higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

18 November 2022 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

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

086Q1E2218

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 calculations should consist of at least the following FOUR steps:

   4.1 The formula used or the manipulation thereof
   4.2 The substitution of the given data in the formula
   4.3 Round-off your answer to three decimal places where applicable
   4.4 Include the correct SI unit in your final calculation

5. The following values must be used in this question paper, whenever applicable:

Gravitational acceleration	= 9,8 m/s²
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 °C
Specific heat capacity of steam	= 2 100 J/kg °C
Specific heat capacity of steel	= 500 J/kg °C
Specific heat capacity of copper	= 390 J/kg °C
Specific heat capacity of aluminium	= 900 J/kg °C
Linear coefficient of expansion of steel	= 0,000 012/°C
Linear coefficient of expansion of copper	= 0,000 017/°C
Linear coefficient of expansion of aluminium	= 0,000 023/°C
Resistivity of steel at 20 °C	= 0,000 000 155 Ω.m
Resistivity of copper at 20 °C	= 0,000 000 018 Ω.m
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ω.m

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

QUESTION 1: DYNAMICS

1.1 Convert 0,002 m to cm. (1)

1.2 A man runs for 6 km directly east until he gets to a T-junction where he turns around and runs another 8 km directly west.

Determine the following:

1.2.1 Total displacement of the man (2)

1.2.2 Average speed of the man if he takes 47 minutes to complete the exercise. Give the answer in km/h. (2)

1.3 A motor car travels at a constant velocity of 10 m/s for 15 seconds and then accelerates at 0,5 m/s^2 for 10 seconds.

1.3.1 Calculate the final velocity of the motor car. (2)

1.3.2 Make a neat, labelled sketch of the velocity-time graph for this motion. (3)

1.4 Determine from the graph mentioned in QUESTION 1.3.2:

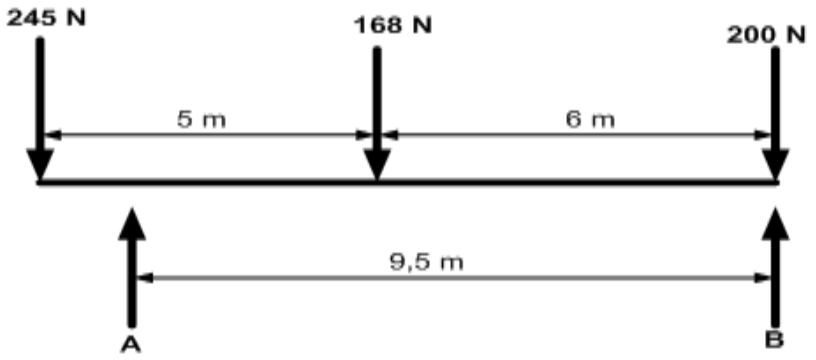
1.4.1 The total displacement (3)

1.4.2 The average velocity of the motor car (2)
[15]

QUESTION 2: STATICS

2.1 State the law of moments. (2)

2.2 The horizontal beam shown in the diagram, rests on two supports, A and B.



2.2.1 Determine the reaction of both supports by taking moments about each support. Ignore the weight of the beam. (6)

2.2.2 Test the answers of QUESTION 2.2.1. (1)

2.3 Give ONE example of couples. (1)
[10]

QUESTION 3: ENERGY AND MOMENTUM

3.1 Define the term *potential energy.* (2)

3.2 A lorry with a mass of 3 tons, travels at 92 km/h on a horizontal plane.

Calculate the following:

3.2.1 Kinetic energy of the lorry (2)

3.2.2 Momentum of the lorry (1)

3.3 Determine to what height the load of 25 kg can be lifted, when 10 kJ of energy is used. (2)
[7]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define the SI unit *joule.* (1)

4.2 A chain that is 50 m long with a weight of 160 N/m will be wound around a drum that is 50 m above the ground.

4.2.1 Draw a force-distance graph for the chain when it is wound onto the drum. (2)

4.2.2 Calculate the work done to wound the 50 m chain onto the drum. (2)

4.2.3 Calculate the power required to pull the full length of the chain if it takes 2 minutes to complete the task. (2)

4.3 Calculate the diameter of a pulley if an effective force of 130 N exerts a torque of 10,5 Nm on the pulley. (3)
[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Name TWO disadvantages of gear drives. (2)

5.2 Name the gear that ensures that the driver and the driven gears rotate in the same direction. (1)

5.3 Three gears, A, B and C engage and have 70, 130 and 65 teeth respectively. Gear A rotates at 600 rev/min.

Calculate the rotational frequency of gear C in rev/s. (3)

5.4 The driving pulley of the belt drive has a diameter of 130 mm and runs at 625 rev/min. The maximum allowable tension in the belt is 2 300 N and the tension ratio of the tight side to the slack side in the belt is 1,5.

Calculate the following:

5.4.1 The belt velocity (3)

5.4.2 The diameter of the driven pulley in mm, if it rotates at 15 rev/s (2)

5.4.3 Power transmitted (3)

5.5 Make a neat, labelled line sketch of a Weston pulley block lifting machine. (3)
[17]

QUESTION 6: FRICTION

6.1 Name ONE application of friction in practice. (1)

6.2 A body with a mass of 70 kg is pulled down an incline with an angle of 10^0 to the horizontal. The frictional force against the motion is 200 N.

Draw a neat sketch to show the above motion and label all the forces acting on a body and indicate the direction of each force. (2)

6.3 Refer to QUESTION 6.2 and calculate the following:

6.3.1 The coefficient of friction (2)

6.3.2 The component of the weight parallel to the plane (2)

6.3.3 The force required to pull the body down the incline (2)
[9]

QUESTION 7: HEAT

7.1 Define the *heat capacity of a substance*. (1)

7.2 Name THREE forms in which fuels are found and give ONE example of each. (3)

7.3 State THREE factors that influence the gain or loss of the heat energy of a substance. (3)

7.4 Determine the amount of water in kg which cooled down from 15 ^{0}C to -10 ^{0}C when 93 730 J of heat is released. (2)

7.5 A copper wire with a length of 2,3 m is heated from 12 ^{0}C to 33 ^{0}C.

Calculate the final length of the copper wire. (2)

[11]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define an *ion*. (1)

8.2 Name THREE fundamental constituents of an atom and their charges. (3)

8.3 Explain why pure water does not conduct electricity. (2)

8.4 Give TWO practical examples where electrolytes are used. (2)

[8]

QUESTION 9: ELECTRICITY

9.1 Name TWO types of resistors that may be used in a circuit. (2)

9.2 State Ohm's law. (2)

9.3 Two resistors are connected in parallel and their total resistance is 2 Ω.

Calculate the resistance of one resistor if the other one has a resistance of 3 Ω. (3)

9.4 Calculate the length of a copper conductor with a diameter of 1,3 mm and a resistance of 3 Ω at 20 ^{0}C. (3)

9.5 Draw a neat, labelled sketch to demonstrate mutual induction by using soft iron rod. (3)

[13]

TOTAL: 100

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ENGINEERING SCIENCE N2

FORMULA SHEET

All formulae needed are not necessarily included. Any other applicable formula may also be used.

$w = m \cdot g$

$W = F \cdot s$

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

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

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

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

$\mu = \tan \Phi$

$F_T = F_\mu \ldots \frac{horizontal}{horisontaal} \cdots a = 0$

$F_S = w \sin \theta$

$F_C = w \cos \theta$

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

$F_e = T_1 - T_2$

$\frac{T_1}{T_2} = \frac{tension\ \ ratio}{spanningsverhouding}$

$P = F_e \cdot v$

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

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

$N_A \cdot T_A = N_B \cdot T_B$

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

$E_p = m.g.h.$

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

$E_T = E_p + E_K$

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

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

$l_f = l_o \pm \Delta l$

1 m/s = 3,6 km/h

$s = u.t + \frac{1}{2}.a.t^2$

$v = u + a.t$

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

$\Sigma \uparrow F = \Sigma \downarrow F$

$\Sigma \curvearrowleft M = \Sigma \curvearrowright M$

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

$p = \Delta.g.h$

$\frac{1}{R_{PAR}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$

$R_{SER} = R_1 + R_2 + \ldots + R_n$

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