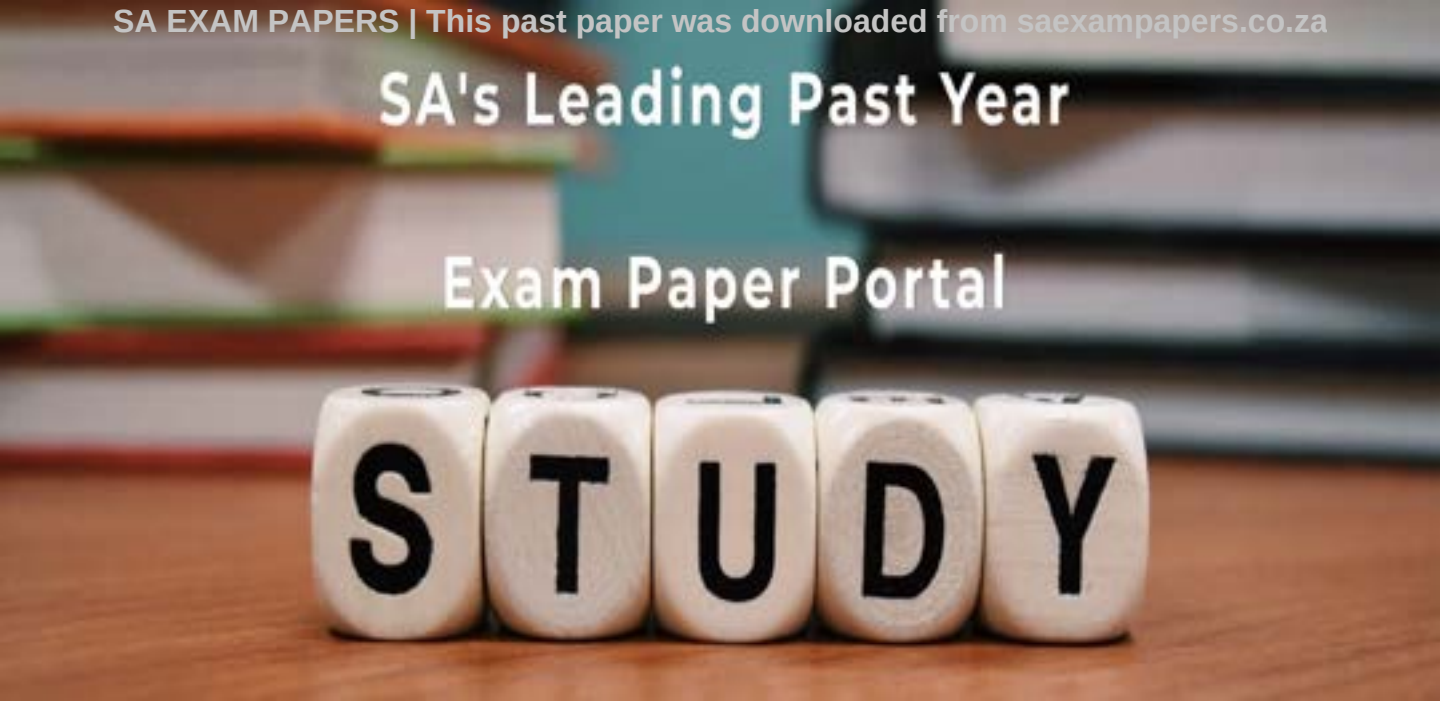


Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2024

PHYSICAL SCIENCES P1 (PHYSICS)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 21 pages, including 3 data sheets.

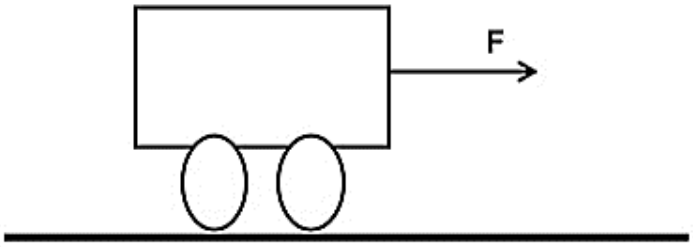
INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 11 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A trolley moves on a flat, horizontal surface when a constant force, **F**, is applied to it.



Which ONE of the following physical quantities will ALWAYS remain constant while the trolley is moving?

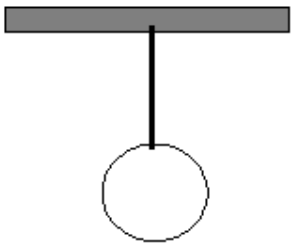
A Momentum

B Acceleration

C Kinetic energy

D Gravitational potential energy (2)

1.2 A sphere is attached to a string, which is suspended from a fixed horizontal bar, as shown in the diagram below.



The reaction force to the gravitational force exerted by the earth on the sphere is the …

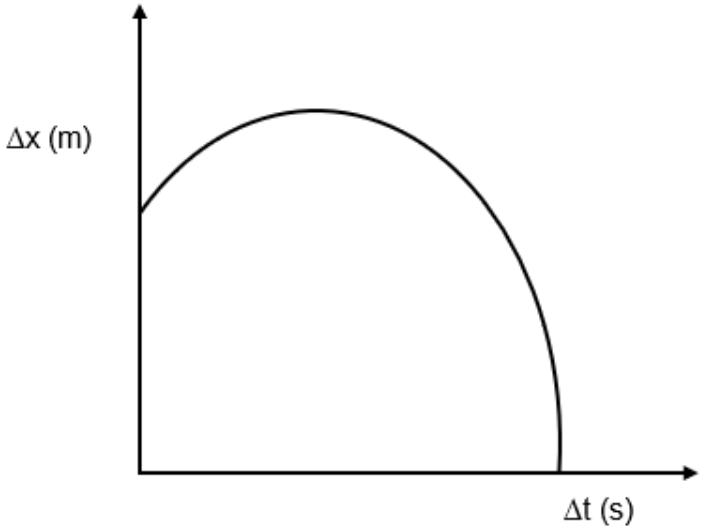
A force of the bar on the sphere.

B force of the string on the sphere.

C force of the sphere on the earth.

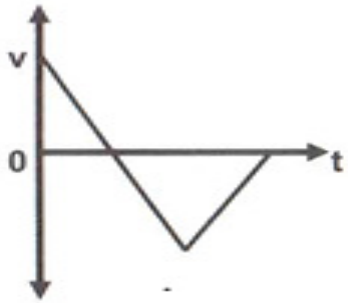
D force of the bar on the string. (2)

1.3 The position versus time, graph below shows the motion of an object in a vertical direction. Take the ground as zero reference.

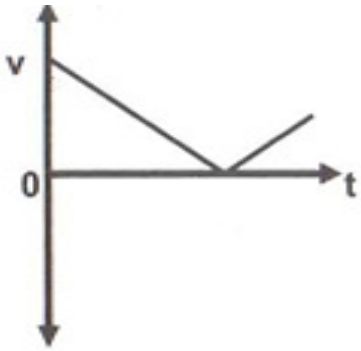


Which ONE of the following velocity-time graphs below best represents the motion of the object?

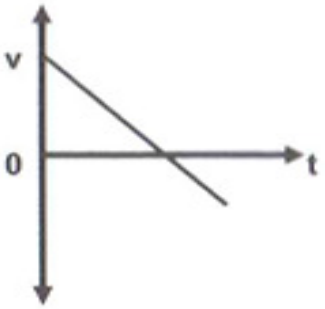
A



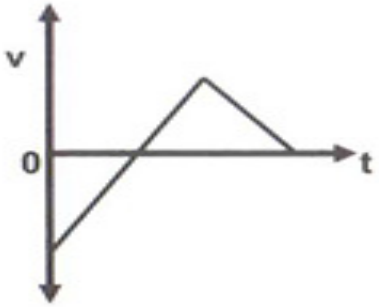
B



C

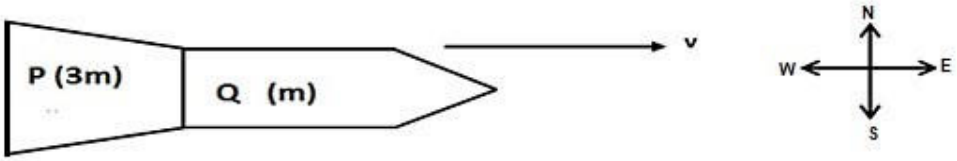


D



(2)

1.4 A spacecraft, made up of two modules **P** and **Q** of masses **3m** and **m** respectively, is travelling horizontally at a velocity **v** due east. An explosion causes the two modules to separate.



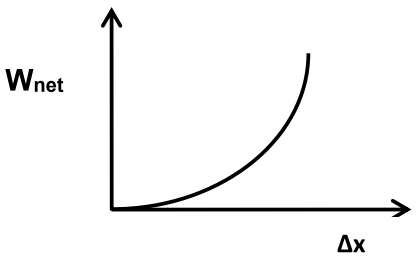
Module **Q** continues in its original direction immediately after the explosion with a velocity of 3**v**. What will the **magnitude and direction** of module **P's** velocity immediately be after the explosion?

	MAGNITUDE OF VELOCITY OF P	DIRECTION OF P AFTER EXPLOSION
A	⅓ v	East
B	v	West
C	v	East
D	⅓ v	West

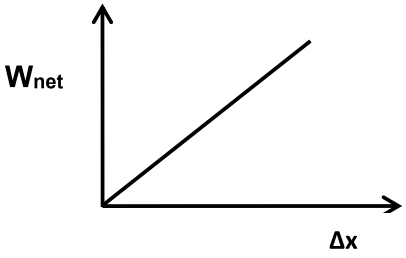
1.5 A car moves from rest in a straight line under the influence of a constant net force.

Which ONE of the following graphs best represents the net work done (W_{net}) on the car in relation to its displacement (Δx)?

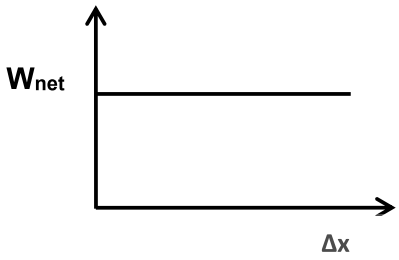
A



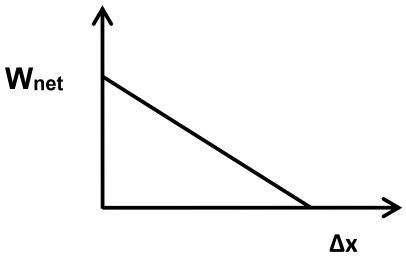
B



C



D

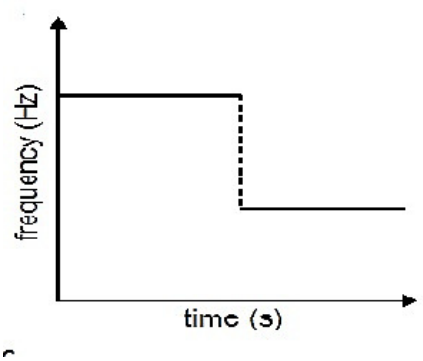


(2)

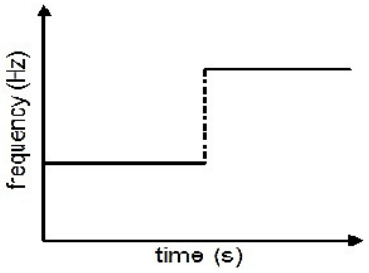
1.6 A source of sound approaches a stationary listener in a straight line at constant velocity. It passes the listener and moves away from him in the same straight line at the same constant velocity.

Which ONE of the following graphs best represents the change in observed frequency against time?

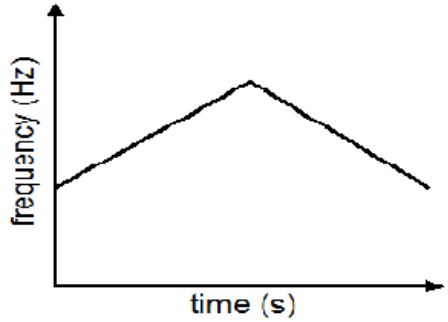
A



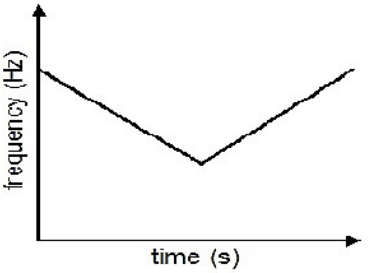
B



C

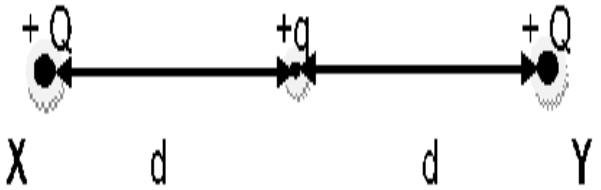


D



(2)

1.7 A small test charge +q is placed exactly halfway between two identical positive charges, **X** and **Y**, each with a charge +Q, as shown below.



The test charge +q will …

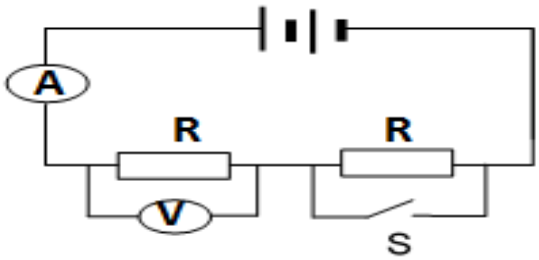
A move vertically downwards.

B move towards **X**.

C move towards **Y.**

D remain stationary. (2)

1.8 The internal resistance of the battery in the circuit diagram below is negligible.

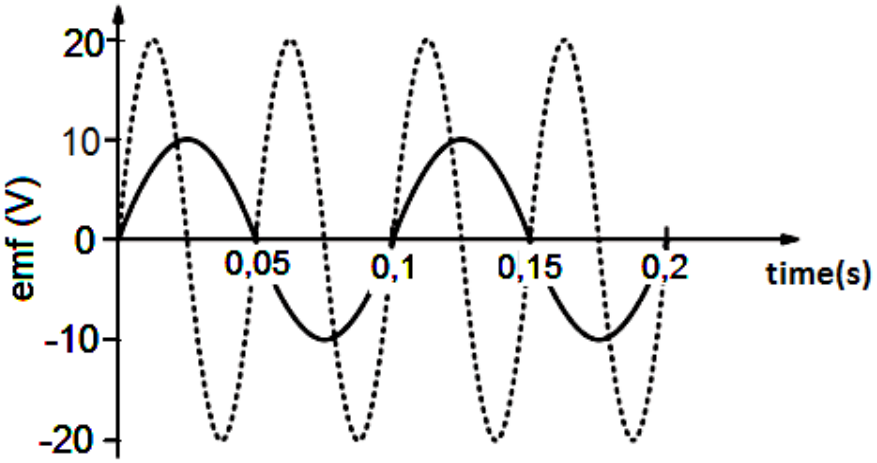


When switch **S** is closed, which ONE of the following represents the change in the voltmeter and ammeter readings?

	VOLTMETER READING	AMMETER READING
A	Decreases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Increases	Increases

(2)

1.9 In the graph below, the solid line graph represents how the emf produced by a simple generator, changes with time. The dotted line shows the emf of the same generator after a change was made.



What change was made to produce the results on the dotted line graph?

A The speed of rotation is halved.

B The speed of rotation is doubled.

C A split-ring commutator is added.

D More brushes are added. (2)

1.10 When an excited electron moves from a higher energy level to a lower energy level a specific ...

A emission line in an emission spectrum is observed.

B emission line in an absorption spectrum is observed.

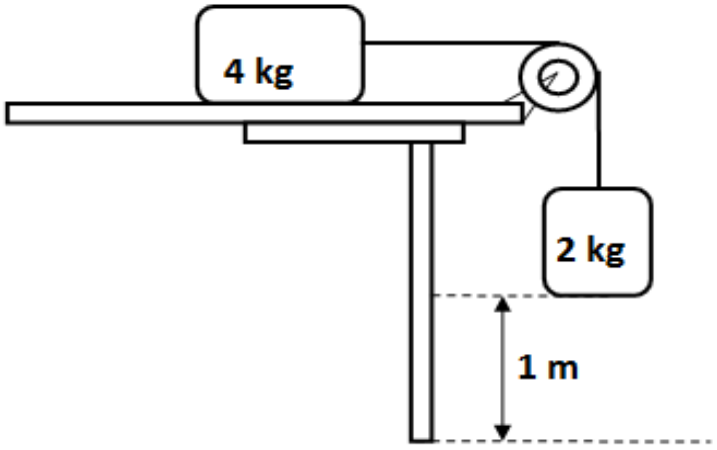
C absorption line in an emission spectrum is observed.

D absorption line in an absorption spectrum is observed. (2)

[20]

QUESTION 2 (Start on a new page.)

A block with a mass of 4 kg is held at rest on a rough horizontal table. The block is connected by a light inextensible string which passes over a light frictionless pulley to another block of mass 2 kg. The 2 kg block hangs vertically as shown in the diagram below.



The 4 kg block is now released, and the system of masses moves to the right. The coefficient of kinetic friction between the 4 kg block and the surface of the table is 0,25. Ignore the effects of air friction.

2.1 State Newton's Second Law of motion in words. (2)

2.2 Draw a free-body diagram showing ALL the forces acting on the 4 kg block before motion. (4)

2.3 Calculate the magnitude of the:

2.3.1 Frictional force acting on the 4 kg block (3)

2.3.2 Speed with which the 2 kg block mass strikes the ground (7)

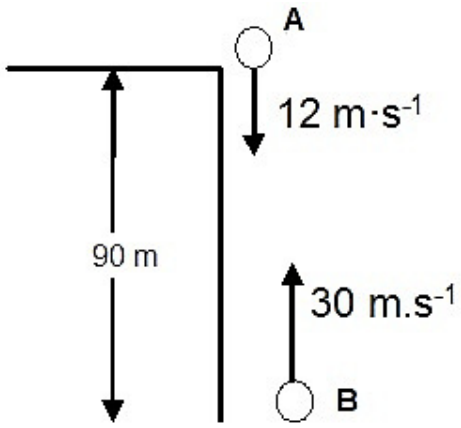
2.4 Explain why the motion of the 2 kg block CANNOT be categorised as 'free fall' motion. (2)

[18]

QUESTION 3 (Start on a new page.)

Ball **A** is thrown vertically downwards from the top of a building, 90 m high, at a velocity of 12 $m \cdot s^{-1}$. At the same instant, a second identical ball **B** is thrown upwards at a velocity of 30 $m \cdot s^{-1}$. Ball **A** and ball **B** pass each other after 2,135 s.

Ignore the effects of air friction.



3.1 Give the direction of the acceleration of ball **B** while moving upwards. (1)

3.2 Calculate the velocity of ball **B** the moment it passes ball **A**. (3)

3.3 Calculate the distance between ball **A** and **B** 2,5 s after the balls were projected. (5)

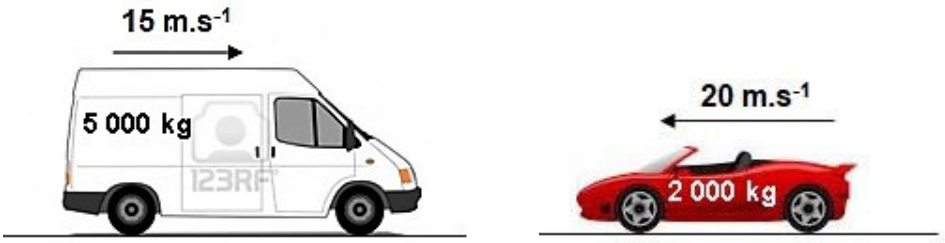
3.4 On the same set of axes draw sketch position-time graphs for the motion of ball **A** and ball **B**.

- For ball **A**, from the moment it was projected until it reached the ground.
- For ball **B** from the moment, it was projected until it passed ball **A**.
- Clearly indicate the time at which the two balls pass each other.
- Use the ground as zero position.
- Label the graphs **A** and **B**. (3)

[12]

QUESTION 4 (Start on a new page.)

A delivery vehicle of mass 5 000 kg, moving at a velocity of 15 $m \cdot s^{-1}$ to the right collides head-on with a car of mass 2 000 kg moving at 20 $m \cdot s^{-1}$ in the opposite direction. Immediately after the collision, the car moves at a velocity of 5 $m \cdot s^{-1}$ to the right.



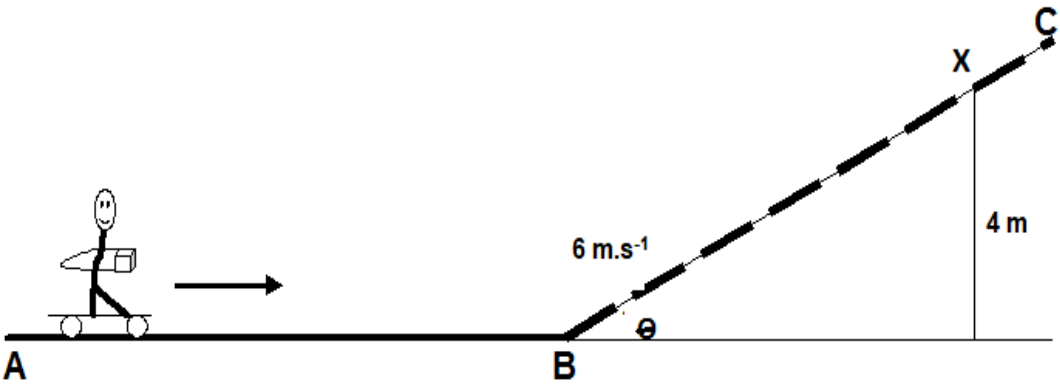
4.1 Write down the principle of conservation of linear momentum in words. (2)

4.2 Calculate the magnitude of the velocity of the delivery vehicle immediately after the collision. (4)

4.3 If the collision lasts 0,4 seconds, calculate the force the delivery vehicle exerts on the car during the collision. (4)
[10]

QUESTION 5 (Start on a new page.)

A boy on roller-skates moves at a constant velocity in an easterly direction along a frictionless horizontal part **AB** of a track carrying a parcel. He decides to increase his velocity by throwing the parcel horizontally away from him.



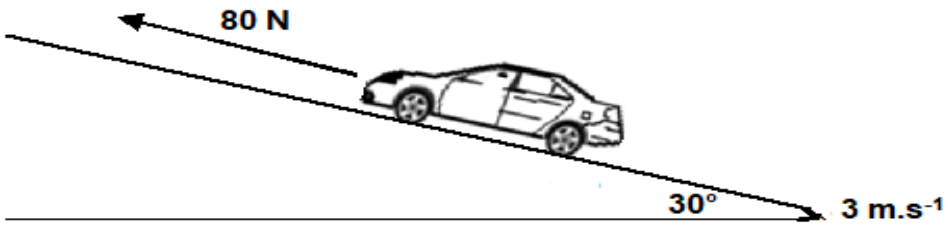
5.1 In which direction must the parcel be thrown to cause a maximum increase in the velocity of the boy? (1)

5.2 Name and define in *words* the Law of physics that was applied in QUESTION 5.1**.** (3)

He reaches point **B** at a velocity of 6 m·s^{-1} and continues to move up a rough section **BC** of the track and comes to rest at position **X,** 4 m above the ground as shown in the diagram below. A constant frictional force of 40 N acts on the roller skates. The combined mass of the boy and roller skates is 57 kg.

5.3 Calculate the value of **Θ** of the inclined plane. (5)

5.4 A remote-controlled car of mass 4 kg is driven up an inclined plane which makes an angle of 30° with the horizontal by an average forward force of 80 N as shown in the diagram below. The car experiences a constant frictional force of 15 N, as it moves up the inclined plane. The speed of the car at the bottom of the inclined plane is 3 m·s^{-1}.



Use energy principles to calculate the speed of the car after it has travelled 5 m up the inclined plane. (6)

[15]

QUESTION 6 (Start on a new page.)

The siren of a stationary fire truck emits sound waves with a frequency of 1 800 Hz. A car, travelling on a straight horizontal road at a constant speed of 30 $m.s^{-1}$, passes the fire truck and continues at the same constant speed.

6.1 State the Doppler effect in words. (2)

6.2 How does the pitch of the siren, heard by the driver of the car, change when the car is moving …
(State only INCREASE, DECREASE or REMAIN THE SAME.)

6.2.1 Towards the fire engine? (1)

6.2.2 Away from the fire truck? (1)

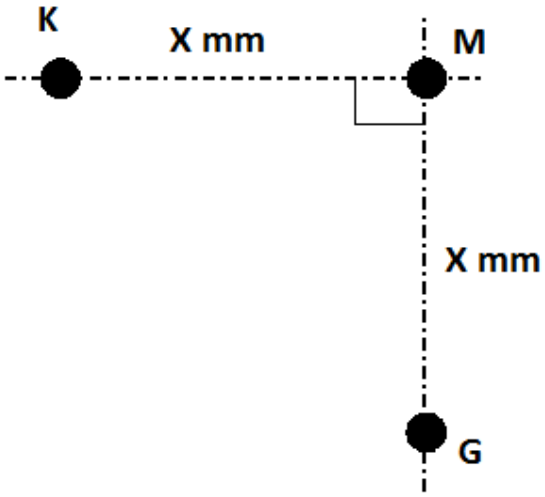
6.3 Calculate the frequency detected by the driver of the car as the car moves towards the fire truck. (Take the speed of sound in air as 330 $m{\cdot}s^{-1}$.) (5)

6.4 Sketch a graph to show how the frequency of the siren changes as a function of time as the driver approaches and then passes the fire truck.
(No numerical values are required.) (3)

6.5 Name a medical instrument that makes use of the Doppler effect. (1)
[13]

QUESTION 7 (Start on a new page.)

Three small, identical metal spheres, **K**, **M** and **G** are placed in a vacuum. Each sphere carries a charge of 6 nC. The spheres are arranged such that **K** and **G** are each **X mm** from **M** as shown in the diagram below:



7.1 State Coulomb's law in words. (2)

The magnitude of the net force exerted on **M** by **K** and **G** is 2,864 x 10^{-6} N.

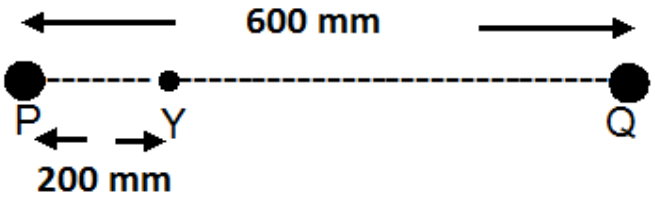
7.2 Calculate the distance, **X**, between **G** and **M**. (8)
[10]

QUESTION 8 (Start on a new page.)

Below is an isolated point charge, **P**, of magnitude + 200 nC.

8.1 Draw an electric field pattern around point charge **P**. (3)

A second point charge, **Q**, also carrying a charge of +200 nC, is placed 600 mm away from the point charge **P** as shown in the diagram below:



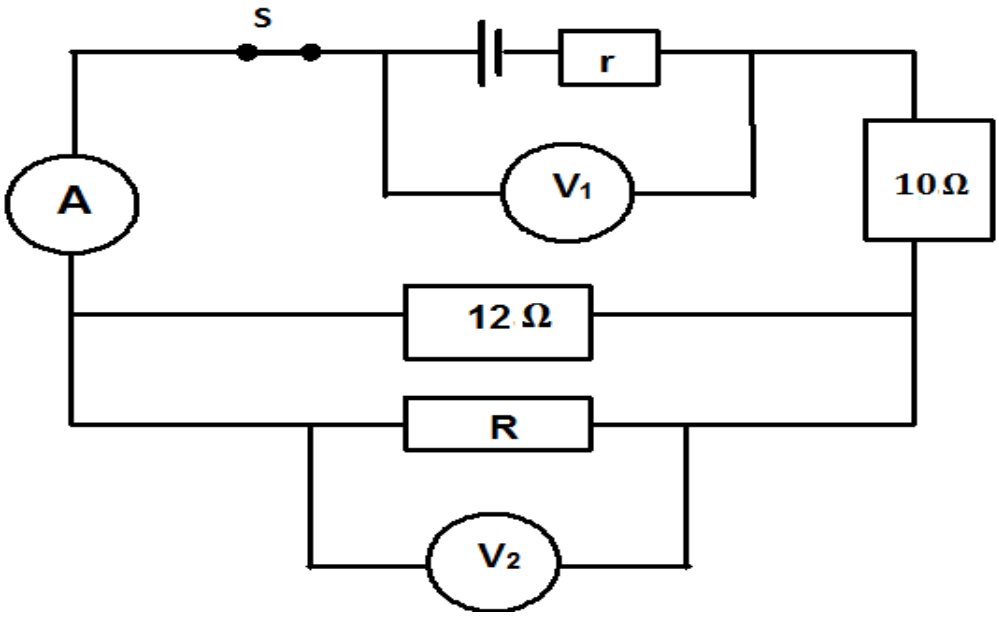
Y is a point 200 mm to the right of point charge **P**.

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

8.3 Calculate the net electric field at point **Y** due to charges **P** and **Q**. (5)
[10]

QUESTION 9 (Start on a new page.)

The battery in the circuit diagram below, has an internal resistance **r**. When switch **S** is closed, the reading on voltmeter V_2 is 18 V and resistor **R** dissipates 13,5 W.



9.1 State Ohm's Law in words. (2)

9.2 Calculate the resistance of resistor **R**. (3)

9.3 Calculate the reading on the ammeter **A**. (5)

9.4 Explain, in words, what is meant by the term *internal resistance* of a battery. (2)

9.5 Calculate the potential difference across the 10 Ω resistor. (3)

9.6 When switch **S** was opened, the reading on voltmeter V_1 was 45,9 V.

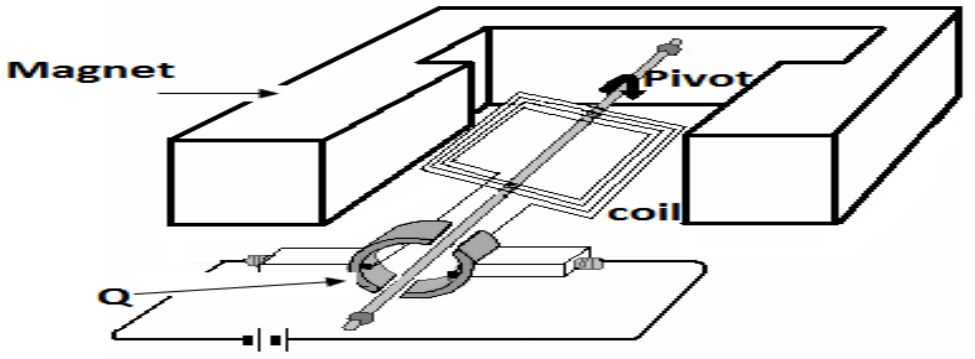
Calculate the internal resistance of the battery. (5)

9.7 Does the internal resistance in the circuit INCREASE, DECREASE, or REMAIN THE SAME when resistor **R** is removed? (1)

[21]

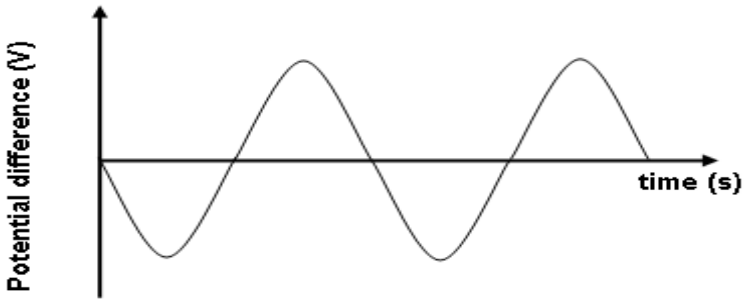
QUESTION 10 (Start on a new page.)

Study the sketch given below.



10.1 Write down the function of the component labelled **Q** in the above sketch. (1)

Two changes are made to the structure of the device shown in the above sketch to obtain the following output potential difference.



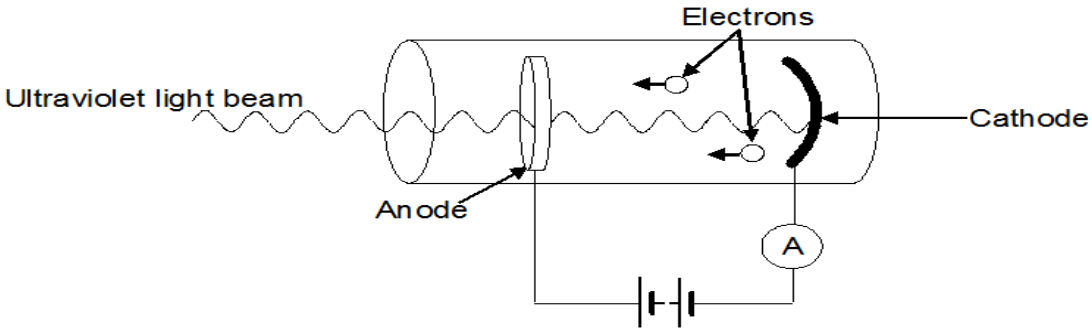
10.2 Write down the TWO changes that were made to the device. (2)

When a 60 W light bulb is connected to the new device, a peak current of 0,54 A flows through the light bulb.

10.3 Calculate the potential difference of a DC supply that will produce the same brightness as the light bulb. (5)
[8]

QUESTION 11 (Start on a new page.)

The photoelectric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



The largest wavelength of monochromatic light that will cause the ejection of photoelectrons in the above photocell, is 229 nm. When a person interrupts the beam, the sudden drop in current activates a switch, which sets off the alarm.

11.1 Calculate the frequency of the monochromatic light of wavelength 229 nm. (3)

11.2 Give the scientific term for the frequency that was calculated in QUESTION 11.1 above. (1)

11.3 Define *work function* in words. (2)

11.4 Calculate the frequency of the monochromatic light that must be used, to emit photoelectrons with a velocity of $1,57 \times 10^6$ $m.s^{-1}$ from the cathode of the above photocell. (4)

11.5 How will the answer in QUESTION 11.4 change if the largest wavelength of monochromatic light needed to eject photoelectron is reduced to 189 nm?

Write down INCREASE, DECREASE, or REMAINS THE SAME.

Give a reason for your answer. (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}
Mass of earth / *Massa op aarde*	M	5,98 × 10^{24} kg
Radius of earth / *Radius van aarde*	R_E	6,38 × 10^{6} m
Speed of light in a vacuum / *Spoed van lig in 'n vakuum*	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

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*

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

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 $E_k = \frac{1}{2}mv^2$	$W_{nett} = \Delta K$ or/*of* $W_{nett} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv$	

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*

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

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 = VIΔt 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*

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