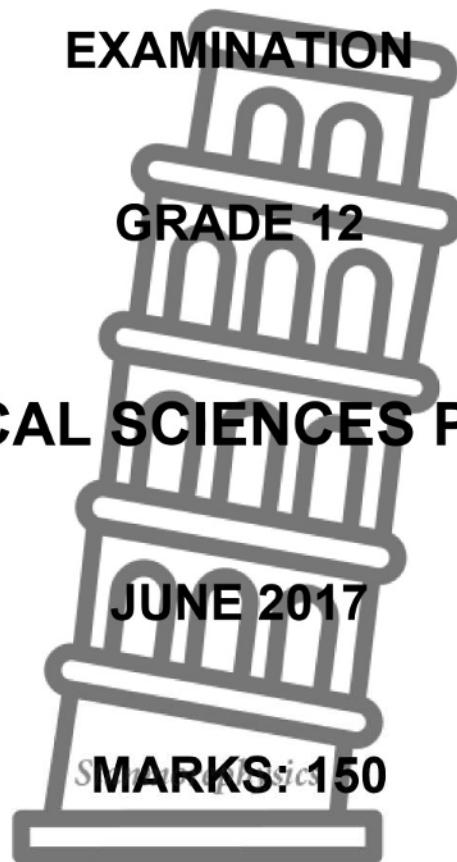




# education

Department of  
Education  
FREE STATE PROVINCE

EXAMINATION  
GRADE 12  
PHYSICAL SCIENCES PAPER 1



TIME: 3 HOURS

This paper consists of 11 pages, three data sheets and one graph paper.

## INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.
2. This paper consists of EIGHT 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 sub-questions, 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 where necessary.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.



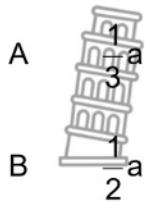
## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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, B, C or D next to the question number (1.1 – 1.10) in the ANSWER BOOK.

- 1.1 A roller-coaster climbs up a hill at  $4 \text{ m.s}^{-1}$  and then goes down the hill at  $30 \text{ m.s}^{-1}$ . The magnitude of the roller-coaster's momentum ...
- 
- A is greater up the hill than down the hill.
  - B is greater down the hill than up the hill.
  - C remains the same throughout the ride.
  - D is zero throughout the ride. (2)
- 1.2 Two objects, **P** and **Q**, with the same masses, hit a wall perpendicular with the same velocity. They both rebound with the same velocity. Object **P** experiences twice the net force as object **Q**. Which one of the following equations is correct?
- A  $\Delta t \text{ (of P)} = \frac{1}{2} \Delta t \text{ (of Q)}$
  - B  $\Delta t \text{ (of P)} = \Delta t \text{ (of Q)}$
  - C  $\Delta t \text{ (of P)} = 2\Delta t \text{ (of Q)}$
  - D  $\Delta t \text{ (of P)} = 2^2 \Delta t \text{ (of Q)}$  (2)
- 1.3 A ball is thrown vertically upwards from the surface of Earth. Ignore the effect of friction. What is the acceleration of the ball, in  $\text{m.s}^{-2}$ , when it reaches a velocity of zero at the highest point of its trajectory?
- A Zero
  - B 9,8; upwards
  - C 9,8; downwards
  - D 19,6; downwards (2)



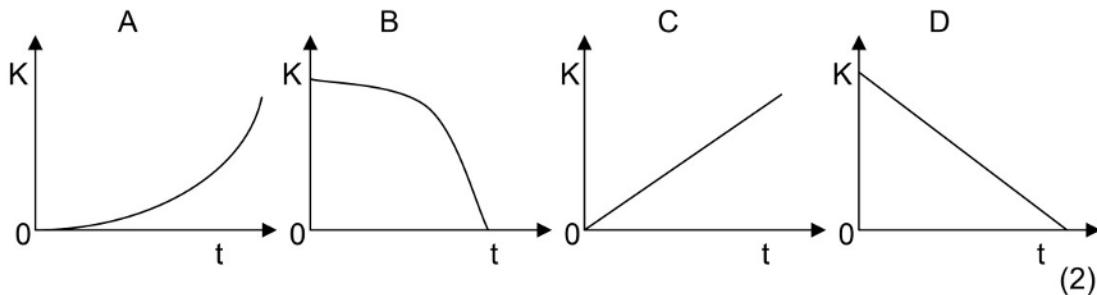
- 1.4 A boy, mass  $3m$ , and a girl, mass  $m$ , are facing each other on roller skates that are completely frictionless. With their hands, they push off against one another. The boy experiences a force  $F$  and an acceleration  $a$  to the left. What is the magnitude of the girl's acceleration in terms of  $a$ ?



- A  $1/a$   
 B  $\frac{1}{2}a$   
 C  $2a$   
 D  $3a$

(2)

- 1.5 A stone is dropped from the edge of a cliff. Which one of the following graphs best represents the change in kinetic energy  $K$  of the stone during its fall if friction is ignored?



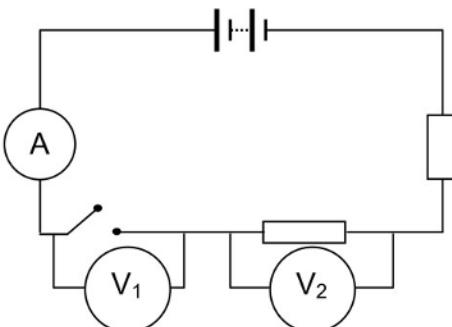
(2)

- 1.6 An object moves in a straight line on a ROUGH, horizontal surface. If the net work done on the object is zero, the object ...

- A has zero kinetic energy.  
 B moves at constant speed.  
 C moves at increasing speed.  
 D moves at non-zero constant acceleration.

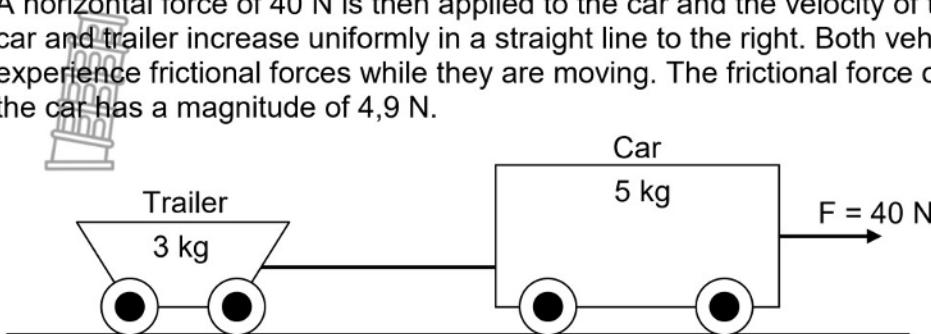
(2)



- 1.7 Which one of the following would result in you hearing a lower pitch than that of a single note played by a trumpet player who is standing on a stage?
- A Play the sound much louder through headphones.
  - B Run away from the trumpet player.
  - C Run towards the trumpet player.
  - D Cover your ears.
- (2)
- 1.8 Two small, metallic spheres, **P** and **Q**, on insulated stands carry identical negative charges. The distance between their centres is  $d$  and the magnitude of the force exerted by **Q** on **P** is  $F$ . The distance is then changed to  $\frac{1}{2}d$ . What is the magnitude of the new force exerted by **Q** on **P** in terms of  $F$ ?
- A  $\frac{1}{4}F$
  - B  $\frac{1}{2}F$
  - C  $2F$
  - D  $4F$
- (2)
- 1.9 Which one of the following combinations of SI units represents ohm ( $\Omega$ )?
- A  $V \cdot A$
  - B  $J \cdot C^{-1}$
  - C  $C \cdot s^{-1}$
  - D  $V \cdot A^{-1}$
- (2)
- 1.10 The battery in the circuit diagram below has an emf of 12 V and negligible resistance. Two voltmeters, **V**<sub>1</sub> and **V**<sub>2</sub>, are connected as shown. What are the readings on **V**<sub>1</sub> and **V**<sub>2</sub> when the switch is open?
- 
- |   | <b>V</b> <sub>1</sub><br>(V) | <b>V</b> <sub>2</sub><br>(V) |
|---|------------------------------|------------------------------|
| A | 12                           | 12                           |
| B | 0                            | 12                           |
| C | 12                           | 0                            |
| D | 0                            | 0                            |
- (2)  
[20]

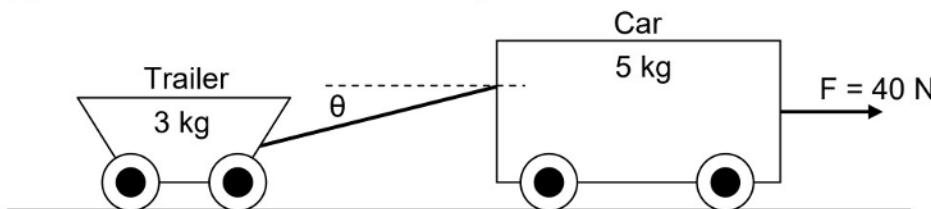
## QUESTION 2

- 2.1 A toy trailer, mass 3 kg, is connected to a toy car, mass 5 kg, by means of a light, inelastic string. The system is at rest on a horizontal surface. A horizontal force of 40 N is then applied to the car and the velocity of the car and trailer increase uniformly in a straight line to the right. Both vehicles experience frictional forces while they are moving. The frictional force on the car has a magnitude of 4,9 N.



- 2.1.1 Write down Newton's second law of motion in words. (3)
- 2.1.2 What type of frictional force do the vehicles experience? (1)
- 2.1.3 Show by means of a calculation that the frictional force on the trailer has a magnitude of 2,94 N if the coefficient of friction is 0,1. (2)
- 2.1.4 Calculate the magnitude of the acceleration of the system. Write down separate equations for the two moving objects using Newton's second law of motion and then calculate the acceleration. (5)
- 2.1.5 Calculate the force exerted by the string ON THE CAR. (3)

The string is disconnected from the car and reconnected at a higher point to make an angle  $\theta$  with the horizontal. The horizontal force of 40 N is again applied to the car to accelerate the system from rest as before.



- 2.1.6 Draw a free-body diagram, with labels, of all the forces acting on the CAR. Where possible the lengths of your arrows should display the comparative magnitudes of the forces. (6)

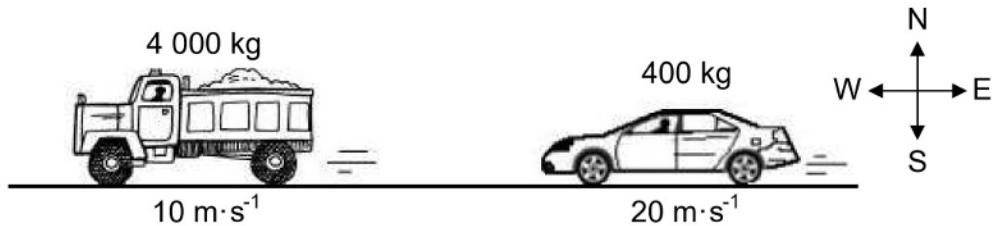
With the string in the new position, is the frictional force on the ...

- 2.1.7 trailer greater than, the same as or less than 2,94 N? (2)
- 2.1.8 car greater than, the same as or less than 4,9 N? (2)

- 2.2 The planet Mars has an approximate mass and radius of  $6,39 \times 10^{23}$  kg and  $3,39 \times 10^3$  km respectively. Calculate the approximate magnitude of the gravitational acceleration on the surface of Mars. (4)  
[28]

### QUESTION 3

The diagram shows a car with a mass of 400 kg, moving at a velocity of  $20 \text{ m}\cdot\text{s}^{-1}$  (west) on a straight, horizontal road. A truck with a mass 4 000 kg is moving at  $10 \text{ m}\cdot\text{s}^{-1}$  (also west) on the same road. Ignore the effects of friction where applicable. The vehicles collide, but DO NOT STICK TOGETHER AFTER THE COLLISION.



- 3.1 Write down the *principle of conservation of linear momentum* in words. (2)
- 3.2 Immediately after the collision the truck's velocity is  $14 \text{ m}\cdot\text{s}^{-1}$  west. Calculate the velocity of the car immediately after the collision. (5)
- 3.3 Calculate the net force on the truck during the collision if it takes place in 0,8 s. (5)  
[12]

### QUESTION 4

- 4.1 A player throws a cricket ball vertical upwards with an initial speed of  $14,5 \text{ m}\cdot\text{s}^{-1}$  and catches it again at the same height from where it was projected. The table below shows the velocity of the ball at different times during the interval  $t = 0 \text{ s}$  to  $t = 2,5 \text{ s}$ . UPWARD is taken as the POSITIVE DIRECTION.

| Time (s)                                  | 0    | 0,5  | 1,0 | 1,5  | 2,0  | 2,5   |
|---|------|------|-----|------|------|-------|
| Velocity ( $\text{m}\cdot\text{s}^{-1}$ ) | 14,5 | 10,0 | 4,0 | -0,5 | -5,5 | -10,5 |

- 4.1.1 Use the tabulated data to draw a velocity-time graph of the ball's motion. Use the graph paper that is provided at the end of this question paper. Plot the points and draw the BEST-FIT graph. (5)
- 4.1.2 Use THE GRAPH to calculate the displacement of the ball from  $t = 1,5 \text{ s}$  to  $t = 2,5 \text{ s}$ . EQUATIONS OF MOTION MAY NOT BE USED. (5)
- 4.1.3 Under which condition can you consider the cricket ball to be a projectile? (1)

- 4.2 A cannonball with a mass of 0,5 kg is fired vertical upwards from a platform, which is 14 m above the ground. The cannonball leaves the barrel of the cannon at a speed of  $40 \text{ m.s}^{-1}$ , at a height of 1 m above the platform. Ignore air resistance.

4.2.1 Calculate the maximum height the cannonball reaches above the ground. (5)

4.2.2 Calculate how long it takes to reach the maximum height. (3)

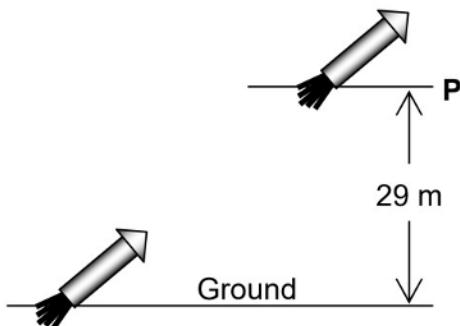
4.2.3 The total time elapsed from launching until it hits the ground can be calculated with the equation  $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ .

Use THIS EQUATION ONLY (NO OTHER ONE IN ADDITION TO THIS) and substitute the relevant values in order to determine the time. It is not necessary to solve the equation; just show the equation and the substitutions. (3)

[22]

## QUESTION 5

- 5.1 A 0,20 kg rocket in a fireworks display is launched from rest from the ground and follows a straight flight path to reach point P, as shown in the figure below. Point P is 29 m above the starting point. In the process, 425 J of work is done on the rocket by the NON-CONSERVATIVE force generated by the burning propellant. Ignore air resistance and the mass lost due to the burning propellant.



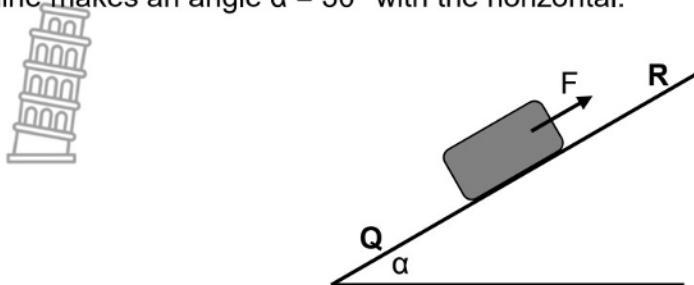
5.1.1 Explain what a non-conservative force is. (2)

5.1.2 Write down the *work-energy theorem* in words. (2)

5.1.3 Calculate the speed of the rocket at point P. (5)



- 5.2 A constant force  $F$  is applied to a crate to move it upwards along a frictionless, inclined plane. Force  $F$  is parallel to the inclined plane and the mass of the crate is 25 kg. When the crate reaches point **Q**, its speed is  $12 \text{ m}\cdot\text{s}^{-1}$ , and  $10,8 \text{ m}\cdot\text{s}^{-1}$  when it reaches point **R**, which is 3,5 m further up the incline. The incline makes an angle  $\alpha = 30^\circ$  with the horizontal.



- 5.2.1 Draw a free-body diagram, with labels, of the forces acting on the crate while it is moving. (3)
- 5.2.2 Is mechanical energy conserved during this motion? Write down YES or NO and briefly explain your answer. (2)
- 5.2.3 Give a reason why the normal force does not do any work on the crate during its motion. (1)
- 5.2.4 Use ENERGY PRINCIPLES to calculate the magnitude of force  $F$ . (6) [21]

## QUESTION 6

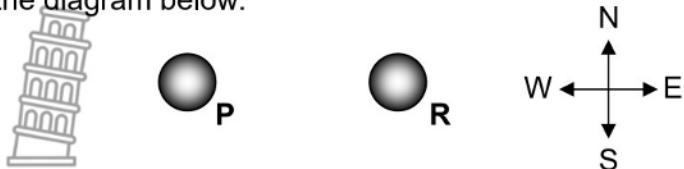
While Anne is riding on her skateboard, she hears a sound from a foghorn in a lighthouse at a frequency of 81 Hz. Dineo, her friend, is standing in front of the lighthouse and hear the foghorn's sound at a frequency of 80 Hz.

- 6.1 Define the *Doppler effect* in words. (2)
- 6.2 What is the frequency at which the foghorn emits the sound waves? Explain your answer. (3)
- 6.3 Calculate the speed at which Anne is moving if the speed of sound in air is  $340 \text{ m}\cdot\text{s}^{-1}$ . (5) [10]



### QUESTION 7

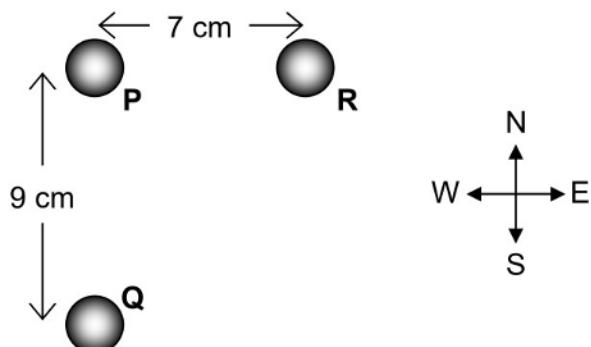
Two identical, small, metallic spheres, **P** and **R**, carry electric charges of  $-20 \mu\text{C}$  and  $+30 \mu\text{C}$  respectively. They are placed on the east-west axis of a compass as shown in the diagram below.



- 7.1 Define *electric field at a point* in words. (2)

- 7.2 Draw the electric field pattern for the combined field of **P** and **R**. (3)

The centre of **P** is 7 cm from the centre of **R**. A third identical sphere, **Q**, is then placed as shown below, with its centre 9 cm away from the centre of **P**. **P** and **Q** are placed on the north-south axis of a compass and **Q** carries a charge of  $-45 \mu\text{C}$ .



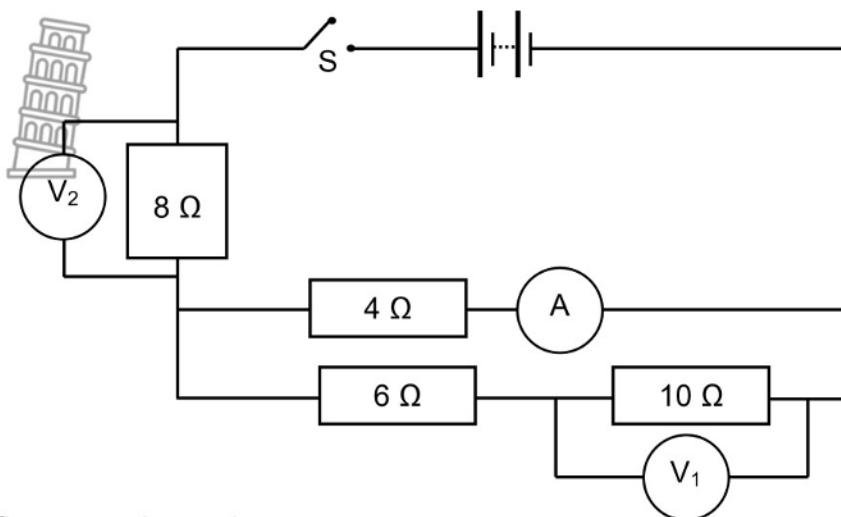
- 7.3 Write down *Coulomb's law* in words. (3)

- 7.4 Draw a free-body diagram, with labels, of all the electrostatic forces acting on **P** as a result of **Q** and **R**. (3)

- 7.5 Calculate the net electrostatic force experienced by **P** as a result of **Q** and **R**. (8)  
**[19]**

### QUESTION 8

The circuit diagram below shows four resistors connected to a battery with negligible internal resistance.



8.1 Define *power* in words. (2)

8.2 Write down *Ohm's law* in words. (2)

Switch **S** is closed. The power-rating of the  $4\ \Omega$  resistor is 36 W. Calculate the following:

8.3 The ammeter reading (3)

8.4 The reading on voltmeter  $V_1$  (5)

8.5 The reading on voltmeter  $V_2$  (3)

8.6 The potential difference across the terminals of the battery (3)

[18]

**GRAND TOTAL: 150**



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

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

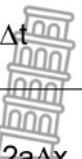
**TABLE 1: PHYSICAL CONSTANTS / TABEL 1: FISIESE KONSTANTES**

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



**TABLE 2: FORMULAE / TABEL 2: FORMULES**

**MOTION / BEWEGING**

|  |  |
|--|--|
| $v_f = v_i + a\Delta t$<br> | $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of<br>$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$         |
| $v_f^2 = v_i^2 + 2a\Delta x$ or/of<br>$v_f^2 = v_i^2 + 2a\Delta y$   | $\Delta x = \left( \frac{v_f + v_i}{2} \right) \Delta t$ or/of<br>$\Delta y = \left( \frac{v_f + v_i}{2} \right) \Delta t$ |

**FORCE / KRAG**

|   |                      |
|---|----------------------|
| $F_{net} = ma$  | $p = mv$             |
| $F_{net} \Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$             |
| $F = \frac{Gm_1 m_2}{r^2}$                                | $g = \frac{Gm}{r^2}$ |
| $f_s^{max} = \mu_s N$                                     | $f_k = \mu_k N$      |

**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 $W_{net} = \Delta E_k$<br>$\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$ |
| $W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$   |
| $P_{ave} = Fv_{ave}$ / $P_{gem} = Fv_{gem}$                             |  |

**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 $E = h\frac{c}{\lambda}$   |
| $E = W_o + E_k$ where/waar<br>$E = hf$ and/en $W_o = hf_o$ and/en $E_k = \frac{1}{2} mv^2$ |  |

## ELECTROSTATICS / ELEKTROSTATIKA

|   |                      |
|---|----------------------|
| $F = \frac{kQ_1 Q_2}{r^2}$                  | $E = \frac{kQ}{r^2}$ |
| $E = \frac{F}{q}$                           | $V = \frac{W}{q}$    |
| $n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$ |                      |

## ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

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

## ALTERNATING CURRENT / WISSELSTROOM

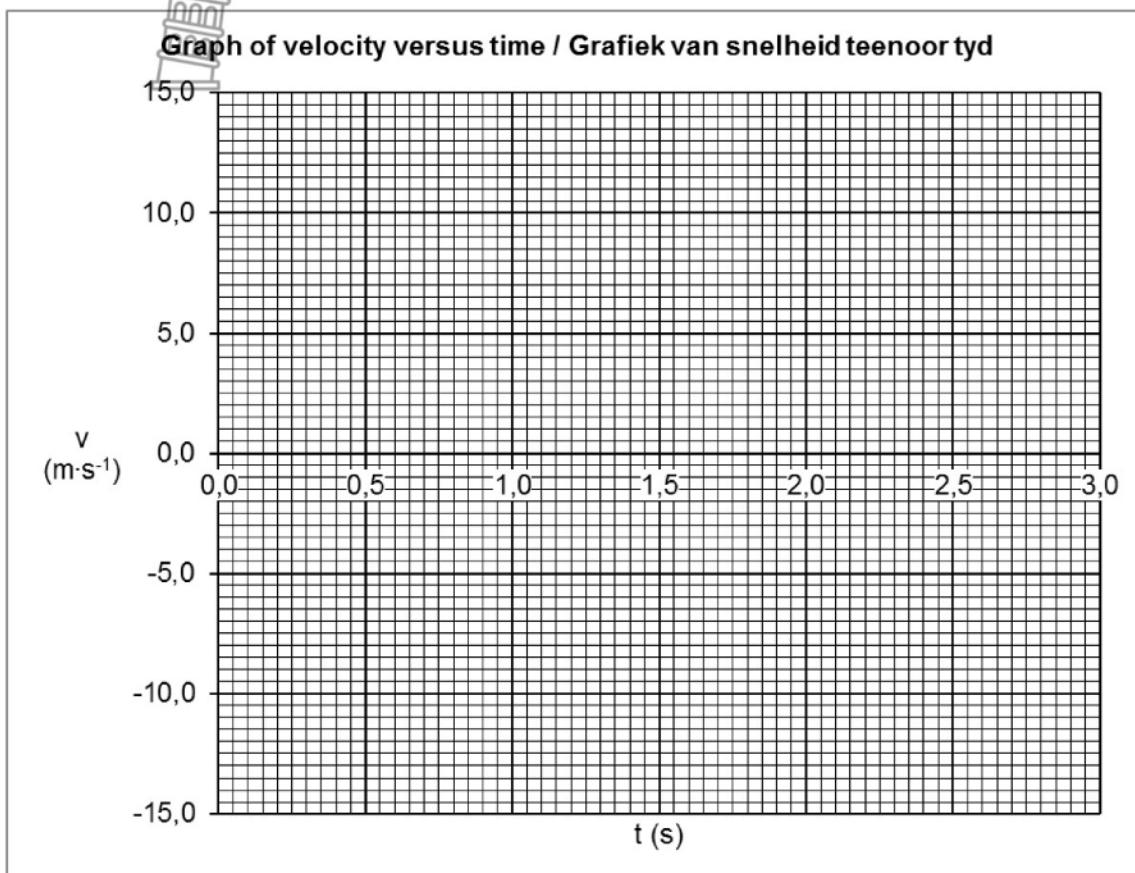
|  |  |   |
|--|--|---|
| $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ | $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$ | $P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ |
|  |  | $P_{average} = I_{rms}^2 R$ / $P_{gemiddeld}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



**Graph paper for question 4.1.1**

Name of learner: \_\_\_\_\_ Grade: \_\_\_\_\_

**REMEMBER TO HAND IN THIS GRAPH PAPER WITH YOUR ANSWER BOOK.**





# education

Department of  
Education  
FREE STATE PROVINCE

## EXAMINATION *EKSAMEN*

**GRADE/GRAAD 12**

# **PHYSICAL SCIENCES PAPER 1** ***FISIESE WETENSKAPPE VRAESTEL 1***

**MEMORANDUM**

**JUNE/JUNIE 2017**

**TIME/TYD: 3 HOURS/UUR**

**MARKS/PUNTE: 150**



This memorandum consists of 11 pages.  
*Hierdie memorandum bestaan uit 11 bladsye.*

### QUESTION 1 / VRAAG 1

- |     |   |     |   |     |   |      |   |
|-----|---|-----|---|-----|---|------|---|
| 1.1 | B | 1.4 | D | 1.7 | B | 1.10 | C |
| 1.2 | A | 1.5 | A | 1.8 | D |      |   |
| 1.3 | C | 1.6 | B | 1.9 | D |      |   |

[ $10 \times 2 = 20$ ]

### QUESTION 2 / VRAAG 2

- 2.1.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force (✓) at an acceleration directly proportional to the force (✓) and inversely proportional to the mass of the object.(✓)

*Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag (✓) teen 'n versnelling direk eweredig aan die krag (✓) en omgekeerd eweredig aan die massa van die voorwerp. (✓)*

(3)

**Accept Newton's second law of motion in terms of momentum:**

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

**Aanvaar Newton se tweede bewegingswet in terme van momentum:**

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

- 2.1.2 Kinetic ✓ (friction) Kinetiese ✓ (wrywing) (1)

2.1.3

$$\begin{aligned} f_3 &= \mu N \checkmark \\ &= \mu mg \\ &= (0,1)(3)(9,8)\checkmark \\ &= 2,94 \text{ N} \end{aligned}$$

(2)

|  |  |
|--|--|
| <b>OPTION 1/OPSIE 1</b><br>Right: +<br>Regs: +<br><br>Trailer/Wa:<br>$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ T + f_3 &= ma \\ \underline{T - 2,94} \checkmark &= 3a \end{aligned}$ | <b>OPTION 2/OPSIE 2</b><br>Right: -<br>Regs: -<br><br>Trailer/Wa:<br>$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ T + f_3 &= ma \\ -T + 2,94 \checkmark &= -3a \end{aligned}$ |
|--|--|

**OPTION 3/OPSIE 3** Right/Regs: +  
**SYSTEM METHOD/SISTEEMMETODE**

$$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ F + f_5 + f_3 &= ma \\ 40 - 4,9 - 2,94 &= 8a \checkmark \\ a &= 4,02 \text{ m}\cdot\text{s}^{-2} \checkmark \end{aligned}$$

**Max/Maks:**  
 3/5



(5)

2.1.5

**OPTION 1/OPSIE 1 (Car/Kar)**

Right: +

Regs: +

$$\begin{aligned} F_{\text{net}} &= ma \\ F + f_5 + F_T &= ma \\ 40 + (-4,9) + F_T &= 5(4,02) \checkmark \\ F_T &= -15 \text{ N} \checkmark \end{aligned}$$

$F_T = 15 \text{ N}; \text{left/links} \checkmark$

2.1.4

**OPTION 3/OPSIE 3 (Trailer/Wa)**

Right: +

Regs: +

$$\begin{aligned} F_{\text{net}} &= ma \\ f_3 + F_T &= ma \\ -2,94 + F_T &= 3(4,02) \checkmark \\ F_T &= 15 \text{ N} \checkmark \end{aligned}$$

2.1.4

$F_T \text{ on car/op kar} = 15 \text{ N}; \text{left/links} \checkmark$

**OPTION 2/OPSIE 2 (Car/Kar)**

Right: -

Regs: -

$$\begin{aligned} F_{\text{net}} &= ma \\ F + f_5 + F_T &= ma \\ -40 + (+4,9) + F_T &= 5(-4,02) \checkmark \\ F_T &= 15 \text{ N} \checkmark \end{aligned}$$

$F_T = 15 \text{ N}; \text{left/links} \checkmark$

2.1.4

**OPTION 3/OPSIE 3 (Trailer/Wa)**

Right: -

Regs: -

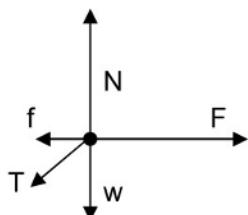
$$\begin{aligned} F_{\text{net}} &= ma \\ f_3 + F_T &= ma \\ 2,94 + F_T &= 3(-4,02) \checkmark \\ F_T &= -15 \text{ N} \checkmark \end{aligned}$$

2.1.4

$F_T \text{ on car/op kar} = 15 \text{ N}; \text{left/links} \checkmark$

(3)

2.1.6



Each arrow plus label: One mark each (5)  
 Length of N > length of w. } Both correct  
 Length of F > length of (T\_h + f). } for one mark (1)

Elke pyl plus byskrif: Een punt elk (5)  
 Lengte van N > length van w. } Beide korrek  
 Lengte van F > lengte van (T\_h + f). } vir een punt. (1)

If a force diagram is given: **Max 4/6**  
 Components of T are not acceptable.  
 Any extra force(s): **-1 up to max of -2**.  
 As 'n kragtediagram gegee word: **Maks 4/6**  
 Komponente van T is nie aanvaarbaar nie.  
 Enige ekstra krag(te): **-1 tot maks van -2**.

|   | Acceptable symbols   | Aanvaarbare simbole   |
|---|--|---|
| N | $F_N$ / Normal / Normal force  | $F_N$ / Normaal / Normaalkrag   |
| T | Tension / $F_{\text{rope}}$  | Spanning / Spanningskrag / $F_{\text{tou}}$                             |
| w | $F_g$ / $F_w$ / force of Earth on object / weight / mg / gravitational force | $F_g$ / $F_w$ / krag van Aarde op voorwerp / gewig /mg / gravitasiekrag |
| f | $F_f$ / $f_k$ / (Kinetic) Frictional force                                   | $F_f$ / $f_k$ / (Kinetiese) Wrywingskrag                                |
| F | $F_{\text{app}}$   | $F_{\text{app}}$  |

Numbers as labels are not accepted./Getalle as byskrifte word nie aanvaar nie.

(6)

2.1.7 Less than ( $\checkmark \checkmark$ )

Kleiner as ( $\checkmark \checkmark$ )



(2)

2.1.8 Greater than ( $\checkmark \checkmark$ )

Groter as ( $\checkmark \checkmark$ )

(2)

2.2

$$g = \frac{Gm}{r^2} \checkmark = \frac{(6,67 \times 10^{-11})(6,39 \times 10^{23})}{(3,39 \times 10^6)^2} \checkmark = 3,71 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(4)

[28]

### QUESTION 3 / VRAAG 3

- 3.1 The total linear momentum of an isolated system remains constant (is conserved). (✓✓)
- Die totale lineêre momentum van 'n geïsoleerde sisteem bly konstant (behoue). (✓✓) (2)

**Do not accept "closed".**

"Geslote" word **nie aanvaar nie.**

3.2

**OPTION 1/OPSIE 1**

West:+ / Wes:+

$$\begin{aligned} \sum p_f &= \sum p_i \\ m_1 v_f + m_2 v_f &= m_1 v_i + m_2 v_i \quad \left. \right\} \checkmark \\ (4000)(14) + (400)v_f \checkmark &= (4000)(10) + (400)(20) \checkmark \\ v_f &= -20 \text{ m}\cdot\text{s}^{-1} \checkmark \end{aligned}$$

$v_f = 20 \text{ m}\cdot\text{s}^{-1}$ ; east/opp to original motion ✓  
 oos/teenoorg aan oospronklike beweging  
**Right not acceptable./Regs is nie aanvaarbaar nie.**

**OPTION 2/OPSIE 2**

West:- / Wes:-

$$\begin{aligned} \sum p_f &= \sum p_i \\ m_1 v_f + m_2 v_f &= m_1 v_i + m_2 v_i \quad \left. \right\} \checkmark \\ (4000)(-14) + (400)v_f \checkmark &= (4000)(-10) + (400)(-20) \checkmark \\ v_f &= +20 \text{ m}\cdot\text{s}^{-1} \checkmark \end{aligned}$$

$v_f = 20 \text{ m}\cdot\text{s}^{-1}$ ; east/opp to original motion ✓  
 oos/teenoorg aan oospronklike beweging  
**Right not acceptable./Regs is nie aanvaarbaar nie.**

(5)

3.3

**OPTION 1/OPSIE 1**

West:+ / Wes:+

$$\begin{aligned} F_{\text{net}}\Delta t &= m\Delta v \checkmark \\ F_{\text{net}}(0,8) \checkmark &= (4000)(14 - (+10)) \checkmark \\ F_{\text{net}} &= 20000 \text{ N} \checkmark \end{aligned}$$

$F_{\text{net}} = 20000 \text{ N};$   
 west/same as original motion ✓  
 wes/dieselde as oorsp beweging

**Left is not acceptable./Links is nie aanvaarbaar nie.**

**OPTION 2/OPSIE 2**

West:- / Wes:-

$$\begin{aligned} F_{\text{net}}\Delta t &= m\Delta v \checkmark \\ F_{\text{net}}(0,8) \checkmark &= (4000)(-14 - (-10)) \checkmark \\ F_{\text{net}} &= -20000 \text{ N} \checkmark \end{aligned}$$

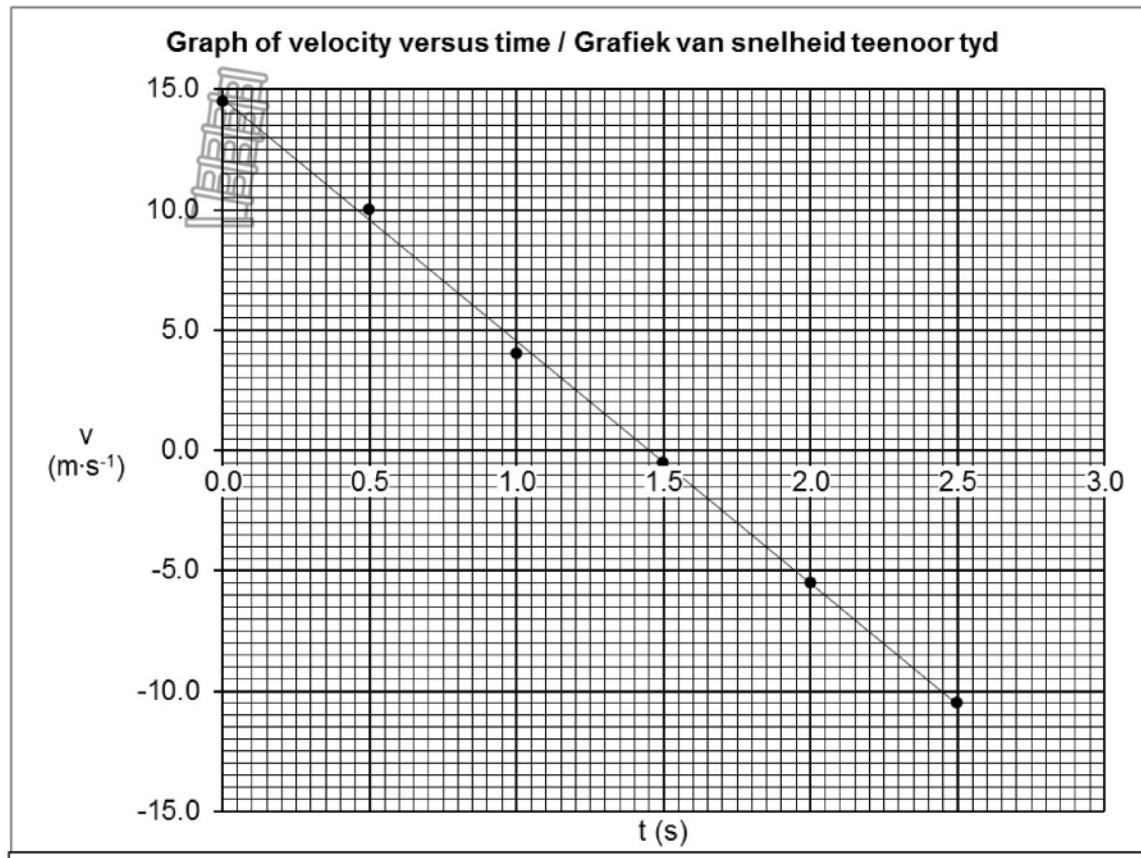
$F_{\text{net}} = 20000 \text{ N};$   
 west/same as original motion ✓  
 wes/dieselde as oorsp beweging  
**Left is not acceptable./Links is nie aanvaarbaar nie.**



(5)  
 [12]

#### QUESTION 4 / VRAAG 4

4.1.1



##### Marking criteria/Nasienriglyne

Any first point plotted correctly./Enige eerste punt korrek gestip. ✓

Any second point plotted correctly./Enige tweede punt korrek gestip. ✓

Any third and fourth points plotted correctly./Enige derde en vierde punte korrek gestip. ✓

Any fifth and sixth points plotted correctly./Enige vyfde en sesde punte korrek gestip. ✓

Best-fit line drawn./Bes-passende lyn getrek. ✓

(5)

Positive marking from the graph to Q4.1.2/Positiewe nasien vanaf grafiek na V4.1.2.

4.1.2

##### For triangle+rectangel/Vir driehoek+région

$$\begin{aligned}\Delta y &= \frac{1}{2}bh + l \times w \quad \checkmark \text{ (or similar)} \\ &= \frac{1}{2}(1)(-10) + (1)(-0.5) \\ &\quad \checkmark \quad \checkmark \\ &= -5.5 \text{ m } \checkmark\end{aligned}$$

$$\Delta y = 5.5 \text{ m; downwards / afwaarts } \checkmark$$

##### For trapezium/Vir trapesium

$$\begin{aligned}\Delta y &= \frac{1}{2}(\Sigma h)\Delta t \quad \checkmark \text{ (or similar)} \\ &= \frac{1}{2}[-0.5 + (-10.5)] \times (1) \\ &\quad \checkmark \quad \checkmark \\ &= -5.5 \text{ m } \checkmark\end{aligned}$$

$$\Delta y = 5.5 \text{ m; downwards / afwaarts } \checkmark$$

(5)

4.1.3 When the only force acting on it is the force of gravity. ✓

Wanneer die enigste krag wat daarop inwerk die gravitasiekrag is. ✓

(1)

4.2.1

**OPTION 1/OPSIE 1**

Upwards: + / Opwaarts: +

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0^2 &= 40^2 + 2(-9,8)\Delta y \end{aligned}$$

$$\checkmark \quad \checkmark$$

$$\Delta y = 81,6327 \text{ m}$$

$$\begin{aligned} \text{Height/Hoogte} &= 81,63 + 15 \checkmark \\ &= 96,63 \text{ m} \checkmark \end{aligned}$$



**OPTION 2/OPSIE 2**

Upwards: - / Opwaarts: -

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0^2 &= (-40)^2 + 2(9,8)\Delta y \end{aligned}$$

$$\checkmark \quad \checkmark$$

$$\Delta y = -81,6327 \text{ m}$$

$$\begin{aligned} \text{Height/Hoogte} &= 81,63 + 15 \checkmark \\ &= 96,63 \text{ m} \checkmark \end{aligned}$$

(5)

4.2.2

**OPTION 1/OPSIE 1**

Upwards: + / Opwaarts: +

$$\begin{aligned} v_f &= v_i + a\Delta t \checkmark \\ 0 &= 40 + (-9,8)\Delta t \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

**OPTION 2/OPSIE 2**

Upwards: - / Opwaarts: -

$$\begin{aligned} v_f &= v_i + a\Delta t \checkmark \\ 0 &= -40 + (9,8)\Delta t \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

**OPTION 3/OPSIE 3**

Upwards: + / Opwaarts: +

$$\begin{aligned} \Delta y &= \left( \frac{v_f + v_i}{2} \right) \Delta t \checkmark \\ 81,63 &= \left( \frac{0 + 40}{2} \right) \Delta t \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

$\Delta y$  from Q4.2.1

$\Delta y$  vanaf V4.2.1

**OPTION 4/OPSIE 4**

Upwards: - / Opwaarts: -

$$\begin{aligned} \Delta y &= \left( \frac{v_f + v_i}{2} \right) \Delta t \checkmark \\ -81,63 &= \left( \frac{0 + (-40)}{2} \right) \Delta t \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

**OPTION 5/OPSIE 5**

Upwards: + / Opwaarts: +

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark \\ 81,63 &= 40\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

**OPTION 6/OPSIE 6**

Upwards: - / Opwaarts: -

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark \\ -81,63 &= -40\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark \\ \Delta t &= 4,08 \text{ s} \checkmark \end{aligned}$$

(3)

4.2.3

**OPTION 1/OPSIE 1**

Upwards: + / Opwaarts: +

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ -15 &= +40\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \end{aligned}$$

**OPTION 2/OPSIE 2**

Upwards: - / Opwaarts: -

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ 15 &= -40\Delta t + \frac{1}{2}(9,8)\Delta t^2 \end{aligned}$$

(3)  
[22]



### QUESTION 5 / VRAAG 5

- 5.1.1 A non-conservative force is a force for which the work done in moving an object between two points (✓) depends on the path taken. (✓)

'n Nie-konserwatiewe krag is 'n krag waarvoor die arbeid verrig om 'n voorwerp tussen twee punte te beweeg. (✓) afhanklik is van die roete wat gevolg word. (✓) (2)

- 5.1.2 The net/total work done on an object is equal to the change in the object's kinetic energy. (✓✓)

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

Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp. (✓✓)

OF Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp. (2)

- 5.1.3

#### OPTION 1/OPSIE 1

$$\begin{aligned} W_{\text{net}} &= \Delta K \\ W_{\text{app}} + W_w &= K_f - K_i \end{aligned} \quad \boxed{\checkmark}$$

$$\frac{425}{\checkmark} + \frac{(0,20)(9,8)(29)(\cos 180^\circ)}{\checkmark} = \frac{\frac{1}{2}(0,20)v_p^2}{\checkmark} - 0$$

$$v_p = 60,68 \text{ m}\cdot\text{s}^{-1} \quad \boxed{\checkmark}$$

#### OPTION 2/OPSIE 2

$$\begin{aligned} W_{\text{nc}} &= \Delta U + \Delta K \\ W_{\text{nc}} &= U_f - U_i + K_f - K_i \end{aligned} \quad \boxed{\checkmark}$$

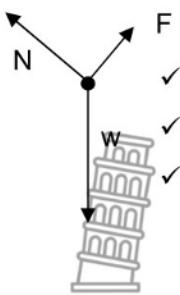
$$\frac{425}{\checkmark} = [\frac{(0,20)(9,8)(29) - 0}{\checkmark}] + [\frac{\frac{1}{2}(0,20)v_p^2 - 0}{\checkmark}]$$

$$v_p = 60,68 \text{ m}\cdot\text{s}^{-1} \quad \boxed{\checkmark}$$

(5)



5.2.1



Each arrow plus label; one mark each.  
 Components of w are not acceptable.  
 Numbers as labels are not accepted.

Elke pyl plus byskrif; een punt elk.  
 Komponente van w is nie aanvaarbaar nie.  
 Getalle as byskrifte word nie aanvaar nie.

If a force diagram is given: **Max 2/3**  
 Any extra force(s): **-1 max**

As 'n kragtediagram gegee word: **Maks 2/3**  
 Enige ekstra krag(te): **-1 maks**

|   | Acceptable symbols   | Aanvaarbare simbole   |
|---|--|---|
| N | $F_N$ / Normal / Normal force  | $F_N$ / Normaal / Normaalkrag   |
| w | $F_g$ / $F_w$ / force of Earth on object / weight / mg / gravitational force | $F_g$ / $F_w$ / krag van Aarde op voorwerp / gewig /mg / gravitasiekrag |
| F | $F_{app}$  | $F_{app}$   |

(3)

5.2.2 No ✓

Weight is not the only force doing work on the crate. ✓

Nee ✓

Gewig is nie die enigste krag wat arbeid op die krat verrig nie. ✓

(2)

5.2.3 N is perpendicular to displacement. ✓

N is loodreg op verplasing. ✓

(1)

5.2.4

**Correct alternative for  $W_w$**   
**Korrekte alternatief vir  $W_w$**

$$\begin{aligned} W_w &= -\Delta U \\ &= -[U_f - U_i] \\ &= -[(25)(9,8)(3,5\sin30^\circ) - 0] \end{aligned}$$

**Correct alternative for  $W_w$**   
**Korrekte alternatief vir  $W_w$**

$$\begin{aligned} W_w &= W_{w/\parallel} = mg\sin30^\circ \Delta x \cos 180^\circ \\ &= (25)(9,8)(\sin30^\circ)(3,5) \times \cos 180^\circ \end{aligned}$$

**OPTION 1/OPSIE 1**

$$\begin{aligned} W_{net} &= \Delta K \\ W_F + W_N + W_w &= K_f - K_i \end{aligned}$$

$$F(3,5)(\cos 0^\circ) + 0 + [(25)(9,8)(3,5\sin30^\circ) \times \cos 180^\circ] = \frac{1}{2}(25)(10,8^2) - \frac{1}{2}(25)(12^2)$$

$$F = 24,79 \text{ N} \checkmark$$

**OPTION 2/OPSIE 2**

$$\begin{aligned} W_{nc} &= \Delta U + \Delta K \\ W_F &= U_f - U_i + K_f - K_i \end{aligned}$$

$$F(3,5)(\cos 0^\circ) = [(25)(9,8)(3,5\sin30^\circ) - 0] + [\frac{1}{2}(25)(10,8^2) - \frac{1}{2}(25)(12^2)]$$

$$F = 24,79 \text{ N} \checkmark$$



(6)  
 [21]

## QUESTION 6 / VRAAG 6

- 6.1 The 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. (✓)

*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 waarin die klank voortgeplant word, het. (✓)* (2)

- 6.2 80 Hz ✓

 Dineo is stationery (✓) and hears sound with the same frequency of the source. (✓)

- 80 Hz ✓

 Dineo staan stil (✓) en hoor klank met dieselde frekwensie as die bron. (✓)

(3)

- 6.3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark$$

$$81 = \left[ \frac{340 + v_L}{340 + 0} \right] 80 \quad \checkmark$$

$$v_L = 4,25 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

(5)

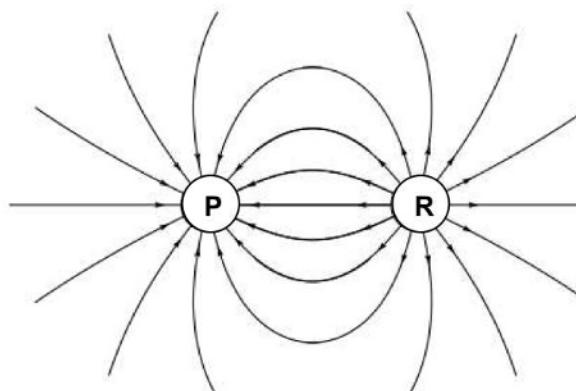
[10]

## QUESTION 7 / VRAAG 7

- 7.1 The electric field at a point is the electrostatic force (✓) experienced per unit positive charge placed at that point. (✓)

*Die elektriese veld by 'n punt is die elektrostatisiese krag (✓) wat per eenheidpositiewelading onvervind word wat by daardie punt geplaas word. (✓)* (2)

- 7.2



### Marking criteria/Nasienriglyne

Pattern ✓  
 Direction ✓  
 Field lines must touch charges at 90°. ✓

Patroon ✓  
 Rigting ✓  
 Veldlyne moet ladings teen 90° raak. ✓

The magnitudes of the two charges differ; hence the density of the field lines should differ slightly. Ignore this phenomenon when marking this question. Accept as above, as well as for different field line densities.

*Die grootte van die twee ladings verskil; dus moet die digtheid van die veldlyne effens verskil. Ignoreer hierdie verskynsel wanneer die vraag nagesien word.  
 Aanvaar soos hierbo, sowel as vir verskillende veldlyndigthede.*

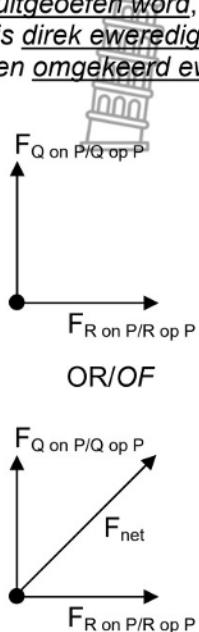
- 7.3 The magnitude of the electrostatic forces exerted by two point charges on each other (✓) is directly proportional to the product of the magnitudes of the charges (✓) and inversely proportional to the square of the distance between them. (✓)

Die grootte van die elektrostasiese kragte wat deur twee puntladings op mekaar uitgeoefen word, (✓)

is direk eweredig aan die produk van die grootte van die ladings (✓) en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (✓)

(3)

7.4



Dot represents sphere P. ✓  
 Horizontal arrow to the right and any identifiable label for  $F_{R \text{ on } P}$  ✓  
 Vertical upward arrow and any identifiable label for  $F_{Q \text{ on } P}$  ✓  
 $F_{\text{net}}$  per se carry no marks.  
 Numbers as labels are not accepted.  
 Any extra force(s) except for  $F_{\text{net}}$ : -1 max

Kol stel steer P voor. ✓  
 Horizontale pyl na regs en enige identifiseerbare byskrif vir  $F_{R \text{ op } P}$  ✓  
 Vertikaal opwaartse pyl en enige identifiseerbare byskrif vir  $F_{Q \text{ op } P}$  ✓  
 $F_{\text{net}}$  per se dra geen punte.  
 Getalle as byskrifte word nie aanvaar nie.  
 Enige ekstra krag(te), behalwe  $F_{\text{net}}$ : -1 maks

(3)

7.5

$$\begin{aligned} F_{RP} &= \frac{kQQ}{r^2} \quad \checkmark \\ &= \frac{(9 \times 10^9)(30 \times 10^{-6})(20 \times 10^{-6})}{0,07^2} \quad \checkmark \\ &= 1,102 \times 10^3 \text{ N} \end{aligned} \quad \begin{aligned} F_{QP} &= \frac{kQQ}{r^2} \\ &= \frac{(9 \times 10^9)(45 \times 10^{-6})(20 \times 10^{-6})}{0,09^2} \\ &= 1 \times 10^3 \text{ N} \end{aligned}$$

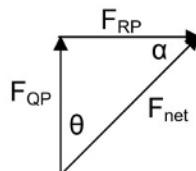
$$\begin{aligned} F_{\text{net}}^2 &= F_{RP}^2 + F_{QP}^2 \quad \checkmark \\ &= (1,102 \times 10^3)^2 + (1 \times 10^3)^2 \quad \checkmark \\ F_{\text{net}} &= 1,49 \times 10^3 \text{ N} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \theta &= \tan^{-1}(1,102 \times 10^3 / 1 \times 10^3) \quad \checkmark \\ &= 47,78^\circ \quad \checkmark \end{aligned}$$

OR/OF

If  $\alpha$  is used:

$$\begin{aligned} \alpha &= \tan^{-1}(1 \times 10^3 / 1,102 \times 10^3) \quad \checkmark \\ &= 42,22^\circ \quad \checkmark \end{aligned}$$



Accept correct trigonometry if  $F_{\text{net}}$  and  $F_{QP}$  or  $F_{\text{net}}$  and  $F_{RP}$  are used.

Aanvaar korrekte trigonometrie as  $F_{\text{net}}$  en  $F_{QP}$  of  $F_{\text{net}}$  en  $F_{RP}$  gebruik is.



(8)  
 [19]

**QUESTION 8 / VRAAG 8**

- 8.1 Power is the rate at which work is done (or energy is transferred). (✓✓)

*Drywing is die tempo waarteen arbeid verrig word (of energie oorgedra word). (✓✓) (2)*

- 8.2 The potential difference across a conductor is directly proportional to the current in the conductor (✓) at constant temperature. (✓)

*Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier (✓)  
by konstante temperatuur. (✓) (2)*



8.4

$$\begin{aligned}
 & P = I^2 R \checkmark \\
 & 36 = I^2(4) \checkmark \\
 & I = 3 A \checkmark
 \end{aligned}$$

(3)

$$\begin{aligned}
 R_{10} &= \frac{V_1}{I_{16}} \checkmark \\
 10 \checkmark &= \frac{V_1}{4 \times 3} \checkmark \checkmark \\
 V_1 &= 7,5 V \checkmark
 \end{aligned}$$

$$\begin{aligned}
 I &= I/4 \\
 I/4 &
 \end{aligned}$$

$$\begin{aligned}
 R_4 &= \frac{V_P}{I_4} \checkmark \\
 4 &= \frac{V_P}{3} \checkmark \\
 V_P &= 12 V
 \end{aligned}$$

$$\begin{aligned}
 R_{16} &= \frac{V_P}{I_{16}} \\
 16 &= \frac{12}{I_{16}} \checkmark \\
 I_{16} &= 0,75 A
 \end{aligned}$$

$$\begin{aligned}
 R_{10} &= \frac{V_1}{I_{16}} \\
 10 &= \frac{V_1}{0,75} \checkmark \\
 V_1 &= 7,5 V \checkmark
 \end{aligned}$$

$$\begin{aligned}
 R_6 &= \frac{V_6}{I_{16}} \\
 6 &= \frac{V_6}{0,75} \checkmark \\
 V_6 &= 4,5 V
 \end{aligned}$$

$$\begin{aligned}
 V_1 &= 12 - 4,5 \checkmark \\
 &= 7,5 V \checkmark
 \end{aligned}$$

8.5

$$\begin{aligned}
 R_8 &= \frac{V_2}{I_T} \\
 8 \checkmark &= \frac{V_2}{3,75} \checkmark \\
 V_2 &= 30 V \checkmark
 \end{aligned}$$

(5)

$$\begin{aligned}
 R_8 &= \frac{V_2}{I_T} \\
 8 \checkmark &= \frac{V_2}{3,75} \checkmark \\
 V_2 &= 30 V \checkmark
 \end{aligned}$$

$$\begin{aligned}
 I &+ I_{16} \\
 I + I_{16} &
 \end{aligned}$$

$$\begin{aligned}
 R_8 &= \frac{V_2}{I_T} \\
 8 \checkmark &= \frac{V_2}{3,75} \checkmark \\
 V_2 &= 30 V \checkmark
 \end{aligned}$$

8.6

$$\begin{aligned}
 R_4 &= \frac{V_P}{I_4} \\
 4 &= \frac{V_P}{3} \checkmark \\
 V_P &= 12 V
 \end{aligned}$$

(3)

$$\begin{aligned}
 V_{bat} &= V_2 + V_p \checkmark \\
 &= 30 + 12 \checkmark \\
 &= 42 V \checkmark
 \end{aligned}$$

$$\begin{aligned}
 V_{bat} &= V_2 + V_p \checkmark \\
 &= 30 + 12 \checkmark \\
 &= 42 V \checkmark
 \end{aligned}$$

$$\begin{aligned}
 V_{bat} &= V_2 + V_p \checkmark \\
 &= 30 + 12 \checkmark \\
 &= 42 V \checkmark
 \end{aligned}$$



(3)  
[18]

**Another option for Q8.4/Verdere opsie vir V8.4**

|                                    |  |
|------------------------------------|--|
| $R_4 = \frac{V_p}{I_4} \checkmark$ | $I_{16} = \frac{V_1}{R_{10}} = \frac{V_p}{R_{16}}$     |
| $4 = \frac{V_p}{3} \checkmark$     | $\frac{V_1}{10} \checkmark = \frac{12}{16} \checkmark$ |
| $V_p = 12 \text{ V}$               | $V_1 = 7,5 \text{ V} \checkmark$                       |

(5)

**Another option for Q8.6/Verdere opsie vir V8.6**

$$\begin{aligned} \frac{1}{R_p} &= \frac{1}{R_4} + \frac{1}{R_{16}} \\ &= \frac{1}{4} + \frac{1}{16} \\ R_p &= 3,2 \Omega \end{aligned}$$

$\downarrow$

$$\begin{aligned} R_T &= R_8 + R_p \\ &= 8 + 3,2 \\ &= 11,2 \Omega \end{aligned}$$

$\downarrow$

$$\begin{aligned} R_T &= \frac{V_{\text{bat}}}{I_T} \checkmark \\ 11,2 &= \frac{V_{\text{bat}}}{3,75} \end{aligned}$$

$\downarrow$

I from/van 8.3 + I/4

$\downarrow$

$$V_{\text{bat}} = 42 \text{ V} \checkmark$$

(3)

**GRAND TOTAL/GROOTTOTAAL: 150**