education

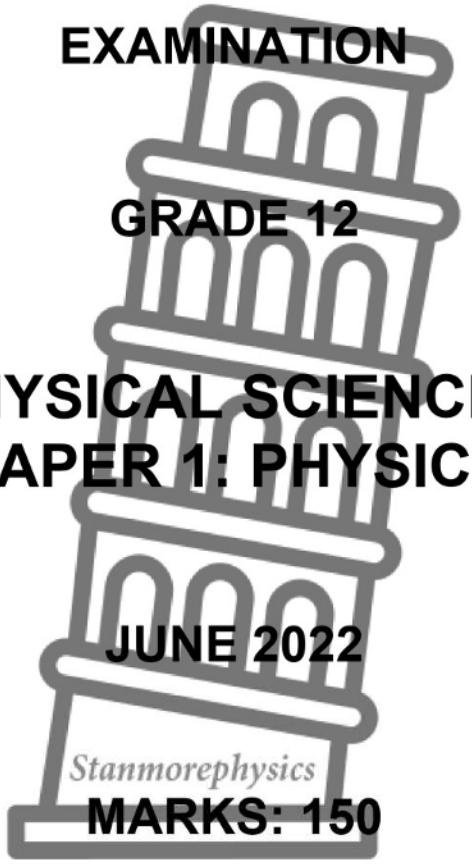
Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES (PAPER 1: PHYSICS)

JUNE 2022



MARKS: 150

TIME: 3 HOURS

This paper consists of 16 pages and three information sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket 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 where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.



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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1-1.10) in your ANSWER BOOK.

1.1 Two balls of masses $\frac{1}{2}m$ and $2m$ are dropped simultaneously from the same height above the ground. Ignore air resistance.

Which ONE of the following physical quantities will be the same for both balls when they strike the ground?

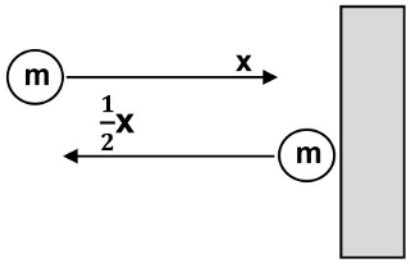
A Weight

B Velocity

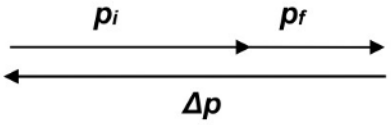
C Momentum

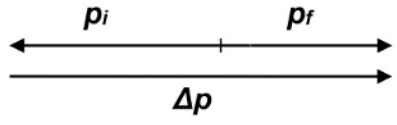
D Kinetic energy (2)

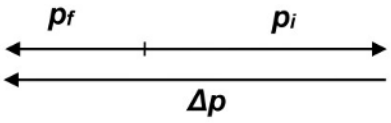
1.2 A tennis ball of mass m, travelling east at a velocity of x m.s^{-1}, hits a wall and bounces back at a velocity of $\frac{1}{2}x$ m.s^{-1} as shown below.

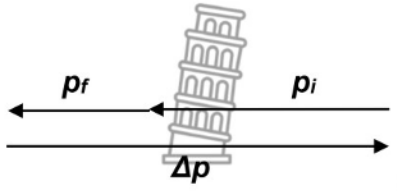


Which ONE of the following vector diagrams (not drawn to scale) correctly represents the relationship between initial, final and change in momentum of the tennis ball?

A


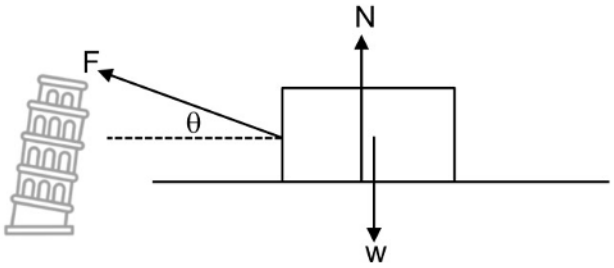
B


C


D


(2)

1.3 The diagram below shows the forces acting on a box.



Which ONE of the following equations is correct for the magnitude of the normal force (N)?

A $N = w - F\sin\theta$

B $N = w + F\sin\theta$

C $N = w - F\cos\theta$

D $N = w + F\cos\theta$ (2)

1.4 The product of the net force (resultant force) acting on an object and the time the net force acts on the object is the …

A power.

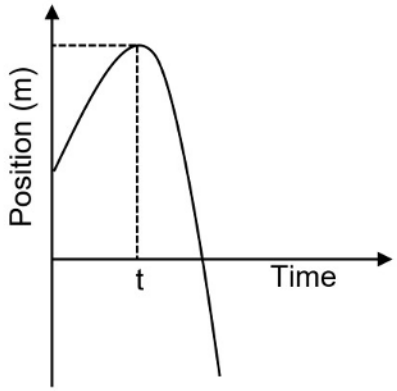
B impulse.

C momentum.

D acceleration. (2)

1.5 A stone is projected vertically upwards from the top of a building at a speed of v m·s^{-1}. The position-time graph below represents the motion of the stone. Ignore the effects of air resistance.





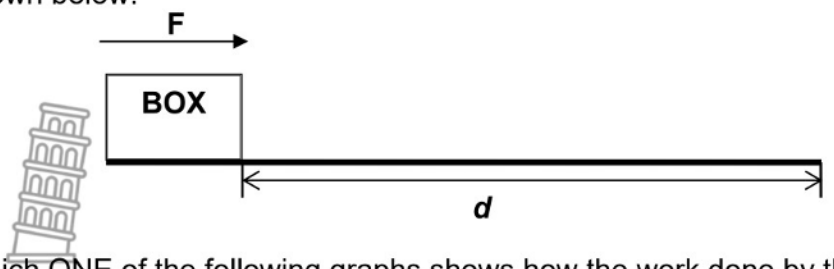
Which ONE of the following combinations regarding the magnitudes of the stone's velocity and acceleration, at time t, is correct?

	Magnitude of velocity (m·s^{-1})	**Magnitude of acceleration (m·s^{-2})**
A	0	9,8
B	0	0
C	v	0
D	v	9,8

(2)

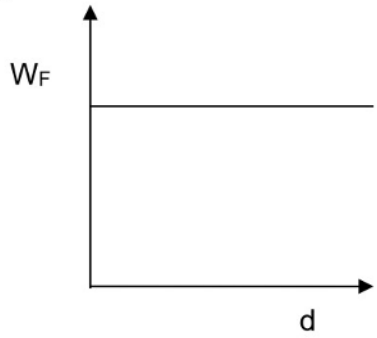


1.6 A constant force *F* is applied to move a box through a displacement *d* as shown below.

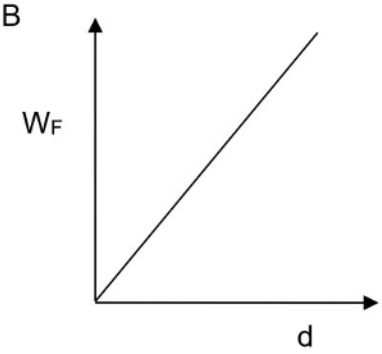


Which ONE of the following graphs shows how the work done by the constant force *F* (W_F) changes with displacement *d*? Ignore friction.

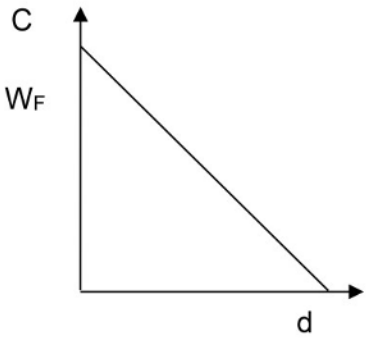
A



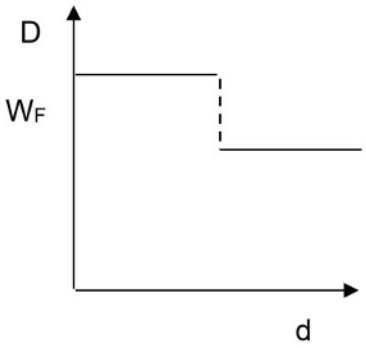
B



C

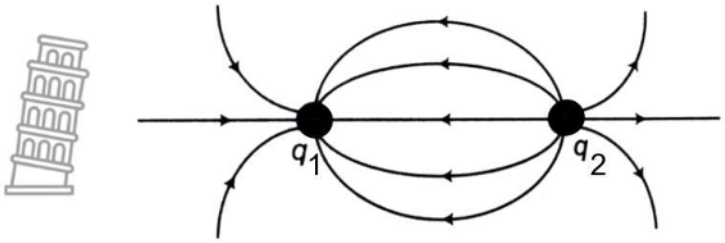


D



(2)

1.7 Consider the electric field pattern of two point charges q_1 and q_2 below, with the three statements numbered (i), (ii), and (iii).



(i) Both charges have equal magnitudes.
(ii) Charges q_1 and q_2 are oppositely charged.
(iii) Charge q_1 is positively charged and charge q_2 is negatively charged.

Which ONE of the following represents one or more INCORRECT statements?

A (i) only

B (iii) only

C (ii) and (iii)

D (i), (ii) and (iii) (2)

1.8 Point charge **Z** is a distance x from point **P**. The electric field at **P** due to **Z** is E. What would be the electric field at a point that is HALF the distance of x from **Z**?

A ¼E

B ½E

C 2E

D 4E (2)

1.9 The minimum value of the resistance that can be obtained by connecting two 4 Ω resistors is …

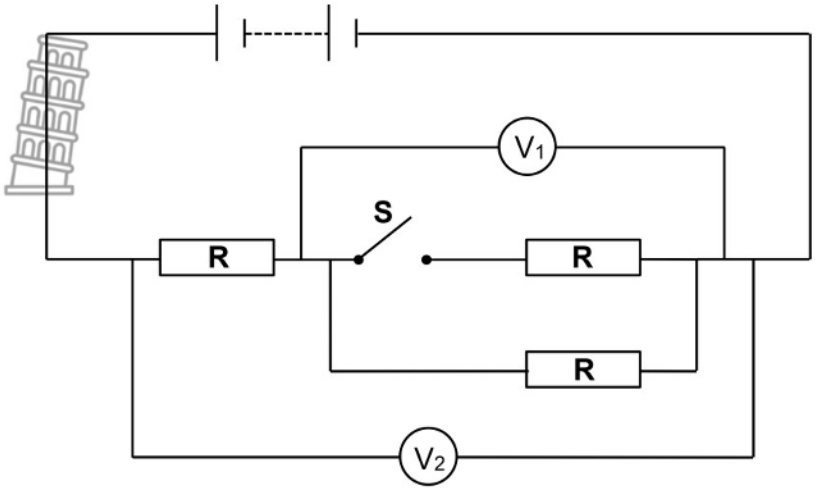
A 1 Ω.

B 2 Ω.

C 3 Ω.

D 4 Ω. (2)

1.10 In the circuit diagram below, the three resistors are identical, each with a resistance *R*. Switch **S** is open and the battery has NEGLIGIBLE internal resistance. Ignore the resistance of the connecting wires.



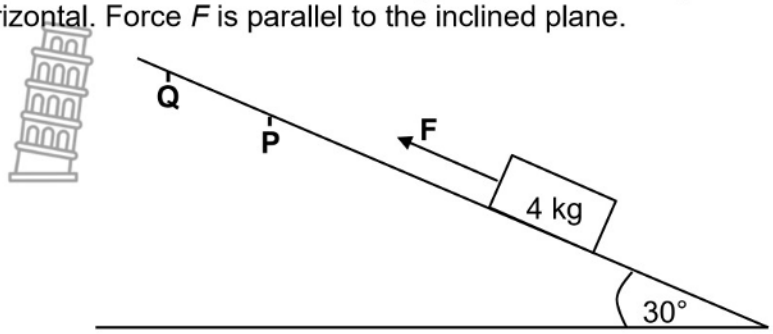
How will the readings on the voltmeters be influenced if switch **S** is closed?

	Voltmeter V_1	**Voltmeter V_2**
A	Decreases	Decreases
B	Increases	Increases
C	Decreases	Remains the same
D	Increases	Remains the same

(2)
[20]

QUESTION 2

2.1 A 4 kg block is pulled by a constant force *F* up a rough, inclined plane at a CONSTANT SPEED. The inclined plane makes an angle of 30° with the horizontal. Force *F* is parallel to the inclined plane.



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

2.1.2 Draw a labelled free-body diagram for the block to show all the forces acting on it. (4)

A constant, kinetic frictional force of 12,5 N acts on the block.

2.1.3 Calculate the magnitude of force *F*. (5)

Force *F* is removed when the block reaches point **P**. The block continues to move up the inclined plane and comes to rest momentarily at point **Q**.

2.1.4 Identify the COMPONENTS of the net force on the block as it moves from **P** to **Q**. (2)

2.1.5 Calculate the magnitude of the acceleration of the block from **P** to **Q**. (4)

2.2 A satellite, mass 250 kg, is in a circular orbit a certain height above the surface of the earth. The earth exerts a gravitational force of $2,4 \times 10^3$ N on the satellite to keep it in its orbit.

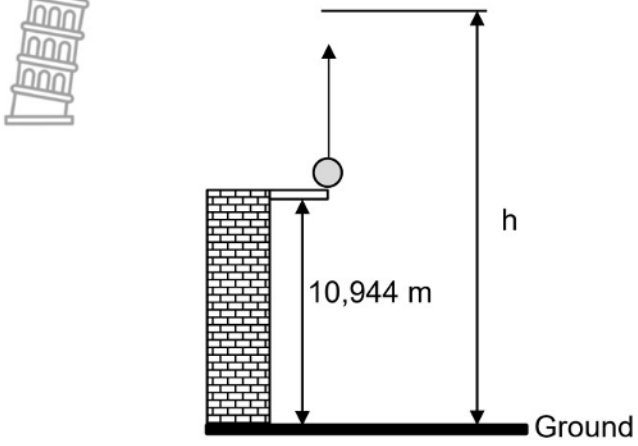
2.2.1 State *Newton's Law of Universal Gravitation* in words. (2)

2.2.2 Calculate the height of the satellite above the surface of the earth. (5)

[24]

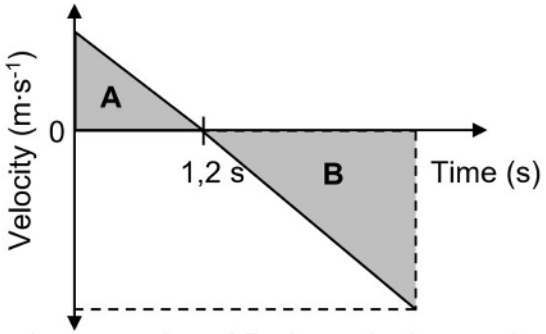
QUESTION 3

3.1 A ball is thrown vertically upwards from the top of a building, 10,944 m above the ground. The ball reaches a maximum height *h* above the ground as shown in the diagram below. Ignore the effects of air resistance.



3.1.1 Name the force acting on the ball while it is in free fall. (1)

The motion of the ball, from the instant it is thrown upwards until it hits the ground, is represented by the velocity-time graph below.



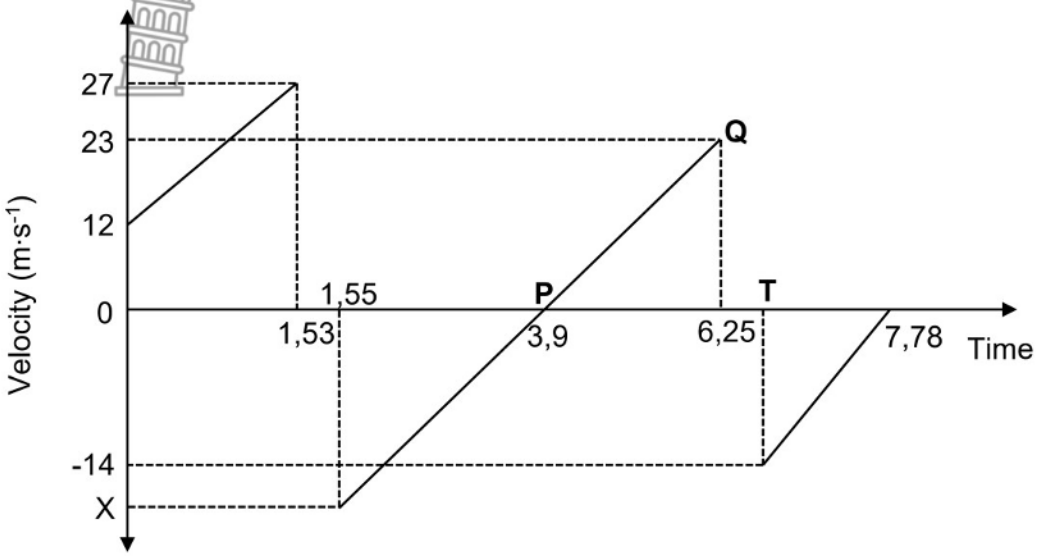
3.1.2 Consider the areas **A** and **B** shown in the graph above. Write down the numerical value of the physical quantity represented by the DIFFERENCE in areas **A** and **B**. (1)

Calculate the:

3.1.3 Speed at which the ball is thrown upwards. (3)

3.1.4 Height, *h*, above the ground (4)

3.2 Another ball is THROWN VERTICALLY DOWNWARDS from the top of another building and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is thrown, up until 7,78 s. Take DOWNWARDS AS THE POSITIVE DIRECTION and the ground as zero reference. The graph is NOT necessarily drawn to scale. Ignore the effects of air friction.



3.2.1 Write down the speed with which the ball is thrown downwards. (1)

3.2.2 All parts of the graph have the same gradient. Give a reason for this observation. (2)

3.2.3 Calculate the height from which the ball is thrown. (3)

3.2.4 Calculate the time *T* shown on the graph. (4)

Write down the following:

3.2.5 Number of times the ball has bounced. (1)

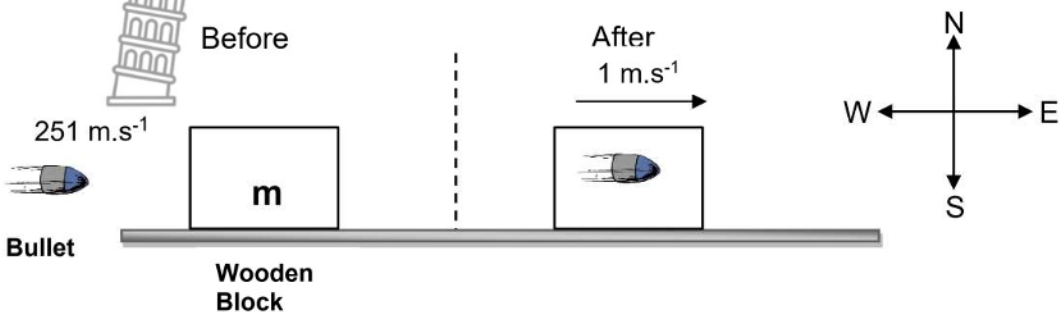
3.2.6 How long the ball is in contact with the ground during the first bounce. (1)

3.2.7 Time at which the ball reaches its maximum height after the first bounce. (1)

3.2.8 Direction in which the ball is moving between points **P** and **Q**. (1)
[23]

QUESTION 4

4.1 A wooden block of unknown mass *m* is at rest on a smooth, horizontal surface. A bullet of mass 0,02 kg, travelling east at a velocity of 251 m.s^{-1}, strikes the block and gets stuck in the block. The block-bullet system then moves towards the east at 1 m.s^{-1}. Refer to the diagram below.

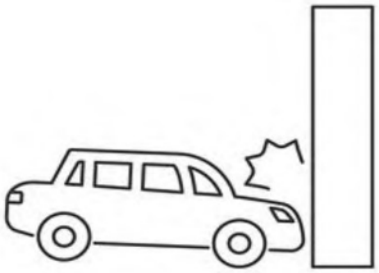


4.1.1 State the principle of *conservation of linear momentum* in words. (2)

4.1.2 Calculate mass *m* of the wooden block. (5)

4.1.3 Use calculations to determine whether the collision is elastic or inelastic. (5)

4.2 A 90 kg woman drives her 2 410 kg car into a wall at 20 m.s^{-1} as shown below. Airbags have been proven to reduce the chances of serious injuries to drivers and passengers during collisions.



4.2.1 Explain, using physics' principles, how airbags can reduce the chances of serious injuries during collisions. (3)

It took the car 0,3 s to come to a stop during the collision.

4.2.2 Calculate the net force exerted by the wall on the car during the collision. (4)

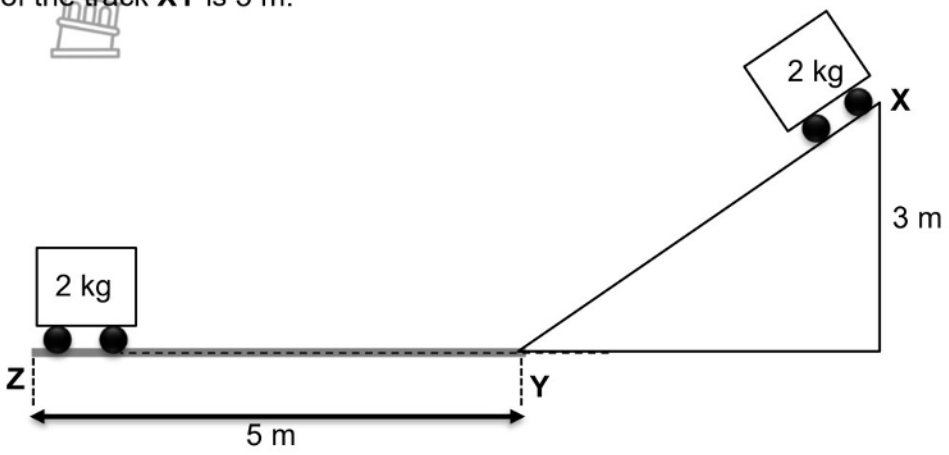
4.2.3 Give the magnitude and direction of the net force the car exerts on the wall. (2)

4.2.4 Name a physics law or principle that you have used to answer QUESTION 4.2.3. (1)

[22]

QUESTION 5

A 2 kg trolley is held stationary at point **X**, which is at the top of a frictionless track **XY**. When the trolley is released, it moves down the track and passes point **Y**, which is at the bottom of the track. The trolley then enters a ROUGH path **YZ** where it comes to a stop at point **Z**, which is 5 m from point **Y**. The height of the track **XY** is 3 m.



5.1 Is the system between points **X** and **Y** isolated? Write down YES or NO and give a reason for your answer. (2)

5.2 State the *principle of conservation of mechanical energy* in words. (2)

5.3 Calculate the speed of the trolley when it reaches point **Y**. (4)

5.4 Draw a free-body diagram showing ALL the forces acting on the trolley as it moves along path **YZ**. (3)

5.5 Define the term *non-conservative force*. (2)

5.6 Give the NAME of a conservative force acting on the trolley as it moves along path **YZ**. (1)

5.7 In which direction is the trolley accelerating as it moves along path **YZ**? Write down FROM **Y** TO **Z** OR FROM **Z** TO **Y**. Give a reason for your choice. (2)

5.8 Use energy principles ONLY to calculate the magnitude of the frictional force acting on the trolley as it moves along path **YZ**. (5)

[21]

QUESTION 6

6.1 A high-speed train is travelling at an unknown constant speed *v* when its horn emits a sound with a frequency *f*. A stationary man waiting at the station hears the frequency of the horn as 1,3*f*. Take the speed of sound in air as 343 $m \cdot s^{-1}$.

6.1.1 Is the train moving towards or away from the man? Give a reason for your answer. (2)

6.1.2 Calculate speed *v* at which the train is travelling. (5)

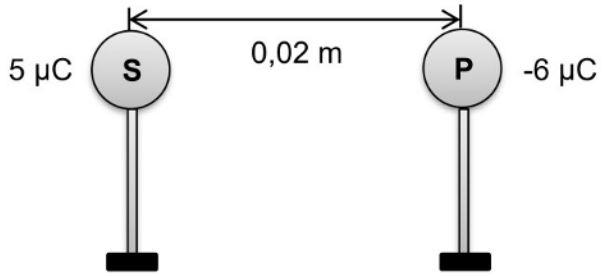
6.1.3 Give ONE application of the Doppler effect in medicine. (1)

6.2 Explain the term *red shift*. (2)

[10]

QUESTION 7

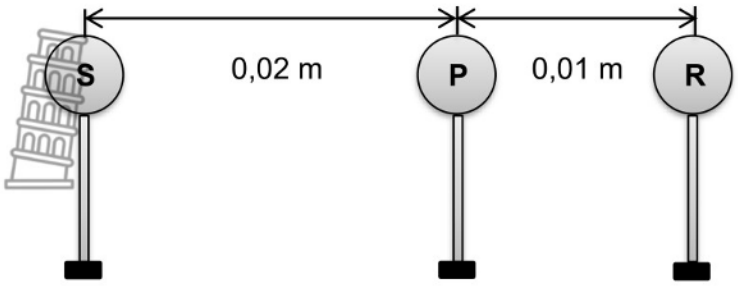
Two charged spheres, **S** and **P**, on insulated stands, with charges of 5 µC and -6 µC respectively, are placed 0,02 m apart, as shown in the diagram below.



7.1 State *Coulombs' Law* in words. (2)

7.2 Calculate the magnitude and direction of the electrostatic force that sphere **S** exerts on sphere **P**. (4)

Spheres **S** and **P** are brought into contact with each other and then returned to their original positions. A third, negatively charged, sphere **R** with an UNKNOWN charge is now placed 0,01 m to the right of sphere **P** as shown below.



7.3 Calculate the magnitude of the NEW charge on **S** after being in contact with **P**. (1)

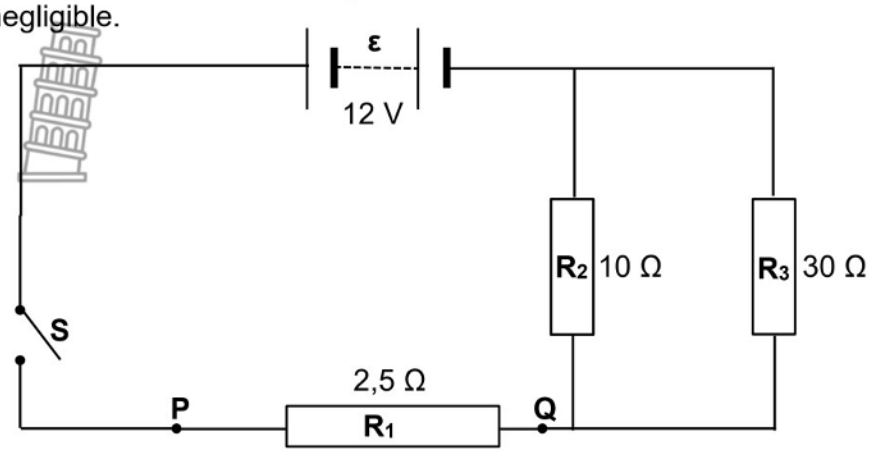
7.4 Draw a free-body diagram showing ALL the electrostatic forces experienced by **P**. (2)

7.5 The magnitude of the net electrostatic force experienced by **P** due to **S** and **R** is 84,375 N. Calculate the magnitude of the charge on **R**. (5)

7.6 Calculate the magnitude of the net electric field at a point 0,01 m to the LEFT of **R** due to the charges on **S** and **R**. (3)
[17]

QUESTION 8

A battery with an emf of 12 V and negligible internal resistance is connected to three resistors as shown in the circuit diagram below. The resistance of the connecting wires is negligible.



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

Switch **S** is closed.

8.2 How much energy does the battery transfer to each coulomb of charge? (1)

8.3 Calculate the following when switch **S** is closed:

8.3.1 The total resistance of the circuit (4)

8.3.2 The current in $\mathbf{R_1}$ (4)

8.4 A wire, with negligible resistance, is used to connect points **P** and **Q**. How will this affect the TOTAL CURRENT in the circuit? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (2)

[13]

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

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VRAESTEL 1 (FISIKA)

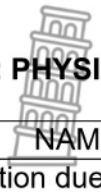


TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

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 x 10^{-11} $N \cdot m^2 \cdot kg^2$
Radius of the earth *Radius van die aarde*	R_E	6,38 x 10^6 m
Mass of the earth *Massa van die aarde*	M_E	5,98 x 10^{24} kg
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge of electron *Lading op elektron*	e	-1,6 x10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg



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TABLE 1: 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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemiddeld} = Fv_{gemiddeld}$	

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

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

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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*

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

ALTERNATING CURRENT / *WISSELSTROOM*

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

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