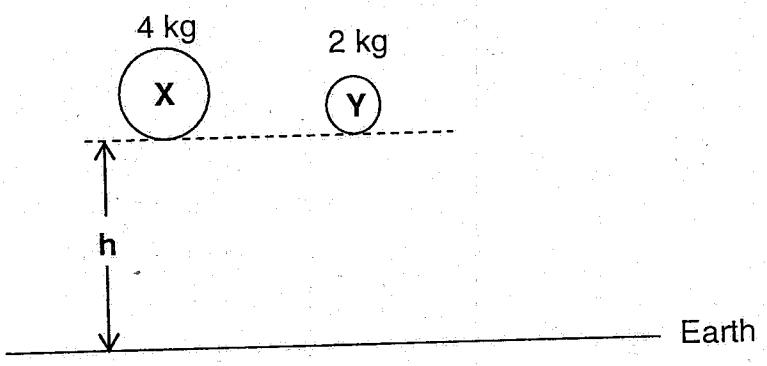
B Momentum

C Net force

D Impulse

(2)

1.2 Two spheres, **X** with a mass of 4 kg and **Y** with a mass of 2 kg, are released simultaneously from the same height **h**. Each one of the spheres experiences an acceleration to the Earth due to a force.




Which ONE of the following is the CORRECT relationship of the force acting on each sphere and the acceleration of each sphere?

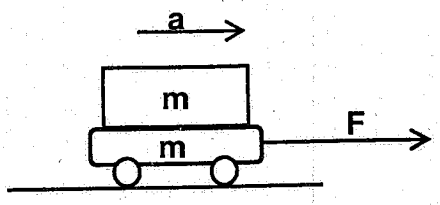
| | FORCE (F) | ACCELERATION (a) |
|---|---|---|
| A | $F_x > F_y$ | $a_x = a_y$ |
| B | $F_x = F_y$ | $a_x = a_y$ |
| C | $F_x = F_y$ | $a_x > a_y$ |
| D | $F_x > F_y$ | $a_x > a_y$ |

(2)



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1.3 A learner applies a constant force **F** on a trolley of mass **m** resting on a horizontal, frictionless surface. A wooden block with the SAME mass **m** is placed on the trolley. The trolley-block system moves to the right with an acceleration **a**.




The wooden block is now removed while the learner still applies the SAME FORCE **F**.

The magnitude of the acceleration of the trolley without the wooden block is:

A ½ **a**

B **a**

C 2**a**

D 4**a** (2)

1.4 An object on the surface of the Earth experiences a gravitational force **F**.
Planet **Q** has a mass AND radius half that of the Earth.
Which ONE of the following is the gravitational force experienced by the object on the surface of planet **Q**?

A **F**

B ½ **F**

C 2 **F**

D 4 **F** (2)

1.5 Light from distant solar systems undergoes a red shift. This phenomenon takes place because the...

A frequency of light from distant solar systems is low.

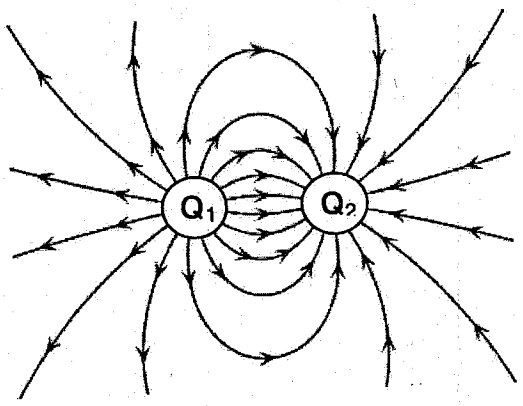
B distance that the light must travel causes the frequency to decrease.

C distant solar systems are moving towards the Earth.

D light energy from distant solar systems that move away from the earth is directly proportional to the frequency. (2)

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1.6 The electric field pattern between two charges $Q_1$ and $Q_2$ is shown below.

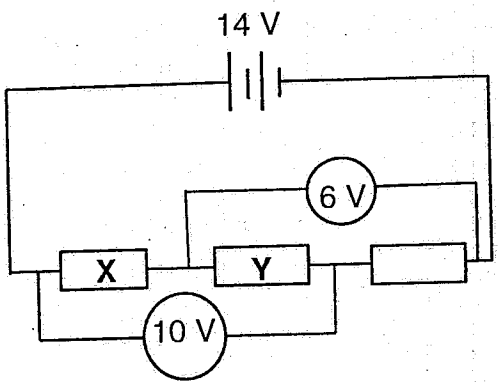



Which ONE of the following statements regarding the charge $Q_1$ and $Q_2$ is CORRECT?

| | Charge $Q_1$ | Charge $Q_2$ |
|---|---|---|
| A | Negative | Negative |
| B | Positive | Negative |
| C | Negative | Positive |
| D | Positive | Positive |

(2)

1.7 A battery with an emf of 14 V and a negligible internal resistance is connected in a circuit to three resistors as shown in the diagram below. The resistance of the resistor **Y** is R. The two voltmeters show readings of 6 V and 10 V respectively. Ignore the resistance of the connecting wires.




Which ONE of the following is the CORRECT value of the resistance of resistor **X**?

A ½ R

B R

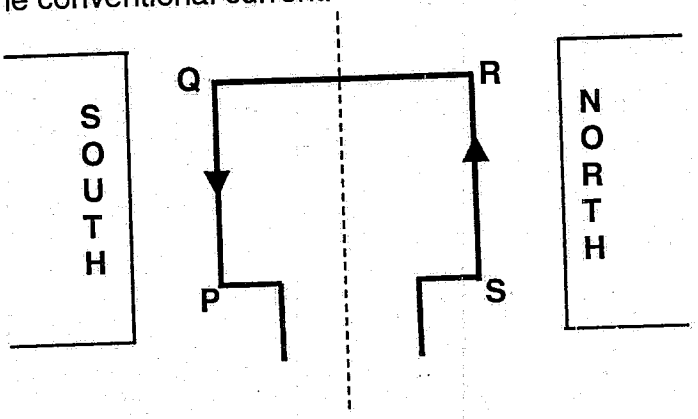
C 2 R

D 4 R

(2)

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1.8 A rectangular current carrying coil, **PQRS**, is placed between two bar- magnets with the coil parallel to the field as shown below. The arrows indicate the direction of the conventional current.




The coil will...

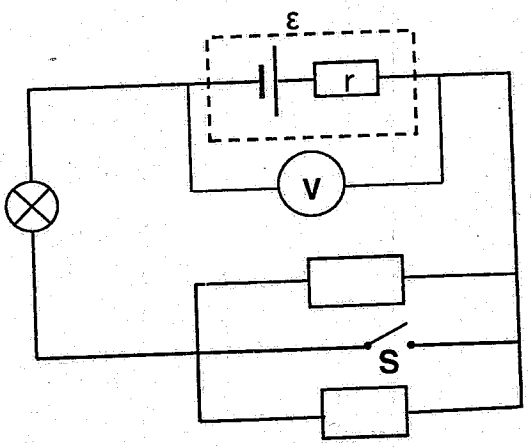
A first rotate clockwise and then anticlockwise.

B rotate clockwise.

C remain motionless.

D rotate anticlockwise. (2)

1.9 A bulb and two identical resistors are connected in the circuit as shown below. The cell has an emf ε and an internal resistance r. The power rating of the bulb is **P**. Switch **S** is OPEN.




Switch **S** is now CLOSED.
Which ONE of the following statements regarding the change in the voltmeter reading and the power of the bulb is CORRECT?

| | VOLTMETER READING | POWER IN BULB |
|---|---|---|
| A | Increases | Decreases |
| B | Remains the same | Remains the same |
| C | Decreases | Increases |
| D | Decreases | Decreases |

(2)

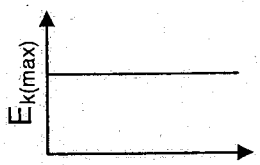


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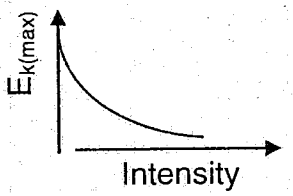
1.10 Violet light with variable intensity is shone on a metal plate.
Photoelectrons are ejected from the surface of the metal plate.

Which ONE of the following graphs shows the correct relationship between the maximum kinetic energy of the ejected photoelectrons and the intensity of the incident light?

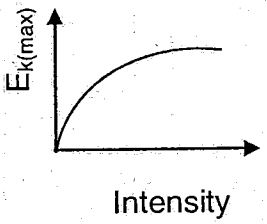
**A**



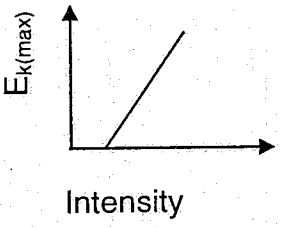

**B**




**C**



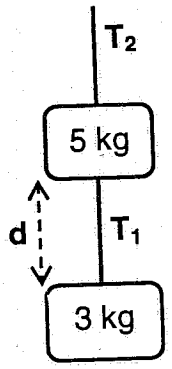

**D**




(2)
**[20]**

## QUESTION 2 (Start on a new page)

A 5 kg block and a 3 kg block are connected by a light, inextensible string $T_1$. A second light, inextensible string $T_2$ is connected to the 5 kg block. The blocks are at rest as shown in the diagram below. Ignore all effects of air resistance.




2.1 State Newton's First Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on the 5 kg block. (3)

2.3 In which string is the tension greater? Choose from $T_1$ or $T_2$. (1)

When the force in string $T_2$ is 120 N, the blocks accelerate upwards. The string $T_1$ can experience a maximum tension of 50 N before it breaks.

2.4 Determine by means of a calculation if the string $T_1$ will break. (6)

When string $T_2$ is removed, the blocks fall to the ground. Ignore all effects of air resistance.

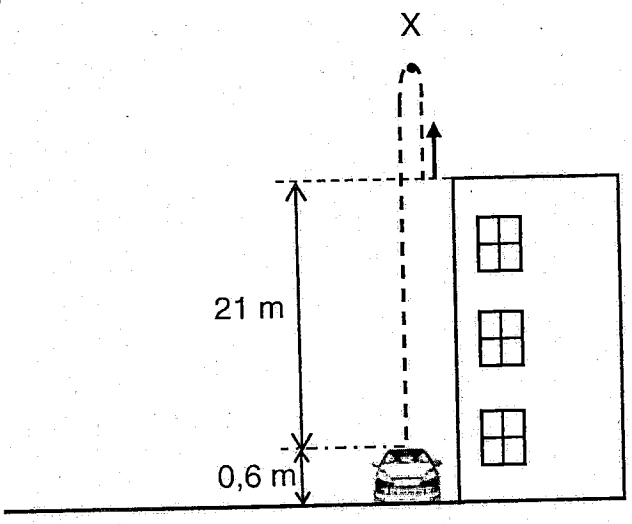
2.5 How will the distance **d** between the blocks change during the motion? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1) **[13]**



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## QUESTION 3 (Start on a new page)

A car, 0,6 m high, is parked next to a block of flats. A learner leans over the edge of the roof of the building, 21 m above the roof of the car. The learner throws a ball, with a mass of 500 g, vertically upwards. The ball moves upwards to point ***X***, falls back past the top of the building and hits the roof of the car after 2,88 s. Ignore all effects of air resistance.




3.1 Define the term *free fall.* (2)

3.2 Write down the following experienced by the ball at point **X**:

3.2.1 Magnitude of the net force (1)

3.2.2 Direction of the acceleration (1)

3.3 Calculate the:

3.3.1 Magnitude of the velocity with which the ball was thrown upwards (4)

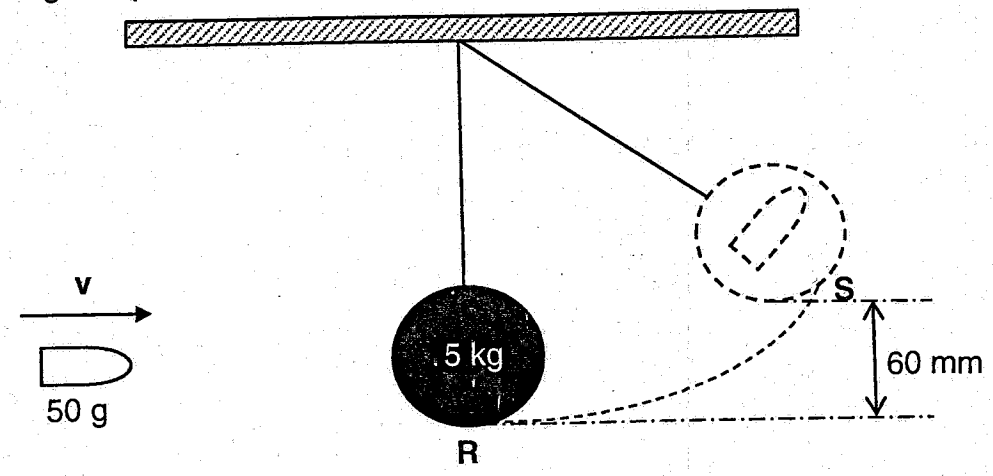
3.3.2 Maximum height that the ball will reach above the ground (4)

3.4 The ball hits the roof of the parked car and bounces from the roof with a speed of 18 $m \cdot s^{-1}$. The ball is in contact with the roof of the car for 0,1 s. Calculate the magnitude of the force that the roof of the car exerts on the ball. (5)
**[17]**

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**QUESTION 4 (Start on a new page)**

A wooden sphere of mass 5 kg hangs stationary from a light string. A bullet of mass 50 g moves horizontally with a constant speed **v** and hits the wooden sphere. The bullet enters the wooden sphere and the sphere-bullet system swings further to a maximum height at point **S** as shown in the diagram below.




4.1 Define the term *gravitational potential energy*. (2)

4.2 Calculate the:

4.2.1 Gravitational potential energy of the sphere-bullet system at point **S** (3)

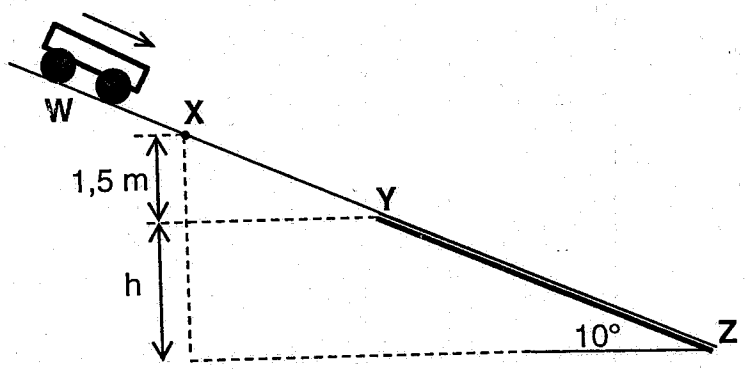
4.2.2 Speed of the sphere-bullet system at point **R** (4)

4.2.3 Speed **v** of the bullet before it hits the sphere (4)
**[13]**

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## QUESTION 5 (Start on a new page)

A trolley of mass 76 kg moves from rest from point **W** on a straight slope **WXYZ**. The trolley reaches point **X** with a speed of 3 $m \cdot s^{-1}$. The part **WXY** of the slope is frictionless and **YZ** is a rough surface.




5.1 Define the term *normal force.* (2)

5.2 Draw a labelled free-body diagram to show ALL the forces acting on the trolley while it is moving from point **X** to point **Y**. (2)

5.3 Calculate the speed of the trolley at point **Y**. (4)

The coefficient of kinetic friction ($\mu_k$) between the trolley and the surface of the slope **YZ** is 0,21. The trolley comes to rest at point **Z**.

5.4 Calculate the magnitude of the kinetic frictional force on the trolley while it moves from point **Y** to point **Z**. (3)

5.5 Explain why NO work is done by the normal force on the trolley. (1)

5.6 Use ENERGY PRINCIPLES only to calculate the height h. (6)

A block of 5 kg is added onto the trolley and the trolley-block system moves again from rest from point **W**.

5.7 How will the speed of the trolley-block system at point **Y** compare to the speed of the TROLLEY ONLY, as calculated in QUESTION 5.3? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
**[19]**



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## QUESTION 6 (Start on a new page)

A sound source emits sound waves with a frequency of 945 Hz. The sound source moves towards a stationary listener at a constant velocity. The listener measures the frequency of the sound waves as 980,6 Hz. Take the speed of sound in air as 340 $m \cdot s^{-1}$. Ignore the effects of wind.

6.1 Define the term *frequency*. (2)

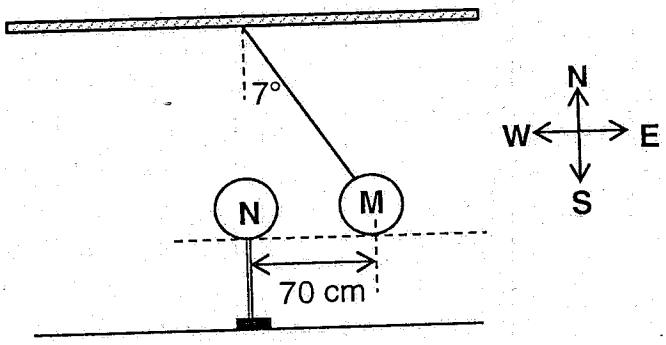
6.2 Explain why the listener observes a higher frequency than the frequency of the sound source. (2)

6.3 Calculate the speed of the sound source. (4)

6.4 Draw a graph of the observed frequency versus time as the sound source moves towards the listener, passing it and then moves away from the listener. Clearly indicate the frequency of the sound source (945 Hz) on the graph. (3)
**[11]**

## QUESTION 7 (Start on a new page)

An uncharged metal sphere **M** is suspended from the ceiling by means of a light, inextensible isolated string. The metal sphere is brought into contact with an identical isolated sphere **N** with a charge of +20 µC that is mounted on a stand. After contact sphere **M** experiences a repulsive force resulting in the string making an angle of 7° with the vertical as shown in the diagram below.




7.1 State Coulomb's law in words. (2)

7.2 Calculate the magnitude of the charge on each of the metal spheres **M** and **N** after contact. (2)

7.3 Write down TWO conservative forces acting on the metal sphere **M**. (2)

7.4 Calculate the:

7.4.1 Magnitude of the electrostatic force between the spheres AFTER CONTACT (4)

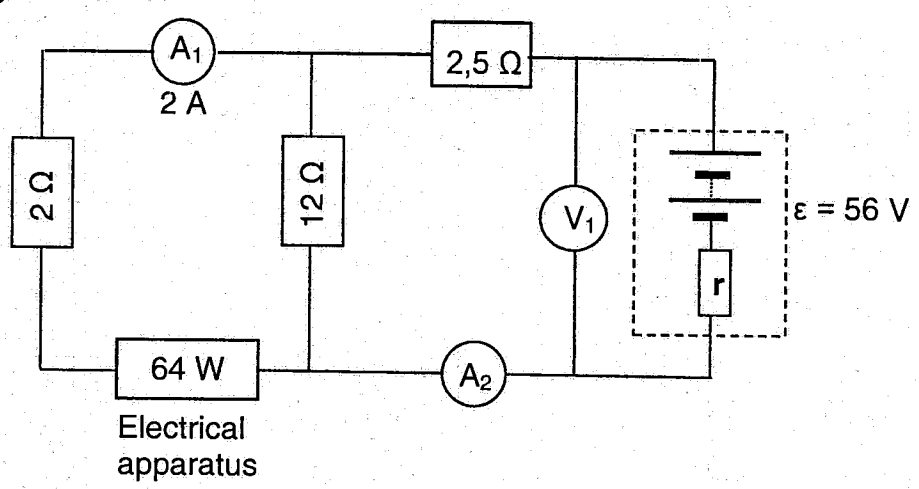
7.4.2 Mass of the metal sphere **M** (3)
**[13]**



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

Three resistors and a 64 W electrical apparatus are connected to a battery with an emf of 56 V and an internal resistance **r** as shown in the diagram below. The ammeter $A_1$ has a reading of 2 A.




8.1 State Ohm's law in words. (2)

8.2 How does the reading on ammeter $A_1$ compare to the reading on ammeter $A_2$? Choose from LARGER THAN, SMALLER THAN or THE SAME AS. Explain the answer (2)

8.3 Calculate the:

8.3.1 Resistance of the electrical apparatus (3)

8.3.2 Current passing through the battery (4)

8.3.3 Voltmeter reading $V_1$ (5)

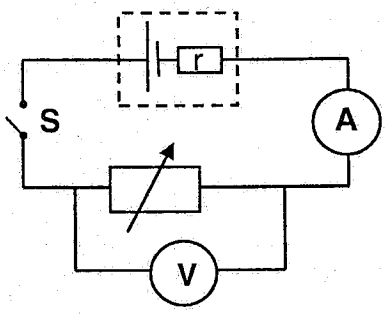
8.4 The electrical apparatus is removed and replaced by another electrical appliance. The ammeter reading on $A_1$ changes to 0 A. Which electrical apparatus is connected in the circuit? Write down only RESISTOR, VOLTMETER or CELL. Explain the answer. (2)

**[18]**

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## QUESTION 9 (Start on a new page)

A group of learners conduct an experiment to determine the internal resistance (r) of a battery. They set up the circuit as shown in the diagram below.




The following results were obtained when switch **S** was closed.

| | | | | |
|---|---|---|---|---|
| Reading on voltmeter (V) | 9 | 7,2 | 5,4 | 2,2 |
| Reading on ammeter (A) | 0,06 | 0,17 | 0,3 | 0,47 |

9.1 Explain the term *internal resistance*. (1)

9.2 Use the above results to draw a graph of the potential difference versus current ON THE ATTACHED GRAPH SHEET. (3)

9.3 Use the graph drawn in QUESTION 9.2 to determine the following:

9.3.1 The emf of the battery (1)

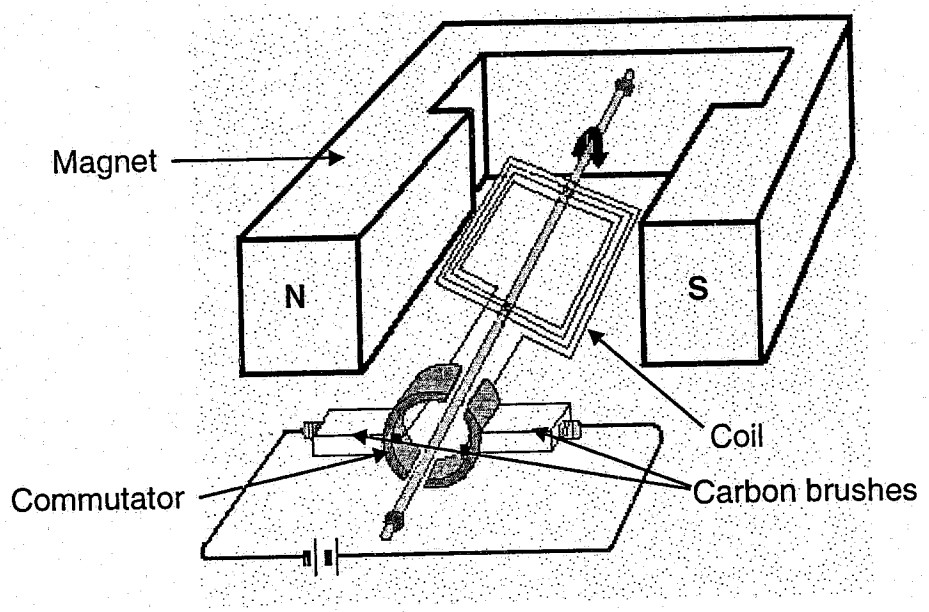
9.3.2 The gradient of the graph (2)

9.3.3 The internal resistance of the battery (1)
**[8]**

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

A simplified sketch of a DC motor is shown in the diagram below.




10.1 Name the component that ensures continuous rotation of the coil in this electric motor. (1)

10.2 Which structural change must be done to the components of the DC motor to change it into an AC motor? (1)

An AC generator (alternator) delivers a peak current of 6,43 A when it is connected to an electrical heater with a resistance of 48,4 Ω.

10.3 Calculate the:

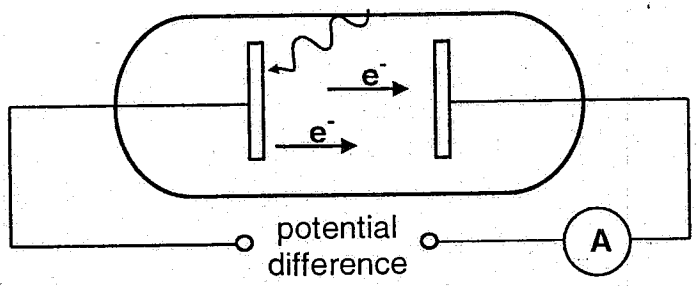
10.3.1 rms current delivered by the generator (3)

10.3.2 Peak voltage supplied by the generator (5)
**[10]**

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**QUESTION 11 (Start on a new page)**

The apparatus used to demonstrate the photoelectric effect is shown below. When a specific monochromatic light is shone on the metal plate, the ammeter shows a reading.




11.1 Define the term *photo-electric effect.* (2)

A photon in the monochromatic light has a wavelength of 260 nm. When this incident light shines on the metal plate, electrons are ejected from the metal plate with a maximum speed of $5 \times 10^5$ $m \cdot s^{-1}$.

11.2 Calculate the:

11.2.1 Energy of a photon of the incident light (3)

11.2.2 Threshold frequency of the metal plate (3)
**[8]**

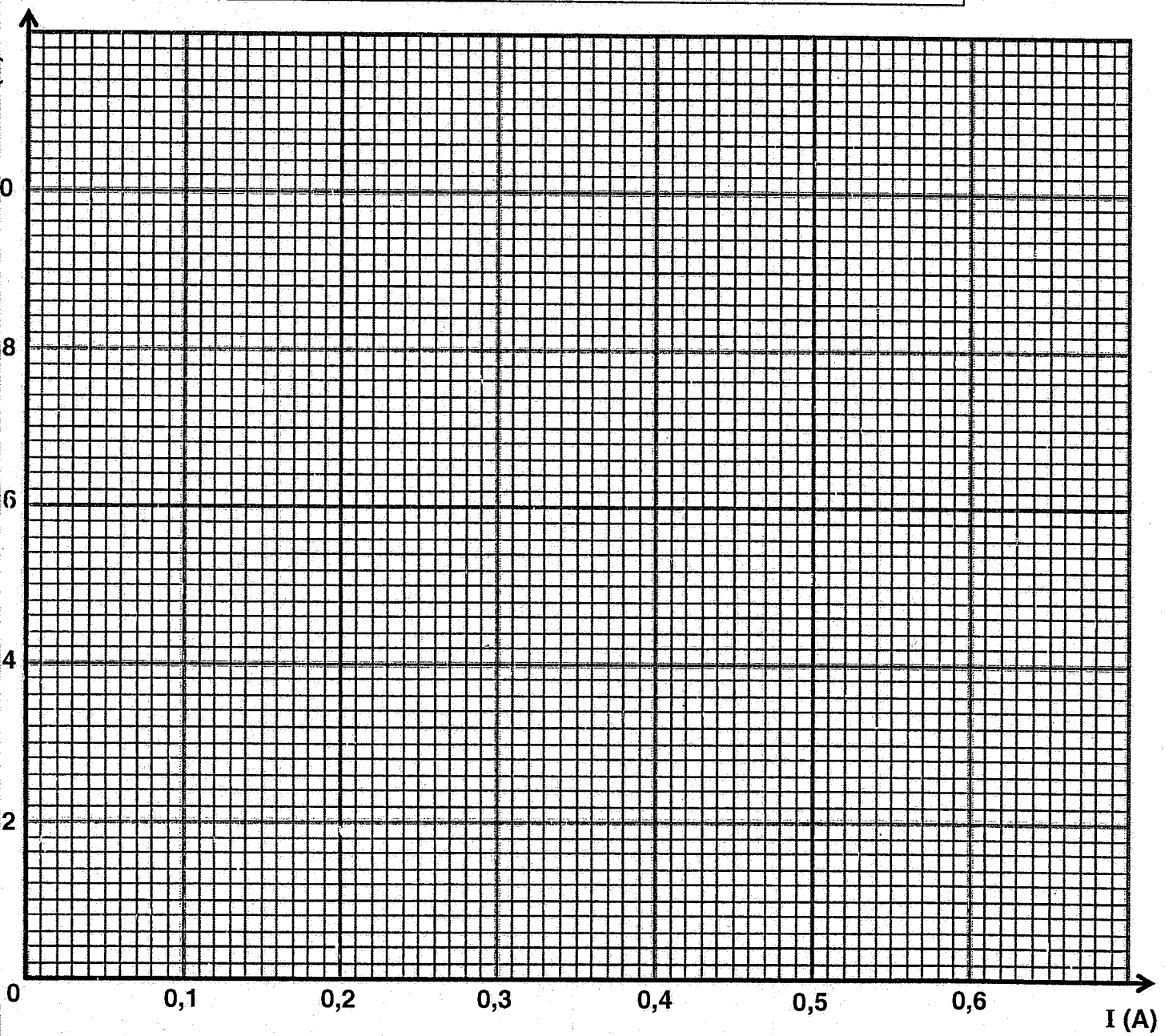
**TOTAL: 150**

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**NAME:** _____

## QUESTION 9

**GRAPH OF POTENSIAL DIFFERENCE VERSUS CURRENT**



# 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<br>*Swaartekragversnelling* | g | $9{,}8\ m{\cdot}s^{-2}$ |
| Universal gravitational constant<br>*Universele gravitasiekonstante* | G | $6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$ |
| Speed of light in a vacuum<br>*Spoed van lig in 'n vakuum* | c | $3{,}0 \times 10^{8}\ m{\cdot}s^{-1}$ |
| Planck's constant<br>*Planck se konstante* | h | $6{,}63 \times 10^{-34}\ J{\cdot}s$ |
| Coulomb's constant<br>*Coulomb se konstante* | k | $9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$ |
| Charge on electron<br>*Lading op elektron* | $e^-$ | $-1{,}6 \times 10^{-19}\ C$ |
| Electron mass<br>*Elektronmassa* | $m_e$ | $9{,}11 \times 10^{-31}\ kg$ |
| Mass of Earth<br>*Massa van die Aarde* | M | $5{,}98 \times 10^{24}\ kg$ |
| Radius of Earth<br>*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*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\,\Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$ |
| $F = G\frac{m_1 m_2}{d^2}$ 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 $W_{nc} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$ | | |
| $P_{ave} = F\cdot v_{ave}$ / $P_{gemid} = F\cdot v_{gemid}$ | | | |

## 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* $E = h\frac{c}{\lambda}$ |
| $E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar*<br>$E = hf$ and/*en* $W_o = hf_o$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$<br>or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$ | |

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## 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 $(\varepsilon) = I(R + r)$<br>emk $(\varepsilon) = I(R + r)$ |
| $R_s = R_1 + R_2 + \ldots$<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ | $q = I\Delta t$ |
| $W = Vq$<br>$W = VI\Delta t$<br>$W = I^2R\Delta t$<br>$W = \frac{V^2\Delta t}{R}$ | $P = \frac{W}{\Delta t}$<br>$P = VI$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |

## ALTERNATING CURRENT / WISSELSTROOM

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

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