education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

NATIONAL SENIOR CERTIFICATE EXAMINATION

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 Hours

This paper consists of 17 pages and 3 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name on the ASWER 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 open between two subsections, 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.

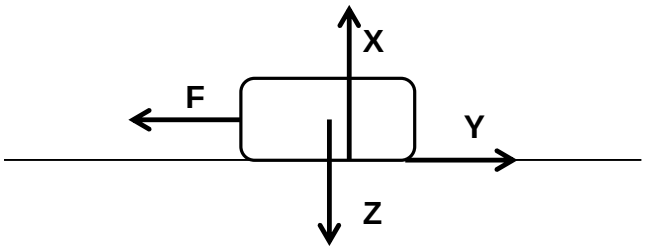
11. Give brief motivations, discussions, et cetera where required.

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) next to the question number (1.1-1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 A learner pulls a block at a CONSTANT SPEED over a rough horizontal surface with a force **F**. The force diagram below shows all the forces acting on the block.



Which ONE of the following relationships between the magnitudes of the forces **F**, **X**, **Y** and **Z** is true?

A **F** > **Y** and **X** = **Z**

B **F** > **Y** and **X** < **Z**

C **F** = **Y** and **X** = **Z**

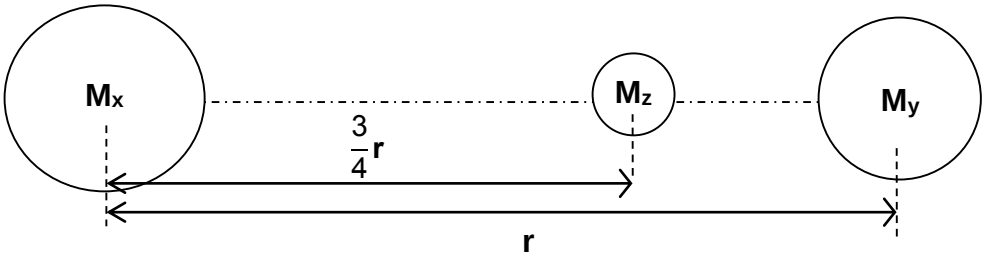
D **F** = **Y** and **X** < **Z** (2)

1.2 A stone is thrown vertically upwards into the air. Which combination in the table below shows the correct change in the momentum and the potential energy of the stone? (Ignore the effects of air friction)

	Momentum	**Potential energy**
A	Increases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Decreases	Stays constant

(2)

1.3 Two masses $\mathbf{M_x}$ and $\mathbf{M_y}$ are placed at a distance **r** apart. A third mass $\mathbf{M_z}$ experiences a ZERO resultant horizontal gravitational force when it is placed $\frac{3}{4}\mathbf{r}$ from $\mathbf{M_x}$ on the line between $\mathbf{M_x}$ and $\mathbf{M_y}$.



The ratio of the two masses $\mathbf{M_x}$: $\mathbf{M_y}$ is:

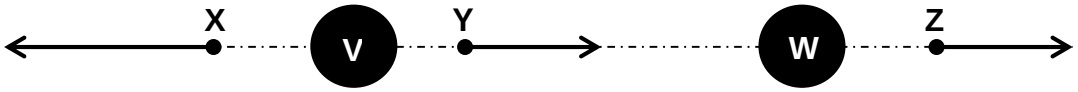
A 3 : 1

B 4 : 3

C 9 : 1

D 16 : 1 (2)

1.4 Two charged spheres **V** and **W** are located on a straight line. **X, Y** and **Z** are three points on the same straight line. The positions of points X, Y and Z are as indicated and the direction of the NET electric field at points **X, Y** and **Z** is shown in the diagram below.

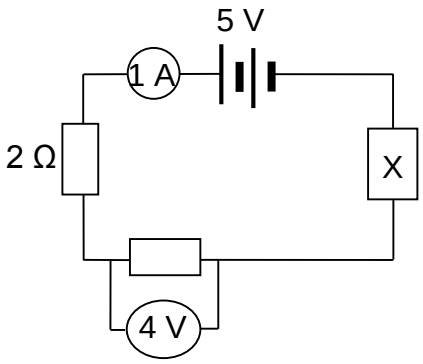


Which ONE of the following combinations represent the charges on each of the spheres **V** and **W**?

	Charge of V	**Charge of W**
A	Positive	Positive
B	Neutral	Positive
C	Negative	Negative
D	Positive	Negative

(2)

1.5 The battery in the diagram below has negligible internal resistance.
If the current in the circuit is 1 A, the component indicated by X is a/an:



A Light bulb

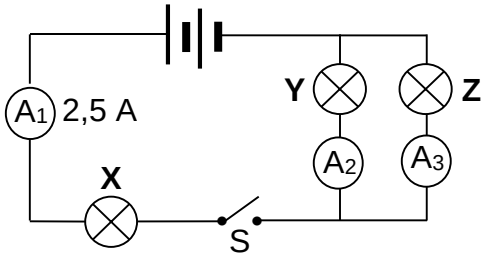
B Cell

C Ammeter

D Switch (2)

1.6 Three identical light bulbs **X**, **Y** and **Z** are connected in a circuit diagram as shown below. The internal resistance of the battery is negligible.

When switch S is closed, the reading on the ammeter A_1 is 2,5 A.

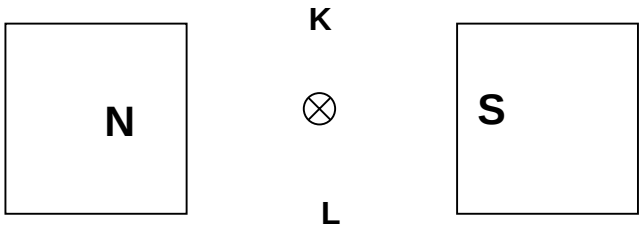


Which ONE of the following options correctly describes the readings on the ammeters (in ampère) if light bulb **Z** burns out?

	A_1	**A_2**	**A_3**
A	3,2	3,2	0
B	2,5	1,25	0
C	1,8	1,8	0
D	1,2	1,1	0,1

(2)

1.7 Two strong bar magnets are arranged with the north and south poles facing each other as shown in the diagram below. A current carrying conductor placed between the two magnets carries conventional current into the plane of the page.



The conductor experiences a force in the direction of…

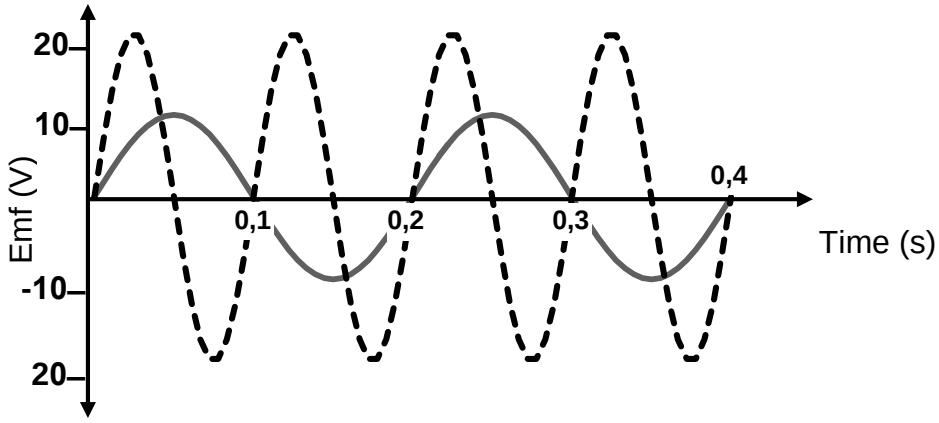
A K

B L

C N

D S (2)

1.8 In the graph below, the solid line represents how the emf, produced by a simple generator, changes with time. The dotted line shows the output of the same generator after a change was made to the generator.



Which change is made to produce the result as shown?

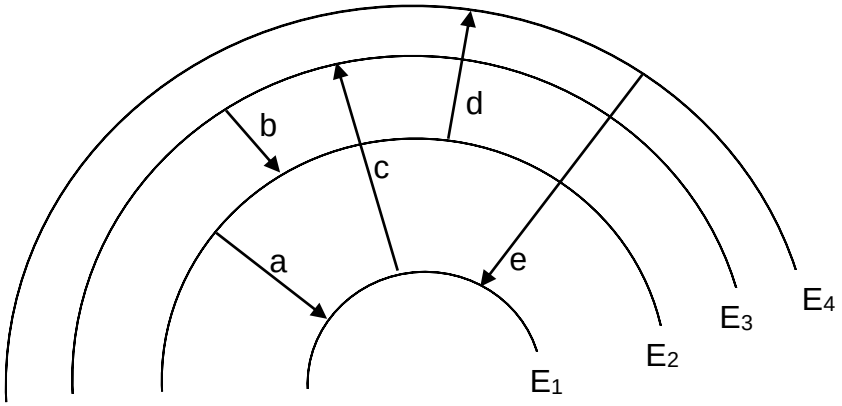
A The amount of turns in the coil is doubled.

B The speed of rotation is doubled.

C A split ring commutator is added.

D The strength of the magnets is doubled. (2)

1.9 The diagram below shows possible transitions of electrons between ENERGY LEVELS (E_1 to E_4) in an atom of a specific element.



Which transition will produce the line of SHORTEST WAVELENGTH on the emission spectra of the element?

A Transition a

B Transition c

C Transition d

D Transition e (2)

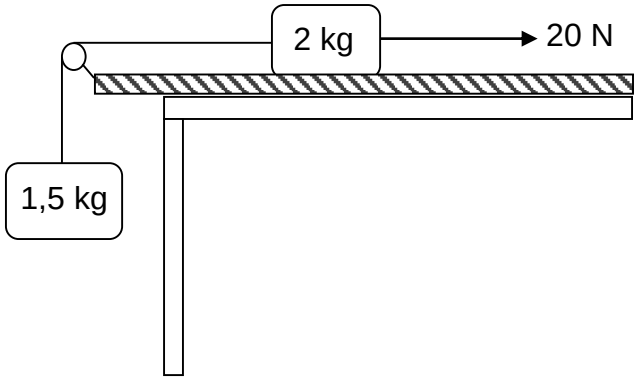
1.10 A bundle of GREEN light is incident on the cathode of a photo-electric cell. The milli-ammeter registers a current in the circuit.The green light is removed and BLUE light with a lower intensity is incident on the same photo-electric cell. How does the amount of photo-electrons released per second and the speed of the photoelectrons compare when BLUE light is used?

	Amount of photoelectrons per second	**Speed of photoelectrons**
A	Decreases	Decreases
B	Increases	Decreases
C	Decreases	Increases
D	Stays the same	Increases

(2)
[20]

QUESTION 2 (Start on a new page)

A block of mass 2 kg is at rest on a rough horizontal suface. The block is connected to another block of mass 1,5 kg by means of a light inextensible string which hangs over a frictionless pulley. The 2 kg block experiences a constant frictional force of 3,1 N when a force of 20 N is applied to the block as shown in the diagram below. Ignore the effects of air friction.



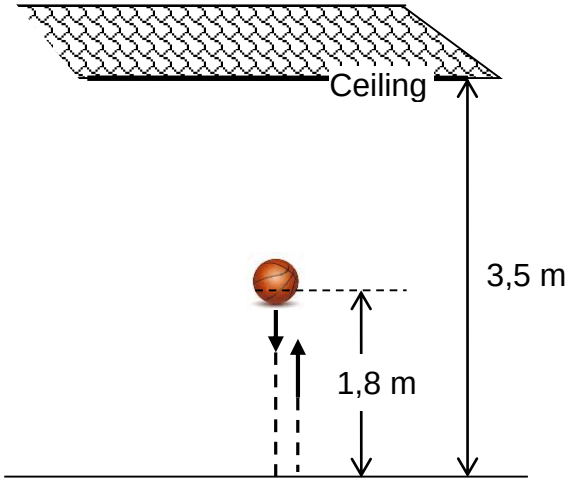
2.1 Define the term *kinetic frictional force*. (2)

2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **2 kg block**. (5)

2.3 Apply Newtons' Second Law to each of the blocks and calculate the magnitude of the acceleration of the blocks. (6)
[13]

QUESTION 3 (Start on a new page)

A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a speed of 8 $m \cdot s^{-1}$ from a height of 1,8 m above the floor. Ignore the effects of air friction.



3.1 Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)

3.2 Is the motion of the ball, while it is moving downwards towards the floor, *free fall*? Explain the answer. (2)

3.3 Calculate the magnitude of the velocity with which the ball hits the floor. (4)

3.4 How long does it take the ball to hit the floor? (3)

The ball bounces INELASTICALLY on the floor where the speed of the ball DECREASES by 20%. The ball is in contact with the floor for 0,01 s.

3.5 Determine by means of calculations, whether the ball will reach the ceiling after it bounced. (5)

3.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.

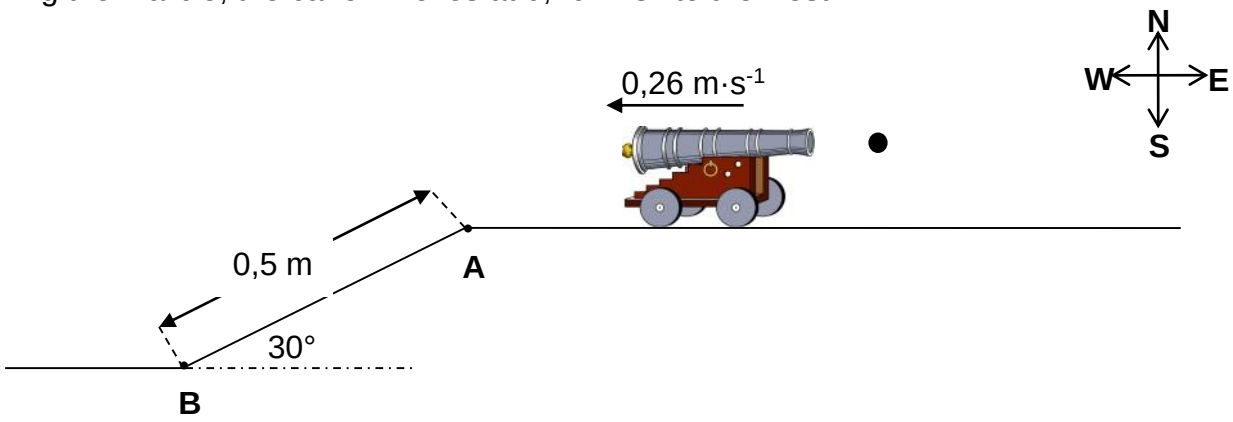
Clearly show the following on the graph:

- The initial velocity of the ball.
- The velocity and time when the ball hits the floor.
- The velocity and time when the ball leaves the floor.

(4)
[20]

QUESTION 4 (Start on a new page)

A toy canon, mass 1,6 kg, is at rest on a rough horizontal surface as shown in the diagram. A steel marble, mass 0,8 kg, is fired horizontally to the east from the canon. Immediately after firing the marble, the canon moves at 0,26 $m \cdot s^{-1}$ to the west.



4.1 Calculate the speed of the steel marble immediately after firing the marble. (4)

4.2 The steel marble experiences a force **F** during the firing. Explain in terms of **F** how the force experienced by the CANON compares with that experienced by the steel marble. (3)

The canon reaches point **A** with a speed of 0,2 $m \cdot s^{-1}$ and then moves down a rough 0,5 m long slope **AB**.

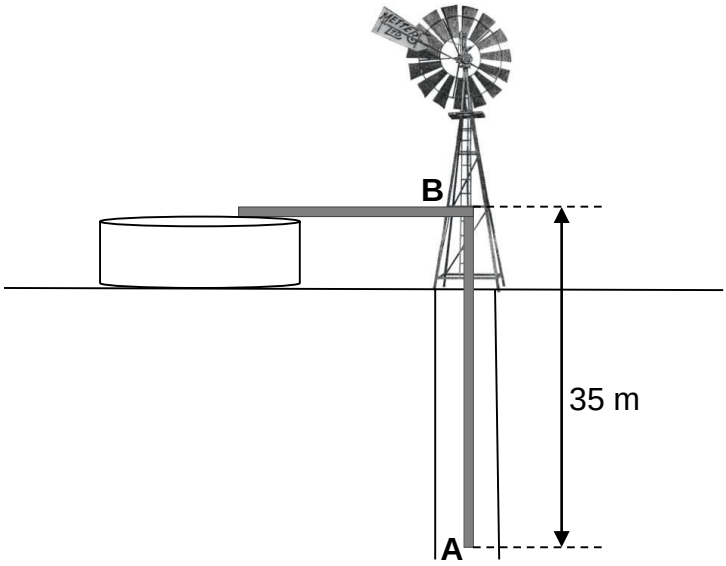
4.3 Explain why this is NOT a closed system. (1)

4.4 Calculate the kinetic frictional force experienced by the canon as it moves from **A** to **B** if the coefficient of kinetic friction (μ_k) is 0,12. (3)

4.5 Using ENERGY PRINCIPLES only, calculate the velocity of the canon at point **B**. (5)
[16]

QUESTION 5 (Start on a new page)

A windmill on a farm is used to pump stationary water, from point **A**, in a well. The water flows past point **B**, 35 m above point **A**, at a speed of 2,1 $m \cdot s^{-1}$.

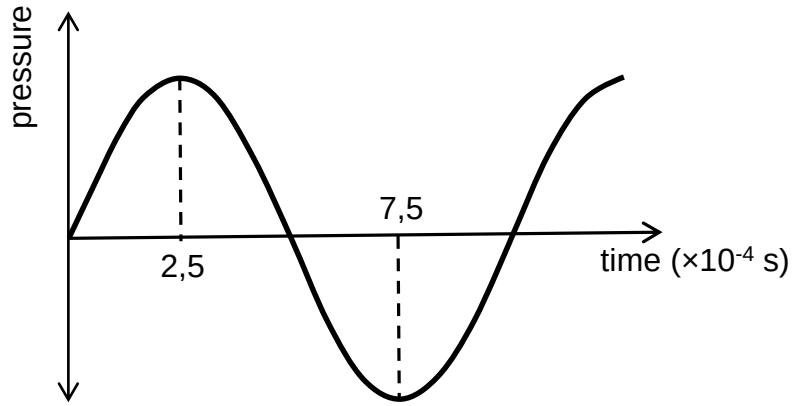


5.1 Define the term *conservative force*. (2)

5.2 Calculate the maximum power delivered by the windmill if 87 kg water is pumped from the well per minute. (5)
[7]

QUESTION 6 (Start on a new page)

A man mounts a siren, which produces a constant frequency of 800 Hz, on the roof of his car. He drives at a constant speed up and down a straight road while a stationary learner measures the observed sound. At a certain stage of the journey, the learner obtains the following pressure-time graph of the sound wave:



6.1 What is the period of the detected sound wave? (1)

6.2 Calculate the frequency of the detected sound wave. (3)

6.3 State the Doppler-effect in words. (2)

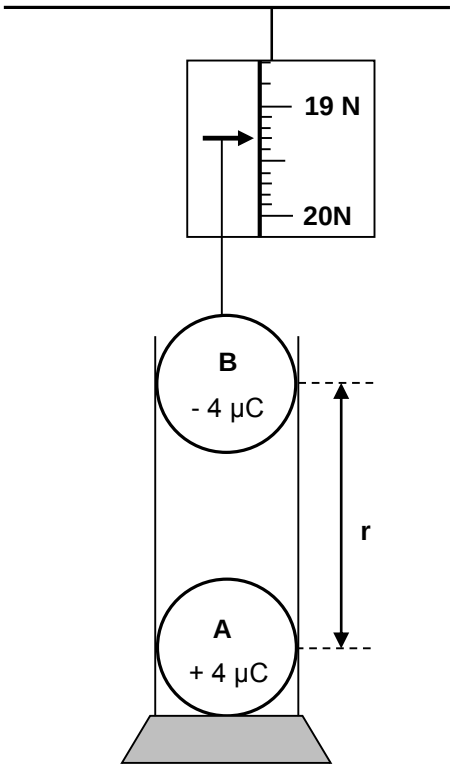
6.4 Calculate the speed of the moving car. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.5 While the car is stationary, the frequency of the siren is changed to 900 Hz. Will the wavelength of the detected sound wave INCREASE, DECREASE or REMAIN THE SAME? Explain the answer. (3)

[14]

QUESTION 7 (Start on a new page)

Sphere **A** has a charge of +4 µC and is placed in an insulated cylinder.
A second identical but oppositely charged sphere **B,** mass 500 g,hangs at rest at a distance **r,** directly above **A.** Sphere **B** is attached to a scale as shown below.



7.1 Draw the net electric field pattern due to spheres **A** and **B.** (3)

7.2 State Coulomb's Law in words. (2)

7.3 Draw a labelled force diagram of all the forces acting on sphere **B**. (3)

7.4 What is the magnitude of the net upward force that acts on sphere **B?** (1)

7.5 Calculate the distance **r** between spheres **A** and **B**. (6)
[15]

QUESTION 8 (Start on a new page)

Grade 12 learners conduct an experiment to determine the INTERNAL RESISTANCE of a battery. The learners are divided into two groups and each group receives the following circuit components:

- a battery
- a rheostat
- an ammeter
- a voltmeter
- connecting wires
- a switch

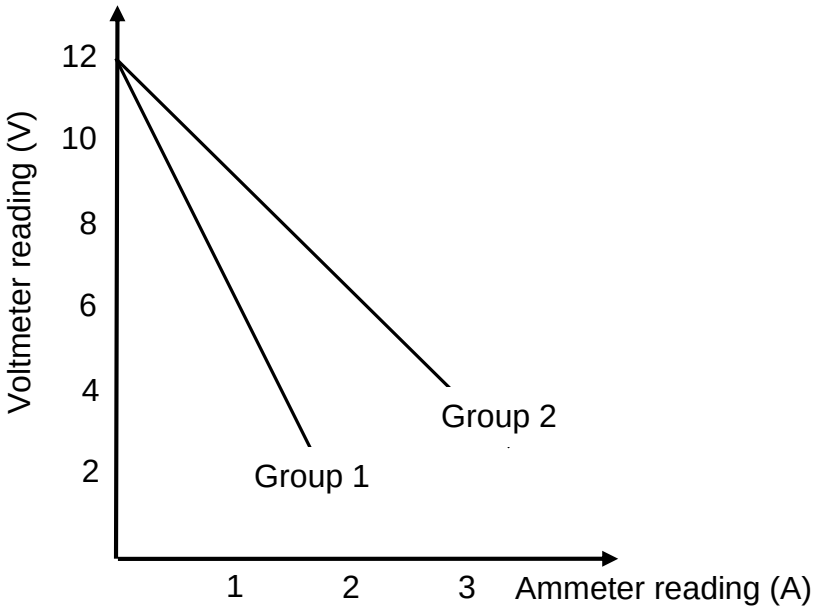
8.1 Explain the term *internal resistance* in words. (2)

8.2 Draw a circuit diagram by making use of the above-mentioned components to show the experimental set-up. (2)

Group 1 uses battery 1 with an internal resistance r_1.

Group 2 uses battery 2 with an internal resistance r_2.

The results of each group are shown in the graph below.



8.3 Refer to the graph and state ONE quantity of the batteries that is the same. (1)

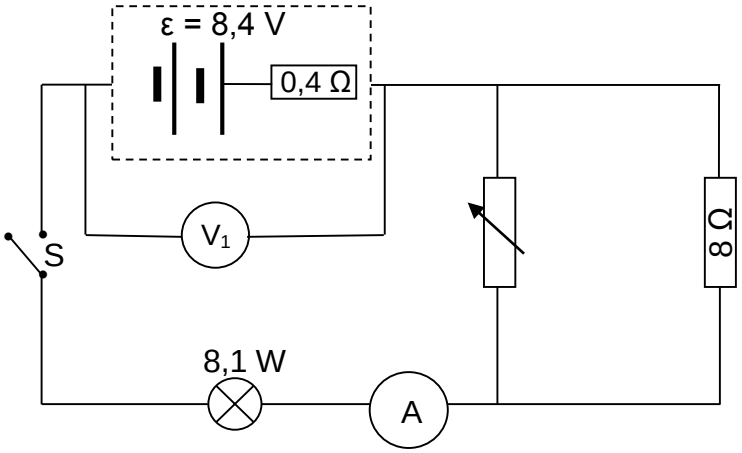
8.4 Explain why the reading on the voltmeters decreases as the current increases. Applicable equations may be used in your explanation. (3)

8.5 Which group, 1 or 2, uses the battery with the highest internal resistance? Explain the answer by referring to the graph. (2)

[10]

QUESTION 9 (Start on a new page)

A 8 Ω resistor, a light bulb and a rheostat are connected to a 8,4 V battery with an internal resistance of 0,4Ω as shown in the circuit diagram below. The power of the light bulb is 8,1 W. The rheostat is changed until the ammeter shows a reading of 1,5 A when the switch is closed.



9.1 Calculate the resistance of the light bulb. (3)

9.2 Calculate the resistance of the rheostat when the reading on the ammeter is 1,5 A. (6)

The rheostat is changed so that the resistance of the rheostat INCREASES dramatically.

9.3 How will the following readings be influenced? Write down only INCREASES, DECREASES or REMAINS THE SAME.

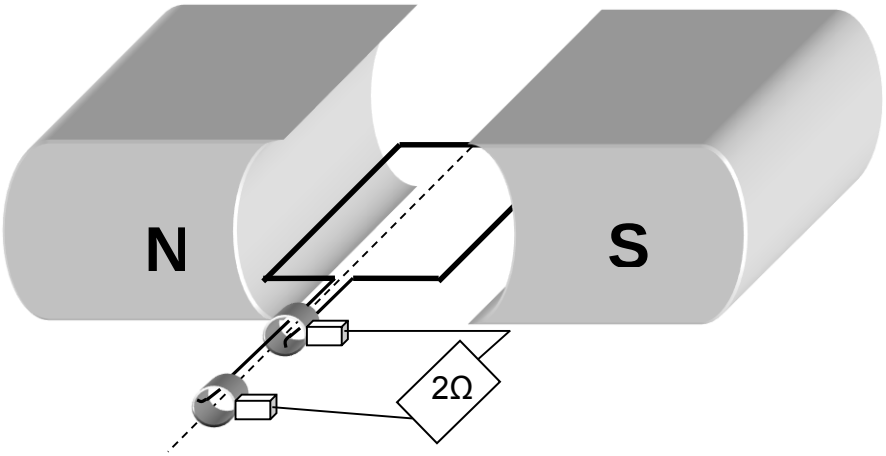
9.3.1 The total resistance in the circuit. (1)

9.3.2 The emf of the battery. (1)

9.3.3 The reading on V_1. (1)
[12]

QUESTION 10 (Start on a new page)

The diagram below represents a simplified alternating current (AC) generator.



10.1 State the energy conversion that takes place in an AC generator. (1)

10.2 A 2 Ω resistor is attached to the AC generator. Calculate the maximum current that flows through the resistor if the resistor dissipates an average power of 80 W. (5)

A television is switched on for an average of 142 hours per month. The television is rated 1 200 W ; 220 V.

10.3 If the ESKOM tariff is R1,25 per unit, calculate the monthly cost of the electricity used by the television. (2)

[8]

QUESTION 11 (Start on a new page)

Learners perform an experiment to investigate the effect of the wavelength of light on the photo-electric effect. They irradiate a metal disc **M** with three light sources of different wavelengths and note the ejection of the photoelectrons from the metal.
The results obtained are shown in the table below:

Light Source	Wavelength ($\times 10^{-9}$ m)	Ejection of photoelectrons
A	480	Electrons ejected and moving away from the metal
B	620	No electrons ejected
C	570	Electrons ejected and NOT moving away from the metal

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

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

11.3 Give a reason why light source A and not light source B will eject electrons from the metal disc **M**. (2)

11.4 Calculate the work function of the metal **M**. (3)

11.5 Calculate the maximum speed with which the electrons will be ejected from the metal disc **M** when it is irradiated with light source **A**. (5)

11.6 Light source **A** is BLUE light and light source **B** is ORANGE light. Which colour is possibly light source **C**? Choose only between VIOLET, GREEN or RED. (1)

[15]

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 gravitasiekonstante*	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

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F\cdot v_{av}$ / $P_{gem} = F\cdot v_{gem}$	

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 $E = hf$ and/en $W_o = hf_o$ 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

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

