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 17 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 D.

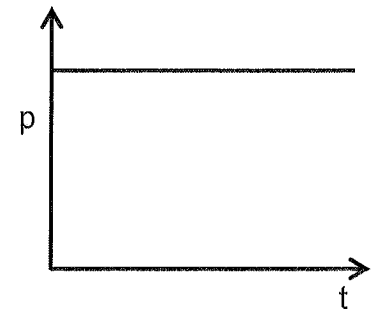
1.1 Two objects are involved in a perfectly elastic collision.
Which ONE of the following statements describing the collision is TRUE?

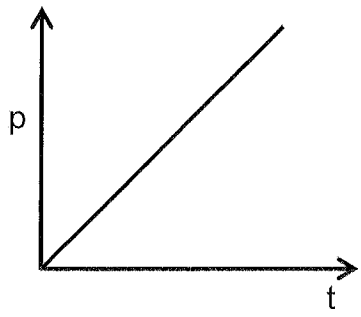
A Both the momentum and kinetic energy is conserved.
B Neither the momentum nor the kinetic energy is conserved.
C The momentum is conserved but the kinetic energy is not conserved.
D The kinetic energy is conserved but the momentum is not conserved. (2)

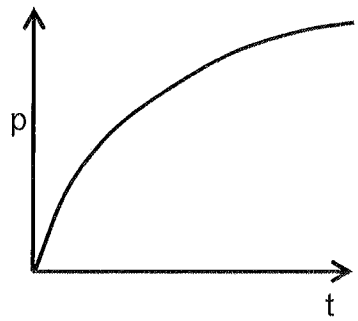
1.2 Which ONE of the following statements regarding frictional force is CORRECT? A frictional force is . . .

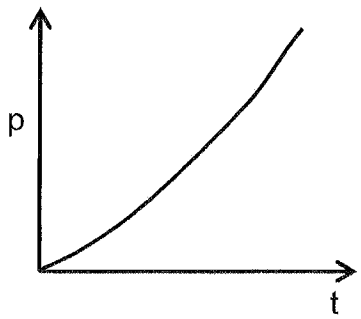
A dependant on the applied force.
B independant of the normal force.
C independent of the area of contact.
D dependent on the velocity of the motion. (2)

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


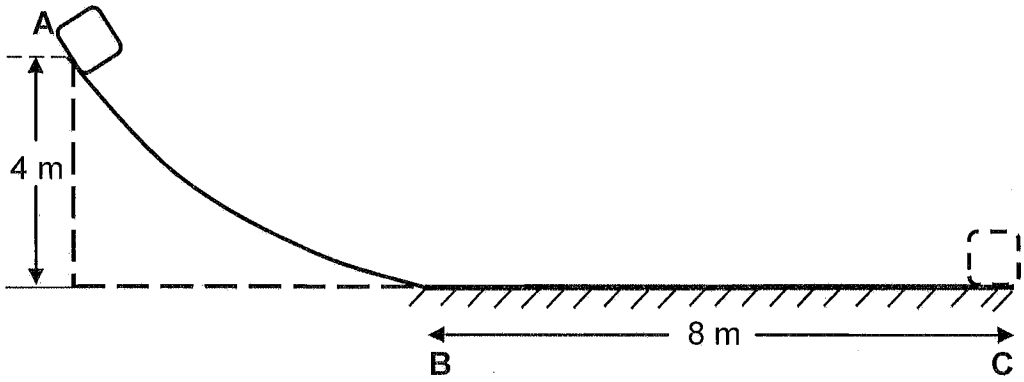
B


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.



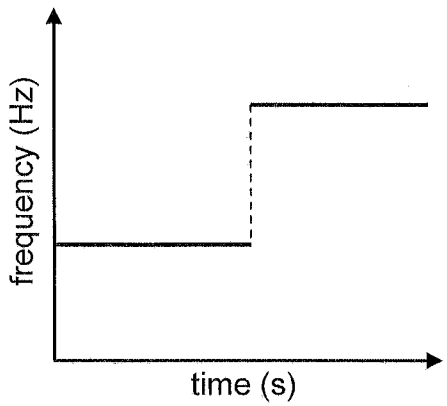
An object of mass 10 kg is released from point **A** which is 4 m above the ground. It slides down the track and comes to rest at point **C**.

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

The mechanical energy . . .

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

1.5 The siren of a moving ambulance emits sound waves of a frequency of 800 Hz. The sketch graph below shows the change in frequency observed by a stationary listener against time.



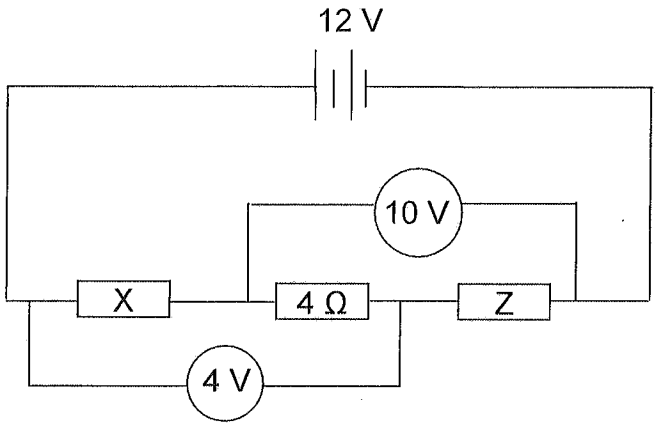
The motion of the ambulance can best be described as moving . . .

A at a lower speed and then a higher speed.
B at a higher speed and then a lower speed.
C towards the listener and then away from the listener.
D away from the listener and then towards the listener. (2)

1.6 Which ONE of the following statements about an alternating current generator is TRUE when it is in operation?

A The emf produced decreases as the frequency of the rotation increases.
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.



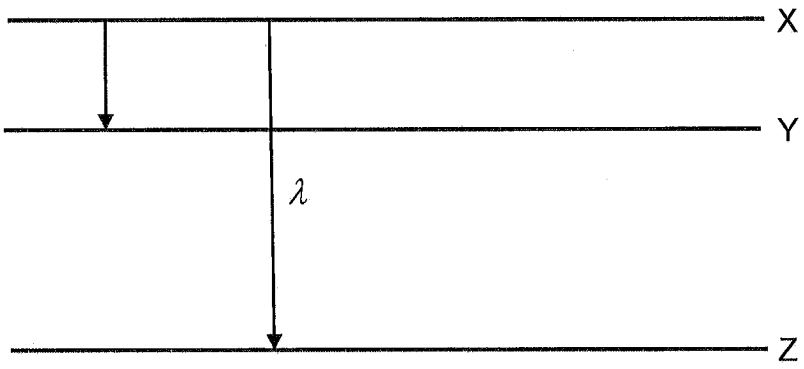
The battery has no internal resistance and the resistance of the conducting wires can be ignored.

The value of resistor X is . . .

A 2 Ω B 4 Ω

C 6 Ω D 8 Ω (2)

1.8 The diagram below, 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?

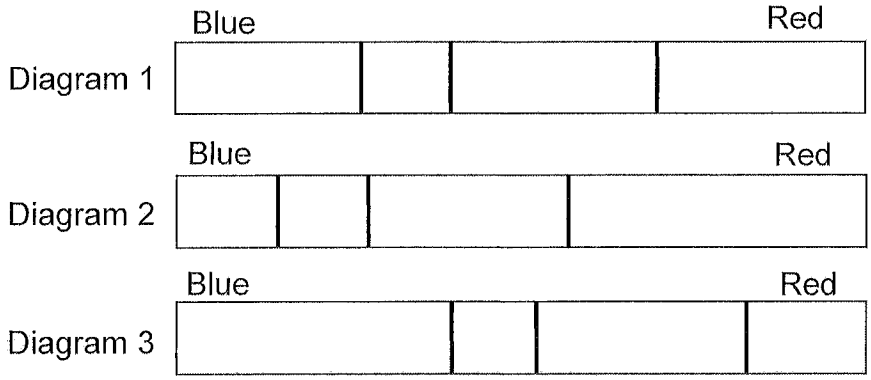
A $\frac{\lambda}{3}$

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.



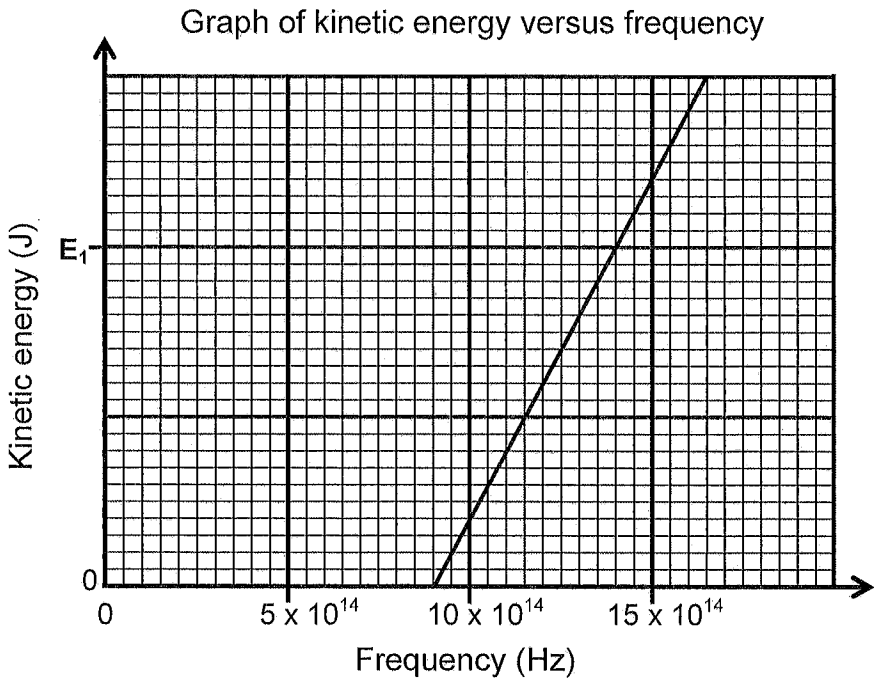
The following conclusions are made from the above diagrams.

(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	$\frac{E}{5 \times 10^{14}}$
B	Kinetic energy	$\frac{E}{5 \times 10^{14}}$
C	Kinetic energy	9×10^{14}
D	Frequency	9×10^{14}

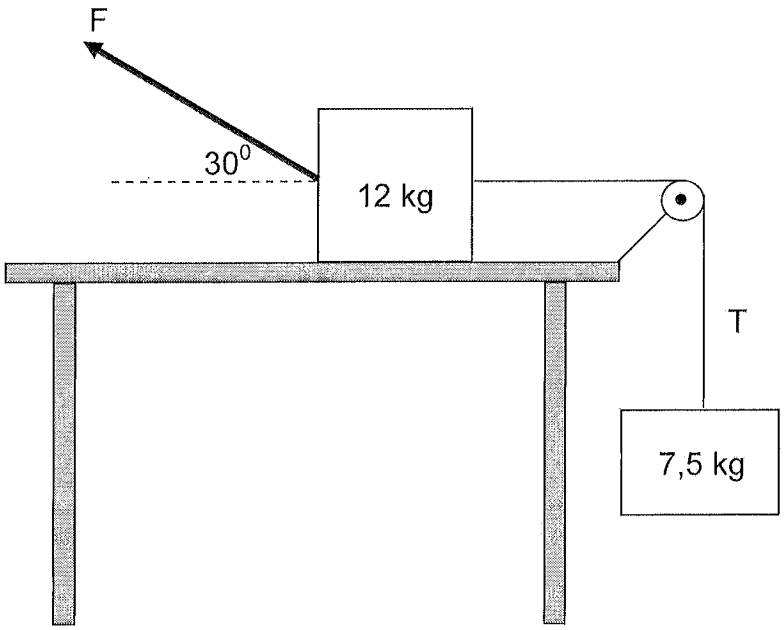
(2)

[20]

QUESTION 2 (Start on a new page)

2.1 State 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)

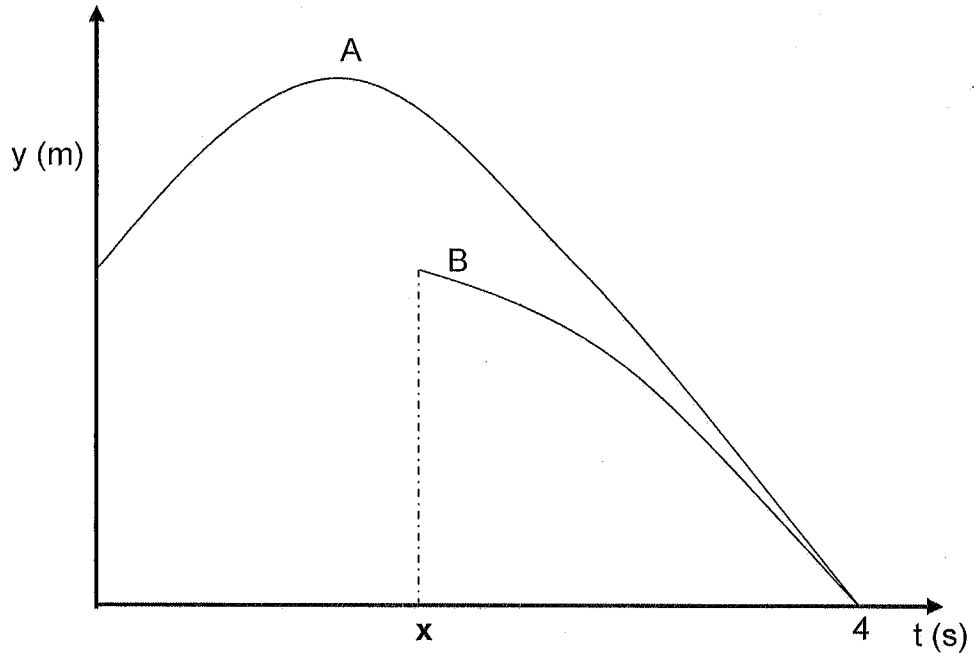
2.2.2 Calculate the minimum value of F that will prevent the blocks from moving. (4)

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 (Start on a new page)

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 after **x** seconds and strikes the ground at the same time that stone A strikes the ground.

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

3.2 Which stone strikes the ground with a higher velocity?
Give a reason for the answer. (2)

3.3 Determine the numerical value of **x**. (5)

3.4 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:

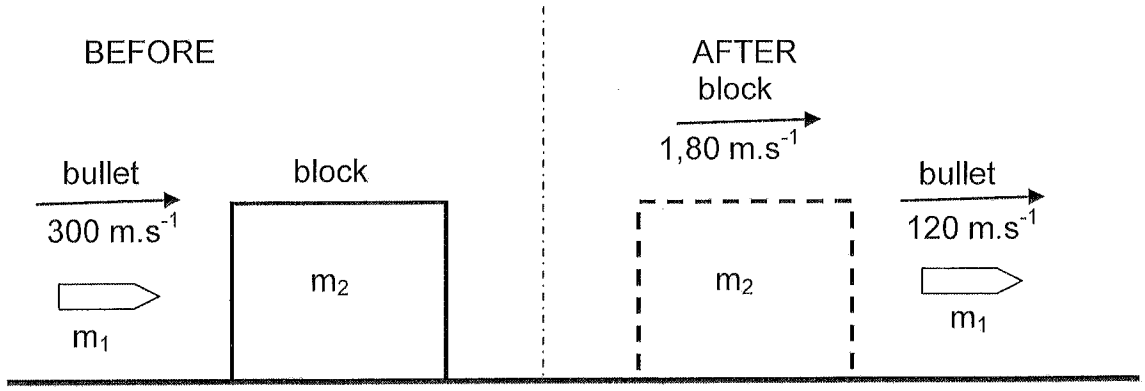
(a) The initial velocity of stone A.
(b) The time when stone B is dropped.
(c) The time taken for stone A to reach its maximum height. (5)

[15]

QUESTION 4 (Start on a new page)

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 1,80 $m.s^{-1}$ in the original direction of the bullet.
Assume that the mass of the block remains constant.



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)

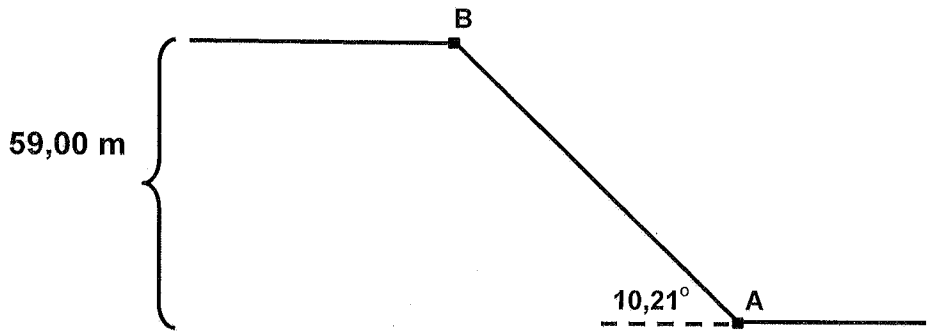
4.2 Use the principle of Conservation of Linear Momentum to calculate the mass of the block in terms of the mass of the bullet. (4)

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

[11]

QUESTION 5 (Start on a new page)

A car of mass 1500 kg needs to maintain a constant speed of 10 $m.s^{-1}$, up a hill of height 59,00 m. The hill is inclined at 10,21° 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 245,94 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 (Start on a new page)

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

The wavelength of the sound detected by the traffic officer is 0,72 m. The speed of sound in air 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 officer. (3)

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

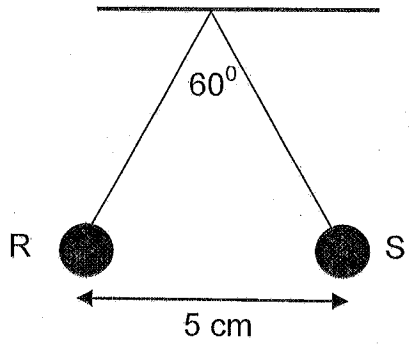
6.4 Perform a calculation to determine whether the car is exceeding the speed limit. (6)

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

[14]

QUESTION 7 (Start on a new page)

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]

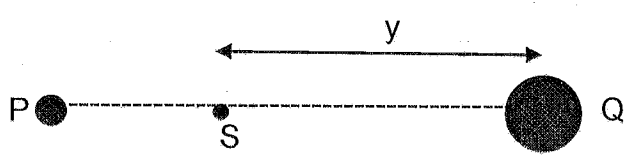
QUESTION 8

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.

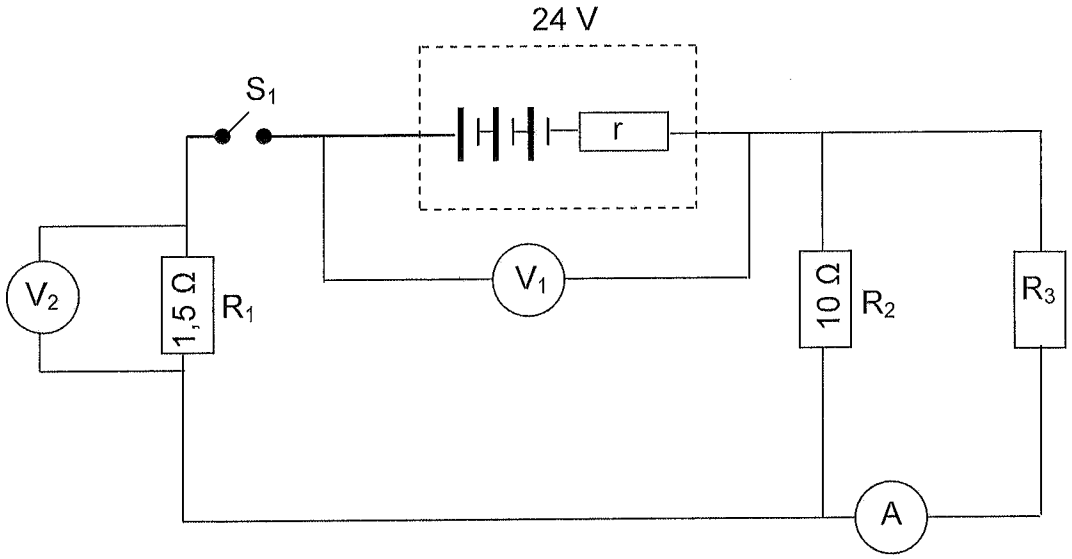


Determine the numerical value of y, in metres. (6)

[10]

QUESTION 9 (Start on a new page)

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 higher resistance.

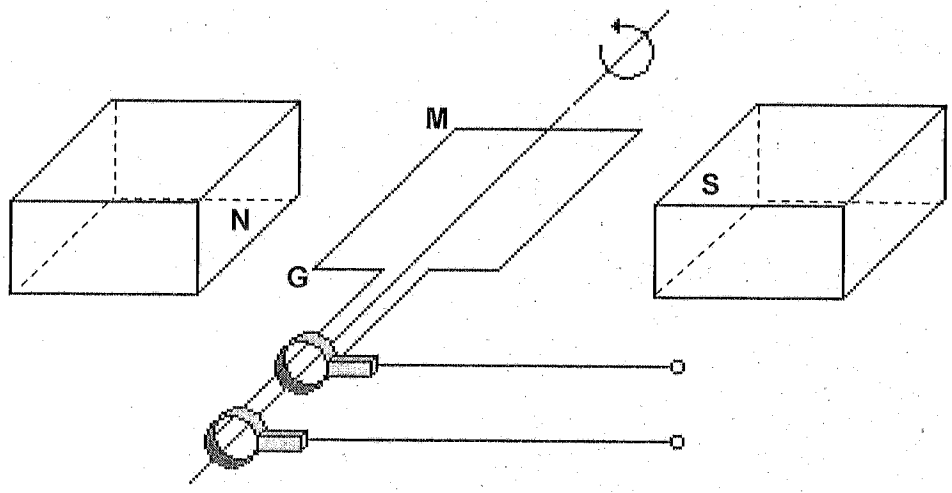
9.3.1 Will the reading on the voltmeter V_1 connected across the terminals of the battery increase, decrease or remain the same? (1)

9.3.2 Explain the answer to question 9.3.1, by making reference to relevant formulae. (4)

[17]

QUESTION 10 (Start on a new page)

In a generator the 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)

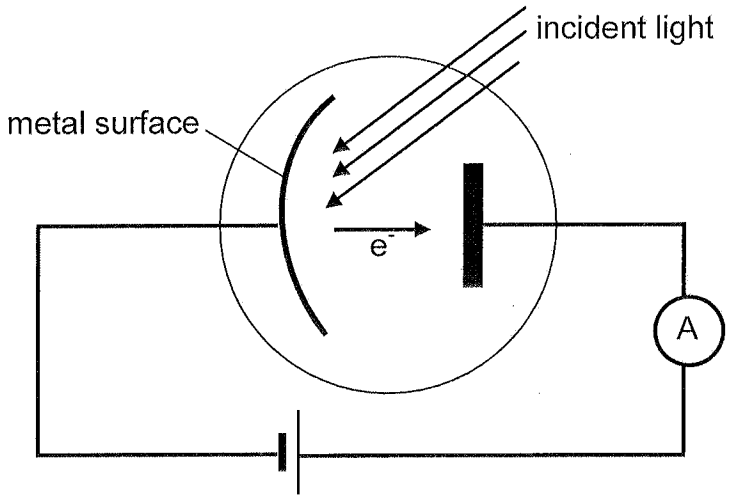
10.2.2 maximum current through the electrical device when connected to the generator shown above. (6)

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 (Start on a new page)

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: 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 gravitasiekonstante*	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*

$F_{net} = ma$	$p = mv$
$f_s^{\ max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf $(\varepsilon) = I(R + r)$ emk $(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

QUESTION 1

1.1 A✓✓ (2)
1.2 C✓✓ (2)
1.3 B✓✓ (2)
1.4 A✓✓ (2)
1.5 D✓✓ (2)
1.6 D✓✓ (2)
1.7 B✓✓ (2)
1.8 C✓✓ (2)
1.9 A✓✓ (2)
1.10 D✓✓ (2)

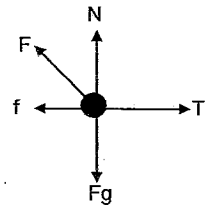
QUESTION 2

2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the net force ✓ and inversely proportional to the mass of the object✓ (2)

2.2.1 **For the 7,5 kg mass**

$T - Fg = ma$✓
$T - (7,5)(9,8) = 0$✓
$T = 73,5\ N$ (2)

2.2.2 **For the 12 kg mass**



$F\cos 30^0 - f - T = ma$
$0,866\ F + \mu_s N - 73,5 = 0$✓
$0,866\ F + (0,45(12)(9,8) - (0,45)F\sin 30^0)$ ✓✓ $- 73,5 = 0$
$0,64\ F + 52,92 - 73,5 = 0$
$F = 32,16\ N$✓ (accept range: 32,106 – 32,16)

(4)

Education

KwaZulu-Natal Department of Education

REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: (PHYSICS) P1

PREPARATORY EXAMINATION

SEPTEMBER 2016

MEMORANDUM

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

This memorandum consists of 13 pages.

OPTION 2 DOWNWARDS POSITIVE

STONE A: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (19)(4)$ ✓ $+ \frac{1}{2}(9,8)(4^2)$✓
$= 2,4$ m

STONE B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$2,4 = (0)(4 - x) + \frac{1}{2}(9,8)(4 - x)^2$✓
$x = 3,30$ s✓

(for any one) ✓

(5)

OPTION 3 UPWARDS POSITIVE

STONE A: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (19)(4)$ ✓ $+ \frac{1}{2}(-9,8)(4^2)$✓
$= - 2,4$ m

STONE B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-2,4 = (0)(4 - x) + \frac{1}{2}(-9,8)(t_B)^2$✓
$t_B = 0,7$ s
$4 - x = 0,7$
$x = 3,30$ s✓

(for any one) ✓

(5)

OPTION 4 DOWNWARDS POSITIVE

STONE A: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (19)(4)$ ✓ $+ \frac{1}{2}(=9,8)(4^2)$✓
$= = 2,4$ m

STONE B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$2,4 = (0)(4 - x) + \frac{1}{2}(9,8)(t_B)^2$✓
$t_B = 0,7$ s
$4 - x = 0,7$
$x = 3,30$ s✓

(for any one) ✓

(5)

OPTION 5 UPWARDS POSITIVE

$\Delta y_A = \Delta y_B$ any one✓
$(v_i\Delta t + \frac{1}{2}a\Delta t^2)_A = (v_i\Delta t + \frac{1}{2}a\Delta t^2)_B$
$(19,4)(4)$ ✓ $+ \frac{1}{2}(-9,8)(4)^2$✓ $= (0) + \frac{1}{2}(-9,8)(4 - x)^2$ ✓
$x = 3,3$ s✓

(5)

2.3

$F = \frac{Gm_1m_2}{r^2}$ ✓

$6346,07$ ✓ $= \frac{6,67 \times 10^{-11} \times 5,98 \times 10^{24} \times 650}{(R+h)^2}$ ✓

$R + h = 6391720,24$ m

$h = 6391720,24 -$ ✓ $6,38 \times 10^6$
$= 11720,24$ m
$= 1,17$ km✓

(5)
[13]

QUESTION 3

3.1

OPTION 1 UPWARDS POSITIVE

$v_f = v_i + a\Delta t$✓

$0 = +19 + (-9,8)(\Delta t)$ ✓

$\Delta t = 1,94$ s✓

(3)

OPTION 2 DOWNWARDS POSITIVE

$v_f = v_i + a\Delta t$✓

$0 = -19 + (+9,8)(\Delta t)$ ✓

$\Delta t = 1,94$ s✓

(3)

3.2 A✓
A accelerates for a greater time than B/ A travels a greater downward distance than B✓

(2)

3.3 OPTION 1 UPWARDS POSITIVE

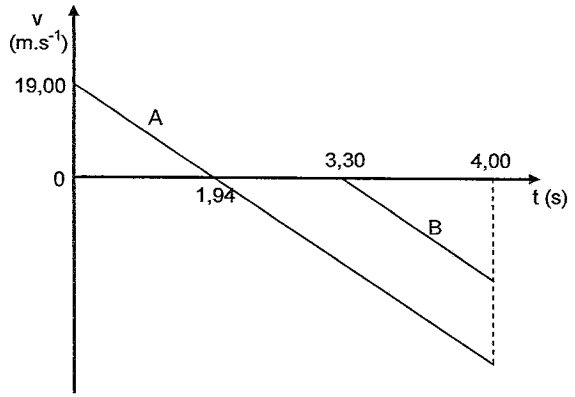
STONE A: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (19)(4)$ ✓ $+ \frac{1}{2}(-9,8)(4^2)$✓
$= - 2,4$ m

STONE B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-2,4 = (0)(4 - t) + \frac{1}{2}(-9,8)(4 - t)^2$✓
$t = 3,30$ s✓

(for any one) ✓

(5)

3.4 OPTION 1 UPWARDS POSITIVE



CRITERIA
- For one of the graphs: v = 19 m.s^{-1} at t = 0 / v = 0 m.s^{-1} at t = 1,94 s✓
- The other graph starts at time = 3,30 s and v = 0 m.s^{-1}✓
- Both graphs are straight lines and parallel to each other✓
- Both graphs are correctly labeled with A to the left of B✓
- Both graphs end at t = 4,00 s. ✓

(5)

OPTION 6 DOWNWARDS POSITIVE

$\Delta y_A = \Delta y_B$ } any one✓
$(v_i\Delta t + \frac{1}{2}a\Delta t^2)_A = (v_i\Delta t + \frac{1}{2}a\Delta t^2)_B$ }
$(19,4)(4)$ ✓ + $\frac{1}{2}(9,8)(4)^2$✓ = (0) + $\frac{1}{2}(9,8)(4 - x)^2$ ✓
$x = 3,3$ s✓

(5)

OPTION 7 UPWARDS POSITIVE

$\Delta y_A = \Delta y_B$ } any one✓
$(v_i\Delta t + \frac{1}{2}a\Delta t^2)_A = (v_i\Delta t + \frac{1}{2}a\Delta t^2)_B$ }
$(19,4)(4)$ ✓ + $\frac{1}{2}(-9,8)(4)^2$✓ = (0) + $\frac{1}{2}(-9,8)(\Delta t_B)^2$ ✓
$\Delta t_B = 0,7$ s
$4 - x = 0,7$
$x = 3,30$ s✓

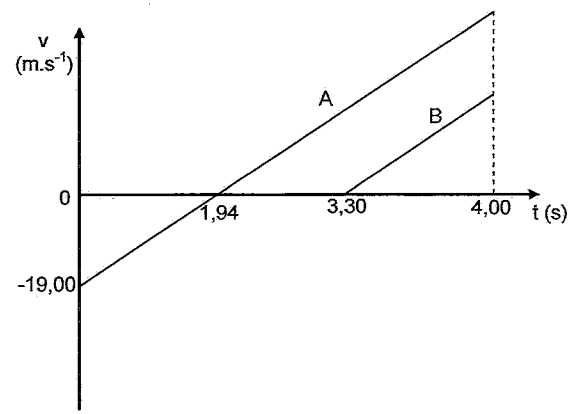
(5)

OPTION 8 DOWNWARDS POSITIVE

$\Delta y_A = \Delta y_B$ } any one✓
$(v_i\Delta t + \frac{1}{2}a\Delta t^2)_A = (v_i\Delta t + \frac{1}{2}a\Delta t^2)_B$ }
$(19,4)(4)$ ✓ + $\frac{1}{2}(9,8)(4)^2$✓ = (0) + $\frac{1}{2}(9,8)(\Delta t_B)^2$ ✓
$\Delta t_B = 0,7$ s
$4 - x = 0,7$
$x = 3,30$ s✓

(5)

OPTION 2 DOWNWARDS POSITIVE (maximum 4 out of 5)



CRITERIA
- For one of the graphs: v = -19 m.s^{-1} at t = 0 / v = 0 m.s^{-1} at t = 1,94 s✓
- The other graph starts at time = 3,30 s and v = 0 m.s^{-1}✓
- Both graphs are straight lines and parallel to each other✓
- Both graphs are correctly labeled with A to the left of B✓
- Both graphs end at t = 4,00 s. ✓

[15]

QUESTION 4

4.1 Inelastic✓, the kinetic energy is not conserved. ✓ (2)

4.2
Total p before = Total p after ✓
(m_1v_{1i})bullet + (m_2v_{2i})block = (m_1v_{1f})bullet + (m_2v_{2f})block
$(m_1)(300) + 0$ ✓ = $(m_1)(120) + (m_2)(1,8)$ ✓
$m_2 = 100\ m_1$ ✓ (4)

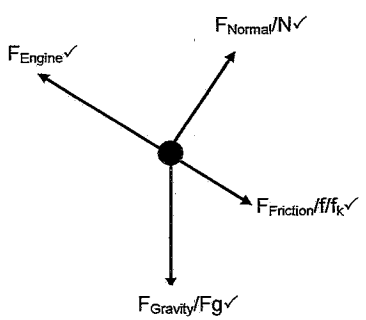
4.3
Ek(bullet) + Ek(block) - 752,76 = Ek(bullet) + Ek(block)
$\frac{1}{2}mv_i^2 + \frac{1}{2}mv_i^2 - 752,76 = \frac{1}{2}mv_f^2 + \frac{1}{2}mv_f^2$
$\frac{1}{2}m_1(300)^2 + 0$ ✓ $- 752,76$ ✓ $= \frac{1}{2}m_1(120)^2$ ✓ $+ \frac{1}{2}m_2(1,8)^2$ ✓
$45\,000m_1 - 752,76 = 7200\ m_1 + 1,62\ m_2$
$45\,000m_1 - 752,76 = 7200\ m_1 + 1,62\ (100\ m_1)$
$m_1 = 0,02$ kg
$m_2 = 2$ kg✓ (5)

[11]

QUESTION 5

5.1 Net work done on an object is equal to the change in the kinetic energy of the object. ✓✓ (2)

5.2



-1 for additional forces
Direction and label must be correct

(4)

5.3
$f_k = \mu_k N$✓
$= (0,017)$ ✓ $(1500)(9,8)(\cos 10,21^0)$ ✓
$= 245,94$ N (3)

5.4
$\sin 10,21 = 59/AB$
$AB = 332,85$ m

$W = \Delta Ek$✓
$W_{Fe} + W_N + W_{Ff} + W_{Fg} + W_{Fgp} = 0$✓
$F_e\Delta x \cos\theta + 0 + F_f\Delta x \cos\theta + 0\ F_{gp}\Delta x \cos\theta = 0$
$Fe(332,85)(\cos 0^0) + (245,94)(332,85)(\cos 180^0) + mg\sin\theta\,\Delta x \cos\theta = 0$
$332,85\ Fe$ ✓ $- 81861,13$ ✓ $+ (1500)(9,8)(\sin 10,21^0)(332,85)(\cos 180^0)$ ✓ $= 0$
$332,85\ Fe = 949158,63$
$Fe = 2851,61$ N
$P = Fv$✓
$= (2851,61)(10)$
$= 28516,10$ W✓ (7)

OR

$W_{nc} = \Delta Ep + \Delta Ek$✓
$W_f + W_{Fe} = mg\Delta h + 0$ ✓
$F_f\Delta x \cos\theta + F_e\Delta x \cos\theta = (1500)(9,8)(59)$ ✓
$(245,94)(332,85)(-1)$ ✓ $+ 332,85\ Fe$✓ $= 867300$
$Fe = 2851,62$ N
$P = Fv$✓
$= (2851,62)(10)$
$= 28516,20$ W✓ (7)

[16]

QUESTION 6

6.1 The change in the frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to each other. ✓✓ (2)

6.2
$v = f \times \lambda$ ✓
$340 = f \times 0,72$ ✓
$f = 472,22$ Hz ✓ (3)

6.3 Towards. ✓ The frequency of the sound waves heard by the traffic official is greater than the frequency of the sound waves emitted by the hooter. ✓ (2)

6.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$472,22$ ✓ $= \frac{340}{340 - v_s}$ ✓ $\times 433,64$ ✓

$v_s = 27,78 \text{ m.s}^{-1}$

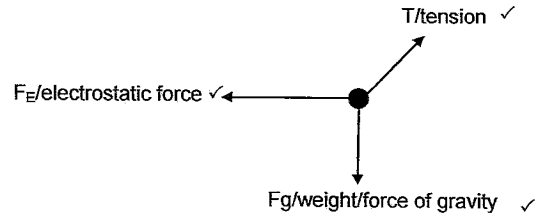
The car is not exceeding the speed limit✓ as the speed limit is 100 km.hr^{-1}(27,78 m.s^{-1}), while the speed of the car is 100 km.hr^{-1}(27,78 m.s^{-1}) ✓ (6)

6.5 less than✓ (1)
[14]

QUESTION 7

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between them. ✓ (2)

7.2



(3)

7.3
$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{9 \times 10^9 \times 40 \times 10^{-9} \times 40 \times 10^{-9}}{0,05^2}$ ✓

$= 5,76 \times 10^{-3}$ N

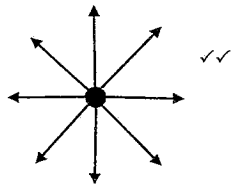
$Fg = F_E \tan 60^0$
$m \times 9,8$ ✓ $= (5,76 \times 10^{-3})(\tan 60^0)$ ✓
$m = 1,02 \times 10^{-3}$ kg ✓

OR

$Fg = F_E / \tan 30^0$
$m \times 9,8$ ✓ $= (5,76 \times 10^{-3}) / (\tan 30^0)$ ✓
$m = 1,02 \times 10^{-3}$ kg ✓ (6)
[11]

QUESTION 8

8.1



✓✓ (2)

8.2 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓ (2)

8.3

Any one equation:

$E_P = \frac{kQ_1}{r^2}$ ✓

$= \frac{9 \times 10^9 \times 3 \times 10^{-9}}{(0,012 - y)^2}$ ✓ ✓ right

$E_Q = \frac{kQ_1}{r^2}$

$= \frac{9 \times 10^9 \times 27 \times 10^{-9}}{(y)^2}$ ✓

$\frac{9 \times 10^9 \times 3 \times 10^{-9}}{(0,012 - y)^2} = $ ✓ $\frac{9 \times 10^9 \times 27 \times 10^{-9}}{(y)^2}$ left

$y = 0,009$ m ✓ (6)
[10]

QUESTION 9

9.1 $R_1 = \frac{V}{I}$ ✓

$1,5 = \frac{4,5}{I}$ ✓

$I = 3A$

$I_{R2} = 3 - 1,2$✓

$= 1,8\ A$

$V_{R3} = V_{R2}$

$= IR$

$= 1,8 \times 10$✓

$= 18\ V$

$R3 = \frac{V}{I}$

$R3 = \frac{18}{1,2}$ ✓✓

$= 15\ \Omega$ ✓ (7)

9.2 OPTION 1

emf = $V_2 + V_p + Ir$ ✓

24✓ = 4,5 + 18 ✓ + (3)(r) ✓

r = 0,5 Ω ✓ (5)

OPTION 2

$R_P = \frac{10(15)}{(10+15)}$

$= 6\ \Omega$✓

$\varepsilon = I(R + r)$ ✓

24✓ = 3 [(6 + 7,5) ✓ + r]

r = 0,5 Ω ✓ (5)

9.3.1 increases✓ (1)

9.3.2 The total resistance of the circuit increases. ✓
The circuit current decreases. ✓
Therefore Ir decreases
$V_1 = \varepsilon - Ir$ ✓
Since ε remains constant and Ir decreases ✓
V_1 increases (4)
[17]

QUESTION 10

10.1 M to G✓ (1)

10.2.1 $P = \frac{W}{\Delta t}$ ✓

$P = \frac{9,45 \times 10^6}{7200}$ ✓

$= 1312,5\ W$✓ (3)

10.2.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{rms} = \frac{311.13}{\sqrt{2}}$ ✓

$= 220,00\ V$

$P_{ave} = V_{rms}I_{rms}$✓

$1312,5 = 220,00 \times I_{rms}$✓

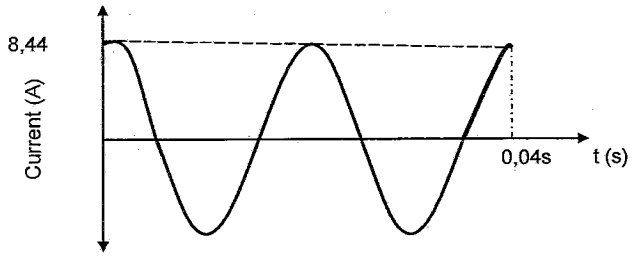
$I_{rms} = 5,97\ A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$5,97 = \frac{I_{max}}{\sqrt{2}}$

$Imax = 8,44\ A$✓ (6)

10.3



Criteria	Marks
Two full cycles with correct shape	✓
Showing the maximum current	✓
Showing the time 0,04 s for two cycles	✓

(3)
[13]

QUESTION 11

11.1 photoelectric effect✓ (1)

11.2 the minimum energy that an electron in a metal needs to be emitted from the metal surface. ✓✓ (2)

11.3

$$E = W_o + E_k \checkmark\checkmark$$

$$h\frac{c}{\lambda} = W_0 + \frac{1}{2}mv_{max}^2$$

$$6{,}63 \times 10^{-34}\frac{3 \times 10^8}{487 \times 10^{-9}}\checkmark = W_0 + \frac{1}{2}(9{,}11 \times 10^{-31})(3{,}51 \times 10^5)^2\checkmark$$

$$W_0 = 3{,}52 \times 10^{-19}\ J\checkmark$$ (4)

11.4.1 increases, ✓the number of photoelectrons emitted per second increases. ✓ (2)

11.4.2 remains the same. ✓ (1)
[10]

TOTAL MARKS: [150]