higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

21 November 2024 (X-paper)
09:00–12:00

REQUIREMENTS: Properties of water and steam (BOE 173)

Drawing instruments and non-programmable calculators may be used.

This question paper consists of 7 pages, 1 information sheet and a formula sheet of 2 pages.

060Q1E2421

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N3
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. Start each section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.
7. Steam tables to be supplied by the examination centre.

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QUESTION 1: MOTION, ENERGY AND POWER

1.1 A pulley is driven at 650 r/min by a flat belt driven at 20 m/s. The tension in the tight side of the belt is 700 N and the tension ration between the tight side and the slack side is 5:2.

Calculate the following:

1.1.1 The tension in the slack side (2)

1.1.2 Power transferred in kilowatt (3)

1.2 A BMW motor car with mass of 1,2 ton accelerates from rest uniformly from rest up a gradient 1 of 3 and reaches a speed of 72 km/h after 3 minutes.

Calculate:

1.2.1 The acceleration of the BMW. (2)

1.2.2 The kinetic energy that the BMW possess after 3 minutes. (2)

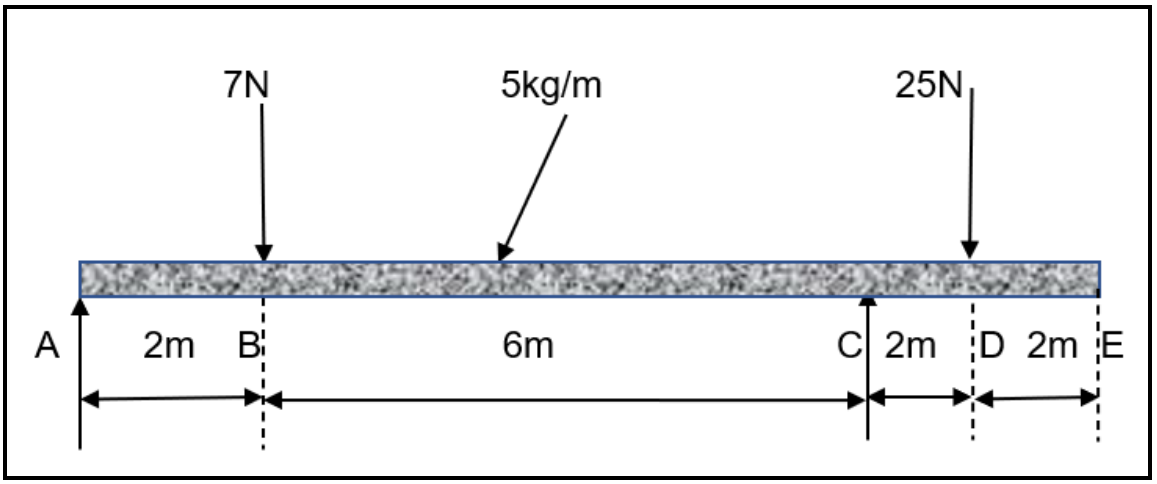
1.2.3 Potential energy after 3 minutes. (7)

[16]

QUESTION 2: MOMENTS

2.1 Give TWO types of loads acting on a beam. (2)

2.2



From the above beam, answer the following questions:

2.2.1 Calculate the reactions of the supports A and C and test the answers. (5)

2.2.2 Draw the shear force diagram using suitable scale. (5)

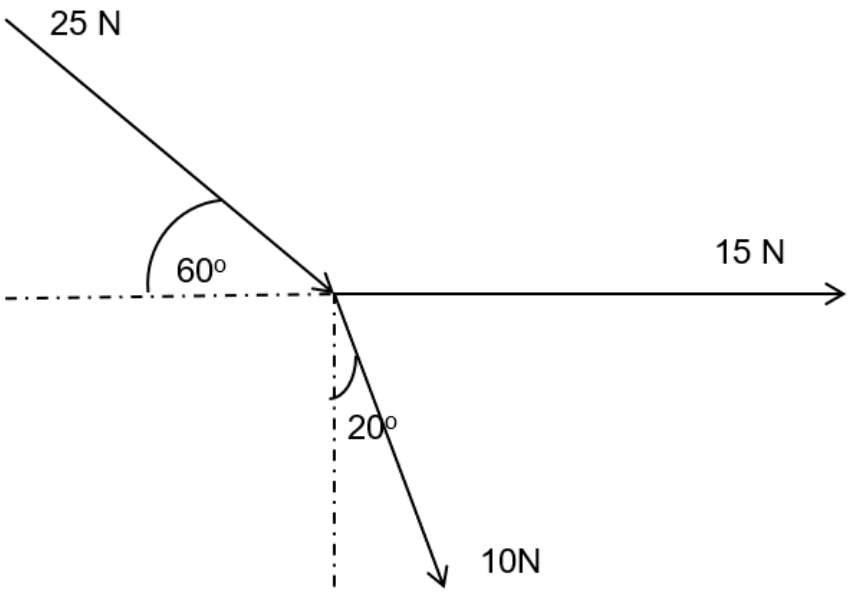
[12]

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QUESTION 3: FORCES

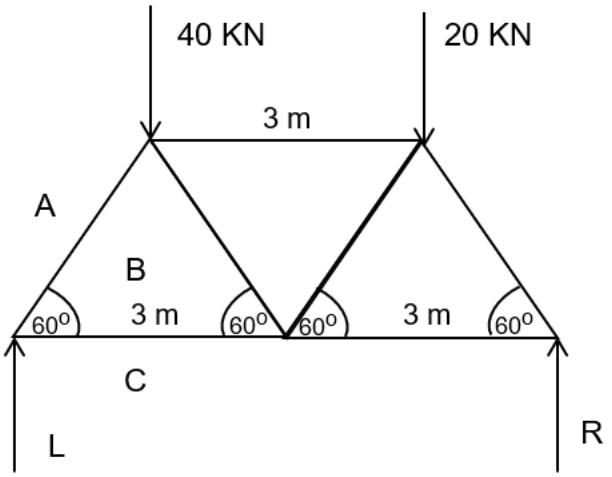
3.1 Define *equilibrium of forces*. (2)

3.2 For the system of forces below, find magnitude and direction of the resultant.



(7)

3.3 Calculate the magnitude and nature of members AB and BC for the frame below:



(6)
[15]

QUESTION 4: FRICTION

4.1 Give THREE advantages of friction. (3)

4.2 The parallel weight component of a block on an incline is 54,26 N. The angle of the incline to the horizontal is 18°. A force of 120 N is just sufficient to move the block across a horizontal plane.



Calculate the:

4.2.1 Weight of the block

4.2.2 Perpendicular weight component

4.2.3 Frictional force

4.2.4 Co-efficient of friction between the block and incline

(4 × 2) (8)

[11]

QUESTION 5: HEAT



5.1 Give FOUR disadvantages of steam. (4)

5.2 A mass of 4,28 kg of fuel is burnt for 55 minutes to heat 200 *litres* of water from 28 °C. to 120 °C. Only 60% of the energy of the fuel was dissipated to the water.

Calculate:

5.2.1 The heat energy required for the temperature change. (2)

5.2.2 The heat energy given off by the fuel. (2)

5.2.3 The heat value of the fuel. (2)

5.2.4 Name the fuel in QUESTION 5.2.3. (1)

5.3 State the nature of the steam with properties below and determine its enthalpy:



P = 1,2 Mpa
t = 400 °C (2)

[13]

QUESTION 6: HYDRAULICS

6.1 Make a neat, labelled sketch to showing working Pascal's principle of the hydraulic jack. (4)

6.2 The pressure exerted at the bottom of a column of liquid is 30 kPa. The height of the column is 3,327 m.

Calculate:

6.2.1 The density of the liquid (round your answer to zero decimal). (3)

6.3 A water pump with a piston diameter of 150 mm has to deliver $2,5 \times 10^{-3} m^3$ per stroke. The average force exerted on the piston is 3,65 kN per working stroke.

Calculate:

6.3.1 The pressure of the fluid during the working stroke in Mpa (3)

6.3.2 The length of the stroke in cm (2)

6.3.3 The work done per stroke (2)

[14]

QUESTION 7: ELECTRICITY

7.1 Draw the sketch of a simple transformer. (3)

7.2 Differentiate between *alternating current* and *direct current*. (2)

7.3 A single-phase transformer has a supply voltage of 210 V. At full load the Primary current is 11 A and the secondary current is 55 A. There are 600 turns on the primary coil.

Calculate the:

7.3.1 Secondary voltage

7.3.2 Number of turns on the secondary

7.3.3 Turns ratio

7.3.4 Power of the transformer

(4 × 2) (8)

[13]

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QUESTION 8: CHEMISTRY

8.1 Briefly describe an atom. (1)

8.2 Briefly describe an element. (2)

8.3 List THREE precautionary measures which can be implemented to combat corrosion. (3)
[6]

TOTAL: 100

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INFORMATION SHEET

PHYSICAL CONSTANTS

HOEVEELHEID	KONSTANTE CONSTANTS	QUANTITY
Atmosferiese druk	101,3 kPa	Atmospheric pressure
Digtheid van koper	8 900 kg/m^3	Density of copper
Digtheid van aluminium	2 770 kg/m^3	Density of aluminium
Digtheid van goud	19 000 kg/m^3	Density of gold
Digtheid van alkohol (etiel)	790 kg/m^3	Density of alcohol (ethyl)
Digtheid van kwik	13 600 kg/m^3	Density of mercury
Digtheid van platina	21 500 kg/m^3	Density of platinum
Digtheid van water	1 000 kg/m^3	Density of water
Digtheid van minerale olie	920 kg/m^3	Density of mineral oil
Digtheid van lug	1,05 kg/m^3	Density of air
Elektrochemiese ekwivalent van silwer	1,118 mg/C	Electrochemical equivalent of silver
Elektrochemiese ekwivalent van koper	0,329 mg/C	Electrochemical equivalent of copper
Swaartekragversnelling	9,8 m/s^2	Gravitational acceleration
Warmtewaarde van steenkool	30 MJ/kg	Heat value of coal
Warmtewaarde van antrasiet	35 MJ/kg	Heat value of anthracite
Warmtewaarde van petrol	45 MJ/kg	Heat value of petrol
Warmtewaarde van waterstof	140 MJ/kg	Heat value of hydrogen
Lineêre uitsettingskoëffisiënt van koper	17 × 10^{-6}/°C	Linear coefficient of expansion of copper
Lineêre uitsettingskoëffisiënt van aluminium	23 × 10^{-6}/°C	Linear coefficient of expansion of aluminium
Lineêre uitsettingskoëffisiënt van staal	12 × 10^{-6}/°C	Linear coefficient of expansion of steel
Lineêre uitsettingskoëffisiënt van lood	54 × 10^{-6}/°C	Linear coefficient of expansion of lead
Spesifieke warmtekapasiteit van stoom	2 100 J/kg.°C	Specific heat capacity of steam
Spesifieke warmtekapasiteit van water	4 187 J/kg.°C	Specific heat capacity of water
Spesifieke warmtekapasiteit van aluminium	900 J/kg.°C	Specific heat capacity of aluminium
Spesifieke warmtekapasiteit van olie	2 000 J/kg.°C	Specific heat capacity of oil
Spesifieke warmtekapasiteit van staal	500 J/kg.°C	Specific heat capacity of steel
Spesifieke warmtekapasiteit van koper	390 J/kg.°C	Specific heat capacity of copper

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FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

$\eta = \frac{Uitset/Output}{Inset/Input}\ 100\%$

$F = m.a$

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

$\mu = \tan\Phi$

$N_R = F_C \pm F_T sin\alpha \ ... \ a = 0$

$F_S = wsin\theta$

$F_C = wcos\theta$

$F_T cos\alpha = F_\mu \pm F_S \ ... \ a = 0$

$F_e = T_1 - T_2$

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

$P = F_e \ . \ v$

$v = \pi \ . \ d \ . \ n \ ... \ n = \frac{N}{60}$

$W_\mu = F_\mu \ . \ s$

$\Delta E_p = m.g.\Delta h$

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

$Q = I^2 \ . \ R \ . \ t$

$m = I \ . \ z \ . \ t$

$\frac{V_P}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$

$m_1.u_1 \pm m_2.u_2 = m_1.v_1 \pm m_2.v_2$

$D_e = (D + t)$

$h_{nat/wet} = h_f + x.h_{fg}$

$P = 2.\pi.T.n \ ... \ T = F.r$

$P = \frac{F_{RAM}}{A_{RAM}} = \frac{F_{PL}}{A_{PL}} \ ... \ A = \frac{\pi D^2}{4}$

$V_{RAM} = V_{PL} \times n$

$A_{RAM} \ . \ H_{RAM} = A_{PL} \ . \ L_{PL}$

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

$\Sigma F_X = F_1 cos\theta_1 + ... + F_n cos\theta_n$

$\Sigma F_y = F_1 sin\theta_1 + ... + F_n sin\theta_n$

$R = \sqrt{\Sigma F_X^2 + \Sigma F_Y^2}$

$tan\varphi = \frac{\Sigma F_Y}{\Sigma F_X}$

$Q = m \ . \ c \ . \ \Delta t \ ... \ t_F = to \pm \Delta t$

$m.ww = Q = m.hv$

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

$\Delta L = Lo \ . \ \alpha \ . \ \Delta t \ ... \ L_f = Lo \pm \Delta L$

$\Delta A = A_0 \ . \ \beta \ . \ \Delta t \ ... \ A_f = A_0 \pm \Delta A$

$2.a.s = v^2 - u^2$

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

$v = u + a.t$

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

$M = F \ . \perp s$

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$$\Sigma\ CWM = \Sigma ACWM$$

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

$$P = \delta \times g \times h$$

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

$$R_{SER} = R_1 + ... R_n$$

$$V_1 - V_2 = -e(U_1 - U_2)$$

$$V = I \times R$$

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