higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T630**(E)**(A2)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

2 April 2019 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. ALL the calculations should consist of at least the following THREE steps:
   - 4.1 The formula used or the manipulation thereof
   - 4.2 The substitution of the given data in the formula
   - 4.3 The answer together with the correct SI-unit
5. The following values MUST be used in this question paper, whenever applicable:

Gravitational acceleration	$= 9{,}8\ m/s^2$
Atmospheric pressure	$= 101{,}3\ kPa$
Heat value of petrol	$= 25\ MJ/kg$
Heat value of coal	$= 30\ MJ/kg$
Density of water	$= 1\,000\ kg/m^3$
Specific heat capacity of water	$= 4\,187\ J/kg\ ℃$
Specific heat capacity of steam	$= 2\,100\ J/kg\ ℃$
Specific heat capacity of steel	$= 500\ J/kg\ ℃$
Specific heat capacity of copper	$= 390\ J/kg\ ℃$
Specific heat capacity of aluminium	$= 900\ J/kg\ ℃$
Linear coefficient of expansion of steel	$= 0,000\,012/℃$
Linear coefficient of expansion of copper	$= 0,000\,017/℃$
Linear coefficient of expansion of aluminium	$= 0,000\,023/℃$
Resistivity of steel at 20 ℃	$= 0,000\,000\,155\ \Omega m$
Resistivity of copper at 20 ℃	$= 0,000\,000\,018\ \Omega m$
Resistivity of aluminium at 20 ℃	$= 0,000\,000\,028\ \Omega m$

6. Rule off on completion of each question.
7. Drawing instruments MUST be used for all the drawings.
8. Subsections of questions must be kept together.
9. Write neatly and legibly.

QUESTION 1: DYNAMICS

1.1 Define the term *acceleration.* (1)

1.2 A car maintains the following velocities over the times given:

Time (s)	0	2	7	11
Velocity (m/s)	0	5	5	0

1.2.1 Make a neat sketch of the velocity/time graph. (3)

1.2.2 Describe the motion of the car from $2\ s$ to $7\ s$ and $7\ s$ to $11\ s$. (2)

1.2.3 Calculate the total displacement of the car over $11\ s$. (3)

1.2.4 Calculate the deceleration of the car from $7\ s$ to $11\ s$. (2)

1.3 A truck is brought to rest from a velocity of 80 km/h over a distance of 50 metres.

Determine the following:

1.3.1 The deceleration of the truck (3)

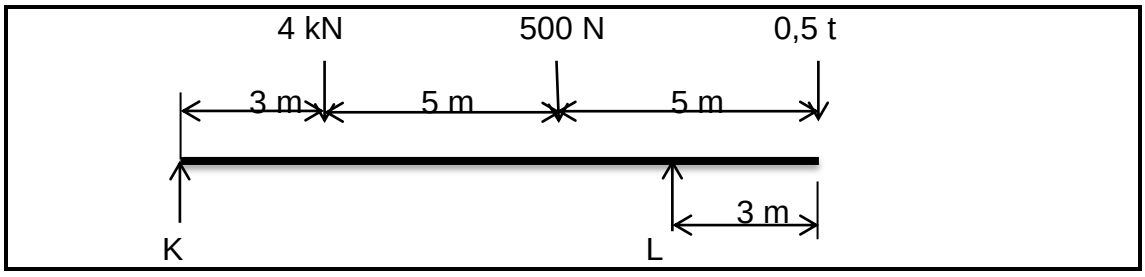
1.3.2 The time taken for the deceleration (1)

[15]

QUESTION 2: STATICS

2.1 Define *resultant of forces.* (2)

2.2 A light horizontal beam rests on two supports K and L as shown in the diagram below:



2.2.1 Ignore the weight of the beam and calculate the reactions of the supports of the beam by taking moments in kN about each support, namely K and L. (6)

2.2.2 Check your answer. (2)

[10]

QUESTION 3: ENERGY AND MOMENTUM

3.1 Define *potential energy.* (2)

3.2 A metal ball with a mass of 1,5 kg is thrown 2 m vertically upwards.

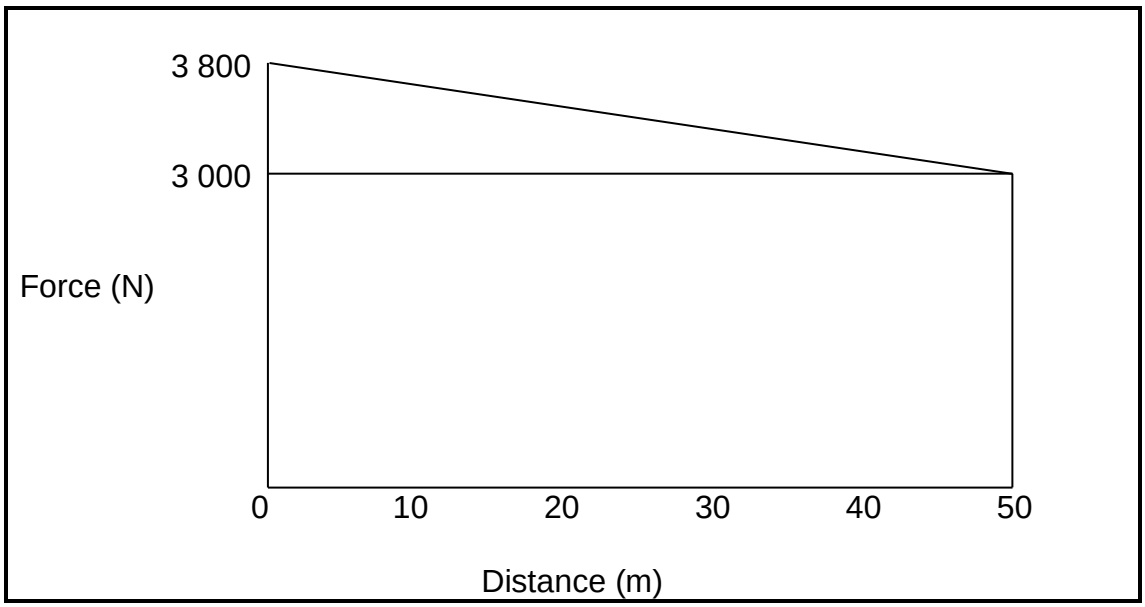
3.2.1 Calculate the potential energy of the ball when it reaches the highest point. (2)

3.2.2 Calculate the kinetic energy of the metal ball as it leaves the hand by first calculating the velocity with which the ball leaves the hand. (3)

[7]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1



4.1.1 Calculate the weight of the cable from the above graph in N/m. (1)

4.1.2 Calculate the total work done in hoisting the lift and the cable. (3)

4.1.3 Calculate the power required when the lift is at $30\,m$ from the bottom (20 m from the top) and the velocity is 3 m/s. (2)

4.2 A mass of 800 kg is lifted by the drum of a lifting device. The drum has a radius of 400 mm.

Calculate the following:

4.2.1 Torque delivered

4.2.2 Work done for one revolution of the drum

(2 × 2) (4)

[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 State THREE disadvantages of chain drives. (3)

5.2 A bicycle has a big sprocket with 36 teeth and a small sprocket with 6 teeth. One revolution is made by the big sprocket.

Calculate the number of revolutions made by the small sprocket. (2)

5.3 State TWO types of lifting devices other than a differential wheel and axle. (2)

5.4 A differential wheel and axle lifting machine has D=600 mm, d_1 = 300 mm and d_2 =240 mm. It also has an effort mass of 30 kg and a load mass of 400 kg.

Calculate the following:

5.4.1 The mechanical advantage (2)

5.4.2 The velocity ratio (3)

5.4.3 The efficiency of the machine (2)

5.5 Pressure applied by the pump in the swimming pool is $800\ kPa$.

Calculate the equivalent depth of the pump in the water. (3)
[17]

QUESTION 6: FRICTION

6.1 State THREE advantages of friction. (2)

6.2 An object of 50 kg is placed on an inclined plane and has to be moved up this plane. The angle between the inclined plane and the horizontal is 40° and the coefficient of friction is 0,3.

6.2.1 Calculate the weight component parallel to the plane. (2)

6.2.2 Calculate the weight component perpendicular to the plane. (2)

6.2.3 Calculate the minimum force required to pull the object up the incline. (3)
[9]

QUESTION 7: HEAT

7.1 State TWO differences between *heat* and *temperature*. Give your answer in table form. (4)

7.2 A fuel with heat energy of $25\,MJ/kg$ is used in an engine that has an output power of 10 kW. The thermal efficiency is 30% after the test ran for 30 minutes.

Calculate the following:

7.2.1 The input power of the fuel used

7.2.2 The heat energy given off by the fuel

7.2.3 The mass of the fuel used

(3 × 2) (6)

7.3 Give ONE advantage of steam. (1)
[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Name the TWO charges found in the nucleus and their charges. (4)

8.2 State TWO uses of electrolysis. (2)

8.2 Explain what is meant by *superheated steam.* (2)
[8]

QUESTION 9: ELECTRICITY

9.1 An electrical circuit consisting of a supply voltage of $12\,V$ is connected in series with a resistor; $R_1 = 4\,\Omega$. The resistor R_1 is also connected in series with other two resistors, $R_2 = 6\,\Omega$ and $R_3 = 3\,\Omega$ which are connected in parallel to each other.

9.1.1 Calculate the voltage drop across resistor R_1. (5)

9.1.2 Calculate the current flowing through resistor R_2. (3)

9.1.3 Calculate the current flowing through resistor R_3. (2)

9.2 A copper conductor is $66\,m$ long and has a diameter of $4\,mm$. The resistivity of copper is $0{,}017\ \mu\Omega m$. Calculate the resistance of the conductor. (3)
[13]

TOTAL: 100

FORMULA SHEET

All formulae needed are not necessarily included.

Any applicable formula may be used.

$W = m.g$

$W = F.s$

$P = \frac{W}{t}$

$\eta = \frac{Output}{input} .100\%$

$\eta = \frac{Uitset}{Inset} .100\%$

$\mu = \frac{F_\mu}{N_R}$

$\mu = \tan \phi$

$F_T = F_\mu \ldots \begin{matrix} horizontal/ \\ horisontaal \end{matrix} \ldots a = o$

$F_S = w \sin \theta$

$F_C = w \cos \theta$

$F_T = F_\mu \pm F_S \ldots a = 0$

$F_e = T_1 - T_2$

$\frac{T_1}{T_2} = \begin{matrix} tension\ ratio/ \\ spanningsverhouding \end{matrix}$

$P = F_e . v$

$v = \pi . d . n$

$n = \frac{N}{60}$

$N_A . T_A = N_B . T_B$

$SV = \frac{N_A}{N_Z} = VR$

$E_P = m . g . h$

$E_k = \frac{1}{2} . m . v^2$

$E_T = E_p + E_k$

$HV = \frac{L}{E} = MA$

$VV \frac{S_E}{S_L} = DR$

$\frac{HV}{VV} .100\% = \eta = \frac{MA}{DR} .100\%$

$VV = \frac{2D}{(d_1 - d_2)} = DR$

$VV = \frac{2D}{(D - d)} = DR$

$Q = m . c . \Delta t$

$m . ww = Q = m . h_v$

$P = \frac{Q}{t}$

$\Delta l = l_o . \alpha . \Delta t$

$l_f = l_o \pm \Delta l$

$1\ m/s = 3{,}6\ km/h$

$s = ut + \frac{1}{2} at^2$

$v = u + at$

$v^2 = u^2 + 2as$

$\sum \uparrow F = \sum \downarrow F$

$\sum \curvearrowleft M = \sum \curvearrowright M$

$P_{ABS} = P_{ATM} + P_{MET}$

$P = pgh$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$

$R_s = R_1 + R_2 + \cdots + R_n$

$R = \frac{p . l}{a}$