



# education

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Department:  
Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2009**

**MARKS: 150**

**TIME: 3 hours**

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



**INSTRUCTIONS AND INFORMATION**

1. Write your examination number and centre number in the appropriate 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 SECTIONS A and 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 in the ANSWER BOOK.

**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 rate of change of momentum (1)
- 1.2 Motion of an object near the surface of the earth under the influence of the earth's gravitational force alone (1)
- 1.3 The phenomenon that causes dispersion of white light when it passes through a triangular prism (1)
- 1.4 The law which relates the current in a resistor, maintained at constant temperature, to the potential difference across its ends (1)
- 1.5 The source of an intense narrow beam of coherent monochromatic light (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.

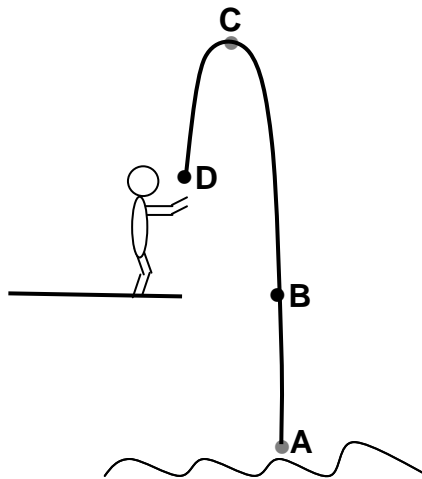
- 2.1 The work done by a non-zero net (resultant) force on an object, moving on a horizontal plane, is equal to the change in the potential energy of the object. (2)
- 2.2 When a bird, flying at a velocity of  $10 \text{ m}\cdot\text{s}^{-1}$  east, encounters a wind blowing at  $8 \text{ m}\cdot\text{s}^{-1}$  west, its velocity relative to an observer on the ground is  $18 \text{ m}\cdot\text{s}^{-1}$  west. (2)
- 2.3 The number of bright bands per unit length observed in an interference pattern on a screen, will increase when the wavelength of the waves passing through a double slit increases. (2)
- 2.4 A lamp functioning at peak voltage (AC) will glow with the same brightness when connected to a battery of the same voltage (DC). (2)
- 2.5 Monochromatic light has photons of different energies. (2)
- [10]**



**QUESTION 3: 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 (3.1 – 3.5) in the ANSWER BOOK.

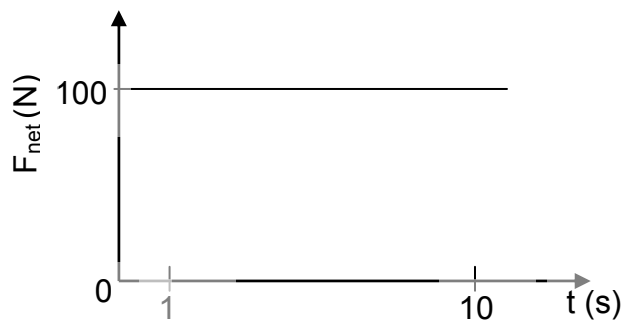
- 3.1 A person dives from a high platform into a pool. At which ONE of the positions A, B, C or D will the magnitude of his momentum be a maximum?



- A Position A  
B Position B  
C Position C  
D Position D

(2)

- 3.2 The sketch graph below may be used to calculate the impulse of a constant net force of 100 N that acts on an object over a period of time.



Which ONE of the following can be used to calculate the impulse (in  $\text{kg}\cdot\text{m}\cdot\text{s}^{-1}$ ) of the force for the time interval  $t = 1 \text{ s}$  to  $t = 10 \text{ s}$ ?

- A  $100 \times 1$   
B  $100 \times 10$   
C  $100 \times 9$   
D  $10 \times 9$

(2)



3.3 A listener moves at constant velocity towards a stationary source of sound. The frequency of sound heard by the listener is higher than the frequency of the sound emitted by the source, because ...

- A the wavelength observed by the listener becomes shorter.
- B the wavelength observed by the listener becomes longer.
- C more wave fronts reach the listener per second.
- D less wave fronts reach the listener per second.

(2)

3.4 A potential difference  $V$  is applied across two identical, parallel plates a distance  $y$  apart, as shown in the diagram below. The magnitude of the electric field between the plates is  $E$ .



Which ONE of the following changes to the above arrangement will result in an electric field of magnitude  $2E$ ?

	Potential difference	Distance between plates
A	$2V$	$2y$
B	$2V$	$\frac{1}{2}y$
C	$V$	$2y$
D	$V$	$\frac{1}{2}y$

(2)

3.5 A line emission spectrum is formed when electrons in an atom, that moves from ...

- A higher to lower energy levels, emit energy as light.
- B higher to lower energy levels, absorb light energy.
- C lower to higher energy levels, emit energy as light.
- D lower to higher energy levels, absorb light energy.

(2)

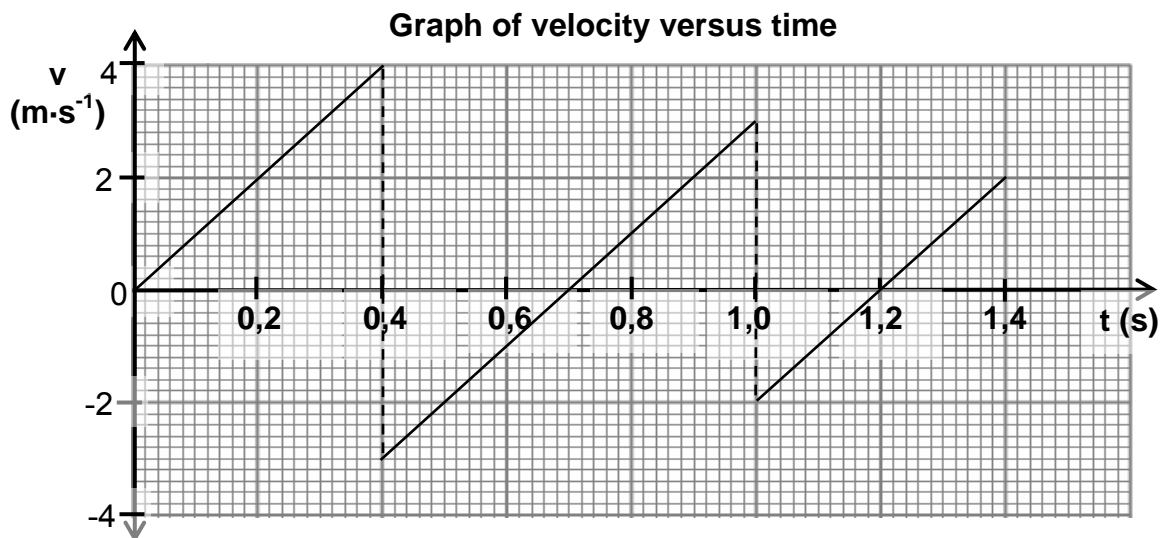
**[10]****TOTAL SECTION A: 25**

**SECTION B****INSTRUCTIONS AND INFORMATION**

1. Answer this section in the ANSWER BOOK.
2. Start each question on a NEW page.
3. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.
4. The formulae and substitutions must be shown in ALL calculations.
5. Round off your answers to TWO decimal places, where applicable.

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

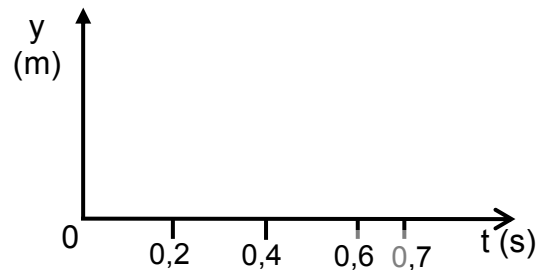
A ball is released from a certain height. The velocity-time graph below represents the motion of the ball as it bounces vertically on a concrete floor. The interaction time of the ball with the floor is negligibly small and is thus ignored.



- 4.1 Describe the changes, if any, in velocity and acceleration of the ball from  $t = 0$  s to  $t = 0,4$  s. (4)
- 4.2 Without using the equations of motion, calculate the height from which the ball has been dropped initially. (4)



4.3 Copy the set of axes below into your ANSWER BOOK.



Use the given velocity versus time graph for the motion of the ball to sketch the corresponding position-time graph for the time interval 0 s to 0,7 s.

(3)

4.4 Is the first collision of the ball with the floor elastic or inelastic? Give a reason for your answer.

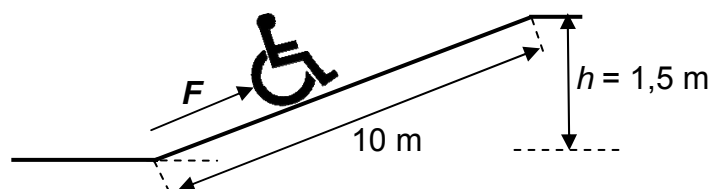
(2)

**[13]**

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

John applies a force  $F$  to help his friend in a wheelchair to move up a ramp of length 10 m and a vertical height of 1,5 m, as shown in the diagram below. The combined mass of his friend and the wheelchair is 120 kg. The frictional force between the wheels of the wheelchair and the surface of the ramp is 50 N. The rotational effects of the wheels of the wheelchair may be ignored.

The wheelchair moves up the ramp at constant velocity.



5.1 What is the magnitude of the net force acting on the wheelchair as it moves up the ramp? Give a reason for your answer.

(2)

5.2 What is the magnitude of the net work done on the wheelchair on reaching the top of the ramp?

(1)

5.3 Calculate the following:

5.3.1 Work done on the wheelchair by force  $F$

(5)

5.3.2 The magnitude of force  $F$  exerted on the wheelchair by John

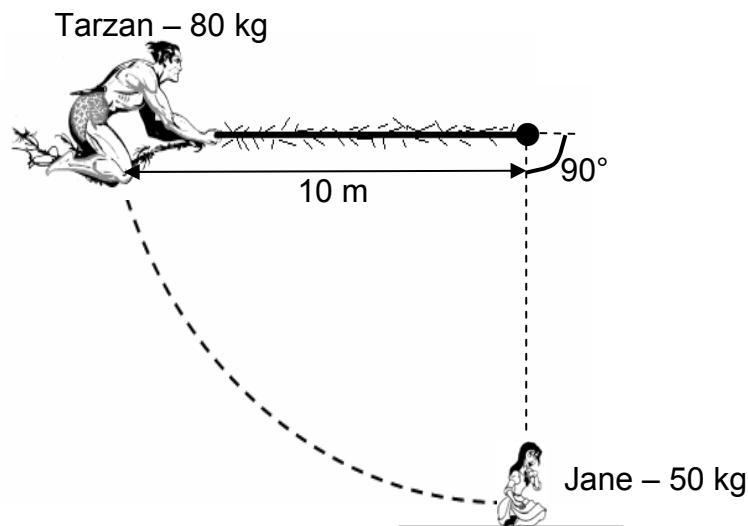
(4)

**[12]**

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

Tarzan, of mass 80 kg, swings from rest on a rope of length 10 m that is horizontal when he starts, as shown in the diagram below. At the bottom of his swing, he picks up Jane, sitting on the ground, in an inelastic collision. Jane has a mass of 50 kg. They then swing upwards as one unit.

The mass of the rope and the effects of air friction may be ignored.



- 6.1 State the principle of conservation of linear momentum in words. (2)
- 6.2 Calculate the combined speed of Tarzan and Jane just after he picks her up. (8)
- 6.3 Will Tarzan and Jane reach a height of 10 m on their upward swing? Give a reason for your answer. (2)
- 6.4 If Jane is holding on to a bag of bananas at the time when Tarzan picks her up, how will their combined speed compare to that obtained in QUESTION 6.2? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (2)

**[14]**



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

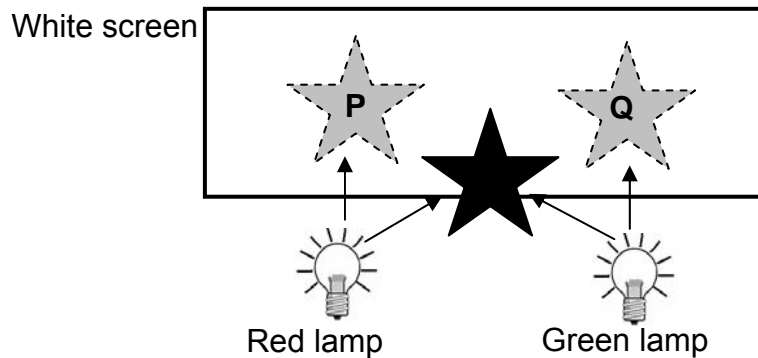
The siren of a police car produces a sound of frequency 420 Hz. A man sitting next to the road notices that the pitch of the sound changes as the car moves towards and then away from him.

- 7.1 Write down the name of the above phenomenon. (1)
- 7.2 Assume that the speed of sound in air is  $340 \text{ m}\cdot\text{s}^{-1}$ . Calculate the frequency of the sound of the siren observed by the man, when the car is moving towards him at a speed of  $16 \text{ m}\cdot\text{s}^{-1}$ . (4)
- 7.3 The police car moves away from the man at constant velocity, then slows down and finally comes to rest.
- 7.3.1 How will the observed frequency **compare** with the original frequency of the siren when the police car moves away from the man at constant velocity? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (2)
- 7.3.2 How will the observed frequency **change** as the car slows down whilst moving away? Write only INCREASES, DECREASES or REMAINS THE SAME. (2)
- [9]**



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

- 8.1 During a practical investigation, a learner shines light from a red lamp and a green lamp onto a wooden star. Coloured shadows of the star, P and Q, appear on a white screen behind the star as shown below.



- 8.1.1 What colour is observed for each of the coloured shadows P and Q? (2)
- 8.1.2 What colour is observed on the rest of the screen? (1)

The learner adds a third lamp to the above arrangement. He observes a third coloured shadow right behind the wooden star. The background on the screen appears white.

- 8.1.3 What is the colour of the third lamp? Give a reason for your answer. (2)

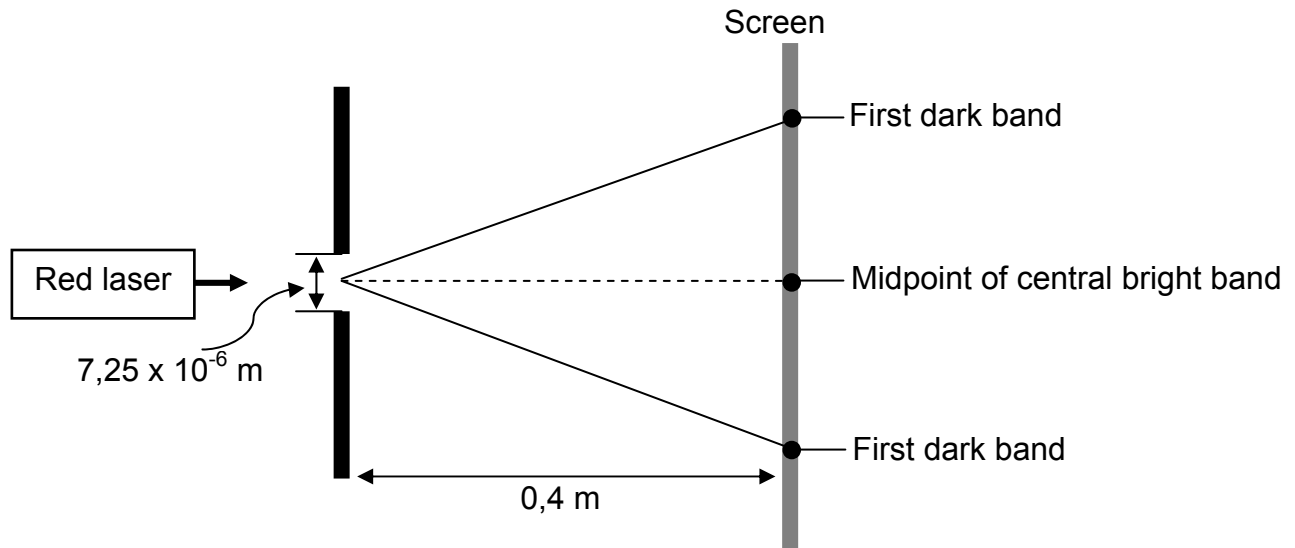
- 8.2 With repeated washing, white fabrics become yellowish. A manufacturer of a certain detergent adds blue dye to the detergent and claims that it makes your fabric whiter by removing these yellow stains.

- 8.2.1 Define the term *complementary colours*. (2)

- 8.2.2 It is possible that the dye does not really remove the yellow stains, although it makes the fabric end up looking whiter. Explain how this may be the case. (3)
- [10]**

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

A learner uses a single slit to determine the wavelength of a red laser light. He sets up the slit and screen as shown below and shines the laser through the single slit of width  $7,25 \times 10^{-6}$  m. The distance between the screen and the slit is 0,4 m.



- 9.1 Name the type of pattern observed on the screen. (1)
- 9.2 State ONE safety precaution that the learner must take when using the above apparatus. (1)
- 9.3 The learner measures the distance between the midpoint of the central bright band and the first dark band as 3,5 cm. Calculate the wavelength of the red laser light. (5)
- 9.4 The learner wants to decrease the distance between the midpoint of the central bright band and the first dark band. What change can the learner make to the above arrangement to achieve this? Assume that the same laser is used. (1)
- [8]**

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

The ability of capacitors to store charge makes them essential components in electrical appliances. Users are often warned of the dangers associated with capacitors inside appliances.

- 10.1 Briefly explain why it can be dangerous to touch a charged capacitor. (2)
- 10.2 A certain parallel plate capacitor consists of two identical aluminium plates, each of area  $2 \times 10^{-4} \text{ m}^2$ . The plates are separated by a distance of 0,03 mm, with air occupying the space between the plates.
- 10.2.1 Calculate the capacitance of the capacitor. (4)
- 10.2.2 Calculate the charge stored on the plates of the capacitor when connected to a 6 V battery. (3)
- 10.3 How will the capacitance of the capacitor in QUESTION 10.2 change (INCREASES, DECREASES or REMAINS THE SAME) if:
- 10.3.1 Paper is used to fill the gap between the plates instead of air (1)
- 10.3.2 The distance between the plates is increased (1)
- [11]**

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

Deaths associated with lightning in South Africa are about four times higher than the global average. A typical thundercloud may be at a potential of  $1,2 \times 10^8 \text{ V}$  and the thunder strike may result in a charge transfer of 20 C.

- 11.1 Define *electric current*. (2)
- 11.2 Calculate the current generated during the above thunder strike if the charge transfer takes place in  $1,1 \times 10^{-4} \text{ s}$ . (3)
- 11.3 Calculate the amount of energy transferred during the strike. (3)

Injuries caused by lightning can be reduced if the necessary precautions are taken. The following is an example of such a precaution:

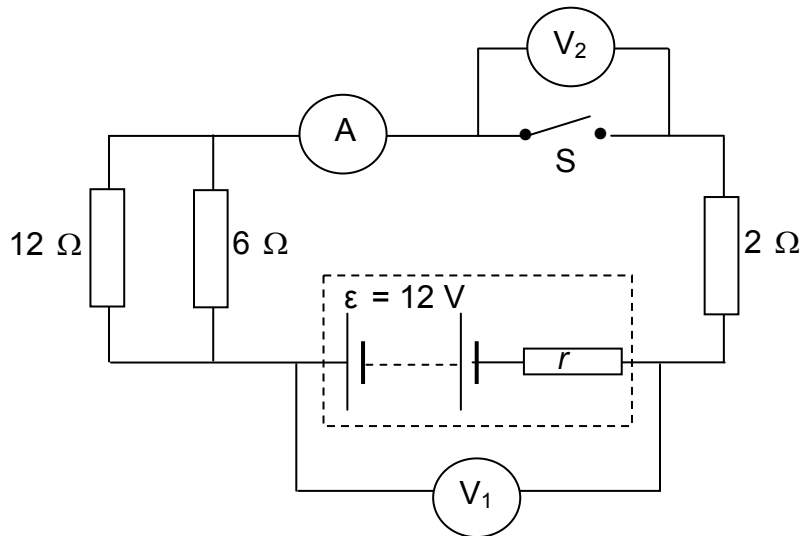
*If you are far from a shelter during lightning, crouch with your feet together.*

- 11.4 Give a reason why you must do the following:
- 11.4.1 Crouch (1)
- 11.4.2 Keep your feet together (1)
- [10]**



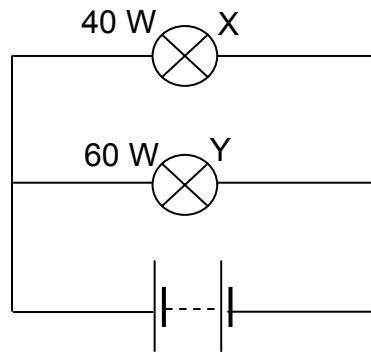
**QUESTION 12 (Start on a new page.)**

- 12.1 The battery in the circuit diagram below has an EMF of 12 V and an unknown internal resistance  $r$ . Voltmeter  $V_1$  is connected across the battery and voltmeter  $V_2$  is connected across the switch  $S$ . The resistance of the connecting wires and the ammeter is negligible.



- 12.1.1 Write down the respective readings on voltmeters  $V_1$  and  $V_2$  when switch  $S$  is open. (2)
- Switch  $S$  is now closed.** The reading on voltmeter  $V_1$  changes to 9 V.
- 12.1.2 What will the new reading on  $V_2$  be? (1)
- 12.1.3 Calculate the total **external** resistance of the circuit. (4)
- 12.1.4 Calculate the internal resistance,  $r$ , of the battery. (5)

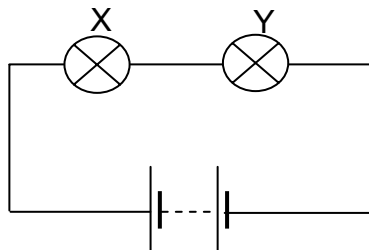
- 12.2 The circuit below shows two light bulbs, X and Y, connected in parallel to a battery with negligible internal resistance.



The bulbs are marked 40 W and 60 W respectively. Bulb Y glows brighter than bulb X.

- 12.2.1 How does the resistance of bulb Y compare to that of bulb X? Use an appropriate equation (or relationship) to explain your answer. (3)

During an experiment a learner connects these two bulbs in series to the same power supply as shown below. He observes that bulb X now glows brighter than bulb Y.



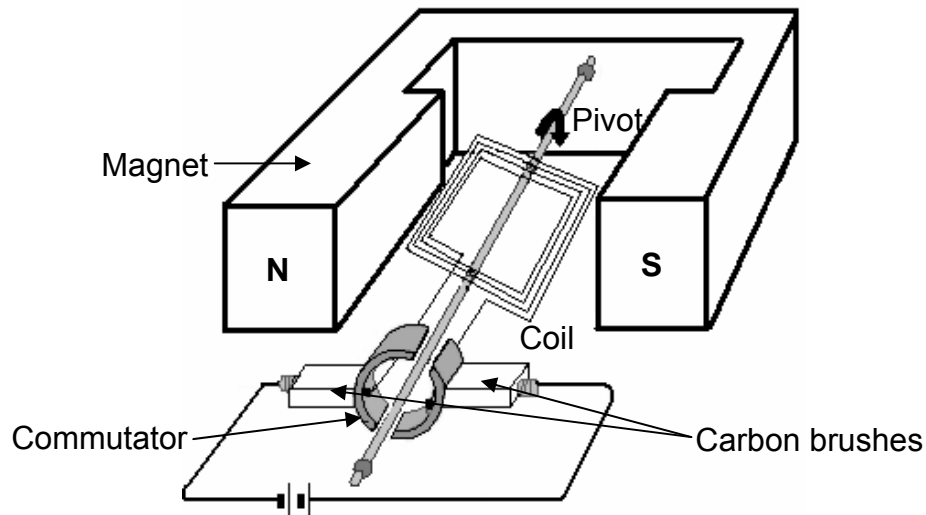
- 12.2.2 Use an appropriate equation (or relationship) to explain why bulb X now glows brighter than bulb Y. (3)

[18]



**QUESTION 13 (Start on a new page.)**

The diagram below represents a simplified sketch of an electric DC motor.

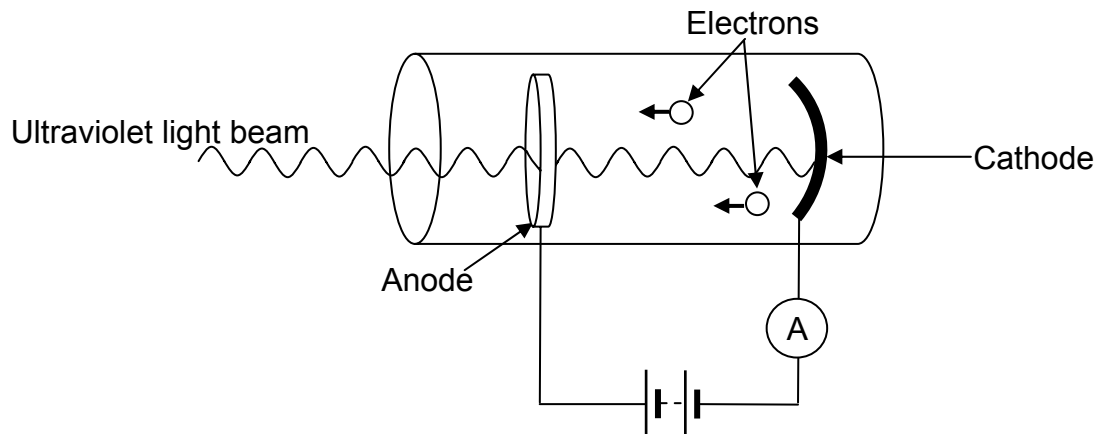


- 13.1 Name the component which ensures continuous rotation of the coil of this electric motor. (1)
- 13.2 Name the part of the motor which becomes an electromagnet when the current flows in the motor. (1)
- 13.3 When the electric motor is connected to a 12 V DC supply, it draws a current of 1,2 A. The motor is now used to lift an object of mass 1,6 kg through a vertical height of 0,8 m at constant speed in 3 s.
- Is all the electrical energy converted to the gain in potential energy of the object? Support your answer with relevant calculations. (7)
- [9]**



**QUESTION 14 (Start on a new page.)**

The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



Ultraviolet light of wavelength 100 nm is used to illuminate the photocell. When a person interrupts the ultraviolet beam, the sudden drop in current activates a switch, which sets off the alarm.

- 14.1 Define the term *threshold frequency*. (2)
- 14.2 How will an increase in intensity of the ultraviolet light influence the ammeter reading? Write only INCREASES, DECREASES or REMAINS THE SAME. Explain your answer. (3)
- 14.3 The work function of the metal used as a cathode in the photocell is  $8,7 \times 10^{-19}$  J. Calculate the velocity at which the electrons are emitted. (6)

**[11]****TOTAL SECTION B: 125****GRAND TOTAL: 150**



**NATIONAL SENIOR CERTIFICATE  
NASIONALE SENIOR SERTIFIKAAT**

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

**FORCE/KRAG**

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

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

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

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

$v = f \lambda$ or/of $v = v \lambda$	$T = \frac{1}{f}$ or/of $T = \frac{1}{v}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/of $E = hv$ 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**

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

**ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE**

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

**ALTERNATING CURRENT/WISSELSTROOM**

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

