



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2016**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 16 pages and 3 data sheets.**

## INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 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

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11 

A
---

B
---

C
---

<del>D</del>
--------------

1.1 The tendency of an object to remain at rest or to continue in its uniform motion in a straight line is known as ...

- A inertia.
- B acceleration.
- C Newton's Third Law.
- D Newton's Second Law. (2)

1.2 The mass of an astronaut on Earth is  $M$ . At a height equal to twice the radius of the Earth, the **mass** of the astronaut will be ...

- A  $\frac{1}{4} M$
- B  $\frac{1}{9} M$
- C  $M$
- D  $2 M$  (2)

1.3 An object is thrown vertically upwards from the ground.

Which ONE of the following is CORRECT regarding the direction of the acceleration of the object as it moves upwards and then downwards? Ignore the effects of air resistance.

	OBJECT MOVING UPWARDS	OBJECT MOVING DOWNWARDS
A	Downwards	Upwards
B	Upwards	Downwards
C	Downwards	Downwards
D	Upwards	Upwards

(2)

- 1.4 A person drops a glass bottle onto a concrete floor from a certain height and the bottle breaks. The person then drops a second, identical glass bottle from the same height onto a thick, woollen carpet, but the bottle does not break.

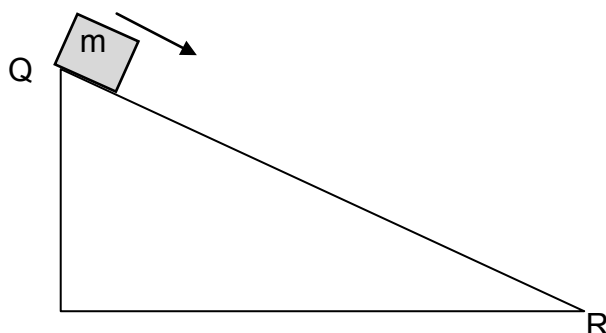
Which ONE of the following is CORRECT for the second bottle compared to the first bottle for the same momentum change?

	AVERAGE FORCE ON SECOND BOTTLE	TIME OF CONTACT WITH CARPET
A	Larger	Smaller
B	Smaller	Smaller
C	Larger	Larger
D	Smaller	Larger

(2)

- 1.5 A block of mass  $m$  is released from rest from the top of a frictionless inclined plane **QR**, as shown below.

The total mechanical energy of the block is  $E_Q$  at point **Q** and  $E_R$  at point **R**. The kinetic energy of the block at points **Q** and **R** is  $K_Q$  and  $K_R$  respectively.



Which ONE of the statements regarding the total mechanical energy and the kinetic energy of the block at points **Q** and **R** respectively is CORRECT?

	TOTAL MECHANICAL ENERGY $E$	KINETIC ENERGY $K$
A	$E_Q > E_R$	$K_Q = K_R$
B	$E_Q = E_R$	$K_Q < K_R$
C	$E_Q = E_R$	$K_Q = K_R$
D	$E_Q < E_R$	$K_Q > K_R$

(2)

- 1.6 The diagram below shows the positions of two stationary listeners, **P** and **Q**, relative to a car moving at a constant velocity towards listener **Q**. The hooter on the car emits sound. Listeners **P** and **Q** and the driver all hear the sound of the hooter.

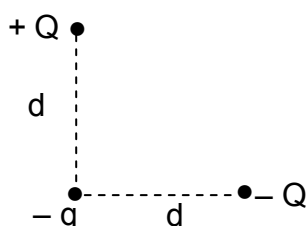


Which ONE of the following CORRECTLY describes the frequency of the sound heard by **P** and **Q**, compared to that heard by the driver?

	FREQUENCY OF THE SOUND HEARD BY P	FREQUENCY OF THE SOUND HEARD BY Q
A	Lower	Higher
B	Higher	Higher
C	Lower	Lower
D	Higher	Lower

(2)

- 1.7 Two charges,  $+Q$  and  $-Q$ , are placed a distance  $d$  from a negative charge  $-q$ . The charges,  $+Q$  and  $-Q$ , are located along lines that are perpendicular to each other as shown in the diagram below.



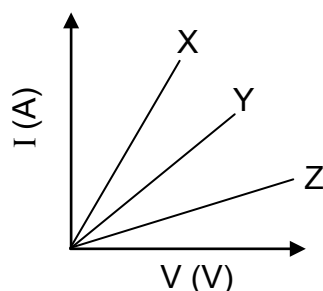
Which ONE of the following arrows CORRECTLY shows the direction of the net force acting on charge  $-q$  due to the presence of charges  $+Q$  and  $-Q$ ?

A	
B	
C	
D	

(2)

- 1.8 Learners investigate the relationship between current ( $I$ ) and potential difference ( $V$ ) at a constant temperature for three different resistors, **X**, **Y** and **Z**.

They obtain the graphs shown below.



The resistances of **X**, **Y** and **Z** are  $R_X$ ,  $R_Y$  and  $R_Z$  respectively.

Which ONE of the following conclusions regarding the resistances of the resistors is CORRECT?

- A  $R_Z > R_Y > R_X$
- B  $R_X = R_Y = R_Z$
- C  $R_X > R_Y > R_Z$
- D  $R_X > R_Y$  and  $R_Y < R_Z$  (2)

- 1.9 Which ONE of the following changes may lead to an increase in the emf of an AC generator without changing its frequency?

- A Decrease the resistance of the coil.
- B Increase the area of the coil.
- C Increase the resistance of the coil.
- D Decrease the speed of rotation. (2)

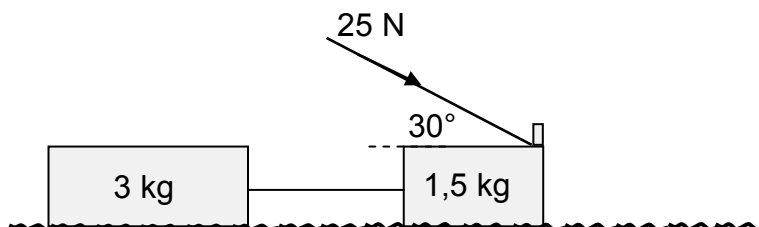
- 1.10 The wavelength of a monochromatic light source **P** is twice that of a monochromatic light source **Q**. The energy of a photon from source **P** will be ... of a photon from source **Q**.

- A a quarter of the energy
  - B half the energy
  - C equal to the energy
  - D twice the energy (2)
- [20]**

**QUESTION 2 (Start on a new page.)**

A learner constructs a push toy using two blocks with masses 1,5 kg and 3 kg respectively. The blocks are connected by a massless, inextensible cord.

The learner then applies a force of 25 N at an angle of  $30^\circ$  to the 1,5 kg block by means of a light rigid rod, causing the toy to move across a flat, rough, horizontal surface, as shown in the diagram below.

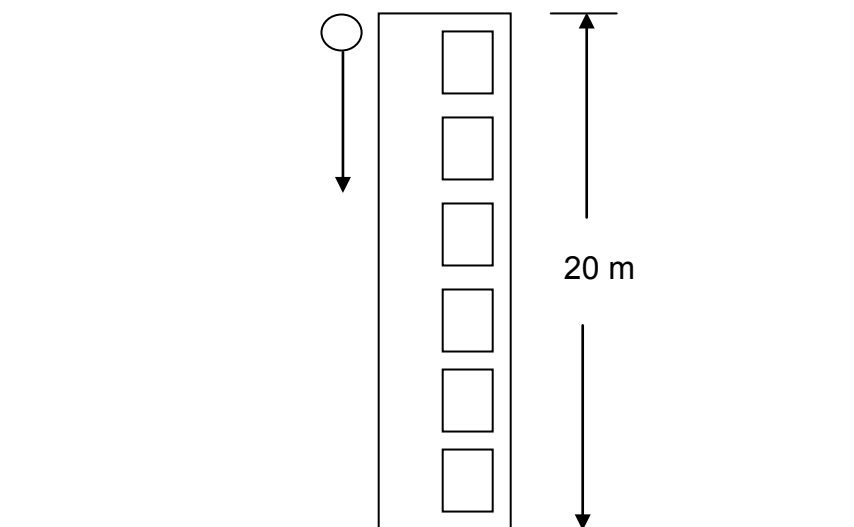


The coefficient of kinetic friction ( $\mu_k$ ) between the surface and each block is 0,15.

- 2.1 State Newton's Second Law of Motion in words. (2)
- 2.2 Calculate the magnitude of the kinetic frictional force acting on the 3 kg block. (3)
- 2.3 Draw a labelled free-body diagram showing ALL the forces acting on the 1,5 kg block. (5)
- 2.4 Calculate the magnitude of the:
- 2.4.1 Kinetic frictional force acting on the 1,5 kg block (3)
- 2.4.2 Tension in the cord connecting the two blocks (5)
- [18]**

**QUESTION 3 (Start on a new page.)**

A ball is dropped from the top of a building 20 m high. Ignore the effects of air resistance.



- 3.1 Define the term *free fall*. (2)
- 3.2 Calculate the:
- 3.2.1 Speed at which the ball hits the ground (4)
- 3.2.2 Time it takes the ball to reach the ground (3)
- 3.3 Sketch a velocity-time graph for the motion of the ball (no values required). (2)
- [11]**



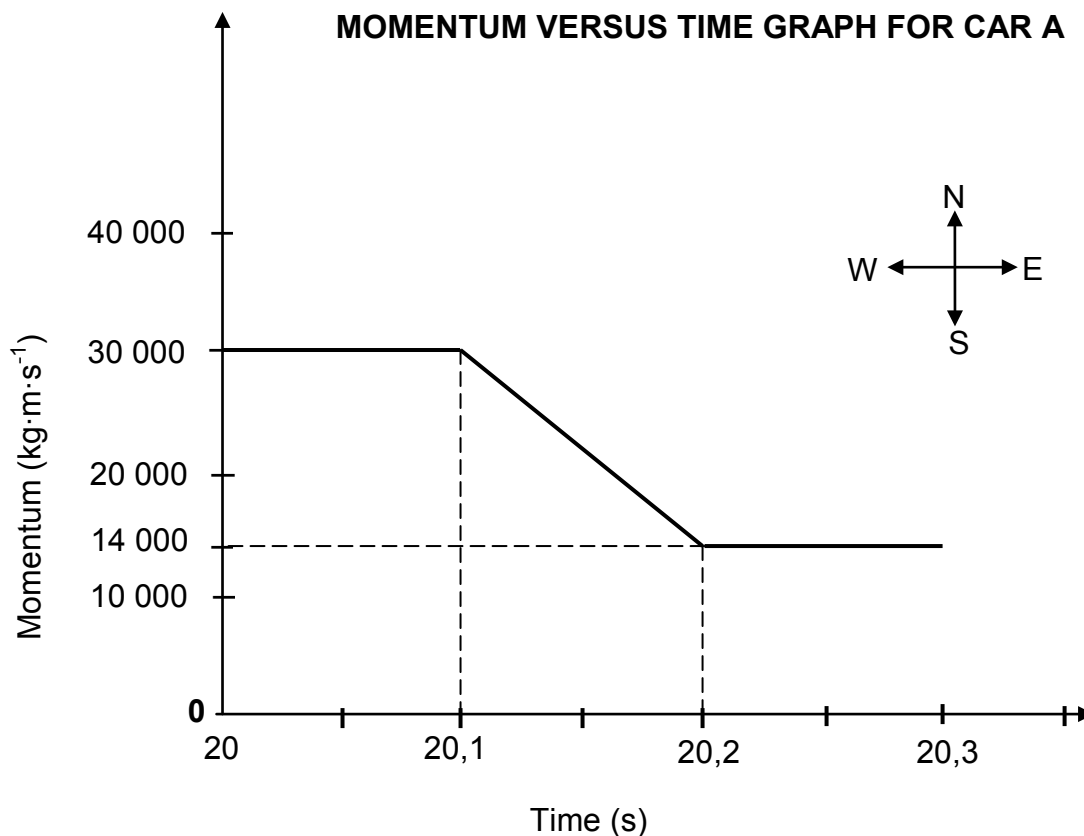
#### QUESTION 4 (Start on a new page.)

The graph below shows how the momentum of car **A** changes with time *just before* and *just after* a head-on collision with car **B**.

Car **A** has a mass of 1 500 kg, while the mass of car **B** is 900 kg.

Car **B** was travelling at a constant velocity of  $15 \text{ m}\cdot\text{s}^{-1}$  west before the collision.

Take east as positive and consider the system as isolated.



- 4.1 What do you understand by the term *isolated system* as used in physics? (1)

Use the information in the graph to answer the following questions.

- 4.2 Calculate the:

- 4.2.1 Magnitude of the velocity of car **A** just before the collision (3)

- 4.2.2 Velocity of car **B** just after the collision (5)

- 4.2.3 Magnitude of the net average force acting on car **A** during the collision (4)

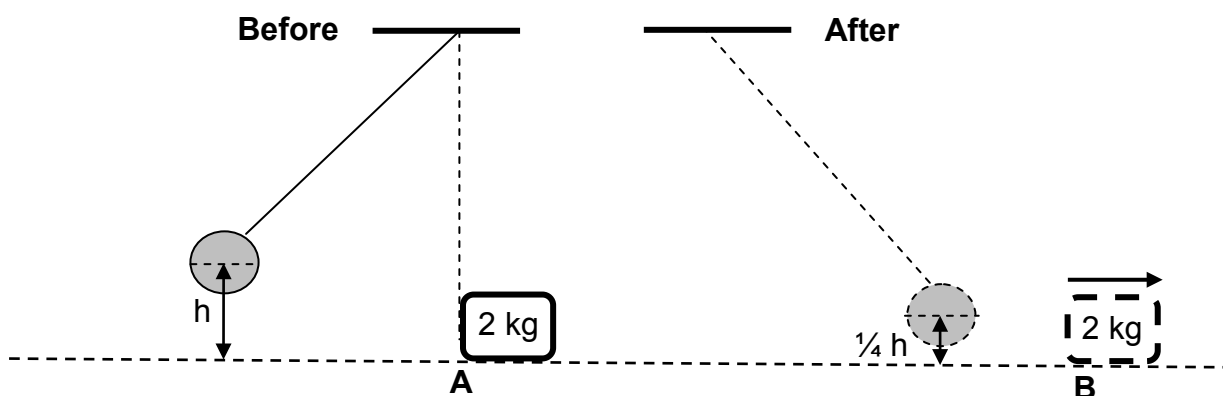
[13]

**QUESTION 5 (Start on a new page.)**

A pendulum with a bob of mass 5 kg is held stationary at a height  $h$  metres above the ground. When released, it collides with a block of mass 2 kg which is stationary at point **A**.

The bob swings past **A** and comes to rest momentarily at a position  $\frac{1}{4}h$  above the ground.

The diagrams below are NOT drawn to scale.



Immediately after the collision the 2 kg block begins to move from **A** to **B** at a constant speed of  $4,95 \text{ m}\cdot\text{s}^{-1}$ .

Ignore frictional effects and assume that no loss of mechanical energy occurs during the collision.

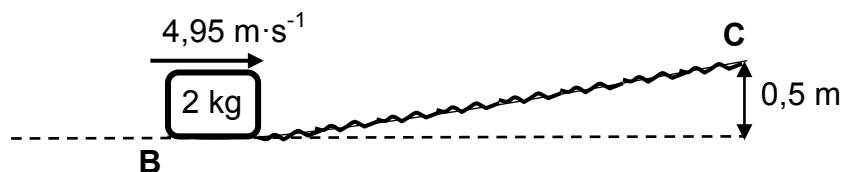
5.1 Calculate the:

5.1.1 Kinetic energy of the block immediately after the collision (3)

5.1.2 Height  $h$  (4)

The block moves from point **B** at a velocity of  $4,95 \text{ m}\cdot\text{s}^{-1}$  up a rough inclined plane to point **C**. The speed of the block at point **C** is  $2 \text{ m}\cdot\text{s}^{-1}$ . Point **C** is 0,5 m above the horizontal, as shown in the diagram below.

During its motion from **B** to **C** a uniform frictional force acts on the block.



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

5.3 Use energy principles to calculate the work done by the frictional force when the 2 kg block moves from point **B** to point **C**. (4)  
[13]

**QUESTION 6 (Start on a new page.)**

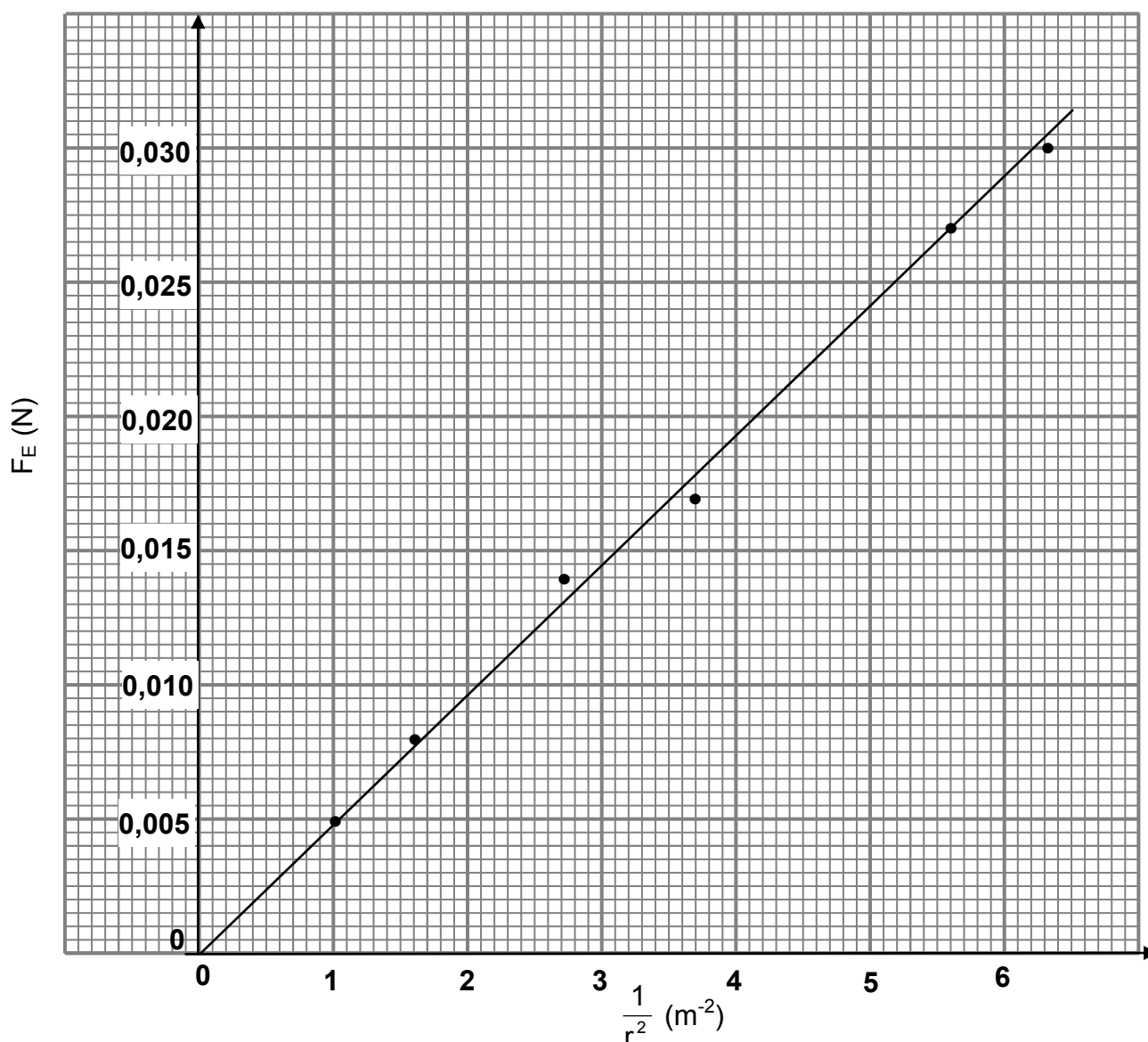
- 6.1 An ambulance is moving towards a stationary listener at a constant speed of  $30 \text{ m}\cdot\text{s}^{-1}$ . The siren of the ambulance emits sound waves having a wavelength of  $0,28 \text{ m}$ . Take the speed of sound in air as  $340 \text{ m}\cdot\text{s}^{-1}$ .
- 6.1.1 State the Doppler effect in words. (2)
- 6.1.2 Calculate the frequency of the sound waves emitted by the siren as heard by the ambulance driver. (3)
- 6.1.3 Calculate the frequency of the sound waves emitted by the siren as heard by the listener. (5)
- 6.1.4 How would the answer to QUESTION 6.1.3 change if the speed of the ambulance were LESS THAN  $30 \text{ m}\cdot\text{s}^{-1}$ ? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 6.2 An observation of the spectrum of a distant star shows that it is moving away from the Earth.
- Explain, in terms of the frequencies of the spectral lines, how it is possible to conclude that the star is moving away from the Earth. (2)

**[13]**

**QUESTION 7 (Start on a new page.)**

- 7.1 In an experiment to verify the relationship between the electrostatic force,  $F_E$ , and distance,  $r$ , between two **identical**, positively charged spheres, the graph below was obtained.

**GRAPH OF  $F_E$  VERSUS  $\frac{1}{r^2}$**

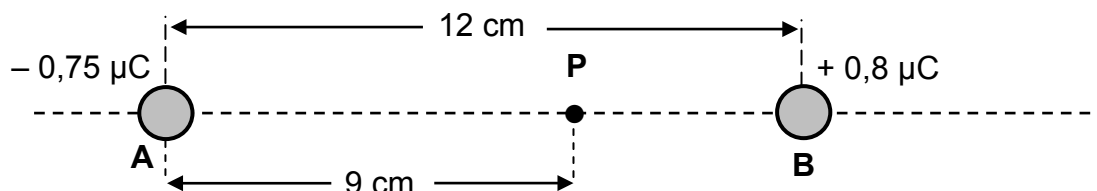


- 7.1.1 State Coulomb's law in words. (2)
- 7.1.2 Write down the dependent variable of the experiment. (1)
- 7.1.3 What relationship between the electrostatic force  $F_E$  and the square of the distance,  $r^2$ , between the charged spheres can be deduced from the graph? (1)
- 7.1.4 Use the information in the graph to calculate the charge on each sphere. (6)

7.2 A charged sphere, **A**, carries a charge of  $-0,75 \mu\text{C}$ .

7.2.1 Draw a diagram showing the electric field lines surrounding sphere **A**. (2)

Sphere **A** is placed 12 cm away from another charged sphere, **B**, along a straight line in a vacuum, as shown below. Sphere **B** carries a charge of  $+0,8 \mu\text{C}$ . Point **P** is located 9 cm to the right of sphere **A**.

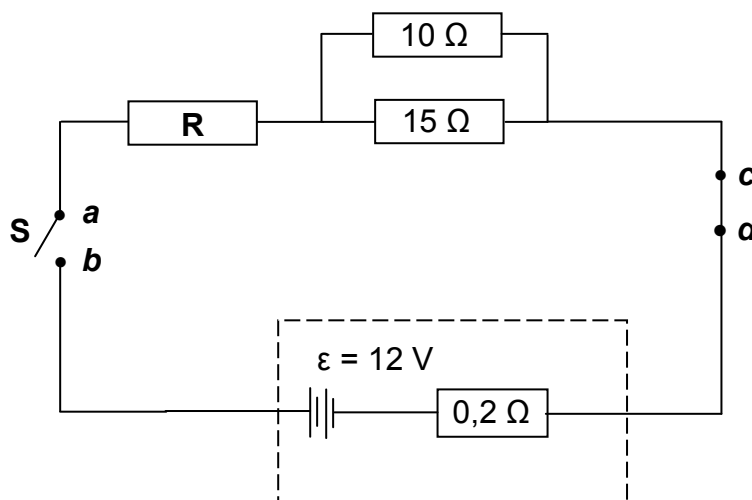


7.2.2 Calculate the magnitude of the net electric field at point **P**. (5)

[17]

### QUESTION 8 (Start on a new page.)

8.1 In the circuit below the battery has an emf ( $\epsilon$ ) of 12 V and an internal resistance of  $0,2 \Omega$ . The resistances of the connecting wires are negligible.



8.1.1 Define the term *emf of a battery*. (2)

8.1.2 Switch **S** is open. A high-resistance voltmeter is connected across points **a** and **b**.  
What will the reading on the voltmeter be? (1)

8.1.3 Switch **S** is now closed. The same voltmeter is now connected across points **c** and **d**.  
What will the reading on the voltmeter be? (1)

When switch **S** is closed, the potential difference across the terminals of the battery is 11,7 V.

Calculate the:

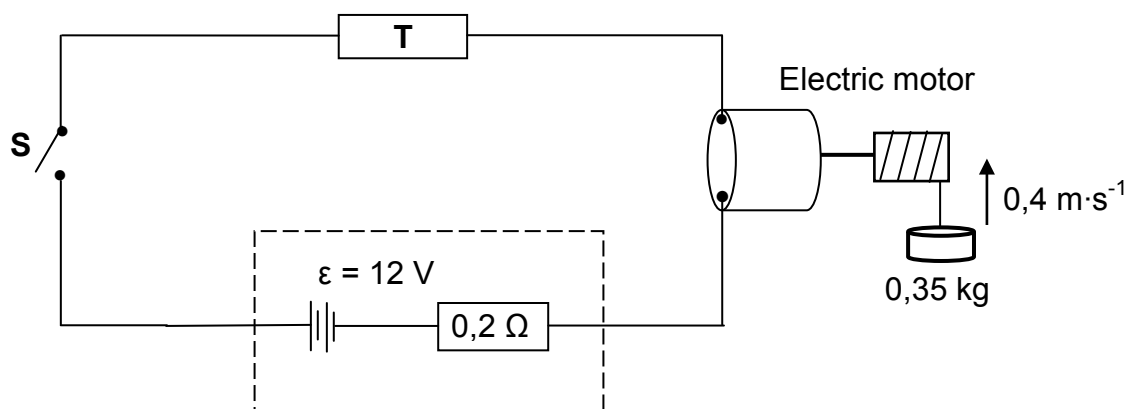
8.1.4 Current in the battery (3)

8.1.5 Effective resistance of the **parallel** branch (2)

8.1.6 Resistance of resistor **R** (4)

8.2 A battery with an emf of 12 V and an internal resistance of  $0,2 \Omega$  are connected in series to a very small electric motor and a resistor, **T**, of unknown resistance, as shown in the circuit below.

The motor is rated **X** watts, 3 volts, and operates at optimal conditions.



When switch **S** is closed, the motor lifts a  $0,35 \text{ kg}$  mass vertically upwards at a constant speed of  $0,4 \text{ m} \cdot \text{s}^{-1}$ . Assume that there is no energy conversion into heat and sound.

Calculate the value of:

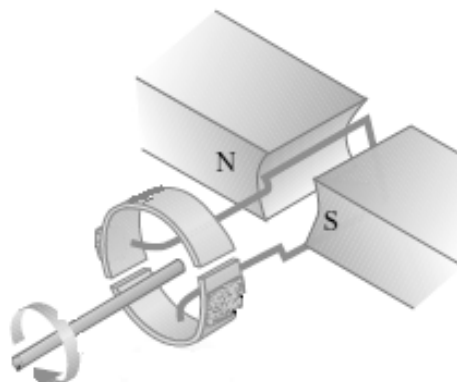
8.2.1 **X** (3)

8.2.2 The resistance of resistor **T** (5)

**[21]**

**QUESTION 9 (Start on a new page.)**

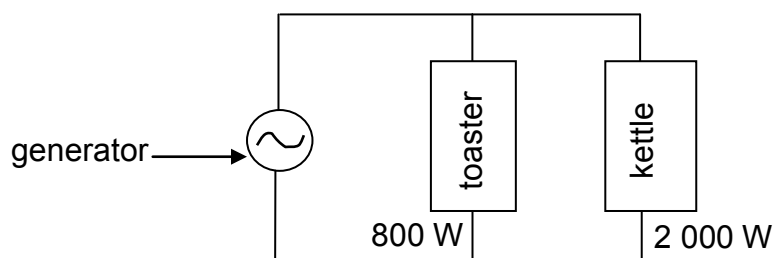
9.1 A generator is shown below. Assume that the coil is in a vertical position.



9.1.1 Is the generator above AC or DC? Give a reason for the answer. (2)

9.1.2 Sketch an induced emf versus time graph for ONE complete rotation of the coil. (The coil starts turning from the vertical position.) (2)

9.2 An AC generator is operating at a maximum emf of 340 V. It is connected across a toaster and a kettle, as shown in the diagram below.



The toaster is rated at 800 W, while the kettle is rated at 2 000 W. Both are working under optimal conditions.

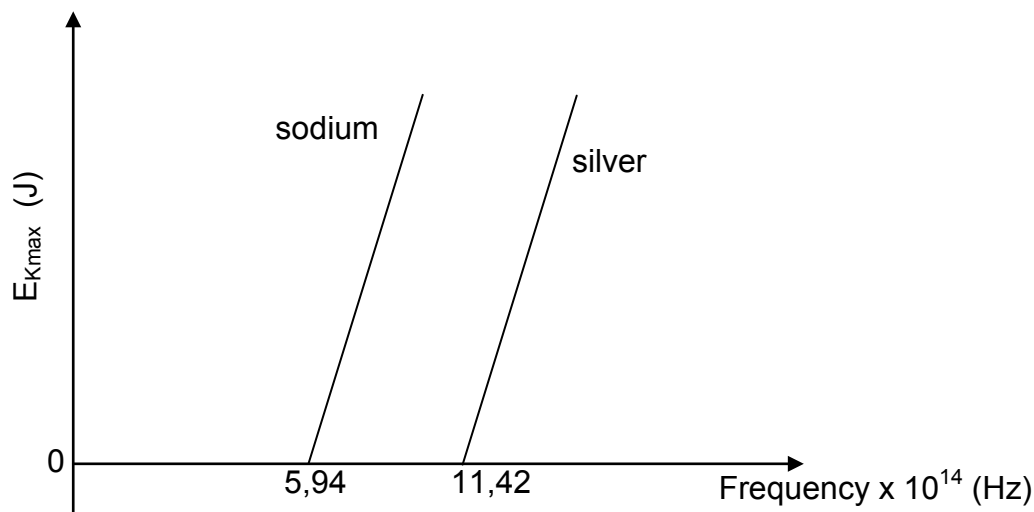
Calculate the:

9.2.1 rms current passing through the toaster (3)

9.2.2 Total rms current delivered by the generator (4)  
**[11]**

**QUESTION 10 (Start on a new page.)**

- 10.1 A learner is investigating the photoelectric effect for two different metals, silver and sodium, using light of different frequencies. The maximum kinetic energy of the emitted photoelectrons is plotted against the frequency of the light for each of the metals, as shown in the graphs below.



- 10.1.1 Define the term *threshold frequency*. (2)
- 10.1.2 Which metal, sodium or silver, has the larger work function? Explain the answer. (3)
- 10.1.3 Name the physical constant represented by the slopes of the graphs. (1)
- 10.1.4 If light of the same frequency is shone on each of the metals, in which metal will the ejected photoelectrons have a larger maximum kinetic energy? (1)
- 10.2 In a different photoelectric experiment blue light obtained from a light bulb is shone onto a metal plate and electrons are released.
- The wavelength of the blue light is  $470 \times 10^{-9} \text{ m}$  and the bulb is rated at 60 mW. The bulb is only 5% efficient.
- 10.2.1 Calculate the number of photons that will be incident on the metal plate per second, assuming all the light from the bulb is incident on the metal plate. (5)
- 10.2.2 **Without any further calculation**, write down the number of electrons emitted per second from the metal. (1)

**[13]**

**TOTAL: 150**



**DATA FOR PHYSICAL SCIENCES GRADE 12  
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 12  
VRAESTEL 1 (FISIKA)**

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

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m} \cdot \text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N} \cdot \text{m}^2 \cdot \text{kg}^{-2}$
Speed of light in a vacuum <i>Spoeed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m} \cdot \text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J} \cdot \text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	$m_e$	$9,11 \times 10^{-31} \text{ kg}$
Mass of the Earth <i>Massa van die Aarde</i>	M	$5,98 \times 10^{24} \text{ kg}$
Radius of the Earth <i>Radius van die Aarde</i>	$R_E$	$6,38 \times 10^6 \text{ m}$

**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**

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ 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 $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

**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 $E = h \frac{c}{\lambda}$
$E = W_o + E_{k(\text{max})}$ or/of $E = W_o + K_{\text{max}}$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or/of $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	

**ELECTROSTATICS/ELEKTROSTATIKA**

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

**ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE**

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

**ALTERNATING CURRENT/WISSELSTROOM**

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



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**NATIONAL  
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**GRADE/GRAAD 12**

**PHYSICAL SCIENCES: PHYSICS (P1)  
FISIESE WETENSKAPPE: FISIKA (V1)**

**NOVEMBER 2016**

**MEMORANDUM**

**MARKS/PUNTE: 150**

**This memorandum consists of 19 pages.  
*Hierdie memorandum bestaan uit 19 bladsye.***

### QUESTION 1/VRAAG 1

- 1.1 A ✓✓ (2)  
 1.2 C ✓✓ (2)  
 1.3 C ✓✓ (2)  
 1.4 D ✓✓ (2)  
 1.5 B ✓✓ (2)  
 1.6 A ✓✓ (2)  
 1.7 C ✓✓ (2)  
 1.8 A ✓✓ (2)  
 1.9 B ✓✓ (2)  
 1.10 B ✓✓ (2)  
**[20]**

### QUESTION 2/VRAAG 2

- 2.1 When a resultant/net force acts on an object, the object will accelerate in the (direction of the net/resultant force). The acceleration is directly proportional to the net force ✓ and inversely proportional to the mass ✓ of the object.  
*Wanneer 'n netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.*

#### OR/OF

The resultant/net force acting on the object is equal (is directly proportional to) to the rate of change of momentum of an object (in the direction of the force). ✓✓

*Die resulterende/netto krag wat op 'n voorwerp inwerk, is gelyk aan (is direk eweredig aan) die tempo van verandering van momentum van die voorwerp (in die rigting van die netto krag).*

- 2.2  $f_k = \mu_k N \checkmark = \mu_k mg$   
 $= (0,15)(3)(9,8) \checkmark$   
 $= 4,41 \text{ N} \checkmark$  (3)

2.3



Accepted Labels/Aanvaarde benoemings	
W	$F_g/F_w$ /force of Earth on block/weight/14,7 N/mg/gravitational force $F_g/F_w$ /krag van Aarde op blok/gewig/14,7 N/mg/gravitasiekrag
N	$F_N/F_{\text{normal}}$ /normal force $F_N/F_{\text{normaal}}$ /normalekrag
T	Tension/ $F_T$ Spanning/ $F_T$
$f_k$	$f_{\text{kinetic friction/kinetiesewrywing}}/f_{f/w}/f//F_{f/w}$ kinetic friction/kinetiesewrywing
25 N	$F_{\text{applied}}/F_A/F$ $F_{\text{toegepas}}/F_A/F$

2.4.1

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$f_k = \mu_k N = \mu_k(25 \sin 30^\circ + mg)$ $= 0,15[(25 \sin 30^\circ) + (1,5)(9,8)]$ $= 4,08 \text{ N} \checkmark$	$f_k = \mu_k N = \mu_k(25 \cos 60^\circ + mg)$ $= 0,15[(25 \cos 60^\circ) + (1,5)(9,8)]$ $= 4,08 \text{ N} \checkmark$

(3)

2.4.2

<b>POSITIVE MARKING FROM QUESTION 2.2 AND QUESTION 2.4.1</b> <b>POSITIEWE NASIEN VANAF VRAAG 2.2 EN VRAAG 2.4.1</b> <b>OPTION 1/OPSIE 1</b> For the 1,5 kg block/Vir die 1,5 kg blok $F_{\text{net}} = ma$ $F_x + (-T) + (-f_k) = ma \checkmark$ $25 \cos 30^\circ - T - f_k = 1,5a$ $(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a$ $17,571 - T = 1,5a \dots\dots\dots(1)$  For the 3 kg block Vir die 3 kg blok $T - f_k = 3a$ $T - 4,41 \checkmark = 3a \dots\dots\dots(2)$ $13,161 = 4,5 a$ $a = 2,925 \text{ m} \cdot \text{s}^{-2}$ $T = 13,19 \text{ N} \checkmark$ (13,17 N – 13,19 N)	
--	--

$\checkmark$  either one  
enigeen

<p><b>OPTION 2/OPSIE 2</b>                  For the 1,5 kg block/Vir die 1,5 kg blok  <math>F_{\text{net}} = ma</math>  <math>F_x + (-T) + (-f_k) = ma</math> ✓  <math>25 \cos 30^\circ - T - f_k = 1,5a</math>  <math>(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a</math>  <math>17,571 - T = 1,5a \dots\dots\dots(1)</math></p> <p>For the 3 kg block                  Vir die 3 kg blok  <math>T - f_k = 3a</math>  <math>T - 4,41 \checkmark = 3a \dots\dots\dots(2)</math></p> <p><math>35,142 - 2T = T - 4,41</math>  <math>T = 13,18 \text{ N} \checkmark</math></p>	<p><b>OPTION 3/OPSIE 3</b>                  For the 1,5 kg block/Vir die 1,5 kg blok  <math>F_{\text{net}} = ma</math>  <math>F_x + (-T) + (-f_k) = ma</math> ✓  <math>25 \cos 30^\circ - T - f_k = 1,5a</math>  <math>(25 \cos 30^\circ - T) - 4,08 \checkmark = 1,5a</math>  <math>17,571 - T = 1,5a \dots\dots\dots(1)</math>  <math>a = \frac{17,571 - T}{1,5}</math></p> <p>For the 3 kg block                  Vir die 3 kg blok  <math>T - f_k = 3a</math>  <math>T - 4,41 \checkmark = 3a \dots\dots\dots(2)</math>  <math>a = \frac{T - 4,41}{3}</math>  <math>\frac{17,571 - T}{1,5} = \frac{T - 4,41}{3}</math>  <math>T = 13,18 \text{ N} \checkmark</math></p>
--	---

(5)  
**[18]**

**QUESTION 3/VRAAG 3**

- 3.1 The motion of an object under the influence of gravity/weight/gravitational force only / Motion in which the only force acting is the gravitational force. ✓✓  
 Die beweging van 'n voorwerp slegs onder die invloed van swaartekrag/gewig gravitasiekrag.  
 Beweging waarin die enigste krag wat op die liggaam inwerk, die gravitasiekrag is. (2)

3.2.1

<p><b>OPTION 1/OPSIE 1</b>  <b>Upwards positive/Opwaarts positief:</b>  <math>v_f^2 = v_i^2 + 2a\Delta y \checkmark</math>  <math>= 0^2 + (2)(-9,8) \checkmark (-20) \checkmark</math>  <math>v_f = 19,80 \text{ m}\cdot\text{s}^{-1} \checkmark</math></p> <p><b>Downwards positive</b>  <b>Afwaarts positief</b>  <math>v_f^2 = v_i^2 + 2a\Delta y \checkmark</math>  <math>= 0^2 + (2)(9,8) \checkmark (20) \checkmark</math>  <math>v_f = 19,80 \text{ m}\cdot\text{s}^{-1} \checkmark</math></p>	<p><b>OPTION 2/OPSIE 2</b>  <b>Upwards positive/Opwaarts positief:</b>  <math>\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2</math>  <math>-20 = 0 + \frac{1}{2}(-9,8)\Delta t^2 \checkmark</math>  <math>\Delta t = 2,02 \text{ s}</math>  <math>v_f = v_i + a\Delta t</math>  <math>= 0 + (-9,8)(2,02) \checkmark</math>  <math>= -19,80 \text{ m}\cdot\text{s}^{-1} \checkmark</math>  <math>= 19,80 \text{ m}\cdot\text{s}^{-1} \checkmark</math></p> <p><b>Downwards positive</b>  <b>Afwaarts positief</b>  <math>\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2</math>  <math>20 = 0 + \frac{1}{2}(9,8)\Delta t^2 \checkmark</math>  <math>\Delta t = 2,02 \text{ s}</math>  <math>v_f = v_i + a\Delta t</math>  <math>= 0 + (9,8)(2,02) \checkmark</math>  <math>= 19,80 \text{ m}\cdot\text{s}^{-1} \checkmark</math></p>
---	--

**OPTION 3/OPSIE 3**

$$\begin{aligned}(E_{\text{mech}})_{\text{Top/Bo}} &= (E_{\text{mech}})_{\text{Ground/Grond}} \\ (E_P + E_K)_{\text{Top}} &= (E_P + E_K)_{\text{Bottom/Onder}} \\ (mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} &= (mgh + \frac{1}{2}mv^2)_{\text{Bottom/Onder}} \\ (9,8)(20) + 0 &= (0 + \frac{1}{2}v_f^2) \\ v_f &= 19,80 \text{ m}\cdot\text{s}^{-1}\end{aligned}$$

✓ 1 mark for any  
1 punt vir enige

**OPTION 4/OPSIE 4**

$$\begin{aligned}W_{\text{nc}} &= \Delta E_p + \Delta E_k \\ 0 &= mg\Delta h + \frac{1}{2}m\Delta v^2 \\ 0 &= m(9,8)(0 - 20) + \frac{1}{2}m(v_f^2 - 0) \\ v_f &= 19,80 \text{ m}\cdot\text{s}^{-1}\end{aligned}$$

**OPTION 5/OPSIE 5**

$$\begin{aligned}W_{\text{net}} &= \Delta E_k \\ mg\Delta x \cos 0^\circ &= \frac{1}{2}m(v_f^2 - 0) \\ m(9,8)(20)(1) &= \frac{1}{2}mv_f^2 \\ v_f &= 19,80 \text{ m}\cdot\text{s}^{-1}\end{aligned}$$

(4)

3.2.2

**POSITIVE MARKING FROM QUESTION 3.2.1/POSITIEWE NASIEN VANAF VRAAG 3.2.1**

**OPTION 1/OPSIE 1**

**Downwards positive/Afwaarts positief**

$$\begin{aligned}v_f &= v_i + a\Delta t \\ 19,80 &= 0 + (9,8)\Delta t \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

**Upwards positive/Opwaarts positief**

$$\begin{aligned}v_f &= v_i + a\Delta t \\ -19,80 &= 0 + (-9,8)\Delta t \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

**OPTION 2/OPSIE 2**

**Upwards positive/Opwaarts positief:**

$$\begin{aligned}\Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ -20 &= 0 + \frac{1}{2}(-9,8)\Delta t^2 \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

**Downwards Positive/Afwaarts positief**

$$\begin{aligned}\Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ 20 &= 0 + \frac{1}{2}(9,8)\Delta t^2 \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

**OPTION 3/OPSIE 3**

**Downwards positive/Afwaarts positief:**

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2}\right)\Delta t \\ 20 &= \left(\frac{0 + 19,80}{2}\right)(\Delta t) \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

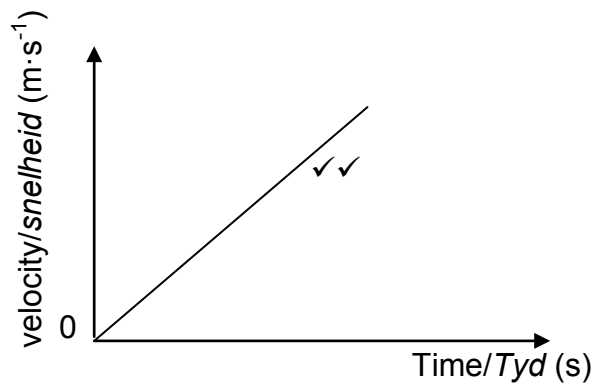
**Upwards positive/Opwaarts positief:**

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2}\right)\Delta t \\ -20 &= \left(\frac{0 - 19,80}{2}\right)(\Delta t) \\ \Delta t &= 2,02 \text{ s}\end{aligned}$$

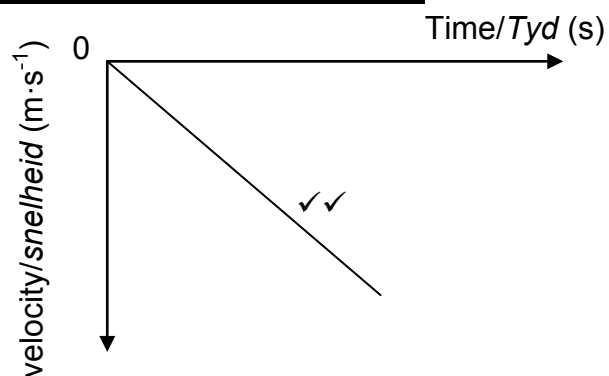
(3)



3.3 **Downward positive/Afwaarts positief**



**Upward positive/Opwaarts positief**



**Notes/Aantekeninge**

✓✓	Straight line through the origin. <i>Reguitlyn deur die oorsprong</i>
----	--

(2)  
[11]

# QUESTION 4/VRAAG 4

- 4.1 A system on which the resultant/net external force is zero/*n Sisteem waarop die resulterende krag/netto eksternekrag nul is* ✓  
 A system which excludes external forces /*n Sisteem wat eksterne kragte uitlaat.* (1)

- 4.2.1
- |                         |  |     |
|-------------------------|--|-----|
| <b>OPTION 1/OPSIE 1</b> | $p = mv$ ✓<br>$30\,000 = (1\,500)v$ ✓<br>$v = 20\text{ m}\cdot\text{s}^{-1}$ ✓                       |     |
| <b>OPTION 2/OPSIE 2</b> | $\Delta p = mv_f - mv_i$ ✓<br>$0 = (1\,500)v_f - 30\,000$ ✓<br>$v = 20\text{ m}\cdot\text{s}^{-1}$ ✓ | (3) |

- 4.2.2 **POSITIVE MARKING FROM QUESTION 4.2.1/POSITIEWE NASIEN VANAF VRAAG 4.2.1**

- |                         |   |                                 |     |
|-------------------------|---|---------------------------------|-----|
| <b>OPTION 1/OPSIE 1</b> | $\sum p_i = \sum p_f$<br>$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ } ✓<br>$30\,000 + (900)(-15) = 14\,000 + 900v_B$ ✓<br>$\therefore v_B = 2,78\text{ m}\cdot\text{s}^{-1}$ ✓ east/oos ✓ (Accept/Aanvaar: to the right/na regs) | 1 mark for any/1 punt vir enige |     |
| <b>OPTION 2/OPSIE 2</b> | $\Delta p_A = -\Delta p_B$<br>$p_f - p_i = -(mv_f - mv_i)$ }<br>$14\,000 - 30\,000 = 900v_f - 900(-15)$ ✓<br>$v_f = 2,78\text{ m}\cdot\text{s}^{-1}$ ✓ east/oos ✓ (Accept/Aanvaar: to the right/na regs)                                  | 1 mark for any/1 punt vir enige | (5) |

- 4.2.3
- |   |  |  |
|---|--|--|
| <b>OPTION 1/OPSIE 1</b>   | Slope/Helling = $\frac{\Delta p}{\Delta t} = F_{\text{net}}$ ✓<br>$= \frac{(14\,000 - 30\,000)}{(20,2 - 20,1)}$ ✓<br>$= -160\,000$<br>$F_{\text{net}} = 160\,000\text{ N}$ ✓ |  |
| <b>OPTION 2/OPSIE 2</b>   | $F_{\text{net}}\Delta t = \Delta p$ ✓<br>$F_{\text{net}}(0,1) = 14\,000 - 30\,000$ ✓<br>$F_{\text{net}} = -160\,000\text{ N}$<br>$F_{\text{net}} = 160\,000\text{ N}$ ✓      |  |
| <b>POSITIVE MARKING FROM QUESTION 4.2.2/POSITIEWE NASIEN VANAF VRAAG 4.2.2</b><br><b>OPTION 3/OPSIE 3</b><br>$F_{\text{net}}\Delta t = \Delta p$ ✓<br>$F_{\text{net}}(0,1) = 900[(2,78) - (-15)]$ ✓<br>$F_{\text{net}} = 160\,020\text{ N}$<br>$F_A = -F_B$<br>$F_{\text{net}} = 160\,020\text{ N}$ ✓ |  |  |

**OPTION 4/OPSIE 4**

$$p = mv$$

$$14\,000 = 1\,500v_f \checkmark$$

$$v_f = 9,33 \text{ m} \cdot \text{s}^{-1}$$

$$F_{\text{net}} = \frac{m(v_f - v_i)}{\Delta t} \checkmark = \frac{1500(9,33 - 20)}{0,1} \checkmark$$

$$= -160\,050$$

$$= 160\,050 \text{ N} \checkmark$$

$$v_f = v_i + a\Delta t$$

$$9,33 = 20 + a(0,1)$$

$$a = -106,7 \text{ m} \cdot \text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$= 1\,500(-106,7) \checkmark$$

$$F_{\text{net}} = -160\,050 \text{ N}$$

$$F_{\text{net}} = 160\,050 \text{ N} \checkmark$$

(4)  
[13]

**QUESTION 5/VRAAG 5**

5.1.1  $E_k/K = \frac{1}{2}mv^2 \checkmark$

$$= \frac{1}{2}(2)(4,95)^2 \checkmark$$

$$= 24,50 \text{ J} \checkmark$$

(3)

5.1.2

**POSITIVE MARKING FROM QUESTION 5.1.1/POSITIEWE NASIEN VANAF**

**5.1.1**

**OPTION 1/OPSIE 1**

$$E_{\text{mech before}} = E_{\text{mech after}}$$

$$[(E_{\text{mech}})_{\text{bob}} + (E_{\text{mech}})_{\text{block}}]_{\text{before/voor}} = [(E_{\text{mech}})_{\text{Block}} + (E_{\text{mech}})_{\text{bob}}]_{\text{after/na}}$$

$$(mgh + \frac{1}{2}mv^2)_{\text{before/voor}} = (mgh + \frac{1}{2}mv^2)_{\text{after/na}}$$

$$(5)(9,8)h + 0 + 0 \checkmark = 5(9,8)\frac{1}{4}h + 0 + 24,50 \checkmark$$

$$h = 0,67 \text{ m} \checkmark$$

Any one/  
Enige een ✓

**OPTION 2/OPSIE 2**

$$W_{\text{nc}} = \Delta E_p + \Delta E_k$$

$$0 = \Delta E_p + \Delta E_k$$

$$-\Delta E_p = \Delta E_k$$

$$-[(5)(9,8)(\frac{1}{4}h) - (5)(9,8)h] \checkmark = 24,50 \checkmark$$

$$h = 0,67 \text{ m} \checkmark$$

Any one/  
Enige een ✓

**OPTION 3/OPSIE 3**

$$\text{Loss } E_p \text{ bob} = \text{Gain in } E_k \text{ of block} \checkmark$$

$$mg(\frac{3}{4}h) = 24,5$$

$$(5)(9,8)(\frac{3}{4}h) \checkmark = 24,5 \checkmark$$

$$h = 0,67 \text{ m} \checkmark$$

(4)

**OPTION 4/OPSIE 4**

**Before/Voor**

$$(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bottom/onder}}$$

$$(5)(9,8)h + 0 = (5)(9,8)h_o + \frac{1}{2}(5)v^2$$

$$v_i^2 = 19,6h - 19,6h_o$$

**After/Na**

$$(mgh + \frac{1}{2}mv^2)_{\text{bottom/onder}} = (mgh + \frac{1}{2}mv^2)_{\text{top/bo}}$$

$$(5)(9,8)h_o + \frac{1}{2}(5)v_f^2 = (5)(9,8)(\frac{1}{4}h) + 0$$

$$v_f^2 = 4,9h - 19,6h_o$$

$$E_{\text{mech/meg before collision/voor botsing}} = E_{\text{mech/meg after collision/na botsing}} \checkmark$$

$$\frac{1}{2}mv_i^2(\text{bob/skietlood}) + 0 = \frac{1}{2}mv_f^2(\text{bob/skietlood}) + \frac{1}{2}mv^2(\text{block/blok})$$

$$\frac{1}{2}(5)(19,6h - 19,6h_o) \checkmark = \frac{1}{2}(5)(4,9h - 19,6h_o) + 24,5 \checkmark$$

$$h = 0,67 \text{ m} \checkmark$$

- 5.2 The net/total work done on an object is equal ✓ to the change in the object's kinetic energy ✓  
*Die netto/totale arbeid op 'n voorwerp verrig is gelyk aan die verandering in die kinetiese energie van die voorwerp.*

**OR/OF**

The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.

*Die arbeid verrig op 'n voorwerp deur 'n resulterende/netto krag is gelyk aan die voorwerp se verandering in kinetiese energie.*

(2)

5.3

**OPTION 1/OPSIE 1**

$$W_{\text{net}} = \Delta E_K \checkmark$$

$$W_f + mg\Delta y \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$W_f + (2)(9,8)(0,5)\cos 180^\circ \checkmark = \frac{1}{2}(2)(2^2 - 4,95^2) \checkmark$$

$$W_f = -10,7 \text{ J} \checkmark$$

**OPTION 2/OPSIE 2**

$$W_{\text{nc}} = \Delta E_K + \Delta U \checkmark$$

$$W_{\text{nc}} = \Delta E_K + \Delta E_P \checkmark$$

$$W_f = \frac{1}{2}(2)(2^2 - 4,95^2) \checkmark + (2)(9,8)(0,5-0) \checkmark$$

$$= -10,7 \text{ J} \checkmark$$

(4)

**[13]**

**QUESTION 6/VRAAG 6**

- 6.1.1 It is the (apparent) change in frequency (or pitch) of the sound (detected by a listener) ✓ because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓  
*Dit is die verandering in frekwensie (of toonhoogte) van die klank (waargeneem deur 'n luisteraar) omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting het.*

**OR/OF**

An (apparent) change in (observed/detected) frequency (pitch), (wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).

*'n Skynbare verandering in (waargenome) frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar.*

(2)

- 6.1.2  $v = f\lambda \checkmark$   
 $340 = f(0,28) \checkmark$   
 $f_s = 1\,214,29 \text{ Hz} \checkmark$

(3)

6.1.3 **POSITIVE MARKING FROM QUESTION 6.1.2/POSITIEWE NASIEN VANAF VRAAG 6.1.2**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v \pm v_L}{v \pm v_s} \times \frac{v}{\lambda_s} \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{f_s}{1 - \frac{v_s}{v}} \checkmark$$

$$f_L = \left( \frac{340}{340 - 30} \right) 1214,29 \checkmark \quad \text{OR/OF} \quad f_L = \left( \frac{340}{340 - 30} \right) \times \frac{340}{0,28} \quad \text{OR/OF} \quad f_L = \frac{1214,29}{1 - \frac{30}{340}}$$

$$= 1\,331,80 \text{ Hz} \checkmark \quad (1\,331,80 \text{ Hz} - 1\,335,72 \text{ Hz}) \quad (5)$$

6.1.4 Decreases/Verlaag  $\checkmark$  (1)

6.2 The spectral lines of the star are/should be shifted towards the lower frequency  $\checkmark$  end, which is the red end (red shift) of the spectrum.  $\checkmark$

*Die spektraallyne van die van die ster is verskuif na die laer frekwensie ent, wat die rooi ent van die spektrum is.*

(2)  
[13]

**QUESTION 7/VRAAG 7**

7.1.1 The (magnitude of the) electrostatic force exerted by one (point) charge on another is directly proportional to the product of the charges  $\checkmark$  and inversely proportional to the square of the distance between their (centres) them.  $\checkmark$   
*Die (grootte) van die elektrostatische krag wat een (punt) lading op 'n ander uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte.*

(2)

7.1.2  $F_E$ /Electrostatic force/Elektrostatische krag  $\checkmark$

(1)

7.1.3 The electrostatic force is inversely proportional to the square of the distance between the charges  $\checkmark$

*Die elektrostatische krag is omgekeerd eweredig aan die kwadraat van die afstand tussen die ladings*

**OR/OF**

The electrostatic force is directly proportional to the inverse of the square of the distance between the charged spheres (charges).  $\checkmark$

*Die elektrostatische krag is direk eweredig aan omgekeerde van die kwadraat van die afstand tussen die gelaaide sfere (ladings).*

**OR/OF**

$$F \propto \frac{1}{r^2} \checkmark$$

**OR/OF**

They are inversely proportional to each other /Hulle is omgekeerd eweredig aan mekaar

(1)

7.1.4

**OPTION 1/OPSIE 1**

$$\text{Slope/Helling} = \frac{\Delta F_E}{\Delta \frac{1}{r^2}} = \frac{(0,027 - 0)}{(5,6 - 0)} \checkmark$$

$$= 4,82 \times 10^{-3} \text{ N} \cdot \text{m}^2 \quad (4,76 \times 10^{-3} - 5 \times 10^{-3})$$

$$\text{Slope/Helling} = F_E r^2 = kQ_1 Q_2 = kQ^2 \checkmark$$

$$4,82 \times 10^{-3} \checkmark = \frac{9 \times 10^9 Q^2}{\checkmark}$$

$$\therefore Q = 7,32 \times 10^{-7} \text{ C} \checkmark$$

**OPTION 2/OPSIE 2**

Accept any pair of points on the line/Aanvaar enige paar punte op die lyn

$$F = \frac{kQ_1 Q_2}{r^2} \checkmark$$

$$( ) \checkmark = \frac{(9 \times 10^9) Q^2}{( )} \checkmark \checkmark$$

$$Q = 7,32 \times 10^{-7} \text{ C} \checkmark \quad (7,32 \times 10^{-7} - 7,45 \times 10^{-7} \text{ C})$$

**Examples/Voorbeelde**

$$(0,005) \checkmark = \frac{(9 \times 10^9) Q^2}{(1)} \checkmark \checkmark$$

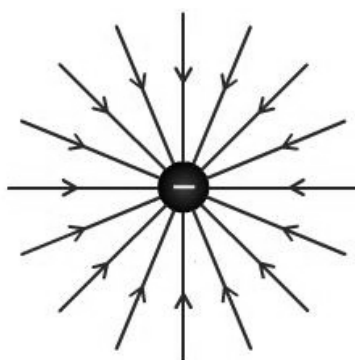
$$Q = 7,45 \times 10^{-7} \text{ C} \checkmark$$

$$(0,027) \checkmark = \frac{(9 \times 10^9) Q^2}{\left(\frac{1}{5,6}\right)} \checkmark \checkmark$$

$$Q = 7,32 \times 10^{-7} \text{ C} \checkmark$$

(6)

7.2.1



Criteria for drawing electric field: <i>Kriteria vir teken van elektriese veld:</i>	Marks/Punte
Direction /Rigting	✓
Field lines radially inward/Veldlyne radiaal inwaarts	✓

7.2.2

$$E = \frac{kQ}{r^2} \checkmark$$

**Take right as positive/Neem regs as positief**

$$E_{PA} = \frac{(9 \times 10^9)(0,75 \times 10^{-6})}{(0,09)^2} \checkmark$$

$$= 8,33 \times 10^5 \text{ N} \cdot \text{C}^{-1} \text{ to the left/na links}$$

$$E_{PB} = \frac{(9 \times 10^9)(0,8 \times 10^{-6})}{(0,03)^2} \checkmark$$

$$= 8 \times 10^6 \text{ N} \cdot \text{C}^{-1} \text{ to the left/na links}$$

$$E_{\text{net}} = E_{PA} + E_{PB}$$

$$= [-8,33 \times 10^5 + (-8 \times 10^6)] \checkmark$$

$$= -8,83 \times 10^6$$

$$= 8,83 \times 10^6 \text{ N} \cdot \text{C}^{-1} \checkmark$$

1 mark for the addition of same signs/  
 1 punt vir optelling van dieselfde tekens

**Take left as positive/Neem links as positief**

$$E_{PA} = \frac{(9 \times 10^9)(0,75 \times 10^{-6})}{(0,09)^2} \checkmark$$

$$= 8,33 \times 10^5 \text{ N} \cdot \text{C}^{-1} \text{ to the left/na links}$$

$$E_{PB} = \frac{(9 \times 10^9)(0,8 \times 10^{-6})}{(0,03)^2} \checkmark$$

$$= 8 \times 10^6 \text{ N} \cdot \text{C}^{-1} \text{ to the left/na links}$$

$$E_{\text{net}} = E_{PA} + E_{PB}$$

$$= (8,33 \times 10^5 + 8 \times 10^6) \checkmark$$

$$= 8,83 \times 10^6 \text{ N} \cdot \text{C}^{-1} \checkmark$$

1 mark for the addition of same signs/  
 1 punt vir optelling van dieselfde tekens

(5)  
**[17]**

**QUESTION 8/VRAAG 8**

8.1.1 (Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it ✓✓ / *Energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheid lading wat daardeur vloei.* (2)

8.1.2 12 (V)✓ (1)

8.1.3 0 (V) / Zero/nul ✓ (1)

8.1.4  $\varepsilon = I(R + r)$   
 $\varepsilon = V_{\text{ext}} + V_{\text{int}}$  } ✓  
 $12 = 11,7 + Ir$   
 $0,3 = I_{\text{tot}}(0,2)$  ✓  
 $I_{\text{tot}} = 1,5 \text{ A}$  ✓

**OR/OF**

$V = IR$  ✓ (Accept/Aanvaar:  $V_{\text{"lost"}} = Ir$ )

$0,3 = I_{\text{tot}}(0,2)$  ✓

$I_{\text{tot}} = 1,5 \text{ A}$  ✓

(3)

8.1.5

**OPTION 1/OPSIE 1**

$\frac{1}{R_{\parallel}} = \frac{1}{R_1} + \frac{1}{R_2}$  } ✓ Any one  
 $\frac{1}{R} = \frac{1}{10} + \frac{1}{15}$  } *Enigeen*  
 $R = 6 \Omega$  ✓

**OPTION 2/OPSIE 2**

$R_{\parallel} = \frac{R_1 R_2}{R_1 + R_2}$  } ✓ Any one  
 $= \frac{(10)(15)}{10 + 15}$  } *Enigeen*  
 $= 6 \Omega$  ✓

(2)

8.1.6

**POSITIVE MARKING FROM QUESTIONS 8.1.4 AND 8.1.5/POSITIEWE NASIEN VANAF VRAE 8.1.4 EN 8.1.5**

**OPTION 1/OPSIE 1**

$V = IR$  ✓  
 $11,7 \text{ ✓} = 1,5(6 + R)$  ✓  
 $R = 1,8 \Omega$  ✓

**OR/OF**

$V = IR$  ✓  
 $11,7 = 1,5R$  ✓  
 $R = 7,8 \Omega$   
 $\downarrow$   
 $R_R = 7,8 - 6$  ✓  
 $= 1,8 \Omega$  ✓



**OPTION 2/OPSIE 2**

$$\begin{aligned}\varepsilon &= I(R + r) \checkmark \\ 12 &= 1,5(R + 0,2) \checkmark \\ R &= 7,8 \, \Omega \\ &\downarrow \\ R_R &= 7,8 - 6 \checkmark \\ &= 1,8 \, \Omega \checkmark\end{aligned}$$

**OPTION 3/OPSIE 3**

$$\begin{aligned}V_{||} &= IR_{||} \\ &= (6)(1,5) \checkmark \\ &= 9 \, \text{V} \\ V_R &= IR \checkmark \\ (11,7 - 9) &= (1,5)R \checkmark \\ R &= 1,8 \, \Omega \checkmark\end{aligned}$$

(4)

8.2.1

$$\begin{aligned}P_{\text{ave/gemid}} &= Fv_{\text{ave/gemid}} \checkmark = mg(v_{\text{ave/gemid}}) \\ &= (0,35)(9,8)(0,4) \checkmark \\ &= 1,37 \, \text{W} \checkmark\end{aligned}$$

**OR/OF**

$$P = \frac{W_{\text{nc}}}{\Delta t} \checkmark = \frac{\Delta E_k + \Delta E_p}{\Delta t} = \frac{0 + (0,35)(9,8)(0,4 - 0)}{1} \checkmark = 1,37 \, \text{W} \checkmark$$

**OR/OF**

$$P = \frac{W}{\Delta t} \checkmark = \frac{E_p}{\Delta t} = \frac{(0,35)(9,8)(0,4)}{1} \checkmark = 1,37 \, \text{W} \checkmark$$

(3)

8.2.2

**POSITIVE MARKING FROM QUESTION 8.2.1/POSITIEWE NASIEN VANAF VRAAG 8.2.1**

**OPTION 1/OPSIE 1**

$$\begin{aligned}P &= VI \\ 1,37 &= (3)I \checkmark \\ I &= 0,46 \, \text{A}\end{aligned}$$

$$\begin{aligned}\varepsilon &= V_{\text{ext}} + V_{\text{int}} \\ &= V_T + V_X + V_{\text{int}} \\ 12 &= V_T + 3 + (0,2)(0,46) \checkmark \\ V_T &= 8,91 \, \text{V}\end{aligned}$$

$$\begin{aligned}V_T &= IR_T \\ 8,91 &= (0,46)R_T \checkmark \\ R_T &= 19,37 \, \Omega \checkmark\end{aligned}$$

✓ Any one  
Enigeen

**OPTION 2/OPSIE 2**

$$P = \frac{V^2}{R}$$

$$1,37 = \frac{3^2}{R} \checkmark$$

$$R = 6,57 \, \Omega$$

$$\begin{aligned}P &= VI \\ 1,37 &= (3)I \checkmark \\ I &= 0,46 \, \text{A}\end{aligned}$$

$$\begin{aligned}\varepsilon &= I(R + r) \\ 12 &= 0,46(6,57 + R_T + 0,2) \checkmark \\ R_T &= 19,38 \, \Omega \checkmark\end{aligned}$$

✓ Any one  
Enigeen

**OPTION 3/OPSIE 3**

$$P = VI \checkmark$$

$$1,37 = (3)I \checkmark$$

$$I = 0,46 \text{ A}$$

$$P_{\text{tot}} = P_r + P_{\text{motor}} + P_T$$

$$(12)(0,46) \checkmark = (0,46)^2(0,2) + 1,37 + (0,46)^2 R_T \checkmark$$

$$R_T = 19,41 \, \Omega \checkmark$$

**OR/OF**

$$P = VI \checkmark$$

$$1,37 = (3)I \checkmark$$

$$I = 0,46 \text{ A}$$

$$P_{\text{tot}} = P_r + P_{\text{motor}} + P_T$$

$$(12)(0,46) = (0,46)^2(0,2) + 1,37 + P_T \checkmark$$

$$P_T = 4,07 \text{ W}$$

$$P = I^2 R$$

$$4,07 = (0,46)^2 R_T \checkmark$$

$$R_T = 19,49 \, \Omega \checkmark$$

**OPTION 4/OPSIE 4**

$$P = VI$$

$$1,37 = (3)I \checkmark$$

$$I = 0,46 \text{ A}$$

✓ Any one  
*Enigeen*

$$\varepsilon = I(R + r)$$

$$12 = (0,46)(R + 0,2) \checkmark$$

$$R = 25,87 \, \Omega$$

$$V = IR$$

$$3 = (0,46)R \checkmark$$

$$R = 6,52 \, \Omega$$

$$R_T = 25,87 - 6,52 \\ = 19,35 \, \Omega \checkmark$$

$$P = I^2 R$$

$$1,37 = (0,46)^2 R \checkmark$$

$$R = 6,47 \, \Omega$$

$$R_T = 25,87 - 6,47 \\ = 19,4 \, \Omega \checkmark$$

$$P_{\text{motor}} = \frac{V^2}{R}$$

$$1,37 = \frac{3^2}{R} \checkmark$$

$$R = 6,56 \, \Omega$$

$$R_T = 25,87 - 6,56 \\ = 19,31 \, \Omega \checkmark$$

(5)  
**[21]**

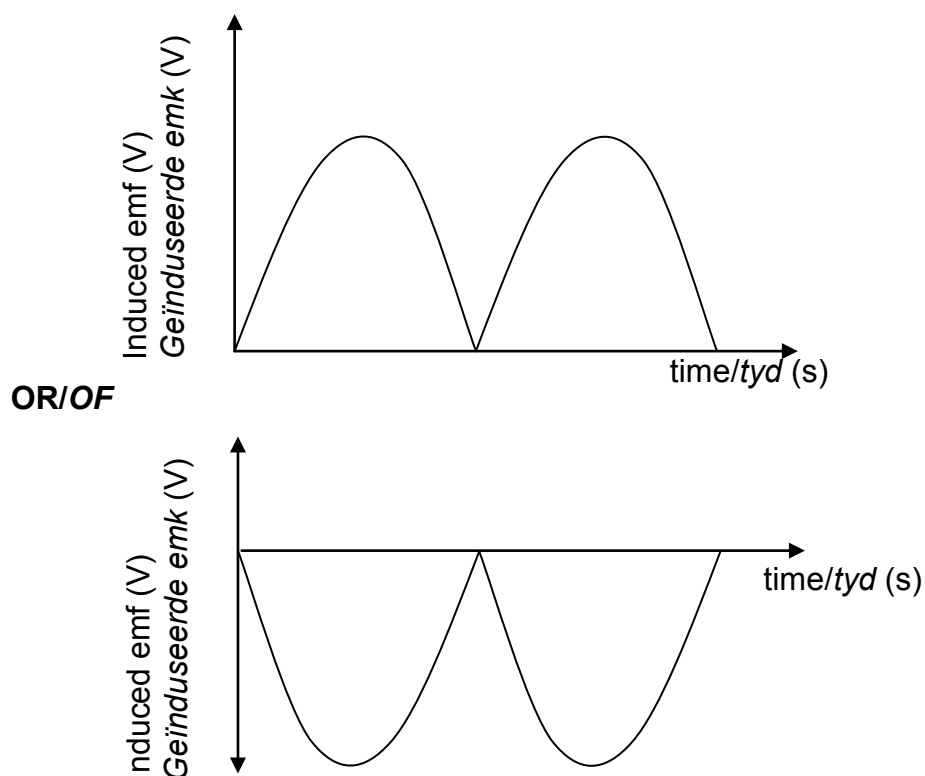
### QUESTION 9/VRAAG 9

9.1.1 DC/GS-generator✓

Uses split ring/commutator/*Gebruik spleetring/kommutator*✓

(2)

9.1.2



(2)

9.2.1

#### **OPTION 1/OPSIE 1**

$$V_{\text{rms/wgk}} = \frac{V_{\text{max/maks}}}{\sqrt{2}}$$

$$P_{\text{ave/gem}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark$$

$$800 = \frac{340}{\sqrt{2}} (I_{\text{rms/wgk}}) \checkmark$$


---


$$I_{\text{rms/wgk}} = 3,33 \text{ A} \checkmark$$

#### **OR/OF**

$$V_{\text{rms/wgk}} = \frac{V_{\text{max/maks}}}{\sqrt{2}} = \frac{340}{\sqrt{2}} = 240,416$$

$$P_{\text{ave/gem}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark$$

$$800 = I_{\text{rms/wgk}} (240,416) \checkmark$$

$$I_{\text{rms/wgk}} = 3,33 \text{ A} \checkmark$$

**OPTION 2/OPSIE 2**

$$P_{\text{ave/gem}} = \left( \frac{V_{\text{rms/wgk}}^2}{R} \right) = \frac{(V_{\text{max/maks}}^2)}{(2)(R)}$$

$$800 = \frac{(340)^2}{(\sqrt{2})^2 (R)}$$

$$R = 72,25 \, \Omega$$

$$V_{\text{rms/wgk}} = I_{\text{rms/wgk}} R$$

$$I_{\text{rms/wgk}} = \frac{240,416}{72,25} \checkmark$$

$$= 3,33 \, \text{A} \checkmark$$

$$P_{\text{ave/gem}} = I_{\text{rms/wgk}}^2 R$$

$$800 = I_{\text{rms/wgk}}^2 (72,25) \checkmark$$

$$I_{\text{rms/wgk}} = 3,33 \, \text{A} \checkmark$$

(3)

9.2.2

**POSITIVE MARKING FROM QUESTION 9.2.1**

**POSITIEWE NASIEN VANAF VRAAG 9.2.1**

**OPTION 1/OPSIE 1**

$$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark$$

for the kettle/vir die ketel:

$$2000 = \frac{340}{\sqrt{2}} (I_{\text{rms/wgk}}) \checkmark$$

$$I_{\text{rms/wgk}} = 8,32 \, \text{A}$$

$$I_{\text{tot}} = (8,32 + 3,33) \checkmark$$

$$= 11,65 \, \text{A} \checkmark$$

**OPTION 2/OPSIE 2**

$$P_{\text{ave/gemid}} = \left( \frac{V_{\text{rms/wgk}}^2}{R} \right) \checkmark = \frac{(V_{\text{max/maks}}^2)}{(2)(R)}$$

$$800 = \frac{(340)^2}{(\sqrt{2})^2 (R)} \checkmark$$

$$R = 72,25 \, \Omega$$

$$2000 = \frac{(340)^2}{(\sqrt{2})^2 (R_{2000})}$$

$$R = 28,9 \, \Omega$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R = \frac{(28,9)(72,25)}{(28,9 + 72,25)} = 20,64 \, \Omega$$

$$V_{\text{rms/wgk}} = I_{\text{rms/wgk}} R$$

$$240,42 = I_{\text{rms/wgk}} (20,64) \checkmark$$

$$I_{\text{rms/wgk}} = 11,65 \, \text{A} \checkmark$$

**OPTION 3/OPSIE 3**

$$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark = \frac{V_{\text{max/maks}} I_{\text{max/maks}}}{2}$$

$$2\,800 \checkmark = \frac{(340) I_{\text{max/maks}} \checkmark}{2}$$

$$I_{\text{max/maks}} = 16,47 \text{ A}$$

$$I_{\text{rms}} = \frac{I_{\text{max/maks}}}{\sqrt{2}} = \frac{16,47}{\sqrt{2}}$$

$$I_{\text{rms/wgk}} = 11,65 \text{ A} \checkmark$$

**OPTION 4/OPSIE 4**

$$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark$$

$$2\,800 \checkmark = \frac{340}{\sqrt{2}} I_{\text{rms/wgk}} \checkmark$$

$$I_{\text{rms/wgk}} = 11,65 \text{ A} \checkmark$$

**OPTION 5/OPSIE 5**

$$P_T : P_K$$

$$800 : 2\,000 \checkmark$$

$$1 : 2,5$$

$$I_T : I_K$$

$$3,33 : 8,325 \checkmark$$

$$I_{\text{rms}} = 3,33 + 8,325 \checkmark$$

$$= 11,66 \text{ A} \checkmark$$

(4)  
**[11]**

**QUESTION 10/VRAAG 10**

- 10.1.1 The minimum frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) ✓  
*Die minimum frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) vry te stel*

**OR/OF**

- The frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) with zero kinetic energy✓  
*Die frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) met nul/geen kinetiese energie vry te stel*

(2)

10.1.2 Silver/*Silwer*✓

Threshold/cutoff frequency (of Ag) is higher/Drumpel/afsnryfrekwensie (van Ag) is hoër✓

$$W_o \propto f_o / W_o = hf_o \checkmark$$

**OR/OF**

To eject electrons with the same kinetic energy from each metal, light of a higher frequency/energy is required for silver. ✓ Since  $E = W_o + E_{k(max)}$  (and  $E_k$  is constant), the higher the frequency/energy of the photon/light required, the greater is the work function/ $W_o$ .✓

*Om elektrone met dieselfde kinetiese energie van elke metal vry te stel, is lig van hoër frekwensie benodig vir silwer. Aangesien  $E = W_o + E_{k(maks)}$  (en  $E_{k(maks)}$  is konstant) word fotone/lig van hoër frekwensie/energie benodig, dus is arbeidsfunksie hoër*

(3)

10.1.3 Planck's constant /*Planck se konstante* ✓

(1)

10.1.4 Sodium/*Natrium*✓

(1)

10.2.1 Energy radiated per second by the blue light /*Energie per sekonde uitgestraal deur die bloulig* =  $\left(\frac{5}{100}\right)(60 \times 10^{-3}) \checkmark = 3 \times 10^{-3} \text{ J} \cdot \text{s}^{-1}$

$$\begin{aligned} E_{\text{photon/foton}} &= \frac{hc}{\lambda} \checkmark \\ &= \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{470 \times 10^{-9}} \checkmark \\ &= 4,232 \times 10^{-19} \text{ J} \end{aligned}$$

$$\begin{aligned} \text{Total number of photons incident per second/} &\text{Totale aantal fotone wat per} \\ \text{sekonde inval} &= \frac{3 \times 10^{-3}}{4,232 \times 10^{-19}} \checkmark \\ &= 7,09 \times 10^{15} \checkmark \end{aligned}$$

(5)

10.2.2 **POSITIVE MARKING FROM QUESTION 10.2.1**  
**POSITIEWE NASIEN VANAF VRAAG 10.2.1**

$$7,09 \times 10^{15} \text{ (electrons per second/elektron per sekonde)} \checkmark$$

**OR/OF**

Same number as that calculated in Question 10.2.1 above/*Dieselfde as die in Vraag 10.2.1 hierbo bereken*

(1)

**[13]**

**TOTAL/TOTAAL: 150**