basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2014

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 1
1084E

10841E

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

X05

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GAUTENG

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 sum of the kinetic energy and gravitational potential energy of an object (1)

1.2 The law of motion that can be used to explain why all persons in moving vehicles should wear safety belts (1)

1.3 The energy a charge possesses as a result of its position relative to other charges that it interacts with (1)

1.4 The bending of waves around corners or obstacles (1)

1.5 The minimum energy needed to remove an electron from the surface of a metal (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are given 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 Net force is a measure of the …

A change in energy.
B rate of change in energy.
C change in momentum.
D rate of change in momentum. (2)

2.2 If air resistance is negligible, the total mechanical energy of a free-falling body …

A remains constant.
B becomes zero.
C increases.
D decreases. (2)

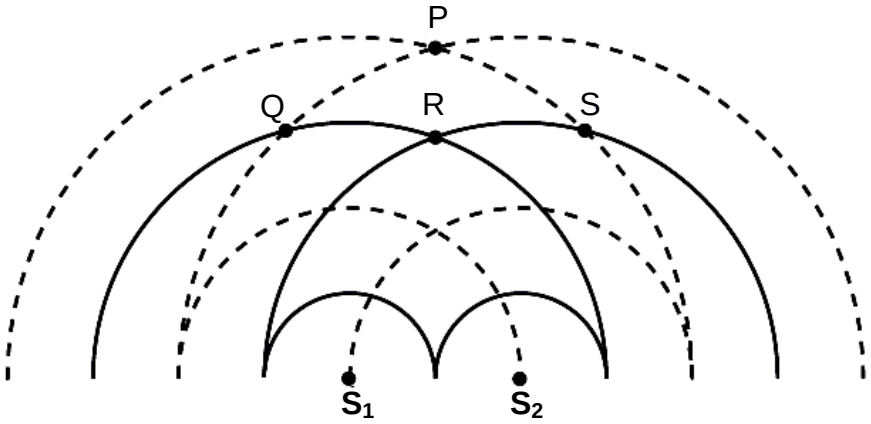
2.3 If the momentum of an object is doubled, then its kinetic energy is ...

A halved.
B doubled.
C three times greater.
D four times greater. (2)

2.4 The degree of diffraction depends on a wave's ...

A phase.
B velocity.
C amplitude.
D wavelength. (2)

2.5 The diagram below shows waves generated by two coherent sources, $\mathbf{S_1}$ and $\mathbf{S_2}$. The solid lines represent CRESTS and the broken (dashed) lines represent TROUGHS.



Destructive interference occurs at points ...

A Q and R.
B Q and P.
C Q and S.
D R and S. (2)

2.6 Two small identical metal spheres, each carrying equal charges Q, are brought into contact and then separated.

The charge on each sphere will now be …

A zero.

B $\frac{Q}{2}$.

C Q.

D $2Q$. (2)

2.7 Two resistors of equal resistance are connected in SERIES to a battery with negligible internal resistance. The current through the battery is I.

When the two resistors are connected in PARALLEL to the same battery, the current through the battery will be …

A $\frac{1}{2}I$.

B I.

C $2I$.

D $4I$. (2)

2.8 Which ONE of the following statements is INCORRECT?
Electromagnetic waves …

A can undergo reflection and refraction.

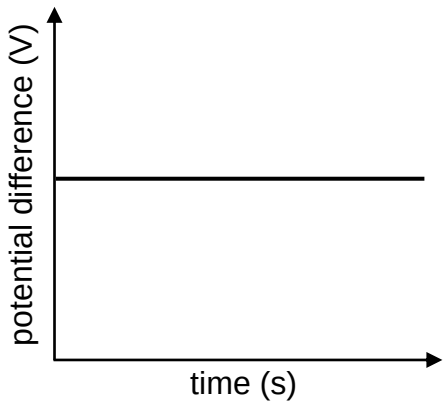
B are longitudinal waves.

C can travel through a vacuum.

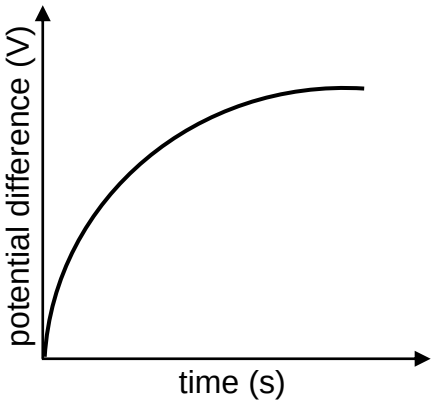
D can undergo diffraction and interference. (2)

2.9 Which ONE of the following graphs represents the change in potential difference across a capacitor as it charges?

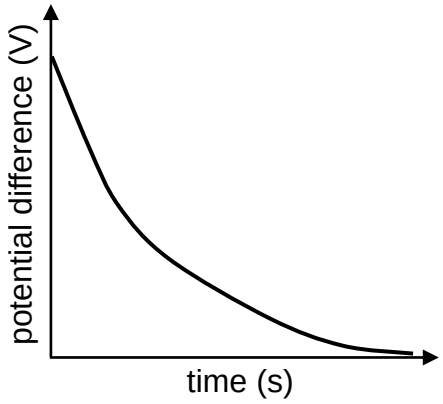
A



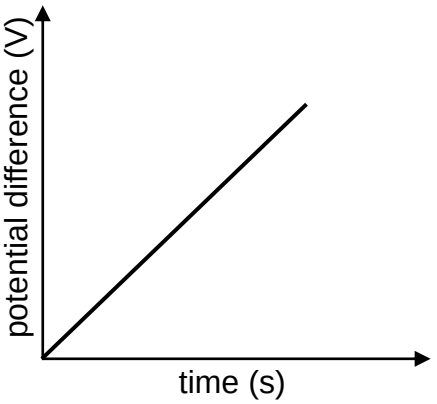
B



C

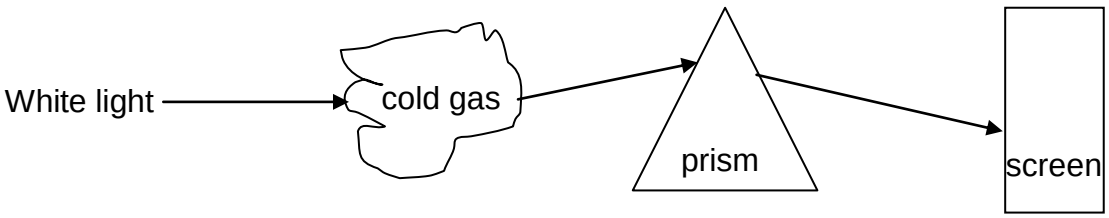


D



(2)

2.10 Light spectra help to identify elements. White light is passed through a cold gas and then through a prism as shown in the sketch below.



What type of spectrum is observed on the screen?

A Line absorption spectrum

B Line emission spectrum

C Continuous absorption spectrum

D Continuous emission spectrum (2)

[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

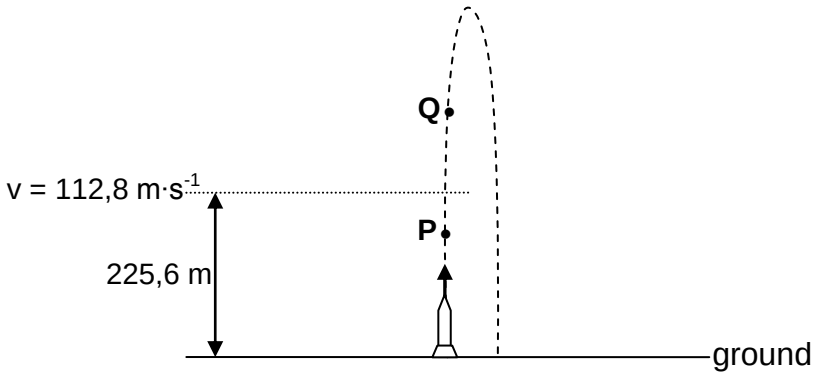
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

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 stationary rocket on the ground is launched vertically upwards. After 4 s, the rocket's fuel is used up and it is 225,6 m above the ground. At this instant the velocity of the rocket is 112,8 $m \cdot s^{-1}$. The diagram below shows the path followed by the rocket. Ignore the effects of air friction. Assume that g does not change during the entire motion of the rocket.



3.1 Write down the direction of the acceleration of the rocket at point:

3.1.1 **P** (1)

3.1.2 **Q** (1)

3.2 At which point (**P** or **Q**) is the rocket in free fall? Give a reason for the answer. (2)

3.3 TAKING UPWARD MOTION AS POSITIVE, USE EQUATIONS OF MOTION to calculate the time taken from the moment the rocket is launched until it strikes the ground. (6)

3.4 Sketch a velocity versus time graph for the motion of the rocket from the moment it runs out of fuel until it strikes the ground. Take the time when the rocket runs out of fuel as t = 0 s.

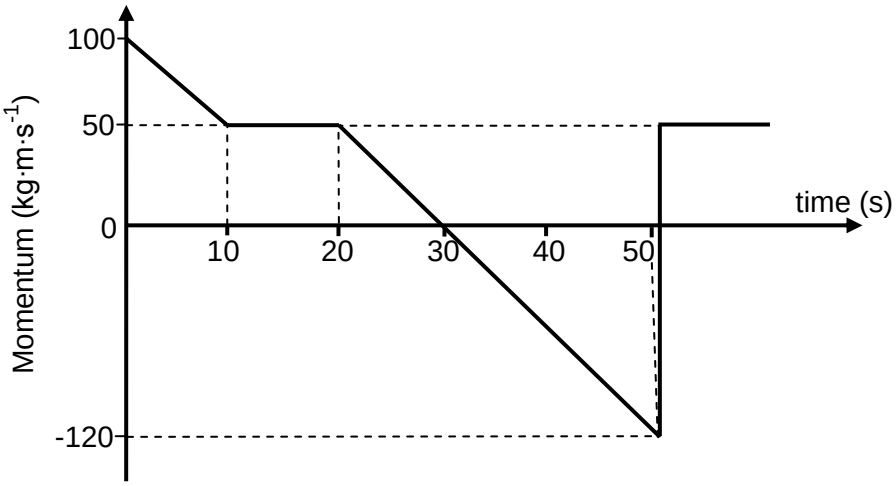
Indicate the following values on the graph:

- Velocity of the rocket when it runs out of fuel
- Time at which the rocket strikes the ground (5)

[15]

QUESTION 4 (Start on a new page.)

The momentum versus time graph of object **A**, originally moving horizontally EAST, is shown below.



4.1 Write down the definition of *momentum* in words. (2)

4.2 *The net force acting on object **A** is zero between t = 10 s and t = 20 s.*

Use the graph and a relevant equation to explain why this statement is TRUE. (2)

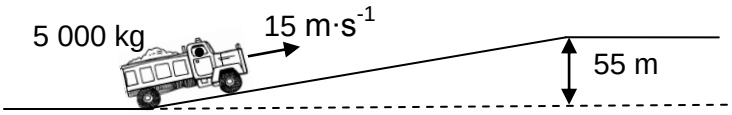
4.3 Calculate the magnitude of the impulse that object **A** experiences between t = 20 s and t = 50 s. (3)

4.4 At t = 50 s, object **A** collides with another object, **B**, which has a momentum of 70 kg·m·s^{-1} EAST.

Use the information from the graph and the relevant principle to calculate the momentum of object **B** after the collision. (5)
[12]

QUESTION 5 (Start on a new page.)

A loaded truck with a total mass of 5 000 kg travels up a straight incline at a constant velocity of 15 m·s^{-1}. At the top of the incline, the truck is at a height of 55 m above its starting point. The work done by frictional forces is 8,5 x 10^4 J. (Ignore the rotational effects of the wheels of the truck.)



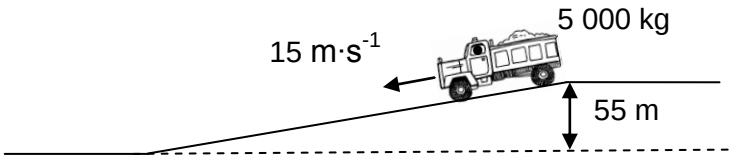
5.1 Define *power* in words. (2)

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the truck as it moves up the incline. (4)

5.3 Use the WORK-ENERGY THEOREM to calculate the work done by the engine of the truck to get it to the top of the incline. (5)

5.4 Calculate the average power delivered by the engine of the truck if the truck takes 60 s to reach the top of the incline. (3)

The truck now returns down the same incline with a constant velocity of 15 m·s^{-1}.



5.5 How will the work done by the engine of the truck on reaching the bottom of the incline compare to that calculated in QUESTION 5.3? Write down GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)
[16]

QUESTION 6 (Start on a new page.)

A sound source on a car produces sound waves of frequency 850 Hz. A stationary observer measures the emitted frequency using a detector which can measure a maximum frequency of 800 Hz. He finds that the detector only registers a reading whilst the car is moving. (Ignore the effects of wind.)

6.1 Must the car move TOWARDS or AWAY from the observer for the detector to register a reading?

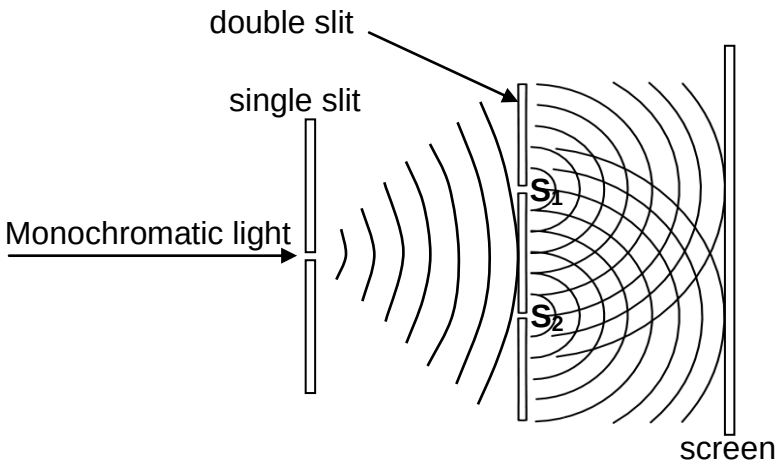
Explain the answer by referring to frequency or wavelength. (3)

6.2 Calculate the minimum speed at which the car must move for the detector to register the maximum reading. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.3 State ONE use of the Doppler effect in medicine. (1)
[9]

QUESTION 7 (Start on a new page.)

The diagram below shows monochromatic light that first passes through a single slit and then through a double slit. An interference pattern is observed on the screen.



7.1 What is the function of the double slit in the above arrangement? (1)

7.2 The width of the two slits S_1 and S_2 and the distance between the slits are kept constant. How will the width of the bands in the interference pattern change if:
(Write down only INCREASES, DECREASES or REMAINS THE SAME.)

7.2.1 Light of longer wavelength is used (1)

7.2.2 Light of higher frequency is used (1)

7.2.3 The distance between the slits and screen is increased for a given frequency of light (1)

The double slit is now removed and the light passes through the single slit only.

7.3 Describe the pattern that will be observed on the screen when the light passes through the single slit. (2)

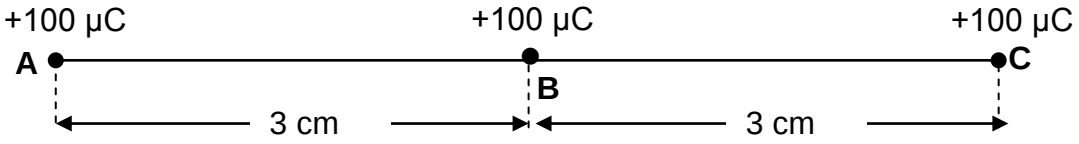
7.4 When light of wavelength 450 nm passes through the single slit, the FOURTH minimum occurs at an angle of 25°. Calculate the width of the single slit. (5)

One can hear sounds around the corners of a doorway, but cannot see around the corners.

7.5 Use your knowledge of diffraction to explain this observation. (2)
[13]

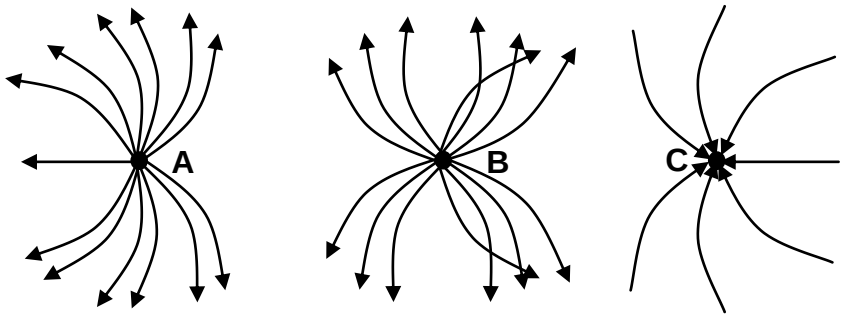
QUESTION 8 (Start on a new page.)

Three +100 µC point charges, **A**, **B** and **C**, are equally spaced on a straight line in a vacuum. The charges are a distance of 3 cm from each other as shown in the sketch below.



8.1 Name the law that describes the electrostatic force exerted by one point charge on another. (1)

8.2 A learner sketches the electric field pattern produced by the three charges as shown below.



Write down THREE mistakes the learner made. (3)

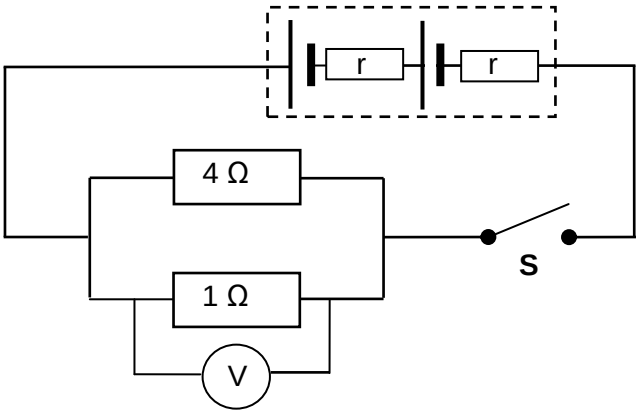
8.3 Calculate the net electrostatic force experienced by point charge **C**. (6)

8.4 Write down the net electrostatic force experienced by point charge **B**. Give a reason for the answer. (2)

[12]

QUESTION 9 (Start on a new page.)

Two identical cells, EACH with an emf of 1,5 V and an internal resistance *r*, are connected in series with each other and to the resistors as shown below.



9.1 Define, in words, the term *electromotive force* (emf). (2)

9.2 Write down the total emf of the circuit. (1)

When switch **S** is closed, the potential difference across the 4 Ω resistor is 2,8 V.

9.3 Calculate the total current in the circuit. (5)

9.4 Calculate the internal resistance *r* of EACH cell. (5)

9.5 An unknown resistor is now connected in parallel with the 4 Ω and 1 Ω resistors. How will this change affect the magnitude of:

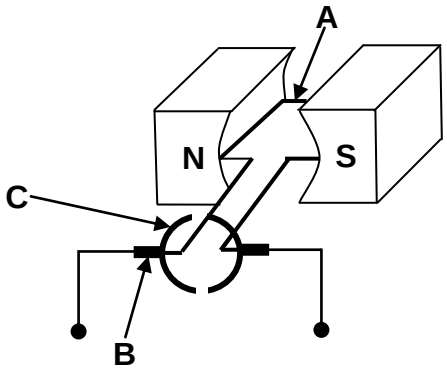
9.5.1 The internal resistance of the battery
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

9.5.2 The reading on the voltmeter
Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer by referring to resistance, current and 'lost volts'. (4)

[18]

QUESTION 10 (Start on a new page.)

10.1 A simplified diagram of an electric motor is shown below.



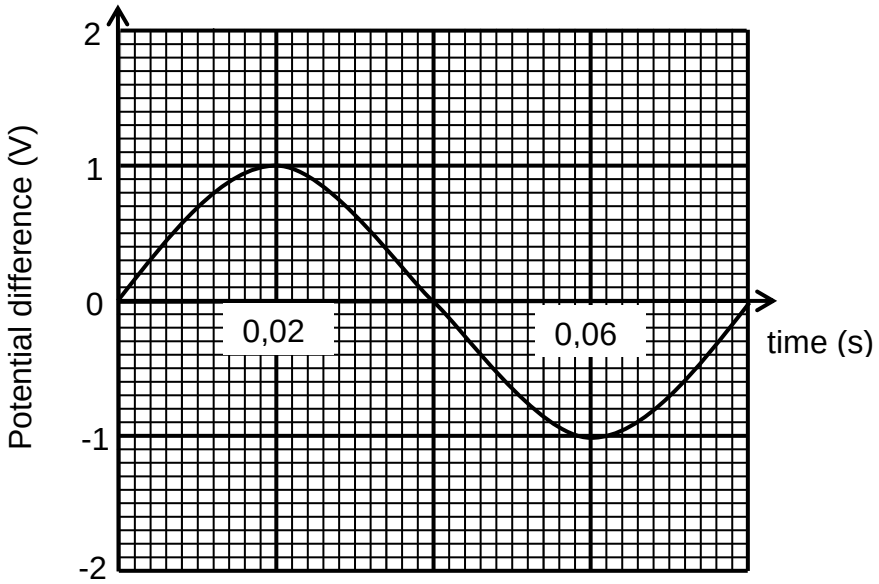
10.1.1 Name the components labelled **A**, **B** and **C**.
Write down only the name of the component next to the letter (A–C). (3)

10.1.2 Write down the function of the component labelled **B**. (1)

10.1.3 Is this motor an AC motor or a DC motor? (1)

10.1.4 Give a reason why component **A** experiences a magnetic force when a current passes through it. (2)

10.2 A coil is rotated in a magnetic field. The varying induced emf obtained is represented in the graph below.



10.2.1 Calculate the induced rms potential difference. (3)

10.2.2 The coil is now rotated at TWICE the original speed.

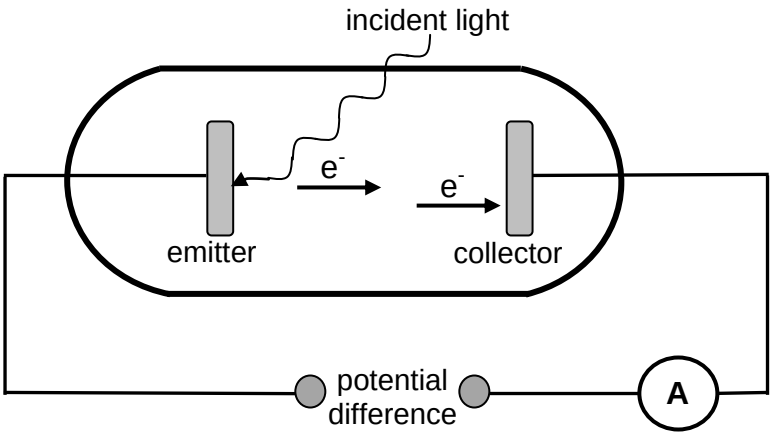
Write down the period of the new wave. (2)

10.2.3 Calculate the average power generated if the generator produces a maximum current of 2 A. (4)

[16]

QUESTION 11 (Start on a new page.)

11.1 The apparatus below is used to demonstrate the photoelectric effect.



11.1.1 Define, in words, the *photoelectric effect*. (2)

The incident monochromatic light transfers $1,8 \times 10^{-9}$ J of energy in one second to a certain area of the emitter. The wavelength of a photon in the incident light is 260 nm.

If one photon releases one electron, calculate the:

11.1.2 Number of electrons released from the surface of that area of the emitter in one second (5)

11.1.3 Current produced, in amperes (4)

11.2 The sketch below shows an example of a line emission spectrum.



11.2.1 Briefly explain how this type of spectrum is formed by referring to electron transitions in atoms. (2)

11.2.2 Write down ONE important use of line emission spectra. (1)
[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150

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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	$9,8\ m{\cdot}s^{-2}$
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	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F{\cdot}m^{-1}$

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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*

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

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

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* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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