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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2011

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 TWO sections:

SECTION A (25)
SECTION B (125)
3. Answer ALL the questions in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. Number the answers correctly according to the numbering system used in this question paper.
7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
8. Give brief motivations, discussions, et cetera where required.

SECTION A**QUESTION 1: ONE-WORD ITEMS**

Give ONE word/term for EACH of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

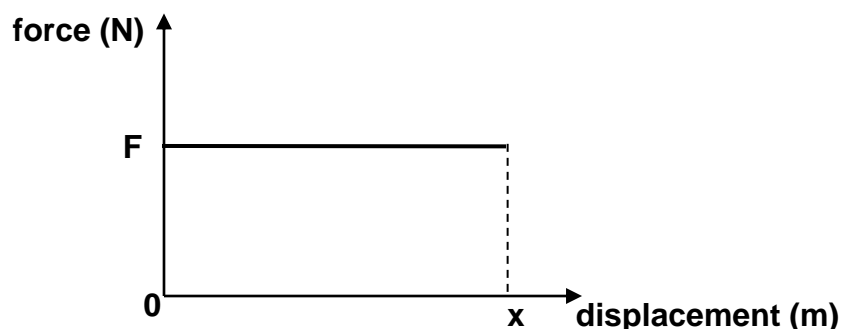
- 1.1 The product of the mass and velocity of a body (1)
- 1.2 The term used to describe two sources that emit waves which maintain a constant phase relation with each other (1)
- 1.3 The type of spectrum formed when light is passed through a cold gas at low pressure (1)
- 1.4 The property of a conductor given by the ratio of the applied potential difference to the current through the conductor (1)
- 1.5 The 'packets of energy' (quanta) of which light consists (1)
- [5]**

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

- 2.1 Which ONE of the following physical quantities represents the RATE OF CHANGE OF MOMENTUM of an object?
- A Force
- B Kinetic energy
- C Impulse
- D Acceleration (2)
- 2.2 The kinetic energy of a car moving at constant velocity \mathbf{v} is K . The velocity of the car changes to $2\mathbf{v}$. What is the new kinetic energy of the car?
- A $\frac{1}{4}K$
- B $\frac{1}{2}K$
- C $2K$
- D $4K$ (2)

- 2.3 The graph below represents a constant force F acting on an object over a displacement x . The force and displacement are in the same direction.



Which ONE of the following statements can be deduced from the graph?

- A The gradient of the graph represents the work done by the force.
- B The gradient of the graph represents the change in kinetic energy of the object.
- C The area under the graph represents the net work done by the force.
- D The area under the graph represents the power dissipated by the force. (2)

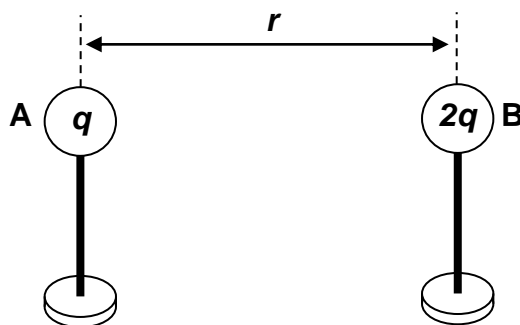
- 2.4 Which ONE of the following is the main principle applied when measuring the rate of blood flow or the heartbeat of a foetus in the womb?

- A Doppler effect
- B Photoelectric effect
- C Huygens' principle
- D Diffraction (2)

- 2.5 The pattern observed in single-slit diffraction is best explained by ...

- A reflection.
- B Huygens' principle.
- C scattering.
- D refraction. (2)

- 2.6 The sketch below shows two small metal spheres, A and B, on insulated stands carrying charges of magnitude q and $2q$ respectively. The distance between the centres of the two spheres is r .



Sphere A exerts a force of magnitude F on sphere B. What is the magnitude of the force that sphere B exerts on sphere A?

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

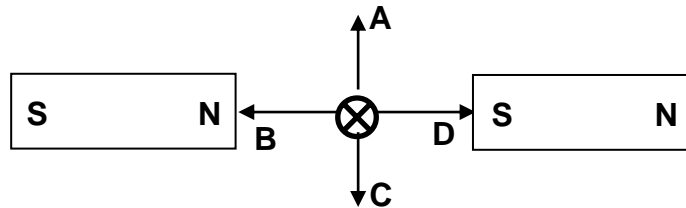
- 2.7 Which ONE of the following is the unit of measurement for the rate of flow of charge?

- A watt
 - B coulomb
 - C volt
 - D ampere
- (2)

- 2.8 Which ONE of the following changes to the design of an AC generator will increase its maximum emf?

- A Change the polarity of the magnets
 - B Use larger slip rings
 - C Use larger brushes
 - D Increase the number of turns on the coil
- (2)

- 2.9 The cross (\otimes) in the diagram below represents a conductor carrying conventional current INTO THE PAGE in the uniform field between the two bar magnets. The conductor is placed between the north (N) pole and south (S) pole of the magnets, as shown.

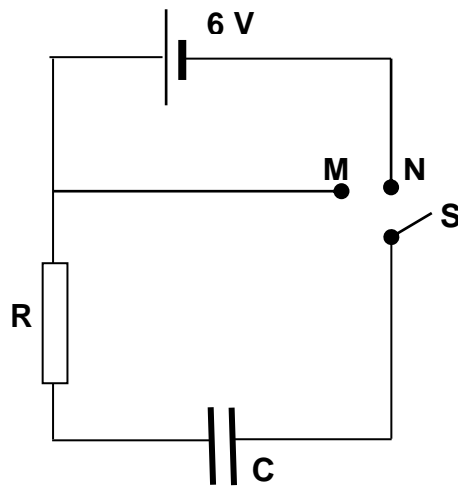


In which ONE of the directions **A**, **B**, **C** or **D** (all lying in the plane of the page) will this conductor experience a force?

- A A
- B B
- C C
- D D

(2)

- 2.10 A 6 V battery, a resistor, a capacitor and a switch S are connected in a circuit as shown in the diagram below. Switch S can be closed at either position M or position N.



Switch **S** is initially at position N. After a while it is moved to position M.

Which ONE of the following statements is correct when the switch is moved to position M?

- A The capacitor discharges.
- B The capacitor charges.
- C The battery discharges.
- D The battery charges.

(2)
[20]

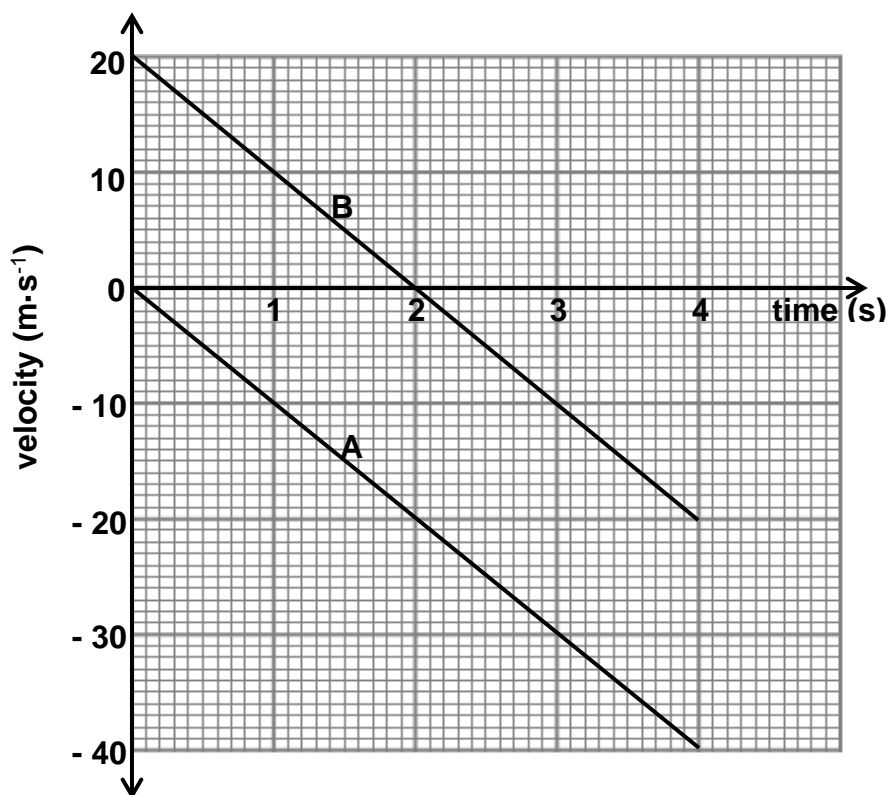
TOTAL SECTION A: 25

SECTION B**INSTRUCTIONS AND INFORMATION**

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

The velocity-time graph shown below represents the motion of two objects, **A** and **B**, released from the same height. Object **A** is released from REST and at the same instant object **B** is PROJECTED vertically upwards. (Ignore the effects of friction.)



- 3.1 Object A undergoes a constant acceleration. Give a reason for this statement by referring to the graph. (No calculations are required.) (2)
- 3.2 At what time/times is the SPEED of object B equal to 10 m·s⁻¹? (2)
- 3.3 What is the velocity of object A relative to object B at t = 1 s? (3)

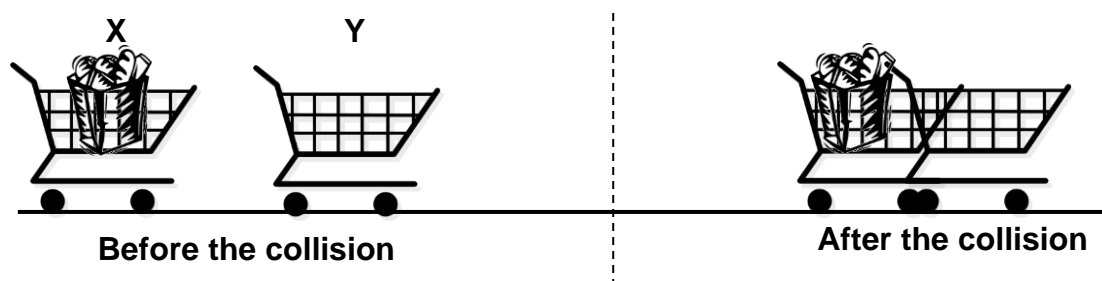
- 3.4 Object **A** strikes the ground after 4 s. USE EQUATIONS OF MOTION to calculate the height from which the objects were released. (3)
- 3.5 What physical quantity is represented by the area between the graph and the time axis for each of the graphs **A** and **B**? (2)
- 3.6 Calculate, WITHOUT USING EQUATIONS OF MOTION, the distance between objects **A** and **B** at $t = 1$ s. (5)
- [17]**

QUESTION 4 (Start on a new page.)

Two shopping trolleys, **X** and **Y**, are both moving to the right along the same straight line. The mass of trolley **Y** is 12 kg and its kinetic energy is 37,5 J.

- 4.1 Calculate the speed of trolley **Y**. (3)

Trolley **X** of mass 30 kg collides with trolley **Y** and they stick together on impact. After the collision, the combined speed of the trolleys is $3,2 \text{ m}\cdot\text{s}^{-1}$. (Ignore the effects of friction.)



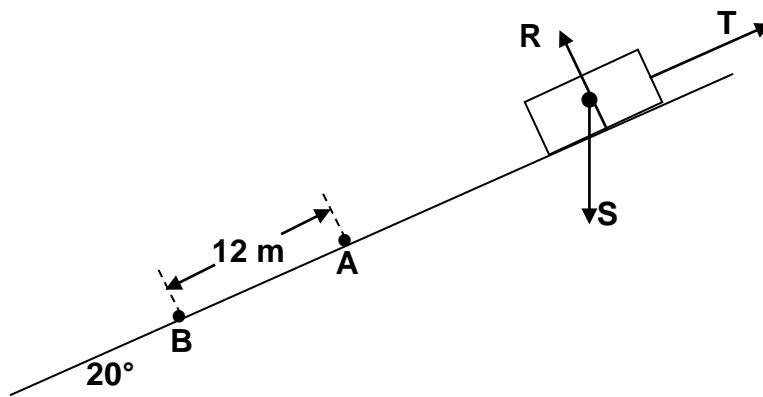
- 4.2 Write down the principle of conservation of linear momentum in words. (2)
- 4.3 Calculate the speed of trolley **X** before the collision. (5)

During the collision, trolley **X** exerts a force on trolley **Y**. The collision time is 0,2 s.

- 4.4 Calculate the magnitude of the force that trolley **X** exerts on trolley **Y**. (4)
- [14]**

QUESTION 5 (Start on a new page.)

A crate of mass 70 kg slides down a rough incline that makes an angle of 20° with the horizontal, as shown in the diagram below. The crate experiences a constant frictional force of magnitude 190 N during its motion down the incline. The forces acting on the crate are represented by **R**, **S** and **T**.



5.1 Label the forces **R**, **S** and **T**. (3)

5.2 Give a reason why force **R** does no work on the crate. (2)

The crate passes point **A** at a speed of $2 \text{ m}\cdot\text{s}^{-1}$ and moves a distance of 12 m before reaching point **B** lower down on the incline.

5.3 Calculate the net work done on the crate during its motion from point **A** to point **B**. (5)

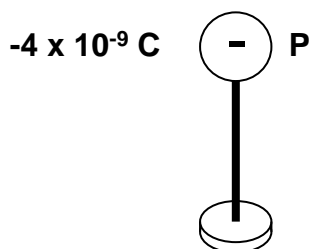
5.4 Write down the work-energy theorem in words. (2)

5.5 Use the work-energy theorem to calculate the speed of the crate at point **B**. (4)

[16]

QUESTION 8 (Start on a new page.)

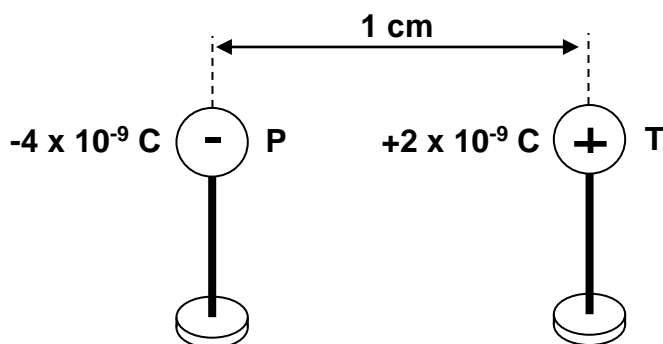
The diagram below shows a small metal sphere **P** on an insulated stand. The sphere carries a charge of $-4 \times 10^{-9} \text{ C}$, as shown in the diagram.



8.1 Draw the electric field pattern around sphere **P**. Assume that no other charges affect this pattern. (2)

8.2 Calculate the number of electrons in excess on sphere **P**. (2)

A second metal sphere **T** carrying a charge of $+2 \times 10^{-9} \text{ C}$ is placed 1 cm from sphere **P**, as shown in the diagram below.



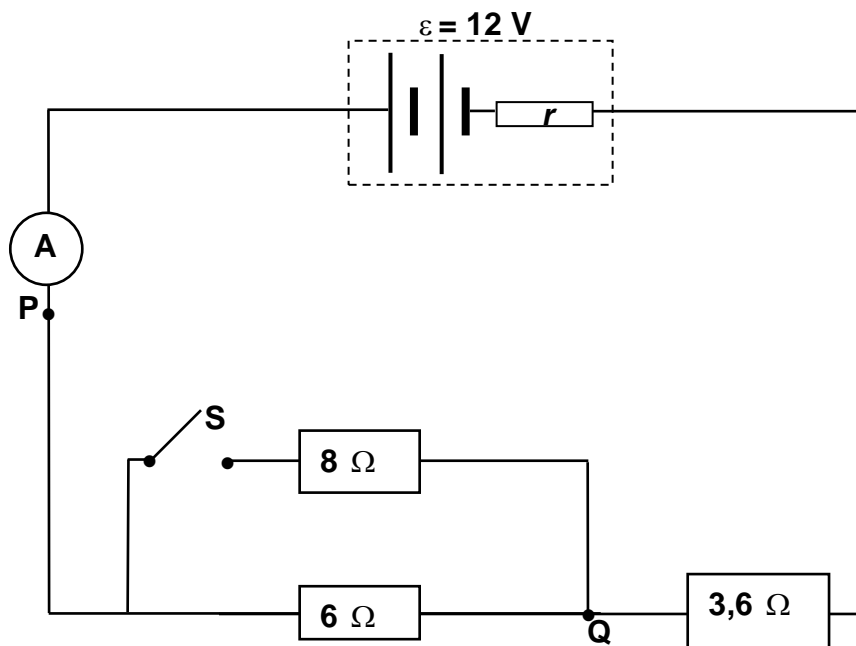
8.3 Calculate the magnitude of the electrostatic force that sphere **P** exerts on sphere **T**. (4)

The spheres are now brought into contact with each other and returned to their original positions.

8.4 Calculate the electric potential energy of the system of two charges. (6)
[14]

QUESTION 9 (Start on a new page.)

The circuit diagram below represents a combination of resistors in series and parallel. The battery has an emf of 12 V and an unknown internal resistance r .



With switch **S** OPEN, ammeter A gives a reading of 1,2 A.

- 9.1 Calculate the total resistance of the circuit. (3)
- 9.2 Calculate the internal resistance of the battery. (4)
- 9.3 Calculate the energy dissipated in the $6\ \Omega$ resistor in 3 minutes. (3)

Switch **S** is now CLOSED.

- 9.4 How will EACH of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.
 - 9.4.1 The total resistance of the circuit (1)
 - 9.4.2 The reading on ammeter A (1)
- 9.5 A conducting wire of negligible resistance is now connected between points **P** and **Q**. What effect will this have on the temperature of the battery?

Write down only INCREASES, DECREASES or REMAINS THE SAME. Explain how you arrived at the answer.

(4)
[16]



QUESTION 10 (Start on a new page.)

AC generators at coal-fired power stations supply most of the electrical energy needed in our country.

10.1 State ONE structural difference between an AC and a DC generator. (2)

A certain AC generator (alternator) produces a peak current (I_{\max}) of 6,43 A when connected to an electrical heater of resistance 48,4 Ω .

10.2 Calculate the rms current (I_{rms}) produced by the generator. (3)

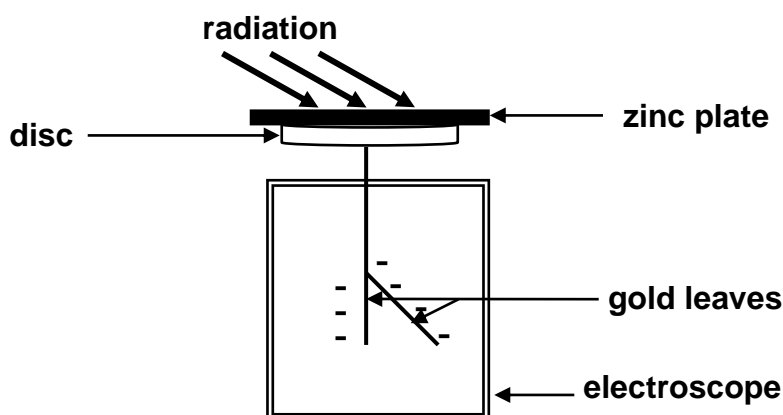
10.3 Calculate the peak voltage (V_{\max}) output of the generator. (5)

10.4 Draw a sketch graph of potential difference versus time for this AC generator. Clearly label the axes and indicate V_{\max} on the potential difference axis. (2)

10.5 To meet energy demands in the country, the government plans building nuclear power stations. State ONE environmental advantage of the generation of electricity in nuclear power stations over coal-fired power stations. (1)
[13]

QUESTION 11 (Start on a new page.)

- 11.1 A group of learners performs an investigation to compare the effect of two types of radiation on the emission of photoelectrons from zinc. They place a zinc plate on top of the disc of a negatively charged electroscope. Ultraviolet and red light are shone alternately onto the zinc plate as shown below, with the electroscope fully charged in each case.



They record the following observations:

| RADIATION | OBSERVATION |
|-------------------|--|
| Ultraviolet light | Gold leaves collapse |
| Red light | No effect on the deflection of gold leaves |

- 11.1.1 Write down an INVESTIGATIVE QUESTION for this investigation. (2)
- 11.1.2 Explain the observation made for ultraviolet light. (3)
- 11.1.3 What conclusion can be drawn from this investigation? (2)
- 11.1.4 The following safety precaution is printed on the ultraviolet light source:

OVEREXPOSURE TO ULTRAVIOLET LIGHT IS A HEALTH RISK

Name ONE health risk associated with overexposure to ultraviolet light. (1)

11.2 The learners have access to the following information:

| | |
|--------------------------------|----------------------------------|
| Work function of zinc | $6,88 \times 10^{-19} \text{ J}$ |
| Frequency of ultraviolet light | $7,89 \times 10^{14} \text{ Hz}$ |
| Frequency of red light | $4,29 \times 10^{14} \text{ Hz}$ |

- 11.2.1 Define the term *work function* of a metal. (2)
- 11.2.2 Name ONE type of electromagnetic radiation with a higher frequency than that of ultraviolet light. (1)
- 11.2.3 Use a calculation to explain why red light fails to emit photoelectrons from the surface of the zinc plate. (4)
- [15]**

TOTAL SECTION B: 125
GRAND 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 m·s ⁻² |
| Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i> | c | 3,0 x 10 ⁸ m·s ⁻¹ |
| Planck's constant <i>Planck se konstante</i> | h | 6,63 x 10 ⁻³⁴ J·s |
| Coulomb's constant <i>Coulomb se konstante</i> | k | 9,0 x 10 ⁹ N·m ² ·C ⁻² |
| Charge on electron <i>Lading op elektron</i> | e | -1,6 x 10 ⁻¹⁹ C |
| Electron mass <i>Elektronmassa</i> | m _e | 9,11 x 10 ⁻³¹ kg |
| Permittivity of free space <i>Permittiwiteit van vry ruimte</i> | ε ₀ | 8,85 x 10 ⁻¹² F·m ⁻¹ |

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

FORCE/KRAG

| | |
|--|----------|
| $F_{\text{net}} = ma$ | $p = mv$ |
| $F_{\text{net}} \Delta t = \Delta p = mv_f - mv_i$ | $w = mg$ |

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 $E_k = \frac{1}{2} mv^2$ | $W_{\text{net}} = \Delta K = K_f - K_i$ $W_{\text{net}} = \Delta E_k = E_{kf} - E_{ki}$ |
| $P = \frac{W}{\Delta t}$ | $P = Fv$ |

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

| | |
|---|---|
| $v = f \lambda$ | $T = \frac{1}{f}$ |
| $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ | $E = hf$ or/of $E = h \frac{c}{\lambda}$ |
| $\sin \theta = \frac{m\lambda}{a}$ | $hf = W_0 + \frac{1}{2} mv^2$ $hf = hf_0 + \frac{1}{2} mv^2$ |

ELECTROSTATICS/ELEKTROSTATIKA

| | |
|---------------------------|------------------------------|
| $F = \frac{kQ_1Q_2}{r^2}$ | $E = \frac{kQ}{r^2}$ |
| $E = \frac{V}{d}$ | $E = \frac{F}{q}$ |
| $U = \frac{kQ_1Q_2}{r}$ | $V = \frac{W}{q}$ |
| $C = \frac{Q}{V}$ | $C = \frac{\epsilon_0 A}{d}$ |

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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

ALTERNATING CURRENT/WISSELSTROOM

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