



education

Department:
Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2008

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages, a 3-page data sheet and an answer sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name and/or examination number (and centre number if applicable) in the appropriate spaces on the ANSWER SHEET and ANSWER BOOK.
2. Answer ALL the questions.
3. Answer SECTION A on the attached ANSWER SHEET.
4. Answer SECTION B in the ANSWER BOOK.
5. Non-programmable calculators may be used.
6. Appropriate mathematical instruments may be used.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Data sheets are attached for your use.
9. Give brief motivations, discussions, et cetera where required.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for EACH of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

- 1.1 The product of force and velocity (1)
- 1.2 The type of collision in which kinetic energy is conserved (1)
- 1.3 The coloured bands produced when white light passes through a triangular prism (1)
- 1.4 A device used to store charge in an electric circuit (1)
- 1.5 A phenomenon that occurs in a LASER when there are more electrons in a high-energy state than in a lower energy state (1)
- [5]**

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A unit of measure equal to $\text{kg}\cdot\text{m}^2\cdot\text{s}^{-2}$	A	opaque
2.2	The rate of change of momentum	B	electric field
2.3	Objects that absorb some light while reflecting others	C	net force
2.4	Electric potential energy per unit charge	D	joule
2.5	A source of monochromatic light	E	light bulb
		F	newton
		G	laser
		H	electric potential
		I	transparent
		J	impulse

[5]

QUESTION 3: TRUE/FALSE ITEMS

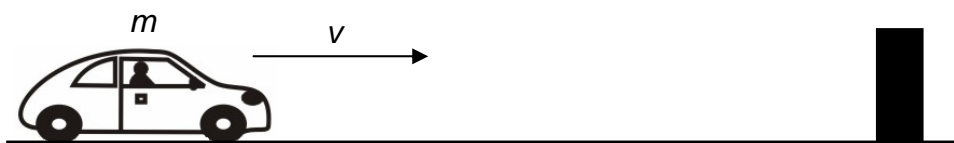
Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

- 3.1 When work is done by a net force on an object moving along a horizontal plane, the kinetic energy of the object is constant. (2)
- 3.2 When car A, travelling at $20 \text{ m}\cdot\text{s}^{-1}$, approaches car B, travelling at $18 \text{ m}\cdot\text{s}^{-1}$ in the opposite direction, its speed relative to car B is $38 \text{ m}\cdot\text{s}^{-1}$. (2)
- 3.3 The degree of diffraction of a wave is directly proportional to its frequency. (2)
- 3.4 In a parallel plate capacitor, a dielectric increases capacitance by increasing the net electric field between the plates. (2)
- 3.5 In a laser, an incident photon leads to the creation of an identical photon travelling in the same direction as the incident photon. (2)
- [10]**

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

- 4.1 A car of mass m moves along a straight line with a velocity of magnitude v . The driver sees an obstruction and immediately applies the brakes. The car stops uniformly in t seconds from the moment that the brakes are applied. The car does not hit the obstruction.



Which ONE of the following represents the MAGNITUDE of the average force exerted on the car during the braking period of t seconds?

A $\frac{v}{t}$

B mv

C $\frac{mv}{t}$

D mvt

(3)

- 4.2 Consider the statements below:

- I Work is done on an object when a force displaces the object in the direction of the force.
- II Mechanical energy of a system is conserved when an external force does no work on the system.
- III The work done on an object by a net force is equal to the kinetic energy of the object.

Which of the above statements is/are TRUE?

A Only I

B I and II only

C II and III only

D I, II and III

(3)

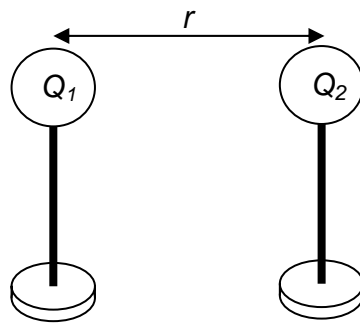
4.3 Which ONE of the statements is CORRECT for the pigment cyan?

Cyan absorbs ...

- A red light while reflecting green and blue light.
- B green light while reflecting red and blue light.
- C blue light while reflecting green and red light.
- D yellow light while reflecting green and blue light.

(3)

4.4 The centres of two identical spheres are a distance r apart. They carry charges of Q_1 and Q_2 respectively as shown in the diagram below. Each sphere exerts an electrostatic force of magnitude F on the other.

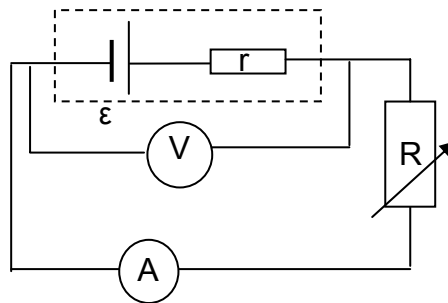


The distance between the charges is now **halved** and the charge on Q_1 is **doubled**. The magnitude of the new force between the charges is ...

- A F
- B $2F$
- C $4F$
- D $8F$

(3)

- 4.5 In the circuit represented below, the resistance of the variable resistor is decreased.



How would this decrease affect the readings on the voltmeter and ammeter?

	Voltmeter reading	Ammeter reading
A	unchanged	unchanged
B	decreases	increases
C	decreases	unchanged
D	increases	increases

(3)
[15]

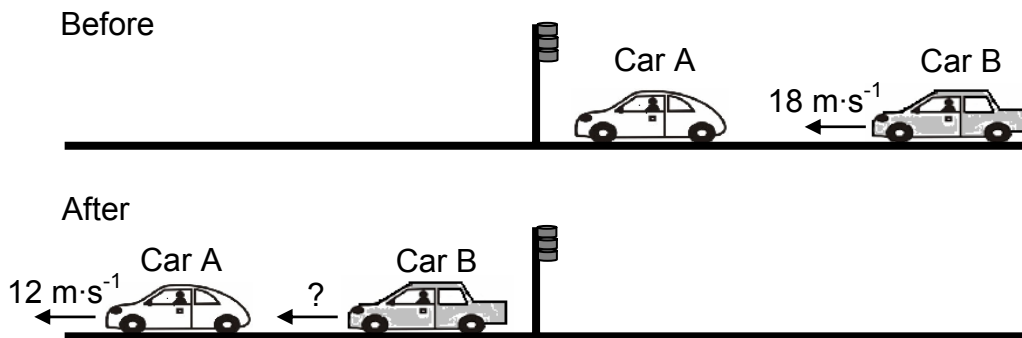
TOTAL SECTION A: 35

SECTION B**INSTRUCTIONS AND INFORMATION**

1. Answer SECTION B in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places.

QUESTION 5

The most common reasons for rear-end collisions are too short a following distance, speeding and failing brakes. The sketch below represents one such collision. Car A of mass 1 000 kg, stationary at a traffic light, is hit from behind by Car B of mass 1 200 kg, travelling at $18 \text{ m}\cdot\text{s}^{-1}$. Immediately after the collision Car A moves forward at $12 \text{ m}\cdot\text{s}^{-1}$.



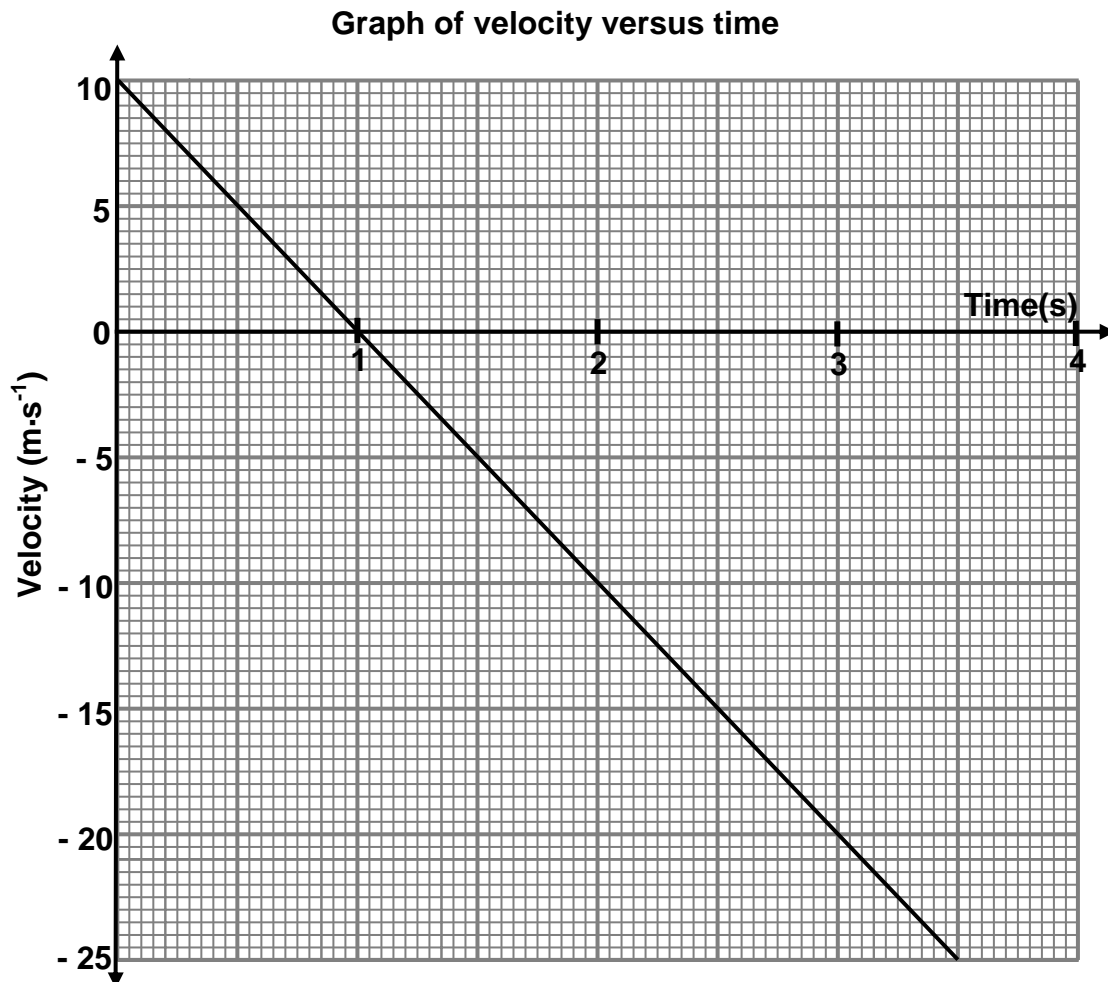
- 5.1 Assume that linear momentum is conserved during this collision. Calculate the speed of Car B immediately after the collision. (4)
- 5.2 Modern cars are designed to crumple partially on impact. Explain why the assumption made in QUESTION 5.1 may NOT be valid in this case. (2)
- 5.3 A traffic officer appears at the scene of the accident and mentions the dangers of a head-on collision. He mentions that for cars involved in a head-on collision, the risk of injury for passengers in a heavier car would be less than for passengers in a lighter car.

Use principles of Physics to explain why the statement made by the traffic officer is correct.

(3)
[9]

QUESTION 6

A boy stands at the edge of a high cliff. He throws a stone vertically upwards with an initial velocity of $10 \text{ m}\cdot\text{s}^{-1}$. The stone strikes the ground at a point below the cliff after 3,5 s. The velocity-time graph below was obtained from *measurements* made during the motion of the stone.



Use the information on the graph to answer the following questions:

- 6.1 Calculate the acceleration of the stone between times $t = 2 \text{ s}$ and $t = 3 \text{ s}$. (3)
- 6.2 At which time(s) is the stone moving at a speed of $5 \text{ m}\cdot\text{s}^{-1}$? (2)
- 6.3 After how many seconds does the stone reach its highest point? (1)
- 6.4 Determine the height of the cliff from which the stone was thrown. (4)
- 6.5 Using the top of the cliff as the initial position of the stone, sketch the position-time graph (displacement-time graph) for the motion of the stone **from its highest point until it reaches the ground**. Only indicate relevant time values on the x-axis. (3)

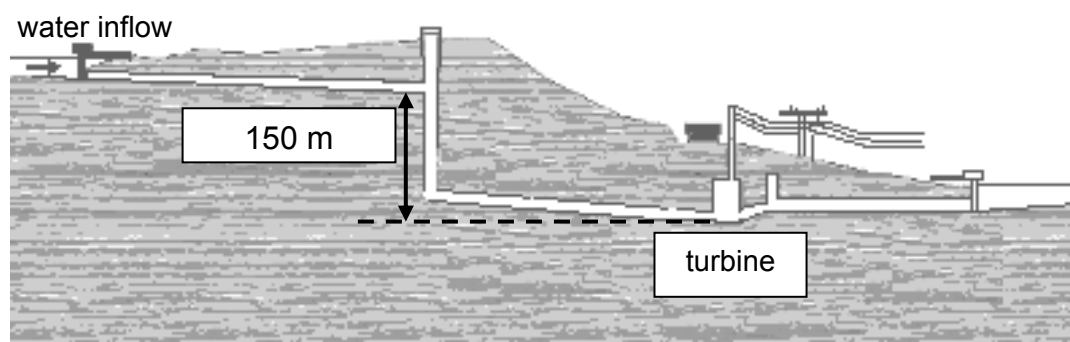
[13]

QUESTION 7

The diagram below represents how water is funnelled into a pipe and directed to a turbine at a hydro-electric power plant. The force of the falling water rotates the turbine.

Each second, 200 m^3 of water is funnelled down a vertical shaft to the turbine below. The vertical height through which the water falls upon reaching the turbine is 150 m . Ignore the effects of friction.

NOTE: One m^3 of water has a mass of $1\,000 \text{ kg}$.

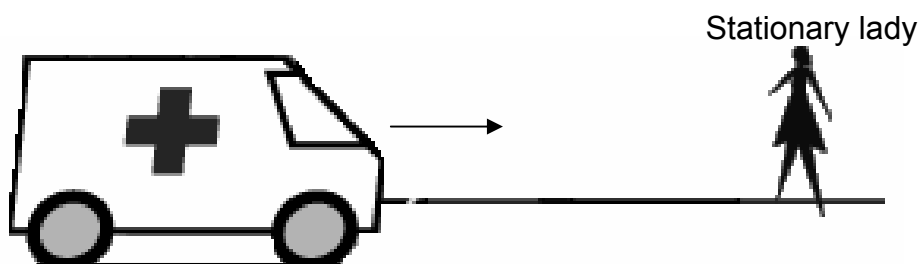


- 7.1 Calculate the mass of water that enters the turbine each second. (1)
- 7.2 Calculate the kinetic energy of this mass of water when entering the turbine. Use energy principles. (4)
- 7.3 Calculate the maximum speed at which this mass of water enters the turbine. (3)
- 7.4 Assume that a generator converts 85% of this maximum kinetic energy gained by the water into hydro-electricity. Calculate the electrical power output of the generator. (2)
- 7.5 Explain what happens to the 15% of the kinetic energy that is NOT converted into electrical energy. (1)
- [11]**

QUESTION 8

An ambulance travelling down a road at constant speed emits sound waves from its siren. A lady stands on the side of the road with a detector which registers sound waves at a frequency of 445 Hz as the ambulance approaches her.

After passing her, and moving away at the same constant speed, sound waves of frequency 380 Hz are registered.



Assume that the speed of sound in air is $343 \text{ m}\cdot\text{s}^{-1}$.

- 8.1 Name the phenomenon that describes the change in the frequency observed by the lady. (1)
- 8.2 Calculate:
- 8.2.1 The speed at which the ambulance is moving (7)
- 8.2.2 The frequency at which the siren emits the sound waves (3)
- [11]**

QUESTION 9

A helium-neon laser emits red light that passes through a single slit. A diffraction pattern is observed on a screen some distance away from the slit.

- 9.1 Define the term *diffraction*. (2)
- 9.2 If the wavelength of red light is 644,4 nm and the slit width is 3 437 nm, calculate the angle at which the third minimum occurs. (3)
- 9.3 Briefly describe the diffraction pattern that will be observed on the screen. (2)

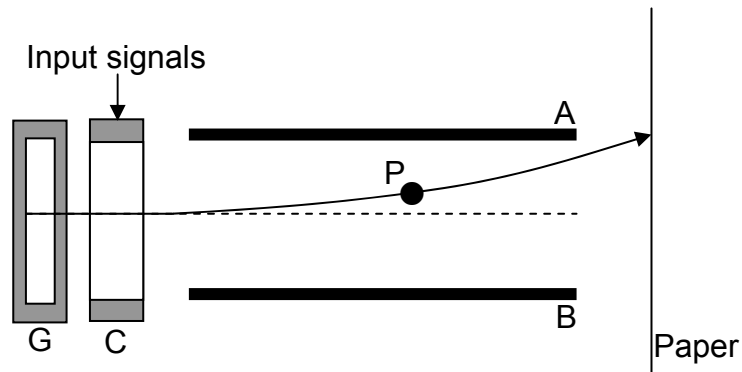
The single slit is replaced with a double slit.

- 9.4 Name ONE similarity and ONE difference in the pattern observed when the single slit is replaced with a double slit. (2)
- 9.5 Will this pattern be observed if the laser is replaced with a light bulb? Give a reason for your answer. (2)
- [11]**

QUESTION 10

An ink-jet printer makes use of the electric field between two oppositely charged parallel plates to control the position of an ink drop on paper.

In the diagram below, the generator (G) of the printer shoots out ink drops that are charged in the charging unit C. The input signal from a computer controls the charge given to each ink drop. **P is a negatively charged ink drop.**



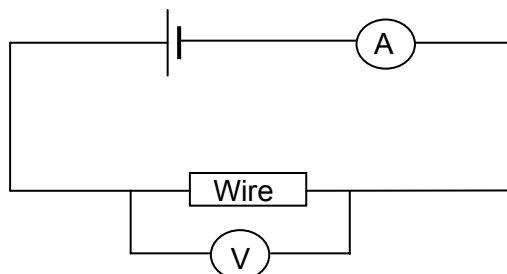
- 10.1 Define the electric field at a point in space. (2)
- 10.2 Is plate B negatively or positively charged? Give a reason for your answer. (2)
- 10.3 Sketch the electric field pattern between plates A and B. (2)

The plates A and B are $6,4 \times 10^{-4}$ m apart and ink drop P has a charge of magnitude $1,5 \times 10^{-13}$ C. When the ink drop enters the field it experiences an electrical force of $2,1 \times 10^{-7}$ N.

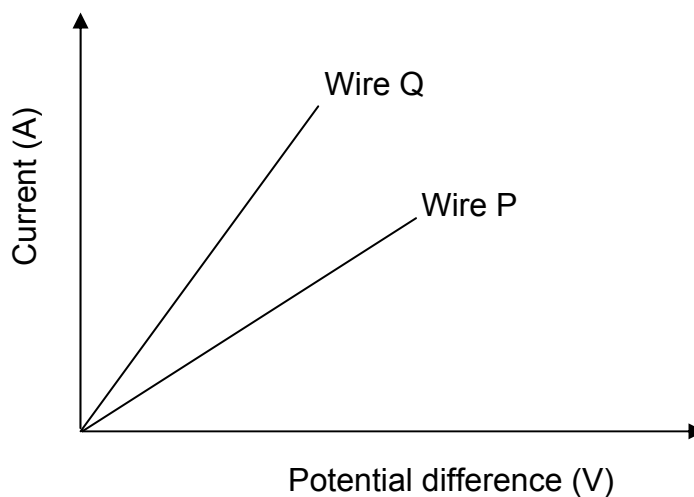
- 10.4 Calculate the potential difference across the parallel plates. (5)
- [11]**

QUESTION 11

Learners investigate the conducting ability of two metal wires P and Q, made of different materials. They connect ONE wire at a time in a circuit as shown below.



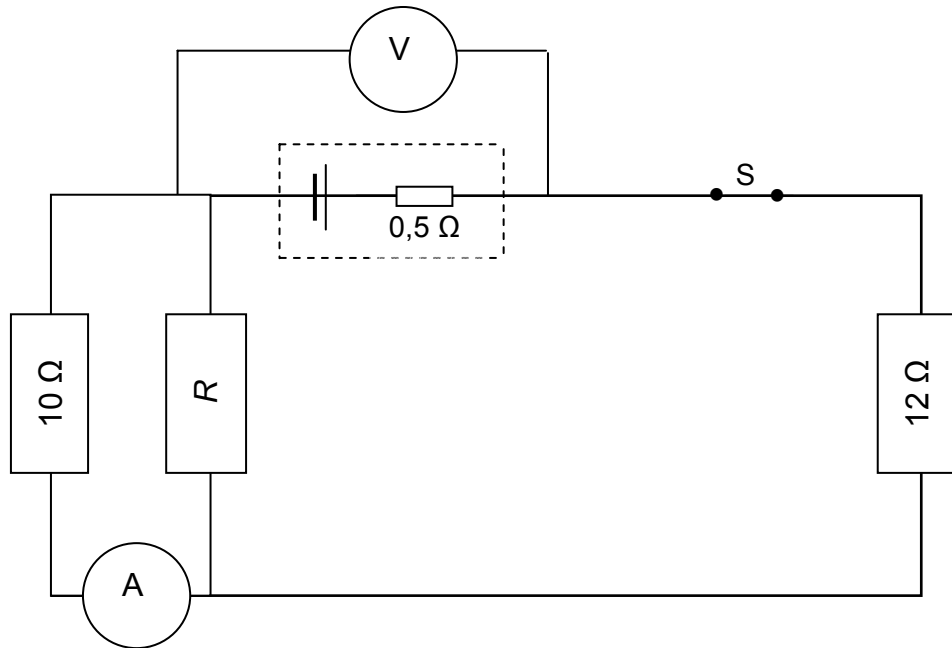
The potential difference across each wire is increased in equal increments, and the resulting current through these wires is measured. Using the measurements, the learners obtained the following sketch graphs for each of the wires.



- 11.1 Name TWO variables that the learners would have controlled in each of the experiments. (2)
- 11.2 Which one (P or Q) is the better conductor? Explain your answer. (4)
- [6]**

QUESTION 12

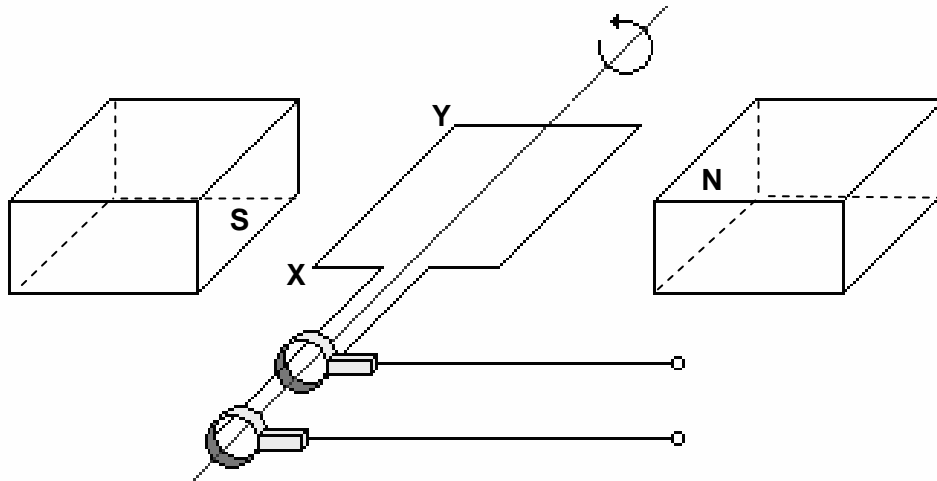
A circuit is connected as shown below. The resistance of R , which is connected in parallel with the $10\ \Omega$ resistor, is unknown. With switch S closed, the reading on voltmeter V decreases from $45\ \text{V}$ to $43,5\ \text{V}$. The internal resistance of the battery is $0,5\ \Omega$.



- 12.1 Calculate the reading on ammeter A . Show ALL your calculations. (8)
- 12.2 Determine the resistance of resistor R . (3)
- 12.3 How will the reading on voltmeter V change if resistor R burns out? Give a reason for your answer. (4)
- [15]**

QUESTION 13

A coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



- 13.1 What type of generator is illustrated in the diagram? Give a reason for your answer. (2)
- 13.2 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (2)
- 13.3 Assume that the speed and direction of rotation are constant. Draw a sketch graph of potential difference against time that represents the output of this device. (2)
- [6]**

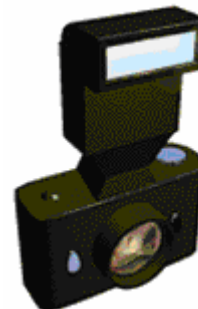
QUESTION 14

The municipality of Dinaledin implements a power cutback in the town. As a result of the cutback the rms voltage drops from $220 V_{\text{rms}}$ to $200 V_{\text{rms}}$.

- 14.1 Calculate the peak voltage during cutback. (3)
- 14.2 A certain electrical appliance dissipates $1\,200\text{ W}$ when it is operated at $220 V_{\text{rms}}$. Calculate the power at which it will operate during the cutback. (4)
- 14.3 It is common practice to connect many appliances to a multi-plug. Modern types of multi-plugs have a cut-off switch built in. (4)
- Using principles in Physics, explain clearly why this cut-off switch is important. (4)
- [11]**

QUESTION 15

A fully automatic camera has a built-in light meter. When light enters the light meter, it strikes a metal object that releases electrons and creates a current.



15.1 What phenomenon is described by the underlined sentence? (1)

15.2 A metal plate is irradiated with electromagnetic radiation of wavelength 200 nm. The metal has a work function of $7,57 \times 10^{-19}$ J.

Show by calculation that the metal plate will emit photo-electrons when irradiated with radiation of this wavelength. (6)

15.3 The intensity of the incident radiation on the metal plate is increased whilst maintaining a constant wavelength of 200 nm. State and explain what effect this change has on the following:

15.3.1 Energy of the emitted photo-electrons (2)

15.3.2 Number of emitted photo-electrons (2)
[11]

TOTAL SECTION B: 115

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES P1 GRADE 12**GEGEWENS VIR FISIESE WETENSKAPPE V1 GRAAD 12****TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES**

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Gravitational constant <i>Swaartekragkonstante</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ϵ_0	$8,85 \times 10^{-12} \text{ F}\cdot\text{m}^{-1}$
Permeability of free space <i>Permeabiliteit van vry ruimte</i>	μ_0	$4 \pi \times 10^{-7} \text{ T}\cdot\text{m}\cdot\text{A}^{-1}$

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 $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_f + v_i}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$F\Delta t = \Delta p = mv_f - mv_i$	$F_g = mg$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F\Delta x \cos \theta$	$U = E_p = mgh$
$K = E_k = \frac{1}{2} mv^2$	$W = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, LIGHT AND SOUND/GOLWE, LIG EN KLANK

$v = f\lambda$ or/of $v = v\lambda$	$T = \frac{1}{f}$ or/of $T = \frac{1}{v}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = hv$ or/of $E = h \frac{c}{\lambda}$
$\lambda = \frac{h}{mv}$	$\sin \theta = \frac{m\lambda}{a}$
$hf = W_0 + \frac{1}{2} mv^2$	

MATTER AND MATERIALS/MATERIE EN MATERIALE

$F = k\Delta x$	$\text{Stress/Spansing} = \frac{F}{A}$
$\text{Strain/Vervorming} = \frac{\Delta x}{l}$	

ELECTRICITY AND MAGNETISM/ELEKTRISITEIT EN MAGNETISME

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} / I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} / V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$
$\Phi = BA$	$P_{\text{average}} = V_{\text{rms}} I_{\text{rms}} / P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{average}} = \frac{V_{\text{rms}}^2}{R} / P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$ $P_{\text{average}} = I_{\text{rms}}^2 R / P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1 Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$U = \frac{kQ_1 Q_2}{r}$
$E = \frac{F}{q}$	$Q = It$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/ELEKTRIESESTROOMBANE

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$R_s = R_1 + R_2 + \dots$	$\text{emf/emk} (\varepsilon) = I(R + r)$

NAME/EXAMINATION NUMBER:

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ANSWER SHEET**QUESTION 1**

- 1.1 _____ (1)
 1.2 _____ (1)
 1.3 _____ (1)
 1.4 _____ (1)
 1.5 _____ (1)
[5]

QUESTION 2

- 2.1 _____ (1)
 2.2 _____ (1)
 2.3 _____ (1)
 2.4 _____ (1)
 2.5 _____ (1)
[5]

QUESTION 3

- 3.1 _____ (2)
 3.2 _____ (2)
 3.3 _____ (2)
 3.4 _____ (2)
 3.5 _____ (2)
[10]

QUESTION 4

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]**TOTAL SECTION A: 35**