education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

SEPTEMBER 2015

MARKS: 150

TIME: 3 HOURS

This question paper consists of 13 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 TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Begin EACH question on a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example between QUESTION 3.1 and QUESTION 3.2.
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 the formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to 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 the ANSWER BOOK.

1.1 An object moving with a constant speed **v** has a kinetic energy **E**. Which one of the following will be true for the kinetic energy if the object has a constant velocity of **2v**?

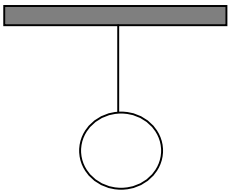
A ½E

B E

C 2E

D 4E

1.2 A sphere is attached to a string, which is suspended from a fixed horisontal bar as shown in the sketch.



The reaction force to the gravitational force exerted by the earth on the sphere is …

A the force of the bar on the sphere.

B the force of the string on the sphere.

C the force of the sphere on the earth.

D the force of the bar on the string. (2)

1.3 A ball is dropped from height **h** above the ground and reaches the ground with kinetic energy **E.** From which height must the ball be dropped to reach the ground with kinetic energy **2E**? (Ignore all effects of friction.)

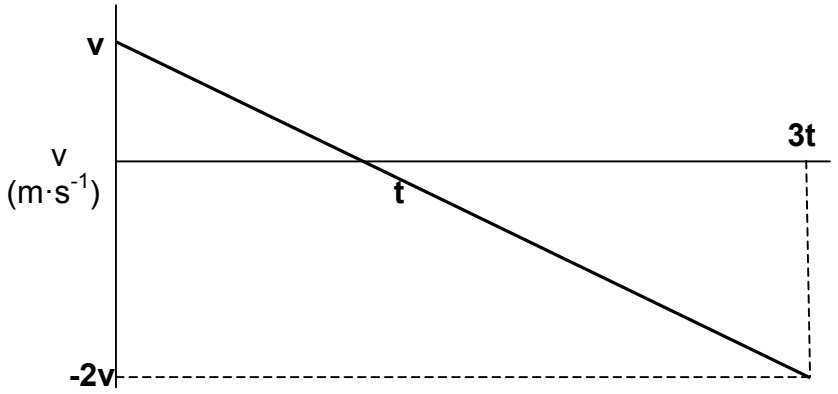
A 2**h**

B 3**h**

C 4**h**

D 8**h** (2)

1.4 The velocity versus time graph below represents the movement of an object under the influence of gravitational force.



The displacement of the object in time **3t** is …

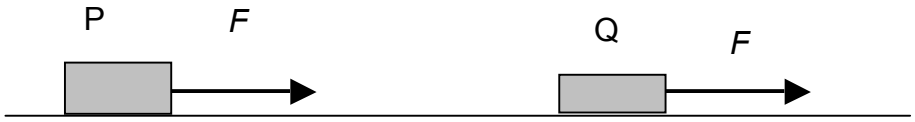
A **vt**.

B zero.

C **-vt**.

D $-\frac{3}{2}$**v t**. (2)

1.5 A net force **F** accelerates two isolated objects, **P** and **Q**, from rest on a straight line for time **t** as shown below. Object **P** experiences an acceleration of **a** and object **Q** an acceleration of **2a.**



If the amount of work done by net force **F** on object **P** equals **W**, the amount of work done on **Q** will be …

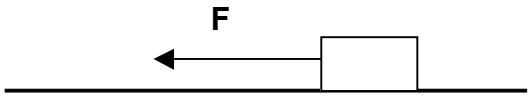
A W.

B ½ W.

C 2 W.

D 4 W. (2)

1.6 A block, being pulled by a force **F**, and moving to the left on a rough horizontal surface, is slowing down.

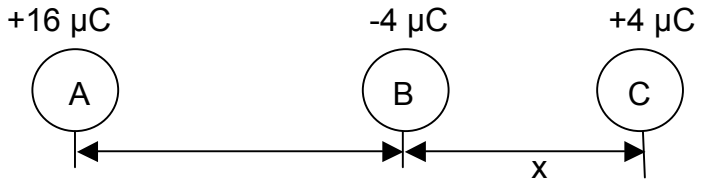


The directions of the resultant force and the acceleration are …

	DIRECTION OF RESULTANT FORCE	DIRECTION OF ACCELERATION
A	to the right	to the left
B	to the right	to the right
C	to the left	to the left
D	to the left	to the right

(2)

1.7 Three small identical spheres, **A**, **B** and **C** is charged as shown in the diagram. The distance between sphere **B** and **C** is **x**.



For sphere **B** to experience no resultant electrostatic force, the distance between **A** and **B** must be …

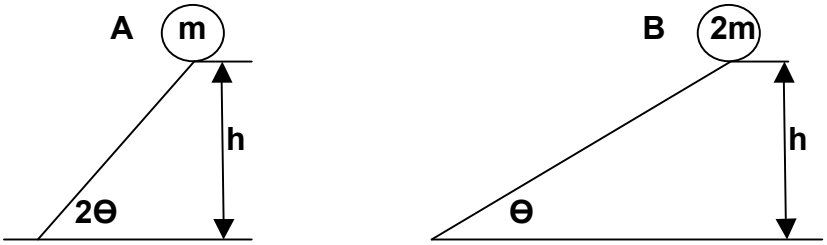
A ¼ x.

B ½ x.

C 2 x.

D 4 x. (2)

1.8 Two metal balls **A** and **B**, mass **m** and **2m** respectively, are allowed to roll down two different frictionless slopes as indicated in the diagram below.

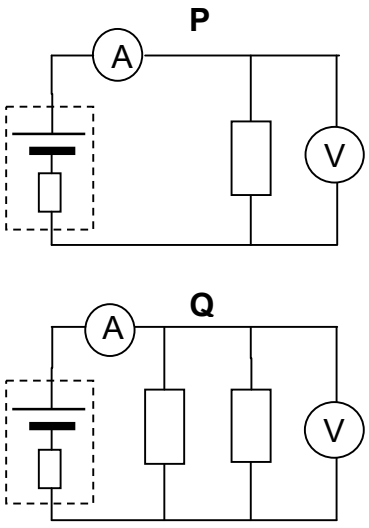


Which ONE of the following is true for the work done and the force acting on balls **A** and **B** respectively?

	MAGNITUDE OF FORCE	WORK DONE
A	$F_A = F_B$	$W_A > W_B$
B	$F_A < F_B$	$W_A < W_B$
C	$F_A > F_B$	$W_A < W_B$
D	$F_A < F_B$	$W_A < W_B$

(2)

1.9 In the circuits shown below all resistors and cells are **identical.**

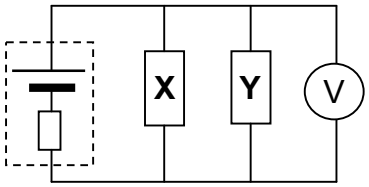


Which ONE of the following gives the correct comparison between the voltmeter and ammeter readings in circuit **P** and **Q.**

	VOLTMETER READING	AMMETER READING
A	$V_P > V_Q$	$A_p > A_Q$
B	$V_P > V_Q$	$A_p < A_Q$
C	$V_P < V_Q$	$A_p = A_Q$
D	$V_P = V_Q$	$A_p < A_Q$

(2)

1.10 In the circuit shown below the resistance of X is **R** and that of Y is **2R**.



If the power dissipated by **X** equals **P**, then the power dissipated by **Y** will be …

A ¼ P.

B ½ P.

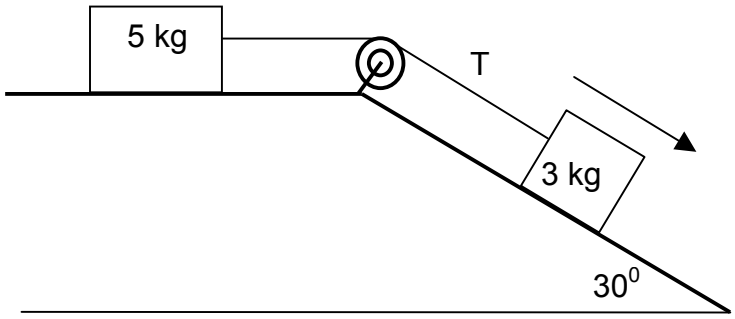
C 2P.

D 4P. (2)

TOTAL SECTION A: 20

QUESTION 2 (Begin on a new page.)

Two blocks of masses 5 kg and 3 kg respectively are connected by a light inextensible string that runs over a light frictionless pulley as shown in the diagram below. The 5 kg block experience a frictional force of 8 N and the coefficient of kinetic friction between the 3 kg block and the surface of the inclined plane is 0,15.



2.1 Define the term *frictional force.* (2)

2.2 Draw a labelled free-body diagram to indicate all the forces acting on the 3 kg block. (3)

2.3 Calculate the:

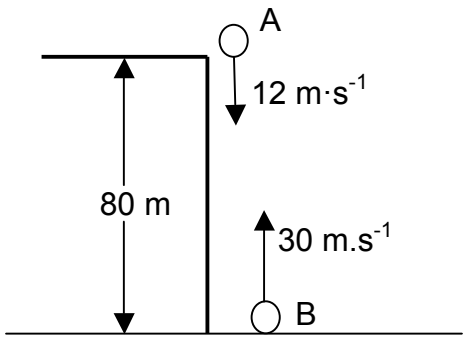
2.3.1 Magnitude of the frictional force acting between the 3 kg block and the surface of the inclined plane (3)

2.3.2 Magnitude of the tension **T** in the string (6)

[14]

QUESTION 3 (Begin on a new page.)

Ball **A** is thrown vertically downwards from the top of a building, 80 m high, at a velocity of 12 m·s^{-1}. At the same instant a second identical ball **B** is thrown upwards at a velocity of 30 m·s^{-1}. Ball **A** and ball **B** pass each other after 2,135 s. Ignore all effects of air friction.



3.1 Give the direction of the acceleration of ball **B** while moving upwards. (1)

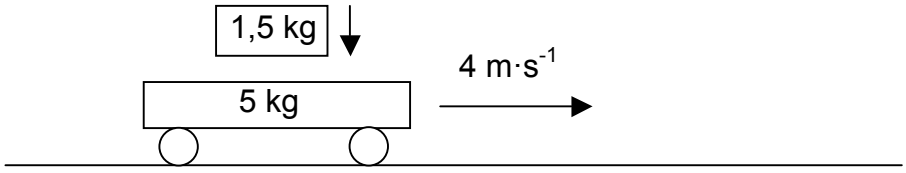
3.2 Calculate the velocity of ball **B** the moment it passes ball **A**. (3)

3.3 Calculate the distance between ball **A** and **B** 2,5 s after it was projected. (6)

3.4 Sketch a position-time graph for the motion of ball **A** till it reaches the ground as well as for the motion of ball **B** until it passes ball **A**. Use the ground as zero position. Clearly indicate the time at which the balls pass each other. (3)
[13]

QUESTION 4 (Begin on a new page.)

A trolley, mass 5 kg, moves at 4 m·s^{-1} east across a frictionless horizontal surface. A brick of mass 1,5 kg is dropped onto the trolley.



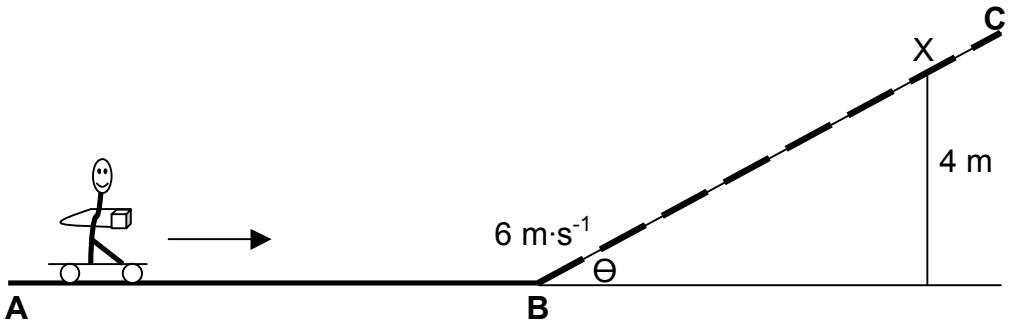
4.1 Define in words the *Law of Conservation of Momentum*. (2)

4.2 State the condition for an elastic collision. (1)

4.3 Calculate the change in momentum of the 5 kg trolley. (5)
[8]

QUESTION 5 (Begin on a new page.)

5.1 A boy on roller-skates moves at a constant velocity in an easterly direction along a frictionless horizontal part **AB** of a track carrying a parcel. He decides to increase his velocity by throwing the parcel horizontally away from him.



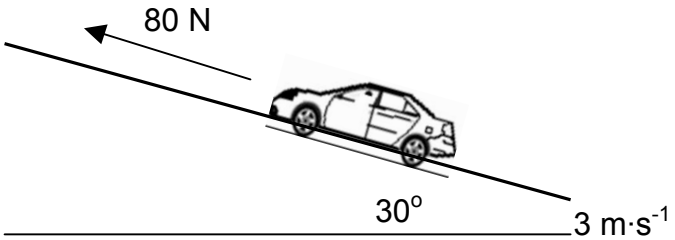
5.1.1 In which direction must the parcel be thrown to cause a maximum increase in the velocity of the boy? (1)

5.1.2 Name and define in words the law in physics that you have applied in QUESTION 5.1.1. (3)

On reaching point **B** at a velocity of 6 $m \cdot s^{-1}$, the boy on the roller-skates, with total mass 57 kg, continues to move up a rough section **BC** of the track and comes to rest at position X, height 4m. The magnitude of the frictional force acting on the roller-skates, is 40 N.

5.1.3 Calculate value Θ of the inclined plane. (6)

5.2 A remote controlled car is driven up an inclined plane at 30^0 to the horizontal as shown below. The car of mass 4 kg, experiences an average forward force of 80 N. A frictional force of 15 N is acting on the car as it moves up the plane. The speed of the car at the bottom of the inclined plane is 3 $m \cdot s^{-1}$.



Use energy principles to calculate the speed of the car after it has travelled 5 m up the inclined plane. (7)
[17]

QUESTION 6 (Begin on a new page.)

Light emitted from distant stars demonstrates the phenomenon known as red shift.

6.1 Explain how the phenomenon known as *red shift* can be used to explain an expanding universe. (2)

6.2 A submarine can use the Doppler effect to detect the speed of ship. A submarine at rest and just below the surface of the water, detects the frequency of a moving ship as 437 Hz, 0,985 times the actual frequency of the sound emitted by the ship. The speed of sound in water is 1470 $m \cdot s^{-1}$.

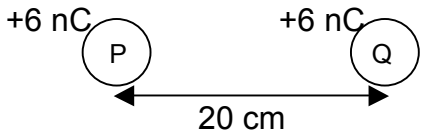
6.2.1 Is the ship moving away from or towards the submarine? Give a reason for your answer. (2)

6.2.2 Calculate the speed of the ship. (5)

6.3 Name two applications of the Doppler effect in Medical Science. (2)
[11]

QUESTION 7 (Begin on a new page.)

The diagram below shows two identical insulated metal spheres. Spheres **P** an **Q** each carry a charge of 6 nC.

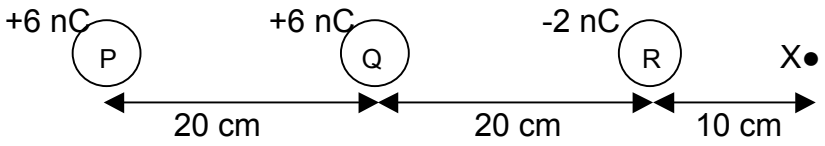


7.1 Define *Coulomb's Law* in words. (2)

7.2 Draw the electric field pattern due to the two spheres **P** and **Q**. (3)

7.3 Calculate the magnitude of the electrostatic force between spheres **P** and **Q**. (4)

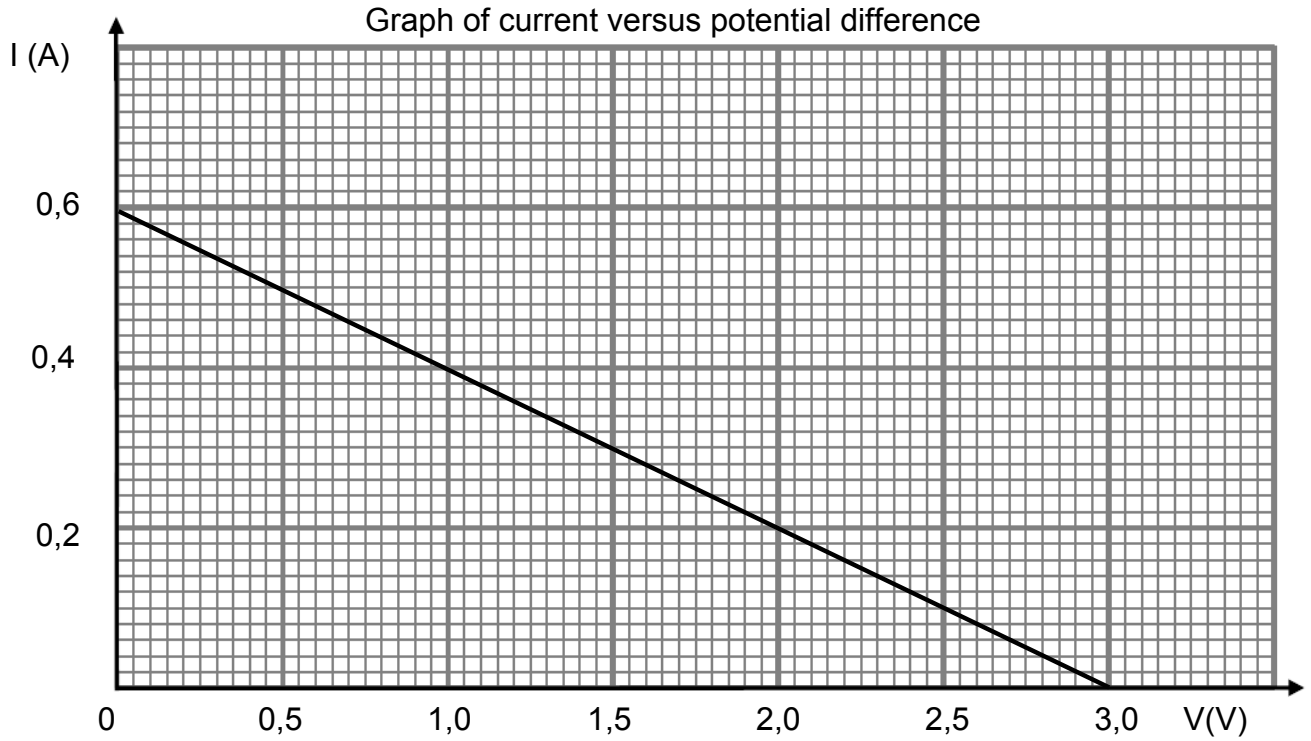
A third sphere, **R**, of charge -2 nC is now placed at a position relative to the other spheres and a chosen point X as shown in the diagram below.



7.4 Calculate the net electric field at point **X** due to spheres **P**, **Q** and **R**. (6)
[15]

QUESTION 8 (Begin on a new page.)

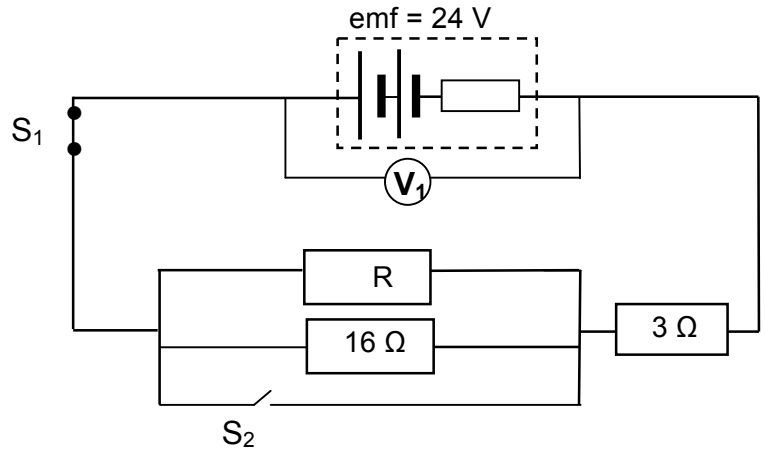
8.1 The graph below is obtained from an experiment to calculate the internal resistance of a battery.



8.1.1 Calculate $V_{internal}$ if the current in the circuit is equal to 0,2 A. (2)

8.1.2 Calculate the internal resistance of the battery. (4)

8.2 A circuit is connected as shown below. When switch S_1 is closed, $V_{external}$ is equal to 22,5 V. The internal resistance of the battery is 0,8 Ω.



8.2.1 Define *Ohm's Law* in words. (2)

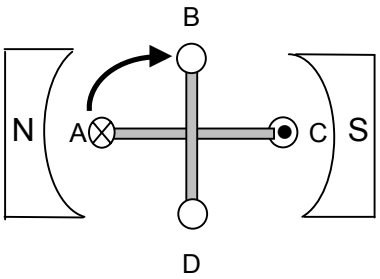
8.2.2 Calculate the power dissipated by the 16 Ω resistor. (7)

8.2.3 Calculate the resistance of **R**. (5)

8.2.4 Switch S_2 is now closed. How will voltmeter reading V_1 be influenced? (Write down only INCREASE, DECREASE or STAYS THE SAME.) Give an explanation to your answer. (4)
[24]

QUESTION 9 (Begin on a new page.)

9.1 The diagram below shows a coil that is rotated through a magnetic field.



9.1.1 Name the principle demonstrated in the above diagram? (1)

9.1.2 The maximum emf is generated at position **A** of the rotation cycle. Give an explanation for this observation. (2)

9.1.3 Name one structural difference between a DC and AC generator. (2)

9.1.4 Use the positions indicated in the diagram above and sketch a graph of current versus position for one complete rotation of a DC generator. (Indicate the positions **A**, **B**, **C** and **D** on the graph.) (4)

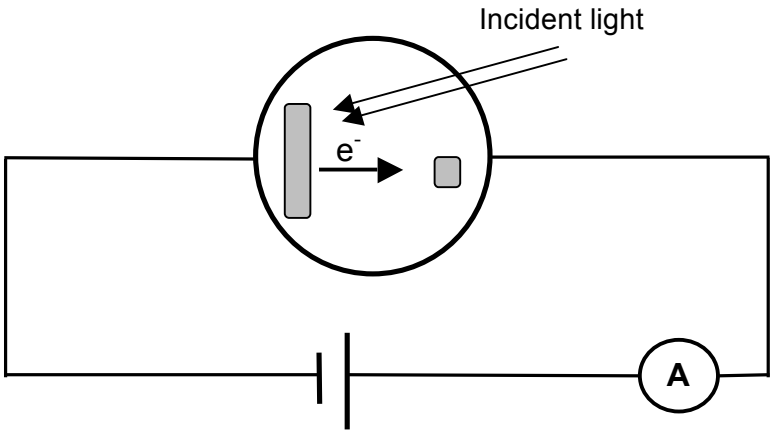
9.2 When an AC supply is connected to a lamp, it lights up with the same brightness as it does when connected to a 18 V battery (DC source). The power dissipated by the lamp is equal to 60 W.

9.2.1 What is the rms voltage of the AC supply? (1)

9.2.2 Calculate the peak current delivered by the AC source. (5)
[15]

QUESTION 10 (Begin on a new page.)

The diagram below shows a circuit in which a photocell is irradiated alternately with red and blue light to demonstrate the photo-electric effect.



10.1 An ammeter reading is recorded when the photocell is irradiated with red light. Give an explanation for this observation. (2)

10.2 Blue light with the same intensity as the red light is now used to irradiate the photocell. How will this influence the following:

10.2.1 The kinetic energy of the photo-electrons (Write down only INCREASE, DECREASE or STAYS THE SAME.) (1)

10.2.2 The ammeter reading. (Write down only INCREASE, DECREASE or STAYS THE SAME.) Give an explanation for your answer. (4)

10.3 The wavelength of the blue light used in the demonstration is $4,5 \times 10^{-7}$ m. Calculate the threshold frequency (cut-off frequency) of the metal used in the photo cell if the average speed of an emitted photo-electron is equal to $4,78 \times 10^{5}$ m·s^{-1}. (6)
[13]

TOTAL SECTION B: 130
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*

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

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*

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

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*

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