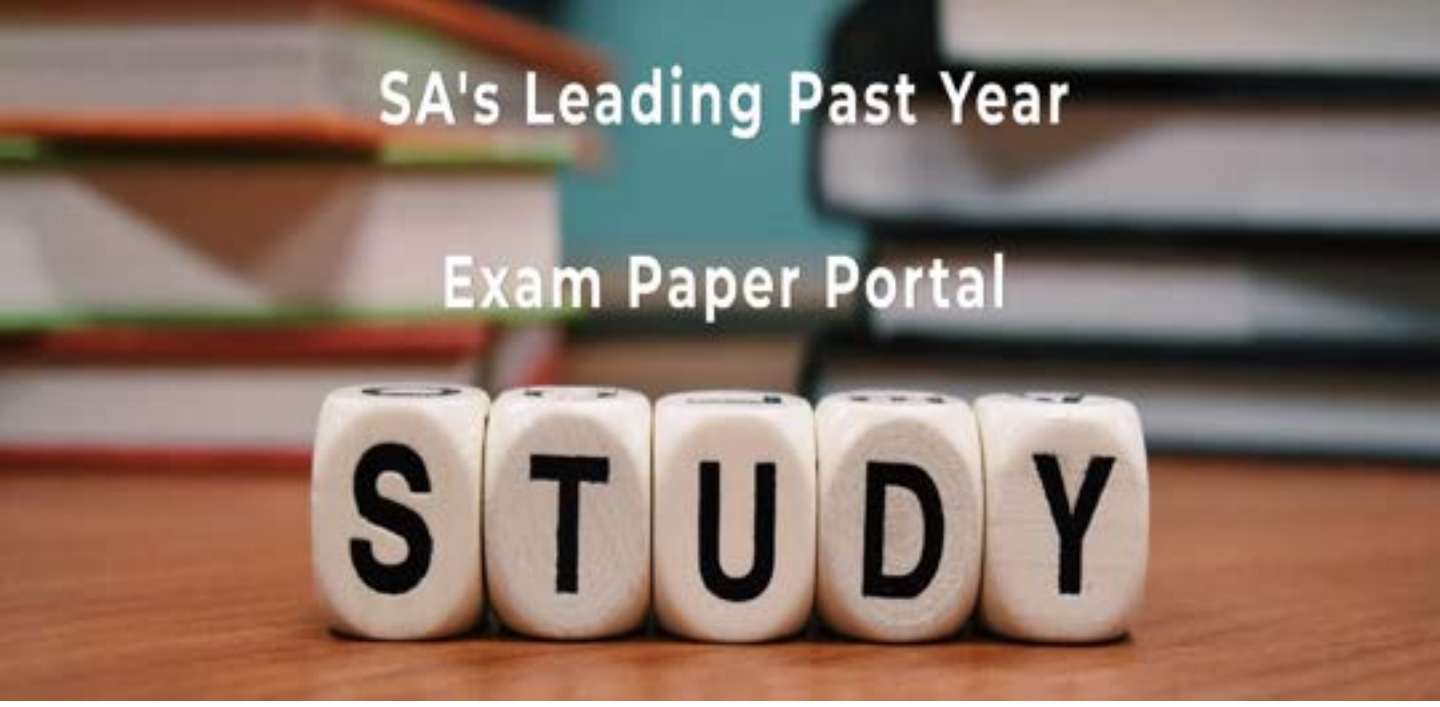

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Basic Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: (PHYSICS) P1

PREPARATORY EXAMINATION

SEPTEMBER 2016

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 150

TIME : 3 hours

This question paper consists of 16 pages and a 3 page data sheet.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.

2. This question paper consists of TEN 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

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, for example 1.11 E.

1.1 A railway coal truck moving with constant velocity collides with a similar truck which is stationary. Both trucks become coupled together and move off in the same direction as the first truck.
Which ONE of the following statements correctly describes the system making up the two trucks above?

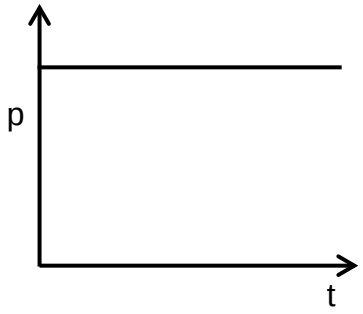
A Both the momentum and kinetic energy is conserved.
B Neither the momentum nor the kinetic energy is conserved.
C The momentum is conserved but the kinetic energy is not conserved.
D The kinetic energy is conserved but the momentum is not conserved. (2)

1.2 Which ONE of the following statements is FALSE? An object can have . . .

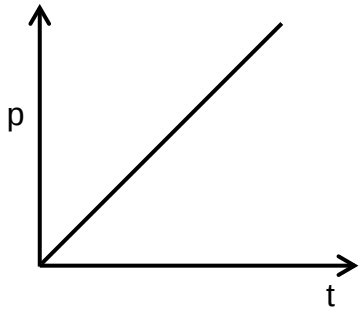
A zero velocity even though it's acceleration is not zero.
B a constant velocity even though it's speed is changing.
C a constant acceleration even though it's velocity is changing.
D a constant acceleration even though it's velocity is reversing direction. (2)

1.3 A constant resultant force acts on a body which moves from rest in a straight line.
Which ONE of the following graphs best shows the relationship between the momentum (p) of the body and time (t) while this constant force is acting on the body?

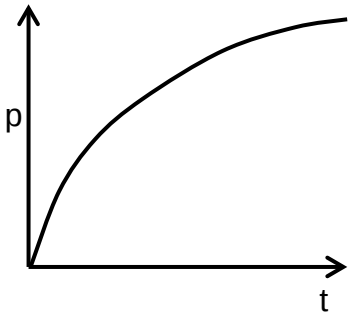
A



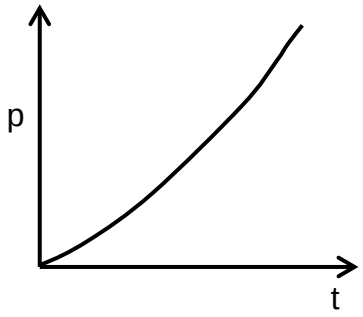
B



C

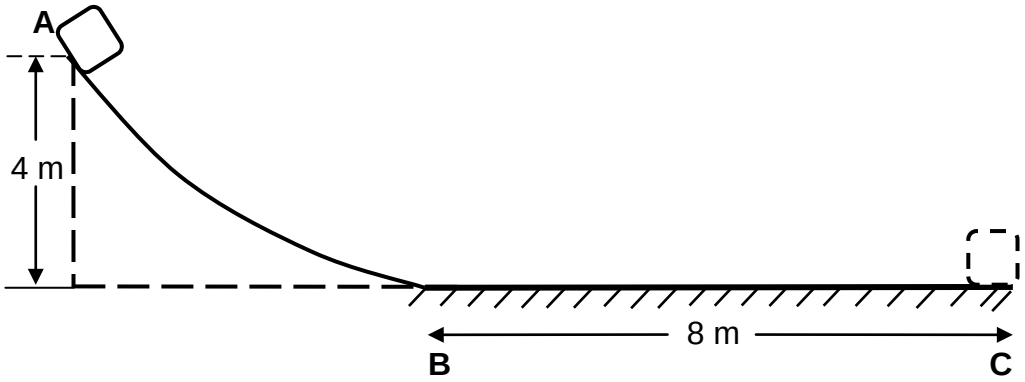


D



(2)

1.4 The diagram below shows a track, **ABC**. The curved section, **AB**, is frictionless. The rough horizontal section, **BC**, is 8 m long.



An object of mass 10 kg is released from point **A** which is 4 m above the ground. It slides down the track and comes to rest at point **C**.

Which ONE of the following statements about the mechanical energy of the 10 kg mass is INCORRECT?

A. The mechanical energy increases from A to B.
B. The mechanical energy decreases from B to C.
C. The mechanical energy at B is equal to the kinetic energy at B.
D. The mechanical energy is not conserved from B to C, but is conserved from A to B. (2)

1.5 A bird flies directly away from a stationary birdwatcher at constant velocity. The bird constantly emits sound waves at a frequency of 1 650 Hz. Which ONE of the following combinations of properties of the sound heard by the birdwatcher, as the bird flies away is correct?

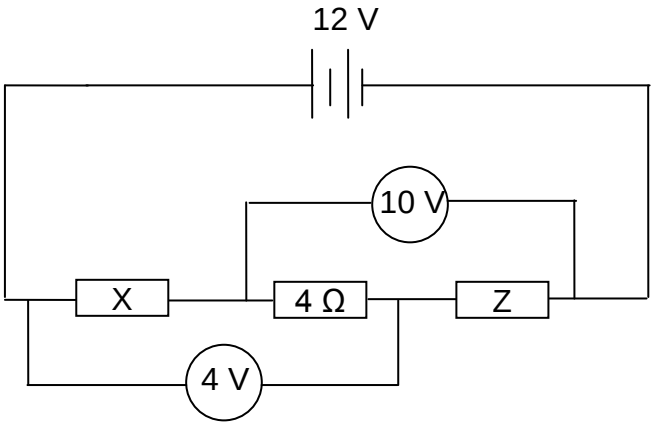
	velocity	frequency
A	decreases	remains the same
B	remains the same	decreases
C	decreases	decreases
D	remains the same	remains the same

(2)

1.6 Which ONE of the following statements about an alternating current generator is TRUE?

A The minimum voltage produced is not zero volts.
B The emf produced decreases as the number of windings in the armature increases.
C The maximum value of the alternating current can be increased by increasing the period of rotation.
D The maximum value of the alternating current produced can be increased by increasing the speed of rotation of the coil. (2)

1.7 A circuit is set up as shown in the diagram below. The emf of the battery is 12 V. The voltmeters read 4 V and 10 V as shown.



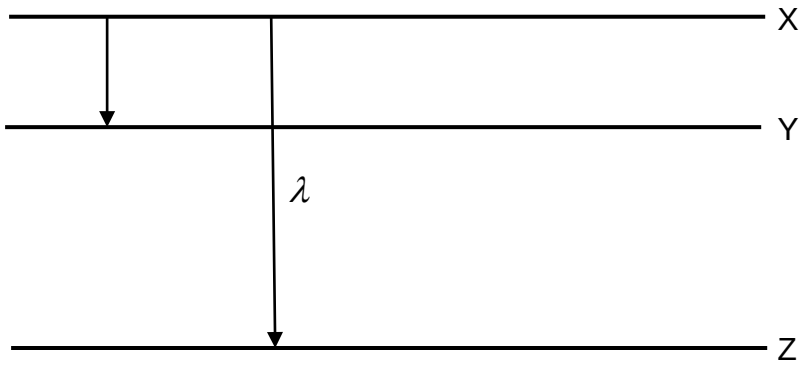
The battery has no internal resistance and the resistance of the conducting wires can be ignored.

The value of resistor X is . . .

A 2 Ω B 4 Ω

C 6 Ω D 8 Ω (2)

1.8 The diagram represents 3 energy levels, X, Y and Z in a certain atom. The energy difference between levels Y and Z is three times the energy difference between levels X and Y.



If the wavelength of a photon emitted as a result of the transition from X to Z, is λ, what is the wavelength of the photon emitted during the transition from X to Y?

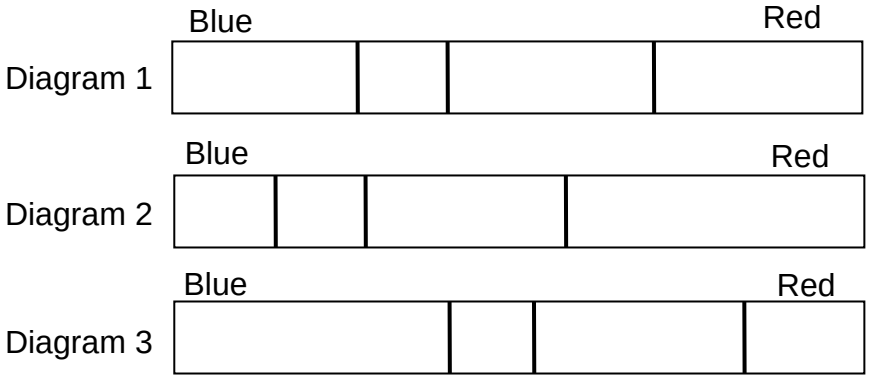
A $\frac{\lambda}{3}$

B 3λ

C 4λ

D $\frac{\lambda}{4}$ (2)

1.9 The diagrams below represent different spectral lines of an element.
Diagram 1 represents the spectrum of the element in a laboratory on Earth.
Diagrams 2 and 3 represents the spectrum of the same element from a distant star.



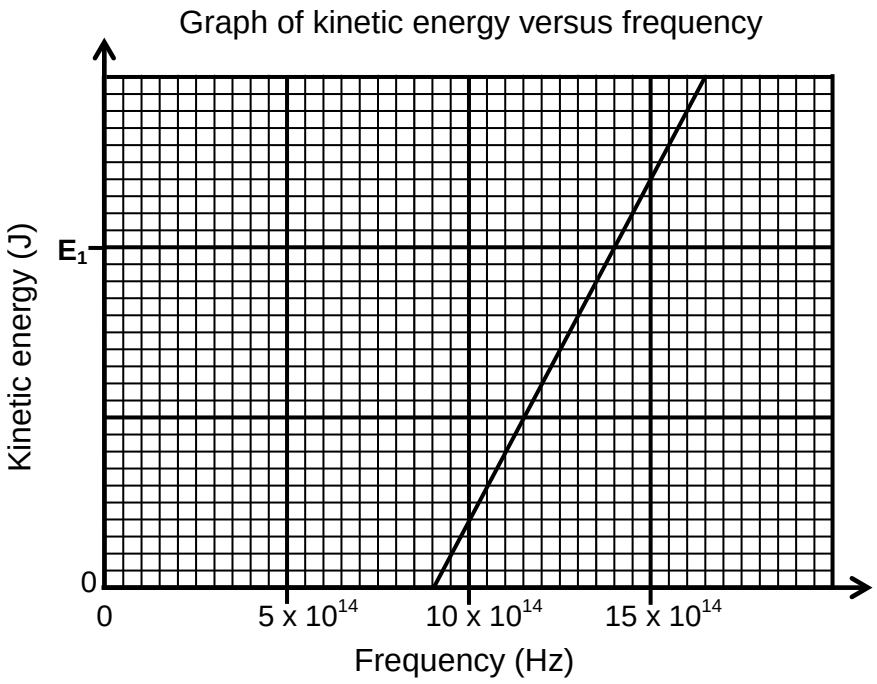
The following conclusions are made from the above diagrams.

(i) According to diagram 2 the distance between the Earth and the Star is decreasing.
(ii) According to diagram 3 the distance between the Earth and the Star is constant.
(iii) The wavelengths of the corresponding spectral lines in diagram 2 are the longest.

Which of the conclusion/s is/are correct?

A (i) only
B (ii) only
C (i) and (iii) only
D (ii) and (iii) only (2)

1.10 During an investigation, light of different frequencies is shone onto the metal cathode of a photocell. The kinetic energy of the emitted photoelectrons is measured. The graph below shows the results obtained.



Which ONE of the following combinations can be deduced from the above graph?

	Independant variable	Threshold frequency(Hz)
A	Frequency	$E_1 \div 5 \times 10^{14}$
B	Kinetic energy	$E_1 \div 5 \times 10^{14}$
C	Kinetic energy	9×10^{14}
D	Frequency	9×10^{14}

(2)

TOTAL FOR SECTION A: [20]

SECTION B

INSTRUCTIONS AND INFORMATION

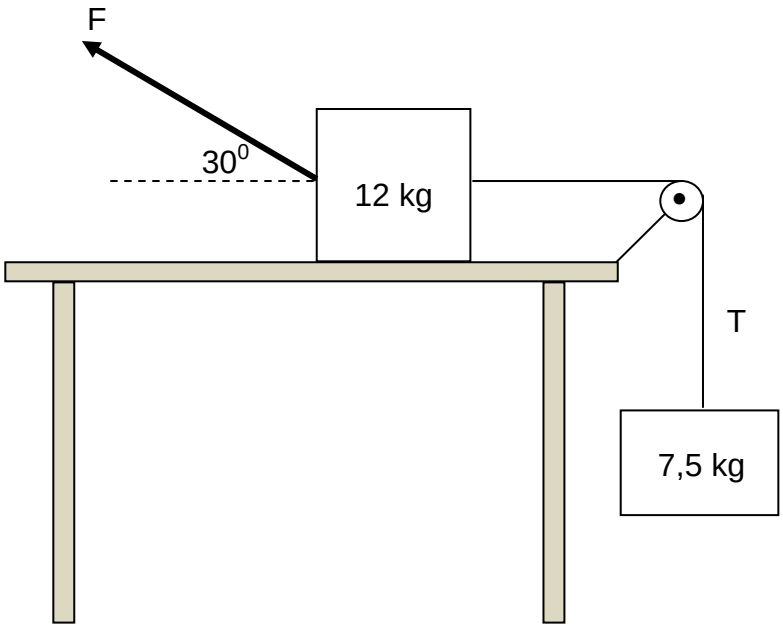
1. Start EACH question on a NEW page.
2. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your numerical answers to at least TWO decimal places.

QUESTION 2

2.1 Write down Newton's Second Law in words. (2)

2.2 A block of mass 12 kg resting on a rough horizontal table is connected by a light inextensible string which passes over a frictionless pulley to another block of mass 7,5 kg. The 7,5 kg block hangs vertically as shown in the diagram below.

A force of magnitude F is applied to the 12 kg block at angle of 30^0 to the horizontal to prevent the blocks from moving.



The maximum co-efficient of static friction(μ_s), between the 12 kg block and the surface of the table is 0,45. Ignore the effects of air friction.

2.2.1 Calculate the tension, T, in the string. (2)

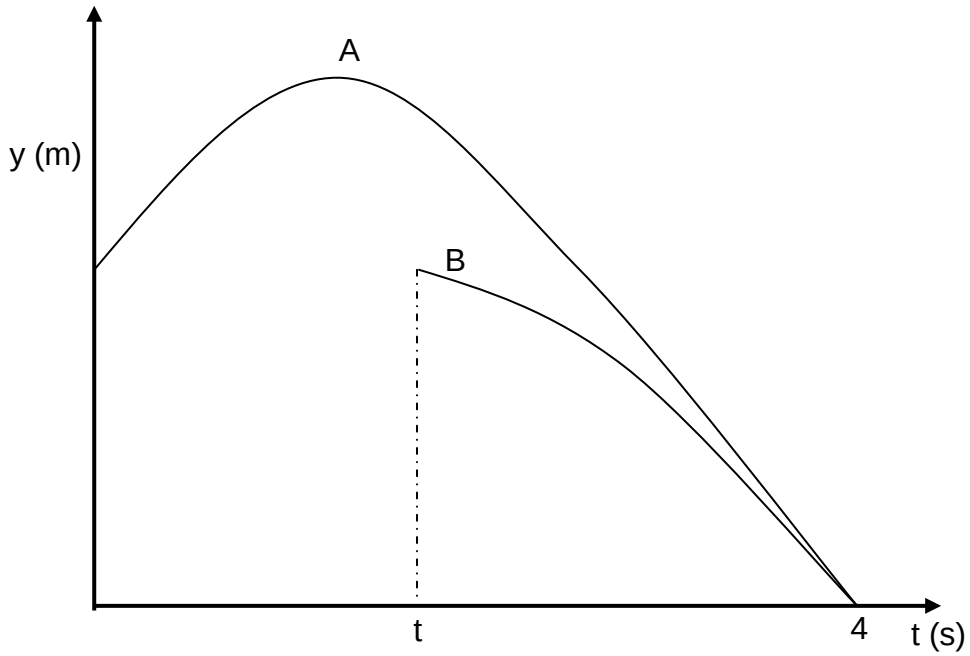
2.2.2 Calculate the minimum value of F that will prevent the blocks from moving. (4)

2.3 A satellite of mass 650 kg is in orbit around the Earth. The Earth exerts a force of magnitude 6346,07 N on the satellite. Calculate the height, in kilometres, of the satellite above the surface of the Earth. (5)

[13]

QUESTION 3

The graph below shows the position-time relationship of two stones, A and B, launched from the top of the same building.



Stone A is thrown vertically upwards at 19 $m.s^{-1}$ and strikes the ground after 4 seconds. Stone B is dropped at time t seconds and strikes the ground at the same time that stone A strikes the ground.

3.1 Express, in terms of t, the time taken for stone B to strike the ground. (1)

3.2 Determine the numerical value of t. (5)

3.3 Calculate the time taken for stone A to reach its maximum height. (3)

3.4 Which stone strikes the ground with a higher velocity? (1)

3.5 Sketch the velocity-time graphs for both stones on the same set of axes. Use the letter A to label the graph for stone A and the letter B to label the graph for stone B.

Indicate the following on the graph:

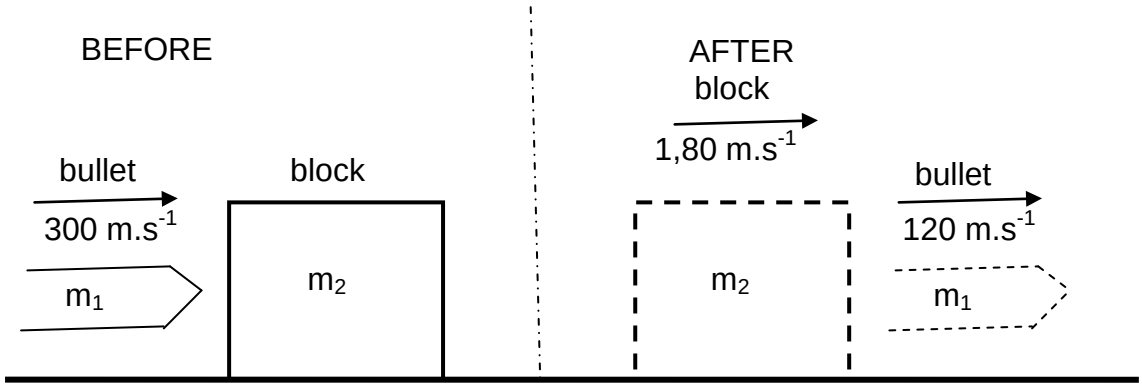
(a) The initial velocity of stone A.
(b) The time when stone B is dropped.
(c) The time taken for stone A to reach its maximum height. (5)

[15]

QUESTION 4

The diagram below shows a bullet of mass, m_1, striking a block of mass m_2 lying stationary on a horizontal, frictionless surface.

The bullet strikes the block with a velocity of 300 $m.s^{-1}$, passes through the block and emerges from the block with a velocity of 120 $m.s^{-1}$. The block moves at 1,8 $m.s^{-1}$ in the original direction of the bullet.



It is observed that the kinetic energy of the bullet – block system decreases by 752,76 J.

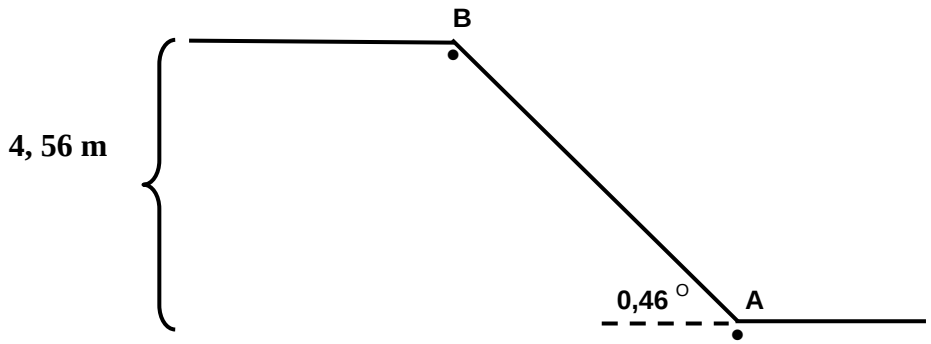
4.1 Is the collision between the bullet and the block, ELASTIC or INELASTIC. Give a reason for the answer. (2)

4.2 Use the principle of Conservation of Linear Momentum to calculate the mass of the block in terms of the mass of the bullet. (4)

4.3 Calculate the mass of the block in kilograms. (5)
[11]

QUESTION 5

A car of mass 1500 kg needs to maintain a constant speed of 10 $m.s^{-1}$ up a constant hill of height 4,56 m inclined at 0,46 ^{o} to the horizontal.



The co-efficient of kinetic friction(μ_k), between the surface of the hill and the tyres of the car is 0,017.

5.1 State the WORK-ENERGY theorem. (2)

5.2 Draw a labelled free body diagram to show all the forces acting on the car whilst it is moving up the incline with a constant speed of 10 $m.s^{-1}$. (4)

5.3 Show that the magnitude of the kinetic frictional force that acts on the car is 249,98 N while it moves up the hill. (3)

5.4 Use the WORK-ENERGY theorem to calculate the average power the engine of the car must provide to ensure that the car is able to get up the hill from A to B whilst maintaining a constant speed of 10 $m.s^{-1}$. (7)
[16]

QUESTION 6

A traffic official is stationary on the side of a road where the speed limit is set at 100 km.hr^{-1}. He hears the hooter of car that is travelling at constant velocity on this road. The hooter emits sound waves of frequency 433,64 Hz.

The wavelength of the sound detected by the traffic official is 0,72 m. The speed of sound in is 340 m.s^{-1}.

6.1 State the Doppler effect in words. (2)

6.2 Calculate the frequency of the waves detected by the traffic official. (3)

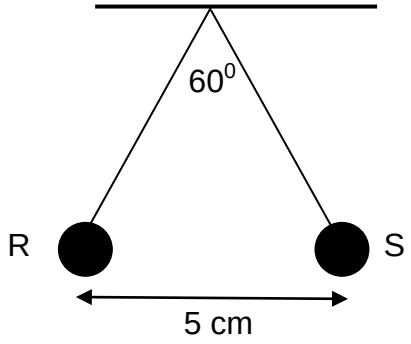
6.3 Is the car travelling towards or away from the traffic official? Give a reason for your answer. (2)

6.4 Perform a calculation to determine whether the car is exceeding the speed limit. (6)

6.5 If the car travels at a lower constant velocity, how will this affect the frequency detected by the traffic official?
Write down GREATER THAN, LESS THAN or THE SAME AS. (1)
[14]

QUESTION 7

Two identical small metal coated spheres R and S, are given identical charges of 40 nC each. They are suspended at the same point from a ceiling by means of identical light, inextensible insulating threads of equal length. The threads are of negligible mass. When the system is in equilibrium the angle between the threads is 60^0 while the distance between R and S is 5 cm.



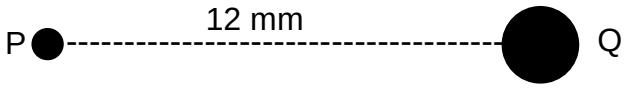
7.1 State Coulomb's Law of electrostatics. (2)

7.2 Draw a labelled free-body diagram showing ALL the forces acting on sphere R. (3)

7.3 Calculate the mass of sphere R. (6)
[11]

QUESTION 8

Two positive point charges, P and Q, are separated by a distance of 12 mm. The charge on P is +3 nC and the charge on Q is +27 nC.



8.1 Draw an electric field pattern for charge P when it is isolated from charge Q. (2)

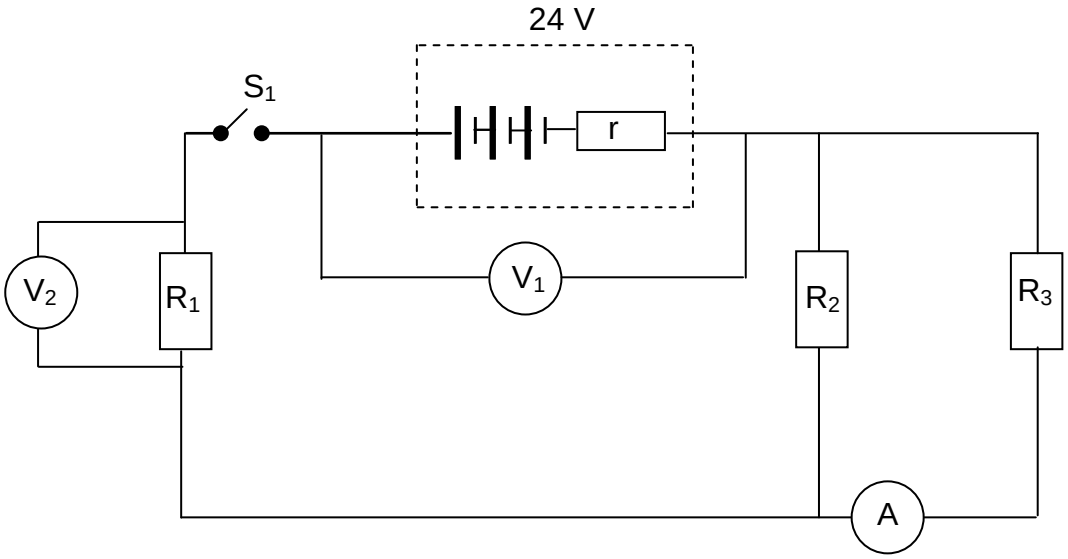
8.2 Define the term *electric field at a point*. (2)

8.3 S is a point between charges P and Q, on the line joining the centres of charges P and Q. S is located y metres from charge Q. The net electric field at point S due to charges P and Q is zero.

Determine the numerical value of y, in metres. (6)
[10]

QUESTION 9

9. An electric circuit is set up as shown in the diagram below. The resistance of the switch, ammeter and connecting wires are negligible. The voltmeters have a very high resistance.



The resistance of R_1 is 1,5 Ω, the resistance of R_2 is 10 Ω, while the resistance of R_3 is unknown.

When the switch is closed, the ammeter reads 1,2 A and the voltmeter V_2 reads 4,5 V.

9.1 Calculate the value of the resistance of R_3. (7)

9.2 Calculate the internal resistance, r, of the battery. (5)

9.3 R_3 is replaced with another resistor of greater resistance.

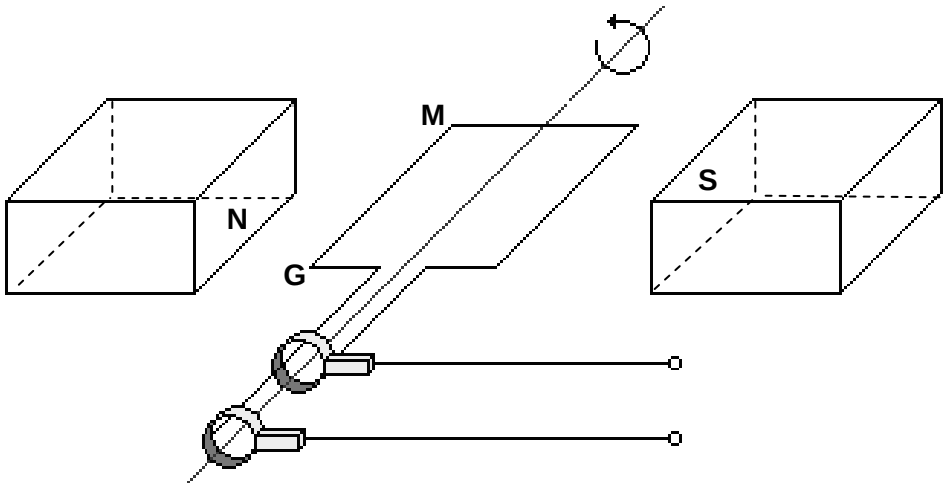
9.3.1 Will the reading on the voltmeter V_1 connected across the terminals of the battery increase, decrease or remain the same? (1)

9.3.2 Explain the answer to question 9.1.3 (a), making reference to relevant formulae. (4)

[17]

QUESTION 10

A coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



10.1 Determine the direction of the current in segment GM when the coil is in the position shown above. Only write down G to M OR M to G. (1)

The output potential difference of the generator shown in the above diagram is 311,13 V at 50 Hz.

10.2 An electrical device connected to the generator shown above, consumes $9,45 \times 10^6$ J of energy in two hours. Calculate the . .

10.2.1 power rating of the electrical device. (3)

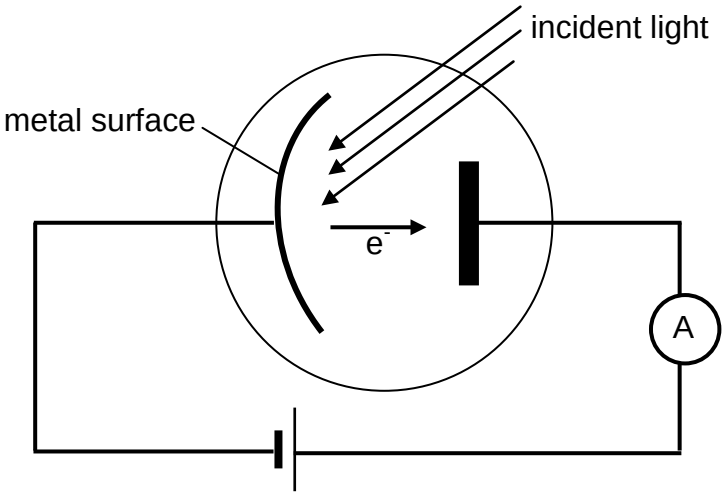
10.2.2 maximum current through the electrical device when connected to the generator shown above. (6)

10.3 Starting from the position shown in the diagram, sketch a graph of the output current versus time when the coil completes TWO full cycles. Indicate the following on the graph:

(a) the maximum current.
(b) The time taken to complete the two cycles. (3)
[13]

QUESTION 11

In the diagram shown below, electrons are released from the surface of a metal plate when light of a certain frequency is shone on its surface.



11.1 Name the phenomenon described above. (1)

The wavelength of the incident light on the metal plate is 487 nm and electrons are released with a velocity of 3,51 x 10^5 $m.s^{-1}$.

11.2 Define, in words, work function. (2)

11.3 Calculate the work function of the metal plate. (4)

11.4 The wavelength of the incident light is kept constant while the intensity is increased. What effect will this change have on the following: (write INCREASES, DECREASES or REMAINS THE SAME)

11.4.1 the reading on the ammeter. Explain the answer. (2)

11.4.2 the threshold frequency of the metal plate. (1)

[10]

TOTAL SECTION B: [130]

TOTAL MARKS: [150]