HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- PHYSICS

SEPTEMBER 2020

TIME: 3 HRS
TOTAL 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

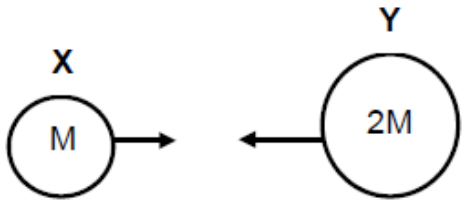
   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations,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

SECTION A

QUESTION 1: MULTIPLE CHOICE QUESTIONS

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 Two fairly large asteroids, **X** and **Y**, have masses M and 2M respectively. They move towards each.



If the magnitude of the acceleration of asteroid **X** is **a**, then magnitude of the acceleration of asteroid **Y** would be …

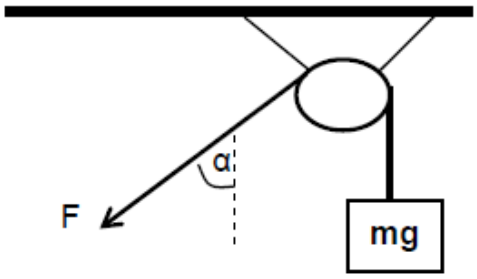
A ¼ **a**

B **a**

C ½ **a**

D 2 **a**

1.2 An object of WEIGHT **mg** hangs from a light cord passing over a light, frictionless pulley, as shown in the diagram below.



What constant force F, applied on the end of the cord, as shown, would hold the object at **REST**?

A **F = mg**

B **F = mg** x sin α

C **F = ½ mg**

D **F = mg** x cos α

1.3 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 3*v*. After the collision, the first ball moves off in the opposite direction with a speed 1,5*v*. 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*

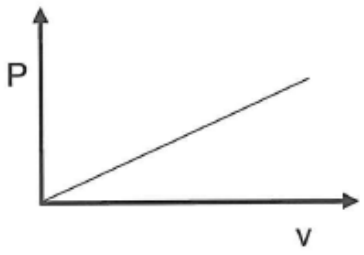
C 2 *v*

D 3 *v*

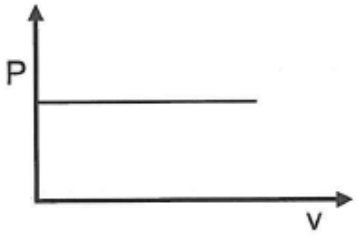
1.4 A car moves along a level road with CONSTANT ACCELERATION.

Which ONE of the following graphs shows the relationship between power (**P**) and velocity (**v**) for the car?

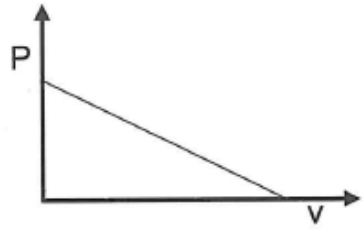
A



B



C



D

1.5 When light wave from a distant star is analysed, it is found that the wave is *red-shifted.*

This confirms that the wave experienced a/an …

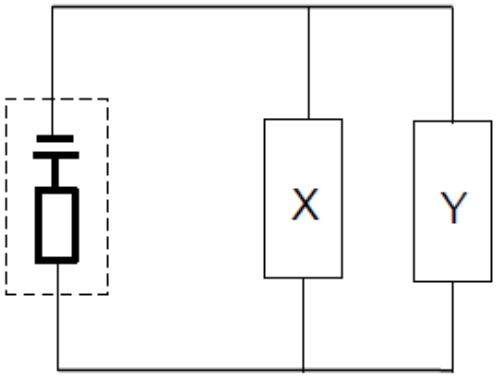
A decrease in wavelength and increase in frequency.

B decrease in wavelength and decrease in frequency.

C increase in wavelength and decrease in frequency.

D increase in wavelength and increase in frequency.

1.6 In the circuit below the resistance of Y is twice that of X.



If the power dissipated in X is *P*, then the power dissipated in Y will be …

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

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

C $2P$.

D $4P$.

1.7 Two charged spheres on insulating stands carrying charges Q_1 and Q_2 are kept a distance *r* apart.

Each sphere exerts an electrostatic force of magnitude *F* on the other. The distance between the spheres is now DOUBLED and the charge on one sphere is HALVED. The magnitude of the new electrostatic force on a sphere is …

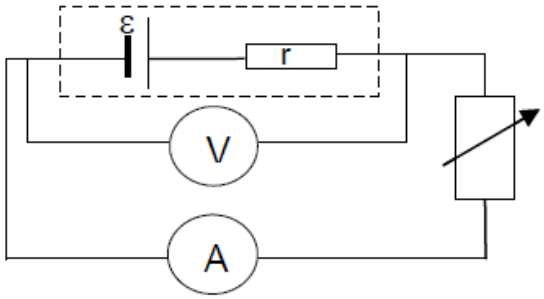
A F.

B $\frac{F}{2}$.

C $\frac{F}{4}$.

D $\frac{F}{8}$.

1.8 In the circuit shown below, a variable resistor is used.



The resistance of the variable resistor is *decreased*. Which ONE of the following combinations of changes will occur in the voltmeter and ammeter readings?

	Voltmeter reading	**Ammeter reading**
A	Unchanged	Unchanged
B	Decreases	Increases
C	Decreases	Unchanged
D	Increases	Increases

1.9 The wavelength of a monochromatic light source **P** is half that of a monochromatic light source **Q**. The energy of a photon from source **P** is E.

What will be the energy of a photon from source **Q**?

A $\frac{E}{4}$

B $\frac{E}{2}$

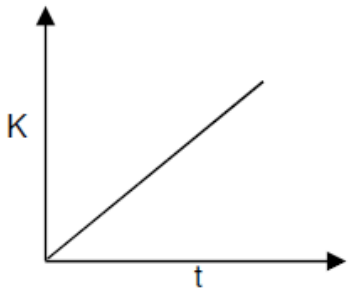
C E

D 2E

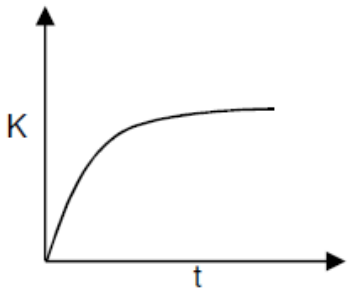
1.10 A ball is dropped from the edge of a cliff.

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.

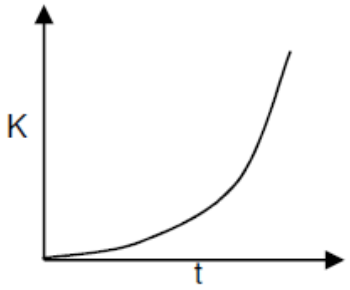
A



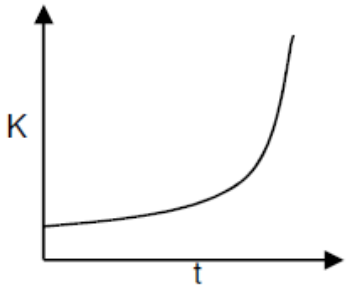
B



C



D



[2 X 10 = 20]

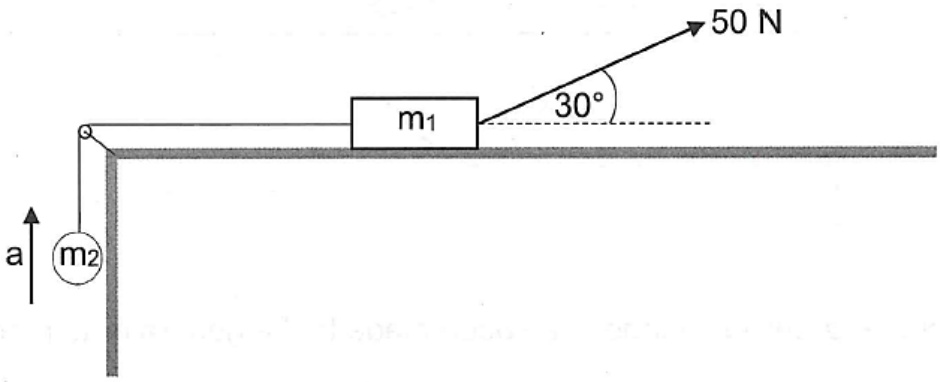
SECTION B
INSTRUCTIONS

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.
3. Round off your final numerical answers to TWO decimal places.

QUESTION 2

2.1 A block of mass m_1 = 5 kg, on a *rough*, horizontal surface is connected to a ball of mass m_2 = 200 g by a string over a frictionless pulley.

A force of magnitude 50 N at an angle of 30° with the horizontal is applied to the block, as shown in the diagram below.



The coefficient of kinetic friction between the block and the surface is 0,21. Ignore the effects of air resistance and the masses of the string and pulley.

2.1.1 State, in words, *Newton's Second Law of Motion* in terms of acceleration. (2)

2.1.2 Draw a labelled free-body diagram for the block. (5)

2.1.3 Applying Newton's Second Law, calculate the tension in the string connecting the block to the ball. (6)

2.2 A body of mass m kg is at a distance of 500 km above the surface of the Earth.

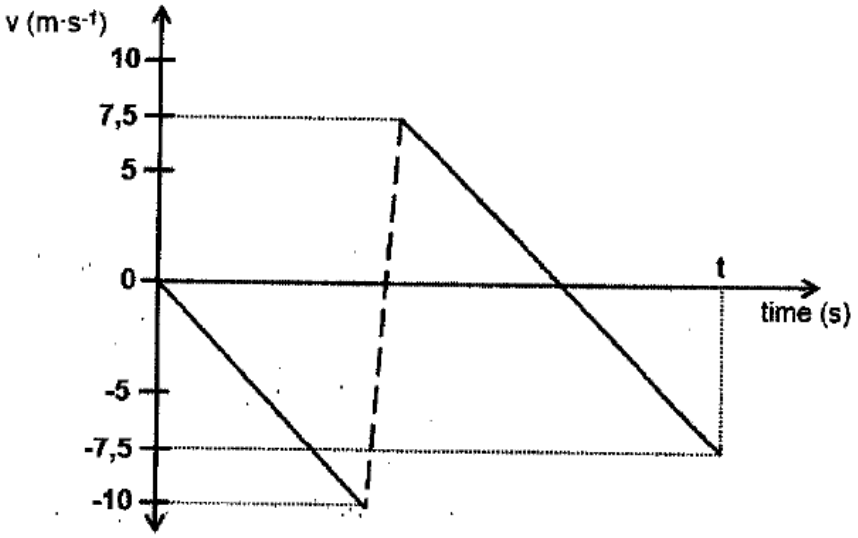
Calculate the *percentage* by which the *weight* of the body is reduced at this altitude. (4)

[17]

Question 3

A ball of mass 0.2kg is dropped vertically from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity versus time graph below shows the motion of the ball. Ignore the effects of air friction.

DOWNWARD MOTION IS TAKEN AS NEGATIVE.



3.1 Explain the term *free fall*. (2)

Use the graph to answer the following questions

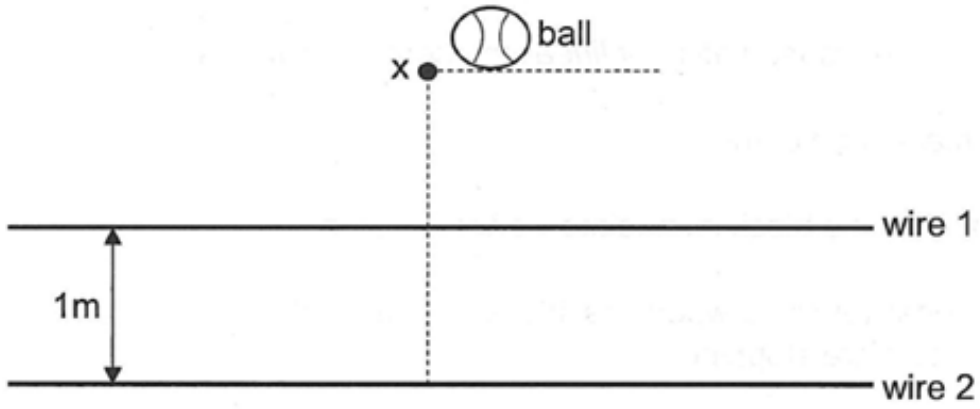
3.2 Write down the number of times the ball hits the floor. (1)

3.3 Calculate the height:

3.3.1 From which the ball was dropped (4)

3.3.2 Reached by the ball after the first bounce (3)

3.4 Two horizontal wires are placed parallel to each other, 1 m apart and one directly above the other. A ball is dropped from some point **X** above the two wires, as shown in the diagram below. Neglect the effect of air resistance.



The ball takes 0,2 s to pass between the two wires.

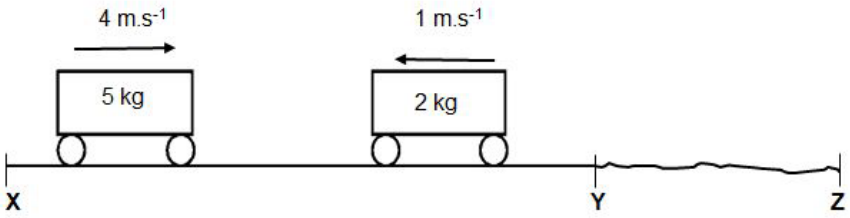
3.4.1 Calculate the speeds (v_1 and v_2) of the ball as it passes the wires, **1** and **2**, respectively. (6)

[16]

QUESTION 4

The diagram below shows two sections, **XY** and **YZ**, of a horizontal, flat surface. Section **XY** is *smooth*, while section **YZ** is *rough*.

A 5 kg trolley, moving with a velocity of 4 $m.s^{-1}$ to the right, collides head-on with a 2 kg trolley moving with a velocity of 1 $m.s^{-1}$ towards the 5 kg trolley. After the collision, the two trolleys stuck together and move to the right pass point **Y.**



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

4.2 Calculate the magnitude of the velocity of the combined trolleys at point Y. (4)

The combined trolleys travel for 0,3 s from point **Y** before coming to a stop at point **Z**.

4.3 Calculate the magnitude of the net force acting on the combined trolleys when they move through section **YZ**. (4)

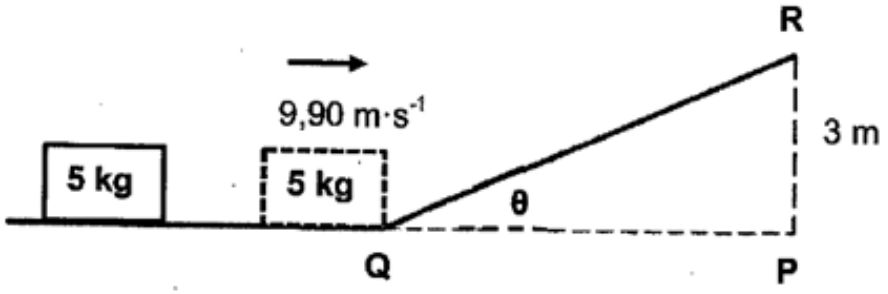
4.4 Section **YZ** serves the same function as an arrestor bed (sandpit to stop run-away heavy trucks). Explain this function of arrestor beds on our roads using the impulse-momentum theorem. (2)

[12]

QUESTION 5

5.1 In an experiment, a rough inclined plane **QR** has been constructed to stop a moving 5kg block. The block reaches point **Q** with a speed 9.90 $m.s^{-1}$. The block comes to a stop at point **R** which is 3m above level **QP**.

The frictional force between the surface **QR** and the block is 18N.



5.1.1 Define a non-conservative force. (2)

5.1.2 Use energy principles and calculate the angle ⊖ of slope **QR**. (7)

[9]

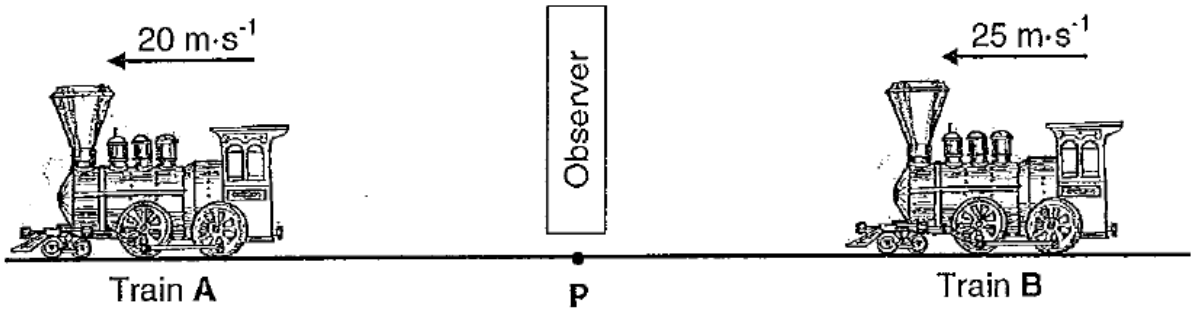
QUESTION 6

6.1 Define the term *wavelength* in words. (2)

6.2 Calculate the wavelength of sound waves released by a stationery siren with a frequency of 1520 Hz. (3)

Two trains, A and B, move at a constant velocity of 20 $m.s^{-1}$ and 25 $m.s^{-1}$ respectively on a straight, horizontal track as shown in the diagram below. An observer is at rest at point **P**. The siren of each train is emitting sound waves with a frequency of 1520 Hz.

Take the speed of sound in the air as 340$m.s^{-1}$. Ignore the effects of wind.



6.3 Calculate the:

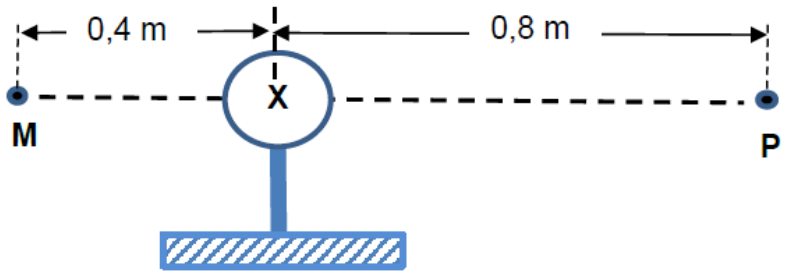
6.3.1 Observed frequency of the siren of train **A**. (4)

6.3.2 Difference between the frequencies observed for trains **A** and **B** (4)

[13]

QUESTION 7

The diagram below shows a metal sphere **X** of negligible mass on an insulated stand in a vacuum. 3,125 x 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)

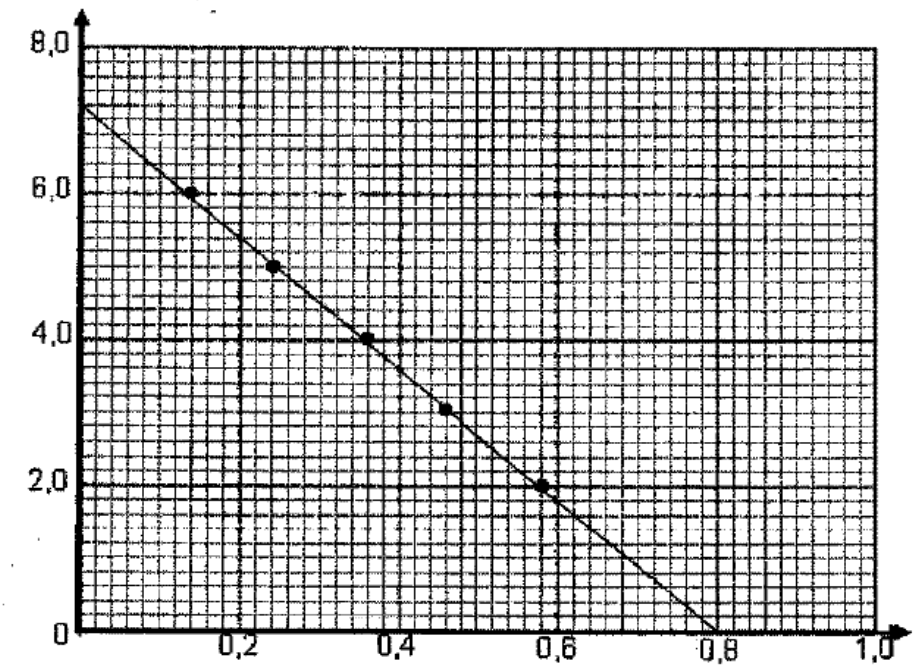
7.5 How does the magnitude of the electric field at point **M** compare with the value calculated in QUESTION 7.4? Write down only GREATER THAN, EQUAL TO or SMALLER THAN. Give a reason for the answer. (2)

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

A group of learners conduct an experiment to determine the emf (E) and internal resistance(r) of a battery. The data obtained from the experiment is used to plot points on graph paper and draw a line of best fit. The graph of one of the learners is given below. The X and Y axes have not been labelled.



8.1 Explain the term internal resistance. (1)

8.2 Write down ONE factor which must be kept constant during this experiment. (1)

Using the graph:

8.3 Provide a label for the y-axis. (1)

8.4 Write down the quantity represented by the gradient? (1)

8.5 Write down the emf of the battery. (1)

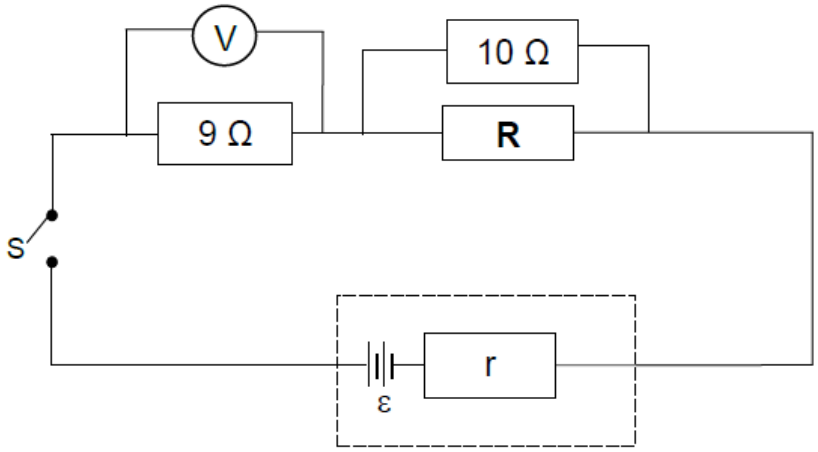
8.6 Calculate the internal resistance of the battery. (4)

8.7 Determine the value of V_{int} when the graph reaches 0.8 on the x-axis. (1)

[10]

Question 9

In the circuit below the battery can supply a maximum of 12 J of energy per 1 coulomb of charge. The resistances of the connecting wires are negligible. The internal resistance of EACH CELL in the battery is 0,2 Ω.



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

9.2 Give the phrase for the underlined words. (1)

Switch **S** is now closed. The voltmeter measures 6,75 V.

9.3 Calculate the:

9.3.1 Current in the battery. (3)

9.3.2 Resistance of resistor **R**. (7)

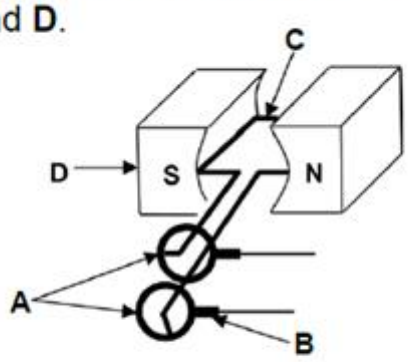
9.4 It is very common to connect many appliances to a multiplug which results in overheating. Modern multiplugs have a cut-off switch built in to avoid this overheating.

Use the knowledge of parallel circuits, explain why this cut-off switch is important. (3)

[16]

Question 10

A simplified AC generator is shown in the diagram below. The main components are labelled **A**, **B**, **C** and **D**.



10.1 Name the principle on which the generator operates. (1)

10.2 Write down the NAME of the component labelled:

10.2.1 **A** (1)

10.2.2 **B** (1)

10.3 Will the induced emf be a MAXIMUM or a MINIMUM as component **C** is in position shown above? (1)

10.4 AC generators can be converted into DC generator.

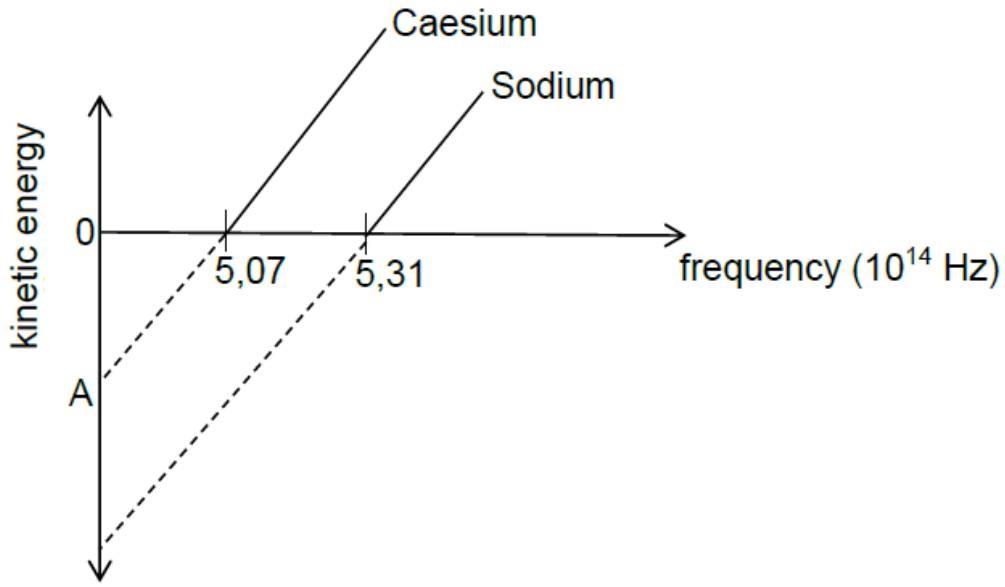
10.4.1 Name the component needed to effect the above conversion. (1)

10.4.2 Sketch an induced emf versus time graph for a DC generator for one complete rotation of component **C**. (2)

[7]

Question 11

In an experiment, light of different frequencies is shone onto two photocells, one with caesium cathode and the other one with sodium cathode. The sketch graph of frequency versus kinetic energy of the emitted electrons is shown below.



11.1 Define the term *threshold frequency (cut-off frequency)*. (2)

11.2 Which photocell will, for the same frequency of light, emit photoelectrons of higher kinetic energy? Choose from caesium or sodium. (1)

11.3 Name the energy value shown as **A**. (1)

11.4 Write down the name of the quantity represented by the gradient of this graph. (1)

For a certain frequency of light, the maximum kinetic energy of a photoelectron from sodium cathode is $2,03 \times 10^{-19}$ J.

11.5 Calculate the wavelength of the light used. (5)

11.6 What influence will the following changes in the incident light have on the maximum kinetic energy of the photo electrons emitted?
Choose from INCREASES, DECREASES or STAYS THE SAME.

11.6.1 An increase in the wavelength of light used. Give a reason for your answer. (2)

11.6.2 An increase in the intensity of light used. Give a reason for your answer. (2)

[14]

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*

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