DEPARTMENT OF EDUCATION
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PROVINCIAL PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1: PHYSICS

SEPTEMBER 2019

MARKS: 150
TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions in the ANSWER BOOK.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Give brief motivations, discussions, et cetera where required.
8. Start EACH question on a NEW page.
9. Show the formulae and substitutions in ALL calculations.
10. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
11. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various possible options are provided as answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The physical quantity which is a quantitative measure of the resistance of an object to any change in its state of rest or motion is called …

A weight.

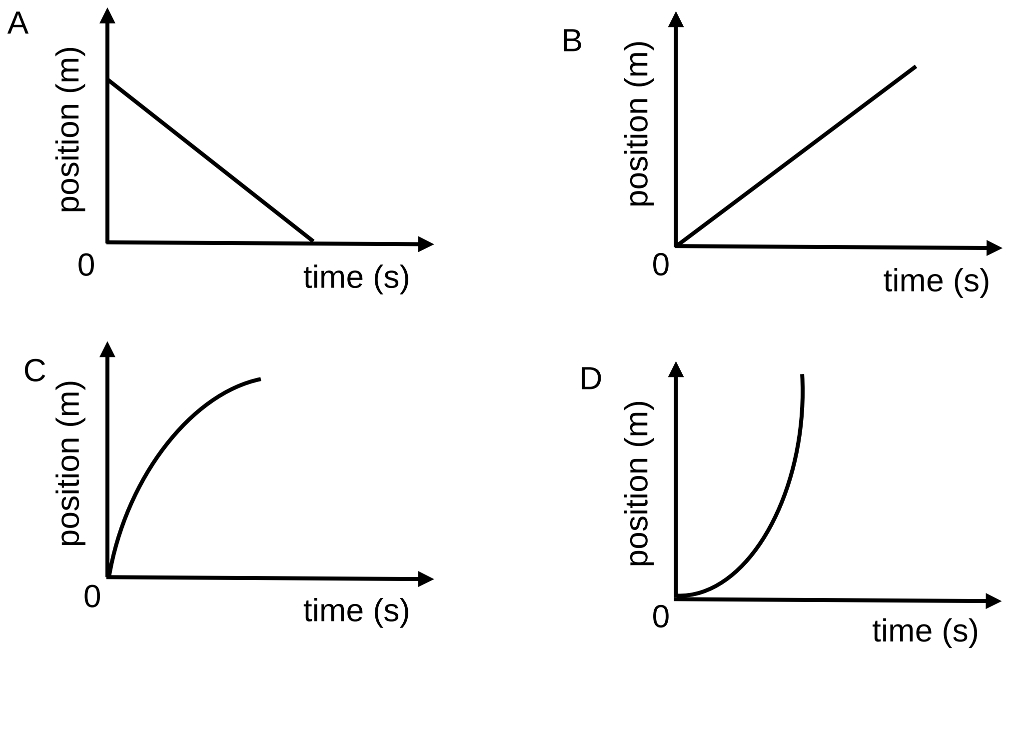
B mass.

C acceleration.

D friction. (2)

1.2 A ball is released from rest from a certain height above the ground. Ignore the effects of air resistance.

Which ONE of the following position-time graphs best represents the motion of the ball?



(2)

1.3 The kinetic energy of a car moving at constant speed v is E_K. The speed of the car changes to $\frac{1}{2}v$. What is the new kinetic energy of the car?

A $\frac{1}{4}\ E_K$

B $\frac{1}{2}\ E_K$

C $2\ E_K$

D $4\ E_K$ (2)

1.4 Two identical billiard balls, moving towards each other, collide head-on. The first ball hits the second ball with a speed v, and the second ball hits the first ball with a speed of 3v. After the collision, the first ball moves off in the opposite direction with a speed 1,5v. Which ONE of the following expressions correctly gives the speed of the second ball after the collision?

A 0,5 v

B 1,5 v

C 2 v

D 3 v (2)

1.5 A car with mass m moves at a constant velocity v and covers a distance Δx under the action of a constant frictional force f. The power required to keep the body in motion at this constant velocity is …

A $f\,\Delta x$.

B $\frac{1}{2}mv^2$.

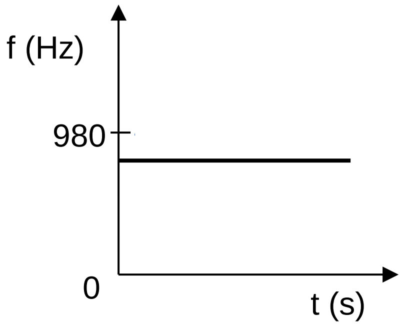
C $f\,v$.

D $f\,\Delta t$. (2)

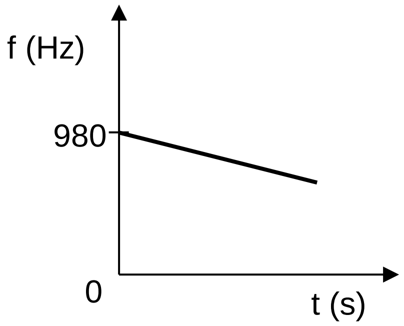
1.6 An ambulance approaches an accident scene at a constant speed of 22,67 m·s^{-1}. The siren of the ambulance emits sound waves at a frequency of 980 Hz. A stationary detector at the scene measures the frequency of the emitted sound waves.

Which ONE of the following frequency-time graphs shows the frequency measured by the detector?

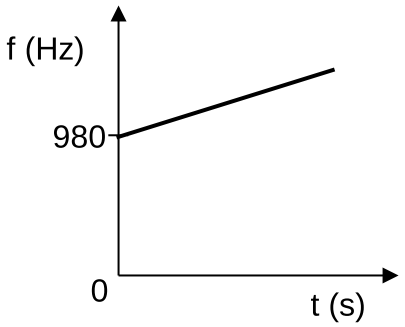
A



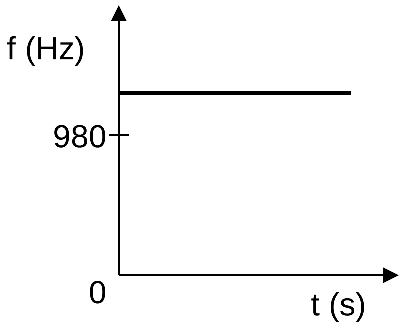
B



C

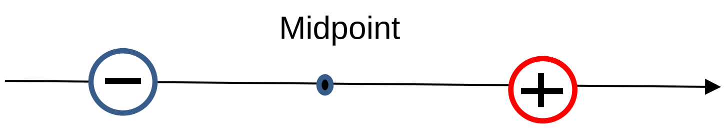


D



(2)

1.7 The sketch below shows a negative and a positive point charge. The magnitude of the positive charge is greater than that of the negative charge.



Where on the line that passes through the charges is the total electric field zero?

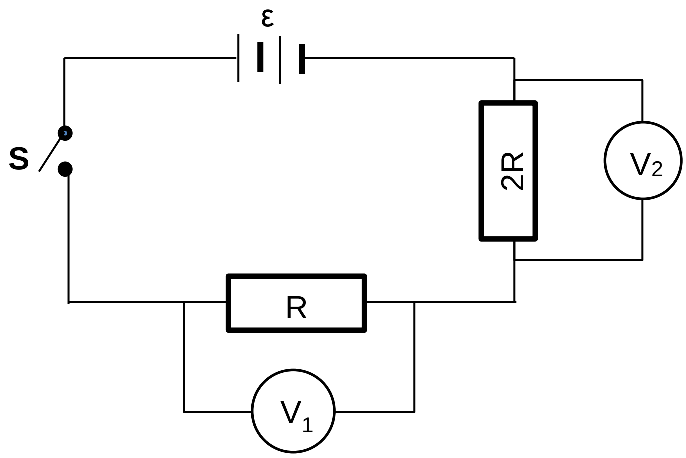
A To the right of the positive charge.

B To the left of the negative charge.

C Between the charges, to the left of the midpoint.

D Between the charges, to the right of the midpoint. (2)

1.8 In the circuit diagram below the internal resistance of the battery and the resistance of the conducting wires are negligible. The *emf* of the battery is ε.



When switch **S** is closed, the reading on voltmeter V_1 is $\frac{1}{3}\varepsilon$ and the reading on voltmeter V_2 is …

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

B $\frac{1}{3}\varepsilon$.

C $\frac{2}{3}\varepsilon$.

D ε. (2)

1.9 The component of a DC motor that ensures that the coil rotates continuously in ONE DIRECTION is the ...

A split ring.

B slip rings.

C carbon brushes.

D battery. (2)

1.10 A grade 12 learner observes a sodium vapour light bulb through a spectroscope. The spectrum observed consists of …

A two dark lines on the yellow part of the spectrum of white light.

B a full range of colours.

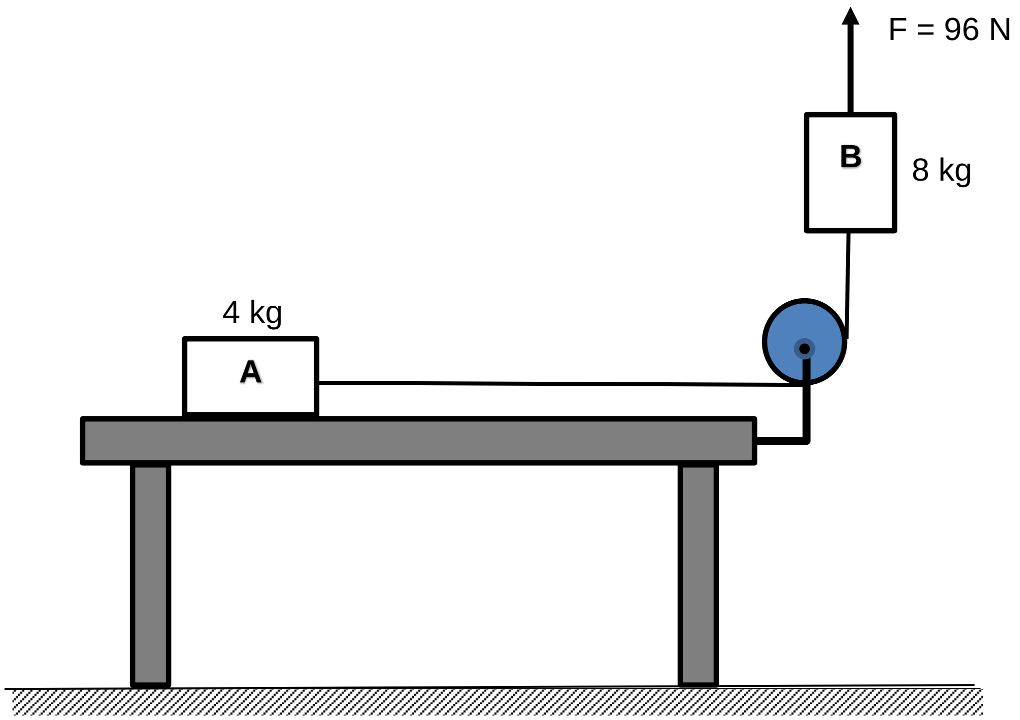
C many dark lines on the spectrum of white light.

D two yellow lines on a dark background. (2)

[20]

QUESTION 2 (Start on a new page.)

A block **A** of mass 4 kg, resting on a rough horizontal table, is connected to another block **B** of mass 8 kg by a light inextensible string which passes over a light frictionless pulley. A force of magnitude 96 N is applied vertically upwards on block **B** as shown in the diagram below.



The kinetic frictional force acting on block **A** is 11,76 N. Ignore the effects of air friction.

2.1 State *Newton's second law of motion* in words. (2)

2.2 Draw a labelled free-body diagram for block **B**. (3)

2.3 Calculate the magnitude of the:

2.3.1 Normal force acting on block **A** (3)

2.3.2 Tension force acting on block **A** (6)
[14]

QUESTION 3 (Start on a new page.)

Object **A** is dropped from a certain height and 5 s later object **B** is projected vertically downwards from the same height. Ignore air resistance.

3.1 Explain what is meant by a *projectile* in Physics. (2)

3.2 Use equations of motion to calculate the following:

3.2.1 Time taken by object **A** to reach a speed of 245 $m \cdot s^{-1}$ (3)

3.2.2 Initial velocity of object **B,** if object **A** has a velocity of 245 $m \cdot s^{-1}$ downwards when they meet. (4)

3.3 Sketch a velocity-time graph for object **B** from the moment it was projected until it reaches object **A**.

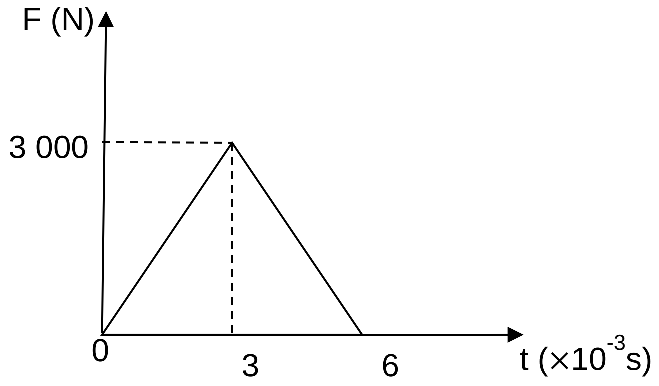
Indicate the following on the graph:

- Initial velocity
- Final velocity
- Time taken by object **B** to reach object **A** (4)

[13]

QUESTION 4 (Start on a new page.)

A 160 g cricket ball is thrown with a speed of 20 m·s^{-1}. It is hit straight back towards the cricket bowler. The contact time of the ball with the cricket bat is 6 x 10^{-3} s. The graph below represents the force exerted by the bat on the ball as a function of time.



4.1 Define *impulse* of a force in words. (2)

4.2 What is the magnitude of the maximum force exerted by the ball on the bat? (1)

4.3 What does the area under the graph represent? (1)

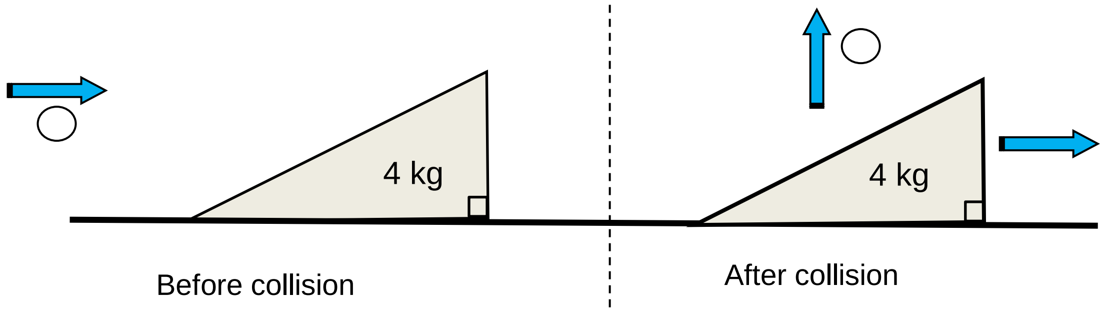
4.4 Calculate the speed with which the ball leaves the bat. (4)

4.5 While catching a ball a cricket fielder pulls his arms towards his body. Explain why this is done by using Newton's second law in terms of momentum. (3)

[11]

QUESTION 5 (Start on a new page.)

A 4 kg wooden triangle is at rest on a horizontal frictionless surface. A ball of mass 0,1 kg, thrown horizontally at 10 m·s^{-1}, collides ELASTICALLY with the wooden triangle. As a result of the collision the ball rebounds vertically upwards as shown below. Ignore air friction.



5.1 State the *law (principle) of conservation of linear momentum* in words. (2)

5.2 Explain when a collision is said to be elastic. (2)

5.3 Calculate the speed of the wooden triangle immediately after the collision. (4)

5.4 Use ONLY energy considerations to calculate the maximum height reached by the ball after colliding ELASTICALLY with the wooden triangle. (6)

After the collision the wooden triangle continues to move on the horizontal frictionless surface and then strikes a ROUGH surface. It experiences fictional force of 4,8 N when sliding across the rough surface until it comes to rest.

5.5 Use ONLY energy principles to calculate the distance covered by the wooden triangle on the ROUGH surface. (4)
[18]

QUESTION 6 (Start on a new page.)

A whistle of a locomotive, moving at a constant speed, emits a sound wave of 2 000 Hz. A man that stands on the side of the railroad hears a sound of frequency 1 836,0 Hz when the locomotive moves away from him. A girl that stands on the side of the railroad detects a sound of frequency 2 196,2 Hz when the locomotive approaches her. Use the speed of sound in air as 340 $m\cdot s^{-1}$.

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

6.2 Explain why the girl detects a sound of higher frequency as the locomotive approaches her. (3)

6.3 Will the frequency detected by the driver of the locomotive be GREATER THAN, EQUAL TO or SMALLER THAN 2 000 Hz? Give a reason for the answer. (2)

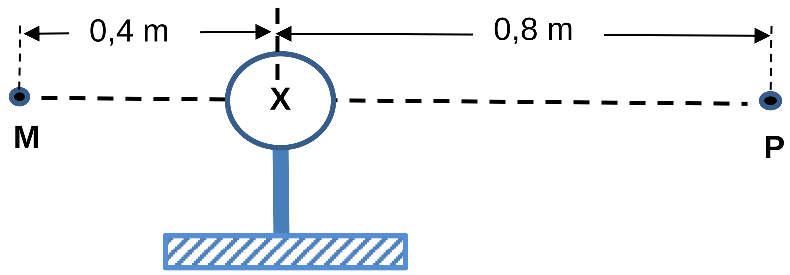
6.4 Calculate the speed of the locomotive. (5)

6.5 Write down ONE application of Doppler Effect in medicine. (1)

[13]

QUESTION 7 (Start on a new page.)

The diagram below shows a metal sphere **X** of negligible mass on an insulated stand in a vacuum. $3,125 \times 10^{10}$ electrons have been removed from the sphere.



7.1 Draw the electric field pattern associated with sphere **X**. (2)

7.2 Describe an *electric field*. (2)

7.3 Calculate the net charge on the sphere. (3)

7.4 Calculate the electric field at point **P**. (3)

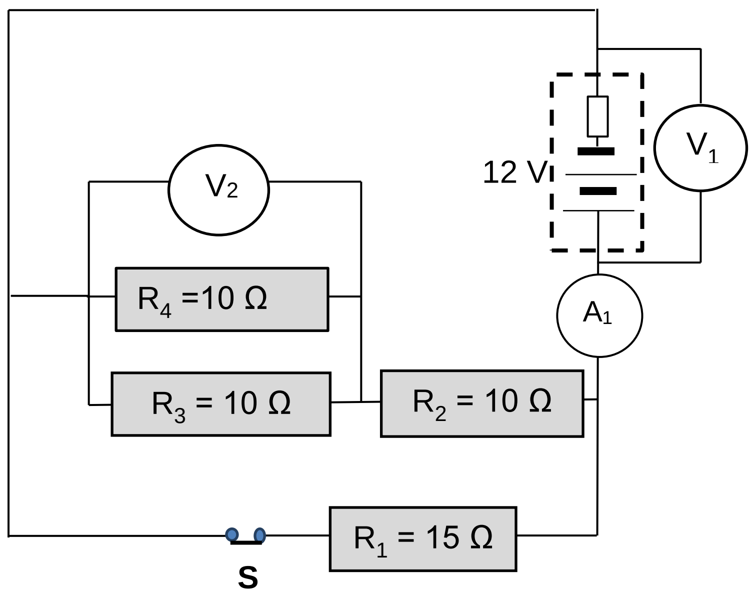
7.5 How does the magnitude of the electric field at point **M** compare with the value calculated in QUESTION 7.4? Write down only GREATER THAN, EQUAL TO or SMALLER THAN. Give a reason for the answer. (2)

7.6 A metal sphere **Y,** on an insulated stand carrying a charge of -4 nC, is now placed at point **M**. Show by calculations where a positive point charge **Q** should be placed so that it is in equilibrium. (4)

[16]

QUESTION 8 (Start on a new page.)

In the circuit diagram below the resistance of the conductors and the ammeter are negligible. The *emf* of the battery is 12 V and the internal resistance is 0,5 Ω. The switch **S** is closed.



8.1 State *Ohm's law* in words. (2)

8.2 Calculate the:

8.21 Reading on ammeter $\mathbf{A_1}$ (6)

8.2.2 Power dissipated in the 15 Ω resistor (4)

8.2.3 Reading on voltmeter $\mathbf{V_2}$ (3)

8.3 Switch **S** is now opened.

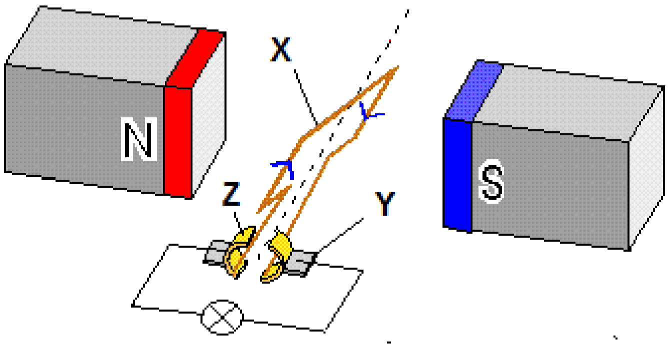
8.3.1 How will the reading on the ammeter $\mathbf{A_1}$ be affected? Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

8.3.2 How will the reading on voltmeter $\mathbf{V_1}$ be affected? Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

[21]

QUESTION 9 (Start on a new page.)

The diagram below shows a simplified version of a generator. A light bulb of 25 Ω is connected to it with wires of negligible resistance.



9.1 What type of generator (AC or DC) is represented in the diagram? (1)

9.2 State the energy conversion in generators. (1)

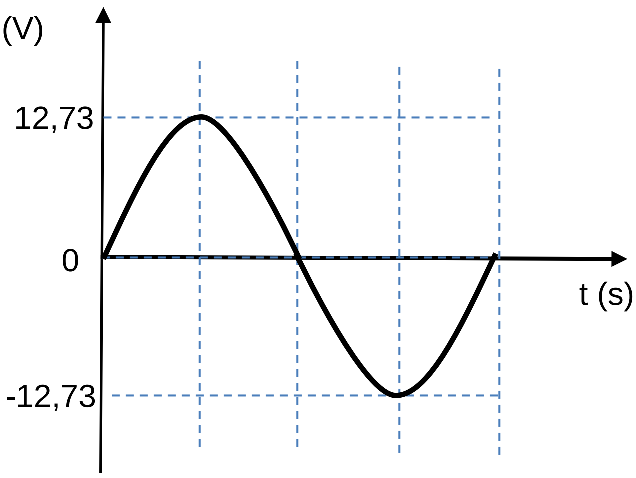
9.3 Write down the name of component **X**. (1)

9.4 Explain the function of:

9.4.1 Component **Y** (1)

9.4.2 Component **Z** (1)

Component **Z** in the above generator is replaced by slip rings. The graph below shows how the potential difference across the light bulb, resistance 25 Ω, changes with time for one complete cycle when this generator is functioning.



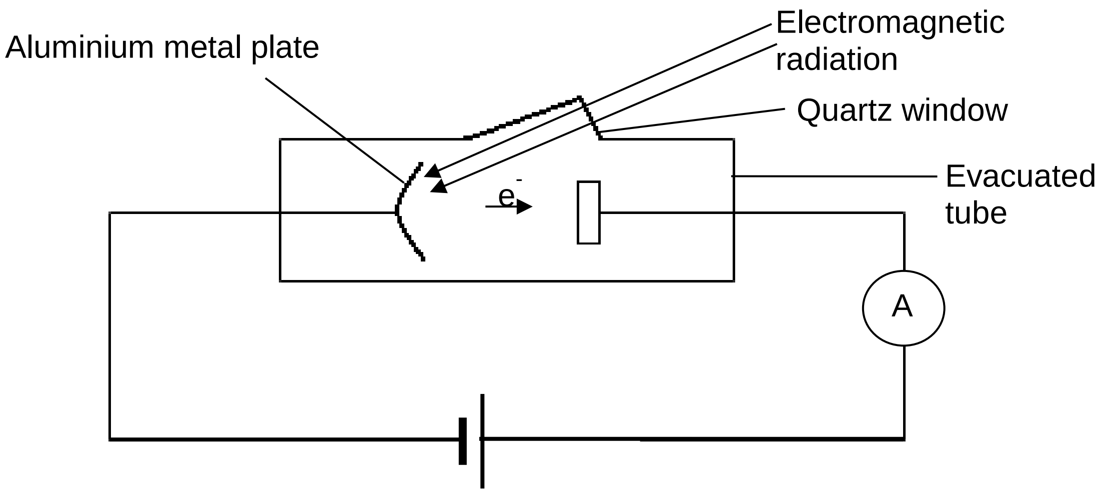
9.5 Calculate the:

9.5.1 rms voltage across the light bulb. (3)

9.5.2 Average power dissipated in the bulb (3)
[11]

QUESTION 10 (Start on a new page.)

The diagram below shows an aluminium metal plate that emits electrons when radiation of wavelength 200 nm is incident on it. The aluminium metal plate is connected to a source of potential difference and an ammeter that reads the saturated current as shown in the circuit below.



10.1 Name the phenomenon described above. (1)

10.2 State the significance of this phenomenon. (2)

The work function of aluminium is $6,7 \times 10^{-19}$ J.

10.3 Define the term *work function* of a metal in words. (2)

10.4 Calculate the maximum kinetic energy of the ejected photoelectrons. (4)

10.5 How will the reading on the ammeter change if the intensity of the electromagnetic radiation is increased? Write down INCREASES, DECREASES or REMAINS THE SAME. Explain your answer. (3)

10.6 Incident radiation with a greater frequency is now used. How will the reading on the ammeter change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[13]

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	$9,8\ m\cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
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	$9,11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^{6}\ m$

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*

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

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*

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