GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2018

11101

TECHNICAL SCIENCES

PAPER 1

TIME: 3 hours

MARKS: 150

12 pages + 2 data sheets

INSTRUCTIONS AND INFORMATION

1. This question paper consists of ELEVEN questions.
   Answer ALL the questions in the ANSWER BOOK.

2. Start EACH answer 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 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 et cetera where required.

11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions.
Each question has only ONE correct answer. Choose the correct 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 Imagine a place in the cosmos, far from all gravitational and frictional influences. Suppose that you visit that place and throw a rock.
The rock will …

A gradually slow down until it stops.

B continue moving in the same direction, at the same speed.

C fall vertically downward.

D not move, because force is required to keep the rock moving. (2)

1.2 Consider two carts, of masses, *m* and 2*m*, at rest on an air track. If you push the first cart for 3 s and then the other for the same length of time, exerting equal force on each, the change in momentum of the light cart is …

A four times the change in momentum of the heavy cart.

B twice the change in momentum of the heavy cart.

C equal to the change in momentum of the heavy cart.

D one-half the change in momentum of the heavy cart. (2)

1.3 Which of the following is a correct unit of energy?

A $kg \cdot m \cdot s^{-2}$

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

C $kg \cdot m \cdot s^{-3}$

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

1.4 Power is …

A the rate at which energy is expended.

B work per unit of time.

C the rate at which work is done.

D none of the above. (2)

1.5 Which one of the following describes Hooke's law?

A Instantaneous force divided by the original cross-sectional area of the test material

B Stress value required to produce unit strain in a tensile specimen of a particular material

C Strain is directly proportional to the stress causing it, provided that the limit of elasticity is not exceeded.

D A measurement of the deformation produced by the application of the external forces (2)

1.6 What do you understand by the term Young's modulus of elasticity?

A The force required to produce a unit area in a tensile test specimen

B The ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded

C A measurement of the extension of material due to the load experienced

D A ratio of the deformation because of the application of an external force (2)

1.7 A perpendicular force is applied to a certain area and produces a pressure *P*. If the same force is applied to an area twice as large, what would be the new pressure on the surface?

A 2P

B 4P

C $\frac{2}{P}$

D $\frac{4}{P}$ (2)

1.8 Which one of the following statements describes Pascal's law?

A The area is inversely proportional to the pressure on it, if the temperature remains constant.

B The pressure exerted on the surface of a liquid in a closed hydraulic system is transmitted equally in all directions.

C The pressure is proportional to the volume if the temperature remains constant.

D Volume is inversely proportional to the pressure on it, if the temperature increases. (2)

1.9 The capacitance of a parallel plate capacitor is *C*. If the distance between the plates is doubled, the new capacitance of the capacitor will be …

A 4 C.

B 2 C.

C C.

D $\frac{1}{2}$C. (2)

1.10 An electrical machine that uses a split-ring (commutator) and converts mechanical energy into electrical energy is a(an) …

A DC generator.

B AC generator.

C DC motor.

D AC motor. (2)

[20]

QUESTION 2 (Start on a new page.)

Give ONE word for each of the following.

2.1 When object A exerts a force on object B, object B simultaneously exerts an oppositely-directed force of equal magnitude on object A. (2)

2.2 The product, the force and the time interval during which the force acts (2)

2.3 The property of the body by virtue of which, the body regains its original shape and size when the deforming force is removed (2)

2.4 The property by virtue of which, a liquid opposes relative motion between its different layers (2)

2.5 The normal force exerted by a liquid at rest on a given surface in contact with it (2)

2.6 The direction of the induced emf in the coil opposes the effect that produces it (2)

2.7 The rate at which electrical energy is converted in an electric circuit (2)

2.8 A ... allows current flow in only one direction. (2)

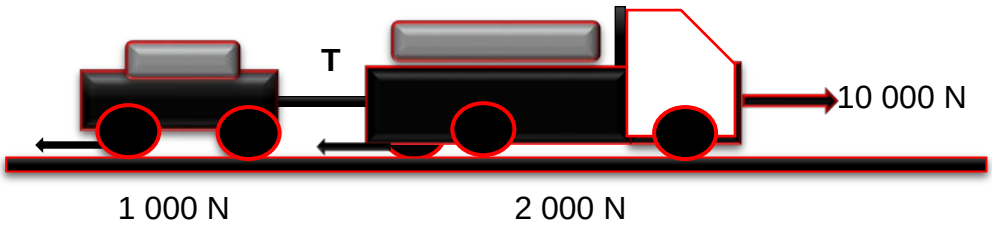
2.9 The number of field lines perpendicular to a given surface per unit area (2)

2.10 A device that converts electrical energy to mechanical energy (2)

[20]

QUESTION 3 (Start on a new page.)

A truck of mass m_1 = 4 000 kg pulls a trailer with a mass m_2 = 2 000 kg.
The frictional force on the truck is 2 000 N and on the trailer is 1 000 N.
The truck engine exerts a force of 10 000 N.



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

3.2 Draw a free-body diagram to indicate all the forces experienced by the trailer. (4)

3.3 Calculate the:

3.3.1 Acceleration of the truck and trailer (6)

3.3.2 Tension on the towing bar connecting the truck and the trailer (3)
[15]

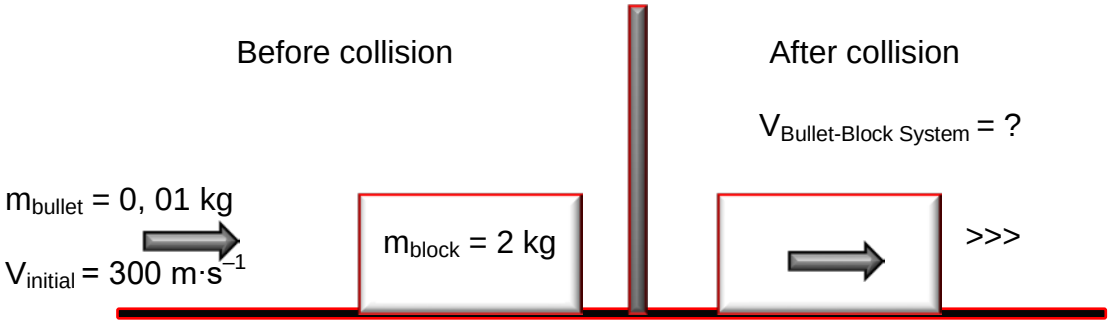
QUESTION 4 (Start on a new page.)

A dart of mass 0, 01 kg strikes a dartboard with a horizontal velocity of 6 $m \cdot s^{-1}$. The dart pushes its way, a little into the dart board, and takes 0, 04 s to stop moving.

4.1 State *Newton's Second Law* in terms of momentum. (2)

4.2 Calculate the magnitude of the **average force** that the dartboard exerts on the dart to stop. (3)

A bullet of mass 0, 01 kg, moving at a speed of 300 $m \cdot s^{-1}$, strikes a wooden block of mass 2 kg, which is resting on a flat horizontal surface. The bullet becomes embedded in the block (as shown in the diagram below).
Ignore the effects of air friction.



4.3 State the principle of *conservation of linear momentum*. (2)

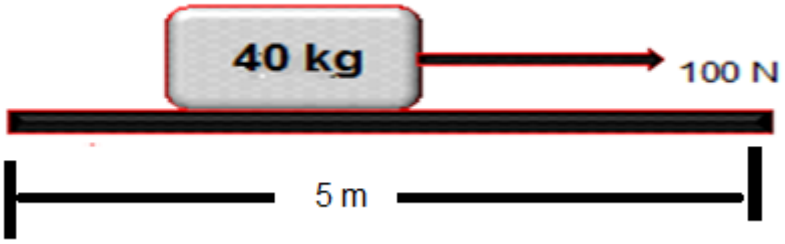
4.4 Calculate the speed of the bullet-block system immediately after the collision. (5)

4.5 By means of calculations, show whether the collision is *elastic* or *inelastic*? (6)

[18]

QUESTION 5 (Start on a new page.)

The diagram below shows a crate of mass 40 kg. A force of 100 N pulls the crate in a straight line along a horizontal, rough surface. The coefficient for kinetic friction (μk) = 0,41



5.1 Define the term *work done*. (2)

5.2 Draw a free-body diagram to indicate all the forces experienced by the box. (4)

5.3 Calculate the work done by the:

5.3.1 *Applied force* (3)

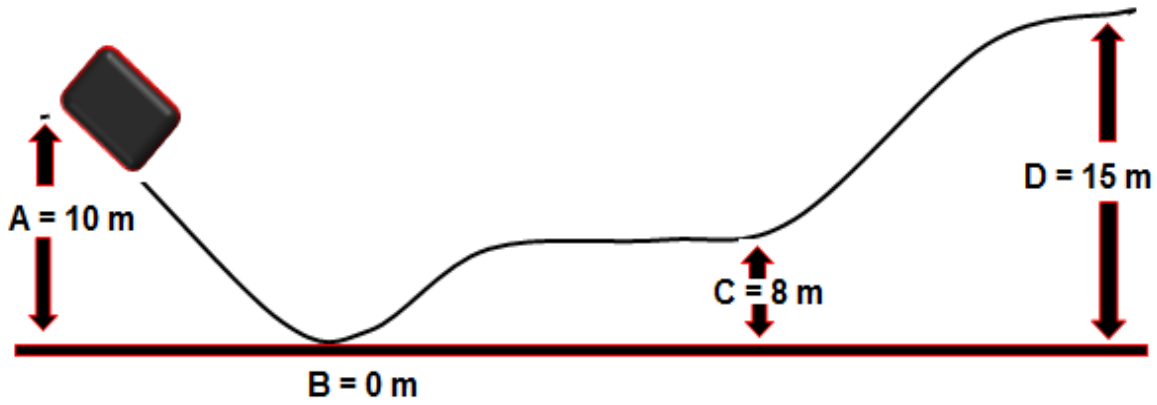
5.3.2 *Kinetic frictional force* (4)

5.4 A 120 W electric pump is used to bring water out of a borehole that is 40 m deep.

Calculate the mass of water that is let out of the borehole in 60 s. (3)
[16]

QUESTION 6 (Start on a new page.)

The diagram below represents a frictionless track. A 5 kg block starts from rest at point A and slides along the track.



6.1 State the principle of *conservation of mechanical energy*. (2)

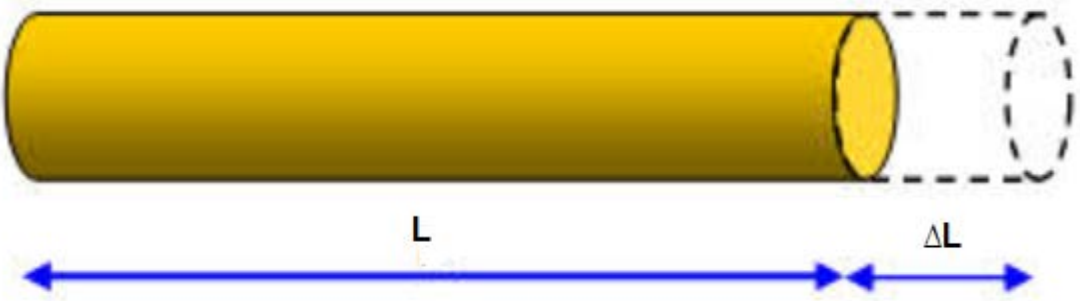
6.2 Calculate the *mechanical energy* of the block at point A. (4)

6.3 Calculate the *speed* of the block at point C. (4)

[10]

QUESTION 7 (Start on a new page.)

A compressive force causes internal stress of 16 MPa, in a round bar made of an unknown metal. The resistance area of the round bar is 1, 26 × 10^{-3} m^2 and the original length is 80 mm. The force causes the round bar to increase by 1,44 × 10^{-3} mm.



7.1 State *Hooke's Law* in words. (2)

7.2 Calculate the:

7.2.1 *Force* that causes the bar to stretch (3)

7.2.2 *Strain* in the metal caused by the force (3)

7.2.3 *Elasticity modulus* for this metal (3)

[11]

QUESTION 8 (Start on a new page.)

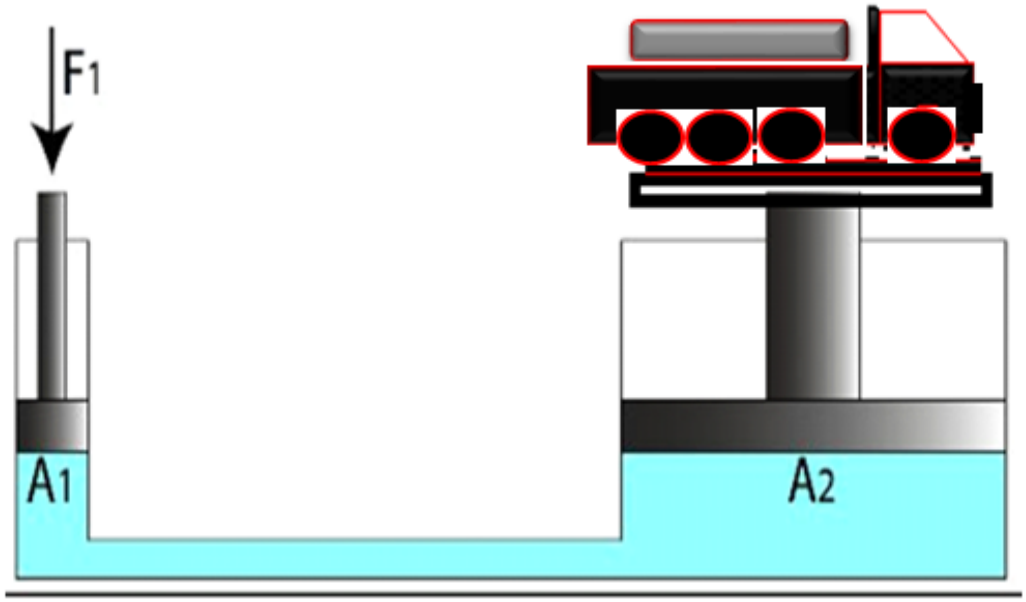
Fluids are used in designing hydraulic machines because of their ability to flow. Liquids are more preferable than gases in making hydraulic machines.

8.1 Define the term *viscosity*. (2)

8.2 Discuss the effect of temperature on the viscosity of liquids. (1)

8.3 The wreckage of the ship, the *Titanic* is under 3 800 m of ocean water. If the density of the cold, salt-water above the Titanic is 1 050 kg·m^3, what is the fluid pressure of the ocean water at that depth? (3)

8.4 A hydraulic system is used to lift a 2 000 kg vehicle into an auto garage. The vehicle sits on a piston of area 0,5 m^2, and a force is applied to a piston of area 0,03 m^2



8.4.1 State *Pascal's Law* in words. (2)

8.4.2 What is the minimum force that must be applied to lift the vehicle? (5)

8.4.3 List ONE application of hydraulics in technology. (1)

[14]

QUESTION 9 (Start on a new page.)

In order to improve the conducting properties of a semiconductor, small amounts of impurities can be added to silicon or germanium to make it either a p-type or an n-type material.

9.1 What is this process called? (1)

9.2 Define this process. (2)

9.3 Explain why doping is done in semiconductors. (2)
[5]

QUESTION 10 (Start on a new page.)

10.1 Define the term *capacitance*. (2)

10.2 A parallel-plate capacitor has an area of 0,0002 m^2 and the plates are separated by 0,001 m.

Calculate the capacitance of the capacitor. (3)

10.3 An electrical appliance with a resistance of 20 Ω takes a current of 12 A from 240 V.

Calculate the:

10.3.1 The power rating of the electric fire (3)

10.3.2 The energy (heat) transferred in 20 hours (3)
[11]

QUESTION 11 (Start on a new page.)

11.1 State *Faraday's law of electromagnetic induction*. (2)

11.2 Calculate an *emf induced* in a coil of 1 200 turns when the magnetic flux linking with it changes from 0, 03 Wb to 0, 045 Wb in 0,1 s. (3)

11.3 Name TWO factors that influence the magnitude of the induced current. (2)

11.4 A transformer has 500 primary turns and 3 000 secondary turns.
If the primary voltage is 240 V calculate the *secondary voltage*, assuming an ideal transformer. (3)
[10]

END

DATA SHEETS – PAPER 1

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$

TABLE 2: FORMULAE

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
	$F_g = mg$

MOMENTUM

$F_{net}\Delta t = \Delta p$	$\Delta p = mv_f - mv_i$
$\vec{p}_{T(before)} = \vec{p}_{T(after)}$	

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ or $E_P = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$\Delta K = K_f - K_i$ or $\Delta E_k = E_{kf} - E_{ki}$
$M_E = E_k + E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

ELASTICITY, VISCOSITY AND HYDRAULICS

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

ELECTROSTATICS

$C = \frac{\kappa \varepsilon_o A}{d}$ and $C = \frac{\varepsilon_o A}{d}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	

CURRENT ELECTRICITY

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

ELECTROMAGNETISM

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