

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

JUNE 2022

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours



This question paper consists of 17 pages including a 2-page data sheet.

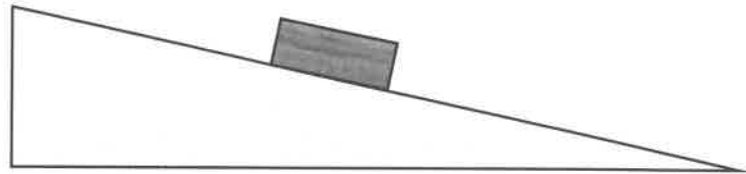
INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. You are advised to use the attached DATA SHEETS.
7. The formulae and substitutions must be shown in ALL calculations.
8. Give brief motivations, discussions, et cetera where required.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Start EACH question on a NEW page.
11. All diagrams are not necessarily drawn according to scale.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write ONLY the letter (A–D) next to the question numbers (1.1–1.10) in the ANSWER BOOK, for example 1.11 B.

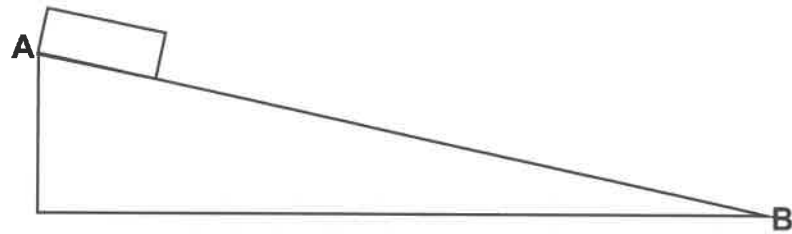
- 1.1 A wooden crate rests on an inclined plane as shown in the diagram below. Which ONE of the following formulae is the CORRECT expression regarding the forces acting on the block?



- A $F_f = F_{\text{applied}}$
- B $F_N = F_{//}$
- C $F_N = F_{\perp}$
- D $F_{\perp} = F_{//}$

(2)

- 1.2 A glass block moves from point A to point B on a frictionless inclined surface as shown in the diagram below. Which ONE of the following statements is TRUE for the TOTAL Mechanical Energy (E_{mech}) and Kinetic Energy (E_k) as the block moves from point A to point B?



	TOTAL MECHANICAL ENERGY E_{mech}	Kinetic Energy E_k
A	$E_{\text{mech}}(A) = E_{\text{mech}}(B)$	$E_k(A) = E_k(B)$
B	$E_{\text{mech}}(A) < E_{\text{mech}}(B)$	$E_k(A) < E_k(B)$
C	$E_{\text{mech}}(A) = E_{\text{mech}}(B)$	$E_k(A) < E_k(B)$
D	$E_{\text{mech}}(A) > E_{\text{mech}}(B)$	$E_k(A) > E_k(B)$

(2)

- 1.3 A physical quantity that is described as a measure of the resistance of a body to a change in its state of motion is the ...

- A acceleration.
- B inertia.
- C Newton's Second Law of Motion.
- D Newton's Third Law of Motion.

(2)

1.4 An object is thrown vertically upwards.

Which ONE of the following statements is TRUE concerning the acceleration and velocity of the object when it reaches its maximum height?

	Acceleration	Velocity
A	$9,8 \text{ m.s}^{-2}$ downwards	$9,8 \text{ m.s}^{-1}$ downwards
B	0 m.s^{-2}	$9,8 \text{ m.s}^{-1}$ downwards
C	0 m.s^{-2}	0 m.s^{-1}
D	$9,8 \text{ m.s}^{-2}$ downwards	0 m.s^{-1}

(2)

1.5 A ball rolls from point **A** to **D** as shown in the diagram below. The sections **AB** and **CD** are frictionless, while **BC** is rough. Which ONE of the following statements is TRUE?



- A The total mechanical energy changes when the ball rolls from B to C.
 B The ball has the same kinetic energy at A and C.
 C The total mechanical energy of the ball decreases from C to D.
 D Kinetic energy is conserved during the complete motion from A to D.

(2)

1.6 Two objects of masses **P** and **Q** respectively, are placed such that their centres are a distance **R** apart. The force they exert on each other is **F**.

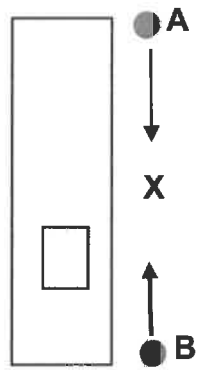


When the mass of **P** is halved ($\frac{1}{2} \text{ P}$) and the distance between their centres is doubled to 2R . The new force they exert on each other will be ...

- A $\frac{1}{2} \text{ F}$.
 B $\frac{1}{4} \text{ F}$.
 C $\frac{1}{8} \text{ F}$.
 D 4 F .

(2)

- 1.7 Ball **A** is dropped from the top of a building. Ball **B** is thrown upwards from the ground 1 s later. They move past each other at point **X**. Ignore the effects of air resistance.



Which ONE of the following statements is TRUE when the two balls meet at point **X**?

- A the distance travelled by each ball will be equal.
- B the sum of the distance travelled by **A** and **B** will be equal to the height of the building.
- C ball **B** will not reach the top of the building.
- D the time ball **A** takes to reach point **X** is less than the time for ball **B** to reach point **X**.

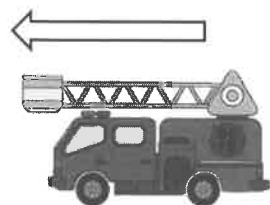
(2)

- 1.8 Which ONE of the following physical quantities below can be measured in the base unit $\text{kg}\cdot\text{m}^2\cdot\text{s}^{-2}$?

- A Kinetic energy
- B Acceleration
- C Velocity
- D Momentum

(2)

- 1.9 A fire engine moves towards a building that is on fire. The siren of the fire engine has a frequency f . The frequency that the firemen in the fire engine will hear as they travel towards the burning building will be ...



- A $3f$.
- B $2f$.
- C f .
- D $\frac{1}{2}f$.

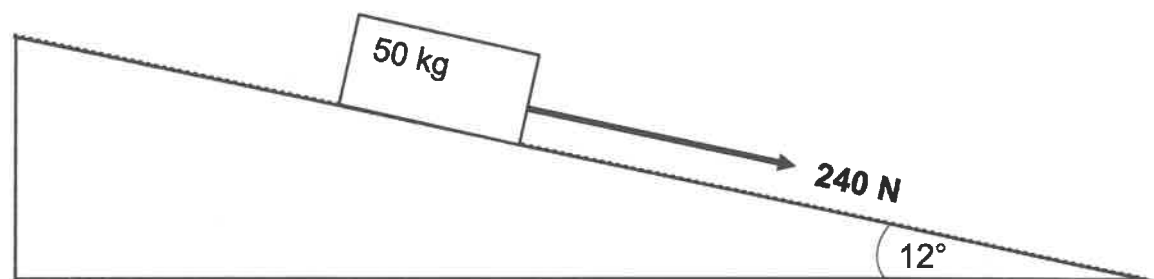
(2)

- 1.10 Two identical conducting spheres **P** with a charge of $+3,2 \times 10^{-19} \text{ C}$ and **Q**, with a charge of $-6,4 \times 10^{-19} \text{ C}$, are brought into contact. During contact, sphere **P** will ...
- A. gain 2 electrons.
 - B. gain 3 electrons.
 - C. lose 3 electrons.
 - D. lose 3 protons.

(2)
[20]

QUESTION 2

A rope is used to apply a force of 240 N to a 50 kg crate to pull it down a rough inclined surface at a **CONSTANT VELOCITY**. The incline surface makes an angle of 12° with the horizontal as shown in the diagram below.



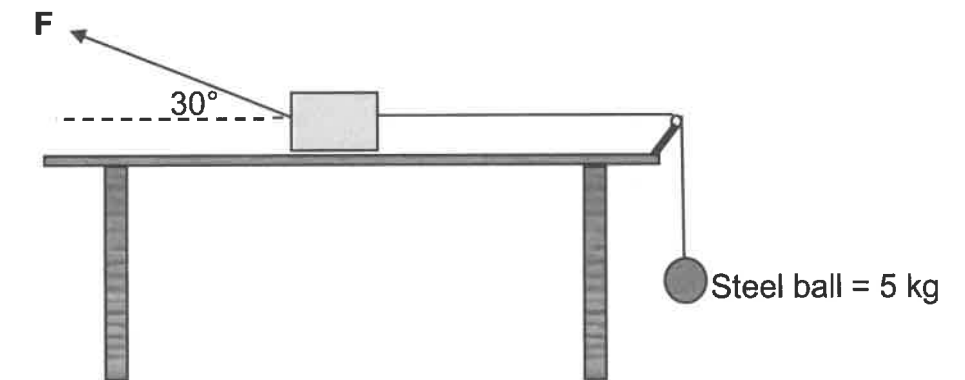
- 2.1 State Newton's Second Law of Motion in words. (2)
- 2.2 Draw a labelled free-body diagram of all the forces acting on the crate. (4)
- 2.3 Define the term *kinetic frictional force*. (2)
- 2.4 Calculate the:
 - 2.4.1 Magnitude of the kinetic frictional force between the crate and the surface of the inclined surface (4)
 - 2.4.2 Value of the coefficient of kinetic frictional force (μ_k) between the crate and the surface of the inclined surface (4)

[16]

QUESTION 3

A metal box is connected to a steel ball of mass 5 kg by means of a light, inextensible string that passes over a frictionless pulley as shown in the diagram below. A force **F** is applied at an angle of 30° to the horizontal to the metal box. The force **F** is gradually increased and just before **F** becomes equal to 65 N, *the system just starts to move*.

The normal force that the table exerts on the metal box is **36,1 N**.

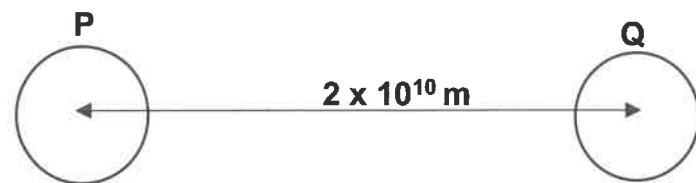


- 3.1 Give the name of the frictional force explained by the term *just before the metal box starts moving*. (1)
- 3.2 Draw a free body diagram of ALL the forces acting on the metal box. (5)
- 3.3 Calculate the:
- 3.3.1 Magnitude of the force mentioned in QUESTION 3.1 (5)
- 3.3.2 Mass of the metal box (4)

[15]

QUESTION 4

Two small, spherical planets P and Q of mass $1,2 \times 10^{18}$ kg and 3×10^{18} kg respectively move in space with their centres 2×10^{10} m apart, as shown in the diagram below. Assume no other forces act on the planets.



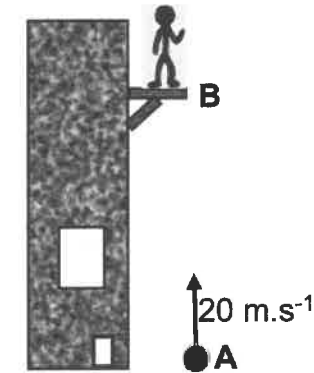
- 4.1 State *Newton's Universal Law of Gravitation* in words. (2)
- 4.2 Calculate the gravitational force between the two planets. (5)
- 4.3 The radii of the planets are equal. How will the acceleration due to gravity on the surface of planet **P** (g_P) compare with the acceleration due to gravity on the surface of planet **Q** (g_Q)?

Write only **GREATER THAN**, **LESS THAN** or **SIMILAR**. Briefly explain your answer. (2)

[9]

QUESTION 5

A cricket ball is projected upwards from the bottom of a building at point **A** at a velocity of $20 \text{ m}\cdot\text{s}^{-1}$. It reaches a maximum height above the building and returns to point **B** as shown in diagram below. A man standing on a balcony of the building at point **B** catches the ball $1,66 \text{ s}$ after it had reached its maximum height. Ignore the effect of air resistance.

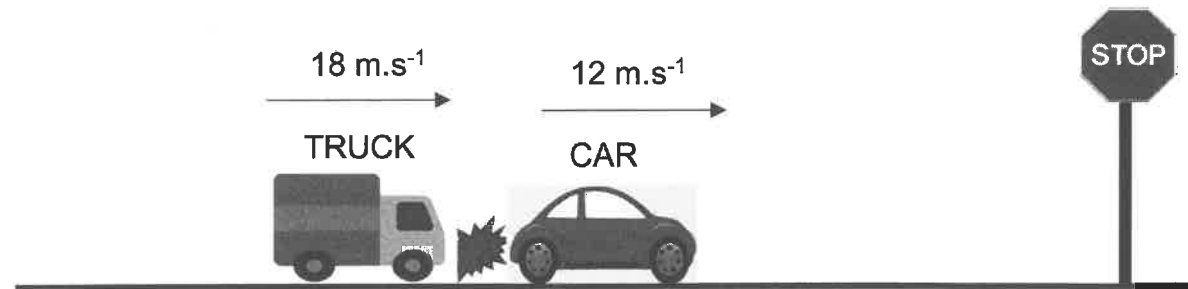


- 5.1 Define the term *free fall*. (2)
- 5.2 Calculate the:
- 5.2.1 Time it took the cricket ball to reach its maximum height (4)
- 5.2.2 Height of the balcony above the ground (5)
- 5.2.3 Speed with which the ball strikes the man's hand when he catches it (3)
- 5.3 Draw a sketch velocity-time graph for the motion of the cricket ball from the moment that it was projected until the man catches the ball at point **B**.
- Indicate the following clearly on your graph:
- Initial velocity of the ball.
 - Time when the ball is at the maximum height.
 - Time when the man catches the ball.
 - Velocity of the ball just before the man catches it. (5)

[19]

QUESTION 6

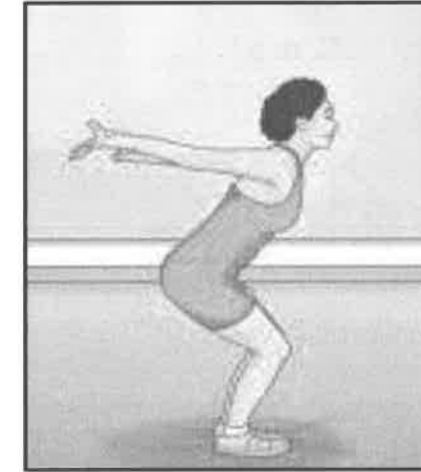
A truck of mass 3 200 kg travelling at a velocity of $18 \text{ m}\cdot\text{s}^{-1}$ to the east, collides with a car of mass 1 800 kg travelling at a velocity of $12 \text{ m}\cdot\text{s}^{-1}$ in the same direction, as shown in the diagram below. After the collision, the truck continues to move in the same direction at velocity of $10 \text{ m}\cdot\text{s}^{-1}$.



- 6.1 Define the term *momentum* in words. (2)
 - 6.2 Calculate the:
 - 6.2.1 Momentum of the truck before the collision (3)
 - 6.2.2 Velocity of the car after the collision (5)
 - 6.3 Is the collision between the truck and the car elastic or inelastic? Explain your answer. (3)
 - 6.4 Name TWO safety features that can be found in vehicles so that serious injuries can be minimised when collisions like this take place. (2)
- [15]**

QUESTION 7

During a gymnastic routine at the Olympic Games, a gymnast jumps in the air and lands vertically as shown in the diagram below. The mass of the gymnast is 45 kg. From her maximum height it takes 0,35 s before she lands on a mat. She bends her knees while landing. After landing on the mat it took her 0,69 s to come to a complete stop.

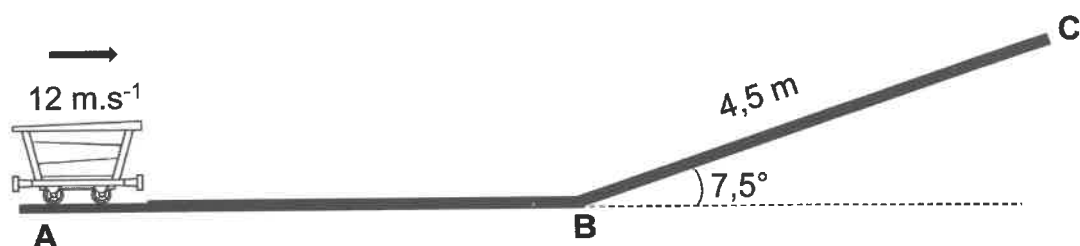


- 7.1 Calculate the velocity with which the gymnast lands on the mat. (4)
- 7.2 Define the term *impulse* in words. (2)
- 7.3 Calculate the force of the mat on the gymnast after she has landed on it. (5)
- 7.4 Using your answer in QUESTION 7.3, explain why it is necessary for the gymnast to bend her knees on landing to avoid serious injury. (3)

[14]

QUESTION 8

A mining trolley of mass 540 kg moving to the right, approaches point **A** with a velocity of $12 \text{ m}\cdot\text{s}^{-1}$ and comes to rest at point **C**. **AB** is rough while **BC** is frictionless. The coefficient of kinetic friction between the trolley and the rough surface **AB** is 0,8. **BC** is 4,5 m long and makes an angle of $7,5^\circ$ with the horizontal as shown in the diagram below.

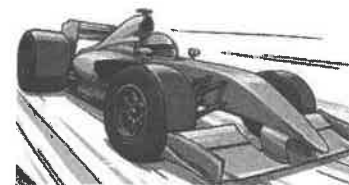


- 8.1 State the Principle of CONSERVATION OF MECHANICAL ENERGY in words. (2)
- 8.2 Use the PRINCIPLE OF CONSERVATION OF MECHANICAL ENERGY to calculate the velocity of the trolley at point **B**. (4)
- 8.3 Calculate the kinetic frictional force between the trolley and the rough surface **AB** in the diagram above. (3)
- 8.4 State the *work-energy theorem* in words. (2)
- 8.5 Use energy principles ONLY to calculate the ...
- 8.5.1 work done by friction as the trolley moves from point **A** to point **B**. (4)
- 8.5.2 distance from point **A** to point **B**. (4)

[19]

QUESTION 9

A racing car races towards a video camera as shown in the diagram below. The frequency that the engine of the racing car produces is 680 Hz. The video camera records the sound at a frequency of 875 Hz. Take the speed of sound to be $340 \text{ m}\cdot\text{s}^{-1}$.



- 9.1 State the phenomenon that causes this apparent change in frequency. (2)
- 9.2 Calculate the velocity of the racing car as it approaches the video camera. Give your answer in $\text{km}\cdot\text{h}^{-1}$. (6)
- 9.4 The racing car passes the video camera and travels further away. How does the frequency change as it travels away? Write only INCREASES, DECREASES or STAYS THE SAME. Briefly explain your answer. (3)
- 9.5 State TWO uses of the phenomenon stated in QUESTION 9.1 in the medical field. (2)

[13]

QUESTION 10

Two identical opposite point charges **A** and **B** each carry a charge of magnitude $4 \times 10^{-6} \text{ C}$ and are placed 75 cm from each other in a vacuum as shown in the diagram below.



10.1 Draw the electric field pattern between charges **A** and **B**. (3)

10.2 Calculate the:

10.2.1 Force on charge **A** due to charge **B** (4)

10.2.2 Number of excess electrons on charge **B** (3)

[10]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESTE WETENSAPPE GRAAD 12

VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/ SIMBOOL	VALUE/WAARDE
Acceleration due to gravity / <i>Swaartekragversnelling</i>	g	9,8 m•s ⁻²
Universal gravitational constant / <i>Universelegravitasiekonstant</i>	G	6,67 × 10 ⁻¹¹ N•m ² •kg ⁻²
Speed of light in a vacuum / <i>Spoed van lig in 'n vacuum</i>	c	3,0 × 10 ⁸ m•s ⁻¹
Planck's constant / <i>Planck se konstante</i>	h	6,63 × 10 ⁻³⁴ J•s
Coulomb's constant / <i>Coulomb se konstante</i>	k	9,0 × 10 ⁹ N•m ² •C ⁻²
Charge on electron / <i>Lading op elektron</i>	e	-1,6 × 10 ⁻¹⁹ C
Electron mass / <i>Elektronmassa</i>	m _e	9,11 × 10 ⁻³¹ kg
Mass of earth / <i>Massa op aarde</i>	M	5,98 × 10 ²⁴ kg
Radius of earth / <i>Radius van aarde</i>	R _E	6,38 × 10 ³ km

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

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{G m_1 m_2}{d^2}$	$g = G \frac{M}{d^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F\Delta x \cos\theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2}mv^2$ or/of $E_k = \frac{1}{2}mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$P_{\text{av}} = Fv$	$P = \frac{W}{\Delta t}$

ELECTROSTATICS/ELEKTROSTATIKA

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

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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

ALTERNATING CURRENT/WISSELSTROOM

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

