LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space 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 the question paper.
5. Leave ONE line between two sub questions, 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.

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) of the answer next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 The **same force** is applied to trolley A and trolley B as shown in the sketch below.

The mass of A is **TWICE** the mass of B. If the rate of change of momentum of A is **x**, then the rate of change of momentum of B will be:

A ½ **x**
B **x**
C 2**x**
D 4**x**

(2)

1.2 A ball is thrown vertically upwards. Which **ONE** of the following physical quantities of the ball will be **ZERO** when the ball reaches its maximum height?

A kinetic energy
B gravitational potential energy
C acceleration
D weight

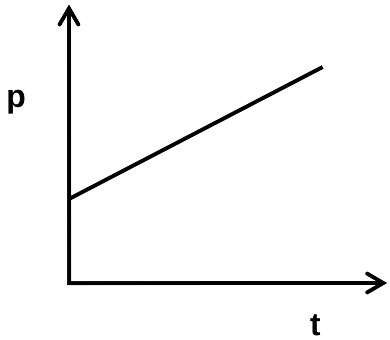
(2)

1.3 Acceleration due to gravity (g), at a particular point, on earth is 9,8 $m.s^{-2}$. If the radius of the earth were to be **halved** and its mass were to remain the same, then the acceleration due to gravity will be:

A 4,9 $m.s^{-2}$
B 9,8 $m.s^{-2}$
C 19,6 $m.s^{-2}$
D 39,2 $m.s^{-2}$

(2)

1.4 The graph below represents the relationship between momentum (**p**) and the time (**t**) for a body travelling in a straight line.



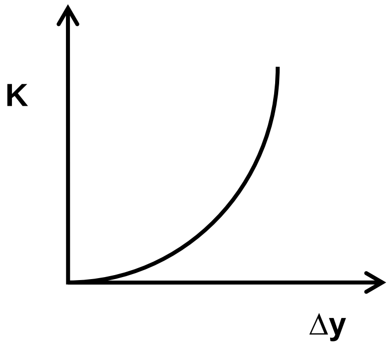
Which **ONE** of the following conclusions, based on the above graph, is TRUE about the resultant (net) force acting on the body? The resultant (net) force is ……

A zero
B uniformly increasing
C constant
D uniformly decreasing

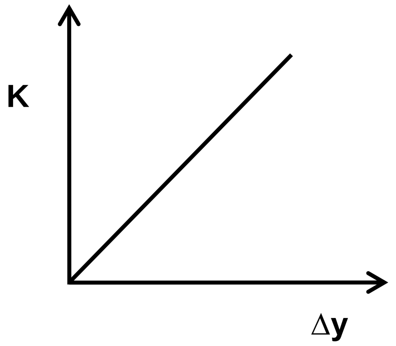
(2)

1.5 A stone falls freely from rest from the top of a building. Ignore air resistance. As the stone falls through the air, which **ONE** of the following graphs best represents the relationship between the kinetic energy (**K**) of the stone and its displacement (Δ**y**)?

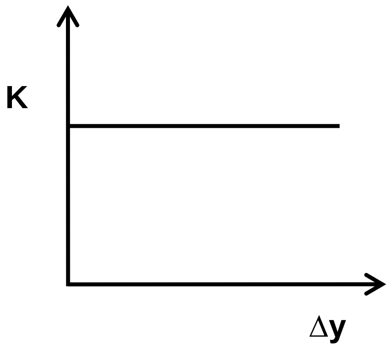
A



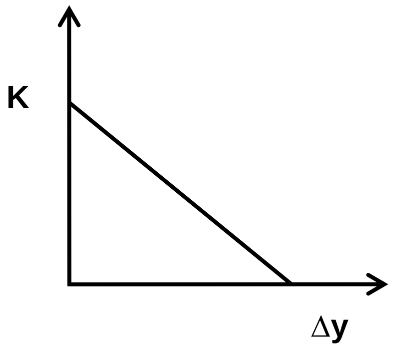
B



C



D



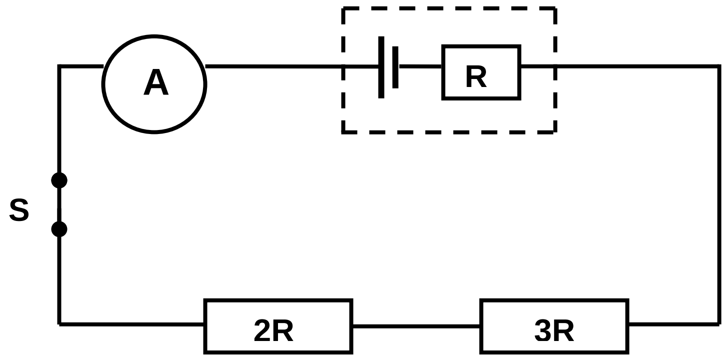
(2)

1.6 How do the emission and absorption spectra of an element differ?

A The emission spectrum contains more lines than the absorption spectrum.
B The emission spectrum is shifted to the left (toward the blue side) of the absorption spectrum.
C The emission spectrum is shifted to the right (toward the red side) of the absorption spectrum.
D The lines are in the same wavelength positions, but are bright and coloured for the emission spectrum and black for the absorption spectrum.

(2)

1.7 In the circuit below, two resistors of resistance 2R and 3R are connected in series with a battery, which has an emf of E and an internal resistance R.



What is the potential difference across the resistor of resistance 2R?

A $\frac{E}{3}$

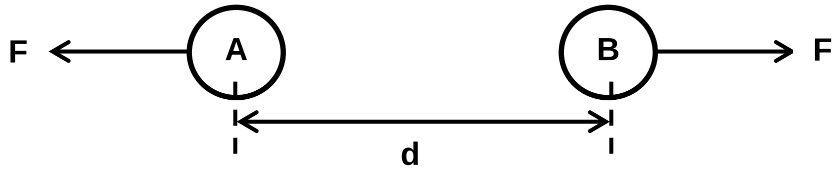
B $\frac{2E}{5}$

C $\frac{E}{2}$

D $\frac{E}{6}$

(2)

1.8 Three identical conducting spheres A, B and C are placed on insulated wooden stands. Spheres A and B carry equal charges. They are separated by a distance **d** and exert a force with magnitude **F** on each other, as shown in the sketch below.



The third sphere C, which is **uncharged,** touches A, then B, and is then removed. If the distance between the spheres remains the same, then the magnitude of the electrostatic force exerted on sphere B is now:

A $\frac{F}{2}$

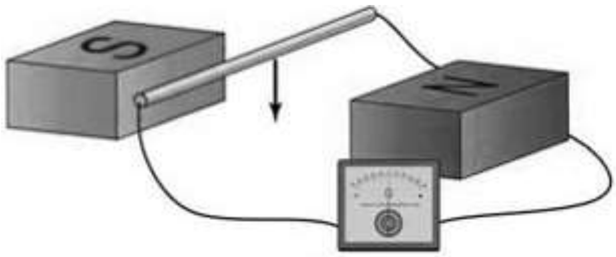
B $\frac{F}{4}$

C $\frac{3F}{8}$

D $\frac{F}{16}$

(2)

1.9 A current is induced when a conductor is moved between two magnets as shown in the diagram below.



The magnitude of induced current can be increased by:

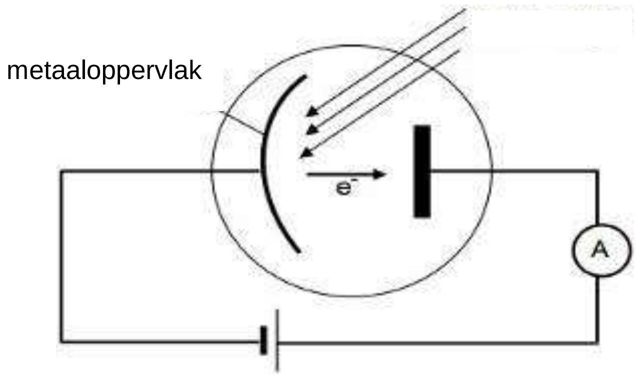
I. using stronger magnets.
II. moving the conductor at higher speed between the magnets.
III. placing the 2 magnets further away from each other.

Which of the above statements are true?

A I and II only
B II and III only
C I and III only
D I, II and III

(2)

1.10 A metallic surface is first irradiated with **ultraviolet light** and THEN with **infrared light** of the SAME intensity as shown in the circuit below. Both forms of light emit electrons from the metal surface.



How will the kinetic energy of the emitted photoelectrons and reading on the ammeter change when the two different forms of lights are used?

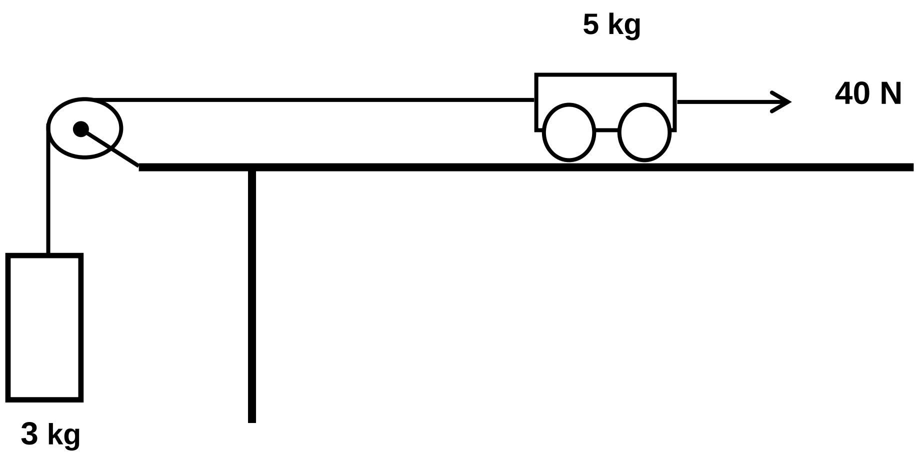
	Kinetic Energy of photoelectrons	**Reading on the ammeter**
A	same	same
B	increase	same
C	decrease	same
D	same	increase

(2)

[20]

QUESTION 2 (Start on a new page)

In the sketch below, a trolley of mass 5 kg is connected to a 3 kg mass piece by means of a light inextensible string passing over a pulley. A constant force of 40 N is applied to the 5 kg trolley as shown in the diagram. The trolley experiences a constant frictional force of 2 N when the force is applied. Ignore the mass of the string and friction of the pulley. Take direction to the **RIGHT** as **positive**.



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

2.2 Draw a labelled force diagram showing ALL <u>the horizontal forces</u> acting on the 5 kg trolley. (3)

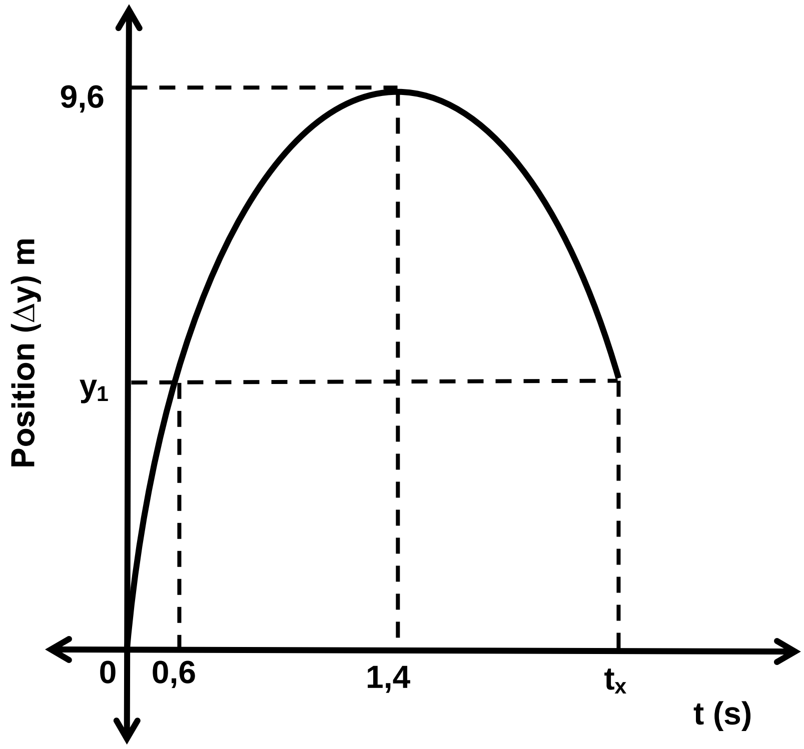
2.3 2.3.1 Apply Newton's Second Law to the mass and the trolley and calculate the magnitude of the acceleration of the trolley. (7)

2.3.2 Hence, determine the magnitude of the tension in the string. (2)

[14]

QUESTION 3 (Start on a new page)

The graph below shows the motion of a brick that is thrown vertically upwards from the ground. It takes 1,4 s to reach its highest point, after which it falls downwards, and is caught by a person, on a scaffold, building a wall for a house. Ignore the effects of friction.



3.1 What does position $\mathbf{y_1}$ represent on the graph? (1)

3.2 Write down the value of the time t_x without performing any calculation. (2)

3.3 At which time will the velocity of the brick be **zero** (0 m.s^{-1})? (1)

3.4 Calculate the:

3.4.1 initial velocity of the brick. (4)

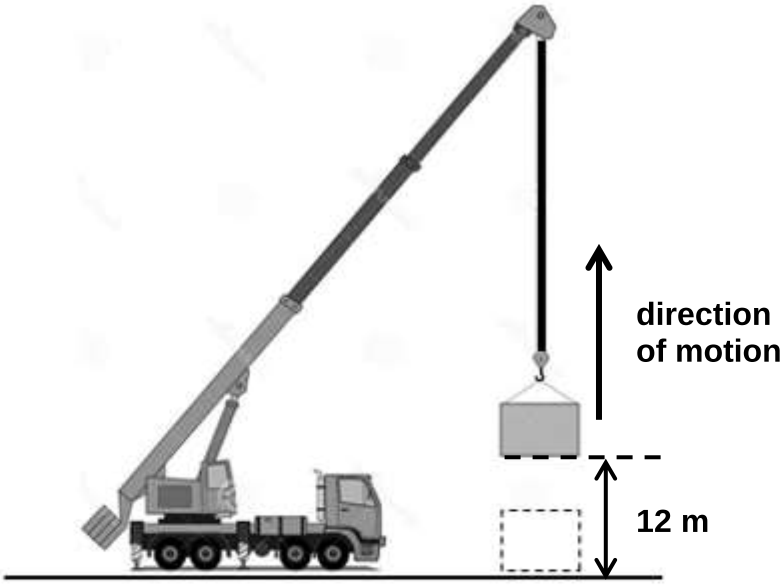
3.4.2 magnitude of position $\mathbf{y_1}$ (4)

3.5 Sketch an acceleration versus time graph for the motion of the brick. (2)

[14]

QUESTION 4 (Start on a new page)

A container of mass 120 kg, hanging from a steel cable attached to a crane is accelerated vertically upwards from **rest** through a height of 12 m, as shown in the diagram below. The container reaches a maximum speed of 5 $m.s^{-1}$ after being lifted through a height of 12 m.



4.1 Draw a labelled free body diagram showing all the forces acting on the container as it is accelerated upwards. (3)

4.2 If the tension in the cable is 800 N, calculate the work done by the cable to move the container to a height of 12 m. (3)

4.3 State the Work Energy Theorem in words. (2)

4.4 Use **Energy Principles** to calculate the work done on the container by friction while it is moving to a height of 12 m. (4)

4.5 Name **ONE** non – conservative force acting on the container as it is lifted. (1)

[13]

QUESTION 5 (Start on a new page)

A 0,5 kg soccer ball, moving horizontally at 6 $m.s^{-1}$, collides with a soccer player's head and is headed directly back at 9 $m.s^{-1}$. The ball is in contact with the player's head for 0,02 s. Ignore the effects of friction.

5.1 What is the relationship between impulse and change in momentum? (1)

5.2 Is the total momentum conserved during this collision?
Provide a reason for your answer. (2)

5.3 Calculate the magnitude of the average force exerted by the soccer player's head on the ball. (4)

5.4 A second ball is pumped to its maximum volume so that it cannot be compressed. Assume that the two balls have the same mass. If the second ball strikes the soccer player's head with a velocity of 6 $m.s^{-1}$, will the force exerted by the soccer player's head on the ball be **greater than, less than or equal to** the force calculated in question 5.3. Give a reason for your answer. (3)

[10]

QUESTION 6 (Start on a new page)

6.1 Humpback whales and bottlenose dolphins emit sound waves that range from 0,2 to 150 kHz as they travel through water. A scientist immerses a frequency meter under water to determine the frequency of the sound that a dolphin emits. The scientist finds that the frequency meter registers a frequency of 50 kHz as the dolphin approaches him at a constant speed and 49 kHz as it moves away from him at the same constant speed.

6.1.1 State the Doppler Effect in words. (2)

6.1.2 If the speed of sound in water is 1560 $m.s^{-1}$, calculate the actual frequency of the sound made by the dolphin. (8)

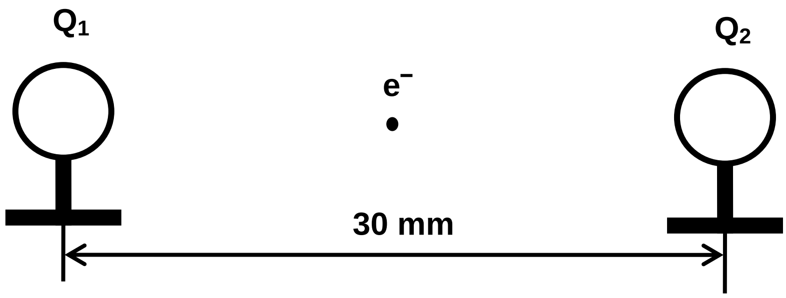
6.1.3 Hence, determine the speed at which the dolphin is moving. (2)

6.2 Briefly explain how an **emission spectrum** and an **absorption spectrum** are formed. (2)

[14]

QUESTION 7 (Start on a new page)

Two identical conducting spheres, Q_1 and Q_2, on insulating stands are placed with their centres 30 mm apart. When Q_1 is brought into contact with Q_2 and then moved back to its original position, Q_1 gains –12,5 nC of charge and the charge on each sphere is now –7,5 nC.



7.1 Draw the electric field pattern around both spheres **after** they have touched and returned to their original positions. (3)

7.2 State, in words, the Law of Conservation of Charge. (2)

7.3 An electron (e^-) is placed exactly midway between Q_1 and Q_2. Will the electron (e^-) move to the **left**, **right** or stay in the **same position**? (1)

7.4 Calculate the magnitude of the electric field due to the charge on sphere Q_2 at a point 10 mm to the right of Q_2. (3)

7.5 The questions that follow relate to the original charged spheres, Q_1 and Q_2 **BEFORE THEY WERE BROUGHT INTO CONTACT WITH EACH OTHER**.

7.5.1 What is the magnitude and sign of charges Q_1 and Q_2 before they touched? (4)

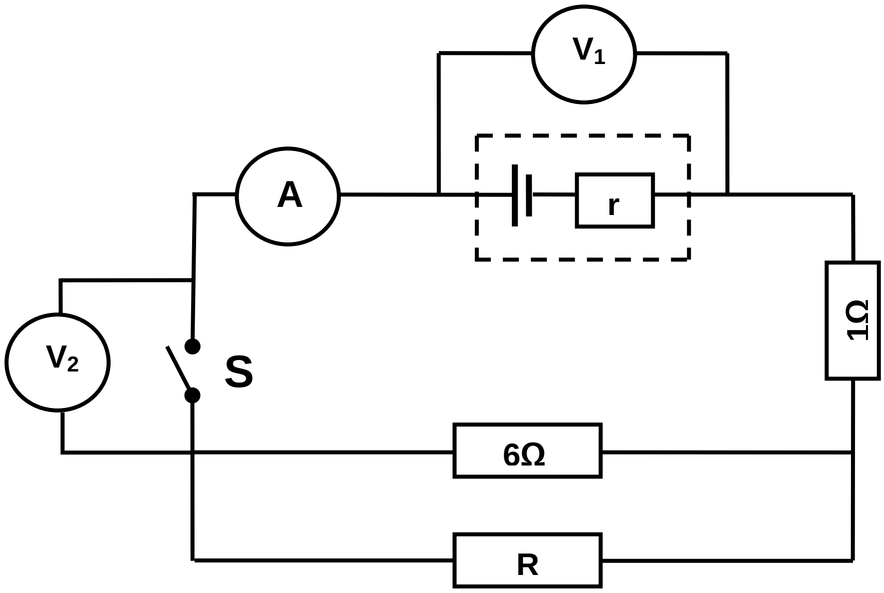
7.5.2 Calculate the electrostatic force that Q_1 exerts on Q_2 before they touched. (4)

7.5.3 Is the electric field pattern between Q_1 and Q_2 before they touched the same as the pattern drawn in 7.1? (1)

[18]

QUESTION 8 (Start on a new page)

In the circuit represented below, the battery has an emf of 10 V and an unknown internal resistance, **r**. Voltmeter V_1 is connected across the battery and voltmeter V_2 is connected across the open switch. Ignore the resistance of the ammeter and connecting wires.



8.1 Switch **S** is **open**. Will the readings on voltmeters V_1 and V_2 be the same? Provide a reason for your answer. (2)

8.2 When the switch **S** is closed the reading on voltmeter V_1 drops to 7,5 V.

8.2.1 What is the reading on voltmeter V_2? (1)

8.2.2 If the reading on the ammeter is 2,5 A, calculate the value of R. (7)

8.2.3 Define, in words, the term *internal resistance*. (2)

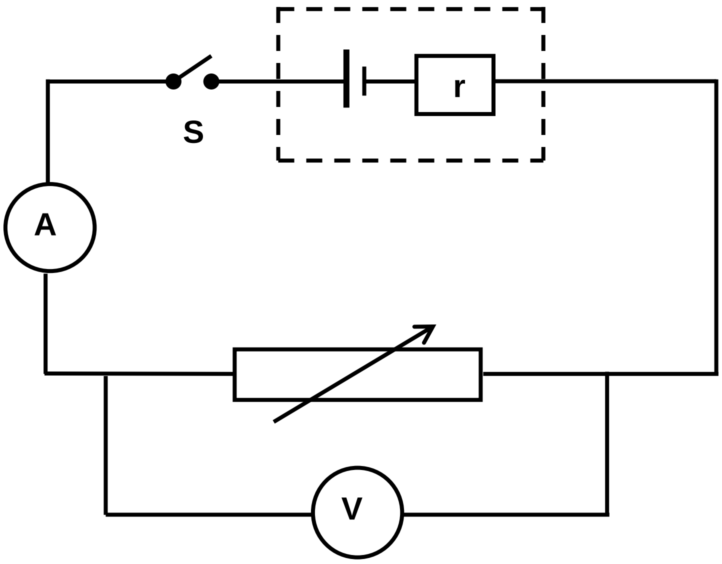
8.2.4 Calculate the internal resistance of the battery. (3)

8.3 Does the reading on the ammeter **INCREASE**, **DECREASE** or **REMAIN THE SAME** when the resistor R is removed? (1)

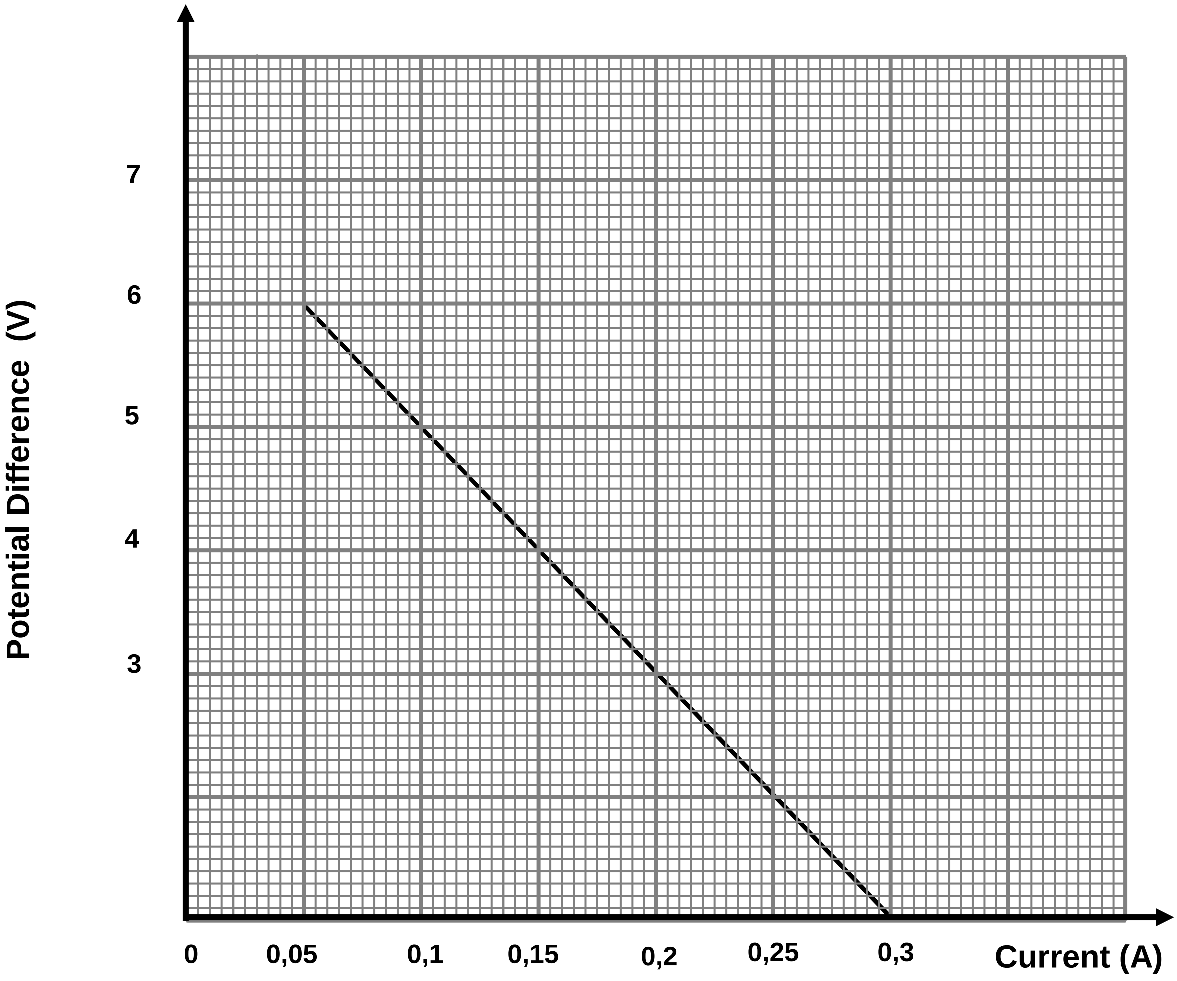
[16]

QUESTION 9 (Start on a new page)

A learner sets up the circuit shown below to determine the emf (ε) and internal resistance (r) of a battery.



The learner obtained the following graph from the data of the investigation.



9.1 State ONE factor that must be kept constant during the experiment. Provide a reason for your answer. (2)

9.2 What does the y – intercept of the graph represent? (1)

9.3 Using the **graph ONLY** determine the exact value for following:

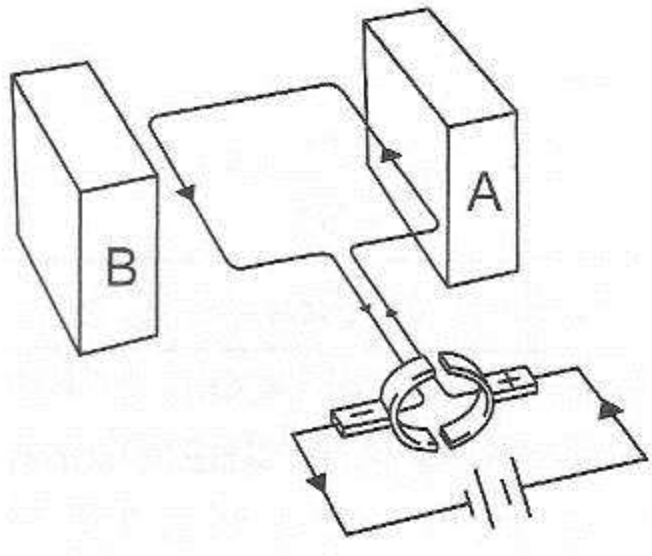
9.3.1 the emf (**ε**) of the battery. (1)

9.3.2 the internal resistance of the battery. (4)

[8]

QUESTION 10 (Start on a new page)

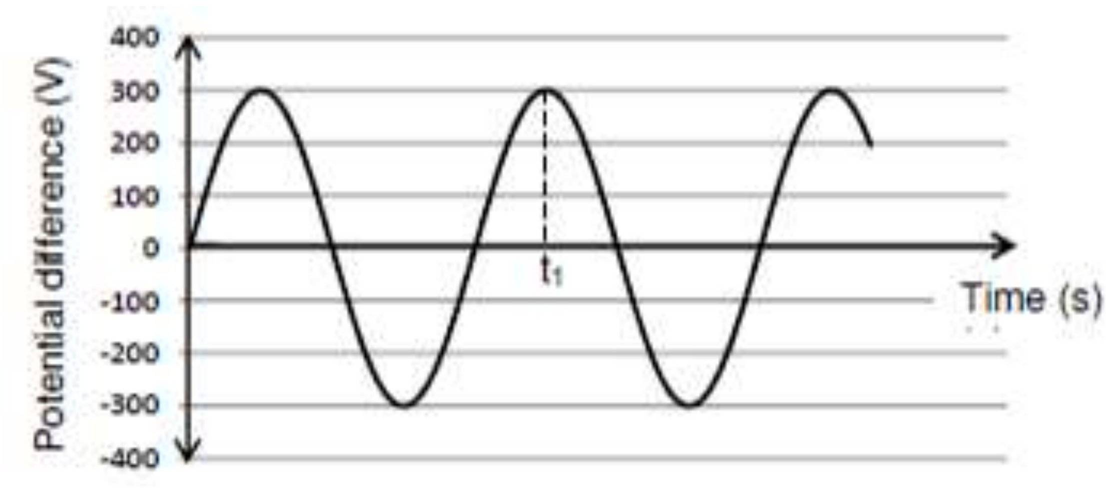
10.1 The simplified sketch below represents the structure of the motor of a cordless drill.



10.1.1 Name the electrical component in the above motor that ensures that the coil rotates in one direction only. (1)

10.1.2 Identify the polarity of magnets A and B if the coil rotates in an anticlockwise direction and the current flows in the coil in the direction indicated in the sketch. (2)

10.2 Another drill operates with alternating current. The maximum current output of this drill is 10,6 A. A graph of the potential difference output of the drill against time is shown below.



10.2.1 Calculate the rms current the drill draws when operating. (3)

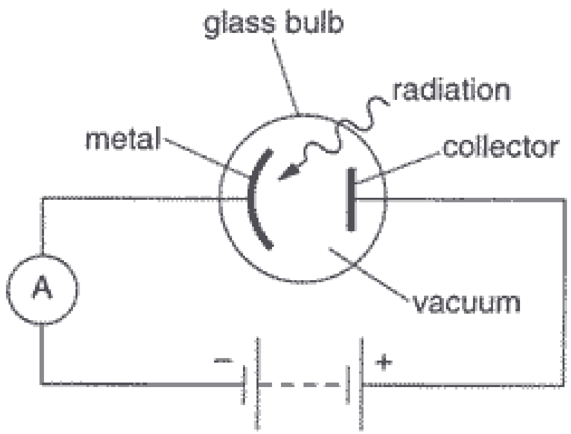
10.2.2 Hence, calculate the average power generated by the drill. (3)

10.2.3 Is the power generated by the drill at time t_1 a **MAXIMUM** or **MINIMUM**? (1)

[10]

QUESTION 11 (Start on a new page)

The diagram represents a photocell. When the metal surface is exposed to electromagnetic radiation, photoelectrons are ejected. The collector collects the photoelectrons and the sensitive ammeter indicates the presence of a tiny current. The metal has a **work function** of 3,5 x 10^{-19} J.



11.1 Name the frequency that is associated with **work function**. (1)

11.2 Calculate the maximum kinetic energy of an ejected photoelectron when the incident radiation is 429 nm. (5)

11.3 The intensity of the incident radiation is doubled but the wavelength is kept constant. State the effect that this has on each of the following: (only write **INCREASE**, **DECREASE** or **REMAIN THE SAME** as your answer):

11.3.1 the energy of each photon . (1)

11.3.2 the maximum kinetic energy of each photoelectron. (1)

11.3.3 the current in the photocell . (1)

11.4 At a certain frequency and intensity of radiation, the ammeter shows a current of 3,2 x 10^{-7} A. Calculate the number of photoelectrons that reach the collector in 4 seconds. (4)

[13]

Grand Total: 150

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 gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
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 Earth *Massa van Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6,38 \times 10^{6}\ m$

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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