Western Cape Government
Education

METRO SOUTH EDUCATION DISTRICT

CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 14 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 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 between two subquestions, for example 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, et cetera where required.

12. Write neatly and legibly.

QUESTION 1 (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 (1.1–1.10) in your answer book.

1.1 A constant net force, F, is applied to a crate which moves along a frictionless horizontal surface. Which ONE the following quantities remains constant while force F acts on the crate?

A the rate of change of velocity
B the change in momentum
C the work done on the crate
D the change in kinetic energy (2)

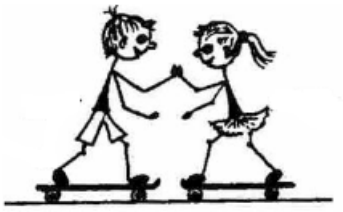
1.2 A satellite experiences a gravitational force of magnitude F on the surface of the earth. The radius of the earth is R. The satellite now circles the earth at an unknown height above the surface of the earth and experiences a gravitational force of magnitude ¼ F. This unknown height above the surface of the earth is ….

A R
B 2R
C 3R
D 4R (2)

1.3 When a light wave from a distant star is analysed it is found that this wave is “red-shifted”. This confirms that the wave experienced a…

A decrease in wavelength and increase in frequency.
B decrease in wavelength and decrease in frequency.
C increase in wavelength and decrease in frequency.
D increase in wavelength and increase in frequency. (2)

1.4 A boy, mass **2m**, and a girl, mass **m**, standing on skateboards are facing each other. They push off against one another. The boy exerts a force on the girl and the boy experiences a change in momentum to the left.



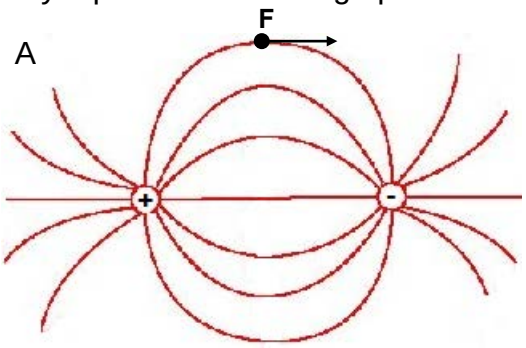
Ignore the effects of friction. Which ONE of the following best describes the magnitudes of the force exerted by the girl and her change in momentum?

	Force exerted by girl	Change in momentum of girl
A	less than the force exerted by the boy	less than the change in momentum of the boy
B	less than the force exerted by the boy	equal to the change in momentum the boy
C	equal to the force exerted by the boy	equal to the change in momentum of the boy
D	equal to the force exerted by the boy	less than the change in momentum of the boy

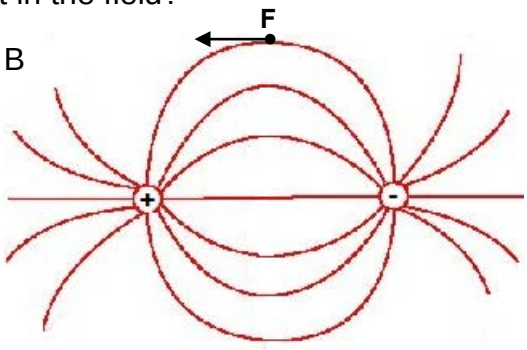
(2)

1.5 The electric field pattern of two small charged objects are shown below. Which one of the following diagrams correctly shows the force experienced by a positive test charge placed at a point in the field?

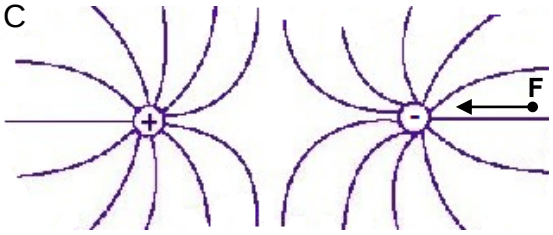
A



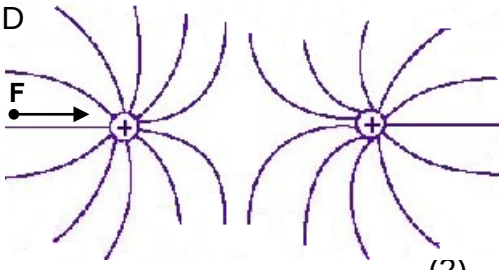
B



C

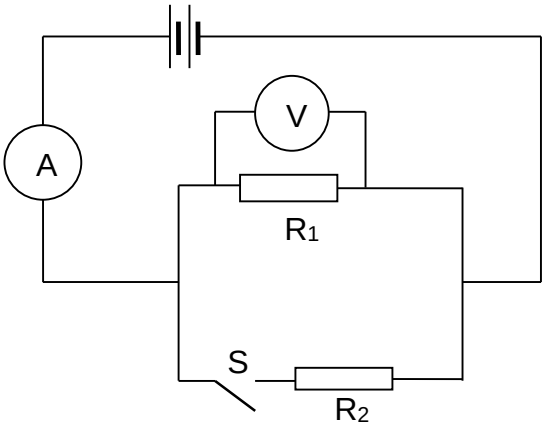


D



(2)

1.6 Consider the following electric circuit, with switch S open.

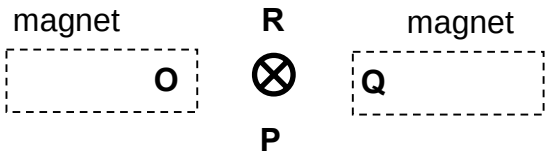


The resistors R_1 and R_2 are identical. The internal resistance of the battery in the circuit is **not** negligible. When switch S is closed, which ONE of the following gives the correct readings on the ammeter (A) and voltmeter (V)?

	READING ON AMMETER	READING ON VOLTMETER
A	decreases	remains the same
B	decreases	increases
C	increases	decreases
D	increases	remains the same

(2)

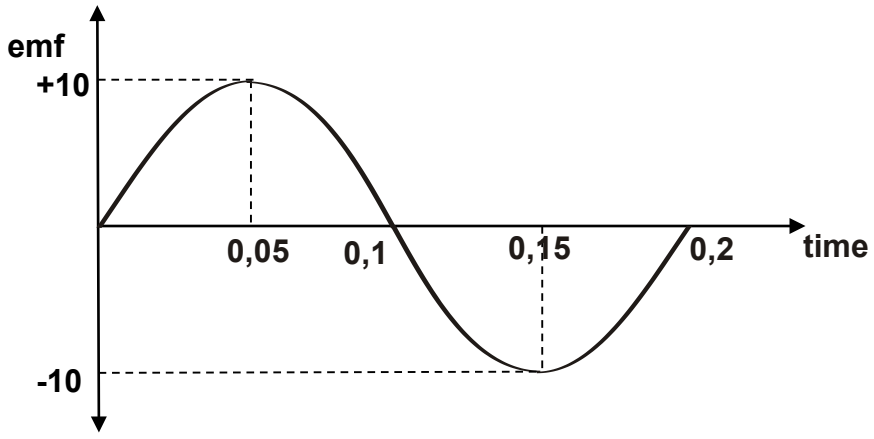
1.7 Two strong bar magnets are arranged with their poles O and Q facing each as shown in the diagram below. A current – carrying conductor carries conventional current into the plane of the paper when placed between the poles of two magnets.



If the force on the conductor is towards R then :-

A O and Q are both north poles.
B Q and O are both south poles.
C Q is a north pole and O is a south pole.
D O is a north pole and Q is a south pole. (2)

1.8 The diagram shows the variation in emf produced by a generator.



If the armature of the generator is rotated at twice the speed how will the emf and the period shown by the graph change?

	Emf	Period
A	Greater than 10 V	0,2 s
B	Greater than 10 V	0,1 s
C	Equal to 10 V	0,1 s
D	Less than 10 V	0,4 s

(2)

1.9 Which ONE of the following provides evidence that light behaves as particles?

A Light can be diffracted.
B Light is refracted by a triangular prism.
C Light ejects electrons from a metal surface.
D The speed of light decreases when it travels from air to glass. (2)

1.10 Which ONE of the following descriptions best explains the formation of a line emission spectrum?

A line emission spectrum is formed when …

A white light passes through a cold gas.
B white light passes through a triangular prism.
C electrons in the ground state move to a higher energy level.
D electrons in the excited state move to a lower energy level.

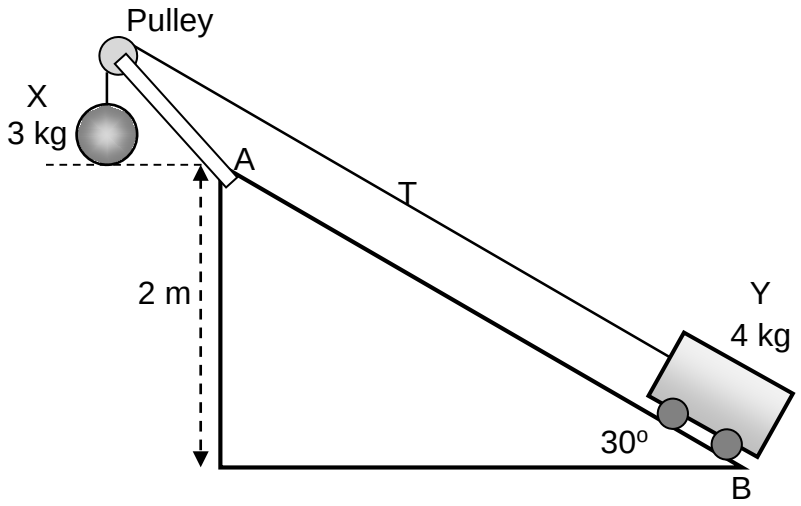
(2)

[20]

QUESTION 2 (Start on a new page)

Ball X of mass 3 kg is attached to trolley Y of mass 4 kg by a light string which passes over a frictionless pulley as shown in the diagram. Initially the trolley is at rest on a slope AB, which makes an angle of 30° with the horizontal. When the ball is released it falls to the ground and the trolley moves 2 m up the slope accelerating at 0,43 $m.s^{-2}$.

The coefficient of kinetic friction along slope AB is $\mu_k = 0,2$. (Ignore the rotation effects of the wheels and air friction.)



2.1 Draw a labelled free body diagram to show ALL the forces acting on the trolley as it moves up the slope. (4)

2.2 Show that a friction force of 6,79 N acts on the trolley as it moves up the slope. (3)

2.3 State Newton's Second Law of motion in words. (2)

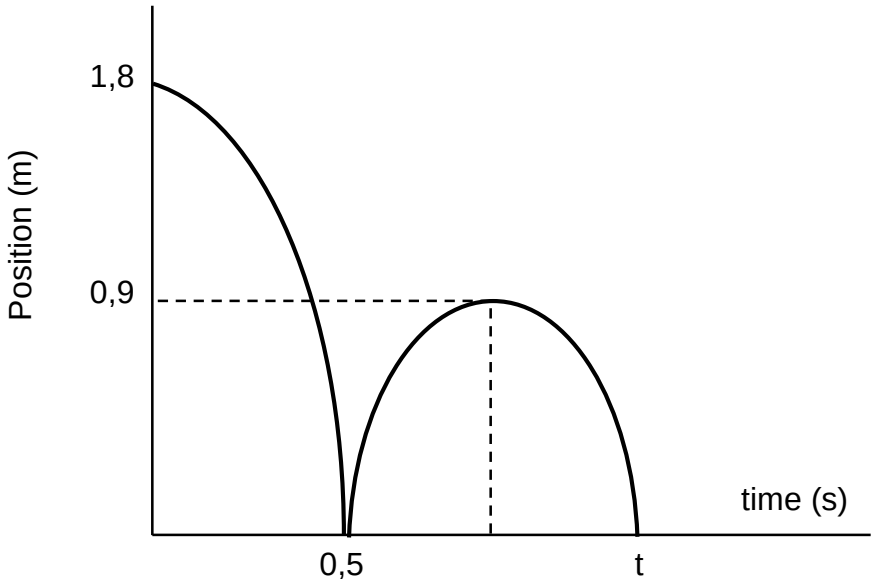
2.5 Calculate the tension T in the string. (5)

2.6 Calculate the speed with which the 3 kg ball strikes the ground. (4)

[18]

QUESTION 3 (Start on a new page)

The position-time graph is given for a ball which is thrown down from a vertical height of 1,8 m and bounces once on reaching the ground. The contact time between the ball and the floor can be ignored.



3.1 Calculate the initial velocity with which the ball was thrown. (3)

3.2 At what speed does the ball strike the ground? (3)

3.3 At what speed did the ball leave the ground after bouncing? (3)

3.4 Calculate the value of time t. (4)

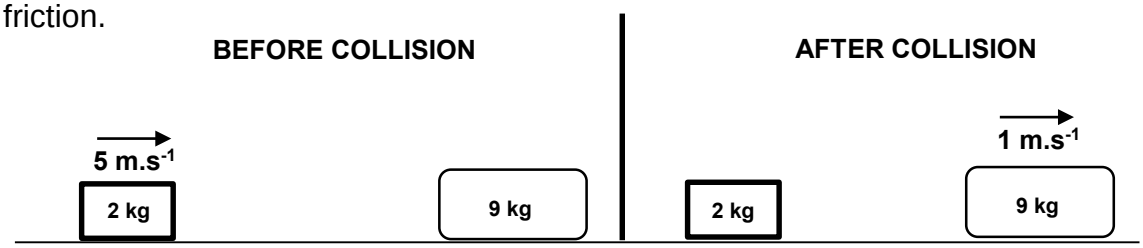
3.5 Sketch a velocity-time graph to represent the motion of the ball. Indicate the following values on the graph:

- The initial velocity at which the object was thrown.
- The velocity at which the ball strikes the ground.
- The velocity at which the ball bounces off the ground.
- The time at which the ball strikes the ground for the first time.
- The time, t, when the ball strikes the ground after the first bounce. (6)

[19]

QUESTION 4 (Start on a new page)

A wooden block of mass 2 kg, moving at a velocity of 5 $m.s^{-1}$, collides with a crate of mass 9 kg resting on a flat horizontal surface as shown in the diagram below. After the collision, the crate moves to the right at 1 $m.s^{-1}$. Ignore the effects of friction.



4.1 Write down the principle of conservation of linear momentum in words. (2)

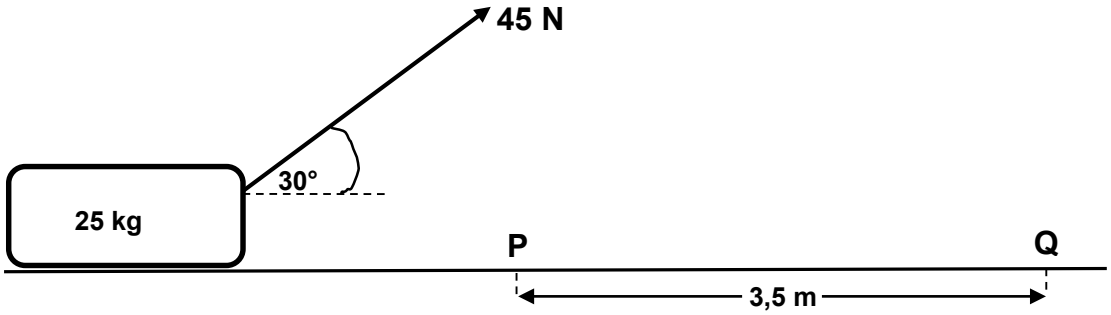
4.2 Calculate the magnitude of the velocity of the wooden block immediately after the collision. (4)

4.3 If the collision lasts 0,6 seconds, calculate the force the wooden block exerts on the crate during the collision. (4)

[10]

QUESTION 5 (Start on a new page)

A worker applies a constant force of 45 N on a crate of mass 25 kg, at an angle of 30° with the horizontal. When the crate reaches point P, its velocity is 12 $m.s^{-1}$ and 3,5 m further it reaches point Q at a velocity of 10,8 $m.s^{-1}$.



5.1 Draw a labelled free-body diagram to show the horizontal forces acting on the crate during its motion. The length of the vectors should be an indication of their relative magnitudes. (3)

5.2 Write down the NAME of the non-conservative force that opposes the forward motion of the crate. (1)

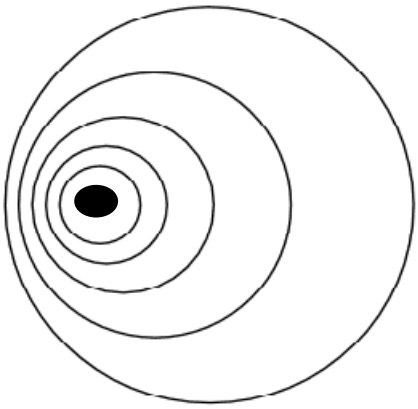
5.3 State the Work-Energy theorem in words. (2)

5.4 Use ENERGY PRINCIPLES to calculate the magnitude of the non-conservative force mentioned in QUESTION 5.2. (6)

[12]

QUESTION 6 (Start on a new page)

The diagram shows a moving source of sound wave in air.



It illustrates the Doppler Effect, a phenomenon named after the German scientist, Christian Doppler.

6.1 Explain in words, what is meant by the Doppler Effect. (2)

6.2 In which direction is the source moving, to the left or to the right? (1)

6.3 What happens to the observed frequency of the waves as the source is moving? (1)

6.4 The sound source is moving towards a stationary observer. Answer the following question by stating whether the pitch INCREASES, DECREASES or REAMINS THE SAME. What will the observer hear as the sound source…

6.4.1 moves towards the observer,
6.4.2 moves away from the observer,
6.4.3 slows down and stops. (3)

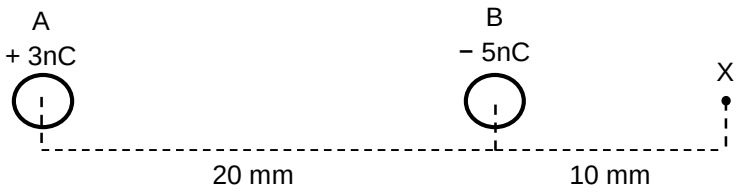
6.5 A submarine is lying motionless under water in the sea. It detects a sound coming from a moving ship. The frequency detected is 1,003 times greater than the actual frequency of the sound emitted by the ship. The speed of sound in salt water is 1 470 $m.s^{-1}$. Ignore the effects of any friction.

Calculate the velocity of the ship. (4)

[11]

QUESTION 7 (Start on a new page)

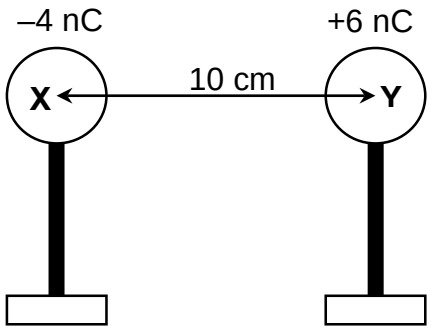
7.1 The diagram shows two point charges which are 20mm apart. A carries a charge of + 3nC and B carries a charge of – 5 nC. X is a point which is situated 10mm to the right of B.



7.1.1 Define the electric field at a point. (2)

7.1.2 Calculate the magnitude and direction of the net electric field at point X due to the presence of both A and B. (6)

7.2 Two small charged spheres, X and Y, on insulated stands are placed 10 cm apart. The charge on X is –4 nC and the charge on Y is +6 nC.



7.2.1 Draw the electric field pattern around charges X and Y. (3)

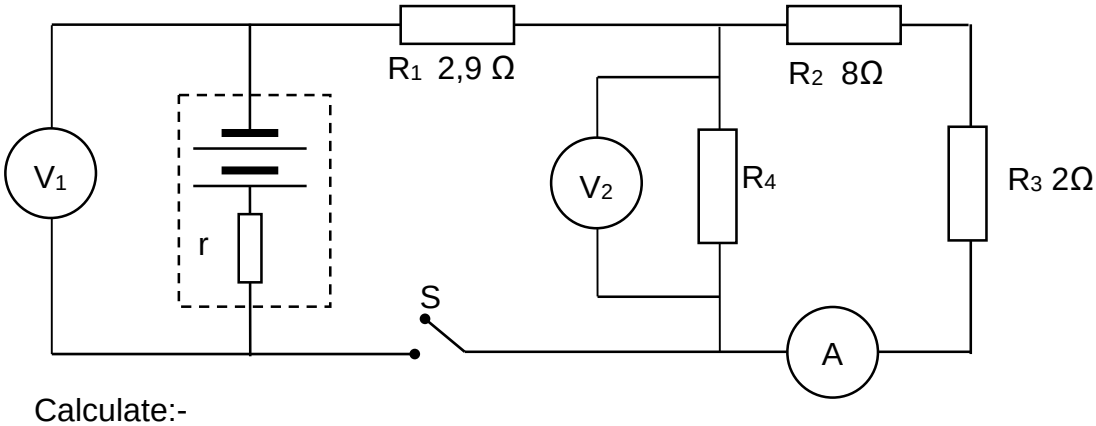
7.2.2 Calculate the magnitude of the force that X exerts on Y. (4)

7.2.3 The charged spheres are now brought into contact with each other and then separated. Calculate the charge on each sphere after separation. (2)

[17]

QUESTION 8 (Start on a new page)

In the circuit represented below, voltmeter V_1 reads 12 V when the switch is open and 10,8 V when the switch is closed. The internal resistance of the battery, r, and the resistance of resistor R_4 are unknown. When the switch S is closed, the power dissipated in resistor R_2 is 2 W.
The voltmeters have a very high resistance and the resistance of the ammeter is so small that it can be disregarded.



8.1 Calculate:-

8.1.1 The reading on the ammeter. (3)

8.1.2 The reading on voltmeter V_2. (3)

8.1.3 The current which flows through the battery. (4)

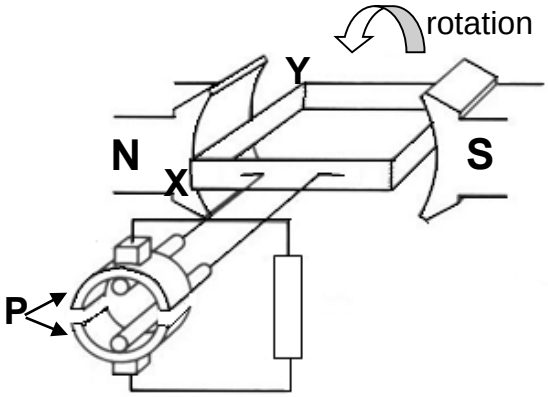
8.1.4 The internal resistance of the battery. (3)

8.2 R_4 is replaced by a conductor with negligible resistance. How will this affect the power of R_2? Write down INCREASE, DECREASE, BECOME ZERO or REMAIN CONSTANT and give a reason for answer. (2)

[15]

QUESTION 9 (Start on a new page)

In a simple generator a coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



9.1 Name the law on which a generator operates. (1)

9.2 Name component P. (1)

9.3 What is the function of component P? (1)

9.4 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (1)

9.5 Is the induced potential difference in the coil illustrated above about to increase or to decrease? Explain your answer by referring to the change in magnetic flux as the loop rotates from the horizontal to the vertical position. (3)

9.6 Draw a sketch graph of emf in the external circuit against time for one complete rotation of the armature coil, starting with the coil in the position shown. (2)

[9]

QUESTION 10 (Start on a new page)

A certain municipality implements a power decrease in the town. As a result of the power decrease the rms voltage drops from 230 V_{rms} to 210 V_{rms}.

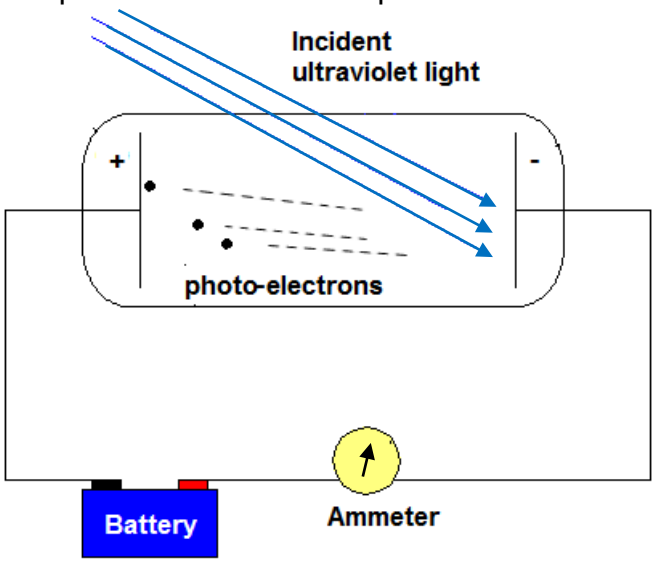
10.1 Calculate the peak voltage during the power decrease. (3)

10.2 A certain electrical appliance dissipates 1 800 W when it is operated at 230 V_{rms}. Calculate the power at which it will operate during the power decrease. (4)

[7]

QUESTION 11 (Start on a new page)

In the diagram below, photons of ultraviolet light with energy 5,6 x 10^{-19} J is incident on the cathode of a photo cell and causes photo-electrons to be emitted from the metal surface.



The threshold (cut-off) frequency of the cathode of the photocell is 7,2 x 10^{14}Hz.

11.1 Which property of light is illustrated by the photo-electric effect (1)

11.2 Define the term *threshold (cut-off) frequency* in words. (2)

11.3 Calculate the maximum kinetic energy of the emitted photo-electrons. (3)

11.4 The brightness of the ultraviolet light is now increased. How will this change affect each following? Only write down INCREASES, DECREASES or REMAINS THE SAME.

11.4.1 The kinetic energy of the emitted photoelectrons. (1)

11.4.2 The reading on the ammeter. (1)

11.5 The ultraviolet light source is now replaced with a light source of wavelength 622 nm. Will this light source be able to eject photo-electrons from the cathode of the photo-cell? Support your answer with a calculation. (4)

[12]

Total: 150 marks

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

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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