basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1

EXEMPLAR 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 20 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT 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 question paper.

4. Leave ONE line between two subquestions, 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. You are advised to use the attached DATA SHEETS.

8. Show ALL formulae and substitutions in ALL calculations.

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

10. Give brief motivations, discussions etc. where required.

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 number (1.1–1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 An object's state of motion in equilibrium remains unchanged until …

A it changes direction.

B there is a non-zero force acting on the object.

C its velocity equals its acceleration.

D all forces acting on the object are balanced. (2)

1.2 One of the properties of action-reaction pairs is that …

A they have the same magnitude.

B they act towards the same direction.

C their net force is always zero.

D they act on the same object. (2)

1.3 The police patrol vehicle in the photograph below collided with a big truck. Forensic tests showed that the collision was inelastic.

Assuming that the system is ISOLATED, the conclusion is only CORRECT if the kinetic energy is …

A conserved.

B not conserved and the total energy of the system is not conserved.

C not conserved and the total energy of the system is conserved.

D conserved and the total energy of the system is conserved. (2)

1.4 At a construction site a worker lifts a cement bag of mass 25 kg to a height of 1,6 m above the ground, as shown in the photograph below. He intends to load it onto a construction truck, which is 10 m away from him.

How much work would he have done after walking a horizontal distance of 8 m towards the truck?

A 1 960 J

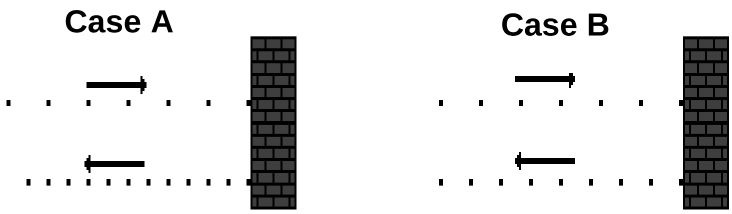
B 2 450 J

C 392 J

D 3 136 J (2)

1.5 The diagram below shows the ticker-tapes of two identical trolleys that moved towards the buffers and then bounced back after hitting the buffers.

TICKER-TAPE DIAGRAM



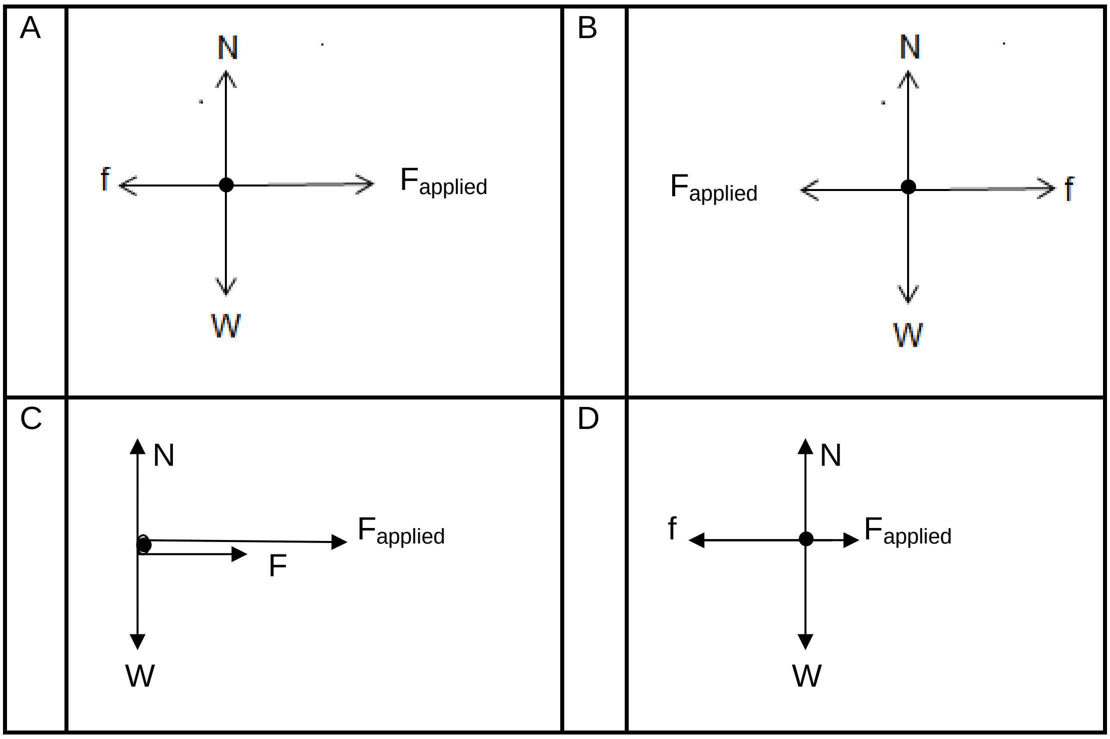
Which ONE of the following combinations is CORRECT about the case (Case A or Case B) where there was the greatest change in velocity, the greatest change in momentum and the greatest acceleration?

	GREATEST CHANGE IN VELOCITY	GREATEST CHANGE IN MOMENTUM	GREATEST ACCELERATION
A	Case A	Case B	Case B
B	Case A	Case A	Case A
C	Case B	Case A	Case B
D	Case B	Case B	Case B

(2)

1.6 A man pushes a vehicle along a rough horizontal surface for 1 m.

Which ONE of the following is the CORRECT free-body diagram that represents ALL the forces acting on the vehicle?



(2)

1.7 A diode can convert …

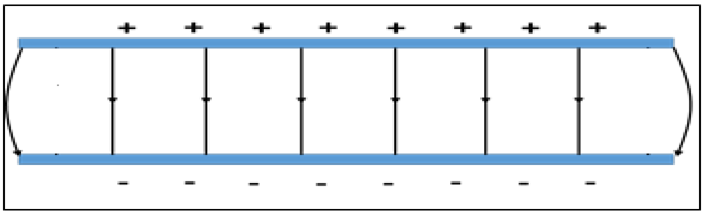
A electrical current to potential difference.

B alternating current to a pulsating direct current.

C potential difference to heat.

D electrical current to light. (2)

1.8 Two parallel metal plates are connected to oppositely charged terminals to form a capacitor.



If the distance between the plates is decreased by half, which ONE of the following will apply? The total capacitance will …

A be halved.

B increase four times.

C be doubled.

D decrease four times. (2)

1.9 Hooke's law gives a relationship between stress and strain. Which ONE of the following is the CORRECT relationship between stress and strain according to Hooke's law?

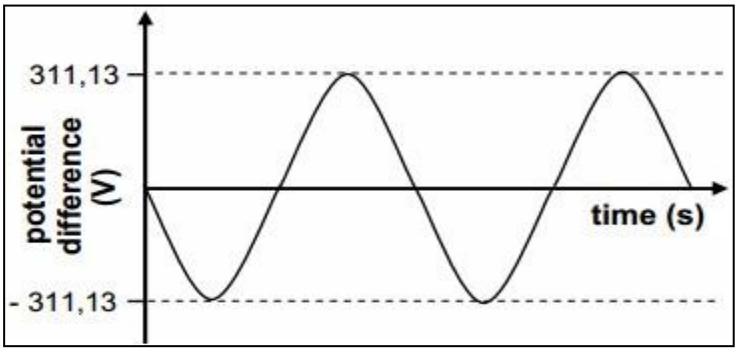
A Stress is directly proportional to strain within the limit of elasticity.

B Stress is inversely proportional to strain within the limit of elasticity.

C Strain is inversely proportional to the stress that causes it, provided that elasticity is not exceeded.

D Strain is directly proportional to the stress that causes it, even if the limit of elasticity is exceeded. (2)

1.10 The graph below represents the output of a/an...



A AC generator.

B DC generator.

C AC motor.

D DC motor. (2)
[20]

QUESTION 2 (Start on a new page.)

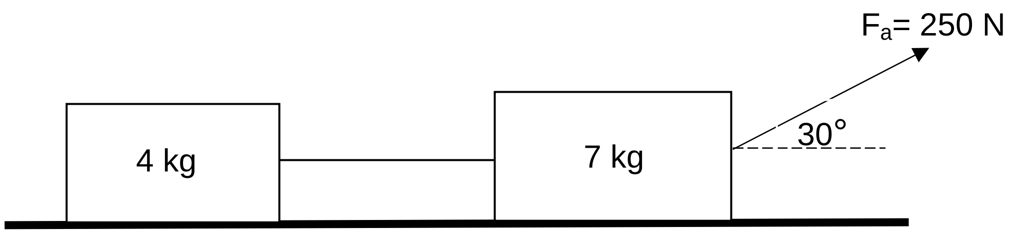
2.1 On her way to work an electrician put her toolbox of mass 2 kg on the backseat of her car. A coworker in the passenger seat noticed that children were crossing the road and he shouted that she should stop. She applied the brakes suddenly and the car stopped.

During the braking period the passenger's body moved to the edge of the seat and the toolbox fell from the backseat.

2.1.1 Name and state the law of motion that could be used to explain the situation above. (3)

2.1.2 Which ONE, the passenger's body or the toolbox, had more inertia? Explain your answer. (2)

2.2 Two blocks of 4 kg and 7 kg are connected by a light inextensible string. A force of 250 N is applied at an angle of 30° to the horizontal on the 7 kg block, as shown in the diagram below. The system moves to the east. Each block experiences a frictional force of 45 N.



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

2.2.2 Draw a labelled free-body diagram of ALL the forces acting on the 7 kg mass. (5)

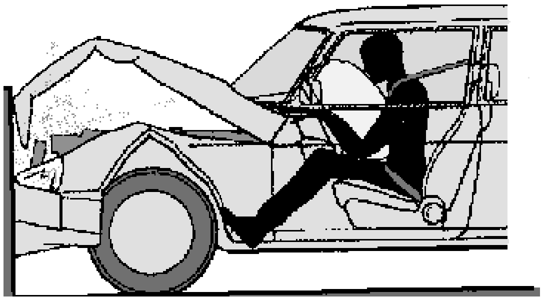
Calculate the:

2.2.3 Acceleration of the system (6)

2.2.4 Tension in the string (2)
[20]

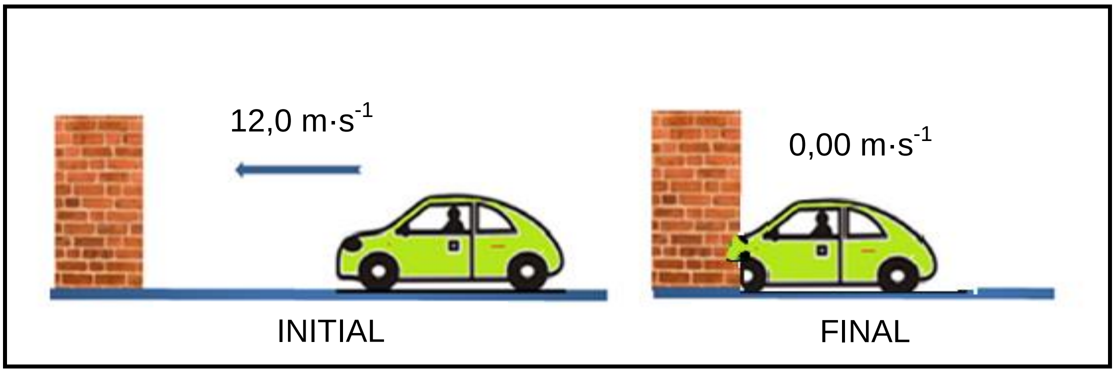
QUESTION 3 (Start on a new page.)

3.1 Modern vehicles use airbags as a protection system to reduce the risk of death or injury during a collision. These airbags inflate at the moment of collision to reduce the risk of death or injury.



Use physics principles to explain how airbags serve as a protection system. (3)

3.2 During a crash test a car of mass $1,5 \times 10^3$ kg collides with a wall and comes to rest within 0,15 s. The initial velocity of the car is 12 $m \cdot s^{-1}$ to the left.



Calculate the:

3.2.1 Impulse exerted by the wall on the car (3)

3.2.2 Magnitude of the average force exerted on the car during the collision (3)

3.3 On a railway shunting line a locomotive of mass 6 000 kg, travelling due east at a velocity of 1,25 $m \cdot s^{-1}$, collides with a stationary goods wagon of mass 4 500 kg in an attempt to couple with it. The coupling fails and instead the goods wagon moves due east at a velocity of 2,5 $m \cdot s^{-1}$.

3.3.1 State the principle of conservation of momentum in words. (2)

3.3.2 Calculate the magnitude and direction of the velocity of the locomotive immediately after the collision. (5)

3.3.3 Show with calculation whether this collision is elastic or inelastic. (7)

[23]

QUESTION 4 (Start on a new page.)

4.1 A 40 kg bag filled with stones is lifted to a balcony that is 6 m above the ground. Assume that the system is ISOLATED.

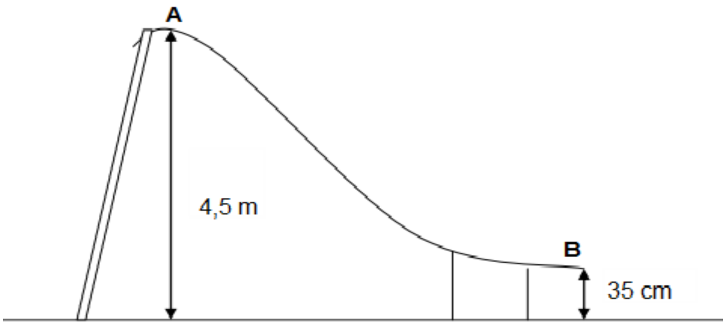
4.1.1 What does the term *isolated system* mean? (2)

4.1.2 Calculate the potential energy gained by the bag and its content at a height of 6 m. (3)

4.1.3 The man applies a horizontal pulling force of 250 N to the bag for 3 m on a frictionless surface. Calculate the amount of work done on the bag. (4)

4.1.4 A 250 N force is now applied to the bag at an angle of 30° to the horizontal surface. How will the net work done on the bag be affected? Write down INCREASE, DECREASE or REMAIN THE SAME. Motivate your answer. (4)

4.2 A learner with a mass of 65 kg slides down a slope that is 4,5 m high and 35 cm from the ground, as shown in the diagram below. Assume that the frictional force is negligible.



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

4.2.2 Calculate the kinetic energy gained by the learner as she reaches the end of the slope. (4)

4.2.3 Without using equations of motion, calculate the learner's velocity at the end of the slope. (3)

[22]

QUESTION 5 (Start on a new page.)

5.1 A load of 50 kN causes a tensile stress of 6 MPa in a round plastic bar. The original length of the bar is 200 mm. Young's modulus for a plastic bar is 70 GPa.

Calculate the:

5.1.1 Diameter of the bar (6)

5.1.2 Strain (3)

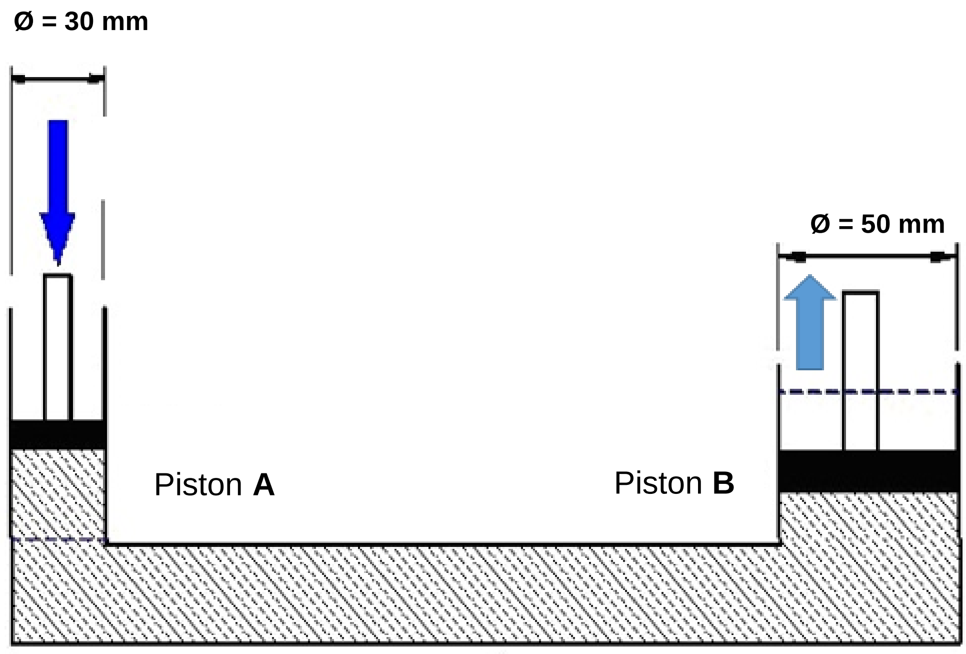
5.1.3 Change in length (2)

5.2 Define the term *viscosity.* (2)

5.3 The diagram below shows a hydraulic floor jack used to lift a car in an automotive workshop. The areas of the input piston and the output piston are $5,1 \times 10^{-4}$ m^2 and $6,5 \times 10^{-3}$ m^2 respectively.

Calculate the force required to lift the side of the car if the jack experiences a weight of 450 N at that point. (3)

5.4 A hydraulic system is shown in the diagram below. Piston **A** and Piston **B** have a diameter of 30 mm and 50 mm respectively. Input force $\mathbf{F_1}$ is 9 kN.



Use the given specifications and calculate the area of Piston **A**. (3)
[20]

QUESTION 6 (Start on a new page.)

6.1 Define the term *doping*. (2)

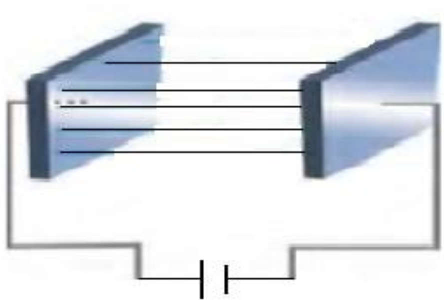
6.2 Silicon is listed as an intrinsic semiconductor. Justify this statement. (2)

6.3 A learner in a school laboratory adds boron to pure silicon to have a better conductor of electricity.

6.3.1 Which type of semiconductor is manufactured by this learner during the process above? (1)

6.3.2 A diode is a simple semiconductor device. How does a diode conduct electric current? (1)

6.4 Two parallel plates of area 0,25 m^2 are placed 1 mm apart to form a capacitor.



6.4.1 Calculate the capacitance of these parallel plates. (3)

6.4.2 Calculate the charge stored in this capacitor if a voltage of 3 000 V is applied across it. (3)

6.4.3 State TWO factors that affect the capacitance of a capacitor. (2)

6.5 A learner connects a light bulb in a circuit with a voltmeter and an ammeter. He records the readings on the ammeter and voltmeter, as shown in the table below. He then repeats the experiment by adding a second and then a third light bulb. He records the readings in each case.

The table also contains values of power for each light bulb.

NUMBER OF LIGHT BULBS	**VOLTAGE (V)**	**CURRENT (A)**	**POWER (W)**
1	2,70	0,3	0,81
2	2,70	0,22	0,59
3	2,70	0,18	0,49

6.5.1 Are these light bulbs connected in series or parallel? Give a reason for your answer. (2)

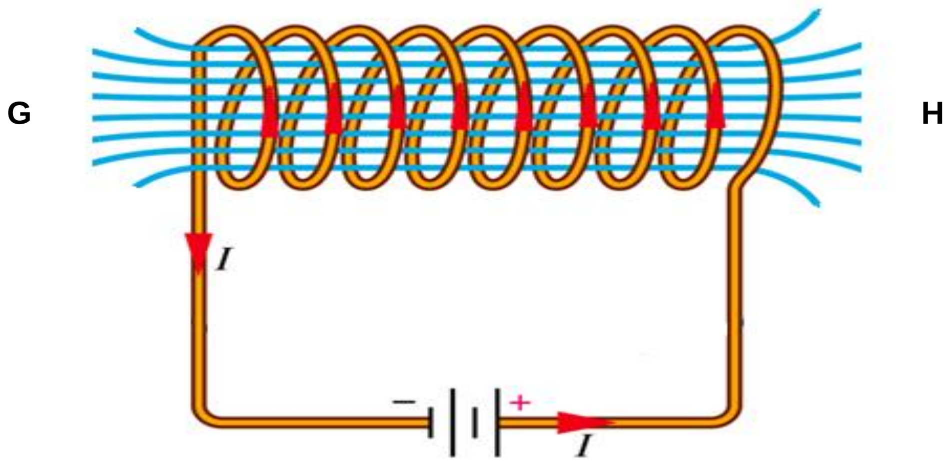
6.5.2 What is the relationship between current and power? (1)

6.5.3 Use an appropriate formula with any TWO sets of data to prove your answer to QUESTION 6.5.2. (5)

6.5.4 After the third bulb was connected, the learner allowed the current to flow for two minutes. Calculate the heat dissipated. (4)
[26]

QUESTION 7 (Start on a new page.)

7.1 Refer to the diagram below.



7.1.1 Determine the direction of the magnetic field through the solenoid. Write from **G** to **H**, or from **H** to **G**. (1)

7.1.2 Define the term *magnetic flux density*. (2)

7.1.3 The diameter of the solenoid is 45 mm. Calculate the magnetic flux density if the magnetic flux is 90 mWb. (5)

7.2 Consider a coil of 11 turns that is subjected to a magnetic field changing uniformly from 5,34 T to 2,7 T in an interval of 12 s. The change in magnetic flux is 14 Wb.

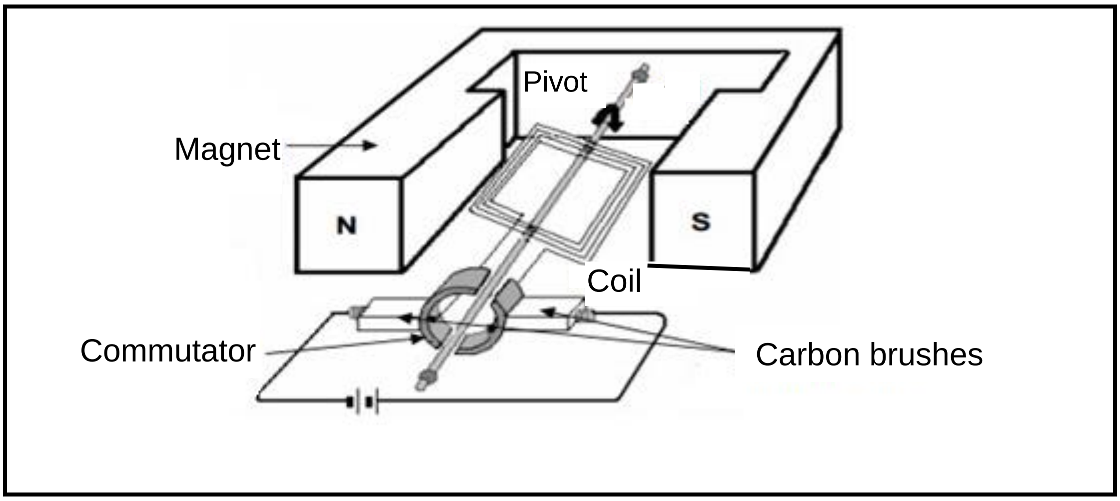
7.2.1 State Faraday's law of electromagnetic induction in words. (2)

7.2.2 Calculate the magnitude of the induced emf. (3)

7.2.3 State TWO factors that influence the magnitude of the induced emf. (2)
[15]

QUESTION 8 (Start on a new page.)

The diagram below represents a simplified DC motor.



8.1 Name the component:

8.1.1 That will ensure that the polarity remains the same in the terminals of this electric motor (1)

8.1.2 Of the motor that becomes an electromagnet when current flows (1)

8.2 State TWO advantages of using alternating current at power stations. (2)
[4]

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 vakuum*	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 elektron*	-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*

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

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* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ 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*

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

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$Q = \frac{Q_1 + Q_2}{2}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_o A}{d}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$R = \frac{V}{I}$	emf/*emk* (ε)= $I(R + r)$
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I \Delta t$
$W = VQ$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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