Education and Sport Development

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NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1

JUNE 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT (8) questions.
   Answer ALL the questions in YOUR 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 question paper.

4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. You are advised to use the attached DATA SHEET.

8. Show ALL formulae and substitution in ALL calculations.

9. Round off your final numerical answers to a minimum of TWO decimal places.

10. Give brief motivation, discussions et cetera where required.

11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has ONE correct answer. Choose the answer and write only the letter (A-D) next to the question number (1.1 to 1.10) in the ANSWER BOOK, for example 1.5 D.

1.1 A force that exist in a taut string, cable or rope.

A Frictional force.

B Normal force.

C Gravitational force.

D Tension force. (2)

1.2 According to Newton's first law of motion, a moving object that is not acted upon by an unbalanced force will…

A remain in motion.

B Change its momentum.

C Eventually come to a stop.

D Accelerate. (2)

1.3 Two bodies undergo an INELASTIC collision in the absence of friction. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Not conserved	Not conserved
D	Conserved	Conserved

(2)

1.4 Impulse is equal to the …

A initial momentum of an object.

B final momentum of an object.

C change in momentum of an object.

D rate of change in momentum of an object. (2)

1.5 The property of a body to regain its original shape and size when the deforming force is removed is known as...

A Stress.

B Strain.

C Elasticity.

D Plasticity. (2)

1.6 Fluid thrust is …

A the normal force exerted by a liquid at rest on a given surface in contact with it.

B. the force that opposes motion.

C the force the earth exerts on any object near its surface

D the ratio of change in dimension to original dimension. (2)

1.7 A brick falls from a high scaffold. What will happen to the kinetic energy, potential energy and mechanical energy as the brick falls.
Ignore the effects of air resistance.

	Kinetic energy	**Potential energy**	**Mechanical energy**
A	Increases	Increases	Remains constant
B	Increases	Decreases	Remains constant
C	Decreases	Increases	Increases
D	Decreases	Decreases	Decreases

(2)

1.8 Electrons are charge carriers in … semiconductors.

A p - type

B c - type

C n - type

D r - type (2)

1.9 The work done …

A depends on the time taken to do the work.

B is equal to the power.

C does not depend on the time taken to complete the work.

D is measured in hp. (2)

1.10 Steel balls of equal masses are dropped into test tubes with motor oils of different viscosities. Which **ONE** of the following has the highest viscosity?

A B C D (2)

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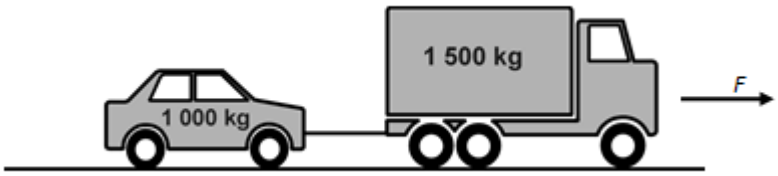
QUESTION 2 (Start on a new page.)

2.1 Define the term *acceleration.* (2)

2.2 A truck with a mass of 1 500 kg tows a car with a mass of 1 000 kg across a rough horizontal road, as shown in the diagram below. The frictional force on the truck is 150 N. The frictional force on the car is 100 N. Ignore the mass of the rope between the car and the truck.



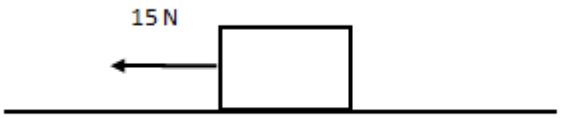
2.2.1 State *Newton's second law of motion* in words. (2)

2.2.2 Draw a labelled free body diagram showing ALL the forces acting on the truck. (5)

2.2.3 Calculate the force *F* needed to accelerate the truck - car system at 1,6 $m.s^{-2}$ to the right as well as the tension (T) in the rope. (10)

2.2.4 What will happen to the magnitude of the acceleration of the truck - car system if the mass of the rope is NOT ignored? Give an explanation for your answer. (3)

2.3 A block is pulled at constant velocity along a rough horizontal floor by a force of 15 N. When the pulling force is increased to 35 N, the block accelerates at 4 $m.s^{-2}$.



2.3.1 Determine the frictional force on the block. (2)

2.3.2 Calculate the mass of the block. (4)

2.3.3 Calculate the coefficient of kinetic friction (μ_k) between the block and the floor. (3)

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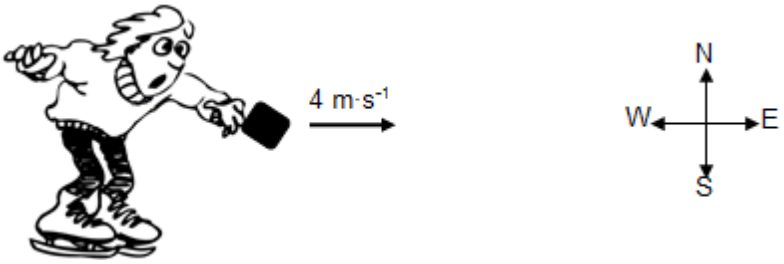
QUESTION 3 (Start on a new page.)

3.1 A boy wearing ice skates is standing stationary on a frozen lake (no friction). He throws a package of mass 5 kg at 4 m.s^{-1} horizontally east as shown below. The mass of the boy is 60 kg.



At the instant the package leaves the boy's hand, the boy starts moving.

3.1.1 State the law of *conservation of linear momentum* in words. (2)

3.1.2 Calculate the velocity of the boy immediately after the package leaves his hand. Ignore the effects of friction (5)

3.2 Dancers have to learn many skills, including how to land correctly .A dancer of mass 50 kg leaps up into the air and lands feet first on the ground. She lands on the ground with a velocity of 5 m.s^{-1}. As she lands, she bends her knees and comes to a complete stop into 0,2 seconds.

3.2.1 Calculate the momentum with which the dancer reaches the ground. (3)

3.2.2 Define the term *impulse* of a force. (2)

3.2.3 Calculate the magnitude of the net force acting on a dancer as she land. (3)

Assume that the dancer performs the same jump as before but lands without bending her knees.

3.3 Will the force be GREATER THAN, SMALLER THAN or EQUALS TO the force calculated in QUESTION 3.2.3? (1)

3.4 Give a reason for the answer to QUESTION 3.3 (3)

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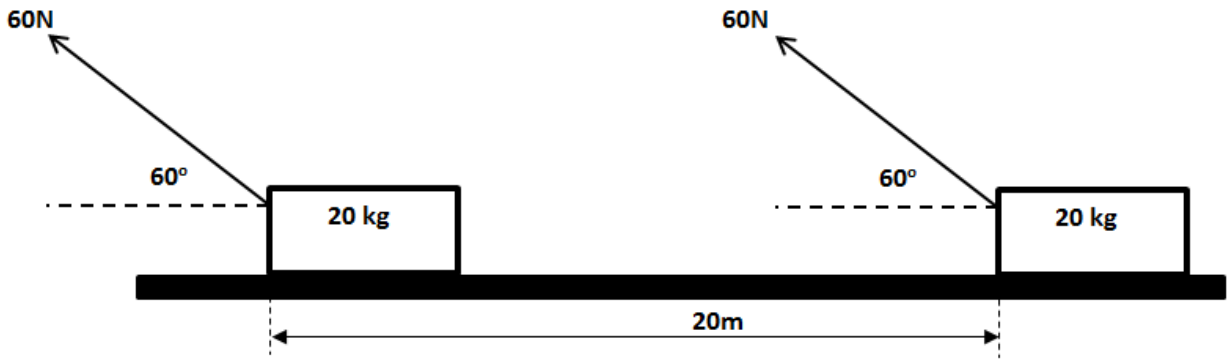
QUESTION 4 (Start on a new page.)

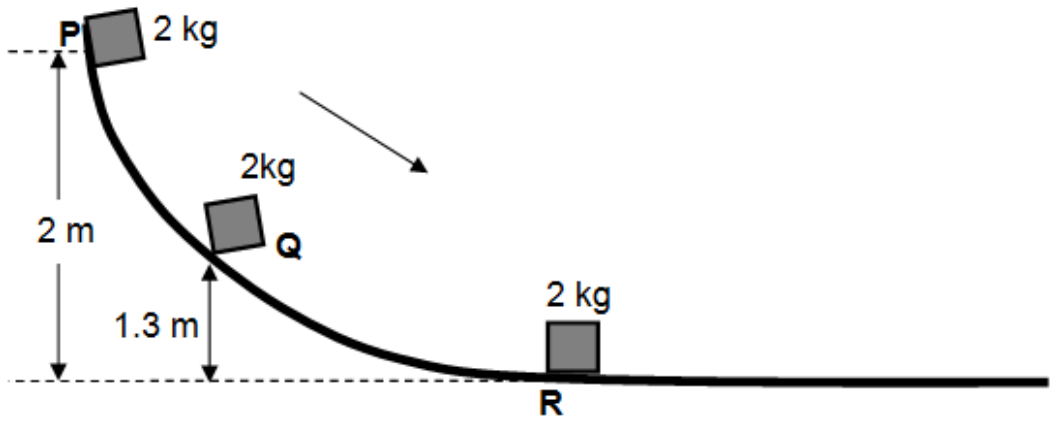
4.1 A cart of mass 20 kg is pulled over a frictionless surface with a force of 60 N as indicated in the diagram below .The cart slides over a distance of 20 m.



4.1.1 Calculate the work done by the applied force. (3)

4.1.2 Does the force of gravity do work on the cart? Explain. (2)

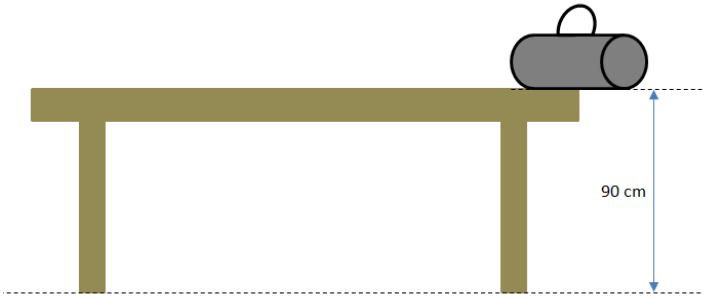
4.2 A wooden block of mass 2 kg is released from rest at point **P** and slides down a rough curved slope from a vertical height of 2 m, the block experience the *kinetic frictional force of 2 N*, as shown in the diagram below. It reaches its lowest position, point **R**, at a speed of 6 m.s^{-1}. (CONSIDER FRICTIONAL FORCE)



4.2.1 State the *law of conservation of mechanical energy.* (2)

4.2.2 Is the mechanical energy conserved while the wooden block slides down the slope? Give reason for your answer. (2)

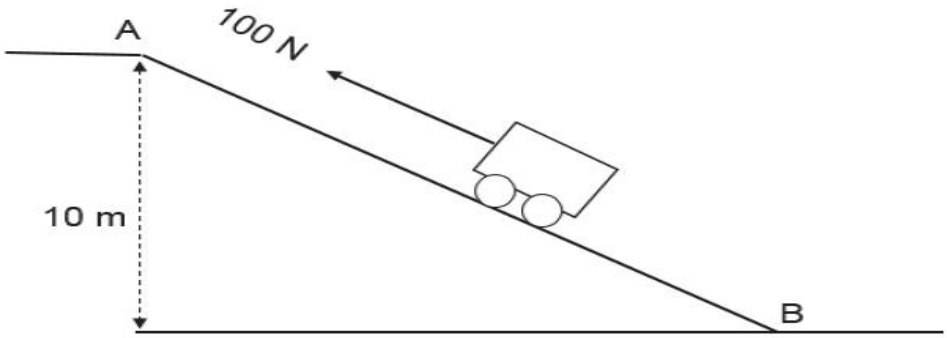
4.3 A 5kg toolbox sits stationary on the edge of a work bench that is 90 cm above the ground. A worker accidentally knocks the toolbox causing it to fall to the ground. Ignore the effects of friction.



4.3.1 What is the velocity of the box as it sits on the edge of the table? (1)

4.3.2 Using the principle of conservation of mechanical energy, determine the velocity with which the toolbox hits the ground. (5)

4.4 A trolley of mass 10 kg filled with bricks of mass 40 kg is pulled up the incline with a force of 100 N. The trolley and its contents move at a constant velocity of 5 $m.s^{-1}$ up the incline. (IGNORE FRICTION).



4.4.1 Define the term *power*. (2)

4.4.2 Calculate the power generated to pull the trolley and its contents up the incline. (3)

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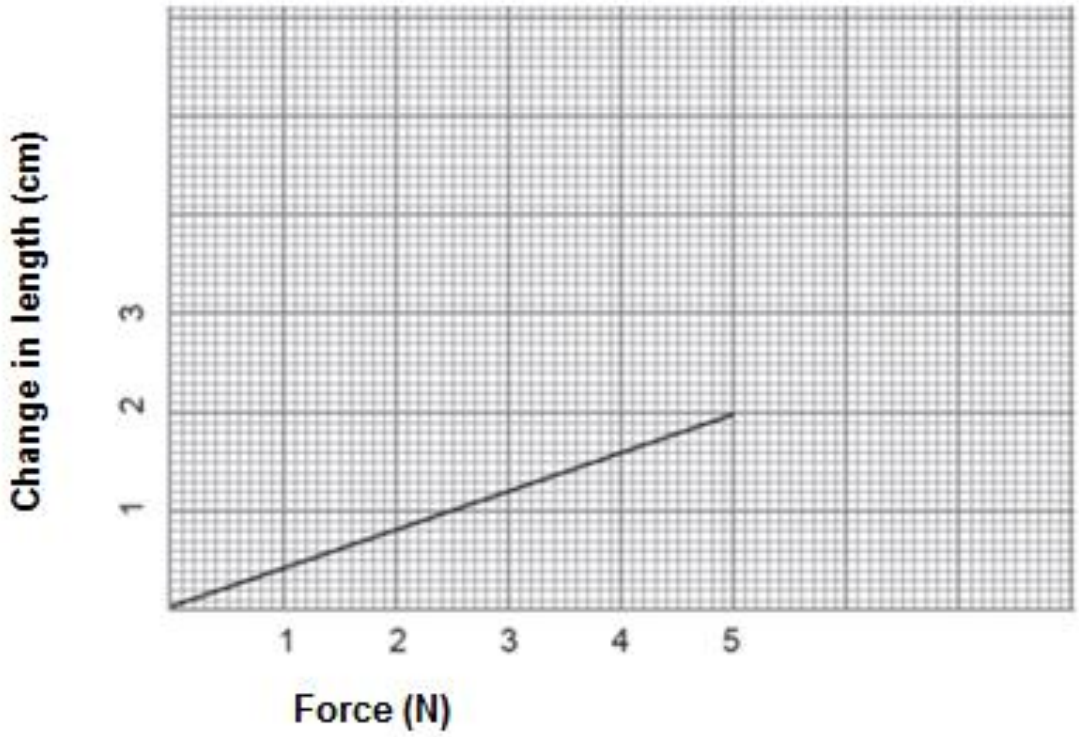
QUESTION 5 (Start on a new page.)

5.1 Grade 12 students carry out an experiment to find out how far a spring stretches when loads are added to it. The results obtained are used to draw the following graph. The unloaded length of the spring is 15 cm.

CHANGE IN LENGTH VS FORCE



5.1.1 What is the change in length of the spring when the applied force is 5 N? (1)

5.1.2 When an object of unknown mass 'm' is hung on the spring, the change in length of the spring is 1,5 cm. Calculate the mass 'm'. (4)

5.1.3 Define the term *strain*. (2)

5.1.4 Calculate strain for a force of 3 N by using the information given in the graph. (4)

5.2 A steel wire has a strain of $3,6 \times 10^{-4}$ and the modulus of elasticity is 200 GPa.

5.2.1 State Hooke's law. (2)

5.2.2 Calculate the stress in the wire. (3)

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QUESTION 6 (Start on a new page.)

6.1 Fluids are preferred in designing hydraulic machines because of their ability to flow. However liquids are more preferable than gases in making hydraulic machines.

6.1.1 Define the term viscosity. (2)

6.1.2 Explain why liquids are preferred over gases in making hydraulic machines. (3)

6.2 Modern day engine oils are multigrade. Explain the meaning of the term 'multigrade oil'. (2)

6.3 How is the low viscosity motor oil an advantage to a motor engine, and how is it a disadvantage? (4)

6.4 Interpret the meaning of the grading 15W40 SAE on the engine oil. (2)

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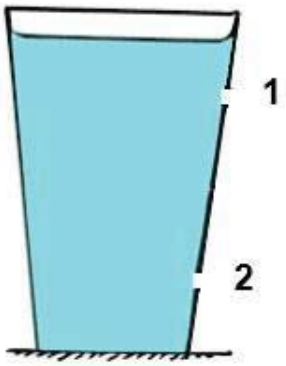
QUESTION 7 (Start on a new page.)

7.1 Name the three factors that affect the pressure exerted by a static fluid. (3)

7.2 A swimmer inside a deep pool experiences fluid pressure of 117 600 Pa, given that the density of water is 1×10^{3} kg.m^{-3}, determine his depth in the pool. (3)

7.3 Ayanda made two identical holes at points **1** and **2** in a plastic container filled with water as shown in the diagram.

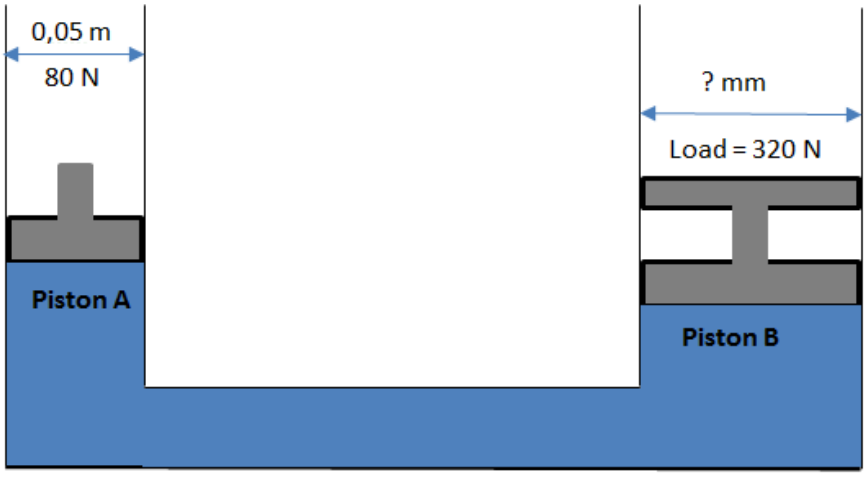


7.3.1 Is the pressure of water at point **2** GREATER THAN, LESS THAN or EQUAL TO the pressure of water at point **1**? Explain your answer. (3)

7.3.2 At which hole will the water be forced out the farthest? (1)

7.4 State Pascal's law in words. (2)

7.5 A hydraulic system is used to compress metals for recycling. The specifications of the system are as shown in the diagram below:



7.5.1 Calculate the pressure in the hydraulic system when in equilibrium. (4)

7.5.2 Calculate the diameter of piston B in mm. (4)

[20]

QUESTION 8 (Start on a new page.)

When we think of electronics, we think of semiconductors. Essential electronic devices, like diodes and transistors, are combinations of n-type and p-type semiconductors. You might have wondered why we use semiconductors, since metals appear to be far better conductors.

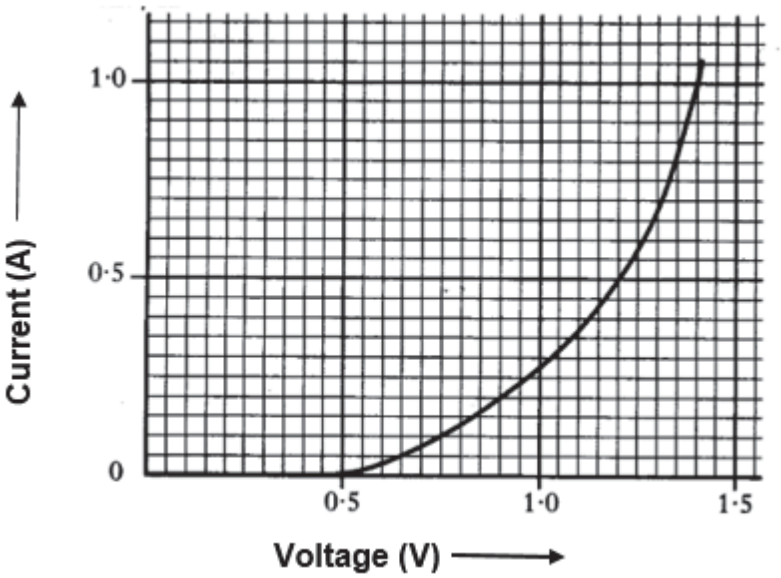
8.1 Define the following terms:

8.1.1 Semiconductor (2)

8.1.2 Doping (2)

8.2 What is the name given to electrons found in the outermost energy level of an atom? (1)

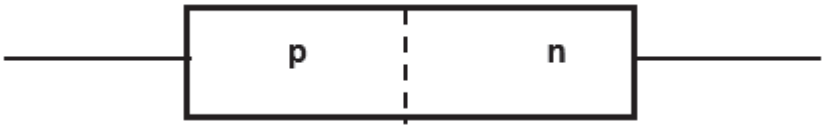
8.3 The following graph shows the relationship between current and potential difference for a diode when it is forward biased.



8.3.1 What is the minimum voltage for this diode to conduct? (2)

8.3.2 What happens to the resistance of the diode if the potential difference is increased above the minimum voltage mentioned in QUESTION 8.3.1? write only DECREASE,INCREASE **OR** REMAINS THE SAME. (2)

8.4 The diagram below represents a **p-n** junction diode.



Draw a diagram showing the p-n junction diode connected to a battery so that the junction is forward bias. (2)

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GRAND TOTAL :150

DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 1

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 1

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vacuum*	c	$3,0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N\cdot m^{2}\cdot C^{-2}$
Charge on electron *Lading op electron*	-e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$
Torque = F x $r_{\perp}$	$MA = \frac{L}{E} = \frac{e}{l}$

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

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

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