



SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE  
SUID-AFRIKAANSE KOMPREENSIEWE ASSESSERINGSINSTITUUT

# PHYSICAL SCIENCES

2021

GRADE 12 PRELIMINARY EXAMINATION

PAPER 1

**TOTAL:** 150

**TIME:** 3 hours

This question paper consists of 17 pages.

**PHYSICAL SCIENCES****TOTAL: 150****TIME: 3 HOURS**

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**INSTRUCTIONS AND INFORMATION**

1. This paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this paper.
4. Leave ONE line between two subsections, e.g. between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions etc. where required.
10. You are advised to use the attached INFORMATION SHEETS (see page 16-17).
11. Write neatly and legibly.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E. Each question only has ONE correct answer.

1.1 Consider the following forces:

- i frictional force
- ii gravitational force
- iii air resistance
- iv electrostatic force

Which one of the following combinations represent conservative forces?

- A i, ii and iv
- B ii and iii
- C ii and iv
- D i, ii and iii (2)

1.2 Which one of the following options will NOT increase the speed of an electric motor?

- A A stronger magnetic field
- B Increased current in the coil
- C Increase the amount of carbon brushes
- D Increase the number of windings (2)

1.3 Airbags and safety belts in cars are necessary for the safety of passengers and decrease the chances of serious injuries during accidents because it...

- A increases the passenger's change in momentum.
- B halts the passenger in a shorter time.
- C decreases the passenger's change in momentum.
- D decreases the net force on the passenger because of an increase in contact time. (2)

- 1.4 An ambulance approaches Sheldon as he is standing beside the road. As the ambulance drives away from him, the pitch and wavelength of the siren that he hears, will undergo the following changes...

	Pitch	Wavelength
A	Higher	Shorter
B	Higher	Greater
C	Lower	Shorter
D	Lower	Greater

(2)

- 1.5 An absorption spectrum of an element forms because of atoms in the element that..

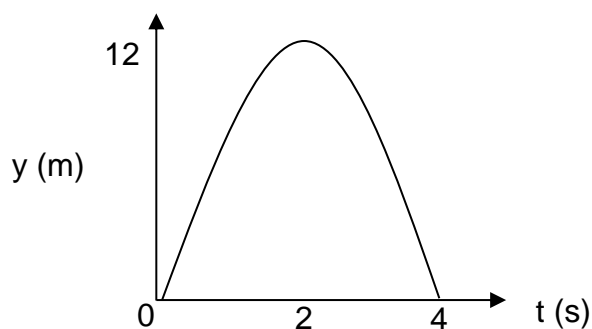
- A emits light photons and the atom's electrons making a transition from high energy state to low energy state.
- B emits light photons and the atom's electrons making a transition from low energy state to high energy state.
- C absorbs light photons and the atom's electrons making a transition from high energy state to low energy state.
- D absorbs light photons and the atom's electrons making a transition from low energy state to high energy state. (2)

- 1.6 Two objects with the same mass,  $m$ , with a certain distance,  $d$ , between them, exerts a force  $F$  on each other. If the mass of one of the objects doubles to  $2m$  and the distance stays the same, the force between the objects will be...

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

(2)

1.7 A position-time graph for a free-falling object is given below.



Which one of the following statements is NOT true?

- A It takes 2 seconds for the object to reach its maximum height.
- B The velocity of the object after 2 seconds is  $0 \text{ m}\cdot\text{s}^{-1}$ .
- C Between 2 seconds and 4 seconds, the velocity of the object decreases.
- D The object's acceleration does not change. (2)

1.8 Two athletes, Lyza and Elly, are both stationary at the start of a race, and both finish the race with the same velocity. Lyza's mass is twice that of Elly's mass. Lyza's change in momentum relative to Elly's change in momentum is...

- A twice as much
- B equal to
- C four times as much
- D half of (2)

1.9 Two spheres,  $Q_1$  and  $Q_2$ , exert an electrostatic force,  $F$ , onto each other. Which one of the following explains a decrease in the magnitude of  $F$ ?

- A An increase in the distance between the spheres.
- B  $Q_1$  and  $Q_2$  switching places.
- C A decrease in the distance between the spheres.
- D An increase in the product of the charges of  $Q_1$  and  $Q_2$ . (2)

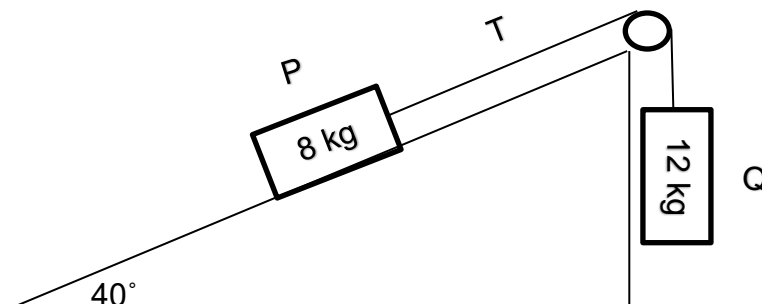
1.10 Three light bulbs are connected in series in a circuit. The light bulbs are marked 12 V;3 W. The effective resistance produced by a single light bulb in the circuit is...

- A 4  $\Omega$
- B 48  $\Omega$
- C 144  $\Omega$
- D 0,75  $\Omega$

(2)  
**[20]**

**QUESTION 2**

Block **P**, with a mass of 8 kg, is connected to block **Q**, with a mass of 12 kg, with a light, inextensible string, **T**, which passes over a frictionless pulley. Block **P** is on a rough plane inclined at an angle of  $40^\circ$  to the horizontal as shown in the diagram below.



The coefficient of kinetic friction between block **P** and the inclined plane is 0.24.

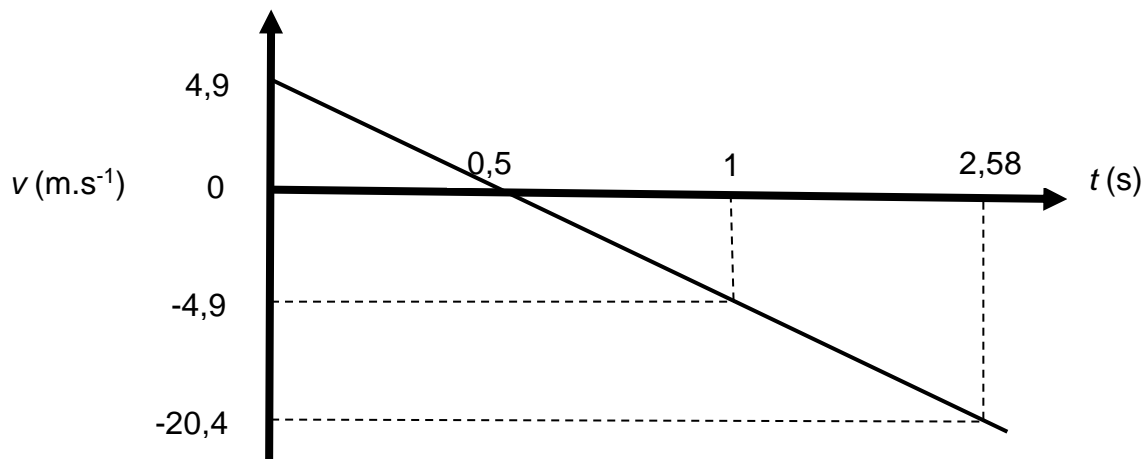
- 2.1 State *Newton's Second Law* in words. (2)
- 2.2 Draw a labelled free-body diagram for block **P**. (4)
- 2.3 Calculate the kinetic frictional force on block **P** as it is moving upward on the inclined plane. (3)
- 2.4 Calculate the tension in the string, **T**, which connects block **P** and **Q**. (7)

**[16]**

**QUESTION 3**

Tony throws a stone vertically upwards from the top of a building. The stone hits the ground beneath the building after 2,58 seconds.

The velocity-time graph below shows the movement of the stone. Ignore the effects of friction.



- 3.1 Define the term *projectile*. (2)
- 3.2 Determine the acceleration of the stone without any calculations. (2)
- 3.3 Use the graph to calculate the maximum height that the stone reaches relative to the top of the building. Equations of motion may NOT be used to calculate the answer. (3)
- 3.4 Calculate the height of the building. (4)
- 3.5 Sketch the corresponding position versus time graph for the stone while it is free-falling. Use the top of the building as reference. (3)

**[14]**



**QUESTION 4**

Amelia, with a mass of 53 kg, and Jean-Pierre, with a mass of 68 kg, are participating in a figure skating contest. Jean-Pierre is skating forward at a velocity of  $7 \text{ m}\cdot\text{s}^{-1}$  and Amelia is skating in the opposite direction at a velocity of  $5 \text{ m}\cdot\text{s}^{-1}$ , right before he picks her up, and they skate forward together.

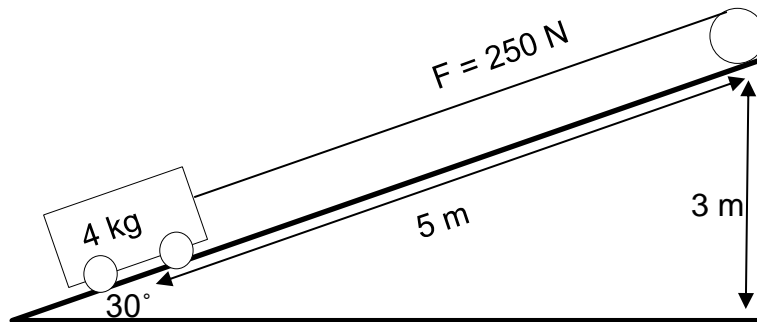
Ignore the effects of friction and the rotational effects of the skates.



- 4.1 State the *Principle of Conservation of Linear Momentum*. (2)
- 4.2 Calculate the combined velocity of Jean-Pierre and Amelia as he picks her up, and they skate forward together. (5)
- 4.3 When Jean-Pierre puts Amelia down, and she lands on the ice, Amelia bends her knees.
- 4.3.1 Because of this action, the force that Amelia experiences when she lands will...  
Choose from INCREASE, DECREASE or STAYS THE SAME. (1)
- 4.3.2 Explain your answer to QUESTION 4.3.1. (2)
- [10]**

## QUESTION 5

A trolley with a mass of 4 kg gets pulled up a rough, 5 m long incline to a height of 3 m as shown in the diagram below. The tension in the cable pulling the trolley, is 250 N. It takes 1,3 seconds for the trolley to reach the top.



- 5.1 Define *non-conservative* forces. (2)
- 5.2 Calculate the work done by the cable as it pulls the trolley up. (3)
- 5.3 Calculate the power generated by the cable as it pulls the trolley up. (3)

The trolley stops when it reaches the top of the incline, but the cable breaks and the trolley starts to accelerate downwards. The trolley has a velocity of  $9 \text{ m}\cdot\text{s}^{-1}$  when it reaches the bottom of the incline.

- 5.4 Using **energy principles**, calculate the magnitude of the work done by friction. (5)

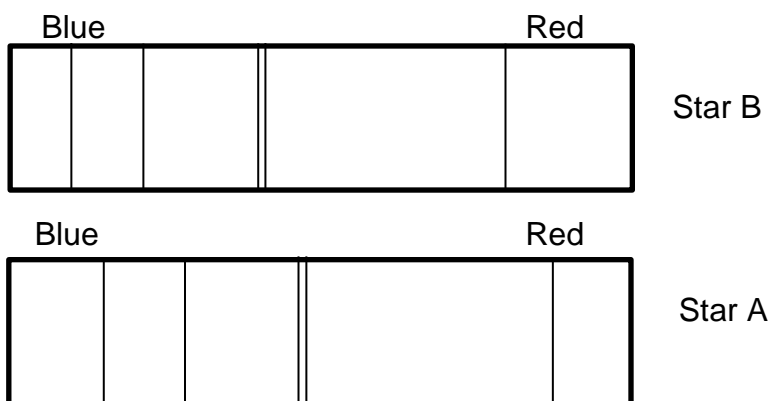
[13]

**QUESTION 6**

An ice cream truck playing a tune, approaches a stationary listener in the street. The ice cream truck is moving at a velocity of  $11 \text{ m}\cdot\text{s}^{-1}$  and the sound waves emitted by the tune, has a wavelength of  $0,34 \text{ m}$ . Take the speed of sound in air as  $340 \text{ m}\cdot\text{s}^{-1}$ .



- 6.1 State the *Doppler-effect* in words. (2)
- 6.2 Calculate the frequency produced by the ice cream truck's tune. (3)
- 6.3 Calculate the frequency as it is heard by the stationary listener. (5)
- 6.4 How will the frequency that the listener hears compare to the frequency calculated in QUESTION 6.3 when the ice cream truck moves away from the listener? Choose from INCREASE, DECREASE or STAY THE SAME. (1)
- 6.5 State any other application of the Doppler-effect in our daily lives. (1)
- 6.6 Consider the representation of the absorption spectrums of two similar stars below. Star **A** is stationary. (1)



- 6.6.1 Is star **B** moving towards star **A** or away from star **A**? Explain your answer. (2)
- 6.6.2 What is this type of shift mentioned in QUESTION 6.6.1 called? (1)

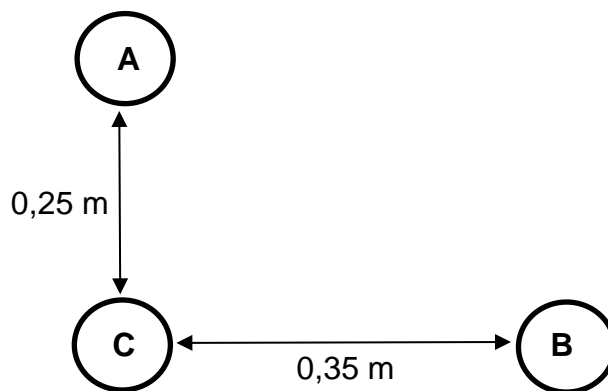
**[15]**

**QUESTION 7**

Two charged spheres, **A** and **B**, with charges of  $+2 \times 10^{-6} \text{ C}$  and  $-8 \times 10^{-5} \text{ C}$  respectively, are allowed to touch.

7.1 Calculate the magnitude of the charge on spheres **A** and **B** after they touched. (2)

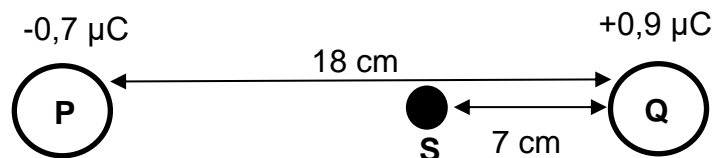
A third sphere, **C**, with a charge of  $+4,2 \times 10^{-5} \text{ C}$ , along with spheres **A** and **B** are placed as shown in the diagram below.



7.2 State *Coulomb's Law* in words. (2)

7.3 Calculate the magnitude of the net electrostatic force exerted on sphere **C**. (5)

Two charged spheres, **P** and **Q**, with charges of  $-0,7 \mu\text{C}$  and  $+0,9 \mu\text{C}$  respectively, are placed 18 cm apart in a straight line as shown in the diagram below. Point **S** is located 7 cm to the left of sphere **Q**.



7.4 Draw a diagram to show the electric field pattern around sphere **P**. (2)

7.5 Calculate the magnitude of the net electric field at point **S**. (5)

**[16]**

**QUESTION 8**

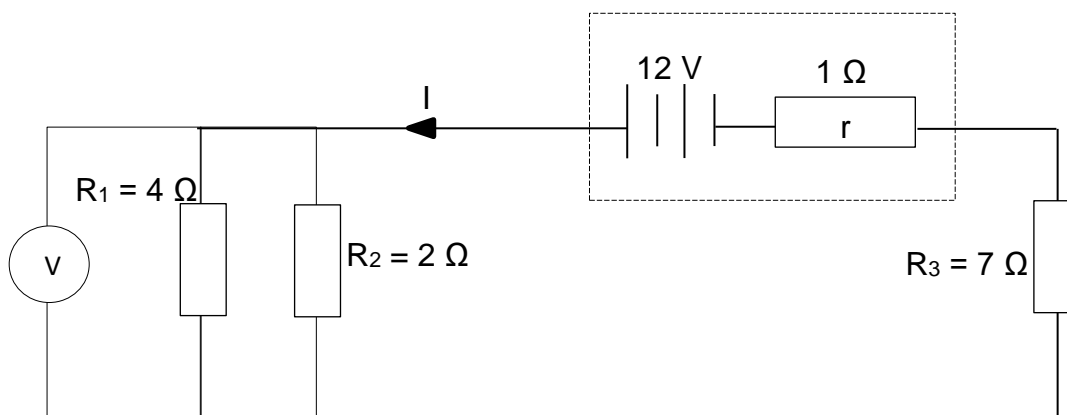
A group of learners are conducting an experiment to investigate the validity of Ohm's Law. The learners want to determine how a change in current will influence the potential difference of the circuit. The learners connect a single rheostat into the circuit since a decrease in the total resistance of the circuit, will cause an increase of the current in the circuit. The learners noted the following results:

<b>Current (A)</b>	0,5	1	2	3	4
<b>Potential difference (V)</b>	1,6	3,3	6,7	10,2	13,2

- 8.1 State *Ohm's Law* in words. (2)
- 8.2 State a hypothesis for this investigation. (2)
- 8.3 For this investigation, write down the...
- 8.3.1 Dependant variable (1)
- 8.3.2 Independent variable (1)
- 8.3.3 Constant variable (1)
- 8.4 Draw a graph to show the results in the table. (4)
- 8.5 If the learners did not have a rheostat, how could they manipulate the composition of the circuit in such a way that an increase in current would still be observed? Explain your answer. (3)

A battery with an emf of 12 V and an internal resistance of 1  $\Omega$  are connected to three resistors and a voltmeter as shown in the diagram below.

The resistance of the connection cable can be ignored.

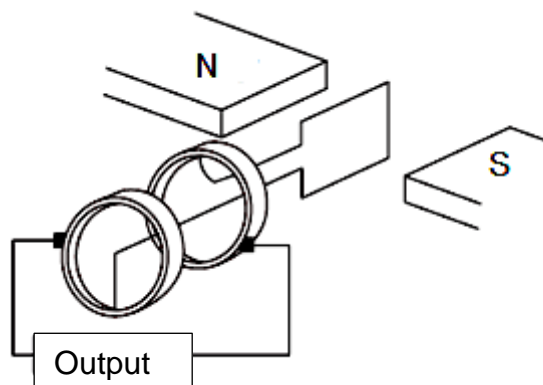


- 8.6 Calculate the current  $I$  in the circuit. (6)

**[20]**

**QUESTION 9**

A simplified diagram of a generator is shown below.



- 9.1 Is the generator in the diagram an alternating current or a direct current generator? Explain your answer. (2)
- 9.2 State the energy conversion in this generator. (2)
- 9.3 Sketch a simple graph to show how the induced emf in the generator changes over time. (2)

An electrical appliance with a resistance of  $35,6 \Omega$  is connected to a 220 V plug.

- 9.4 Calculate the electrical energy used by the appliance per second. (4)
- 9.5 Calculate the maximum current through the appliance. (3)

**[13]**

**QUESTION 10**

Study the table below which shows different colours of light and the frequencies they emit.

Colour light	Frequency (Hz)
Red	$4,3 \times 10^{14}$
Yellow	$5,0 \times 10^{14}$
Green	$5,6 \times 10^{14}$
Blue	$6,6 \times 10^{14}$

- 10.1 Define the term *threshold frequency*. (2)
- 10.2 A photon has an energy of  $3,72 \times 10^{-19}$  J. Use calculations to determine to what colour of light this photon belongs. (3)
- 10.3 The metal caesium has a work function of  $3,32 \times 10^{-19}$  J. Which colour of light will NOT release electrons from the surface of this metal? (4)
- 10.4 Explain what effect an increase in the intensity of the light mentioned in QUESTION 10.3, will have on the release of photoelectrons from the surface of the caesium. (1)
- 10.5 Calculate the maximum kinetic energy of the photoelectrons released from the caesium surface when it is exposed to ultraviolet light with a frequency of  $1,1 \times 10^{15}$  Hz (3)

**[13]****GRAND TOTAL: [150]**

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

**TABLE 1: PHYSICAL CONSTANTS**

NAME	SYMBOL	VALUE
Acceleration due to gravity	$g$	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant	$G$	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth	$R_E$	$6,38 \times 10^6 \text{ m}$
Mass of the Earth	$M_E$	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum	$c$	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant	$h$	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant	$k$	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron	$e$	$-1,6 \times 10^{-19} \text{ C}$
Electron mass	$m_e$	$9,11 \times 10^{-31} \text{ kg}$

**TABLE 2: FORMULAE****MOTION**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left( \frac{v_i + v_f}{2} \right) \Delta t$ or $\Delta y = \left( \frac{v_i + v_f}{2} \right) \Delta t$

**FORCE**

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

**WORK, ENERGY AND POWER**

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

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ or $E = W_o + K_{max}$ where $E = hf$ and $W_o = hf_o$ and $E_{k(max)} = \frac{1}{2}mv_{max}^2$ orf $K_{max} = \frac{1}{2}mv_{max}^2$	

**ELECTROSTATICS**

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

**ELECTRIC CIRCUITS**

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

**ALTERNATING CURRENT**

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