higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

3 April 2020 (X-paper)
09:00–12:00

This question paper consists of 8 pages and 1 formula sheet.

084Q1A2003

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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.

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QUESTION 1: DYNAMICS

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1.1–1.1.3) in the ANSWER BOOK and justify your answer.

1.1.1 The equation $s = ut + \frac{1}{2}at^2$ is used in kinetics. Which one of the following quantities is represented by the product $\frac{1}{2}at^2$?

A Velocity
B Time interval
C Acceleration
D Displacement

1.1.2 The area under the graph of the velocity-time graph represents …

A displacement.
B acceleration.
C velocity.
D deceleration.

1.1.3 If the acceleration of a moving car is $0\ m/s^2$, the car is …

A coming to rest.
B changing direction.
C moving with constant velocity.
D changing its speed.

(2 × 3) (6)

1.2 A racing car is moving with a velocity of $60\ m/s$ on a straight road and then accelerates at $2\ m/s^2$ for $10\ s$.

1.2.1 Calculate the displacement of the car in $10\ s$. (2)

1.2.2 Calculate the velocity of the car at the end of the period of $10\ s$ (2)

1.2.3 The brakes are suddenly applied when the car is flagged down for tyre change and the car experienced a retardation of $10\ m/s^2$.

What is the stopping distance of the car? (3)

1.3 A girl drops a $0{,}3\ kg$ ball from rest at the top of a bridge into the water. (Ignore air resistance.) It takes the ball $3\ s$ to hit the surface of the water.

Calculate the velocity of the ball as it hits the surface of the water. (2)

[15]

QUESTION 2: STATICS

2.1 Define a *couple.* (2)

2.2 Give TWO examples of couples. (2)

2.3 Two forces of 9 N each make up the pair of forces of an approximate couple. If the moment is 16 Nm, calculate how far the forces are apart. (2)

2.4 The horizontal component of a force applied at 22º with the horizontal has a magnitude of 69.539N.Calculate the magnitude of this force and its vertical component. USE GIVEN DATA FOR ALL YOUR CALCULATIONS. (4)

[10]

QUESTION 3: ENERGY AND MOMENTUM

An object with a mass of $15\ kg$ is rolling down an incline plane which has point A at the top and point B at the bottom and the angle formed between the inclined plane and the horizontal is $30°$. The displacement between the two points is$10\ m$ along the plane. Neglect any friction.

Calculate the following:

3.1 The potential energy of the object at point A. (3)

3.2 Velocity of the object at point B. (3)

3.3 Momentum of the object at point B. (1)

[7]

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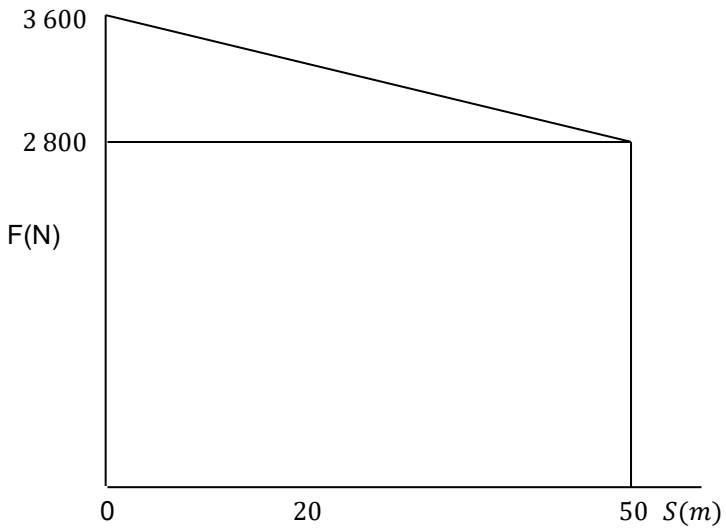
QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 A force/distance graph is shown below. A machine with a load of $2800\ N$ is hoisted vertically by means of a chain:



Calculate the following:

4.1.1 Weight of the chain in N/m, from the graph (1)

4.1.2 Work to be done in hoisting the chain alone when only 40m of the chain is still to be hoisted. (3)

4.1.3 The total power required in hoisting the load and the chain when the load is $20\ m$ from the bottom for the remainder of the chain length and the velocity is $0,25\ m/s$ (2)

4.2 A truck has a tyre with a diameter of $1\ 500\ mm$. The torque required to turn the tyre is $4{,}5\ kNm$.

Calculate the following:

4.2.1 The force applied at the circumference of the tyre.

4.2.2 Work done to turn the tyre through one revolution.

(2 × 2) (4)

[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Give THREE applications of belt drives. (3)

5.2 What is the advantage of using a lifting device? (1)

5.3 The following data refers to a belt drive which has been used to transport coal:

The force in the tight side of the belt is $= 2\,000\ N$
The tension ratio between the tight side and the slack side is $= 4$
The diameter of the driving pulley is $= 500\ mm$
The rotational frequency of the driving pulley is $= 45\ r/s$

Calculate the following:

5.3.1 Velocity of the belt (2)

5.3.2 Tension in the slack side of the belt (2)

5.3.3 Power transmitted by the belt (3)

5.4 A hoisting device is used to pull the engine with a mechanical efficiency of $75\ \%$ and effort distance is $4\,000\ mm$ and the load distance is $300\ mm$.

Calculate the following:

5.4.1 Velocity ratio of the device

5.4.2 Mechanical advantage of the device

5.4.3 The effort if the load is $1200\ N$

(3 × 2) (6)
[17]

QUESTION 6: FRICTION AND HYDRAULICS

6.1 How many bars is 720mm Hg if the density is 13600kg/m^3. (2)
Assume 1bar= 10^5Pa

6.2 An object of $10\ kg$ is placed on an inclined plane which forms an angle of $25°$ to the horizontal. The coefficient of friction between the object and the incline is $0{,}35$.

Calculate the following:

6.2.1 Weight component parallel to the inclined plane (2)

6.2.2 Weight component perpendicular to the inclined plane (2)

6.2.3 External force required to pull the object up the incline (3)
[9]

QUESTION 7: HEAT

7.1 Define *specific heat capacity.* (2)

7.2 Give TWO examples of fluids as a combustible. (2)

7.3 A mass of $15\ kg$ of coal is used to heat a boiler in 1 hour. During the process $25\ \%$ of heat energy is lost.

Calculate the following:

7.3.1 Amount of heat released

7.3.2 The power developed.

(2 × 2) (4)

7.4 A welder dropped a steel plate with a mass of $10\ kg$ and at a temperature of $190\ ℃$ into a container with water which is at a temperature of $20\ ℃$. After the steel plate is dropped into the water, the temperature of the water rises to $55\ ℃$.

Calculate the mass of the water. (3)

[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define *ion.* (1)

8.2 Name the THREE fundamental constituents of an atom and state their polarities. (3 × 2) (6)

8.3 What are electrolytes? (1)

[8]

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QUESTION 9: ELECTRICITY

9.1 How does a current behave when the resistors are connected:

9.1.1 In series

9.1.2 In parallel

(2 × 1) (2)

9.2 A simple DC-circuit consisting of a supply voltage of $12\,V$ and a resistor $R_1 = 4\,\Omega$, is connected in series with two parallel resistors, $R_2 = 6\,\Omega$ and $R_3 = 3\,\Omega$.

Calculate the following:

9.2.1 Total resistance of the circuit (4)

9.2.2 Current flowing through the R_2 branch on the parallel section (6)

9.3 Give ONE practical application of mutual inductance. (1)

[13]

TOTAL: 100

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FORMULA SHEET

All formula needed are not necessarily included.

Any applicable formula may be used.

$W = m.g$

$W = F.s$

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

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

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

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

$\mu = \tan \phi$

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

$F_S = w \sin \theta$

$F_C = w \cos \theta$

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

$F_e = T_1 - T_2$

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

$P = F_e . v$

$v = \pi . d . n$

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

$N_A . T_A = N_B . T_B$

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

$E_P = m . g . h$

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

$E_T = E_p + E_k$

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

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

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

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

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

$Q = m . c . \Delta t$

$m . ww = Q = m . h_v$

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

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

$l_f = l_o \pm \Delta l$

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

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

$v = u + at$

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

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

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

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

$P = pgh$

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

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

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

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