education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2009(1)

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces on the ANSWER BOOK.

2. Answer ALL the questions.

3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

4. Answer SECTION A and 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

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 energy of a stationary object due to its position above the surface of the earth (1)

1.2 The unit of measurement equal to one joule per second (1)

1.3 The term used to describe two light sources that emit waves that maintain the same phase relationship with each other (1)

1.4 Electromagnetic waves with the highest penetrating ability (1)

1.5 The 'packets of energy' making up electromagnetic radiation (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 The magnitude of the acceleration of an object projected vertically upwards from the ground is zero at its maximum height. (2)

2.2 When a bullet is fired from a gun, the momentum of the bullet is the same as the momentum of the gun. (2)

2.3 Dispersion of white light by the parallel tracks on the surface of a CD is the result of refraction. (2)

2.4 Non-identical resistors connected in series have the same current in them and the same potential difference across each of them. (2)

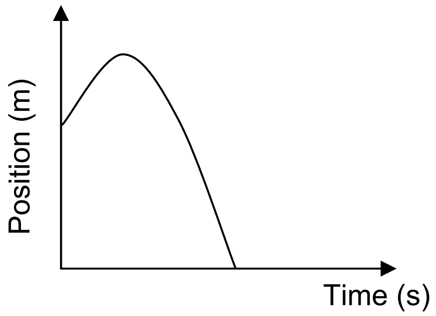
2.5 A line emission spectrum is formed when electrons in an atom move from lower to higher energy levels. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

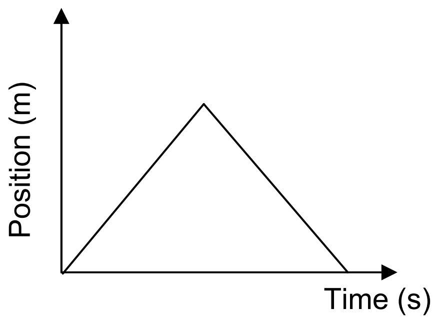
Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following position-versus-time graphs best represents the motion of the stone?

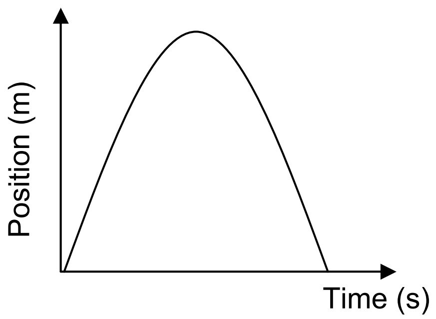
A



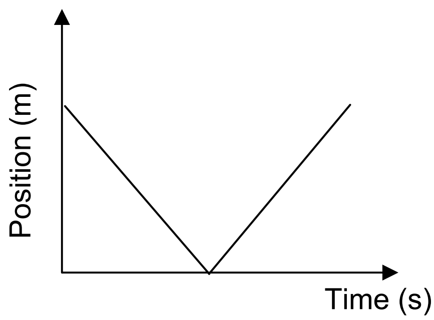
B



C



D



(2)

3.2 Car A moves west at speed *v*. Car B moves east at speed 2*v* along the same straight road. The velocity of Car A relative to Car B is:

A 3*v* west

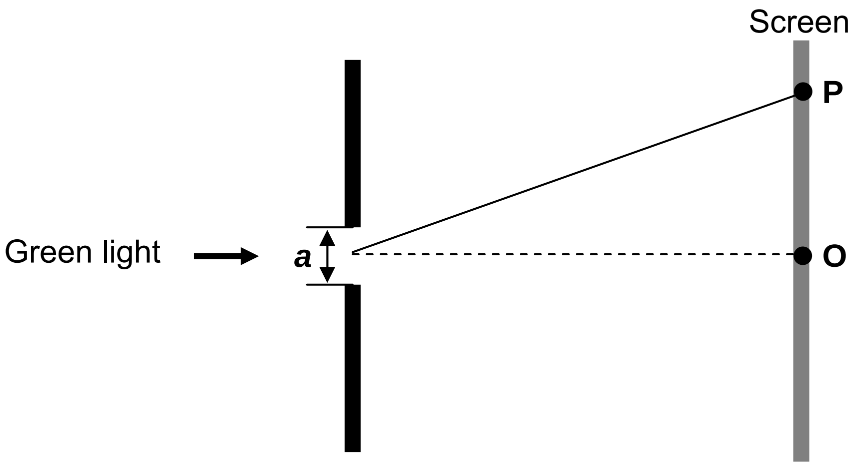
B 3*v* east

C *v* east

D *v* west

(2)

3.3 Green light passes through a narrow slit of width *a*. The first minimum is observed at point P on a screen as shown in the diagram below.

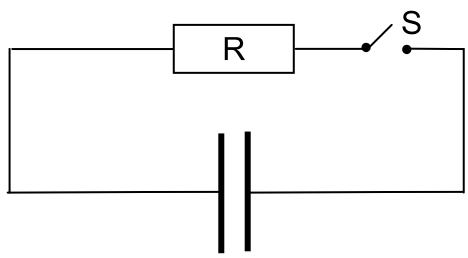


Which ONE of the following changes regarding the colour of the incident light and the width of the slit will cause the GREATEST increase in the distance OP?

	Colour of light	**Width of slit**
A	Red	2*a*
B	Red	½*a*
C	Blue	2*a*
D	Blue	½*a*

(2)

3.4 A fully charged capacitor is connected to a resistor *R* in a circuit, as shown below.

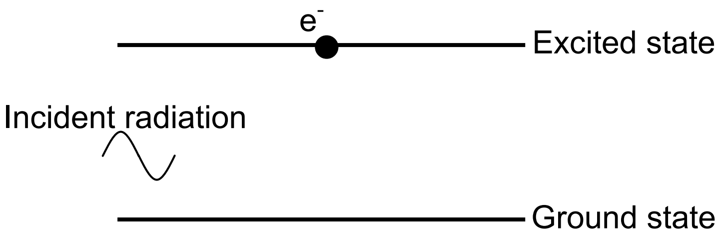


Which ONE of the following correctly describes the changes in the current, I, in the circuit and the potential difference, *V*, across the capacitor when the switch S is closed?

	I	***V***
A	Decreases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Increases	Increases

(2)

3.5 The diagram below represents part of the process of stimulated emission in a laser. An electron in an atom of the lasing material is shown in the excited state, with radiation incident on the lasing material.



The radiation emitted by the electron when dropping to the ground state will be …

A in phase and in the same direction as the incident radiation.

B in phase and opposite in direction to the incident radiation.

C out of phase and in the same direction as the incident radiation.

D out of phase and opposite in direction to the incident radiation. (2)
[10]

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 4.1 and QUESTION 4.2.

3. The formulae and substitutions must be shown in ALL calculations.

4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

The following extract comes from an article in a school newspaper.

THE LAWS OF PHYSICS ARE ACCURATE!

Two construction workers, Alex and Pete, were arguing about whether a smaller brick would hit the ground quicker than a larger brick when both are released from the same height.

Alex said that the larger brick should hit the ground first. Pete argued that the smaller brick would hit the ground first.

4.1 Are their statements correct? Give a reason for your answer. (3)

4.2 A group of Physical Sciences learners decide to test Alex's and Pete's hypotheses. They drop two bricks, one small and the other much larger, from one of the floors of the school building.

4.2.1 Write down TWO precautions they should take to ensure that the result is reliable. (2)

4.2.2 Give a reason why, despite all the necessary precautions, they might not get the correct result. (1)

4.3 In another experiment, the learners **drop** a brick A from a height of 8 m. After 0,6 s, they **throw** a second brick B downwards from the same height. Both bricks, A and B, hit the ground at the same time.

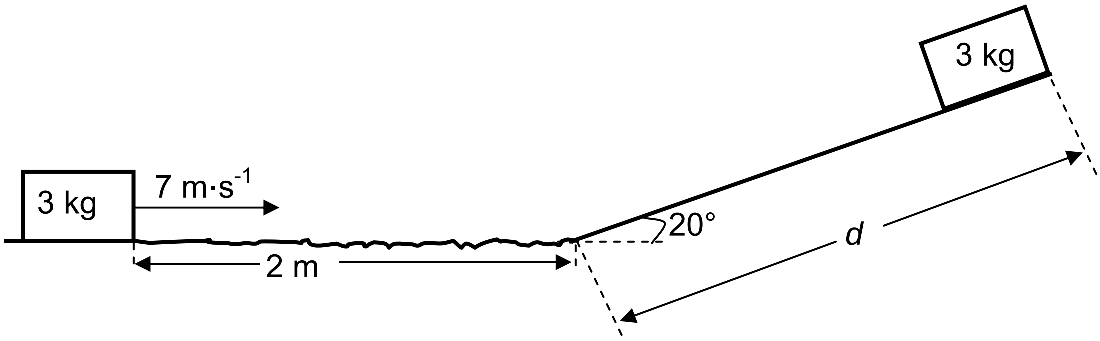
Ignore the effects of friction and calculate the speed at which brick B was thrown. (7)

[13]

QUESTION 5 (Start on a new page.)

A 3 kg block slides at a constant velocity of 7 m·s^{-1} along a horizontal surface. It then strikes a rough surface, causing it to experience a constant frictional force of 30 N. The block slides 2 m under the influence of this frictional force before it moves up a frictionless ramp inclined at an angle of 20° to the horizontal, as shown in the diagram below.

The block moves a distance *d* up the ramp, before it comes to rest.



5.1 Show by calculation that the speed of the block at the bottom of the ramp is 3 m·s^{-1}. (5)

5.2 Draw a free-body diagram to show all the forces acting on the block in a direction parallel to the incline, whilst the block is sliding up the ramp. (2)

5.3 Calculate the distance, *d*, the block slides up the ramp. (5)
[12]

QUESTION 6 (Start on a new page.)

A man of mass 87 kg on roller skates, moving horizontally at constant speed in a straight line, sees a boy of mass 22 kg standing directly in his path. The man grabs the boy and they both continue in a straight line at 2,4 m·s^{-1}.

6.1 Calculate the man's speed just before he grabs the boy. Ignore the effects of friction. (4)

6.2 Is the collision elastic? Use a calculation to support your answer. (6)

6.3 After grabbing the boy, they both continue at a velocity of 2,4 m·s^{-1} along a straight line until they arrive at a loose gravel surface near the end of the path. They now move at constant acceleration in a straight line through the loose gravel for 2 m before coming to rest.

Calculate the magnitude of the force exerted by the gravel surface on the man and the boy. (5)
[15]

QUESTION 7 (Start on a new page.)

A fire truck, with its siren on, is moving at 20 $m.s^{-1}$ towards a burning building. A person standing next to the road with a detector, measures the frequency of the sound emitted by the siren to be 450 Hz. The measured frequency is HIGHER than the frequency of the sound emitted by the siren.

7.1 Is the fire truck moving toward or away from the person? (1)

7.2 Explain why the registered frequency is higher. (2)

7.3 Calculate the frequency of the siren if the speed of sound in air is 340 $m{\cdot}s^{-1}$. (4)
[7]

QUESTION 8 (Start on a new page.)

Before the Industrial Revolution, the range of colours available for art and decorative uses was limited. Pigments were harvested from natural sources such as plants, animal waste, insects and minerals.

Blue and purple, derived from a pigment in a scarce stone, came to be associated with royalty, because only the rich could afford it. Carmine, a red pigment, was produced from harvested, dried and crushed insects in Mexico. It became one of the region's most valuable export products, providing jobs for many of the local inhabitants.

However, the discovery and production of chemical pigments made clothes and paints in colours such as red, blue and purple accessible and affordable to everybody.

[Adapted from: *Wikipedia*]

8.1 Define the term *pigment.* (2)

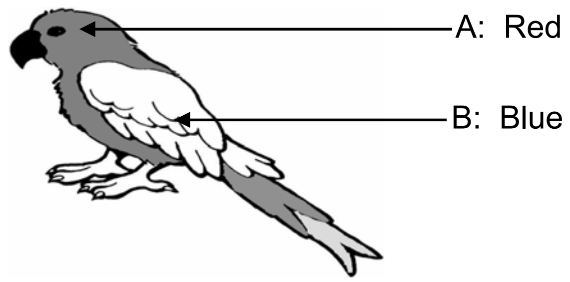
8.2 The production of chemical pigments was beneficial to some people, but not to others. Explain this statement by referring to information from the passage. (2)

8.3 Which colour model, ADDITIVE or SUBTRACTIVE, explains the mixing of pigments? (1)

8.4 An artist has only the following three different colours of paint:

MAGENTA, YELLOW, CYAN

A picture of a parrot is to be painted in the colours shown below.



Suggest how the artist can mix the above THREE colours to paint the various parts of the parrot. Only write down the letters (A and B) and next to each the colour(s) that she must mix. (2)

8.5 A car owner requested a panel beater to paint the door of her car the same green colour as the rest of the car. On receiving her car, she left the workshop satisfied that the colour of the paint used on the door is exactly the same as the colour of the paint used on the rest of the car. However, when she viewed the car outside in the sunlight, she observed that the door was not painted green, but cyan.

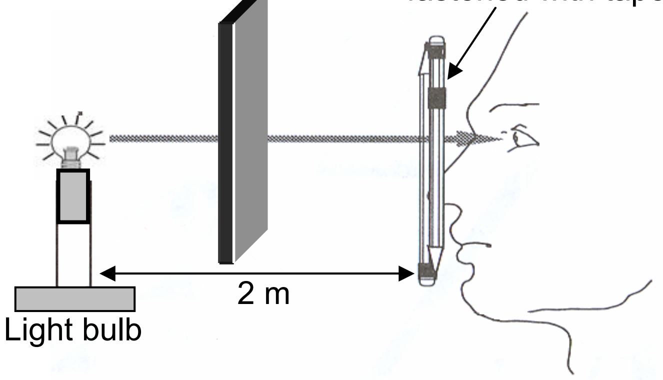
What colour of lighting was used in the workshop to have made her perceive the door as green in the workshop? Explain how you arrived at your answer. (3)

[10]

QUESTION 9 (Start on a new page.)

A learner uses a white light bulb, two pencils and a red filter to investigate a wave phenomenon.

He places the red filter in front of the light bulb and fastens the two pencils together with tape. He then observes the light bulb through the narrow gap between the two pencils from a distance of 2 m, as shown below.



9.1 Name the wave phenomenon investigated by the learner. (1)

9.2 The learner notes the following observations in his practical book:

Observation 1:
Red and dark bands of different widths are observed on either side of the central red band.

Observation 2:
When the two pencils are brought closer together, the red lines become broader.

Observation 3:
When the red filter is removed, spectral colours are observed on either side of the central band.

9.2.1 Write down Huygens's principle. (2)

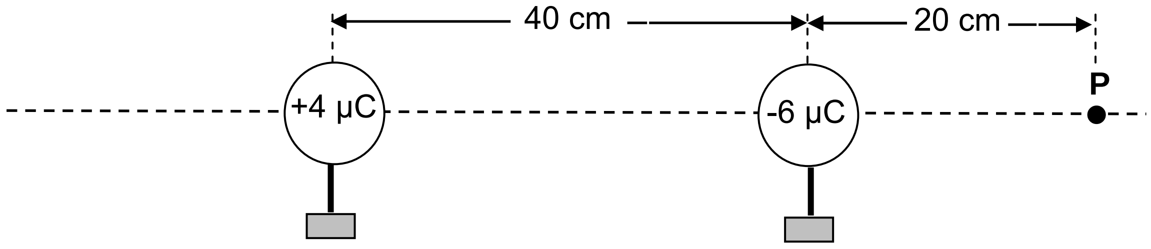
9.2.2 Use Huygens's principle to explain the occurrence of red and dark bands in Observation 1. (2)

9.2.3 Give a reason for Observation 2. (2)

9.2.4 Explain the formation of the spectral colours in Observation 3. (2)
[9]

QUESTION 10 (Start on a new page.)

Two metal spheres on insulated stands carry charges of +4 μC and -6 μC respectively. The spheres are arranged with their centres 40 cm apart, as shown below.



10.1 Calculate the magnitude of the force exerted by each sphere on the other. (4)

10.2 By what factor will the magnitude of the force in QUESTION 10.1 change if the distance between the spheres is halved? (Do not calculate the new value of the force.) (1)

10.3 Calculate the net electric field at point P as shown in the diagram above. (6)

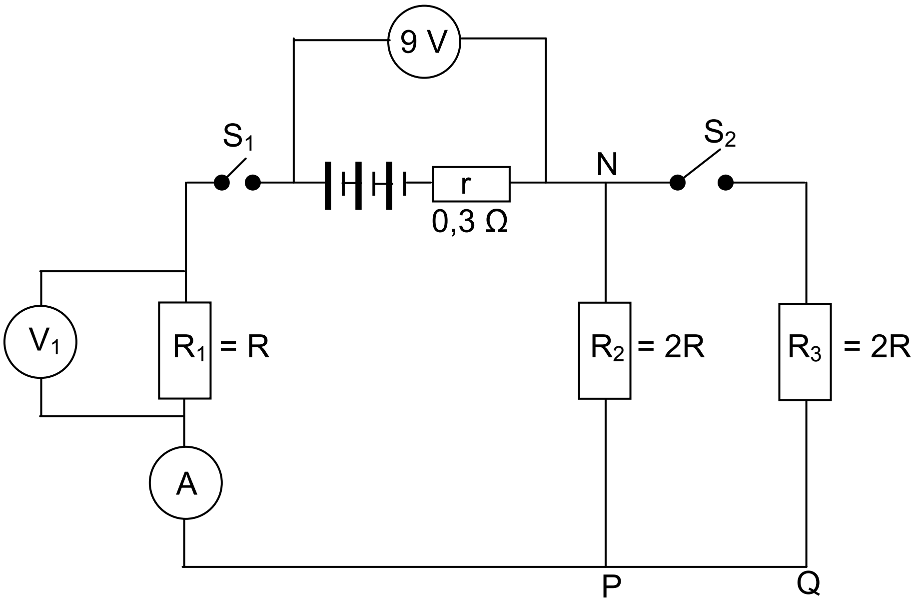
10.4 The spheres are now brought into contact with each other and then returned to their original positions. Now calculate the potential energy of the system of two charges. (5)

[16]

QUESTION 11 (Start on a new page.)

Three resistors, R_1, R_2 and R_3, are connected to a battery, as shown in the circuit diagram below. The internal resistance of the battery is 0,3 Ω. The resistance of R_2 and R_3 is equal. The resistance of R_1 is half that of R_2.

When both switches are open, the voltmeter across the battery reads 9 V.



11.1 What is the value of the emf of the battery? Give a reason for your answer. (2)

11.2 When **only switch S_1 is closed**, the reading on the ammeter is 3 A. Calculate the resistance of R_1. (5)

11.3 Both switches S_1 and S_2 are now closed.

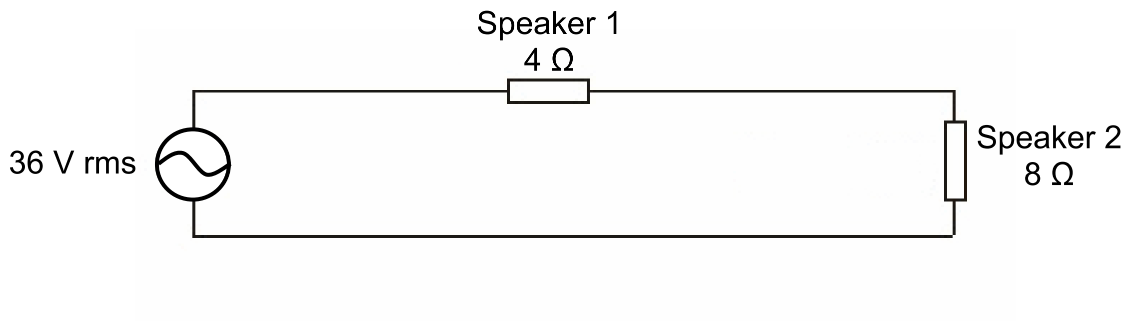
11.3.1 How will the resistance of the circuit change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.3.2 A conducting wire of negligible resistance is connected between points Q and N. What effect will this have on the 'lost volts'? Explain the answer. (3)

[11]

QUESTION 12 (Start on a new page.)

A source provides an rms potential difference of 36 V to a 4 Ω and an 8 Ω speaker connected in series, as shown in the diagram below.



12.1 Calculate the following:

12.1.1 rms current through the 4 Ω speaker (3)

12.1.2 Peak current through each speaker (3)

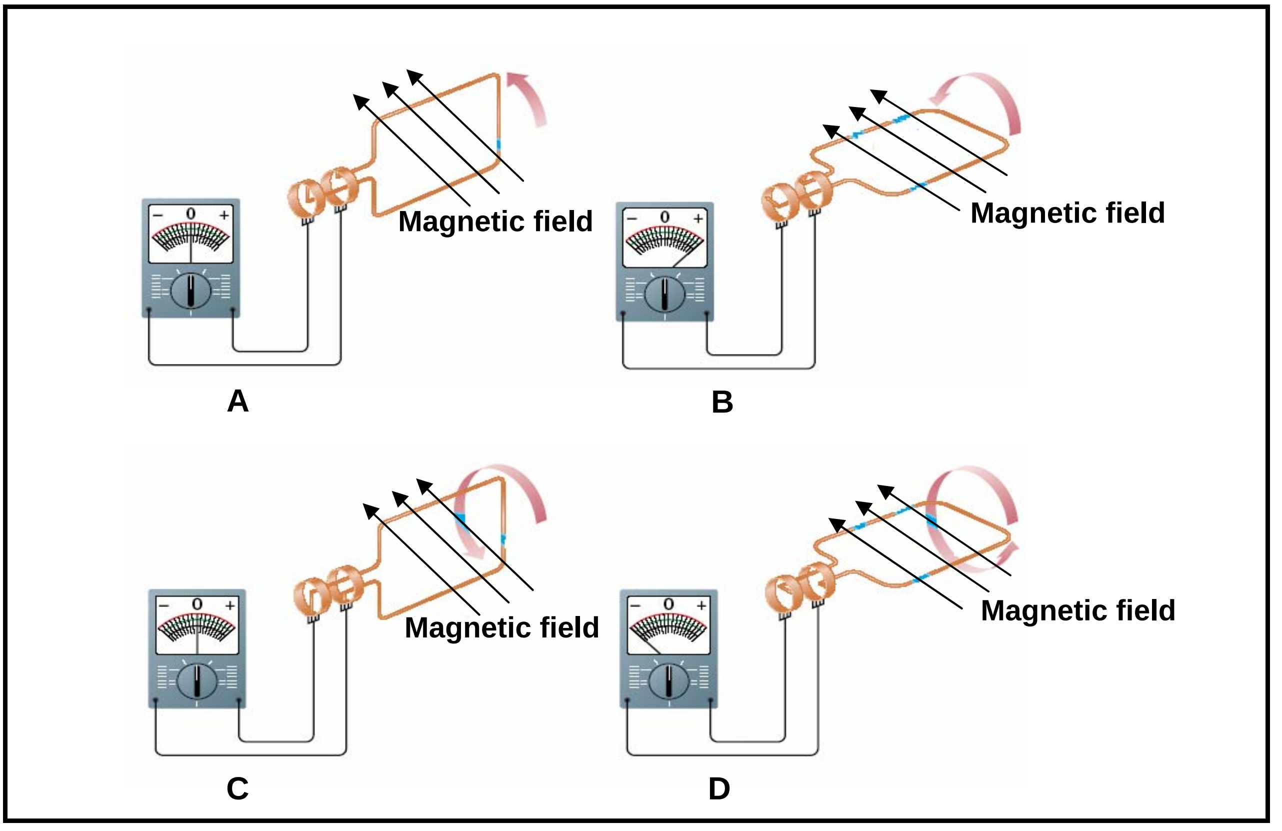
12.1.3 Average power dissipated by the 4 Ω speaker (3)

12.2 Without using a calculation, state how the average power dissipated by the 4 Ω speaker compares with the power dissipated by the 8 Ω speaker. Give a reason for the answer. (3)

[12]

QUESTION 13 (Start on a new page.)

The diagrams A to D below show four positions in sequence during the anti-clockwise rotation of the coil of a simple AC generator.



13.1 Name the fundamental principle on which generators work. (1)

13.2 What is the purpose of the slip rings in an AC generator? (1)

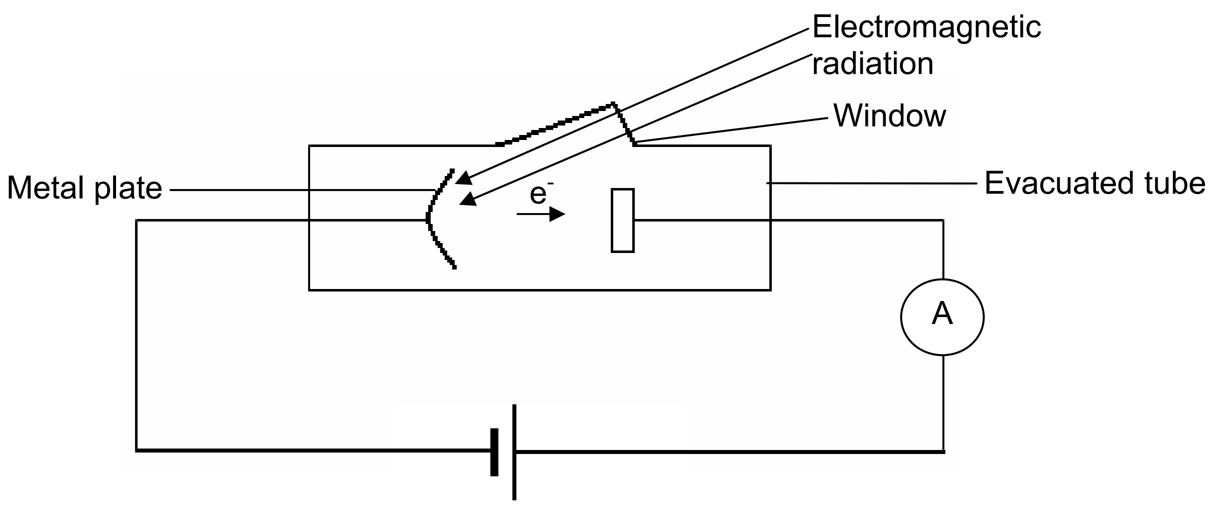
13.3 By referring to the relative positions of the coil in positions A to D, draw the corresponding graph of potential difference versus time for one full rotation (A to D to A). Indicate the positions of the coil (by using the letters A to D) on your graph. (3)

13.4 Name ONE way in which the induced emf of a specific generator can be increased. (1)

13.5 Which component in a DC generator makes it different from an AC generator? (1)
[7]

QUESTION 14 (Start on a new page.)

The diagram below shows a metal plate that emits electrons when a certain frequency of electromagnetic radiation is incident on it. The plate is connected to a source of potential difference and an ammeter as shown in the circuit below.



14.1 Name the phenomenon described above. (1)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

14.2 Define the term *work function* of a metal. (2)

14.3 Calculate the work function of this metal. (6)

14.4 How will the reading on the ammeter change if the intensity of the electromagnetic radiation is increased? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your answer. (3)

14.5 Incident radiation with a longer wavelength is now used. How will the reading on the ammeter change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

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 *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	$8,85 \times 10^{-12}\ F\cdot m^{-1}$

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*

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

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

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

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$

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*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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