education

Lefapha la Thuto la Bokone Bophirima
Noordwes Departement van Onderwys
North West Department of Education
NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.

2. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK.

3 Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line open between sub-questions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round-off your FINAL numerical answers to a minimum of TWO decimal places.

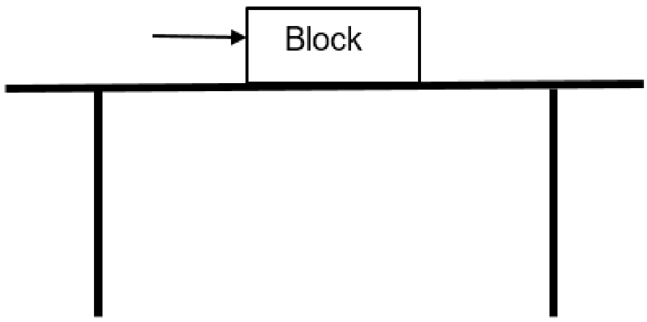
11. Give brief motivations, discussions, etc. where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g.1.11 E.

1.1 A wooden block placed on a table is pushed, causing it to accelerate. Which ONE of the following statements regarding the frictional force is correct?



The frictional force is:

A Increasing as the speed increases

B Equal and opposite to the pushing force

C Greater than the pushing force

D Less than the pushing force (2)

1.2 The kinetic energy of an object with momentum 'p' and mass 'm' is:

A 2 pm

B $\frac{p^2m}{2}$

C $\frac{p^2}{2m}$

D $\frac{pm}{2}$ (2)

1.3 The mechanical energy of a free falling body is conserved. It can be concluded that:

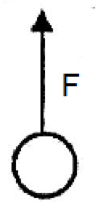
A The body experiences no air friction as it falls through the air

B The potential energy is equal to the kinetic energy at any point during the motion

C The sum of the potential and kinetic energies at any point during the motion is zero

D The work done by Earth on the body is zero throughout its fall (2)

1.4 An object, with mass m, is accelerated vertically upwards by an applied force **F** acting on it. Ignore the effects of air friction.



Which ONE of the following is true for the work done by the applied force **F** and the net force **F_{net}** respectively?

	WORK DONE BY F	**WORK DONE BY Fnet**
A	$\Delta U + \Delta K$	$\frac{1}{2}mv^2$
B	$\Delta U - \Delta K$	$\frac{1}{2}mv^2$
C	$\Delta U + \Delta K$	ΔK
D	$mgh + \frac{1}{2}mv^2$	ΔU

(2)

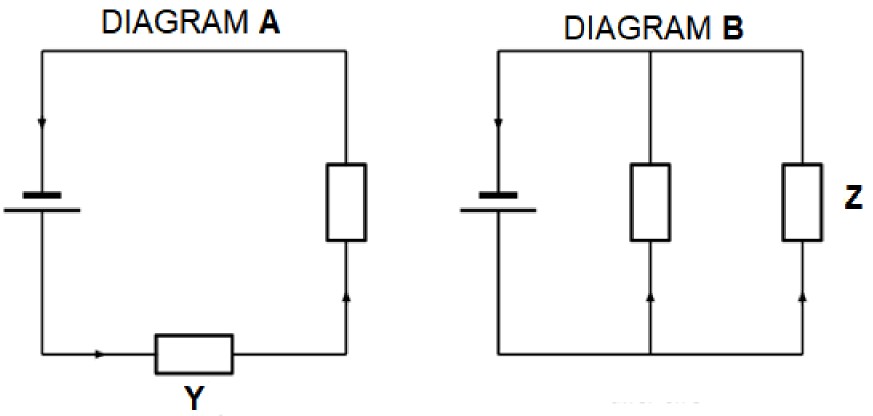
1.5 When two identical metal spheres **F** and **G** are brought in to contact and then separated, it is found that the charge on each sphere is now -5 nC.
Which ONE of the following combinations is CORRECT regarding the original charges on the spheres BEFORE they made contact?

	SPHERE F(nC)	SPHERE G (nC)
A	+25	-15
B	-7	-3
C	-5	neutral
D	-7	+2

(2)

1.6 In the circuit diagrams below, the cells are identical as well as all resistors. The resistance of the connecting wires as well as the internal resistance of the cell can be ignored.

The power dissipated in resistor **Y** in DIAGRAM **A** is P. The power dissipated in resistor **Z** in DIAGRAM **B** is...



A $\frac{1}{2}p$

B P

C 4P

D 2P (2)

1.7 The emf of a battery can be defined as the:

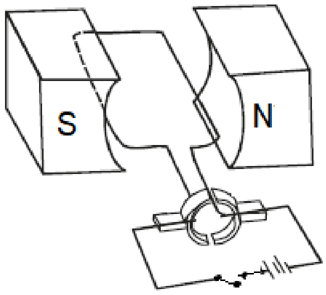
A Rate at which current is delivered

B Rate at which energy is delivered

C Product of potential difference and current

D Total amount of energy supplied per coulomb of charge in a cell (2)

1.8 The following diagram shows a simple electric motor.



When the switch is closed, the coil rotates:

A Clockwise and then anticlockwise after a half cycle

B Anticlockwise and then clockwise after a half cycle

C Continuous clockwise

D Continuous anticlockwise (2)

1.9 The theory that the universe is expanding is supported by the:

A Blue shift of light from distant galaxies

B Red shift of light from distant galaxies

C Attraction between Sun and Earth

D Rotation of Earth around Sun (2)

1.10 Metals with different work functions are illuminated with light of different frequencies and intensities. The maximum kinetic energy of photo electrons emitted by each metal depends on:

A Work function, frequency and intensity

B Work function and intensity

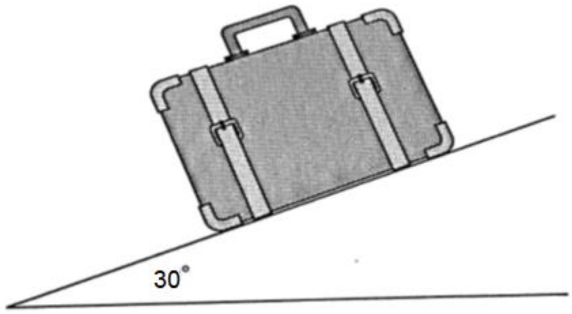
C Frequency and intensity

D Work function and frequency (2)

[20]

QUESTION 2 (Start on a new page)

2.1 The sketch below shows a large suitcase with a mass of 32 kg rests on a rough incline at an angle of 30˚ to the ground.



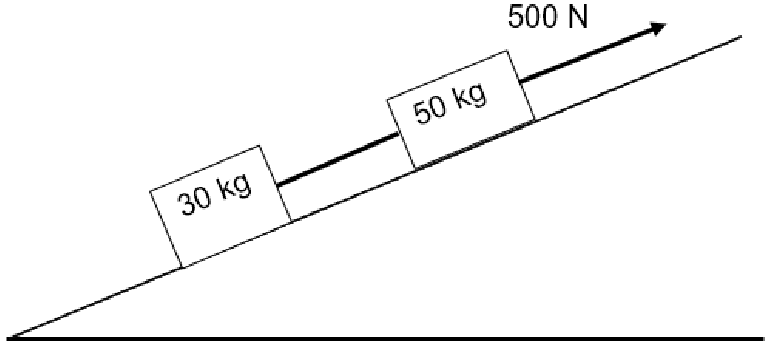
2.1.1 Define *normal* force in words. (2)

2.1.2 Draw a labelled free-body diagram of all the forces acting on the suitcase. (3)

2.1.3 Calculate the magnitude of the force of friction that keeps the suitcase stationery on the incline. (3)

2.1.4 Calculate the coefficient of static friction between the suitcase and the incline, if the suitcase is just about to move on the incline. (3)

2.2 On ANOTHER rough inclined plane, two crates 30 kg and 50 kg are connected with a strong string as in the sketch below. The angle of inclination is UNKNOWN.



The ratio of the parallel and perpendicular components of the gravitational force on each crate is **5:3**. A force of 500 N is applied as shown on the 50 kg crate so that the crates move with an acceleration of 2 $m \cdot s^{-2}$ up the incline.

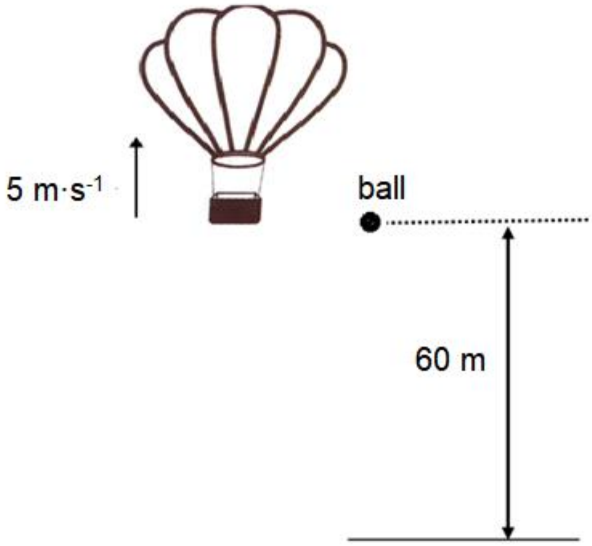
2.2.1 Calculate the magnitude of the TOTAL FRICTIONAL FORCE present. (6)

2.2.2 Calculate the magnitude of the tension in the string connecting the two crates. (2)

[19]

QUESTION 3 (Start on a new page)

A hot air balloon is rising upwards with a constant velocity of 5 $m \cdot s^{-1}$. When the balloon is 60 m above the ground, a ball is released from it and the ball falls freely.



3.1 Define the term *free fall*. (2)

3.2 What is the velocity of the ball at the moment when it is released from the balloon? (1)

3.3 Calculate maximum height reached by the ball. (4)

3.4 How far apart will the ball and the balloon be, 3 s after the ball is released? (6)

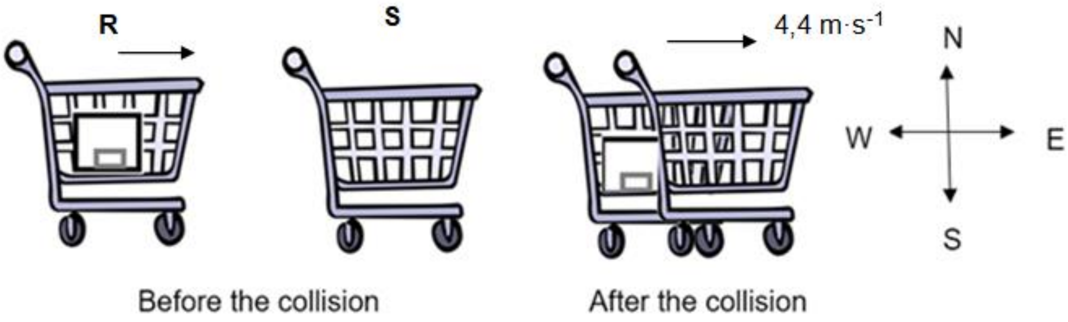
The ball hits the ground, bounces vertically upwards to a height of 8 m above the ground. It falls back to the ground and bounces again to reach a height of 5 m above the ground.

3.5 Explain why the ball does not reach the same height during the second bounce? (2)

[15]

QUESTION 4 (Start on a new page)

A trolley **R**, of mass 15 kg, travelling east collides with a stationery trolley **S** of mass 13,5 kg, and they stick together on impact. After the collision, they continue to move eastwards with a velocity of 4,4 $m \cdot s^{-1}$. Ignore the effects of friction.



4.1 State the principle of conservation of momentum in words. (2)

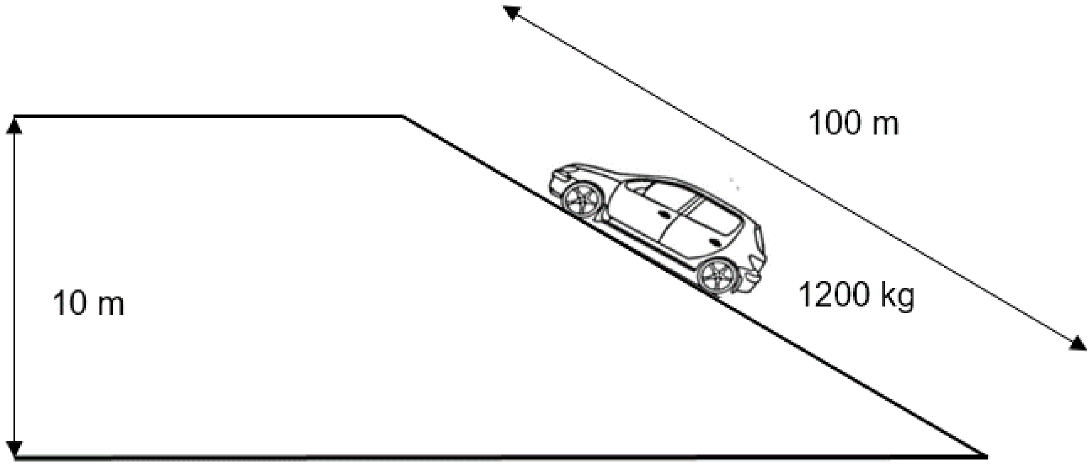
4.2 Calculate the speed of trolley **R** before collision. (3)

After the collision, the coupled trolleys enter into a rough surface and come to rest in 3 s.

4.3 Calculate the magnitude of the frictional force that brought the trolleys to rest. (4)
[9]

QUESTION 5 (Start on a new page)

A car with mass of 1200 kg and engine power of 62 kW needs to climb an incline with a constant speed of 6 m·s^{-1}.
The length of the incline is 100 m and its vertical height is 10 m. The car experiences a frictional force of 820 N while moving up the incline. Ignore the rotational effects of the wheels
of the car.



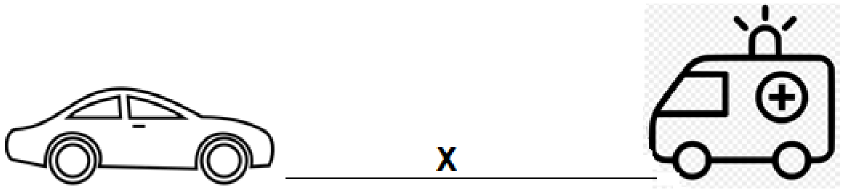
5.1 Write down the work-energy theorem in words. (2)

5.2 Draw a free body diagram of all the forces acting on the car. (4)

5.3 If the engine of the car is 83% effective, determine whether it has enough power to get to the top of the incline maintaining the constant speed of 6 m·s^{-1}. (7)
[13]

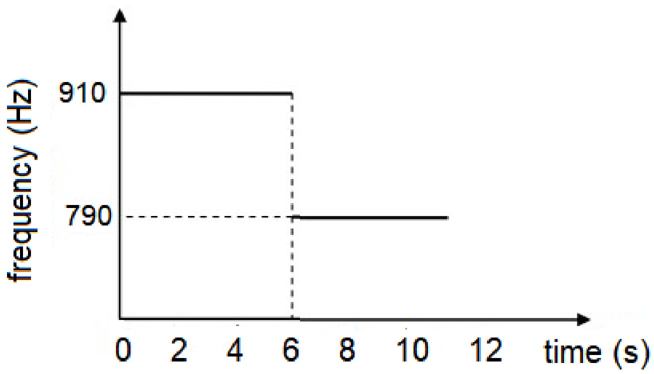
QUESTION 6 (Start on a new page)

The siren of a stationary ambulance emits sound waves at a frequency of 850 Hz. An observer who is 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 at time, t = 0



The observer continues measuring the frequency as he APPROACHES, PASSES, AND MOVES AWAY from the ambulance.

The measured frequencies are plotted against time as shown below:



6.1 State the *Doppler effect* in words. (2)

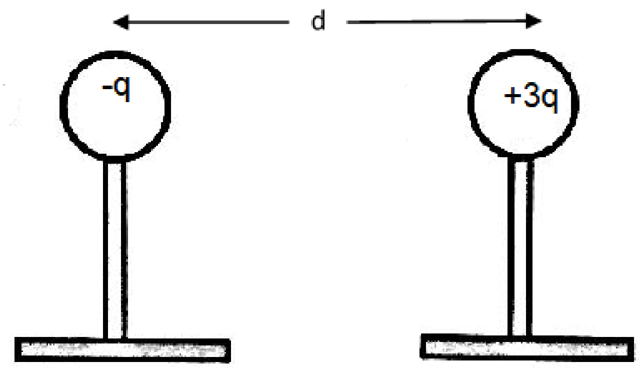
6.2 Calculate the speed of the car. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.3 Determine the distance **X** between the car and the ambulance when the observer BEGINS measuring the frequency. (3)

[10]

QUESTION 7 (Start on a new page)

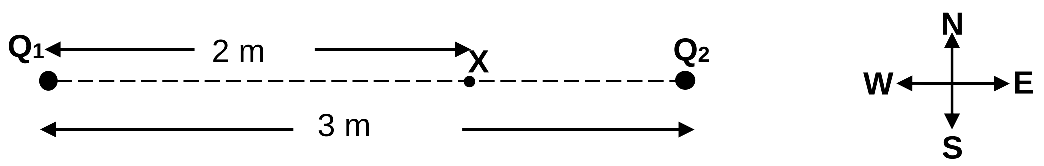
7.1 Two small identical metal spheres, on insulated stands, carry charges -q and +3q respectively. ONE sphere exerts an electrostatic force of magnitude **'F'** on the other when they are separated by a distance 'd',



7.1.1 State *Coulomb's law* in words. (2)

7.1.2 The spheres are now made to touch each other and are then brought back to the same distance d apart. By making use of suitable calculations, determine the new electrostatic force in terms of **F** that the spheres exerts each other? Show all the calculations to verify your answer. (5)

7.2 Two charges, $\mathbf{Q_1}$ with -6×10^{-9} C and $\mathbf{Q_2}$ with -8×10^{-9} C are separated by a distance of 3 m. **X** is a point between charges $\mathbf{Q_1}$ and $\mathbf{Q_2}$ and is 2 m from charge $\mathbf{Q_1}$ as shown below.

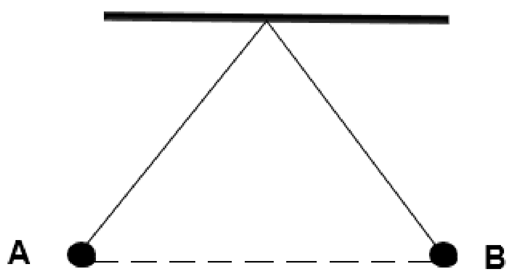


7.2.1 Calculate the magnitude of the net electric field at the point **X**. (4)

[11]

QUESTION 8 (Start on a new page)

Two small, identical positively charged balls, **A** and **B** are suspended by non-conducting threads as shown in the diagram below. Magnitude of the electrostatic force exerted on ball **A** by ball **B** is 3,23 x 10^{-5} N. The charge on each ball is 4,8 nC.



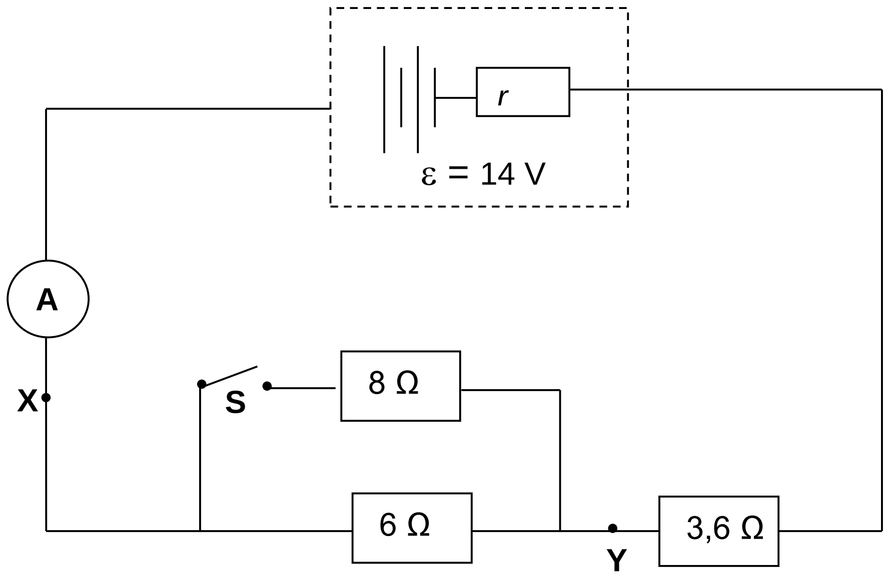
8.1 Draw electric field pattern caused by these metal balls. (2)

8.2 Calculate the electric field strength at **B** due to **A** (3)

8.3 Calculate the distance between the centres of **A** and **B** (3)
[8]

QUESTION 9 (Start on a new page)

A battery with an emf of 14 V and unknown internal resistance 'r' is connected in a circuit as shown below.



When the switch **S** is open, the ammeter reading is 1,4 A.

9.1 Calculate the:

9.1.1 Total resistance of the circuit when the switch **S** is open. (3)

9.1.2 Internal resistance of the battery. (3)

9.1.3 Energy dissipated at 6 Ω resistor in three minutes. (3)

9.2 The switch **S** is now closed. Calculate the current through 8 Ω resistor. (6)

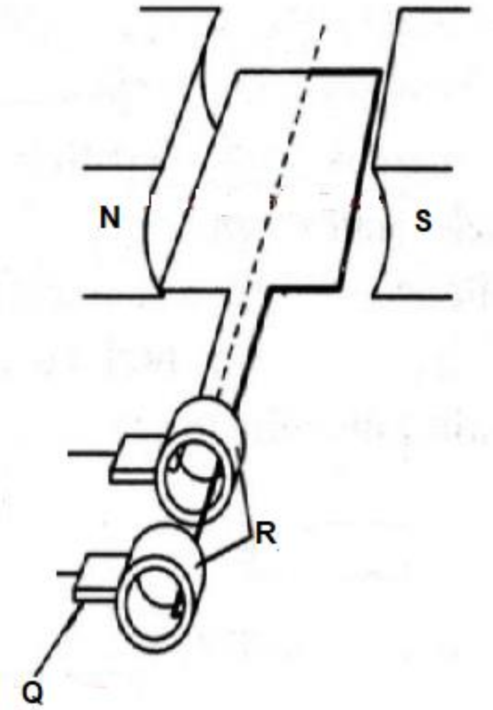
9.3 A conducting wire of negligible resistance is now connected between points **X** and **Y**. What effect will it have on the temperature of the battery?

Choose from INCREASE, DECREASE or STAYS THE SAME.

Give a reason for your answer. (2)
[17]

QUESTION 10 (Start on a new page)

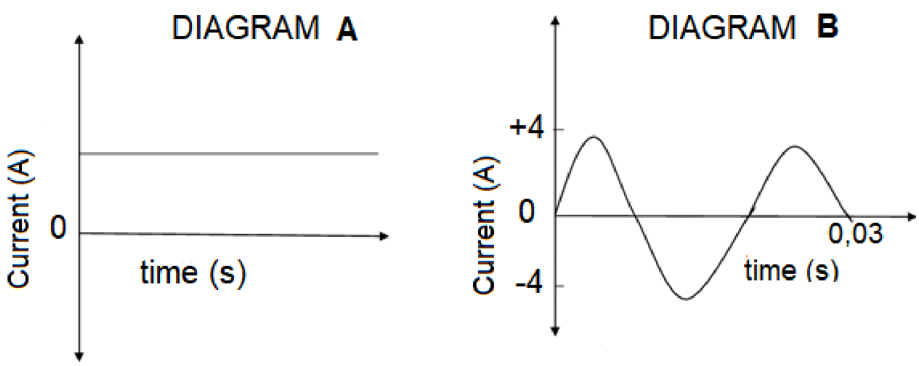
10.1 A simplified diagram of an electric generator is given below.



10.1.1 Is this an AC or a DC generator? (1)

10.1.2 Name the parts labelled **Q** and **R.** (2)

10.2 Current-time graphs from two different sources are shown in the following diagrams **A** and **B.**



10.2.1 Name the types of CURRENTS shown by diagrams **A** and **B**. (2)

10.2.2 Calculate the frequency of the current shown in diagram **B**? (2)

10.3 The rms voltage of 200 V is applied to an electric kettle of resistance 10 Ω.

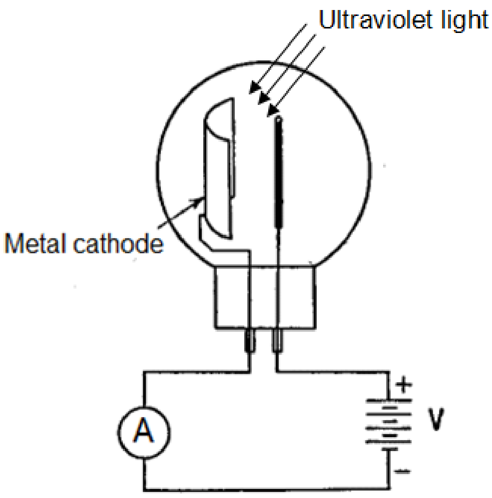
10.3.1 Calculate the peak voltage. (3)

10.3.2 Calculate the rms value of the current. (3)

10.3.3 Calculate the average power dissipated by the kettle. (3)
[16]

QUESTION 11 (Start on a new page)

The diagram below shows a photoelectric cell. An ammeter is connected as shown in the diagram.



11.1 Define the term *work function* in words. (2)

When an ultraviolet light of wavelength 200 nm falls on to the metal cathode of work function of $2{,}3 \times 10^{-19}$ J, photoelectrons are released.

11.2 Calculate the:

11.2.1 Frequency of ultraviolet light (2)

11.2.2 Threshold frequency of the metal (3)

11.2.3 Maximum kinetic energy of the photoelectron (4)

11.3 The intensity of the incident light is LOWERED. Will the reading on the ammeter INCREASE, DECREASE or STAYS THE SAME? (1)
[12]

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	$9,8 \text{ m·s}^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11} \text{ N·m}^2\text{·kg}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8 \text{ m·s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J·s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9 \text{ N·m}^2\text{·C}^{-2}$
Charge on electron *Lading op elektron*	e	$1,6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \text{ kg}$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24} \text{ kg}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6 \text{ m}$

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1m_2}{d^2}$ or/*of* $F = G\frac{m_1m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

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*

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