education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1
(PHYSICS)

SEPTEMBER 2018

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 space on the ANSWER BOOK.
2. This question paper consists of 10 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

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

1.1 An orange falls from a tree. Which ONE of the following statements about the orange, while it is falling, is TRUE? Ignore the effects of air resistance.

A Only momentum is conserved.

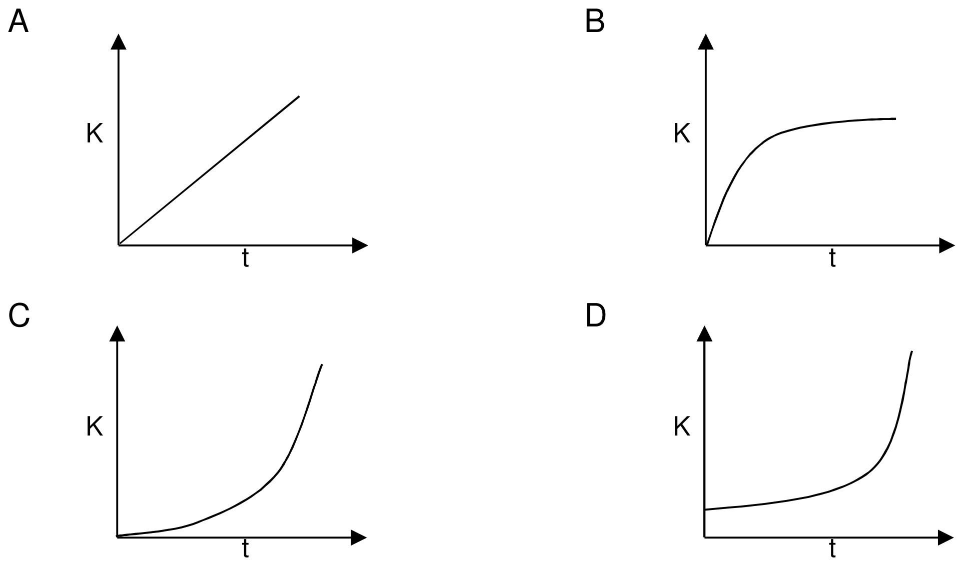
B Only mechanical energy is conserved.

C Kinetic energy is conserved.

D Both momentum and mechanical energy are conserved. (2)

1.2 A ball is dropped from the edge of a cliff.

Which ONE of the graphs below shows the correct relationship between the kinetic energy of the ball and the time taken by the ball to hit the ground? Ignore the effects of air resistance.



(2)

1.3 A cricketer hits an approaching ball back in the opposite direction to its original direction.

Which ONE of the following statements regarding this collision between the bat and the ball is TRUE?

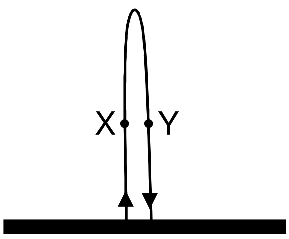
A The collision is perfectly elastic.

B The momentum of the ball stays the same before and after the collision.

C The magnitude of the net force of the ball on the bat is equal to the magnitude of the net force of the bat on the ball.

D The magnitude of the net force of the bat on the ball is greater than the magnitude of the net force of the ball on the bat. (2)

1.4 A ball is thrown vertically upwards and returns to the point of its projection.



Which statement about the acceleration at points **X** and **Y** is CORRECT?

The acceleration is …

A downwards at both points.

B upwards at both points.

C downwards at **X** and upwards at **Y**.

D upwards at **X** and downwards at **Y**. (2)

1.5 The Doppler Effect is the (apparent) change in the … of sound detected by a listener.

A frequency

B amplitude

C loudness

D softness (2)

1.6 A positive test charge q is held at **Y** between two positive charges +Q and +3Q as shown below.

When released, q will …

A remain at **Y**.

B move towards **X**.

C move towards **Z**.

D move vertically downwards. (2)

1.7 An applied force *F* acting on a block, causes the block to move across a rough horizontal surface. While moving, the applied force *F* is gradually changed to a force that has a magnitude less than the frictional force *f*.

Which ONE of the following statements is NOT TRUE for the second part of the movement of the block?

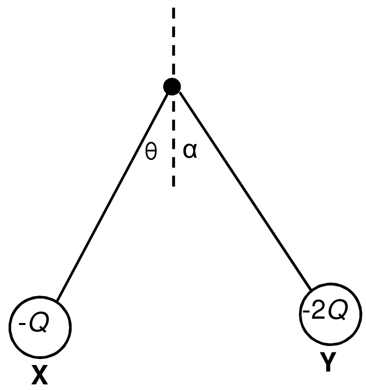
A The work done by the applied force is negative.

B The net work done on the block is negative.

C The block is slowing down.

D The net work done on the block decreases its kinetic energy. (2)

1.8 Two IDENTICAL SPHERES **X** and **Y**, with a charge of -Q and -2Q are suspended from the same insulated point as shown in the diagram below. (The diagram is not drawn to scale.)



The spheres are then allowed to swing freely until they come to rest on their own. How will the magnitudes of the angles θ and α compare to each other once the spheres come to their positions of rest? Ignore the effect of the masses of the strings and the spheres.

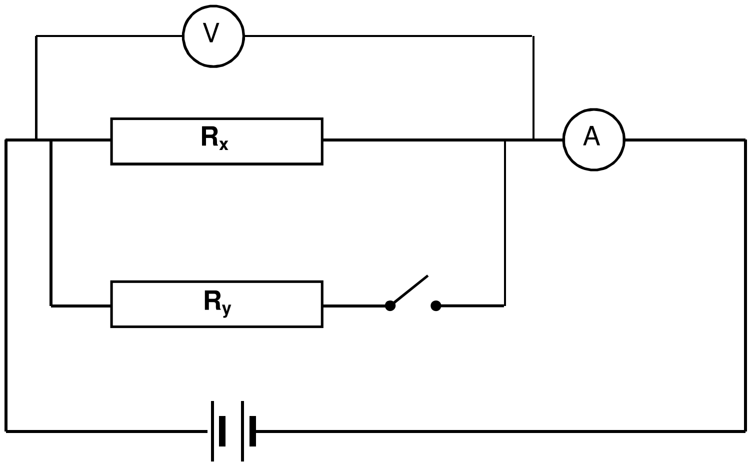
A $\theta < \alpha$

B $\theta > \alpha$

C $\theta = \alpha$

D $\theta = \alpha = 0°$ (2)

1.9 In the circuit diagram below, $\mathbf{R_x}$ and $\mathbf{R_y}$ are identical ohmic resistors connected in parallel. When the switch is open, the ammeter reading is 0,1 A and the voltmeter reading is 3 V. Ignore the internal resistance of the battery.



What will be the reading on the AMMETER and VOLTMETER when the switch is closed?

	READING ON AMMETER	READING ON VOLTMETER
A	Equal to 0,1 A	Equal to 3 V
B	Greater than 0,1 A	Equal to 3 V
C	Less than 0,1 A	Less than 3 V
D	Greater than 0,1 A	Greater than 3 V

(2)

1.10 A large voltage is applied across a neon gas discharge tube. What type of spectrum will be observed when the gas inside the tube is viewed through a diffraction grating?

A Line absorption spectrum

B Line emission spectrum

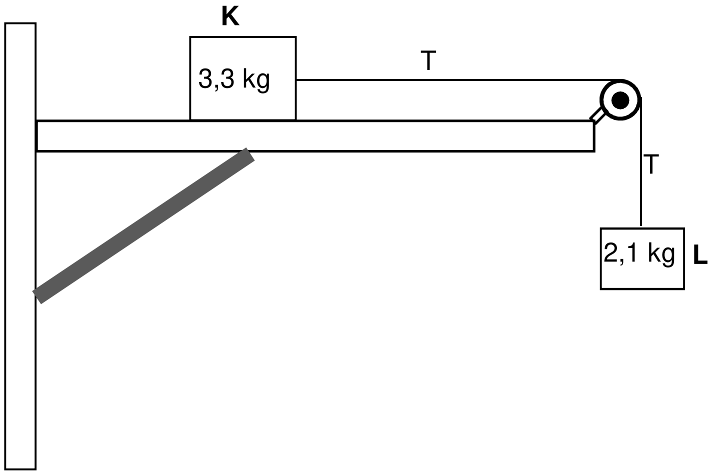
C Continuous emission spectrum

D Absorption spectrum (2)

[20]

QUESTION 2 (Start on a new page.)

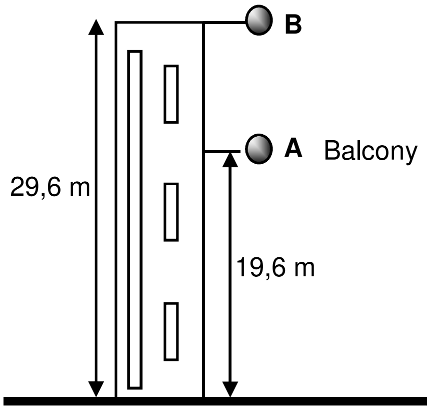
The diagram below shows block **K** of mass 3,3 kg connected by a light inextensible string to block **L** of mass 2,1 kg. The string runs over a light, frictionless pulley. When released, block **L** accelerates downwards. The coefficient of kinetic friction between block **K** and the surface is 0,15.



2.1	State Newton's second law of motion in words.	(2)
2.2	Draw a free-body diagram showing all the forces acting on block **L**.	(2)
2.3	Calculate the kinetic frictional force acting on block **K**.	(3)
2.4	Calculate the magnitude of the tension **T** on the string.	(5)
		[12]

QUESTION 3 (Start on a new page.)

Ball **A** is dropped from a balcony 19,6 m from the ground. AT THE SAME TIME an identical ball **B,** is projected vertically downwards from the top of a building 29,6 m from the ground as shown in the diagram below.



The balls hit the ground simultaneously. Ignore the effects of air resistance.

3.1 Calculate the magnitude of the:

3.1.1 Final velocity of ball **A** (3)

3.1.2 Velocity with which **B** must be projected to reach the ground at the same time as **A** (5)

3.2 On the same set of axes, sketch a velocity versus time graph for each ball (**A** and **B**), for the entire motion. Take down as positive.

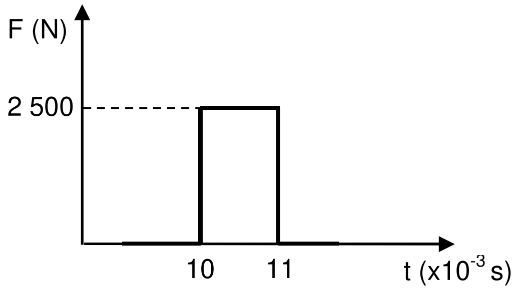
Show the following on your graph:

- Initial velocity of both balls **A** and **B**
- Time taken to hit the ground (4)

[12]

QUESTION 4 (Start on a new page.)

A 2 kg block is sliding to the right on a frictionless horizontal surface at 4 $m \cdot s^{-1}$. A force of 2 500 N is now exerted on the block for a short period of time as indicated in the graph below.



4.1 Define the term *impulse*. (2)

4.2 Calculate the magnitude of the impulse on the block. (3)

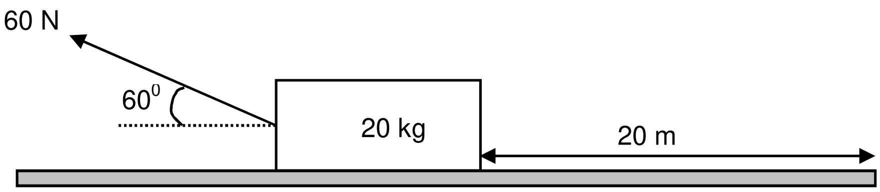
4.3 Calculate the velocity of the block immediately after the force stops acting on the block if the force was exerted to:

4.3.1 The right (4)

4.3.2 The left (3)
[12]

QUESTION 5 (Start on a new page).

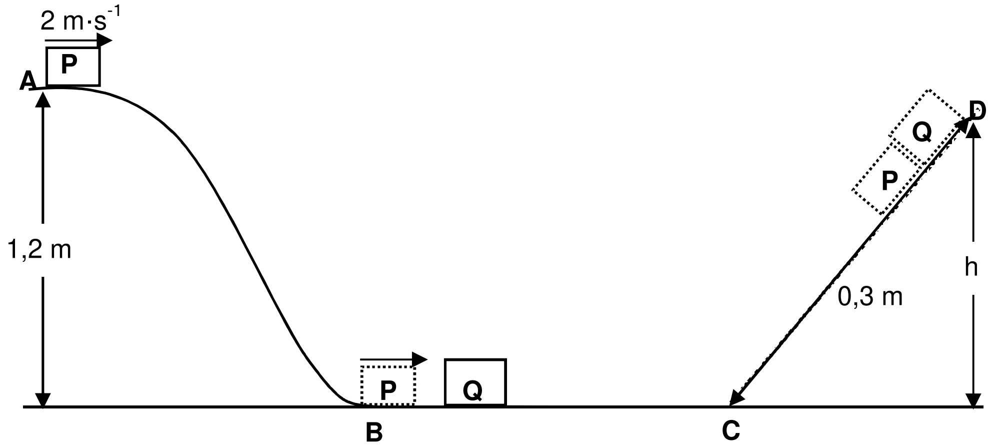
5.1 A cart of mass 20 kg is pulled with a force of 60 N as indicated in the diagram below. The cart slides over a distance of 20 m. Ignore all effects of friction.



5.1.1 Calculate the work done by the applied force. (3)

5.1.2 Does the force of gravity do work on the cart? Explain. (2)

5.2 **ABC** is a frictionless part of a track. **A** is a point 1,2 m above the ground. Block **P** of mass 0,3 kg slides from point **A** with an initial speed of 2 m·s^{-1} and reaches point **B** as shown in the diagram below.



5.2.1 Define the term *conservative force*. (2)

5.2.2 Calculate the speed of block **P** at point **B**. (4)

Block **P** then collides with a stationary block **Q** of mass 0,4 kg. After the collision, the two blocks slide through **BC** and up the rough incline **CD**. The frictional force acting on the blocks as they move up the incline is 0,5 N. The blocks come to rest at a distance of 0,3 m up the incline.

5.2.3 State the law of conservation of linear momentum in words. (2)

Calculate the:

5.2.4 Speed of the combination of blocks **P** and **Q** immediately after the collision (4)

5.2.5 Maximum height, h, reached by the combination of blocks (5)

[22]

QUESTION 6 (Start on a new page.)

A commuter train travelling at a constant speed of 40 $m \cdot s^{-1}$ blows its horn as it passes a stationary boy. The frequency of the sound emitted by the horn is 320 Hz.

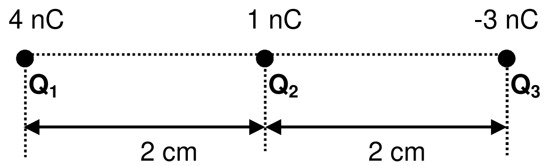
6.1 State the Doppler Effect in words. (2)

6.2 Calculate the WAVELENGTH of the sound observed by the boy when the train moves away from him. Take the speed of sound in air to be 343 $m \cdot s^{-1}$. (6)

6.3 Write down ONE use of the Doppler Effect in medicine. (1)
[9]

QUESTION 7 (Start on a new page).

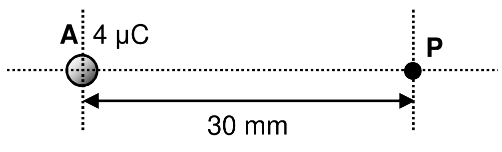
7.1 In the diagram below, $\mathbf{Q_1}$, $\mathbf{Q_2}$ and $\mathbf{Q_3}$ are three stationary point charges placed along a straight line. The charges on $\mathbf{Q_1}$, $\mathbf{Q_2}$ and $\mathbf{Q_3}$ are 4 nC, 1 nC and -3 nC respectively. The distance between $\mathbf{Q_1}$ and $\mathbf{Q_2}$ is 2 cm and that between $\mathbf{Q_2}$ and $\mathbf{Q_3}$ is also 2 cm.



7.1.1 Draw the electric field pattern around an isolated positive point charge. (2)

7.1.2 Calculate the magnitude and direction of the NET FORCE exerted by $\mathbf{Q_2}$ and $\mathbf{Q_3}$ on $\mathbf{Q_1}$. (6)

7.2 **P** is a point in an electric field 30 mm away from a charged sphere **A** which carries a charge of 4 μC as shown below.



7.2.1 Define the term *electric field at a point*. (2)

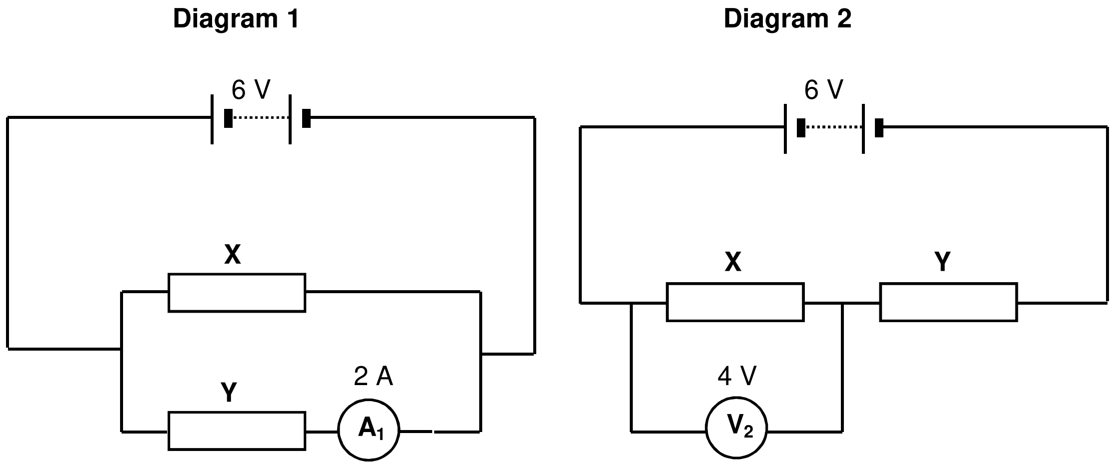
7.2.2 Calculate the electric field at point **P** due to sphere **A**. (4)

7.2.3 A point charge of magnitude 2,5 x 10^{-9} C is now placed at point **P**.

Calculate the magnitude of the electrostatic force experienced by this charge. (3)
[17]

QUESTION 8 (Start on a new page.)

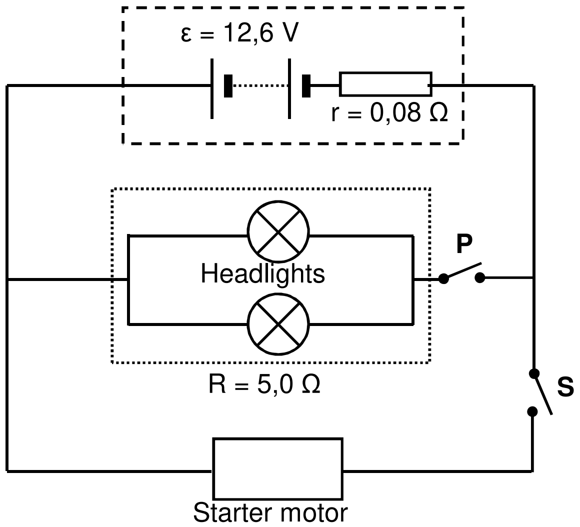
8.1 In diagram 1, when two NON-IDENTICAL resistors **X** and **Y** are connected in parallel across a 6 V battery, the current through $\mathbf{A_1}$ is found to be 2 A.
In diagram 2, when the two resistors are connected in series to the 6 V battery, $\mathbf{V_2}$ reads 4 V. The internal resistance of the battery and the resistance of the conducting wires may be ignored.



8.1.1 State Ohm's law in words. (2)

8.1.2 Calculate the resistance of **X** and **Y** respectively. (6)

8.2 An automobile battery has an emf of 12,6 V and an internal resistance of 0,08 Ω. The two headlights have a TOTAL resistance of 5,0 Ω. The starter motor is connected in parallel with the headlights as shown in the diagram below. Assume the headlights are ohmic resistors.



8.2.1 Write down the magnitude of the potential difference across switch **S** when both switches are open. (1)

Switch **P** is now CLOSED but **S** is still OPEN.

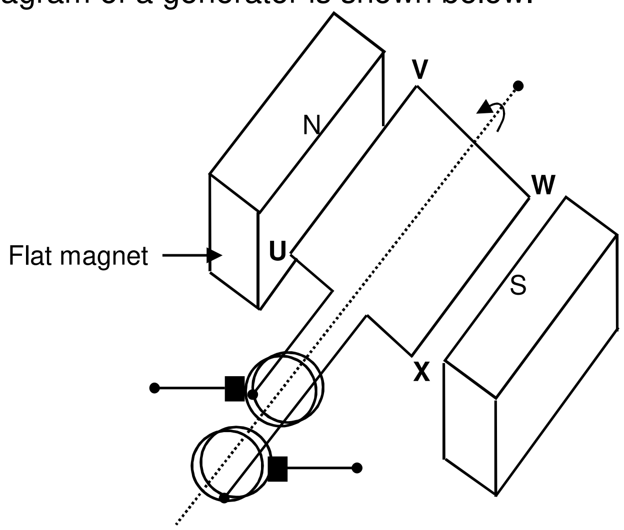
8.2.2 Calculate the potential difference across the headlights when switch **P** is closed. (5)

BOTH switches (**P** and **S**) are now CLOSED.

8.2.3 What will happen with the brightness of the headlights? Write down only INCREASE, DECREASE or THE SAME. Explain your answer. (4)
[18]

QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of a generator is shown below.



9.1.1 What type of generator, AC or DC is shown in this diagram? Give a reason for your answer. (2)

9.1.2 The coil is rotated in an anticlockwise direction as shown in the diagram. In what direction will the current in the section **WX** of the loop move? Only write **W** to **X** or **X** to **W**. (1)

9.1.3 Name the principle on which a generator operates. (1)

9.2 An electric hair dryer is rated at 1500 W at 240 V. The rated power of this hair dryer, or of any other AC device, is THE AVERAGE POWER drawn by the device. The rated voltage is the *rms* voltage. Assume that the hair dryer is a pure resistor.

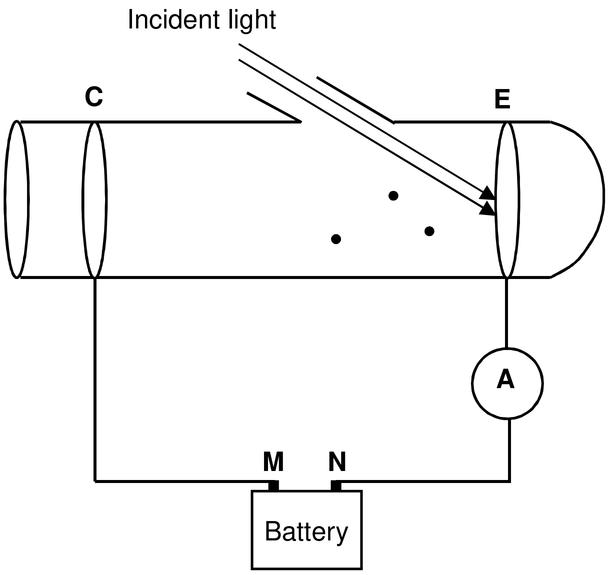
Calculate the:

9.2.1 Resistance of the hair dryer (3)

9.2.2 Maximum current delivered to the hair dryer (5)
[12]

QUESTION 10 (Start on a new page.)

A photocell is set up as shown to investigate photoelectric effect. Metal plate **E** (cathode) and **C** (anode) are connected to the terminals of a battery. An ammeter **A** is connected in series with the battery.



10.1 Which terminal of the battery must be the positive one to record a possible current? Write only **M** or **N**. (2)

10.2 What is meant by *photoelectric effect*? (2)

10.3 The cathode is made up of silver metal with a work function of 7,42 x 10^{-19} J. Monochromatic light of wavelength 300 nm is incident on the cathode of the photoelectric tube.

10.3.1 Define the term *work function*. (2)

10.3.2 Will there be a reading on the ammeter when the monochromatic light is incident on the cathode? Explain the answer by using calculations. (6)

10.4 A certain frequency of light is incident on the photocell and an ammeter reading is registered. How will increasing THE INTENSITY of the incident light affect each of the following? Write down only INCREASE, DECREASE or REMAIN THE SAME. Give an explanation for your answer in QUESTION 10.4.1.

10.4.1 Number of electrons emitted per unit time (3)

10.4.2 The kinetic energy of the photoelectrons (1)
[16]

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 gravitasie konstante*	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 Earth *Massa van Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6,38 \times 10^3\ km$

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*

$F_{net} = ma$	$p = mv$
$\mu_k = \frac{f_k}{N}$	$\mu_s = \frac{f_{s(max)}}{N}$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$
$P = \frac{W}{\Delta t}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R=\frac{V}{I}$	emf (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*

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