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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2013

MARKS: 150

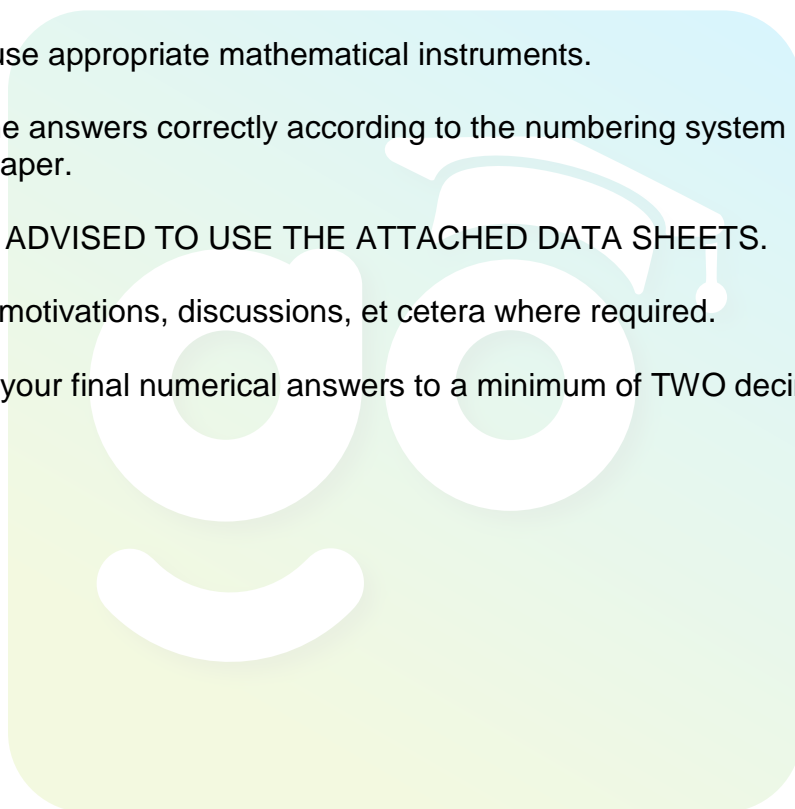
TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

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 TWO sections:

SECTION A (25)
SECTION B (125)
3. Answer ALL the questions in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. Number the answers correctly according to the numbering system used in this question paper.
7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
8. Give brief motivations, discussions, et cetera where required.
9. Round off your final numerical answers to a minimum of TWO decimal places.



SECTION A**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) in the ANSWER BOOK.

- 1.1 The type of electromagnetic radiation that is used to take pictures of the human skeleton (1)
- 1.2 The product of mass and velocity (1)
- 1.3 The principle which states that each point on a wave front acts as a source of secondary waves (1)
- 1.4 The unit of measurement equivalent to a coulomb per second (1)
- 1.5 The general term used to describe a system on which no external forces act (1)
- [5]**

QUESTION 2: 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 (2.1–2.10) in the ANSWER BOOK.

- 2.1 Power is defined as the rate ...
 A of change of velocity.
 B at which work is done.
 C of change of momentum.
 D of change of displacement. (2)
- 2.2 Two cars, **X** and **Y**, are travelling in an easterly direction along a straight level road as shown in the diagram below. The velocity of car **X** is $10 \text{ m}\cdot\text{s}^{-1}$ relative to the ground and the velocity of car **Y** is $5 \text{ m}\cdot\text{s}^{-1}$ relative to the ground.



The velocity of car **X** relative to car **Y** is ...

- A $5 \text{ m}\cdot\text{s}^{-1}$ east.
 B $5 \text{ m}\cdot\text{s}^{-1}$ west.
 C $15 \text{ m}\cdot\text{s}^{-1}$ east.
 D $15 \text{ m}\cdot\text{s}^{-1}$ west. (2)

2.3 Which ONE of the following is an example of a contact force?

- A Frictional force
- B Magnetic force
- C Electrostatic force
- D Gravitational force

(2)

2.4 A sound source approaches a stationary observer at constant velocity. Which ONE of the following describes how the observed frequency and wavelength differ from that of the sound source?

	Observed wavelength	Observed frequency
A	Greater than	Greater than
B	Less than	Less than
C	Greater than	Less than
D	Less than	Greater than

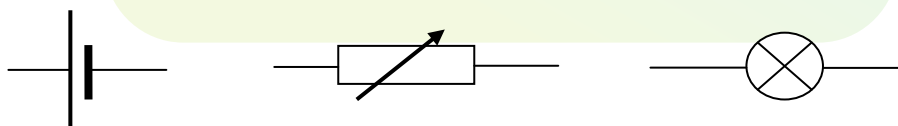
(2)

2.5 Two light sources of the same frequency maintain the same phase relationship with each other. This is an example of ...

- A coherence.
- B Huygens' principle.
- C destructive interference.
- D constructive interference.

(2)

2.6 Consider the three circuit components represented below.



Which ONE of the options below best represents the names of the components in the correct sequence, from left to right?

- A Light bulb, resistor, cell
- B Resistor, light bulb, cell
- C Cell, light bulb, variable resistor
- D Cell, variable resistor, light bulb

(2)

- 2.7 A positively charged metal sphere **X** on an insulated stand is brought into contact with an identical neutral metal sphere **Y** on an insulated stand. The two spheres are then separated.

Which ONE of the following describes the charge on each sphere after they have been separated?

	Sphere X	Sphere Y
A	Positive	Neutral
B	Positive	Positive
C	Neutral	Positive
D	Neutral	Neutral

(2)

- 2.8 When the distance between the plates of a parallel plate capacitor is decreased, its capacitance ...

- A increases.
- B decreases.
- C becomes zero.
- D remains unchanged.

(2)

- 2.9 Consider the types of electromagnetic radiation below:

- (i) Gamma rays
- (ii) X-rays
- (iii) Infrared rays

Which of the above radiations have wavelengths shorter than that of visible light?

- A (i), (ii) and (iii)
- B (i) and (ii) only
- C (i) and (iii) only
- D (ii) and (iii) only

(2)

- 2.10 Which ONE of the following provides evidence that light behaves as particles?

- A Light can be diffracted.
- B Light is refracted by a triangular prism.
- C Light ejects electrons from a metal surface.
- D The speed of light decreases when it travels from air to glass.

(2)

[20]**TOTAL SECTION A: 25**

SECTION B**INSTRUCTIONS AND INFORMATION**

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,2 kg is dropped from a height of 0,8 m onto a hard floor. It bounces to a maximum height of 0,6 m. The floor exerts a force of 50 N on the ball. Ignore the effects of friction.

- 3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)
- 3.2 Calculate the:
 - 3.2.1 Velocity at which the ball strikes the floor (4)
 - 3.2.2 Time that the ball is in contact with the floor if it bounces off the floor at a speed of $3,43 \text{ m}\cdot\text{s}^{-1}$ (4)
- 3.3 The ball takes 0,404 s from the moment it is dropped until it strikes the floor.

Sketch a graph (not to scale) of position versus time representing the entire motion of the ball. USE THE GROUND AS ZERO REFERENCE.

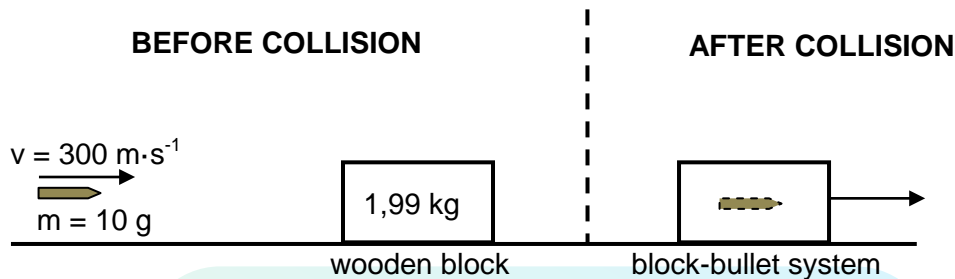
Indicate the following on the graph:

- Height from which the ball is dropped
- Height reached by the ball after the bounce
- Time at which the ball bounces off the floor

(5)
[15]

QUESTION 4 (Start on a new page.)

A bullet of mass 10 g, moving at a velocity of $300 \text{ m}\cdot\text{s}^{-1}$, strikes a wooden block of mass 1,99 kg resting on a flat horizontal surface as shown in the diagram below. The bullet becomes embedded in the block. Ignore the effects of air friction.



- 4.1 Write down in words the *principle of conservation of linear momentum*. (2)
- 4.2 Calculate the speed of the block-bullet system immediately after the collision. (4)
- 4.3 Is this collision elastic or inelastic? Give a reason for the answer. (2)

The floor exerts a constant frictional force of 8 N on the block-bullet system as it comes to rest.

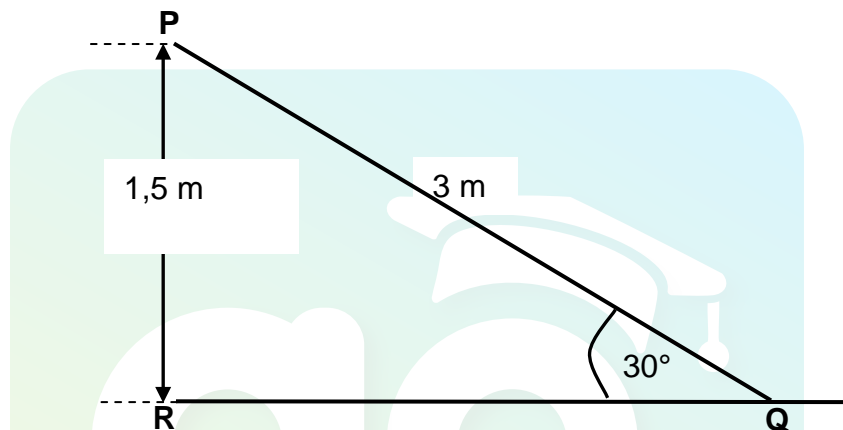
- 4.4 Calculate the distance that the block-bullet system moves after the collision. (4)
[12]

QUESTION 5 (Start on a new page.)

The simplified diagram below shows a slide **PQ** at a playground. The slide is 3 m long and 1,5 m high. A boy of mass 40 kg and a girl of mass 22 kg stand at the top of the slide at **P**.

The girl accelerates uniformly from rest down the slide. She experiences a constant frictional force of 1,9 N.

The boy falls vertically down from the top of the slide through the height **PR** of 1,5 m. Ignore the effects of air friction.



- 5.1 Write down the *principle of conservation of mechanical energy* in words. (2)
- 5.2 Draw a labelled free-body diagram to show ALL the forces acting on the:
 - 5.2.1 Boy while falling vertically downwards (1)
 - 5.2.2 Girl as she slides down the slide (3)
- 5.3 Use the principle of CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the boy when he reaches the ground at **R**. (4)
- 5.4 Use the WORK-ENERGY THEOREM to calculate the speed of the girl when she reaches the end of the slide at **Q**. (5)
- 5.5 How would the velocity of the girl at **Q** compare to that of the boy at **R** if the slide exerts no frictional force on the girl? Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)

[16]

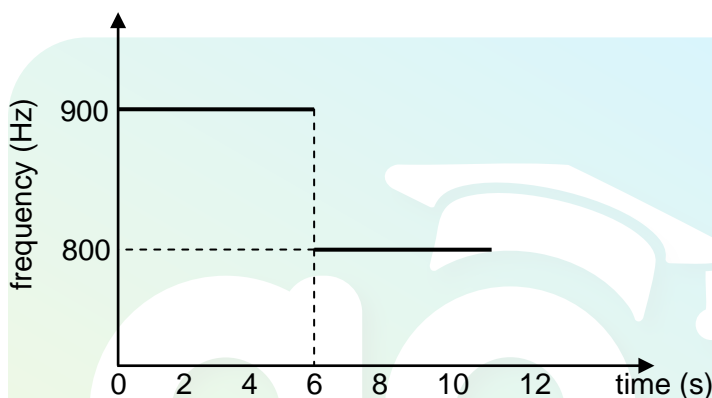
QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a frequency of 850 Hz.

An observer, travelling in a car at a constant speed in a straight line, begins measuring the frequency of the sound waves emitted by the siren when he is at a distance x from the ambulance.

The observer continues measuring the frequency as he approaches, passes and moves away from the ambulance.

The results obtained are shown in the graph below.

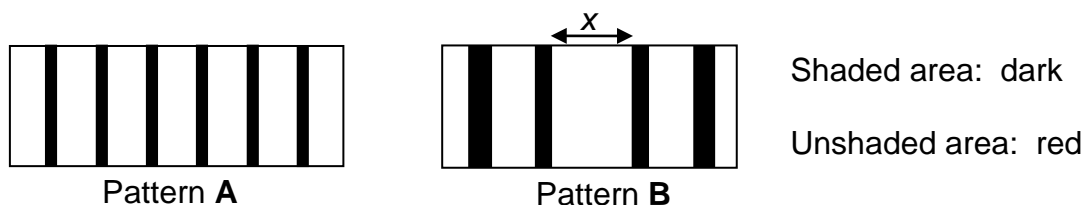


- 6.1 The observed frequency suddenly changes at $t = 6$ s. Give a reason for this sudden change in observed frequency. (1)
- 6.2 Calculate the:
- 6.2.1 Speed of the car
(Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$.) (5)
- 6.2.2 Distance x between the car and the ambulance when the observer BEGINS measuring the frequency (3)
- [9]**

QUESTION 7 (Start on a new page.)

A learner investigates the difference in patterns obtained on a screen when monochromatic red light passes through a single slit and through a double slit.

The diagram below shows two patterns obtained during the investigation.



7.1 Which pattern, **A** or **B**, is a diffraction pattern? (1)

7.2 Write down the name of the phenomenon that explains the formation of the red lines (unshaded area) in pattern **A**. (2)

7.3 The monochromatic red light used to obtain pattern **B** has a frequency of $4,54 \times 10^{14}$ Hz. The broadness of the central band, x , is measured as 20 cm when the distance between the screen and the slit is 1,5 m.

Calculate the:

7.3.1 Wavelength of the red light (3)

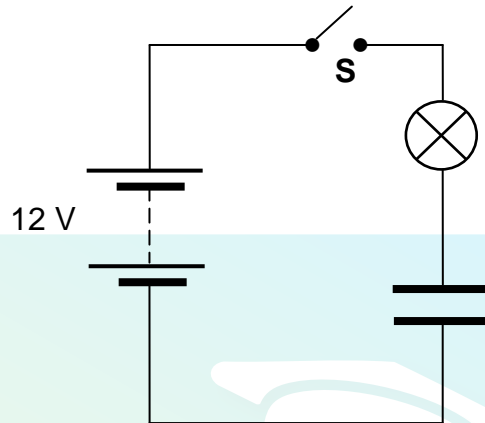
7.3.2 Width of the slit used (6)

7.4 How will the broadness of the central band, x , change if the monochromatic red light is replaced with monochromatic blue light? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

QUESTION 8 (Start on a new page.)

8.1 Write down the main function of a capacitor in a circuit. (1)

A high-resistance light bulb and an uncharged parallel plate capacitor are connected in series with a 12 V battery and a switch **S**, as shown below. The internal resistance of the battery and the resistance of the connecting wires should be ignored.



Switch **S** is now closed and the capacitor charges.

8.2 Describe how the brightness of the light bulb changes during the charging process. (1)

The capacitor is NOW fully charged.

8.3 Write down the potential difference across the:

8.3.1 Light bulb (1)

8.3.2 Capacitor (1)

8.4 The distance between the plates of the capacitor is 5,4 mm.

For the fully charged capacitor, calculate the magnitude of the:

8.4.1 Electric field between the plates (3)

8.4.2 Electrostatic force exerted on an electron between the plates (3)

8.5 An electron is positioned 3,8 mm from the positive plate of the capacitor.

Calculate the:

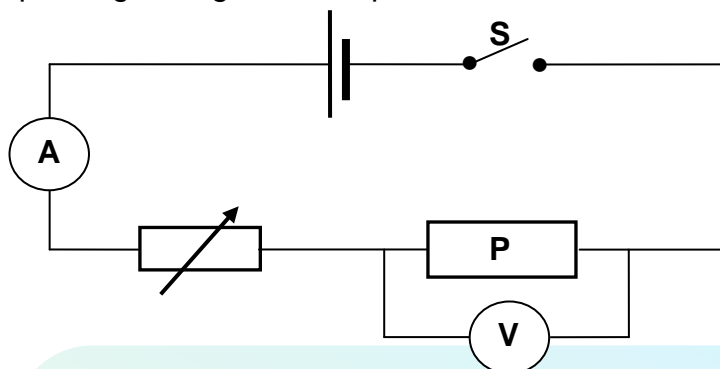
8.5.1 Distance (in mm) between the electron and the negative plate (1)

8.5.2 Work that must be done to move the electron to the negative plate (Ignore the effects of gravitational force.) (4)

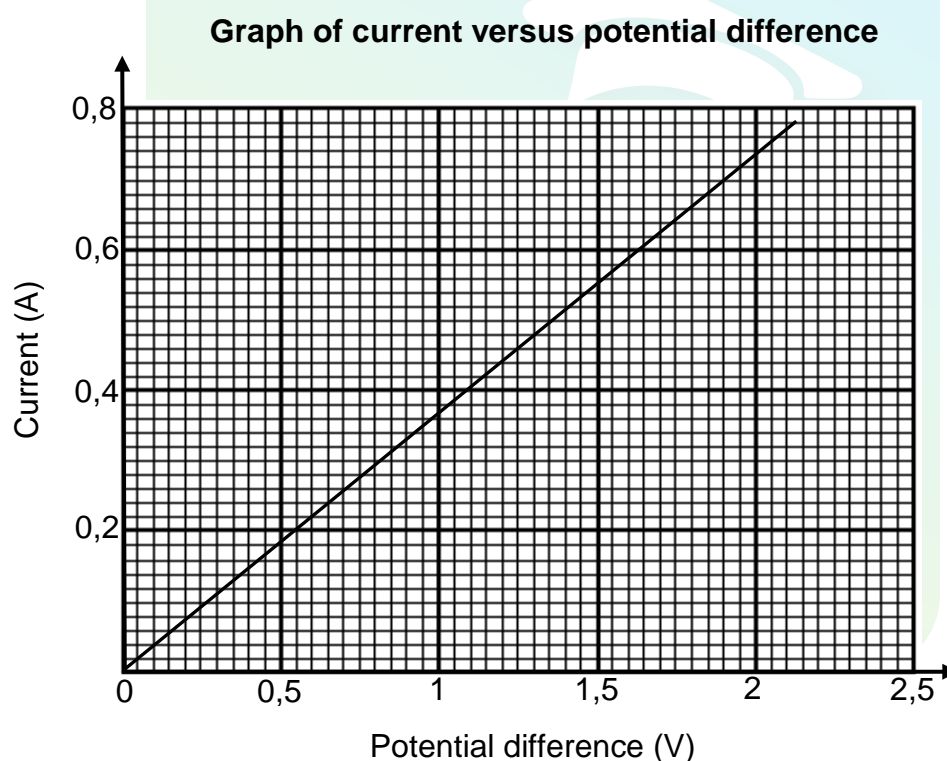
[15]

QUESTION 9 (Start on a new page.)

- 9.1 The circuit represented below is used to investigate the relationship between the current passing through and the potential difference across resistor **P**.

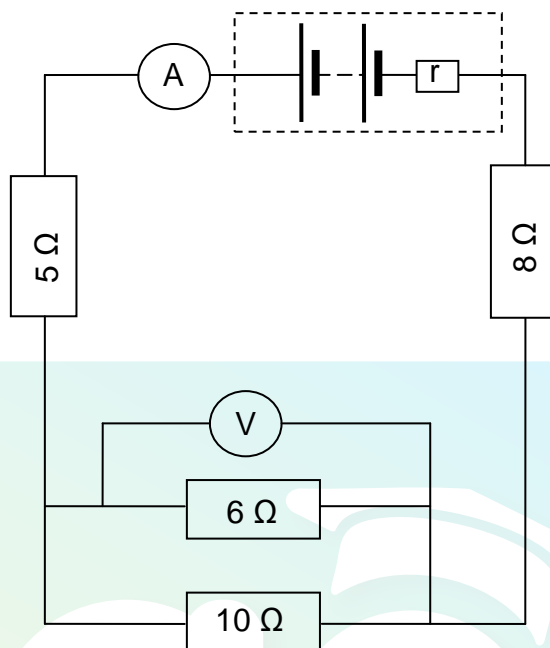


The results obtained are used to draw the graph below.



- 9.1.1 Write down the independent variable. (1)
- 9.1.2 Write down the variable that must be controlled. (1)
- 9.1.3 Write down the conclusion that can be obtained from the graph. (2)
- 9.1.4 Using the gradient of the graph, calculate the resistance of resistor **P**. (4)

- 9.2 In the circuit represented below, a battery of emf 30 V and unknown internal resistance r are connected to resistors, as shown. Ignore the resistance of the ammeter and the connecting wires.



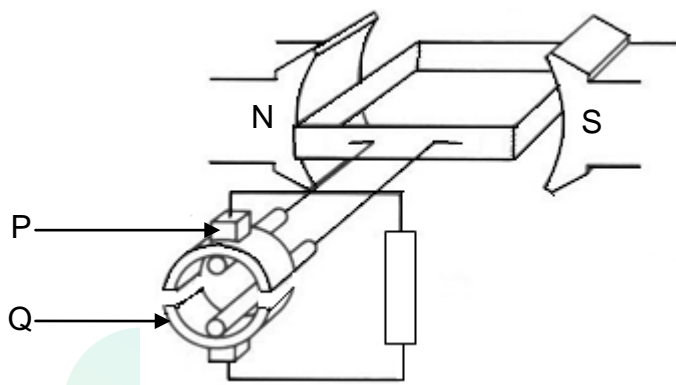
The current passing through the $10\ \Omega$ resistor is 0,6 A.

Calculate the:

- | | | |
|-------|--|-------------|
| 9.2.1 | Equivalent resistance of the two resistors in parallel | (3) |
| 9.2.2 | Current through the $8\ \Omega$ resistor | (4) |
| 9.2.3 | Internal resistance of the battery | (4) |
| | | [19] |

QUESTION 10 (Start on a new page.)

AC generators and DC generators differ in their construction and the type of current they deliver. The simplified sketch below represents a DC generator.



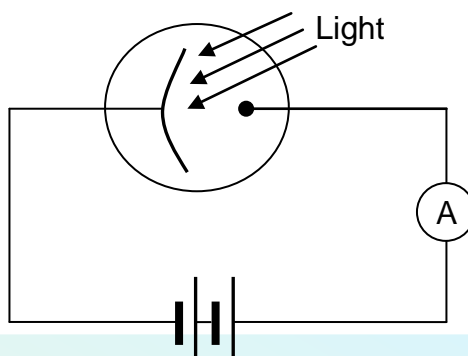
- 10.1 Which component (**P** or **Q**) enables this generator to produce DC? (1)
- 10.2 What structural change must be made to this generator to change it to an AC generator? (1)
- 10.3 Briefly explain why Eskom prefers using AC instead of DC for the long-distance transmission of electricity. (2)
- 10.4 An AC generator delivers $240\text{ V}_{\text{rms}}$ to a 60 W light bulb. The peak current in the light bulb is $0,35\text{ A}$.

Calculate the:

- 10.4.1 rms current in the light bulb (3)
- 10.4.2 Resistance of the light bulb (3)
- [10]**

QUESTION 11 (Start on a new page.)

Light shines onto the cathode of a photocell as shown below. The ammeter registers a reading.



11.1 Define the term *photon*. (2)

11.2 Each photon of light has an energy of $6,9 \times 10^{-19}$ J. The cathode has a work function of $6,4 \times 10^{-19}$ J.

Calculate the:

11.2.1 Wavelength of the light (5)

11.2.2 Kinetic energy of the photoelectrons (3)

11.3 How will the reading on the ammeter change if:

11.3.1 Light of the same frequency, but of higher intensity, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)

11.3.2 Light of the same intensity, but of higher frequency, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)

[16]

TOTAL SECTION B: 125
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 <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	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
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	$8,85 \times 10^{-12} \text{ F}\cdot\text{m}^{-1}$

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

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

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 $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h \frac{c}{\lambda}$
$\sin \theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_k = \frac{1}{2} mv^2$

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\epsilon_0 A}{d}$

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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

ALTERNATING CURRENT/WISSELSTROOM

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