higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

18 November 2020 (X-paper)
09:00–12:00

This question paper consists of 7 pages and 1 formula sheet.

139Q1E2018

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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. Keep subsections of questions together.
5. All calculations should consist of the following three steps:
   - Formula used or manipulation thereof
   - Substitution of given data in formula
   - Answer with the correct SI unit
6. Use the values below 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 expansion of steel	$= 0,000\,012$ / ℃
Linear coefficient 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 ℃	$= 0,000\,000\,028\ \Omega\ m$

7. Drawing instruments must be used for all drawings.
8. Rule off on completion of each question.
9. Write neatly and legibly.

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QUESTION 1: DYNAMICS

1.1 Define *speed*. (1)

1.2 Give TWO effects that the application of a force can have on an object. (2)

1.3 The velocity of a moving car was observed and recorded at different time intervals as shown in the table below.

Time	0	5	10	15	20	25
Velocity	20	40	60	80	80	0

1.3.1 Draw the velocity/time graph of the motion of the car over 25 s. (4)

1.3.2 Calculate the acceleration during the first 15 seconds. (2)

1.3.3 Calculate the displacement after the first 20 seconds. (4)

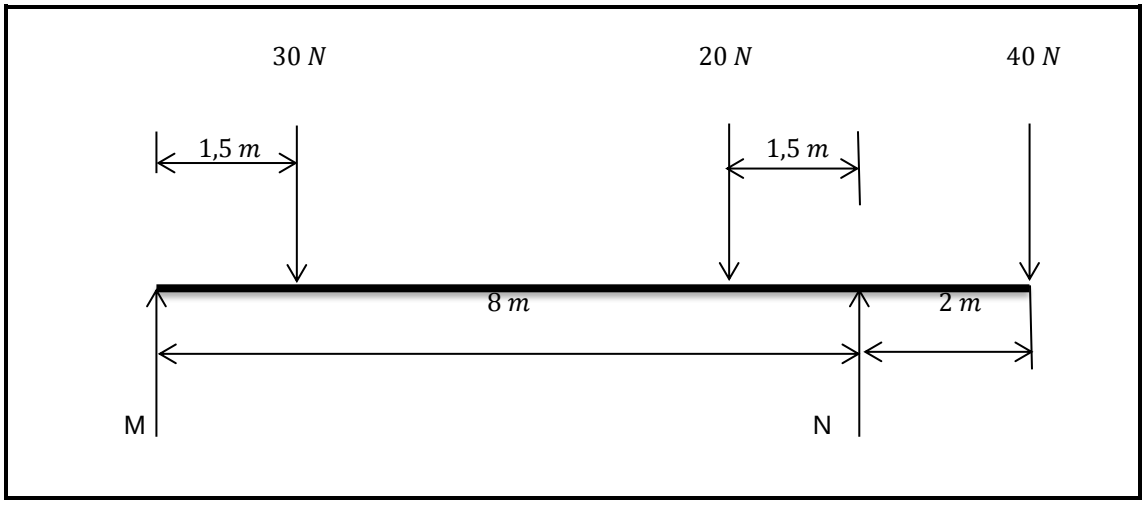
1.4.4 Calculate the acceleration during the last 5 s. (2)

[15]

QUESTION 2: STATICS

2.1 Define *resultant.* (2)

2.2 Study the diagram below in which a horizontal beam resting on two supports carries different loads.



2.2.1 Calculate the magnitude of the reactions by taking moments about both supports. (6)

2.2.2 Use the answers in QUESTION 2.2.1 to check whether the system is in equilibrium. (1)

2.3 Name the SI unit for torque. (1)

[10]

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QUESTION 3: ENERGY AND MOMENTUM

3.1 Define *kinetic energy.* (2)

3.2 A brick with a mass of 10 kg falls from a building at a height of 15 m from the ground. The brick hits a platform 3 m from the ground.

Calculate the kinetic energy as well as the momentum of the brick as it hits the platform. (5)
[7]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define *force.* (1)

4.2 A lift with a load of 1 800 N is hoisted vertically to a height of 40 m by means of a cable with a weight of 30 N/m.

Calculate each of the following:

4.2.1 The total work done in hoisting the lift (3)

4.2.2 The power required to hoist the lift if the action took 2,5 minutes (2)

4.3 A body with a mass of 4 kg is placed on an inclined plane which forms an angle of 15° with reference to the horizontal.

Calculate the force required to pull the object up the incline.(Ignore friction) (2)
[8]

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QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Name TWO gear systems. (2)

5.2 Gear A drives gear B and gear C drives gear D. Gears B and C are mounted on the same shaft. Also given is the data below.

$N_A = 975\ r/min$
$T_A = 13\ T$
$T_B = 33T$
$T_C = 40\ T$
$T_D = 25\ T$

Calculate each of the following:

5.2.1 The rotational frequency of gear B (2)

5.2.2 The rotational frequency of gear D in r/s (3)

5.3 State TWO advantages of *chain drives* over *belt drives*. (2)

5.4 Give THREE examples of different types of lifting devices. (3

5.5 The tension ratio of a belt drive is 4:1 and the tension in the slack side is 400 N. The diameter and the rotational frequency of the driving pulley is 280 mm and 40 r/s respectively.

Calculate each of the following:

5.5.1 The speed of the belt (2)

5.5.2 The power transmitted by the belt (3)

[17]

QUESTION 6: FRICTION

6.1 A cart with a mass of 25 kg is pulled by a horse applying a force of 40 N to the right on a flat surface.

6.1.1 Draw a clearly labelled space diagram or picture diagram of all the forces acting on the cart. Do not draw the horse and the cart. (4)

Calculate each of the following:

6.1.2 The normal or the reaction force acting on the cart (2)

6.1.3 The coefficient of friction (μ) (2)

6.2 What is the height of a squire base container with parallel sides if it is filled with 10kg of water? The length of the base is half the height of the container. (4)

[12]

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QUESTION 7: HEAT

7.1 State the law of the conservation of heat. (1)

7.2 A pressurised container uses 150 kg of coal with a heat value of 30 MJ/kg to boil water. The water temperature rises from $40\,℃$ to $120\,℃$. The water has a mass of 2 400 kg.

Calculate each of the following:

7.2.1 The energy released by the coal (2)

7.2.2 The energy gained by the water in MJ. (2)

7.2.3 The efficiency (2)

7.3 A rod of 15 m with a temperature of 164 °C is exposed to heat. Its temperature increases to 234 °C and it expands by 24,15 mm.

Determine, by means of calculation, the type of rod used. (3)
[10]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define *electrolyte.* (2)

8.2 Give TWO practical uses of electrolytes. (2)

8.3 Give TWO uses of electroplating. (2)

8.4 Name TWO methods to prevent corrosion. (2)
[8]

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QUESTION 9: ELECTRICITY

9.1 State the relationship between voltage and resistance. (1)

9.2 Various options are given as answers to the questions below. Choose the answer and write only the letter (A—D) next to the question number (9.2.1–9.2.2) in the ANSWER BOOK.

9.2.1 Two bulbs, A and B, are connected in parallel and then connected to the supply voltage of a simple DC circuit. What will happen with the brightness of bulb A when bulb B blows?

A Stays the same
B Gets more dim
C Gets brighter
D Gives no light

9.2.2 When two resistors of different magnitude are connected in series the current passing through a bigger resistance would be …

A smaller.
B bigger.
C the same.
D zero.

(2 × 1) (2)

9.3 A simple DC circuit has a supply voltage of 18 V. Resistor $R_1 = 8\,\Omega$ is connected next to the supply in series with two resistors that are connected in parallel to each other. $R_2 = 12\,\Omega$ and $R_3 = 6\,\Omega$ respectively.

Calculate the each of the following:

9.3.1 The equivalent resistance of the parallel section (2)

9.3.2 The total current flowing through the circuit (3)

9.3.3 The voltage drop across the $8\,\Omega$ resistor (2)

9.3.4 The current flowing through the $12\,\Omega$ resistor (3)

[13]

TOTAL: 100

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ENGINEERING SCIENCE N2

FORMULA SHEET

Any other applicable formula may also be used.

$W = m \cdot g$

$W = F \cdot s$

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

$\eta = \frac{Output}{input} \cdot 100\%$ n

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

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

$\mu = \tan \phi$

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

$F_S = w \sin \theta$

$F_C = w \cos \theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \cdot v$

$v = \pi \cdot d \cdot n$

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

$N_A \cdot T_A = N_B \cdot T_B$

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

$E_P = m \cdot g \cdot h$

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

$E_T = E_p + E_k$

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

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

$\frac{HV}{VV} \cdot 100\% = \eta$

$= \frac{MA}{DR} \cdot 100\%$

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

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

$Q = m \cdot c \cdot \Delta t$

$m \cdot ww = Q = m \cdot h_v$

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

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

$l_f = l_o \pm \Delta l$

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

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

$v = u + at$

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

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

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

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

$P = pgh$

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

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

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

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