Education and Sport Development
Department of Education and Sport Development
Departement van Onderwys en Sportontwikkeling
Lefapha la Thuto le Tlhabololo ya Metshameko
NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer QUESTION 1 to 10 in the ANSWER BOOK.
3. Start EACH question on a NEW page in your 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

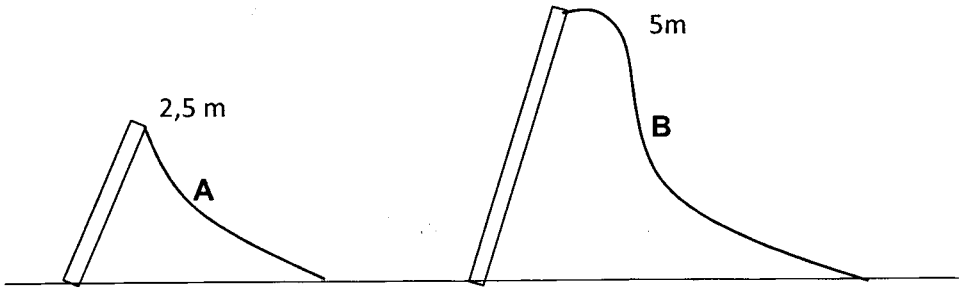
Four options are provided as possible answers to the following questions. Each question has only one correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) on the ANSWER BOOK, for example 1.11 E.

1.1 A large truck collides head-on with a small compact car.

During the collision the magnitude of the force exerted by the ...

A truck on the car is greater than the car on the truck.
B truck on the car is equal to the car on the truck.
C car on the truck is greater than the truck on the car.
D truck and the car are proportional to their masses. (2)

1.2 In a playground there are two frictionless slides, **A** and **B**, with the heights as indicated in the diagram below. Catherine slides down **A** and then down **B**.



How will Catherine's velocity at the bottom of slide **B** compare to her velocity at the bottom of slide **A**?

Her speed at the bottom of ...

A **A** is twice as much as the speed at the bottom of **B**.
B **B** is twice as much as the speed at the bottom of **A**.
C **B** is more, but not twice as much as the speed at the bottom **A**.
D **B** is equal to the speed at the bottom of **A**. (2)

1.3 Two identical bullets, **X** and **Y**, with identical velocities strike a steel block and a wooden block respectively.

Bullet **X** bounces 180° back from the steel block. Bullet **Y** penetrates and becomes embedded inside the wooden block.

Which one of the following statements about the impulse of the bullets is correct?

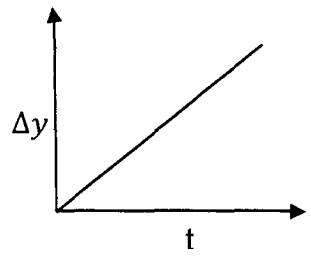
Impulse of bullet **X** ...

A is smaller than the impulse of bullet **Y**.
B is greater than the impulse of bullet **Y**.
C is equal to the impulse of bullet **Y**.
D and bullet **Y** are zero. (2)

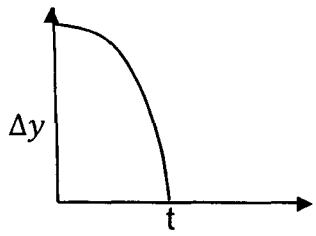
1.4 A stone is thrown vertically upwards from the top of a building.

Which ONE of the following displacement versus time graphs best represents the motion of the stone?

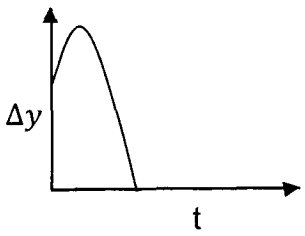
A



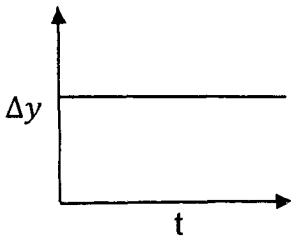
B



C



D



(2)

1.5 An air traffic controller is standing on the tarmac of the runway of an air-field. A small plane moves down the runway. The noise of the engine, as heard by the pilot, has a frequency 1,15 times the frequency that the controller hears.

Which statement best describe the movement of the plane relative to the controller?

A The plane is moving towards the controller.
B The plane is moving away from the controller.
C The plane is passing in front of the controller.
D One cannot determine the movement of the plane relative to the controller. (2)

1.6 Two small objects, each with a net charge of +Q, exert a force of magnitude F on each other.

One of the objects is replaced with another with a charge of +4Q. In the process the distance between the objects is doubled. The force that the one charge now exerts on the other charge is:

A $\frac{1}{2}$F

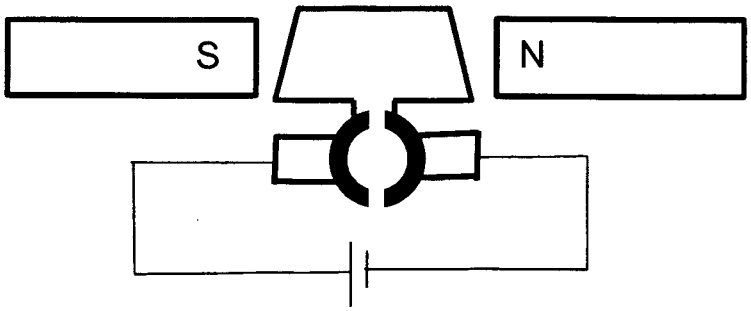
B 2F

C 4F

D F

(2)

1.7 A simple diagram of a DC motor is shown below.



Which ONE of the following statements regarding a DC motor is INCORRECT?

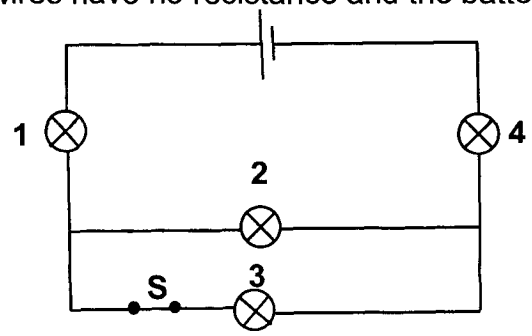
A The split ring commutator serves as a change switch which reverses the current after every half revolution.

B The brushes maintain electrical contact between the battery and the turning commutator.

C The current, in the opposite sides of the coil, flows through the magnetic field in opposite directions.

D The coil will turn clockwise until it is vertical and then it will stop. (2)

1.8 In the circuit below four identical bulbs are connected to a battery. The connecting wires have no resistance and the battery has no internal resistance.



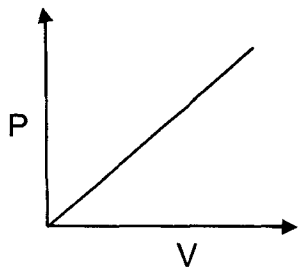
What happens to the current through bulbs **1**, **2** and **4** if switch, **S** is opened?

	Light bulb **1**	Light bulb **2**	Light bulb **4**
A	Decrease	Increase	Decrease
B	Decrease	Increase	Increase
C	Increase	Decrease	Increase
D	Increase	Increase	Decrease

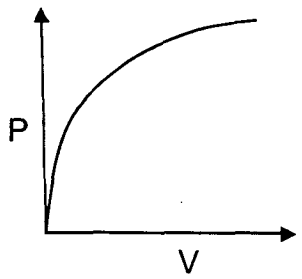
(2)

1.9 A resistor is connected to a variable potential difference. Which ONE of the following graphs best represents the relationship between power **P**, dissipated in the resistor and potential difference **V**, across it? Assume the resistance remains constant.

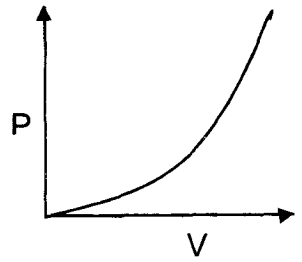
A



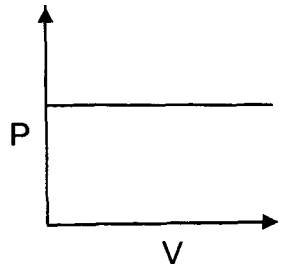
B



C



D



(2)

1.10 When a monochromatic light is shone onto a clean cadmium surface, electrons with kinetic energy up to a maximum of 2P are released. The work function of cadmium is P.

What is the frequency of the photons of this light?

A $\frac{3P}{h}$

B $\frac{P}{h}$

C Ph

D 3Ph

(2)
[20]

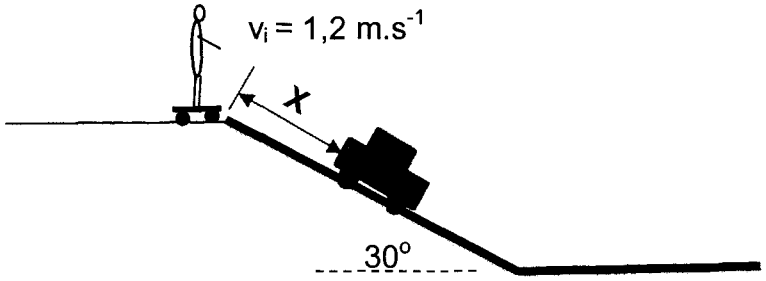
QUESTION 2 (Start on a new page.)

Percy gives his skateboard a push along a horizontal frictionless surface.

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

2.2 Describe and explain the motion of the skateboard after it has travelled 2 metres along the horizontal surface. (2)

2.3 Just before reaching a slope with a rough surface, Percy jumps onto the skateboard. The slope makes an angle of 30° with the horizontal. Percy's speed at the top of slope is 1,2 $m \cdot s^{-1}$. The combined mass of Percy and the skateboard is 95 kg.



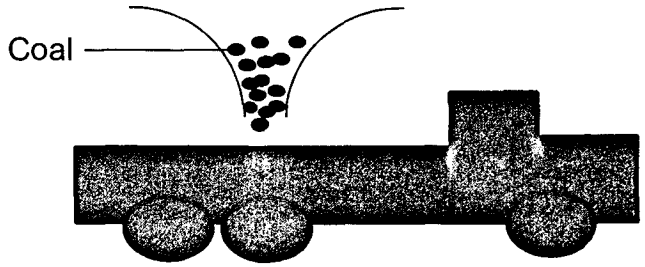
2.3.1 Calculate the friction force down the slope if the coefficient of kinetic friction (μ_k) is 0,2. (3)

2.3.2 Calculate Percy's acceleration down the slope. (4)

2.3.3 It takes Percy 0,3 s from the top of the slope to pass the front of a 2,1 m long car, parked down the slope. Calculate the distance **X**. (5)
[16]

QUESTION 3 (Start on a new page.)

An empty coal-carrying truck moves through a coal loading plant at a constant velocity of 2 $m.s^{-1}$. The truck is filled with coal as it moves through the plant. The mass of the truck is 1×10^4 kg and the mass of the coal load is 5×10^3 kg. At the start of the loading process the truck's engine cuts out and it keeps moving forward.



3.1 Define the concept *conservation of linear momentum.* (2)

3.2 Calculate the speed of the truck after the coal was loaded. (4)

3.3 State Newton's Second Law in terms of momentum. (2)

3.4 If it takes 4 s to load the coal, calculate the impulse on the truck. (4)

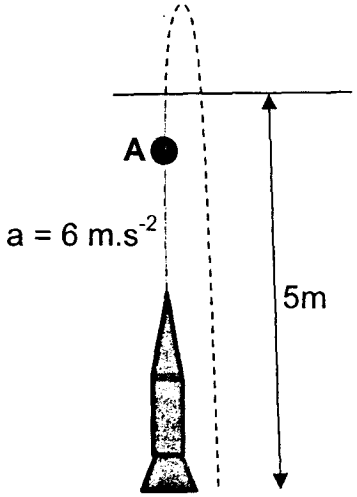
3.5 Show by calculation that the collision during the loading of the truck with the coal was inelastic. (4)

3.6 State the work-energy theorem in words. (2)

3.7 Use the work-energy theorem to calculate how far the truck with coal will move before it comes to a rest. The friction force acting in on the truck is 3×10^3 N. (5)
[23]

QUESTION 4 (Start on a new page.)

A rocket is shot vertically upwards. The rocket has a mass of 250 kg and a load with an unknown mass, m. The rocket accelerates at 6 $m.s^{-2}$ upwards and the burning fuel exerts a force of 7 700 N upwards on the rocket.



4.1 Draw a labelled free body diagram of the forces acting on the rocket at point **A**. (2)

4.2 What is the maximum mass, m, of the load, which the rocket can carry to ensure a constant upwards acceleration of 6 $m.s^{-2}$? (5)

4.3 The fuel completely burns out at a height of 5 m above the ground. Calculate the velocity of the rocket at this height. (3)

4.4 Describe what is meant by a *projectile*? (2)

4.5. Calculate the maximum height from the ground that the rocket reaches. (4)

4.6 Calculate how long it will take for the rocket to fall back to the ground from the maximum height. (3)
[19]

QUESTION 5 (Start on a new page.)

A ship was entering the harbour at a constant speed of 6 $m \cdot s^{-1}$. The captain sounded the ship's horn, producing a sound with a frequency of 95 Hz.

5.1 A stationary tourist, however, observed a different frequency. Assume that the speed of sound in air is 340 $m \cdot s^{-1}$

5.1.1 Name the phenomenon described above. (1)

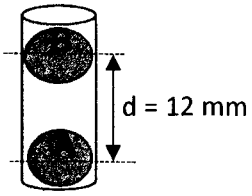
5.1.2 Explain why a different frequency of sound was observed by the tourist. (2)

Another ship now enters the harbour. This ship's horn produced a sound with a frequency of 94 Hz, but the tourist observed exactly the same frequency of sound as that from the first ship.

5.2 Calculate the speed of the second ship, sailing into the harbour. (6)
[9]

QUESTION 6 (Start on a new page.)

Two positively charged spheres are placed into a vacuum sealed cylinder, as shown in the diagram below. Sphere **A** has a charge of +4 $x10^{-6}$ C.



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

6.2. Draw the electric field lines between spheres **A** and **B**. (3)

6.3. Calculate the charge on sphere **B** if its mass is 10 g and the distance between spheres **A** and **B** is 12 mm. (6)
[11]

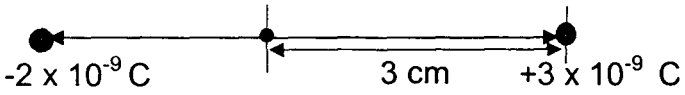
QUESTION 7 (Start on a new page.)

A charge Q has an electric field surrounding it. When a point charge of -2×10^{-9} C is placed in Q's electric field, it experiences an electrostatic force of 3×10^{-6} N.

7.1. Define *electric field strength*. (2)

7.2. Calculate the magnitude of the electric field at the position of the point charge. (3)

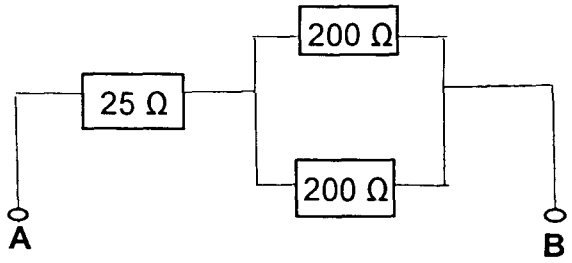
7.3. The -2×10^{-9} C point charge is placed on a horizontal line 5 cm from a $+3 \times 10^{-9}$ C point charge as shown below.



Calculate the net electric field strength at a point 3 cm left of the positive charge. (6)
[11]

QUESTION 8 (Start on a new page.)

The following diagram shows an arrangement of resistors connected in a part of a circuit.



8.1 Calculate the total resistance between **A** and **B**. (3)

An ALTERNATING current power supply is placed between the two terminals **A** and **B**, and the average power dissipated in each of the 200 Ω resistors is 2 W.

8.2 Calculate V_{rms} across ONE of the 200 Ω resistors. (3)

8.3 Calculate the maximum current through the 25 Ω resistor. (4)

8.4 Calculate V_{rms} across **A** and **B**. (3)

8.5 Another 25 Ω resistor is connected in parallel with the original 25 Ω resistor.

8.5.1. How will the maximum potential difference across the 200 Ω resistor change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

8.5.2. Explain the answer in Question 8.5.1. (2)
[16]

QUESTION 9 (Start on a new page.)

A 12 V car battery has an internal resistance of 5×10^{-3} Ω.

9.1. Explain what is meant by the term *internal resistance*. (2)

The battery provides the starter with a current of 800 A in order to start the engine of the car.

9.2. Calculate the potential difference across the terminals of the battery when the ignition switch is turned on to start the engine of the car. (4)

9.3. Calculate the rate of dissipation of energy due to the internal resistance. (3)

9.4. What will be the effect on starting the car with a 12 V battery with a much higher internal resistance? (2)
[11]

QUESTION 10 (Start on a new page.)

The work function of three metals are shown in the table below.

Metal	Work function (W_o) in J
Aluminium	$6{,}54 \times 10^{-19}$
Zinc	$6{,}89 \times 10^{-19}$
Silver	$7{,}59 \times 10^{-19}$

10.1 Give a reason why different metals have different work functions. (1)

10.2 A light of wavelength $2{,}3 \times 10^{-7}$ m is shone onto a metal **X**. The average speed of the emitted electrons is $4{,}8 \times 10^{5}$ m·s^{-1}. Identify metal **X** by performing relevant calculations. (6)

10.3 What property of light is illustrated by the photoelectric effect of light? (1)

10.4 Light, with a higher frequency, but the same intensity as the light in QUESTION 10.2, is now shone onto metal and the release of electrons are observed.

What effect will this change have on the following:

10.4.1 Kinetic energy of the emitted photoelectrons (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

10.4.2 Number of photoelectrons emitted per second (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

10.5 Overexposure to sunlight causes damage to skin cells.

10.5.1 Which type of radiation in sunlight is primarily responsible for this damage? (1)

10.5.2 Name the property of the radiation responsible for this damage. (1)

10.6 Explain how an emission spectrum is formed. (2)
[14]

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 gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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	$9,11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^{6}\ m$

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ 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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ 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* $K_{max} = \frac{1}{2}mv_{max}^2$	