higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

24 November 2023 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

This question paper consists of 7 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 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 rounded-off to three decimal places where applicable together with the correct SI unit.

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
Resistivity of copper at 20 °C	= 0,000 000 018 Ω
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ω

6. Drawing instruments must be used for all drawings.
7. Subsections of questions must be kept together.
8. Use only blue or black ink.
9. Write neatly and legibly.

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QUESTION 1: DYNAMICS

1.1 Define the term *acceleration.* (1)

1.2 A car is travelling at 36 km/h for 8 s, when it begins to accelerate at 2 m/s^2 for 16 s.

Determine the following:

1.2.1 Initial velocity of the car in m/s. (1)

1.2.2 The final velocity of the car in m/s. (2)

1.2.3 Draw a fully labelled velocity-time graph. (3)

1.2.4 From the velocity-time graph ,determine the displacement of the car. (2)

1.2.5 The average velocity of the car. (2)

1.3 A scooter reduces its velocity from 30 m/s to 25 m/s in 0,5 sec.

1.3.1 Determine the deceleration of the scooter.

1.3.2 Determine the distance travelled in 0,5 sec.

(2 × 2) (4)
[15]

QUESTION 2: STATICS

2.1 Name TWO conditions to ensure a beam is in equilibrium. (2)

2.2 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (2.2.1–2.2.3) in the ANSWER BOOK.

If two forces, acting on a point, are represented in magnitude and direction by the two (2.2.1) … of a parallelogram, the (2.2.2) … of the two forces is represented in magnitude and direction by the (2.2.3) … of the completed parallelogram drawn from the point of application. (3)

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2.3 Consider FIGURE 1 and answer the questions that follow:

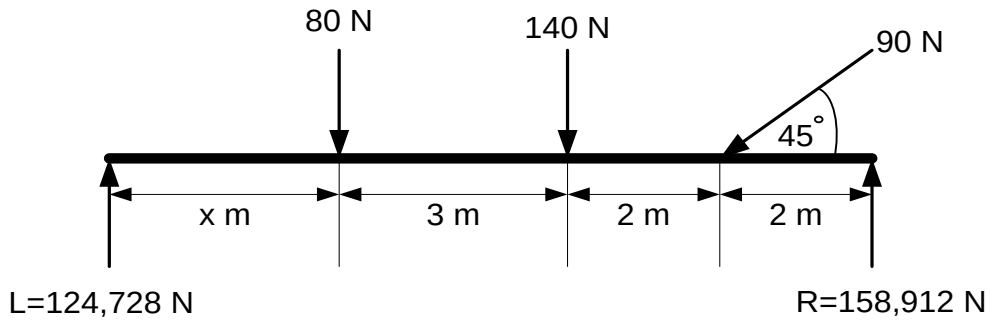

FIGURE 1

Calculate the following:

2.3.1 The vertical component of 90 N force. (2)

2.3.2 The distance x between left end support and 100 N force by taking moments about support R. (3)
[10]

QUESTION 3: ENERGY AND MOMENTUM

A body with a mass of 300 g is released freely from a height of 11 m above the ground level.

Calculate the following:

3.1 The potential energy of the body at the point of release. (2)

3.2 The kinetic energy of the body 6 m above the ground. (2)

3.3 The time taken to hit the ground from initial conditions. (3)
[7]

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QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define *torque*. (1)

4.2 A truck with a mass of one tonne travels at a constant velocity of 54 km/h up an incline of 20° with the horizontal.

Calculate the following:

4.2.1 The force to be developed by the engine if friction is neglected. (2)

4.2.2 The work done by the force in 8 seconds. (3)

4.2.3 The power developed in kW. (2)

4.3 The turning force applied to a flywheel is 1 650 N. The diameter of the flywheel is 350 mm.

Calculate the torque of the flywheel. (2)
[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 State THREE disadvantages of gear drives. (3)

5.2 A chain drive has a driving pulley with 45 teeth and a driven pulley with 90teeth. The rotational frequency of the driving pulley is 660 r/min.

5.2.1 Calculate the rotational frequency of the driven pulley in r/s.

5.2.2 Calculate the velocity ratio of the chain drive.

(2 × 2) (4)

5.3 A differential pulley block with an efficiency of 75% has a mechanical advantage of 20. The large pulley has 30 slots.

Calculate the following:

5.3.1 The load that can be lifted by an effort of 800 N.

5.3.2 The displacement ratio of the pulley block.

5.3.3 The number of slots in the smaller pulley.

(3 × 2) (6)

5.4 Define the SI unit *Pascal.* (1)

5.5 Name the THREE factors for determining the pressure exerted by a vertical liquid column. (3)
[17]

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QUESTION 6: FRICTION

6.1 Define the term *friction.* (1)

6.2 A train weighing 784 N is being pulled up an inclined plane with an angle of 23° with the horizontal. The coefficient of friction between the plane and wheel of the train is 0,3.

Calculate the following:

6.2.1 The weight component perpendicular to the sliding plane.

6.2.2 The weight component parallel to the sliding plane.

6.2.3 The frictional force.

6.2.4 The external force required to pull the train up the plane.

(4 × 2) (8)
[9]

QUESTION 7: HEAT

7.1 Name the instrument used to measure body temperature. (1)

7.2 Name THREE factors that will influence the change in length of the metal. (3)

7.3 Calculate the mass of coal required to heat 500 litres of water from 8 °C to 90 °C if there is no heat loss. (3)

7.4 A steel door with a height of 2,2 m and a width of 0,7 m is manufactured at a temperature of 13 °C.

If the temperature of the steel door increases to 36,7 °C, calculate the following:

7.4.1 The change in temperature. (1)

7.4.2 The change in height of the steel door in mm. (2)

7.4.3 The height of the steel door at a temperature of 36,7 °C. (1)
[11]

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QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (8.1.1–8.1.4) in the ANSWER BOOK. Give ONE reason for each answer.

8.1.1 When salt dissolves in water, the sodium and chlorine ions of many molecules become separated, that phenomenon is called solvent.

8.1.2 If an atom gains electrons, it has a negative charge and is known as an anion.

8.1.3 The charge of the nucleus in an atom is positive.

8.1.4 Distilled water is a good conductor of electricity.

(4 × 1) (4)

8.2 What is the charge of the cathode in an electrolysis process? (1)

8.3 Name THREE examples where electroplating is used. (3)

[8]

QUESTION 9: ELECTRICITY

9.1 A 2-ohm resistor is coupled with a 6-ohm resistor in parallel.

Determine the value of a single resistance that will have the same resistance as the parallel couple. (2)

9.2

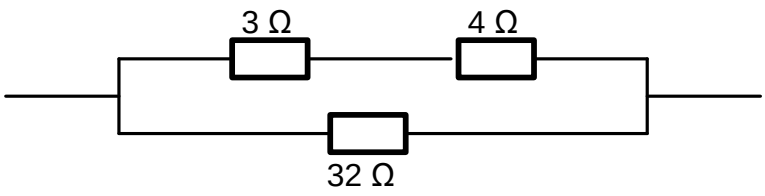

FIGURE 2

Calculate the total resistance of the circuit shown in FIGURE 2 above. (3)

9.3 Name TWO factors that will influence the resistance of the conductor. (2)

9.4 Make a neat, labelled drawing of an apparatus that may be used to demonstrate electromagnetic induction. (3)

9.5 Give TWO examples where mutual induction is used in practice. (2)

9.6 Briefly explain the term *self-induction.* (1)

[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

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

$v = u + a.t$

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

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

$\Sigma \circlearrowleft M = \Sigma \circlearrowright M$

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

$p = \Delta.g.h$

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

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

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

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