Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2023

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

This question paper consists of 19 pages, including a 2-page data sheet.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. You are advised to use the attached DATA SHEETS.
7. The formulae and substitutions must be shown in ALL calculations.
8. Give brief motivations, discussions, et cetera where required.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Start EACH question on a NEW page.
11. All diagrams are not necessarily drawn according to scale.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write ONLY the letter (A–D) next to the question numbers (1.1–1.10) in the ANSWER BOOK, for example 1.11 B.

1.1 The base unit of energy can be written as …

A $kg.m.s^{-1}$.

B $kg.m.s^{-2}$.

C $kg.m^2.s^{-2}$.

D N.s. (2)

1.2 A wooden block is pulled up a rough, inclined surface using a rope. The wooden block moves at a constant velocity. This means that:

A There are no forces acting on the block.

B There are no vertical forces acting on the block.

C Only gravitational force acts on the block.

D The vector sum of all forces acting on the block is equal to zero. (2)

1.3 Which of the following situations is an example of uniform acceleration?

A An astronaut experiences weightlessness while he is in space.

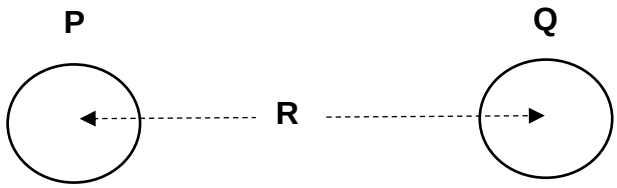
B A feather drops to the ground inside a vacuum.

C A wooden box slides down a smooth surface at a constant velocity.

D A leaf falls to the ground on a windy day. (2)

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1.4 Two objects of mass **P** and **Q** respectively, are placed at a distance **R** from each other. The force they exert on each other is **F**.



When the distance between the objects changes to $\frac{2}{3}$ **R**, the force that the two objects exert on each other will be …

A $\frac{4}{9}$ **F**.

B 2¼ **F**.

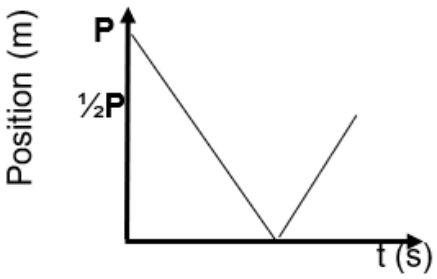
C $\frac{2}{3}$ **F**.

D $\frac{3}{2}$ **F**. (2)

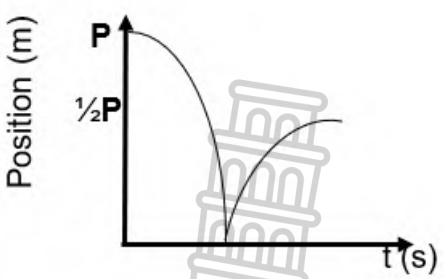
1.5 A rubber ball is thrown vertically downwards from the top of the building which is **P** m above the ground. The ball bounces off the ground and reaches a height of ½ **P** m above the ground. Ignore the effect of air friction and contact time between the ball and the ground.

Which ONE of the following position-time graphs is CORRECT for the motion of the ball described above?

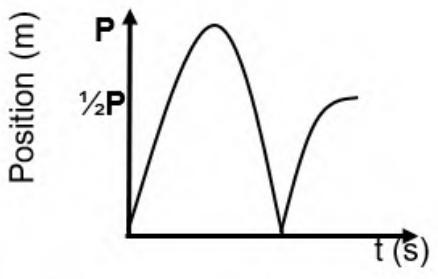
A



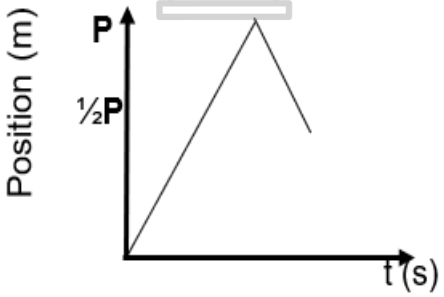
B



C



D



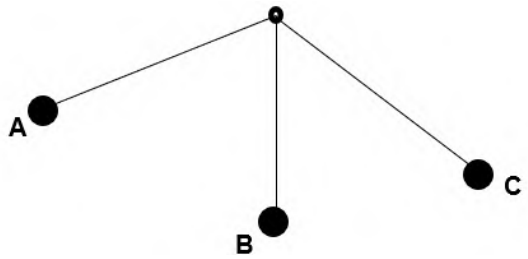
(2)

1.6 Two objects are involved in an elastic linear collision in a closed system. Which ONE of the following is TRUE about their momentum and kinetic energy respectively?

	MOMENTUM	KINETIC ENERGY
A	Conserved	Conserved
B	Conserved	Not conserved
C	Not Conserved	Conserved
D	Not Conserved	Not Conserved

(2)

1.7 A simple pendulum is set up by hanging a metal ball from a thin string as shown in the diagram below. The pendulum swings from point **A** and then past point **B** and passes point **C**. Ignore the effect of air friction.



Which ONE of the following statements is TRUE for this pendulum?

A The gravitational potential energy at **A** and **C** is the same.

B The pendulum comes to rest at point **C** where its gravitational potential energy is a maximum.

C The total mechanical energy of the ball is the same at **B** and **C**.

D The velocity of the pendulum is a maximum at **B** and a minimum at **C**. (2)

1.8 A truck moves at a velocity of ***x*** m.s^{-1}. The mass of the truck is ***m***. A container, mass ½ ***m*** is dropped vertically onto the truck. The velocity of the truck changes to ⅔ ***x***. The kinetic energy of the truck has changed by a fraction of …



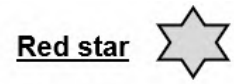
A $\frac{2}{3}$.

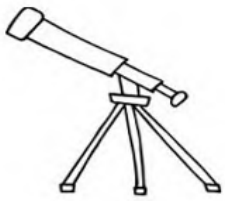
B $\frac{1}{2}$.

C $\frac{3}{4}$.

D $\frac{4}{9}$. (2)

1.9 Jane observes some red stars through a telescope at night. The reason for these observations is as follows:

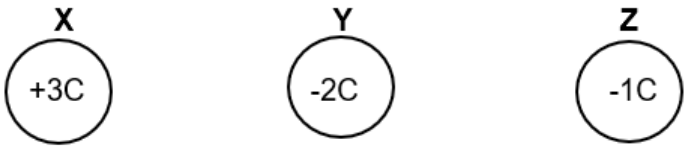




	Relative motion of the red star	**Apparent frequency of the red star**
A	Away from the earth	Higher
B	Towards the earth	Higher
C	Away from the earth	Lower
D	Towards the earth	Lower

(2)

1.10 Three spheres with charges are placed as follows in space. The distance between the **X** and Y is equal to the distance between **Y** and **Z**. Which of the charges will experience a net force to the right?



A Sphere **X** and **Y**

B Sphere **X**

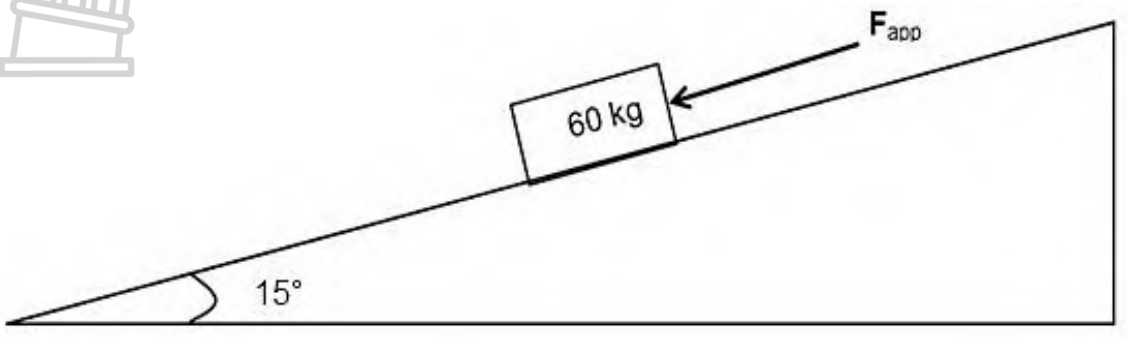
C Sphere **Y**

D Sphere **Z** (2)

[20]

QUESTION 2 (Start on a new page.)

A container of mass 60 kg is placed on an inclined surface which makes an angle of 15° with the horizontal. A force **F** = 120 N is applied to the container as shown in the diagram below. The container accelerates down the inclined surface. The coefficient of kinetic friction (μ_k) between the container and the surface of the inclined surface is 0,75.



2.1 State *Newton's First Law of Motion* in words. (2)

15°

2.2 Draw a labelled free-body diagram of all the forces acting on the container as it moves down the inclined surface. (4)

2.3 Calculate the magnitude of the kinetic frictional force between the crate and the inclined surface. (4)

2.4 The angle between the inclined surface and the horizontal is now increased. How will this affect the answer calculated in QUESTION 2.3 above?

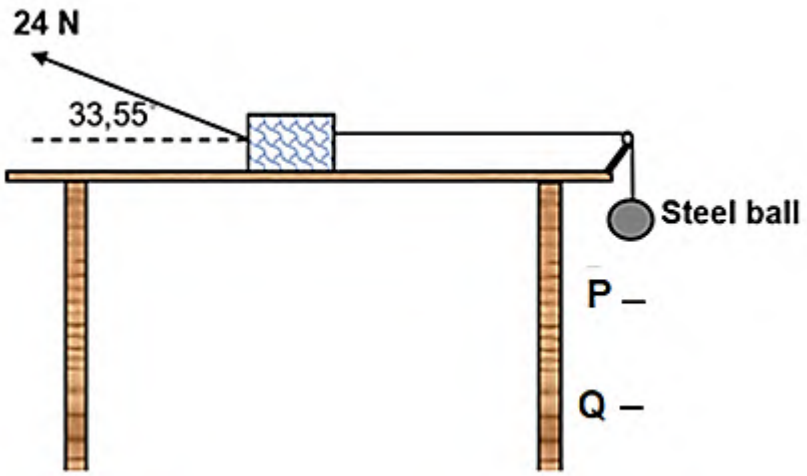
Write only INCREASE, DECREASE or REMAINS THE SAME.
Give a reason for your answer. (2)

2.5 Calculate the magnitude of the acceleration of the container as it moves down the inclined surface. (5)

[17]

QUESTION 3 (Start on a new page.)

A wooden block, placed on a frictionless table, is connected to a steel ball by means of a light, inextensible string that passes over a frictionless pulley. A force of 24 N is applied to the wooden block at an angle of 33,55° to the horizontal to the left as shown in the diagram below. The wooden block moves at a CONSTANT VELOCITY to the right. The steel ball moves past point **P** with a velocity of 0,25 $m.s^{-1}$.



3.1 Name the Newton's Third Law pair (action-reaction) forces acting between the block and the table. (2)

3.2 Calculate the mass of the steel ball. (4)

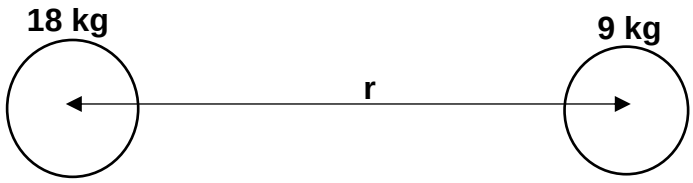
3.3 It takes the wooden block 1,2 s to move from point **P** to point **Q**.

Calculate the distance between points **P** and **Q**. (2)

3.4 At the instant that the steel ball moves past point **Q,** the string breaks.
How long does the steel ball take to reach the ground which is 0,55 m below point **Q**? (4)
[12]

QUESTION 4 (Start on a new page.)

Two spherically shaped objects of masses 18 kg and 9 kg respectively are placed with their centre at a distance of **r** m apart as shown in the diagram below. The objects exert a gravitational force of 1,34 x 10^{-10} N on each other.



4.1 State *Newton's Universal Law of Gravitation* in words. (2)

4.2 Calculate the distance **r** between the centres of the spheres. (5)

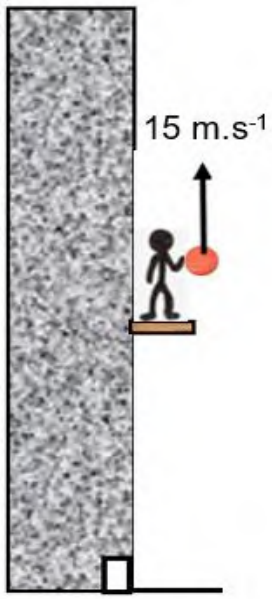
4.3 The 9 kg sphere is replaced by a 12 kg sphere. The gravitational force between the two spheres is still 1,34 x 10^{-10} N.

How will the distance between the two objects compare to the answer in QUESTION 4.2?

Write only LARGER, SMALLER or EQUAL TO. (1)
[8]

QUESTION 5 (Start on a new page.)

A man stands on the balcony of a building which is exactly halfway between the top of the building and the ground as shown in the diagram below. He projects a cricket ball upwards and it passes the top of the building after 1,27 s. Ignore the effect of air resistance. The diagram below is not drawn to scale.



5.1 Define the term *free fall.* (2)

5.2 Calculate the:

5.2.1 Height of the building (4)

5.2.2 Time the cricket ball took to reach its maximum height (3)

5.2.3 Velocity with which the ball hits the ground (4)

5.3 Draw a sketch velocity-time graph for the motion of the cricket ball from the moment that it was projected until it hits the ground.

Indicate the following clearly on your graph:

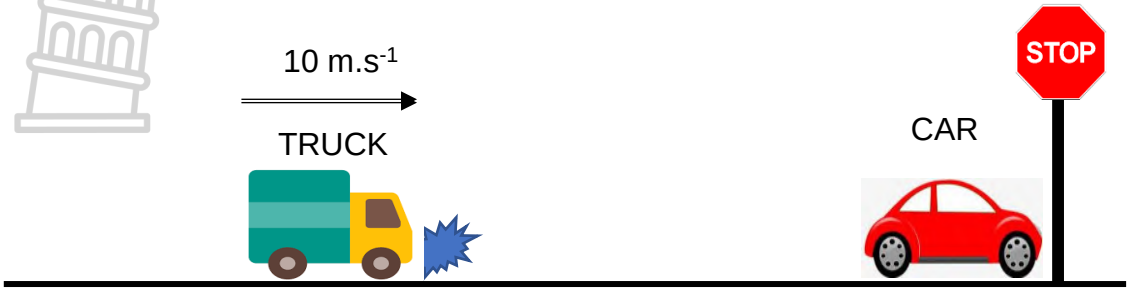
- Initial velocity of the ball
- Time it took the ball to reach the top of the building
- Velocity of the ball when it hits the ground (4)

[17]

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QUESTION 6 (Start on a new page.)

A truck of mass 5 600 kg travelling at a velocity of 10 m.s^{-1} to the east, collides with a stationary car of mass 1 800 kg. The collision lasted for 0,59 s. After the collision, the truck and the car are coupled and move together eastwards.



6.1 State the principle of the *Conservation of Linear momentum* in words. (2)

6.2 Calculate the:

6.2.1 Velocity of the truck-car system after the collision (4)

6.2.2 Force that the truck exerts on the car (5)

6.3 If the collision lasted three (3) times longer, how will your answer in QUESTION 6.2.2 be influenced?

Write down only INCREASE, DECREASE or SIMILAR. (1)

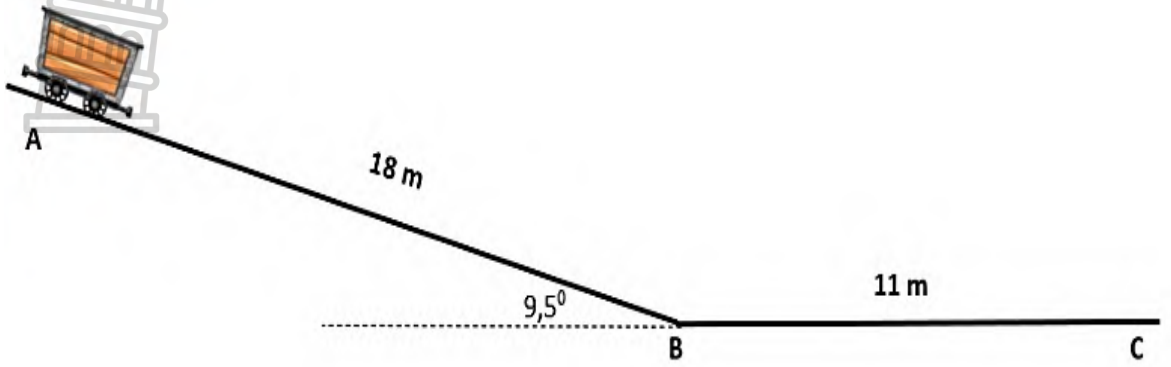
6.4 Explain your answer in QUESTION 6.3. (2)

6.5 Name TWO safety features that can be found in vehicles so that serious injuries can be minimised when collisions like this take place. (2)

[16]

QUESTION 7 (Start on a new page.)

A trolley of mass 685 kg moves from rest from point **A** down a frictionless, inclined surface as shown in the diagram below. **AB** is 18 m long while **BC** is 11 m. The incline makes an angle of 9,5° with the horizontal. The diagram is not drawn to scale.



7.1 State the principle of the CONSERVATION OF MECHANICAL ENERGY. (2)

7.2 Use the principle stated in QUESTION 7.1 to calculate the velocity of the trolley at point **B**. (4)

7.3 Calculate the work done by the gravitational force to move the trolley from **A** to **B**. (4)

The trolley continues to move from point **B** and comes to rest at point **C**.

7.4 State the *work-energy Theorem* in words. (2)

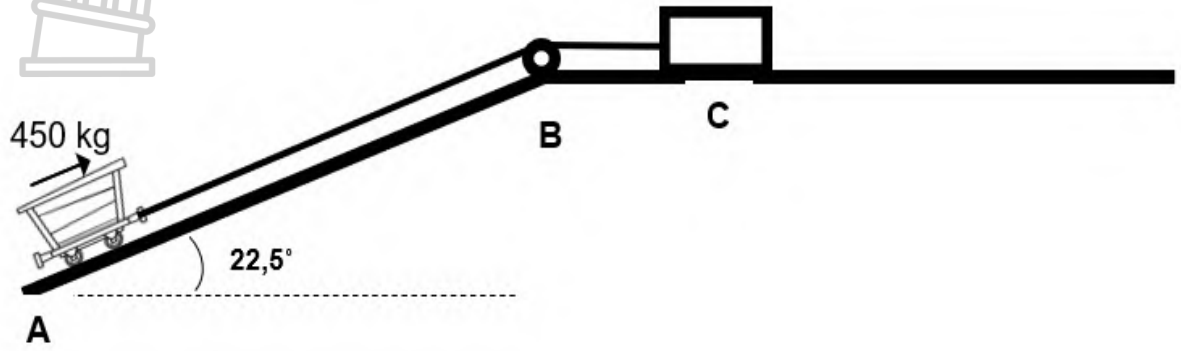
7.5 Use the work-energy Theorem to calculate the magnitude of the frictional force between points **B** and **C**. (4)

7.6 Calculate the coefficient of kinetic friction between the trolley and surface **BC**. (4)

[20]

QUESTION 8 (Start on a new page.)

A trolley of mass 450 kg is pulled up an inclined surface by means of a motor placed at point **C**. The motor and the trolley are connected by a rope of negligible mass that passes over a frictionless pulley. The frictional force between the trolley's wheels and the inclined surface is 1 340 N.



8.1 Write down the name of a conservative force acting on the trolley. (1)

8.2 The trolley moves up the surface with a constant velocity of 1,57 $m.s^{-1}$.

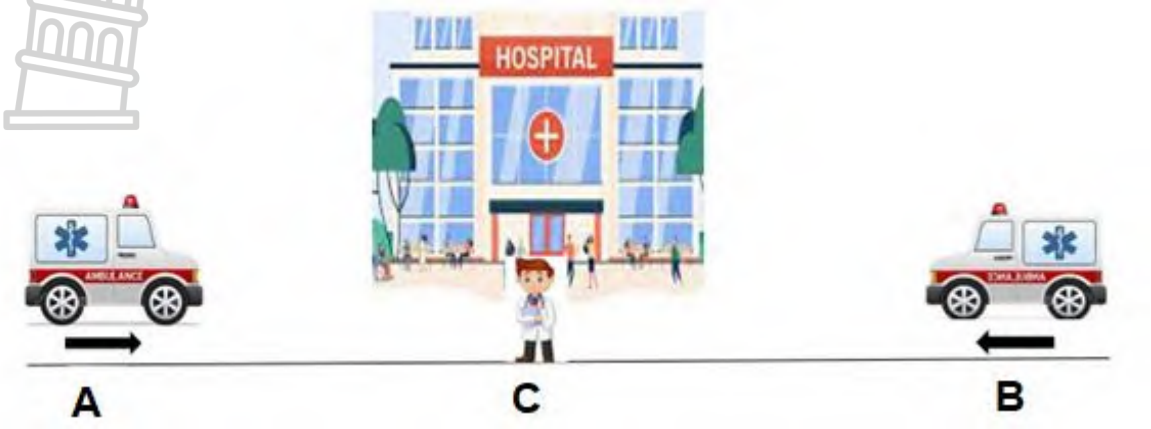
Calculate the:

8.2.1 Force that the motor exerts to move the trolley up the inclined surface (4)

8.2.2 Average power delivered by the motor to move the trolley up the inclined surface (4)
[9]

QUESTION 9 (Start on a new page.)

An ambulance, **A**, approaches a hospital from the west while its siren releases a sound with a frequency of 285 Hz. A doctor, standing in front of the hospital at point **C**, hears the ambulance's frequency to be 307 Hz. The speed of sound is 340 $m.s^{-1}$.



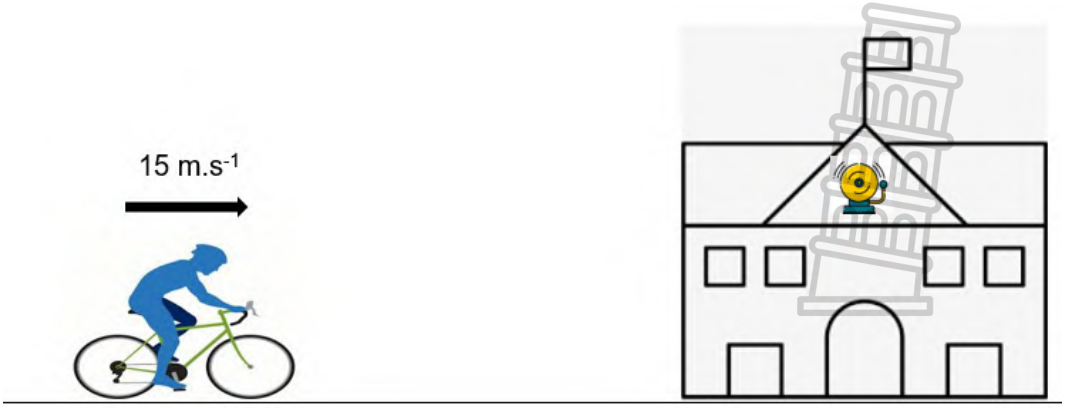
9.1 State the *Doppler effect* in words. (2)

9.2 Calculate the velocity of the ambulance as it approaches the hospital in $km.h^{-1}$. (5)

9.3 Ambulance **B** approaches the hospital from the east at a velocity of 100 $km.h^{-1}$. The two ambulances have similar sirens.
How does the frequency that the doctors hear from ambulance **B** compare to that of ambulance **A**, if the doctors stand at point **C**?
Choose from HIGHER THAN, LOWER THAN or THE SAME. Briefly explain your answer. (3)

9.4 State ONE use of the Doppler effect in die medical field. (1)

9.5 A cyclist rides towards a school and the school bell rings with a frequency of 625 Hz. The cyclist travels with a velocity of 15 $m.s^{-1}$. The speed of sound is 340 $m.s^{-1}$.



9.5.1 Calculate the frequency of the sound that the cyclist hears. (4)

9.5.2 Calculate the wavelength of the sound waves that the cyclist hears. (3)

[18]

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QUESTION 10 (Start on a new page.)

Two identical negative point charges **P** and **Q** each carrying a charge of equal magnitude are placed 60 cm from each other in a vacuum as shown in the diagram below. The electrostatic force that the charges exert on each other is $4,55 \times 10^{-2}$ N.



10.1 Draw the electric field pattern between charges **P** and **Q**. (3)

10.2 In which direction will charge **Q** experience a force due to charge **P**. (1)

10.3 State *Coulomb's Law* in words. (2)

10.4 Calculate the:

10.4.1 Magnitude of the charges on **P** and **Q** (4)

10.4.2 Number of excess charges on charge **P** (3)

[13]

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•s^{-2}
Universal gravitational constant / *Universelegravitasiekonstant*	G	6,67 × 10^{-11} N•m^{2}•kg^{-2}
Speed of light in a vacuum / *Spoed van lig in 'n vacuum*	c	3,0 × 10^{8} m•s^{-1}
Planck's constant / *Planck se konstante*	h	6,63 × 10^{-34} J•s
Coulomb's constant / *Coulomb se konstante*	k	9,0 × 10^{9} N•m^{2}•C^{-2}
Charge on electron / *Lading op elektron*	e	-1,6 × 10^{-19} C
Electron mass / *Elektronmassa*	m_e	9,11 × 10^{-31} kg
Mass on earth / *Massa op aarde*	M	5,98 × 10^{24} kg
Radius of earth / *Radius van aarde*	R_E	6,38 × 10^{6} m

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*

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

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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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $\quad f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ 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*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$V = \frac{W}{q}$	$n = \frac{Q}{q_e}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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