higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T640**(E)**(N19)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

19 November 2018 (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, 1 information sheet and a formula sheet of 2 pages.

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:

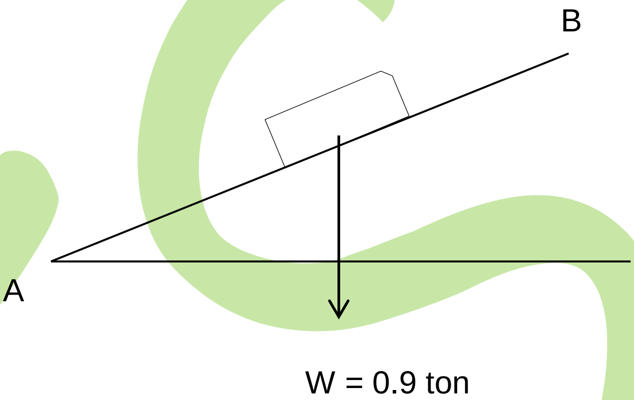
   The formula used or the manipulation thereof
   Substitution of the given data in the formula
   The answer with the correct SI unit
6. Drawing instruments must be used for all drawings/diagrams.
7. All drawings/diagrams must be fully labelled.
8. The constant values, as they appear on the attached information sheet, must 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.

QUESTION 1: MOTION, ENERGY AND POWER

1.1 State the law of conservation of energy in words. (2)

1.2 A motorcar with a mass of 0,9 ton is parked on an incline AB of 1 : 20. The motorcar departs from rest at A and within 12 seconds reaches a speed of 144 km/h.

If all frictional losses are neglected, calculate:



1.2.1 The acceleration of the car from A to B

1.2.2 The pulling force of the car's engine

1.2.3 The length of the gradient

1.2.4 The power of the car's engine

1.2.5 The potential energy at B (5 x 2) (10)

1.3 A Gautrain experiences a tractive resistance of 280 N per 1 000 kg when it moves.

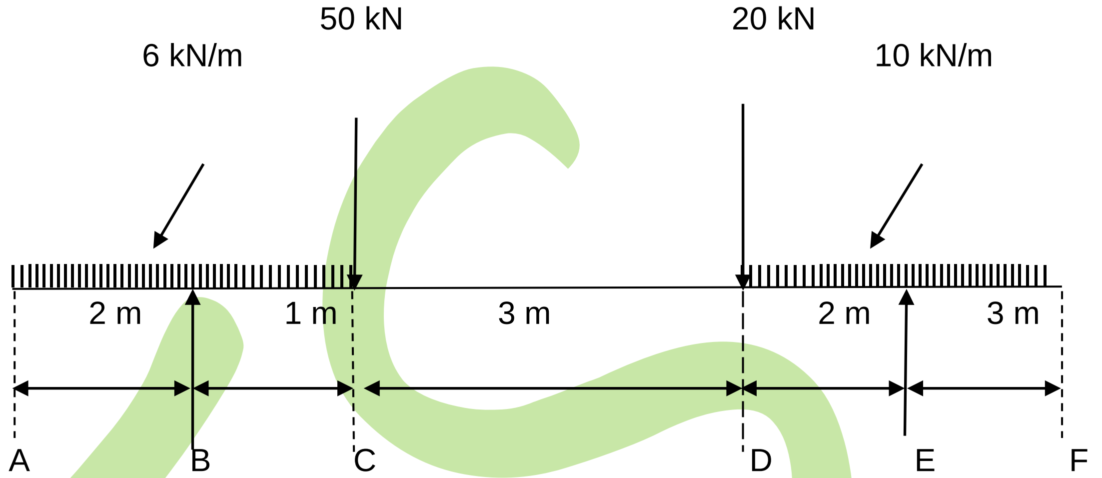
If the Gautrain exerts a force of 80 kN when it has a mass of 40 000 kg, calculate the acceleration of the Gautrain. (4)

[16]

QUESTION 2: MOMENTS

2.1 State the law of moments. (2)

2.2 Given: a light horizontal beam ABCDEF of a uniform cross-section, loaded as shown.



2.2.1 Calculate the reaction of the supports B and E. (4)

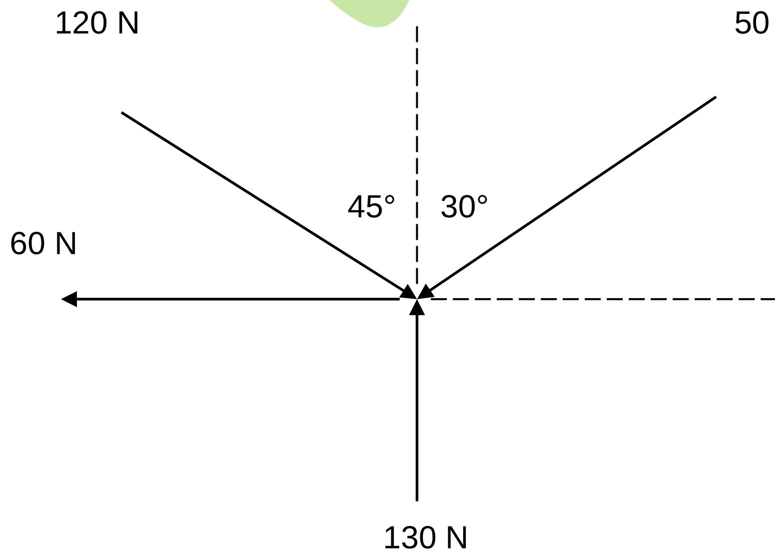
2.2.2 Draw a shear-force diagram, using a suitable scale. Show all the main values on the diagram. (6)

[12]

QUESTION 3: FORCES

3.1 Explain the law of *triangle of forces.* (4)

3.2 Determine the magnitude and direction of the resultant force acting on the system of forces in equilibrium as shown in the figure below.



(7)

3.3 Define the term *direct force*, and give TWO types of direct force. (4)

[15]

QUESTION 4: FRICTION

4.1 Give TWO disadvantages of friction as related to engineering. (2)

4.2 A body with a mass of 60 kg is placed on an inclined plane making an angle of 20° with the horizontal. The coefficient of friction is 0,4. A force F at an angle of 30° to the plane is required to pull the body up the plane.

Calculate the following:

4.2.1 The component F parallel to the plane (1)

4.2.2 The gravity component parallel to the plane (2)

4.2.3 The gravity component perpendicular to the plane (2)

4.2.4 The magnitude of F (4)

[11]

QUESTION 5: HEAT

5.1 Define *specific heat capacity* of a substance. (2)

5.2 45 steel shafts are cooled down in 5 litres of water. The initial temperature of the shafts is 180 °C and that of the water is 20 °C.

If the final temperature of the mixture is 93,97 °C, the specific heat capacity of steel is 0,5 kJ/kg.°C and that of water is 4,187 kJ/kg.°C:

Calculate the mass of EACH steel shaft. (3)

5.3 Steam is generated at a pressure of 2,85 MPa to a dryness fraction of 0,96. The steam is now superheated to a temperature of 300 °C. The specific heat capacity of this superheated steam is 2,9 kJ/kg.°C.

Calculate, for 1 kg of steam, the amount of heat energy required for each of the following:

5.3.1 Enthalpy in the wet steam (1)

5.3.2 Dry steam (h_g) (1)

5.3.3 Superheated steam (h_{su}) (2)

5.4 A fuel with a heat energy value of 42 MJ/kg is used in an engine that develops 12 kW during a test. The test lasts for 35 minutes and a thermal efficiency of 45% is obtained.

Calculate the following:

5.4.1 The equivalent power of the fuel

5.4.2 The heat energy dissipated by the fuel

5.4.3 The mass of the fuel used (3 × 2) (6)

[15]

QUESTION 6: HYDRAULICS

6.1 Define the unit *pascal*. (1)

6.2 The following data refer to a single-acting hydraulic press:

Area of plunger = 0,09 m^2
Stroke of plunger = 13 cm
Area of ram = 0,45 m^2
Force applied to plunger = 300 N
Ignore any losses.

Calculate the following:

6.2.1 The volume of liquid, in litres, displaced by the plunger in 10 strokes

6.2.2 The distance moved by the ram, in mm, after one pumping stroke of the plunger (2 × 3) (6)

6.3 State Pascal's law in words. (2)

6.4 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (6.4.1–6.4.2) in the ANSWER BOOK.

6.4.1 The SI unit of pressure is Pascal

6.4.2 1 m^3 = 10 000 cm^3

(2 × 1) (2)
[11]

QUESTION 7: ELECTRICITY

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

7.2 Four cells, each with an EMF of 2 V and an internal resistance of 0,2 Ω per cell, are connected in series. The battery is then connected to two parallel-connected resistors of 3 Ω and 6 Ω respectively, and a third resistor of 2 Ω is connected in series with the two parallel resistors.

Calculate the following:

7.2.1 The total resistance of the circuit (3)

7.2.2 The total current flow (2)

7.2.3 The voltage drop across the internal resistance (1)

7.2.4 The current through the 3-Ω resistor (2)

7.3 The resistance of the heating element of a heater is 55 Ω. A current of 5 A flows through the heater for 6 hours.

Calculate the following:

7.3.1 The quantity of heat released

7.3.2 The cost if the tariff is 27,45 cents per kW.h (2 × 2) (4)

[14]

QUESTION 8: CHEMISTRY

8.1 Explain the term *oxidation*. (1)

8.2 Give FOUR precautions against corrosion on iron. (4)

8.3 Give the chemical formula for table salt. (1)

[6]

TOTAL: 100

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e . v$

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

$W_\mu = F_\mu . s$

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

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

$Q = I^2 . R . t$

$m = I . z . t$

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F . \perp s$

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

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

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

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

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

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

$$V = I \times R$$

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
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