education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1
SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of TEN (10) questions.
3. Answer ALL the questions in the ANSWER BOOK.
4. Start EACH question on a NEW page in the ANSWER BOOK.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. You are advised to use the attached DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your FINAL numerical answers to a minimum of TWO decimal places.
12. Give brief motivations, discussions, etc. where required.
13. 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 question numbers (1.1 to 1.10) in the ANSWER SHEET, e.g. 1.11 D.

1.1 The sum of all the forces acting on the same object.

A Inertia

B Resultant force

C Acceleration

D Frictional force (2)

1.2 The momentum of an object can be increased by increasing:

A The mass and velocity of the object

B The frictional force acting on an object

C The inertia

D None of the above mentioned (2)

1.3 1 N.s is equivalent to …

A 1 $kg \cdot m^3 \cdot s^{-1}$.

B 1 $kg \cdot m^{-2} \cdot s^{-2}$.

C 1 $kg \cdot m \cdot s^{-1}$.

D 1 $kg \cdot m^{-1} \cdot s^{-2}$. (2)

1.4 When a force is applied to an object perpendicular to the object's displacement, then …

A work is done on the object.

B positive work is done on the object.

C negative work is done on the object.

D no work is done on the object. (2)

1.5 1 hp is equivalent to …

A 846 W.

B 746 W.

C 646 W.

D 546 W. (2)

1.6 A force which changes the shape and size of a body.

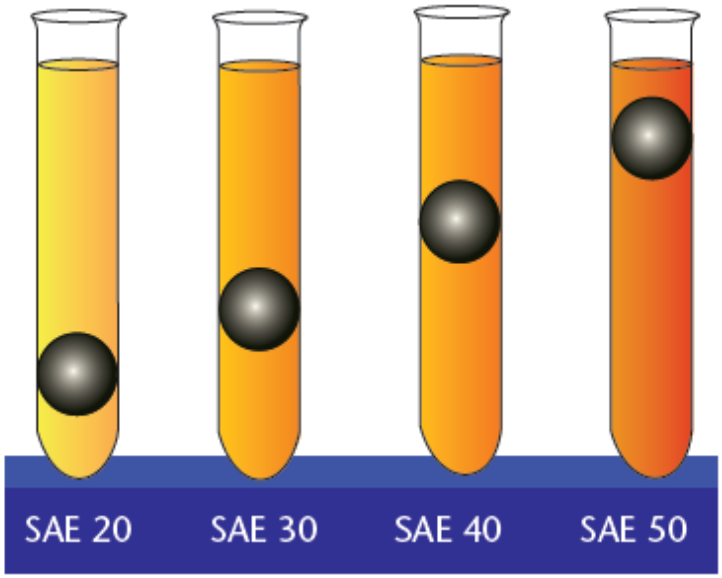
A Restoring force

B Deforming force

C Maximum force

D Elastic force (2)

1.7 Study the diagram of different oils below and answer the question that follows.



Which SAE represents an engine oil with a higher viscosity?

A SAE 20

B SAE 30

C SAE 40

D SAE 50 (2)

1.8 Bending of light when it passes from one medium to another where the speed is different.

A Diffraction

B Reflection

C Refraction

D Convergence (2)

1.9 Which ONE of the following statements is CORRECT about Ohm's law?

A The potential difference across a conductor is inversely proportional to the current in the conductor, provided the temperature is not kept constant.

B The potential difference across a conductor is directly proportional to the current in the conductor, provided the temperature is kept constant.

C The potential difference across a conductor is directly proportional to the current in the conductor, provided the temperature is not kept constant.

D The potential difference across a conductor is inversely proportional to the current in the conductor, provided the temperature is kept constant. (2)

1.10 The direction of the induced emf in the coil opposes the effect that produces it.

A Lenz's law

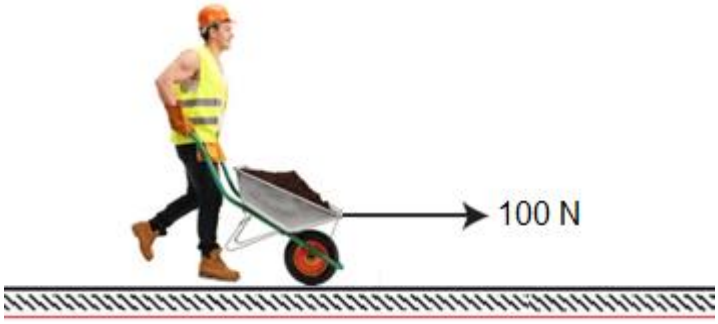
B Faraday's law

C Coulomb's law

D Ampere's law (2)
[20]

QUESTION 2 (Start on a new page.)

2.1 A construction learner is pushing a wheelbarrow filled with sand on a building site. The total mass of the wheelbarrow and its content is 40 kg. When he applies a horizontal force of 100 N, the wheelbarrow moves forward at a constant acceleration, as shown in the diagram below. The wheel of the wheelbarrow experiences a *frictional force* of 5 N.



2.1.1 Define the term *acceleration* in words. (2)

2.1.2 Draw a labelled free-body diagram indicating ALL the forces acting on the wheelbarrow. (4)

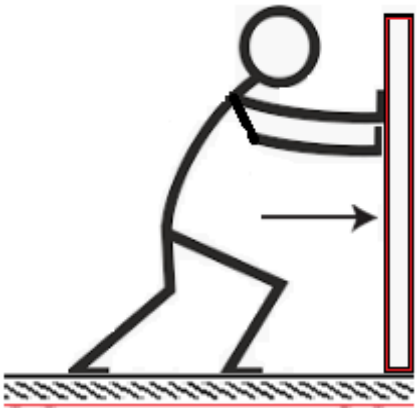
2.1.3 State *Newton's Second Law of Motion* in words. (2)

Calculate the:

2.1.4 *Net (Resultant) force* (3)

2.1.5 Acceleration of the wheelbarrow (3)

2.2 Study the diagram below of a man pushing a wall and answer the questions that follows.



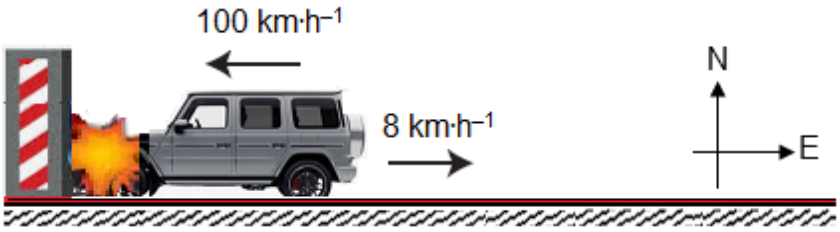
2.2.1 Write down the ACTION-REACTION pairs between the man and the wall. (2)

2.2.2 Name and state in words the law used to answer QUESTION 2.2.1. (3)

[19]

QUESTION 3 (Start on a new page.)

3.1 In a crash test, a car of mass 1 000 kg collides with a wall and rebounds. The initial and final velocities of the car are 100 km·h^{-1} west and 8 km·h^{-1} east respectively.



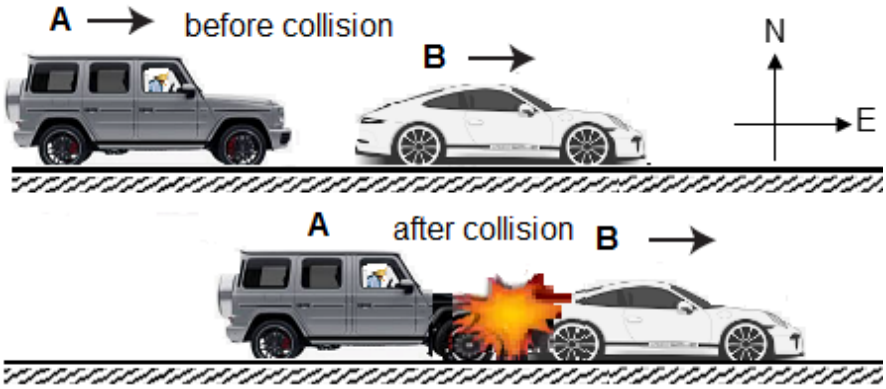
3.1.1 Define the term *momentum.* (2)

3.1.2 Calculate the force exerted by the wall on the car if the collision last for 0,1 s. (4)

3.1.3 How will the magnitude of the force exerted on the car be affected if the time interval of the collision remains 0,1 s, but the car does NOT BOUNCE OFF the wall? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

3.1.4 Give a reason for the answer in QUESTION 3.1.3, refer to change in momentum and net force. (2)

3.2 Car **A** with a mass of 1 000 kg travels east at constant velocity of 31 m·s^{-1} and it collides into the back of car **B** with a mass of 900 kg travelling in the same direction at 20 m·s^{-1}. After the collision, car **B** moves east at 23 m·s^{-1}, as shown in the diagram below.



3.2.1 State the principle of *conservation of linear momentum* in words. (2)

3.2.2 Calculate the velocity of car **A** after the collision. (4)

3.2.3 Differentiate between *elastic* and *inelastic collisions*. (4)
[19]

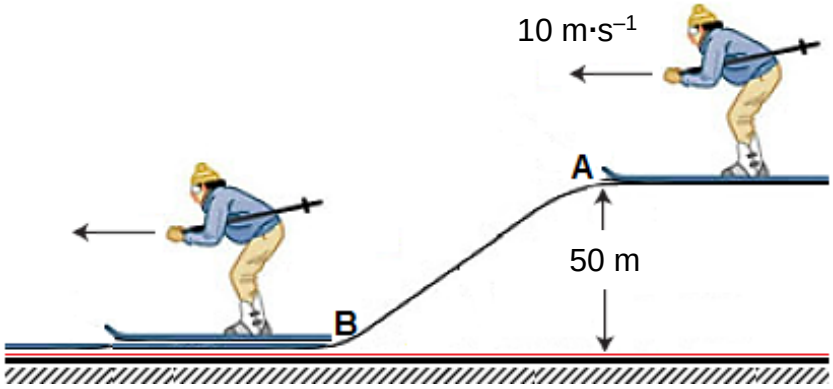
QUESTION 4 (Start on a new page.)

4.1 A car drives at a constant velocity. The engine of the car produces a power of 4 000 W.

4.1.1 Define the term *power.* (2)

4.1.2 Calculate the work done by the engine in 120 s. (3)

4.2 A skier with a mass of 55 kg goes downwards from a 50 m high frictionless slope with an initial speed of 10 m·s^{-1}, as shown in the diagram below.



4.2.1 State the *principle of conservation of mechanical energy* in words. (2)

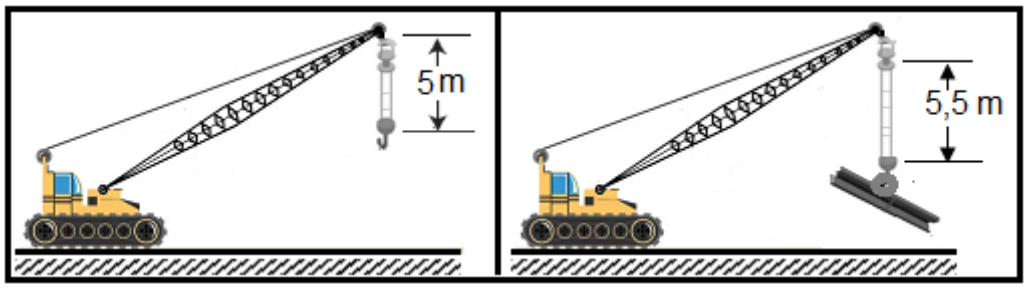
Calculate the:

4.2.2 Mechanical energy at point **A** (3)

4.2.3 Speed of the skier at point **B** (4)
[14]

QUESTION 5 (Start on a new page.)

A crane was used to lift a railway steel bar. The cable with a surface area of 0,2 m^2 is subjected to the railway steel bar weighing 9 800 N. The original length of the cable is 5 m and the length of cable changes to 5,5 m, as shown in the diagram below.



5.1 State *Hooke's law* in words. (2)

Calculate the:

5.2 Stress experienced by the cable (3)

5.3 Strain caused by the force (4)

5.4 Modulus of elasticity (3)
[12]

QUESTION 6 (Start on a new page.)

The temperature of a fluid affects the viscosity of the fluid. The oil used for lubrication should be selected properly considering the functioning temperatures. Study the container below of gear oil and answer the questions that follows.

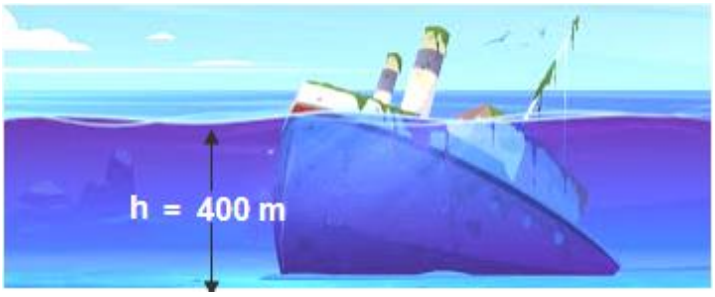
6.1 Define the term *viscosity*. (2)

6.2 What grade is the gear oil represented by the container? Write down only MONO-GRADE or MULTI-GRADE (1)

6.3 Give a reason for the answer in QUESTION 6.2. (2)
[5]

QUESTION 7 (Start on a new page.)

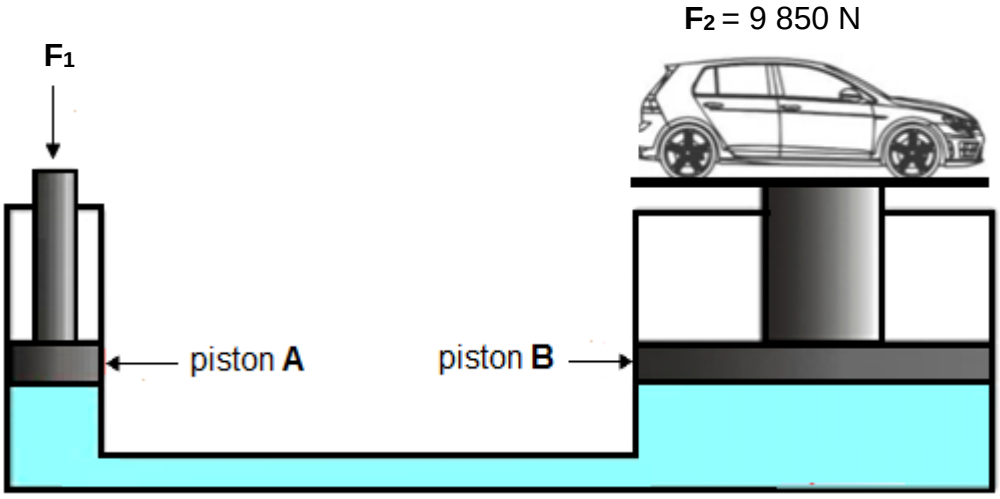
7.1 The wreckage of a ship is 400 m under the ocean water. The density of the cold saltwater above the ship is 1 040 kg·m^{-3}, as shown in the diagram below.



7.1.1 Define the term *pressure at a particular point*. (2)

7.1.2 Calculate the fluid pressure of the ocean water at that depth. (3)

7.2 An UNKNOWN input force is applied to a small piston **A** with an area of 0,5 m^2 to lift a car weighing 9 850 N in a service station. The car is attached to a larger piston **B** with an area of 1,5 m^2, as shown in the diagram below.

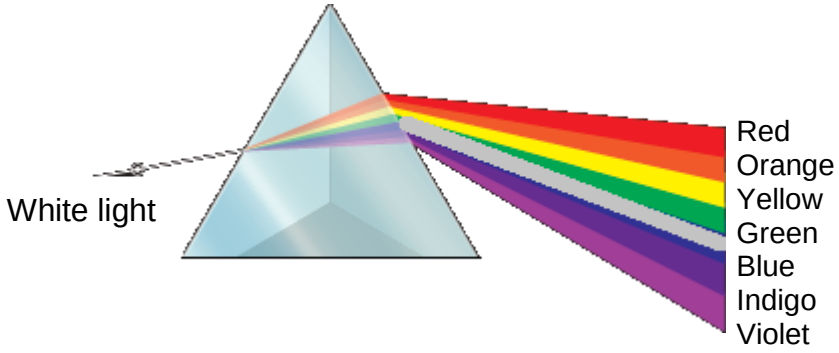


7.2.1 State *Pascal's law* in words. (2)

7.2.2 Calculate the input force (**F$_1$**). (4)
[11]

QUESTION 8 (Start on a new page.)

8.1 When a white light (or visible light) passes through a triangular prism an interesting phenomenon is observed consisting of a collection of component colours, as shown in the diagram below.



8.1.1 Write down the name of the physical phenomenon that is illustrated in the diagram above. (1)

8.1.2 Define the phenomenon named in QUESTION 8.1.1. (2)

8.2 The phenomenon of total internal reflection has a wide application in optical devices such as telescopes, binoculars, periscopes, etc.

8.2.1 Define the term *total internal reflection*. (2)

8.2.2 State TWO conditions of total internal reflection. (2)

8.3 An object of 5 mm tall is placed 20 mm in front of a convex lens with a focal length of 10 mm.

8.3.1 Draw a ray diagram to show how an image is formed when looking through a convex lens. Indicate the following: Convex lens, focal length, position of the object and image. (5)

8.3.2 Describe the POSITION, NATURE and SIZE of the image formed in QUESTION 8.3.1. (3)

8.4 UV rays has an energy of $6,63 \times 10^{-22}$ J in a vacuum.

8.4.1 Define the term *photon of light*. (2)

8.4.2 Calculate the frequency of UV rays. (3)

8.4.3 Give TWO uses of UV rays. (2)

[22]

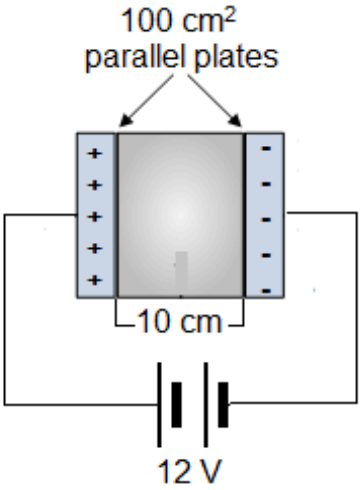
QUESTION 9 (Start on a new page.)

9.1 A square coil has 10 turns with a surface area of 3 m^2. The coil is subjected to a varying magnetic flux that changes uniformly from 4 Wb to 5 Wb in an interval of 0,2 seconds.

9.1.1 State *Faraday's law* in words. (2)

9.1.2 Calculate the induced emf. (3)

9.2 A capacitor has two plates and each has a surface area of 100 cm^2. The separation distance between the plates is 10 cm and the dielectric medium used is air, as shown in the diagram below.



9.2.1 Define the term *capacitor*. (2)

9.2.2 Calculate the capacitance of the capacitor. (4)

9.2.3 What will happen to the capacitance of the capacitor if the distance between the plates is HALVED? Write down only INCREASES, DECREACES or REMAINS THE SAME. (1)

9.3 A geyser that is labelled 2 000 W, is used for an average of 5 hours per day. The cost of electricity is R 0,60 cents per kWh.

9.3.1 What does kilowatt hour (kWh) refers to? (1)

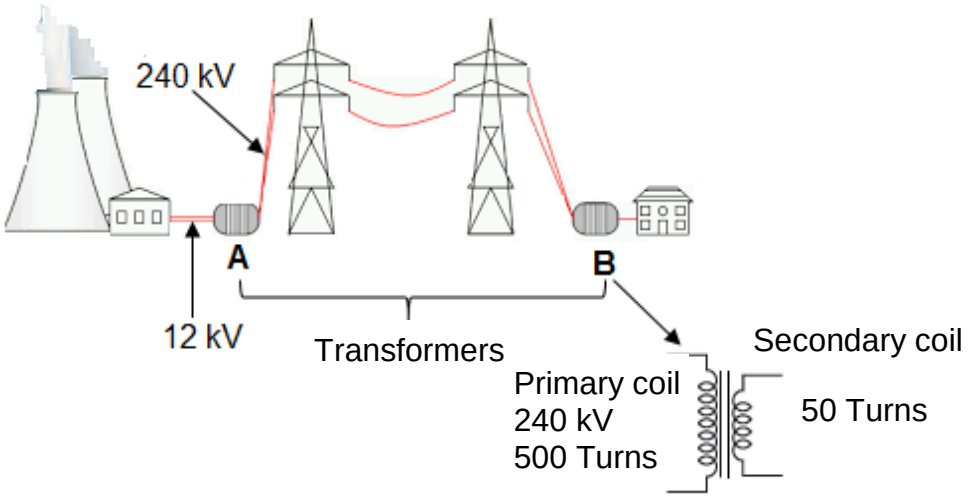
Calculate the:

9.3.2 Energy used by the geyser for 5 hours per day (3)

9.3.3 Cost of electricity to operate the geyser for a month with 30 days (3)
[19]

QUESTION 10 (Start on a new page.)

10.1 Study the diagrams below that illustrate the use of a transformer from power plant to substation.

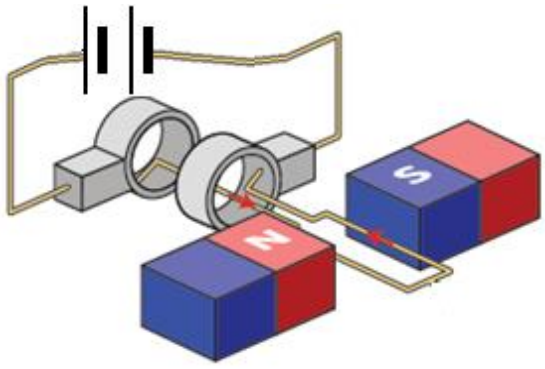


10.1.1 What type of a transformer is indicted by letter **A**? Write down only STEP-UP or STEP-DOWN transformer. (1)

10.1.2 Explain the answer in QUESTION 10.1.1. (2)

10.1.3 Calculate the potential difference on the secondary coil for the transformer indicated by symbol **B**. (3)

10.2 The diagram below illustrates a simple electric motor.



10.2.1 What type of motor is shown in the diagram above? Write down only AC MOTOR or DC MOTOR. (1)

10.2.2 Give a reason for the answer in QUESTION 10.2.1. (1)

10.2.3 State the energy conversion taking place in the diagram above. (2)
[10]

TOTAL: 150

DATA SHEET FOR TECHNICAL SCIENCES GRADE 12: PAPER 1

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12: VRAESTEL 1

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

NAME/*NAAM*	SYMBOL/*SYMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
The permittivity of free space *Permittiwiteit van vrye ruimte*	ε_0	8,85 x 10^{-12} $F \cdot m^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3 x 10^{8} $m \cdot s^{-1}$
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg

TABLE 2: FORMULAE/*TABLE 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$		$Fg = mg$ or/*of* $w = mg$
$f_s = \mu_s N$	$f_{s\,max} = \mu_s N$	$f_k = \mu_k N$
$a = \frac{\Delta v}{\Delta t}$		$v = \frac{\Delta x}{\Delta t}$

MOMENTUM

$p = mv$	
$F_{net}\,\Delta t = \Delta p$	$\Delta p = mv_f - mv_i$

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* $E_k = \frac{1}{2}mv^2$	$M_E = E_k + E_p$
$P_{ave} = Fv_{ave}$ or/*of* $P_{gemid} = Fv_{gemid}$	$P = \frac{W}{\Delta t}$

ELASTICITY, VISCOSITY AND HYDRAULICS/*ELASTISITEIT, VISKOSITEIT EN HIDROULIKA*

$\sigma = \frac{F}{A}$	$\varepsilon = \frac{\Delta \ell}{L}$
$K = \frac{\sigma}{\varepsilon}$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$P = \frac{F}{A}$	$P = \rho gh$

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{\varepsilon_0 A}{d}$	$C = \frac{Q}{V}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$R = \frac{V}{I}$	$R_S = R_1 + R_2$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$W = VQ$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/*ELEKTROMAGMETISME*

$\Phi = BA$	$\varepsilon = -N\frac{\Delta \Phi}{\Delta t}$	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$E = hf$ or/*of* $E = h\frac{c}{\lambda}$	