HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- PHYSICS

SEPTEMBER 2019

TIME: 3 HRS
TOTAL 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (18)
   SECTION B (132)

   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1 A ball is thrown vertically upwards into the air. Ignore the effects of friction. The NET FORCE acting on the ball when the ball is at its highest point is ...

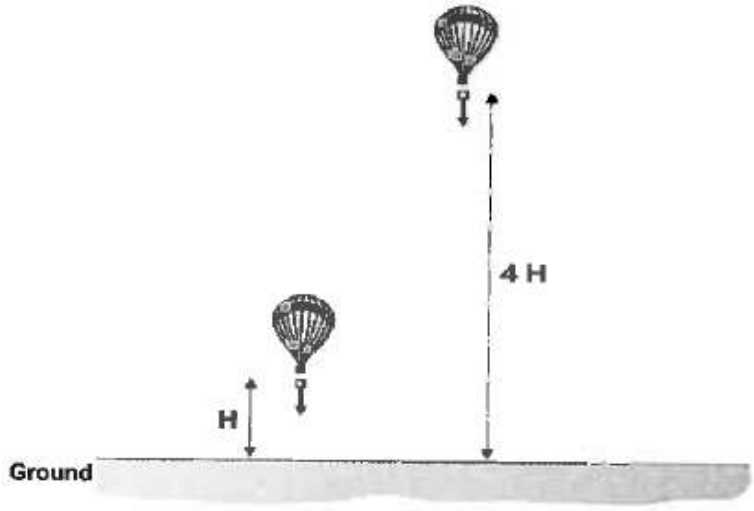
A zero.

B equal to the weight of the ball.

C less than the weight of the ball.

D greater than the weight of the ball.

1.2 A package is dropped from a hot air balloon from two different heights. In the first instance the height of the balloon from the ground is H and it takes t seconds for the package to reach the ground. In the second instance the package is dropped from a height of 4H.



The time for the package, dropped from the height of 4H, to reach the ground compared to the time t of the package dropped from H is:

A. t
B. 2t
C. 4t
D. 16t

1.3 A ball is dropped from rest, in the absence of air friction, from a height h with mechanical energy equals to E. When the ball reaches a height $\frac{1}{3}$ h, the kinetic energy of the ball will be…

A. $\frac{1}{3}E$

B. $\frac{2}{3}E$

C. E

D. $\frac{3}{2}E$

1.4 The hooter of a car emits sound of constant frequency as the car moves away from a stationary listener.

Which ONE of the following properties of the sound heard by the listener will **NOT** change?

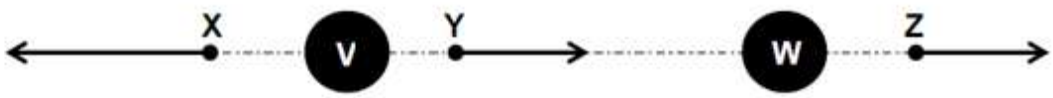
A Velocity

B Frequency

C Both wavelength and frequency

D Both frequency and loudness

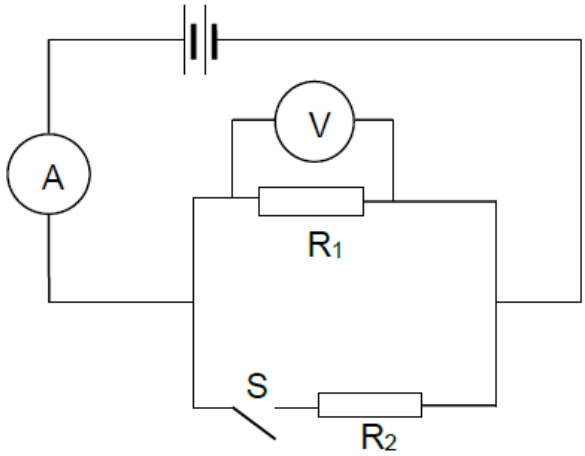
1.5 Two identically charged spheres **V** and **W** are located on a straight line. **X, Y** and **Z** are three points on the same straight line. The positions of points X, Y and Z are as indicated and the direction of the NET electric field at points **X, Y** and **Z** is shown in the diagram below.



Which ONE of the following combinations represent the charges on each of the spheres **V** and **W**?

	Charge of V	Charge of W
A	Positive	Positive
B	Neutral	Positive
C	Negative	Negative
D	Positive	Negative

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

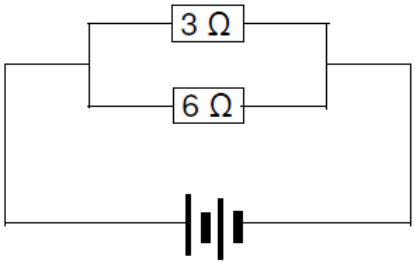


The resistors R_1 and R_2 are identical. The internal resistance of the battery in the circuit is **not** negligible. When switch S is closed, which ONE of the following gives the correct readings on the ammeter (A) and voltmeter (V)?

	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 In the circuit diagram below, the power dissipated by the 3 Ω resistor is **P**. The power dissipated by the 6 Ω resistor is…



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

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

C $2P$

D $4P$

(2)

1.8 A DC generator operates at 80 Hz. The number of times the output voltage reaches a maximum in 1 second is ...

A 40.

B 80.

C 120.

D 160.

1.9 When a monochromatic light is shone onto a clean cadmium surface, electrons with kinetic energy up to a maximum of 2P are released. The work function of cadmium is P.

What is the frequency of the photons of this lights?

A. $\frac{3P}{h}$

B. $\frac{P}{h}$

C. Ph

D. $3Ph$

[2 x 9 = 18]

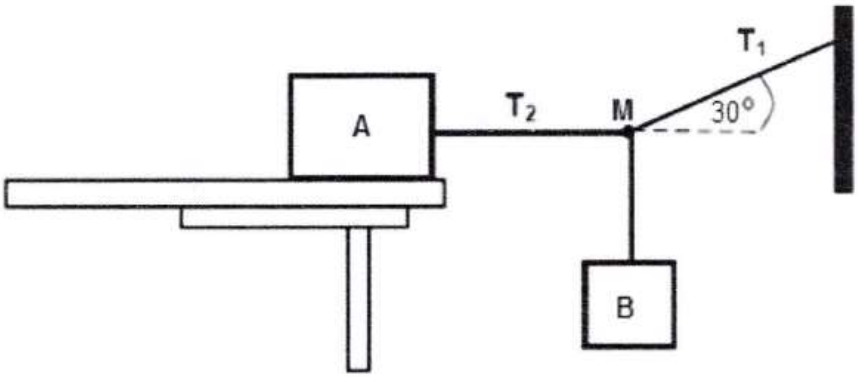
SECTION B
Instructions

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitution in all calculations.
   Round off your final numerical answers to TWO decimal places

Question 2

2.1 A block A, of mass 50kg, is at rest on a table. It is connected to block B by means of two light inextensible strings knotted at M. A third string is arranged in such a way that the string connecting block A is horizontal as shown in the diagram below.

The coefficient of static friction between block A and the surface of the table is 0,20. The resultant of all forces acting at point M is zero.



The tension in the string connecting block A is T_2 and that for the string that pulls at 30^0 is T_1 as shown in the diagram.

2.1.1 Draw a labelled free-body diagram to show all the forces acting on the knot at M (3)

Calculate:

2.1.2 The magnitude of the tension T_2. (4)

2.1.3 The mass of B. (5)
[12]

Question 3

Ball **A** is projected vertically upwards from the ground, near a tall building, with a speed of 30 $m \cdot s^{-1}$. Ignore the effects of air friction.

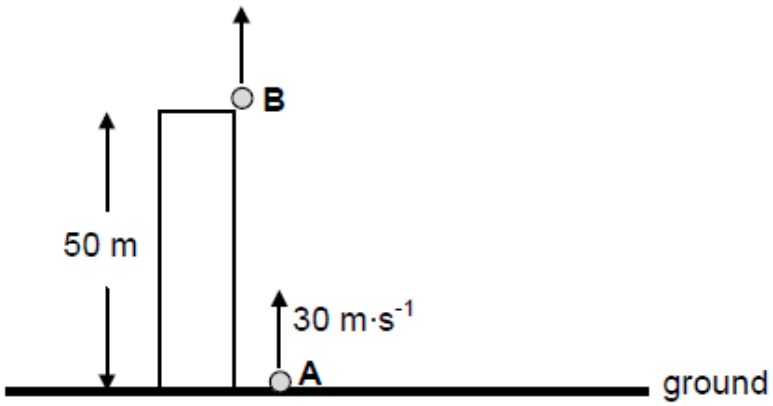
3.1 Explain what is meant by a *projectile*. (2)

3.2 Calculate:

3.2.1 The total time that ball **A** will be in the air (4)

3.2.2 The distance travelled by ball **A** during the last second of its fall (4)

3.3 TWO SECONDS after ball **A** is projected upwards, ball **B** is projected vertically upwards from the roof of the same building. The roof the building is 50 m above the ground. Both balls **A** and **B** reach the ground *at the same time*. Refer to the diagram below. Ignore the effects of air friction.



Calculate the speed with which ball **B** was projected upwards from the roof. (4)

3.4 Sketch velocity-time graphs for the motion of both balls **A** and **B** on the *same set of axes*. Clearly label the graphs for balls **A** and **B** respectively.

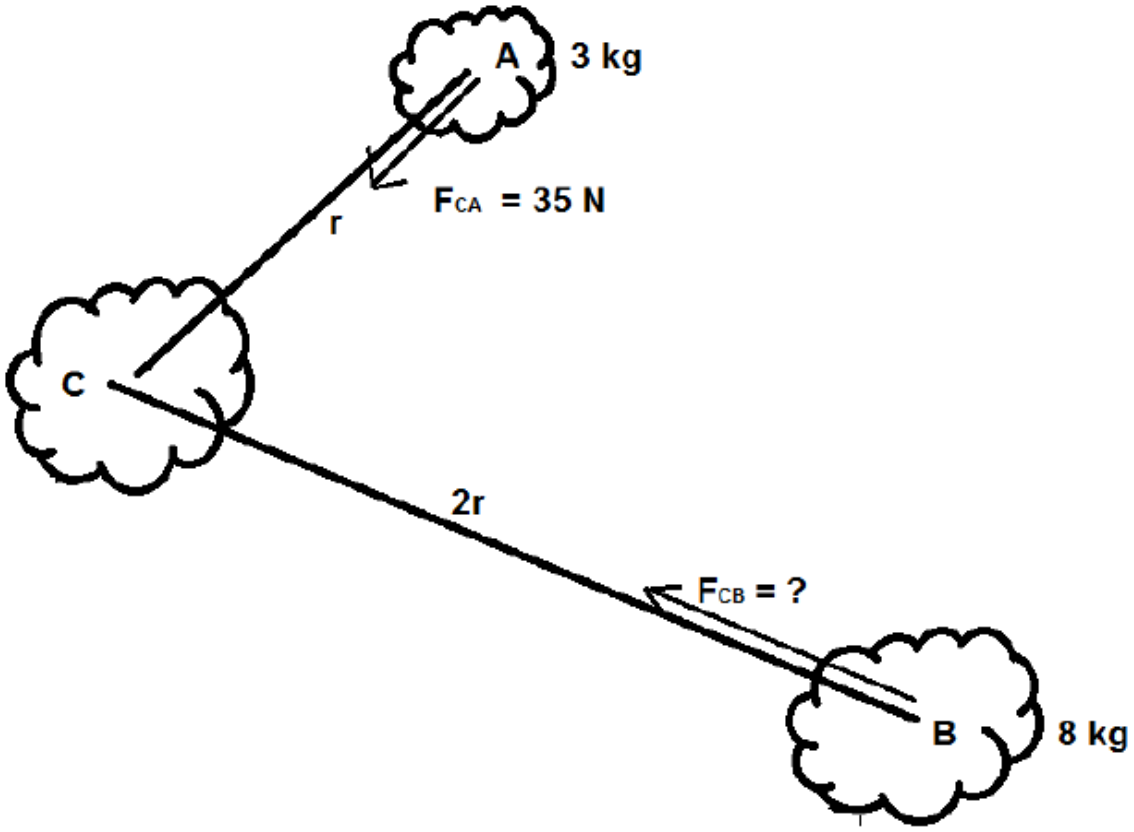
Indicate the following on the graphs:

(a) Time taken by both balls **A** and **B** to reach the ground
(b) Time taken by ball **A** to reach its maximum height
(c) Velocities of each of the balls

(6)
[20]

Question 4

Three objects A, B and C are moving through space at right angles to each other. The mass of A is 3 kg and the mass of B is 8 kg. The distance between C and A is r and the distance between C and B is 2r. F_{CA} is 35 N.



4.1 Define Newton's Law of Universal Gravitation, in words. (2)

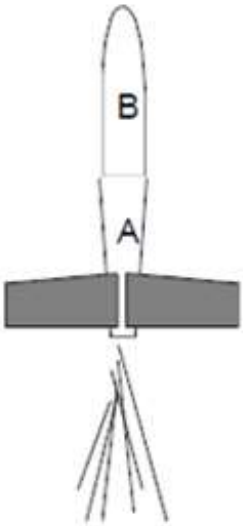
4.2 Calculate the force between C and B. (6)

4.3 Show how F_{CB} will change if the radius CB is halved and the mass of B is doubled. (2)

[10]

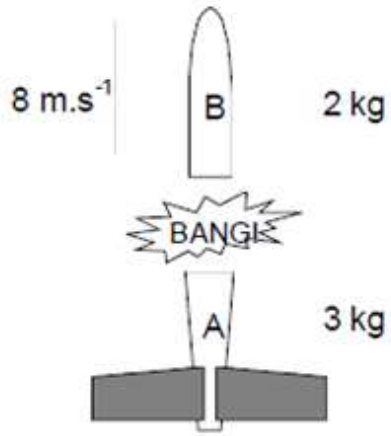
Question 5

Hendrik is an amateur rocket builder. He launches a two-stage rocket as shown below. Section A (stage 1) contains the rocket engine and fuel. Section B (stage 2) has a mass of 2 kg.



5.1 Hendrik says that Newton's Third Law of Motion is used to explain why the rocket moves upwards. Identify one action-reaction pair of forces involved with the launching. (2)

At a certain height, when the rocket has a velocity of 5m.s^{-1}, the last fuel is used up and section A then has a mass of 3 kg. To get section B even higher, a small explosion separates section B from section A at this point and increases the upward velocity of section B to 8 m.s^{-1}.



5.2 State, in words, the **principle of conservation of momentum**. (2)

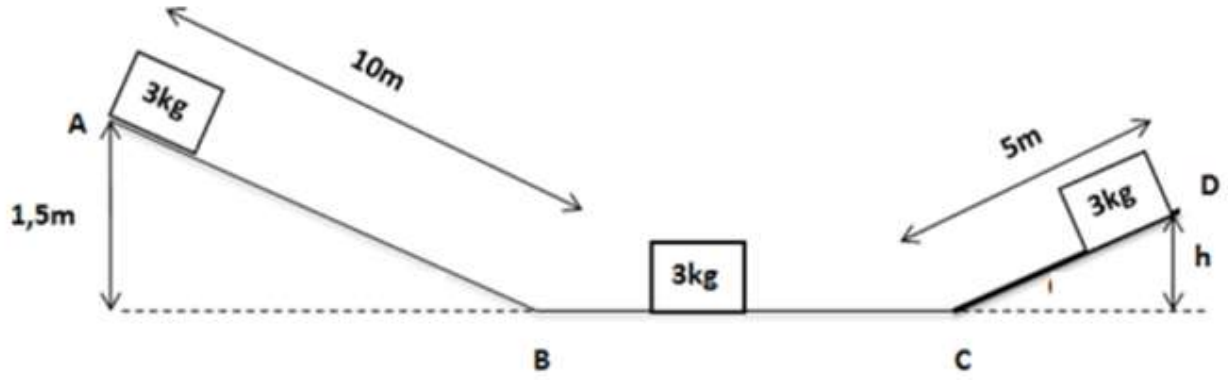
5.3 Calculate the velocity of section A after the explosion. (5)

5.4 Calculate the magnitude of the force that the section A exerts on section B if the blast lasts for 0,1 seconds. (3)

[12]

Question 6

A 3 kg block is released from rest at point **A** from a height of 1,5 m and slides down a 10 m long frictionless incline to point **B** as shown in the diagram below. It then moves along a frictionless horizontal surface **BC**, and finally slides up a 5 m long rough inclined plane **CD**. It comes to a rest at point **D** at an unknown height **h** above the ground.



The work done by friction on the block while it moves up the incline **CD** is 30 J.

6.1 State the *Work- Energy Theorem* in words. (2)

6.2 Draw a free body diagram and show ALL the forces acting on the block as it moves up the incline from **C** to **D.** (3)

6.3 Calculate the height **h** of the incline **CD**. (9)

[14]

Question 7

The siren of a stationary train emits sound waves with a frequency of 520 Hz as observed by a learner standing on a platform at the station. Take the speed of sound in air to be 340m.s^{-1}. Ignore the effects of wind.

7.1 State the Doppler Effect in words. (2)

7.2 Calculate the wavelength of the sound wave observed by the learner. (3)

A second train with an identical siren moves at a constant speed of 15m.s^{-1} towards the learner on the platform.

7.3 Calculate the frequency of the siren of the second train as observed by the learner. (4)

7.4 Write down the frequency heard by the driver of the second train. (1)

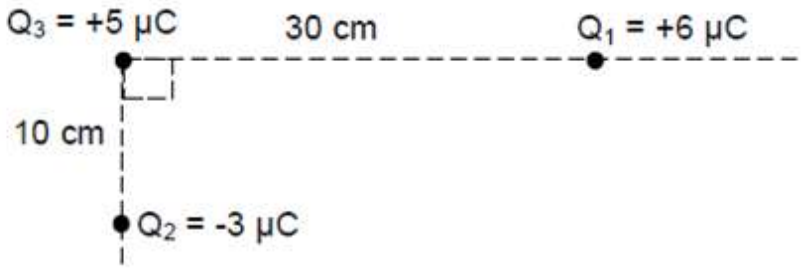
7.5 How does the wavelength of the sound waves from the siren of the SECOND train compare to that of the first train?
Write down only LONGER, SHORTER or THE SAME. Explain the answer. (3)

[13]

Question 8

Three point charges, Q_1, Q_2 and Q_3, carrying charges of +6 µC, -3 µC and +5 µC respectively, are arranged in space as shown in the diagram below.

The distance between Q_3 and Q_1 is 30 cm and that between Q_3 and Q_2 is 10 cm.



8.1 State Coulomb's law in words. (2)

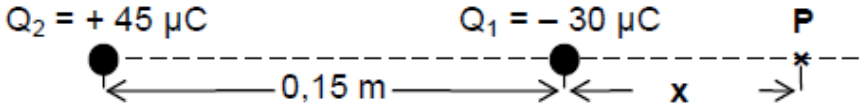
8.2 Calculate the net force acting on charge Q_3 due to the presence of Q_1 and Q_2. (7)
[9]

Question 9

9.1 Define *electric field at a point* in words. (2)

9.2 Draw the electric field pattern for two identical positively charged spheres placed close to each other. (3)

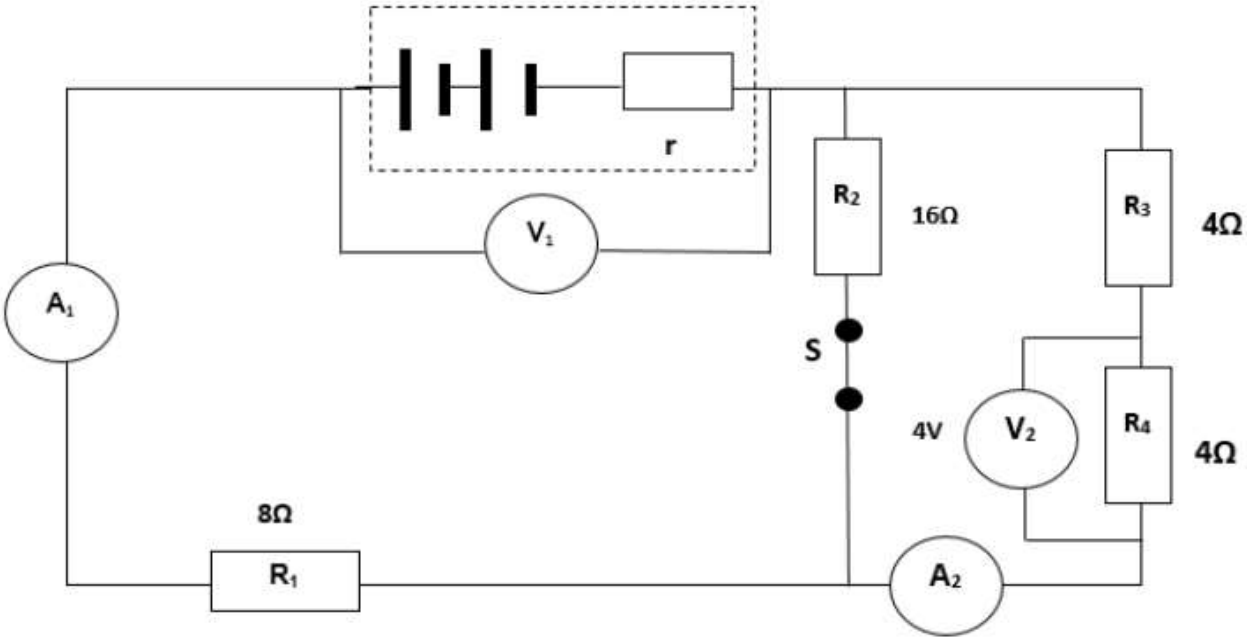
9.3 A – 30 µC point charge, Q_1, is placed at a distance of 0,15 m from a + 45 µC point charge, Q_2, in space, as shown in the diagram below. The net electric field at point **P**, which is on the same line as the two charges, is zero.



Calculate **x**, the distance of point **P** from charge Q_1. (5)
[10]

Question 10

The battery has an emf of 24V in the circuit shown below. When switch **S** is closed, the reading on $\mathbf{V_1}$ is 20V and the reading on $\mathbf{V_2}$ is 4V. The resistance of the different resistors is shown in the diagram. The resistance of the ammeter and connecting wires can be ignored.



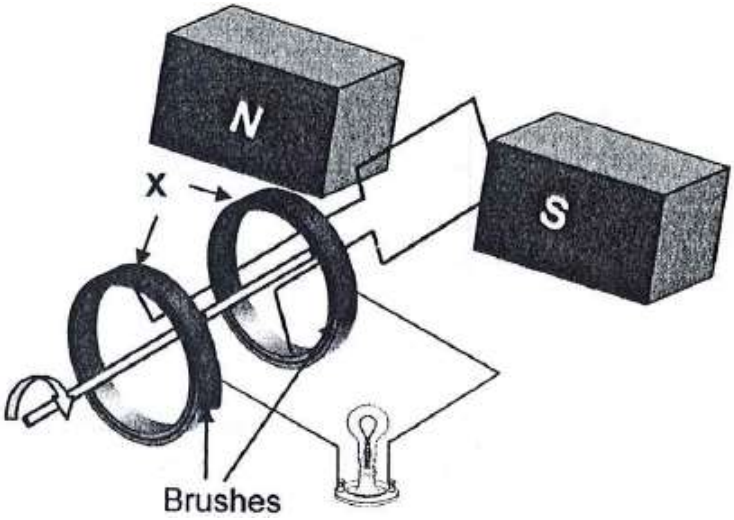
10.1 Calculate the internal resistance of the battery. (9)

10.2 Explain how the reading on $\mathbf{V_1}$ is influenced if switch S is opened. (4)

[13]

Question 11

The diagram below represents a simplified drawing of an electric device that is connected to a bulb.

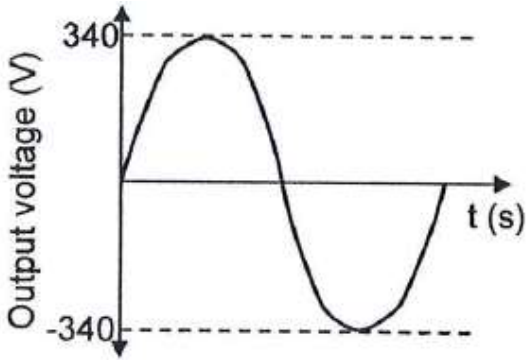


11.1 Write down the principle on which the device operates. (1)

11.2 Write down ONE method to increase the brightness of the bulb (1)

11.3 Write down the name of component X. (1)

The graph below shows the output voltage for one rotation of the coil in this electric device.

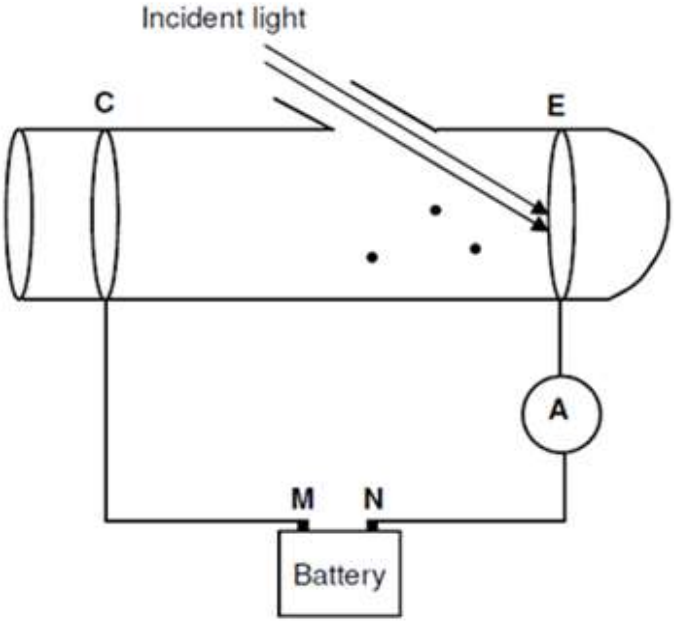


A 100W bulb is connected to this electric device and burns with maximum intensity.

11.4 Calculate the resistance of the bulb. (5)
[8]

Question 12

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.



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

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

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

12.2 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 the following? Write down only INCREASE, DECREASE or REMAIN THE SAME. Give an explanation for your answer

12.2.1 Number of electrons emitted per unit time (3)

[11]

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	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6{,}38 \times 10^{6}\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5{,}98 \times 10^{24}\ kg$
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	$9{,}11 \times 10^{-31}\ kg$

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*

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

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*

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

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) emk (ε) = I(R + r)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
W = Vq W = VI Δ 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*

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