



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2010**

**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.

**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.

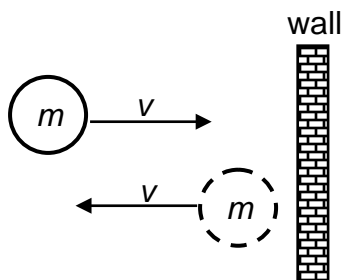
- 1.1 The type of collision in which kinetic energy is conserved (1)
- 1.2 The principle which states that each point on a wave front acts as a source of secondary wavelets (1)
- 1.3 The unit of measure equivalent to one volt per ampere (1)
- 1.4 The component in a DC electric motor that ensures continuous rotation in one direction by reversing the direction of the current every half-cycle (1)
- 1.5 The minimum energy needed to eject an electron from a metal surface (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 An object projected vertically upwards reaches its maximum height and returns to its original point of projection. Ignoring the effects of friction, the direction of the acceleration of the object during its motion is ...
- A always vertically downwards.
- B first vertically upwards and then vertically downwards.
- C first vertically downwards and then vertically upwards.
- D always vertically upwards. (2)

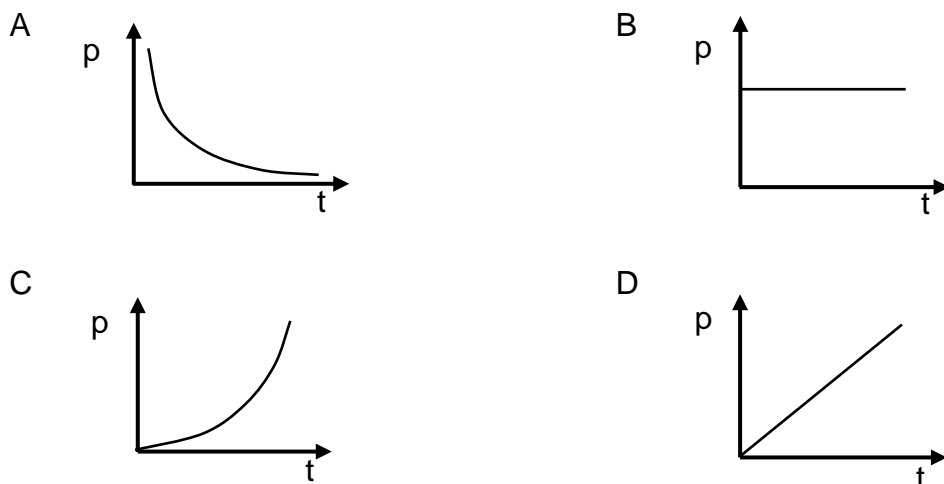
2.2 A ball of mass  $m$  strikes a wall perpendicularly at a speed  $v$ . Immediately after the collision the ball moves in the opposite direction at the same speed  $v$ , as shown in the diagram below.



Which ONE of the following represents the magnitude of the change in momentum of the ball?

- A 0
- B  $mv$
- C  $2mv$
- D  $3mv$  (2)

2.3 Which ONE of the following momentum versus time graphs best represents the motion of an object that starts from rest and moves in a straight line under the influence of a constant net force?



(2)

2.4 Which ONE of the following correctly represents the given types of electromagnetic radiation in order of INCREASING WAVELENGTH?

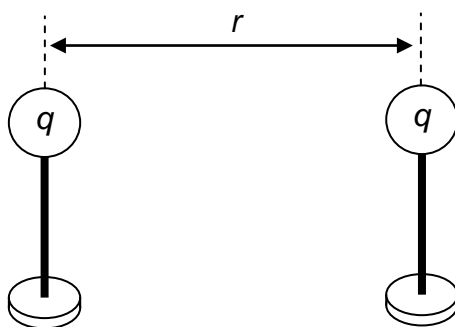
- A Microwaves; infrared; ultraviolet
- B Infrared; ultraviolet; X-rays
- C Radio waves; infrared; gamma rays
- D Ultraviolet; infrared; microwaves (2)

2.5 Which ONE of the following phenomena provides the most conclusive evidence for the wave nature of light?

- A Photoelectric effect
- B Refraction
- C Reflection
- D Diffraction

(2)

2.6 The diagram below represents two small spheres on insulated stands. Each sphere carries a positive charge of magnitude  $q$  and is separated by a distance  $r$ , as shown. The total electrical potential energy of the system of two charges is  $U$ .



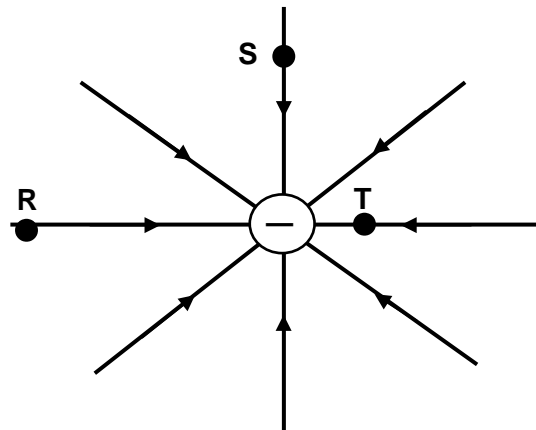
The distance between the centres of the spheres is now HALVED.

Which ONE of the following now represents the magnitude of the electrical potential energy of the system of two charges?

- A  $\frac{1}{4}U$
- B  $\frac{1}{2}U$
- C  $2U$
- D  $4U$

(2)

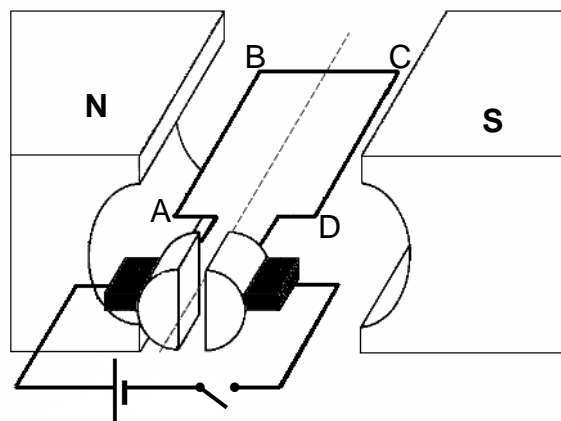
- 2.7 The diagram below represents the electric field pattern around a negative point charge. R, S and T are points at different distances from the negative point charge.



The magnitude of the electric field of the point charge is ...

- A greatest at point R.
- B greatest at point S.
- C greatest at point T.
- D the same at points R, S and T. (2)

- 2.8 The simplified diagram of an electric motor is shown below.



When the switch is closed, coil ABCD rotates ...

- A clockwise.
- B anticlockwise.
- C clockwise until it reaches the vertical position and then reverses its direction.
- D anticlockwise until it reaches the vertical position and then reverses its direction. (2)

2.9 A neon tube lights up when a large external voltage is applied across it.

Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is viewed through a diffraction grating?

A Continuous

B Absorption

C Line emission

D Line absorption

(2)

2.10 When a clean metal plate is irradiated with light of sufficient energy, photoelectrons are emitted. The INTENSITY of the light is now increased. This change will ...

A increase the number of photoelectrons emitted per second.

B decrease the number of photoelectrons emitted per second.

C increase the kinetic energy of the emitted photoelectrons.

D decrease the kinetic energy of the emitted photoelectrons.

(2)

[20]

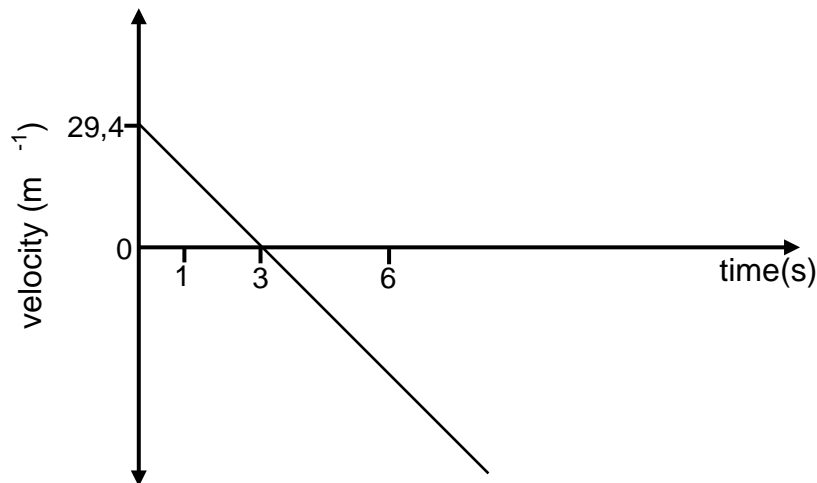
**TOTAL SECTION A: 25**

**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 numerical answers to TWO decimal places.

**QUESTION 3 (Start on a new page.)**

A man fires a projectile **X** vertically upwards at a velocity of  $29,4 \text{ ms}^{-1}$  from the EDGE of a cliff of height 100 m. After some time the projectile lands on the ground below the cliff. The velocity-time graph below (NOT DRAWN TO SCALE) represents the motion of projectile **X**. (Ignore the effects of friction.)



- 3.1 Use the graph to determine the time that the projectile takes to reach its maximum height. (A calculation is not required.) (1)
- 3.2 Calculate the maximum height that projectile **X** reaches above the ground. (4)
- 3.3 Sketch the position-time graph for projectile **X** for the period  $t = 0 \text{ s}$  to  $t = 6 \text{ s}$ . USE THE EDGE OF THE CLIFF AS ZERO OF POSITION.

Indicate the following on the graph:

- The time when projectile **X** reaches its maximum height
- The time when projectile **X** reaches the edge of the cliff (4)



- 3.4 One second (1 s) after projectile **X** is fired, the man's friend fires a second projectile **Y** upwards at a velocity of  $49 \text{ m s}^{-1}$  FROM THE GROUND BELOW THE CLIFF.

The first projectile, **X**, passes projectile **Y** 5,23 s after projectile **X** is fired. (Ignore the effects of friction.)

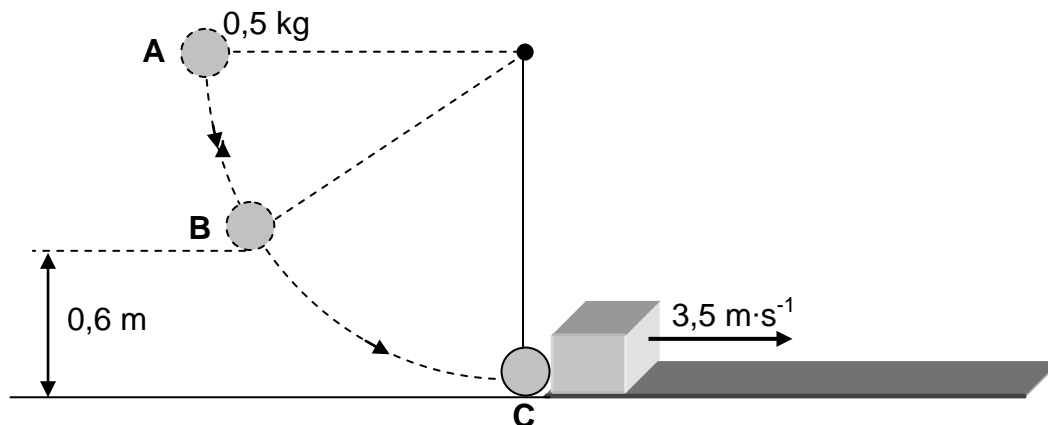
Calculate the following:

- 3.4.1 The velocity of projectile **X** at the instant it passes projectile **Y** (5)

- 3.4.2 The velocity of projectile **X** RELATIVE to projectile **Y** at the instant it passes projectile **Y** (5)  
[19]

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

A steel ball of mass  $0,5 \text{ kg}$  is suspended from a string of negligible mass. It is released from rest at point **A**, as shown in the sketch below. As it passes through point **B**, which is  $0,6 \text{ m}$  above the ground, the magnitude of its velocity is  $3 \text{ m s}^{-1}$ . (Ignore the effects of friction.)



- 4.1 Write down the principle of the conservation of mechanical energy in words. (2)

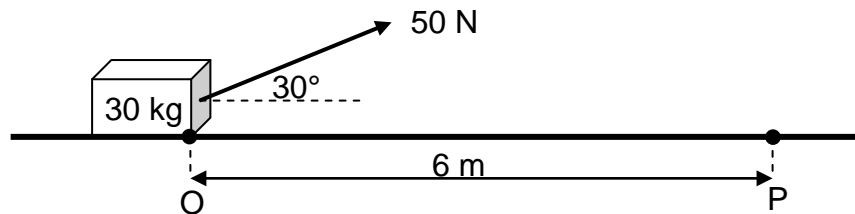
- 4.2 Calculate the mechanical energy of the steel ball at point **B**. (4)

As the steel ball swings through its lowest position at point **C**, it collides with a stationary crate of mass  $0,1 \text{ kg}$ . Immediately after the collision, the crate moves at a velocity of  $3,5 \text{ m s}^{-1}$  to the right.

- 4.3 Calculate the velocity of the steel ball immediately after the collision. (7)  
[13]

**QUESTION 5 (Start on a new page.)**

A worker pulls a crate of mass 30 kg from rest along a horizontal floor by applying a constant force of magnitude 50 N at an angle of  $30^\circ$  to the horizontal. A frictional force of magnitude 20 N acts on the crate whilst moving along the floor.



- 5.1 Draw a labelled free-body diagram to show ALL the forces acting on the crate during its motion. (4)
- 5.2 Give a reason why each of the vertical forces acting on the crate do NO WORK on the crate. (2)
- 5.3 Calculate the net work done on the crate as it reaches point P, 6 m from the starting point O. (4)
- 5.4 Use the work-energy theorem to calculate the speed of the crate at the instant it reaches point P. (3)
- 5.5 The worker now applies a force of the same magnitude, but at a SMALLER ANGLE to the horizontal, on the crate.

How does the work done by the worker now compare to the work done by the worker in QUESTION 5.3? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (No calculations are required.)

(2)  
**[15]**

**QUESTION 6 (Start on a new page.)**

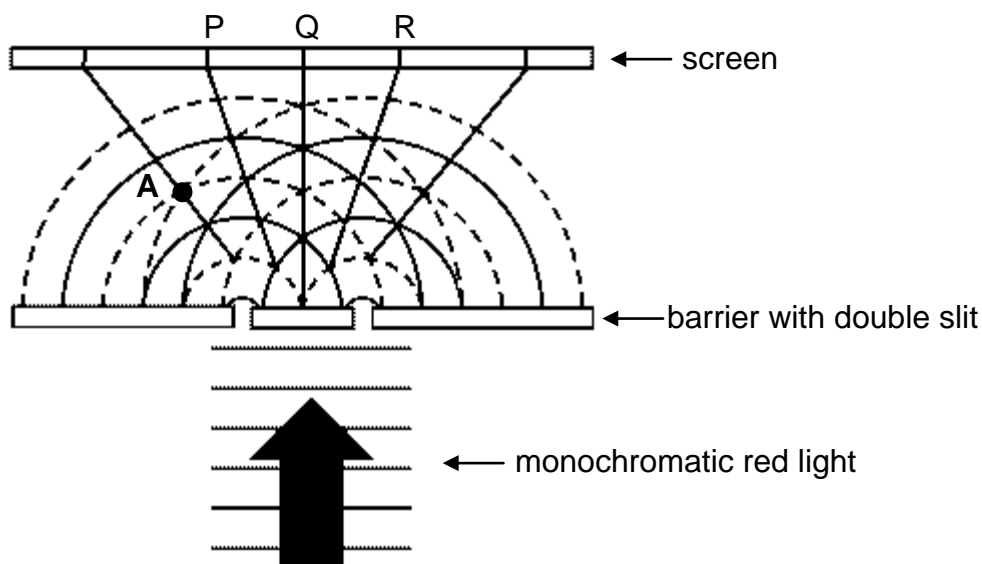
The siren of a burglar alarm system has a frequency of 960 Hz. During a patrol, a security officer, travelling in his car, hears the siren of the alarm of a house and approaches the house at constant velocity. A detector in his car registers the frequency of the sound as 1 000 Hz.

- 6.1 Name the phenomenon that explains the change in the observed frequency. (1)
- 6.2 Calculate the speed at which the patrol car approaches the house. Use the speed of sound in air as  $340 \text{ m}\cdot\text{s}^{-1}$ . (4)
- 6.3 If the patrol car had approached the house at a higher speed, how would the detected frequency have compared to the first observed frequency of 1 000 Hz? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)
- [6]**

**QUESTION 7 (Start on a new page.)**

Monochromatic red light passes through a double slit, as shown in the diagram below. Circular wave fronts, advancing towards the screen, are shown between the slits and the screen as dotted lines and solid lines. The solid lines represent crests and the dotted lines troughs.

Interference of the circular wave fronts results in an interference pattern observed on the screen. **P**, **Q** and **R** represent the centres of different bands in the interference pattern.

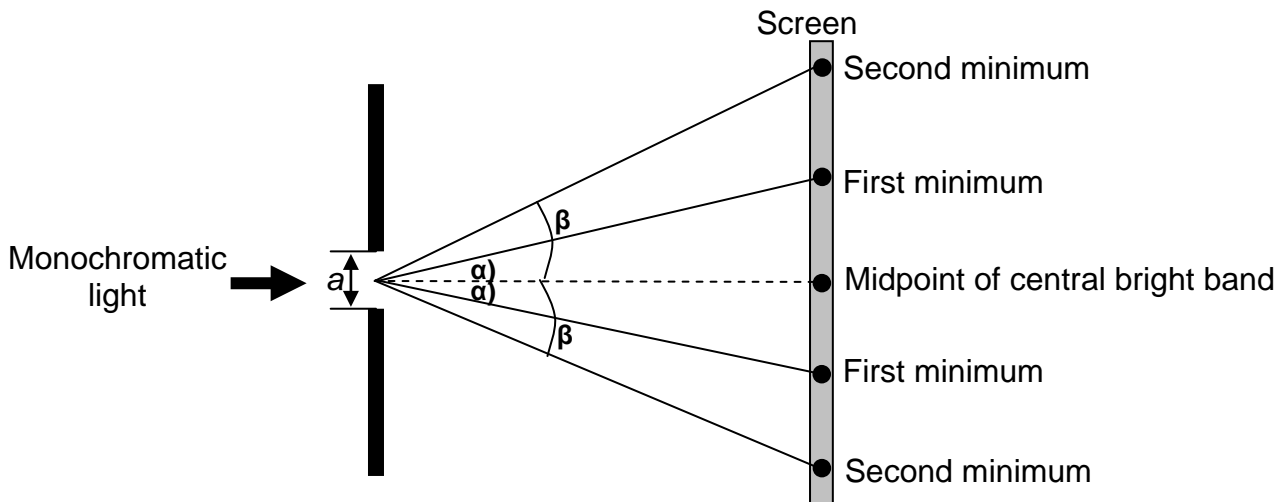


- 7.1 Define the term *interference*. (2)
- 7.2 What type of interference takes place at point **A**? Give a reason for the answer. (2)
- 7.3 Is band **P** a dark band or a red band? Refer to the type of interference involved to explain how you arrived at the answer. (3)
- [7]**

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

The relationship between the degree of diffraction of light and slit width is investigated.

Monochromatic light of wavelength 410 nm is passed through a single slit at a *fixed distance* from a screen. The angles at which the first minimum ( $\alpha$ ) and the second minimum ( $\beta$ ) occur are measured.



The experiment is repeated using the same light source but a slit of different width.

The results obtained from the two experiments are represented in the table below.

	ANGLE OF 1 <sup>ST</sup> MINIMUM ( $\alpha$ )	ANGLE OF 2 <sup>ND</sup> MINIMUM ( $\beta$ )
<b>Slit 1</b>	10°	20°
<b>Slit 2</b>	5°	10°

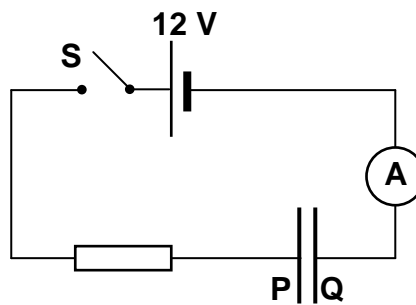
- 8.1 Define the term *diffraction*. (2)
- 8.2 For this investigation, name the following:
- 8.2.1 Dependent variable (1)
- 8.2.2 Independent variable (1)
- 8.3 Which ONE of **Slit 1** or **Slit 2** is the narrower slit? Explain the answer. (2)
- 8.4 Use the data in the table to calculate the width of **Slit 2**. (4)
- [10]**

**QUESTION 9 (Start on a new page.)**

A certain parallel plate capacitor consists of two plates, each of dimension 15 mm by 20 mm, separated by a distance of 1,5 mm. The space between the plates is occupied by air.

- 9.1 Define the term *capacitance*, in words. (2)
- 9.2 Calculate the capacitance of this capacitor. (5)

The circuit diagram below shows the ABOVE CAPACITOR, initially uncharged, connected in series to a resistor, an ammeter of negligible resistance and a source with an emf of 12 V. The internal resistance of the battery is negligible.



Switch **S** is now closed.

- 9.3 Draw a sketch graph of current versus time to show how the ammeter reading changes with time as the capacitor charges. (2)

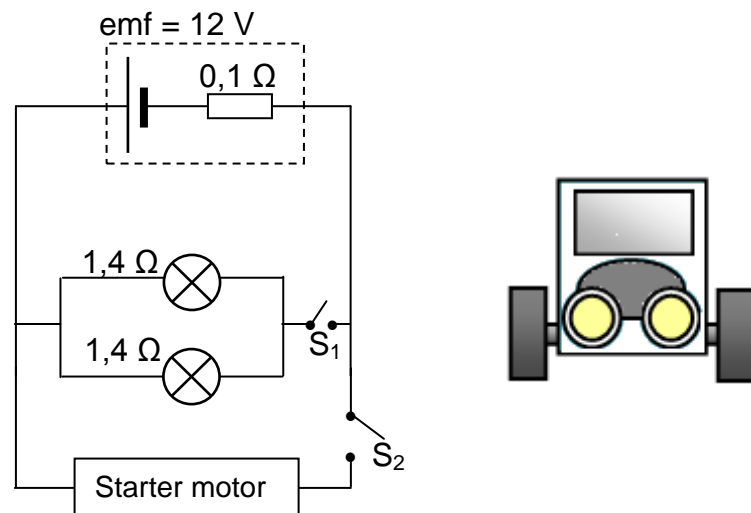
The capacitor is now fully charged.

- 9.4 Calculate the magnitude of the charge on each plate of the capacitor. (3)
- 9.5 One of the molecules in the air between the plates of the capacitor becomes ionised. This ion carries a charge of  $+3,2 \times 10^{-19}$  C. Calculate the magnitude of the electrostatic force experienced by this ion between the plates. (5)

**[17]**

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

The headlights of a car are connected in parallel to a 12 V battery, as shown in the simplified circuit diagram below. The internal resistance of the battery is  $0,1 \Omega$  and each headlight has a resistance of  $1,4 \Omega$ . The starter motor is connected in parallel with the headlights and controlled by the ignition switch,  $S_2$ . The resistance of the connecting wires may be ignored.



- 10.1 State Ohm's law in words. (2)
- 10.2 With only switch  $S_1$  closed, calculate the following:
- 10.2.1 Effective resistance of the two headlights (3)
- 10.2.2 Potential difference across the two headlights (4)
- 10.2.3 Power dissipated by one of the headlights (3)
- 10.3 Ignition switch  $S_2$  is now closed (whilst  $S_1$  is also closed) for a short time and the starter motor, with VERY LOW RESISTANCE, rotates.

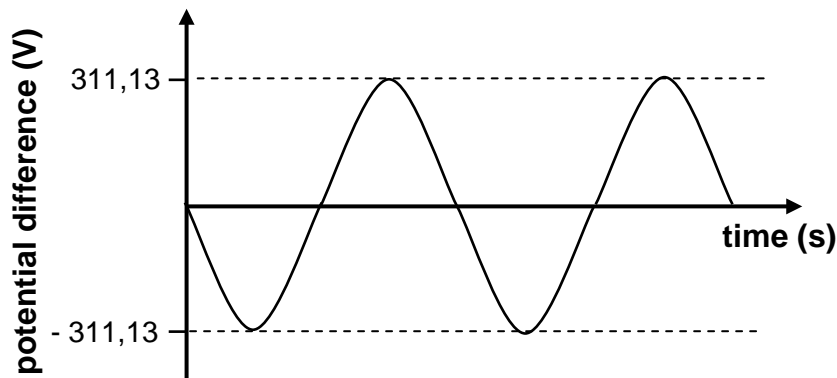
How will the brightness of the headlights be affected while switch  $S_2$  is closed? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Fully explain how you arrived at the answer.

(4)  
[16]

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

The output of an AC generator is shown in the graph below.



A light bulb with an average power rating of 100 W is connected to this generator.

11.1 Calculate the following:

11.1.1 rms potential difference across the light bulb (3)

11.1.2 Peak current ( $I_{\max}$ ) through the light bulb (5)

11.2 The AC generator is replaced with a DC generator. Draw the graph of potential difference versus time for the output of the DC generator. (No numerical values are expected on the axes.) (2)

**[10]**

**QUESTION 12 (Start on a new page.)**

Sunlight is a major source of ultraviolet light.

12.1 Overexposure to ultraviolet light could have harmful effects on humans. State ONE of these harmful effects on humans. (1)

12.2 Medical practitioners expose surgery equipment to ultraviolet light. Give a reason for doing this. (1)

A certain metal has a work function of  $3,84 \times 10^{-19}$  J. The surface of the metal is irradiated with ultraviolet light of wavelength 200 nm causing photoelectrons to be emitted.

12.3 Calculate the energy of a photon of ultraviolet light. (4)

12.4 Calculate the maximum velocity of the emitted photoelectrons. (4)

12.5 Will photoelectrons be emitted from the surface of this metal if it is irradiated with X-rays? Give a reason for the answer. (2)

**[12]**

**TOTAL SECTION B: 125**  
**GRAND TOTAL: 150**



**DATA FOR PHYSICAL SCIENCES GRADE 12  
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12  
VRAESTEL 1 (FISIKA)**

**TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES**

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s <sup>-2</sup>
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	3,0 x 10 <sup>8</sup> m·s <sup>-1</sup>
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 <sup>-34</sup> J·s
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 <sup>9</sup> N·m <sup>2</sup> ·C <sup>-2</sup>
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 <sup>-19</sup> C
Electron mass <i>Elektronmassa</i>	m <sub>e</sub>	9,11 x 10 <sup>-31</sup> kg
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ε <sub>0</sub>	8,85 x 10 <sup>-12</sup> F·m <sup>-1</sup>





**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 ( $\epsilon$ ) = I(R + r)/ emk ( $\epsilon$ ) = 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**

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