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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T640(**E**)(J26)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

26 July 2018 (X-Paper)
09:00–12:00

REQUIREMENTS: **Properties of water and steam (BOE 173)**

Nonprogrammable calculators may be used.

This question paper consists of 7 pages, 2 information sheets and 2 formula sheets.

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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:
   - 5.1 The formula used or the manipulation thereof
   - 5.2 Substitution of the given data in the formula
   - 5.3 The answer with the correct SI-unit
6. Drawing instruments should be used for all the drawings/diagrams.
7. All drawings/diagrams should be fully labelled.
8. The constant values, as they appear on the attached information sheets, should be used wherever possible.
9. Keep subsections of questions together.
10. Rule off on completion of each question.
11. Use g = 9,8 m/s^2.
12. Write neatly and legibly.

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QUESTION 1: MOTION, ENERGY AND POWER

1.1 What is meant by the term *inertia of an object*? (2)

1.2 A car is travelling from point A to point B on a circular path with a radius of 140 m, as shown in FIGURE 1. (Hint: C = 2 πr)

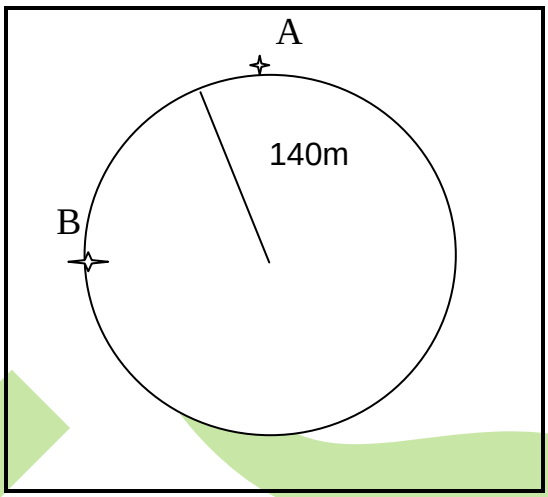

FIGURE 1

Calculate:

1.2.1 Distance from A to B (2)

1.2.2 Displacement from A to B (3)

1.2.3 The traveller's velocity from A to B in 3 minutes (2)

1.3 FIGURE 2 shows two masses suspended by a rope that passes over a frictionless pulley. Mass A = 6 kg and mass B = 8 kg. The masses are allowed to move freely.

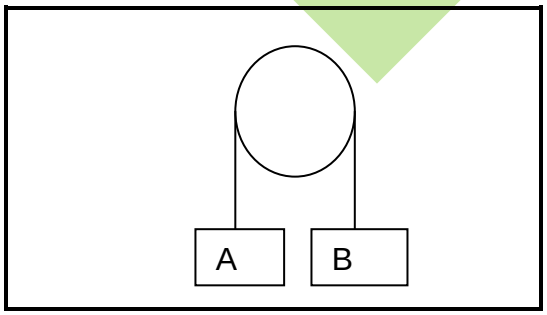

FIGURE 2

Calculate:

1.3.1 The acceleration and direction of the masses (4)

1.3.2 The tensile force in the rope (2)

[15]

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QUESTION 2: MOMENTS

2.1 What is meant by the term *concentrated load*? (1)

2.2 A uniform beam is 20 m long and rests horizontally on two supports. The one support is at the left end and the other support is 4 m from the right end. The beam carries concentrated loads of 200 N, 100 N and 80 N respectively 5 m, 10 m and 12 m from the left end. The beam carries a load of 15 N/m over the first 8 m from the right end.

2.2.1 Draw the diagram indicating all forces acting on the beam. (2)

2.2.2 Calculate the reactions at the supports. (4)

2.2.3 Draw the shearing force diagram. (4)

[11]

QUESTION 3: FORCES

3.1 Name TWO conditions for a number of coplanar forces acting on the same point to be in equilibrium. (2)

3.2 A system of forces is shown in FIGURE 3:

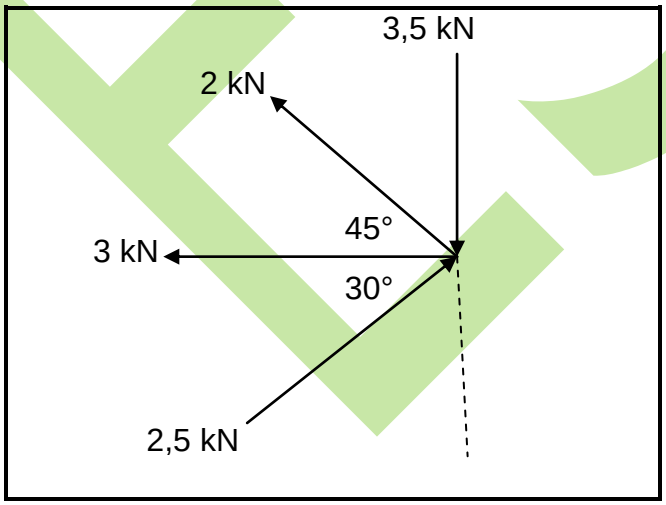

FIGURE 3

Calculate:

3.2.1 The sum of the vertical components and state the direction

3.2.2 The sum of the horizontal components and state the direction

3.2.3 The magnitude of the equilibrant

(4 × 3) (12)

[14]

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QUESTION 4: FRICTION

4.1 State THREE principles of kinetic friction. (3)

4.2 A casting with a mass of 500 kg rests on a surface with a slope of 20^{o} to the horizontal. The coefficient of friction is 0,25.

Calculate:

4.2.1 The component of the weight of the object perpendicular to the surface (2)

4.2.2 The component of the weight of the object parallel to the surface (2)

4.2.3 The friction force between the casting and the incline (2)

4.2.4 The smallest force required to move the casting down the incline (3)
[12]

QUESTION 5: HEAT

5.1 Describe the effect of a change in pressure on the saturation temperature. (1)

5.2 State TWO disadvantages of steam. (2)

5.3 Water is heated from $25^{o}C$ to $75^{o}C$ in 60 minutes by using 35 kg of a fuel with a heat value of 32 MJ/kg. The efficiency of the engine is 45%.

Calculate:

5.3.1 Change in temperature (1)

5.3.2 Heat energy delivered by the fuel in 60 minutes (3)

5.3.3 Volume of the water that is heated (4)

5.4 The sides of a square copper plate are 150 mm at 127 ^{o}C. The coefficient of linear expansion is 20 x $10^{-6}/^{o}C$. The temperature of the plate is decreased to 17 ^{o}C.

Calculate:

5.4.1 Coefficient of area expansion (1)

5.4.2 Final area (4)
[16]

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QUESTION 6: HYDRAULICS

6.1 The pressure exerted at the bottom of a column of liquid is 30 kPa. The height of the column is 3,875 m. What type of liquid is used? (2)

6.2 Make a neat, labelled sketch to illustrate the application of Pascal's law. (3)

6.3 The following data refers to a single-acting hydraulic press:

Force exerted on a ram piston	=	5 200 N
Force applied to a plunger	=	346 N
Diameter of plunger piston	=	0,08 m
Stroke length of plunger piston	=	10 cm

Calculate:

6.3.1 Diameter of the ram piston (2)

6.3.2 The distance that the ram will rise in 30 pumping strokes of the plunger piston (2)

6.3.3 The liquid pressure in the system (3)

[12]

QUESTION 7: ELECTRICITY

7.1 State Faraday's second law of electrolysis. (2)

7.2 A battery has a circuit consisting of three cells, each with an EMF of 6 V and an internal resistance of 0,6 Ω. They are connected in parallel. The battery is then connected to two resistors of 6 Ω and 4 Ω which are connected in parallel and a third resistor of 0,4 Ω connected in series.

Calculate:

7.2.1 The total resistance of the circuit (4)

7.2.2 The current flowing in the circuit (3)

7.2.3 The potential difference of the parallel circuit (2)

7.3 An electric lamp is marked 230 V, 200 W.

Calculate the cost to operate the lamp for 3 hours at a cost of 25 cents per unit. (3)

[14]

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QUESTION 8: CHEMISTRY

8.1 What is meant by the term *oxidation*? (1)

8.2 Name TWO methods used to combat corrosion. (2)

8.3 Name the component elements of:

8.3.1 Brass

8.3.2 Table salt

8.3.3 Phosphor bronze

(3 × 1) (3)
[6]

TOTAL: 100

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FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \ . \ v$

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

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

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

$\Sigma\, CWM = \Sigma ACWM$

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

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

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

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

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

$V = I \times R$

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

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

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

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

$v = u + a.t$

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

$M = F \,.\, \perp s$

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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	Elektrochemiese 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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