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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T640**(E)**(J30)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

30 July 2019 (X-Paper)
09:00–12:00

REQUIREMENTS: Properties of water and steam (BOE 173)

Calculators may be used

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

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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. Answers must be rounded off to THREE decimal places.
5. All the calculations should consist of at least the following THREE steps:
   - The formula used or the manipulation thereof
   - Substitution of the given data in the formula
   - The answer with the correct SI unit
6. All drawings and diagrams must be fully labelled and drawing instruments should be used.
7. The constant values, as they appear on the attached information sheet, must be used wherever possible.
8. Keep subsections of questions together.
9. Rule off on completion of each question.
10. Use $g = 9{,}8\ m/s^2$
11. Write neatly and legibly.

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QUESTION 1: MOTION, ENERGY AND POWER

1.1 Define the term *mass* of an object. (1)

1.2 Distinguish between *displacement* and *distance*. (1)

1.3 A Toyota Yaris moves from rest and accelerates for 15 seconds and reaches a velocity of 20 m/s. It continues with the uniform velocity for 15 seconds and the driver brakes and the car stops after 10 s.

Calculate:

1.3.1 The acceleration in the first 15 seconds (2)

1.3.2 The total distance of the entire motion (2)

1.3.3 The average velocity in 40 seconds (2)

1.4 Make a sketch of a velocity-time graph for the total duration of motion of the Toyota Yaris. (3)

1.5 A flat belt fits around a pulley which has a diameter of 45 cm. The belt has a speed of 17,6 m/s and transmits 9 N per mm belt width. The effective pull in the belt is 423 N and the belt has a width of 18 cm.

Calculate:

1.5.1 The power transmitted by the belt in kW (2)

1.5.2 The tight side of the force (1)

1.5.3 Pulley speed in r/s (2)
[16]

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QUESTION 2: MOMENTS

2.1 State TWO conditions for a beam to be in equilibrium. (2)

2.2 In FIGURE 1 a light horizontal beam ABCDE of a uniform cross section is loaded as shown:

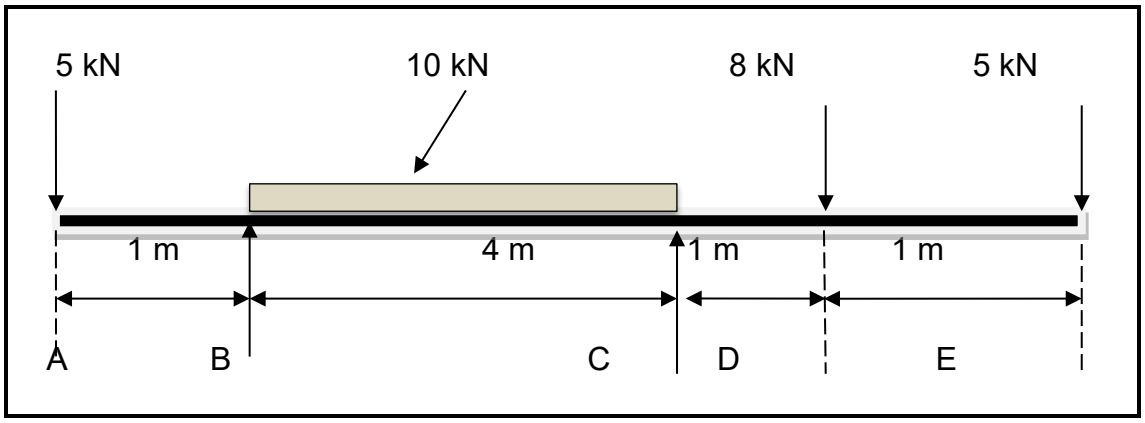

FIGURE 1

2.2.1 Calculate the reactions of the supports and motivate your answer. (6)

2.2.2 Draw a shear force diagram using a suitable scale. Show all the main values on the diagram. (4)

[12]

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QUESTION 3: FORCES

3.1 Define the term *triangle of forces*. (2)

3.2 The forces shown in FIGURE 2 are in equilibrium and in the same plane.

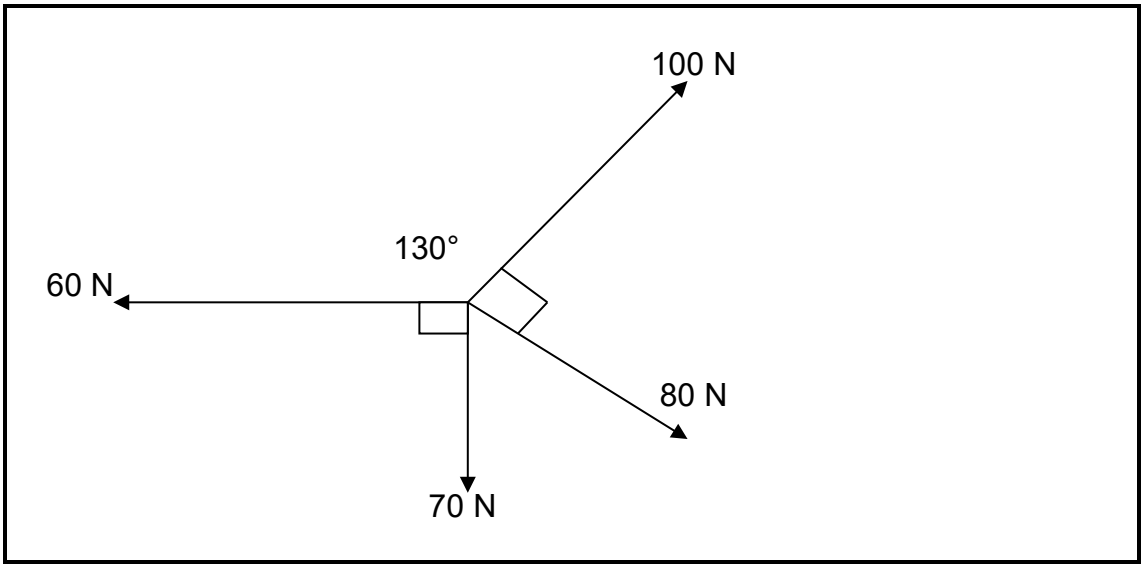

FIGURE 2

Calculate:

3.2.1 The sum of the horizontal components in magnitude and direction (3)

3.2.2 The sum of the vertical components in magnitude and direction (3)

3.2.3 The magnitude and direction of the equilibrant force (6)

[14]

QUESTION 4: FRICTION

4.1 Name FOUR principles of kinetic friction. (4)

4.2 An object is pushed upwards against a slope by a pushing force (P) which forms an angle of 15° with the slope. The object weighs 500 N, and the slope forms an angle of 20° with the horizontal. The coefficient of friction between the surfaces in contact is 0,2.

Calculate:

4.2.1 The mass of the object (1)

4.2.2 The smallest force P needed to push the object upwards (6)

4.3 Give TWO applications of the angle of repose. (2)

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QUESTION 5: HEAT

5.1 State TWO applications of steam. (2)

5.2 A rectangular brass sheet has the following dimensions at 10 °C as indicated on the diagram in FIGURE 3. The coefficient of linear expansion is 20×10^{-6}/°C. The sheet temperature is then raised to 120 °C.

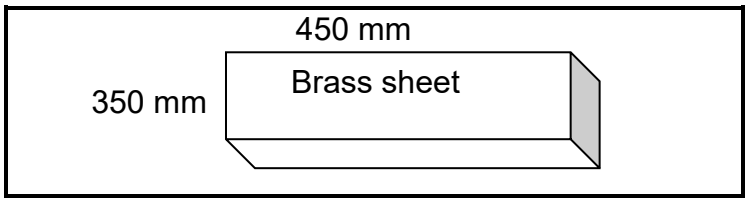

FIGURE 3

Determine the following:

5.2.1 The area coefficient of expansion (1)

5.2.2 The increase in area in m^2 at 120 °C (3)

5.2.3 The dimensions at 120 °C (5)

5.3 Calculate the volume of water in litres, required to cool 45 steel shafts. The initial temperature of the shafts is 800 °C and that of water is 35 °C. The mass of each steel shaft is 300 g. The final temperature of the water and steel shafts is 100 °C. (4)

[15]

QUESTION 6: HYDRAULICS

6.1 The following information refers to a single-acting hydraulic press:

Diameter of the ram	=	5,5 cm
Force applied to the plunger	=	0,4 kN
Diameter of the plunger	=	1,2 cm
Plunger stroke	=	0,2 m

Calculate:

6.1.1 The force exerted by the ram (2)

6.1.2 The distance in mm that the ram piston will move after 20 pumping strokes (3)

6.1.3 The volume of the liquid displaced after 20 pumping strokes of the plunger (3)

6.2 Name THREE elementary experiments dealing with pressure in liquids. (3)

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6.3 State whether the following statement is True or False:

The symbol for the SI unit of pressure is N/m^2. (1)

[12]

QUESTION 7: ELECTRICITY

7.1 State TWO very important uses of electroplating in the manufacturing industry and in engineering. (2)

7.2 A circuit consists of a 6 V battery and two parallel resistors of 4 Ω and 6 Ω and a resistor of 0,6 Ω in series. Ignore the internal resistance.

Calculate:

7.2.1 The total resistance of the circuit (2)

7.2.2 The current in the circuit (2)

7.2.3 Current through the 4 Ω resistor (3)

7.3 A single transformer has a supply voltage of 220 V and a primary current of 20 A at full load. There are 50 primary turns and 280 secondary turns on the transformer.

Calculate the following:

7.3.1 The secondary voltage (2)

7.3.2 The voltage per turn (1)

[12]

QUESTION 8: CHEMISTRY

8.1 State TWO ways in which atoms of different elements differ from one another. (2)

8.2 Name TWO types of corrosion. (2)

8.3 Name the component elements of the following:

8.3.1 Brass

8.3.2 Limestone

(2 × 1) (2)

[6]

TOTAL: 100

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ENGINEERING SCIENCE N3

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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INFORMATION SHEET

PHYSICAL CONSTANTS

QUANTITY	CONSTANTS KONSTANTE	HOEVEELHEID
Atmospheric pressure	101,3 kPa	Atmosferiese druk
Density of copper	8 900 kg/m^3	Digtheid van koper
Density of aluminium	2 770 kg/m^3	Digtheid van aluminium
Density of gold	19 000 kg/m^3	Digtheid van goud
Density of alcohol (ethyl)	790 kg/m^3	Digtheid van alkohol (etiel)
Density of mercury	13 600 kg/m^3	Digtheid van kwik
Density of platinum	21 500 kg/m^3	Digtheid van platina
Density of water	1 000 kg/m^3	Digtheid van water
Density of mineral oil	920 kg/m^3	Digtheid van minerale olie
Density of air	1,05 kg/m^3	Digtheid van lug
Electrochemical equivalent of silver	1,118 mg/C	Elektrocherniese ekwivalent van silwer
Electrochemical equivalent of copper	0,329 mg/C	Elektrochemiese ekwivalent van koper
Gravitational acceleration	9,8 m/s^2	Swaartekragversnelling
Heat value of coal	30 MJ/kg	Warmtewaarde van steenkool
Heat value of anthracite	35 MJ/kg	Warmtewaarde van antrasiet
Heat value of petrol	45 MJ/kg	Warmtewaarde van petrol
Heat value of hydrogen	140 MJ/kg	Warmtewaarde van waterstof
Linear coefficient of expansion of copper	17 × 10^{-5}/°C	Lineêre uitsettingskoëffisiënt van koper

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Linear coefficient of expansion of aluminium	23×10^{-5}/°C	Lineêre uitsettingskoëffisiënt van aluminium
Linear coefficient of expansion of steel	12×10^{-5}/°C	Lineêre uitsettingskoëffisiënt van staal
Linear coefficient of expansion of lead	54×10^{-5}/°C	Lineêre uitsettingskoëffisiënt van lood
Specific heat capacity of steam	2 100 J/kg.°C	Spesifieke warmtekapasiteit van stoom
Specific heat capacity of water	4 187 J/kg.°C	Spesifieke warmtekapasiteit van water
Specific heat capacity of aluminium	900 J/kg.°C	Spesifieke warmtekapasiteit van aluminium
Specific heat capacity of oil	2 000 J/kg.°C	Spesifieke warmtekapasiteit van olie
Specific heat capacity of steel	500 J/kg.°C	Spesifieke warmtekapasiteit van staal
Specific heat capacity of copper	390 J/kg.°C	Spesifieke warmtekapasiteit van koper

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