LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 19 pages and 3 data sheets.

INSTRUCTION AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN (10) questions. Answer ALL 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 sub-questions, 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. Write down the question number (1.1-1.10), choose the answer and make a cross (X) over the letter (A-D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11

A	~~B~~	C	D

1.1 According to Newton's law of universal gravitation, the gravitational force of attraction that two bodies exert on each other is directly proportional to the ...

A product of their masses and inversely proportional to the distance between their centres.

B square of the distance between their centres and inversely proportional to the product of their masses.

C product of their masses and inversely proportional to the square of the distance between their centres.

D total mass and inversely proportional to the square of the distance between their centres. (2)

1.2 Which ONE of the following expressions gives a physical quantity that is a measure of the INERTIA of a body?

A $w = mg$

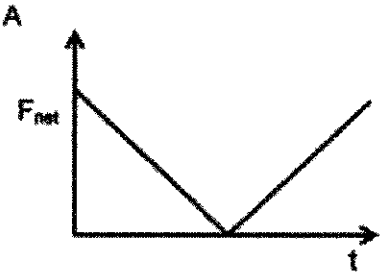
B $p = mv$

C $F_{net} \cdot \Delta t = m\Delta v$

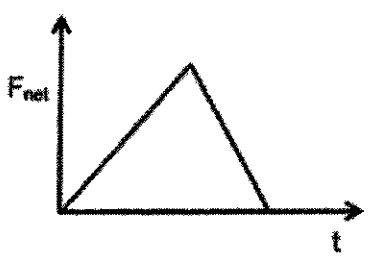
D $m = \frac{F_{net}}{a}$ (2)

1.3 A ball is thrown vertically upwards. Which ONE of the following graphs BEST represents the net force (F_{net}) exerted on the ball against time (t) while the ball is in the air? Ignore the effects of air resistance.

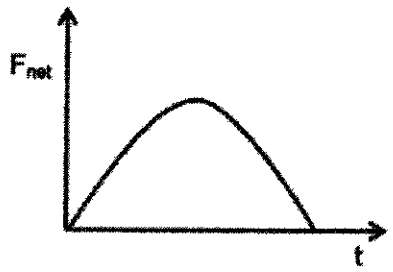
A



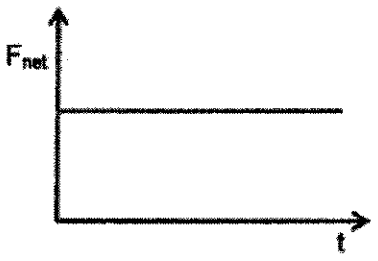
B



C



D



(2)

1.4 In the equation $F_{net} \cdot \Delta t = \Delta p$, the product $F_{net} \cdot \Delta t$ represents ...

A force per unit time.

B inertia of the body.

C impulse of the force.

D rate of change in momentum. (2)

1.5 For a body falling from a GREAT height in the absence of air resistance, which ONE of the following statements regarding kinetic energy (E_K) and gravitational potential energy (E_p) is TRUE at ALL points of the motion?

A $E_p - E_k$ = constant

B $E_p + E_k$ = constant

C E_k is equal to E_p

D E_k is less than E_p (2)

1.6 An astronomer observes certain spectral lines obtained from light from a bright star. The spectral line of one particular colour is found to have shifted towards the blue end of the visible spectrum.

This suggested that the star is ...

A stationary relative to earth.

B moving away from the earth.

C moving towards the earth.

D becoming brighter. (2)

1.7 A point charge Q_1 carrying a charge of **-q** is close to another point charge Q_2 carrying a charge of **+2q**.

If the magnitude of the electrostatic force that Q_1 exerts on Q_2 is F, then the electrostatic force that Q_2 exerts on Q_1 is ...

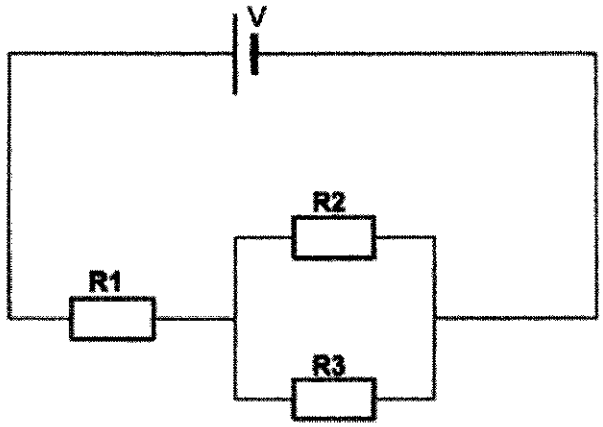
A F directed towards Q_2.

B F directed towards Q_1.

C 2F directed towards Q_2.

D 2F directed towards Q_1. (2)

1.8 The three resistors **R1**, **R2** and **R3**, in the circuit diagram below are identical. They are connected in series to a cell of emf **V** and negligible internal resistance.



If the potential difference across R1 is ½V, then the potential difference across R2 will be ...

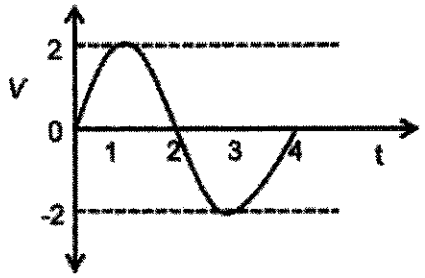
A ¼V.

B ½V.

C V.

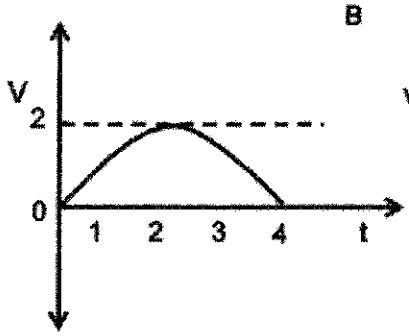
D 2V (2)

1.9 A simple **AC** generator produces a voltage (V) which varies with time (t), as shown in the diagram below.

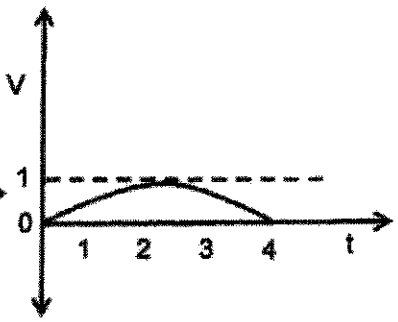


Which ONE of the following graphs shows how the voltage varies with time when the speed of rotation is halved?

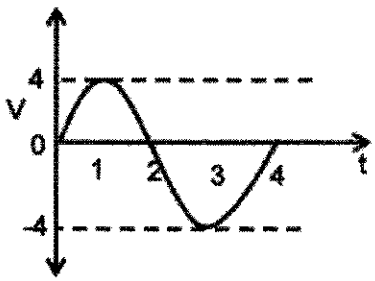
A



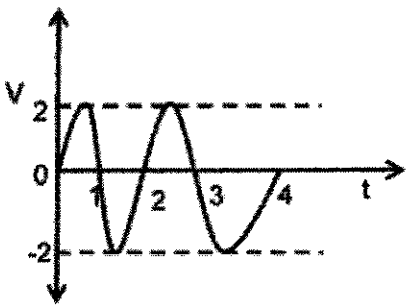
B



C

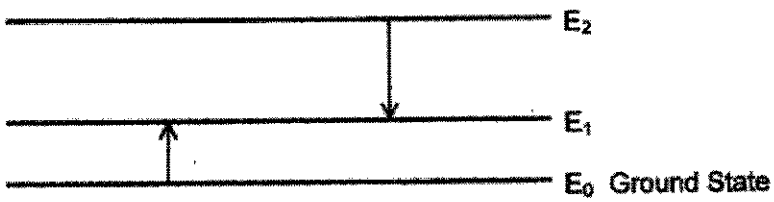


D



(2)

1.10 The energy level diagram for an element is shown in the diagram below.



The electron transition from E_2 to E_1 corresponds to a green line in the element's spectrum.

The transition E_0 to E_1 corresponds to the ...

A absorption of red light.

B absorption of green light.

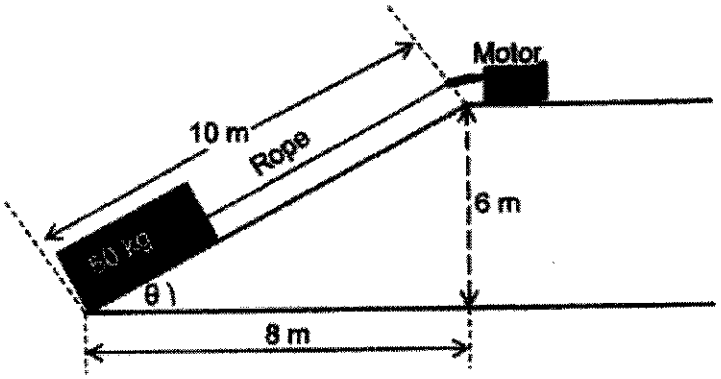
C emission of green light.

D emission of red light. (2)

[20]

QUESTION 2 (Start on a new page.)

A motor is used to pull a 50 kg block up the incline by means of a light (massless), inextensible rope, as the diagram below illustrates.



The coefficient of kinetic friction between the block and the incline is 0,70.

2.1 Define the term *kinetic frictional force* in words. (2)

2.2 Suggest a reason as to why the coefficient of kinetic friction is dimensionless (has no units). (1)

The block moves up the incline at CONSTANT VELOCITY.

2.3 What is the numerical value of the RESULTANT/NETFORCE, along the incline, on the block as it is being pulled? (1)

2.4 State, in words, Newton's First Law of Motion. (2)

2.5 Draw a labeled free-body diagram showing ALL the forces acting on the block as it is being pulled up the incline. (4)

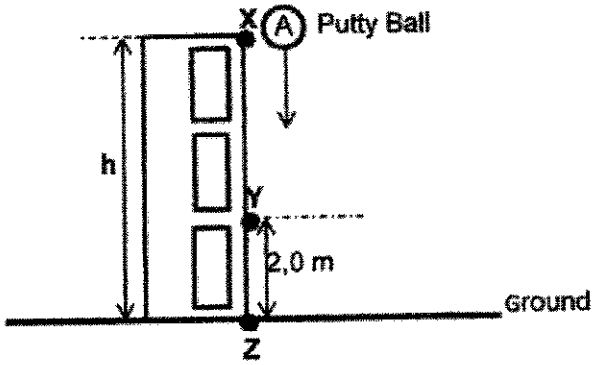
2.6 Show, by means of an appropriate calculation, that the tension in the rope is 568,4 N. (6)

[16]

QUESTION 3 (Start on a new page)

A Physics professor sets up an experiment to determine the height of a building.

- In his experiment he found that a putty ball, **A**, released from the top of a building, **X**, covers the last 2 m in the air in 0,125 s. Ignore the effects of air resistance.



3.1 State the value of the "*change in velocity per second*" for the putty ball. (1)

3.2 Determine the:

3.2.1 Height, **h**, of the building (4)

3.2.2 Time it takes the ball to reach point **Z** (3)

3.3 Sketch a position versus time graph to illustrate the motion of the putty ball from point **X** to point **Z**. **Use the ground as zero reference.**

Clearly indicate the following values on the graph:

- Height from which the ball was dropped
- Time at which the ball strikes the ground (3)

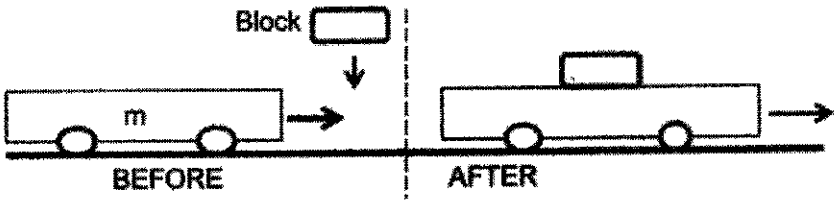
3.4 The experiment is repeated using a putty ball **B** of TWICE the mass of putty ball **A**.

Will the acceleration of ball **B** be GREATER THAN, EQUAL TO or LESS THAN the acceleration of ball **A**? Give a reason for the answer. (2)

[13]

QUESTION 4 (Start on a new page)

In a Physics laboratory, a trolley of unknown mass, m, moves along a track at a constant velocity of 0,4 $m \cdot s^{-1}$. A wooden block, mass 500 g, is released directly above and it lands on top of the trolley. The trolley, along with the block, continues moving at 0,15 $m \cdot s^{-1}$ in the same direction, as the diagram below illustrates.



4.1 Define, in words, the term *momentum* as used in Physics. (2)

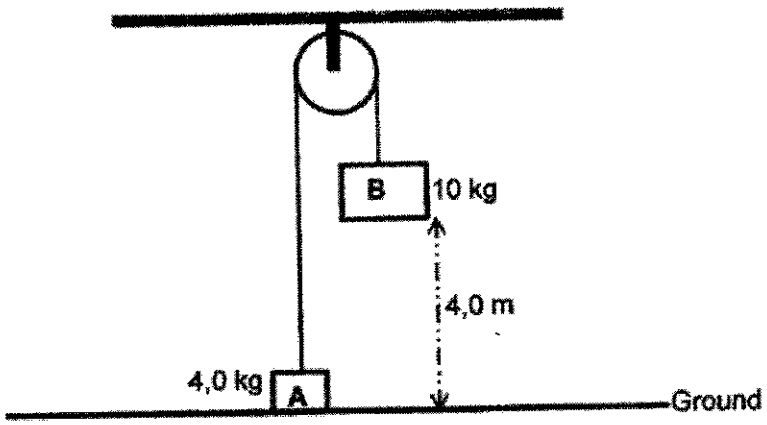
4.2 Is the collision between the wooden block and the trolley ELASTIC or INELASTIC? Use a suitable calculation to justify the answer. (6)

4.3 Draw a velocity versus time sketch graph to illustrate the motion of the trolley BEFORE and AFTER the block lands on it.**(no values required)**. (2)

[10]

QUESTION 5 (Start on a new page)

Blocks **A** and **B** in the diagram below are connected by a light (massless), inextensible string passing over a light, frictionless pulley.



Block **B** is released from rest at a height of 4,0 m above the ground. **Ignore the effects of air resistance.**

5.1 Draw a labeled free-body diagram for block **B** indicating ALL the forces acting on it as it moves downwards. (2)

5.2 State the NAME of the *conservative force* acting on block **A** while moving upwards. (1)

5.3 State, in words, the *work- energy theorem*. (2)

5.4 Using the **work-energy theorem**, show that block **B** hits the ground at a speed of 5, 797 $m \cdot s^{-1}$. (7)

5.5 Calculate the time it takes block **A** to travel 4,0 m upwards. (3)
[15]

QUESTION 6 (Start on a new page)

A car sounds its horn as it travels at a steady speed of 15 $m \cdot s^{-1}$ along a straight road between two stationary observers, **X** and **Y**. Observer **X** hears a frequency of 538 Hz whilst observer **Y** hears a lower frequency. The phenomenon observed by **X** and **Y** is called the Doppler Effect. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1 State ONE condition necessary for the Doppler Effect wave phenomenon to be observed. (1)

6.2 Is the car travelling TOWARDS **X** or TOWARDS **Y**? Explain the answer by referring to **speed of sound**, **wavelength** and **frequency**. (4)

6.3 Calculate the:

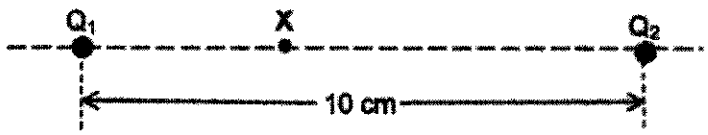
6.3.1 Frequency of the car's horn (4)

6.3.2 Frequency heard by **Y** as the car travels at 15 $m \cdot s^{-1}$. (4)

6.4 State ONE application of the Doppler Effect in the medical field. (1)
[14]

QUESTION 7 (Start on a new page)

7.1 The diagram below shows Q_1 with a charge of $+1,0 \times 10^{-6}$ C placed 10 cm from a charge Q_2 with a charge of $+2,0 \times 10^{-6}$ C.



7.1.1 State *Coulomb's Law of electrostatics* in words. (2)

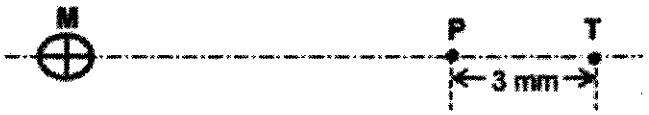
7.1.2 The net electrostatic force exerted on an **electron** placed at point **X** is **zero newton**.

Calculate the distance (in cm) between Q_1 and point **X**. (5)

7.2 **M** is a positive point charge.

7.2.1 Sketch the electric field pattern caused by **M**. (2)

P and **T** are two points some distance to the right of **M**. The distance between **P** and **T** is 3 mm, as the sketch below illustrates.



The magnitudes of the electric field at points **P** and **T** is **$4,0 \times 10^5$ N·C^{-1}** and **$2,5 \times 10^5$ N·C^{-1}** respectively. (2)

7.2.2 Define, in words, the term electric field at a point.

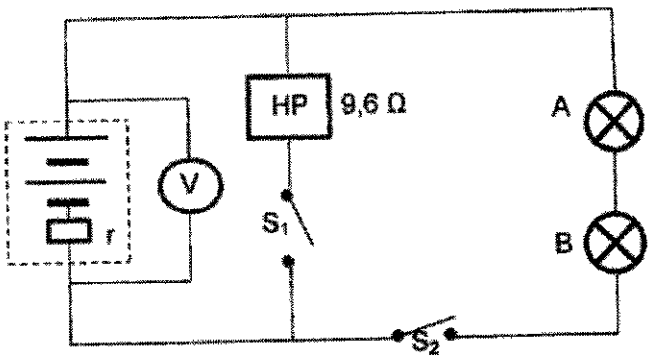
7.2.3 Calculate the magnitude of the charge on **M**. (6)
[17]

QUESTION 8 (Start on a new page)

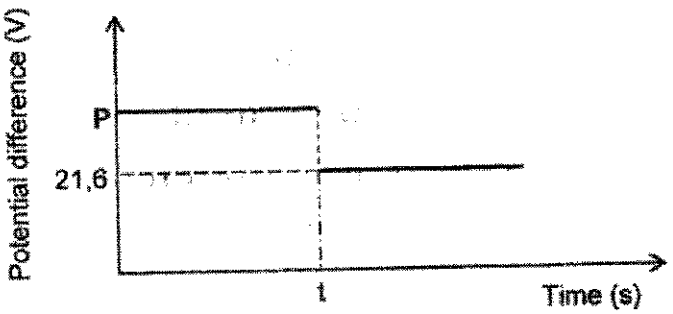
8.1 A customer with a prepaid meter buys 180 kW.h for R 261 (including VAT) at the shop.

Calculate the cost of electricity for the customer to run a 120 W television set for 4 hours a day for 30 days. (4)

8.2 A holidaymaker sets up a circuit in her caravan. She uses **two** 12 volt car batteries of unknown internal resistance and connects a hot plate (HP) of resistance 9,6 Ω in parallel with two identical light bulbs, **A** and **B**, as illustrated in the circuit diagram below. The resistance of the connecting wires is negligible.



The graph below shows the potential difference across the terminals of the battery BEFORE and AFTER switch S_1 is closed. Switch S_1 is closed after t seconds while switch S_2 remains open.



8.2.1 Define the term *emf* of the battery (2)

8.2.2 Refer to the graph and write down the value of **P**. (1)

WITH ONLY SWITCH S_1 CLOSED, calculate the:

8.2.3 Current through the hot plate (3)

8.2.4 Internal resistance, r, of the battery (3)

BOTH SWITCHES, S_1 and S_2, ARE NOW CLOSED and the battery delivers a current of 8 A during this period.

8.2.5 Calculate the resistance of light bulb **A**. (4)

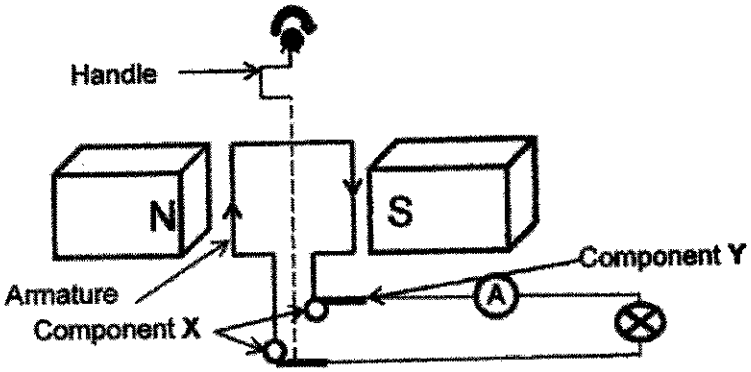
8.2.6 How will the voltmeter reading be affected if the hot plate burns out? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Provide a reason for the answer. (3)
[20]

QUESTION 9 (Start on a new page)

Grade 12 learners investigate a factor which affects the current induced in an alternator (AC generator). They use a hand-operated alternator consisting of a handle, which rotates an armature of conducting coils.

The alternator is connected to a sensitive ammeter and a small light bulb, as shown in the simplified diagram below.



9.1 Write down the following: (1)

9.1.1 The NAME of component X

9.1.2 The function of component Y (1)

9.2 As the handle is turned the light bulb flickers and the ammeter needle fluctuates from left to right. Suggest a reason for this observation. (1)

9.3 State the energy conversion that takes place when the alternator is in operation. (1)

The results obtained are shown in the table below.

TRIALS	SPEED OF ROTATION OF THE ARMATURE (Cycles per second)	MAXIMUM AMMETER READING (A)
1	6	0,21
2	8	0,28
3	10	0,35

9.4 Formulate a suitable INVESTIGATIVE QUESTION for this investigation. (2)

9.5 Write down a suitable conclusion that can be drawn from the results obtained. (1)

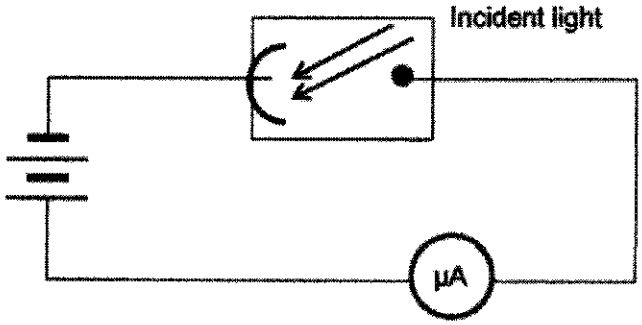
9.6 Write down the fundamental principle on which alternators operate. (1)

9.7 Refer to TRIAL 3 and calculate the root mean square value of the voltage which is induced across the light bulb when the average power dissipated in the bulb is 1,5 W.

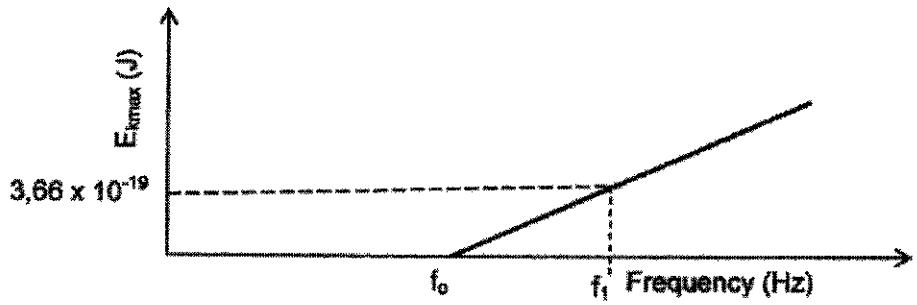
(4)
[12]

QUESTION 10 (Start on a new page)

Some Physics learners conduct an investigation into the relationship between the maximum kinetic energy ($E_{k,max}$) and the frequency of the incident light falling on the cathode of a photo-electric cell. The apparatus shown below is used in the investigation.



The maximum kinetic energy of the ejected photoelectrons versus the frequency of the incident light is plotted, as shown in the graph below.



10.1 For this investigation, write down the INDEPENDENT variable. (1)

10.2 Name the frequency, f_o, shown on the graph. (1)

The work function of the metal used as cathode is 6,08634 x 10^{-19} J.

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

10.4 Calculate the frequency, f_1, shown on the graph. (3)

10.5 Draw a sketch graph of the maximum kinetic energy of the photoelectrons versus the intensity of the incident light (**no values needed**). (2)

10.6 Is it possible for a photoelectron ejected by the incident light to have the SAME energy as the photon of the incident light? State only YES or NO.
Fully explain the answer. (4)
[13]

TOTAL: 150

