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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T740(E)(N16)T
NOVEMBER 2011

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

16 November (X-Paper)
09:00 – 12:00

REQUIREMENTS: Properties of water & steam (BOE 173)
NO graph paper may be issued.

Candidates will require drawing instruments.

Calculators may be used.

This question paper consists of 8 pages, a 2-page formula sheet and an information sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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. ALL the calculations must consist of, at least, the following THREE steps:
   - 3.1 The formula used or manipulation thereof
   - 3.2 Substitution of the given data in the formula
   - 3.3 The answer with the correct SI unit
4. The constant values, as they appear on the attached INFORMATION SHEET, must be used where ever possible.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Keep subsections of questions together.
7. Rule off on completion of each question.
8. Drawing instruments must be used for ALL drawings/diagrams. ALL drawings/diagrams must be fully labelled.
9. ONE mark indicates ONE percentage point, that is 100 marks = 100%.
10. Use $g = 9,8\ m/s^2$.
11. Answers must be rounded off to at least THREE decimal places.
12. Write neatly and legibly.

QUESTION 1

1.1 Describe, in your own words, what is understood with the term *ampere*. (2)

1.2 Define the *calorific value* of a fuel. (2)

1.3 Define the term *displacement*. (2)

1.4 Explain the term *gravity*. (2)

1.5 State Ohm's Law. (2)

1.6 Make a neat, labelled sketch of a typical electrolysis experiment and show ALL the apparatus and materials required. (5)

1.7 Name any FOUR alloys that are used in the engineering industry. Pg 184 (2)

[17] 8

QUESTION 2: MOTION, POWER AND ENERGY

2.1 An object moving in a straight line at a constant velocity of 2 m/s, accelerates uniformly at 3 m/s^2 for 4 seconds.

Calculate the final velocity of the object. (2)

2.2 A load of 2,5 kN is hoisted by means of a rope and a lifting machine with a rotational frequency of 40 r/min and a drum diameter of 700 mm.

Calculate the following:

2.2.1 The torque (2)

2.2.2 The speed of the rope or load in m/s (2) 8

2.2.3 The work done per minute (2)

2.2.4 The power required to lift the load (2)

2.2.5 The efficiency of the lifting machine if an electric motor of 5 kW is required to drive the lifting machine (2)

2.3 A pulley with a diameter of 60 cm is driven by a belt with a thickness of 1,2 mm. The tension in the tight side is 420,324 N and in the slack side is 223,154 N. The belt velocity is 12 m/s.

Consider the belt thickness and calculate the following:

2.3.1 The rotational frequency of the pulley (2)

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

[16]

QUESTION 3: MOMENTS

FIGURE 1 below shows a light horizontal beam ABCDE of uniform cross section loaded as shown:

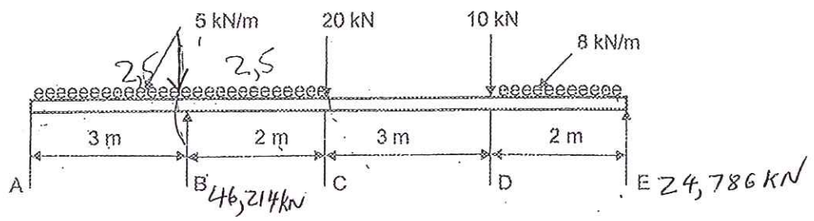
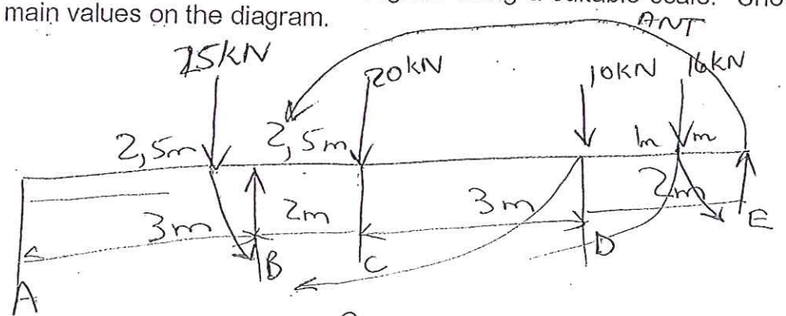


FIGURE 1

3.1 Calculate the magnitude of supports B and E and test your answers. (5)

3.2 Draw a fully labelled shear-force diagram using a suitable scale. Show ALL the main values on the diagram. (5)

[10]



Moment About B

Σ Ant CW = Σ CW

$(25 \times 0{,}5) + (E \times 8) = (10 \times 5) + (20 \times 2)$

$12{,}5 + E8 = 50 + 40 + 16 \times 6)$

$8E = \frac{90}{7{,}5} + 96$

$E = \frac{186}{8} = 23{,}25kN$

PTO

QUESTION 4: FORCES

The following data in FIGURE 2 refers to four forces acting on the same point:

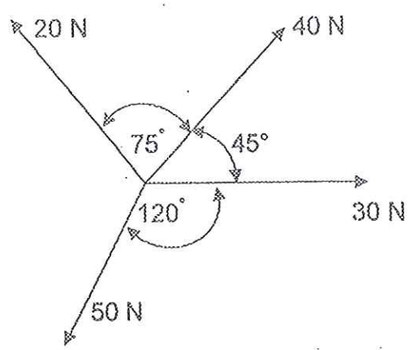


FIGURE 2

Calculate the following:

4.1 The sum of the vertical components and the direction (2)

4.2 The sum of the horizontal components and the direction (2)

4.3 The magnitude of the resultant (2)

4.4 The direction of the resultant (2)
[8]

QUESTION 5: FRICTION

5.1 An iron block with a mass of 12 kg is moving up a plane that makes an angle of 38° with the horizontal. The coefficient of friction is 0,38. The force T pulling the body up the plane, makes an angle of 20° with the plane.

5.1.1 Make a neat, labelled sketch of the body on the inclined plane showing ALL the force(s) and their components acting on it. (2)

5.1.2 Determine the pulling force T. (5)

5.2 A block with a mass of 30 000 kg is pulled along a horizontal plane with a force of 50 kN parallel to the plane and moves at a constant velocity.

Calculate the following:

5.2.1 The frictional force (1)

5.2.2 The coefficient of friction between the block and the plane (2)
[10]

0,8314
33,271 m²

QUESTION 6: HEAT AND TEMPERATURE

6.1 The temperature of 7 kg of copper is 92 °C and must be cooled down to 68 °C.

Calculate the heat energy released by the copper. (2)

6.2 The engine of a motorcar uses 20 kilograms of petrol in two hours. The internal efficiency of the engine is 42%.

Calculate the power dissipated by the engine of the motorcar. (2)

6.3 A circular aluminium plate with a diameter of 200 mm is heated and the temperature is raised by 23 °C.

Calculate the final area of the plate. (2)

6.4 Steam is generated in a boiler at a pressure of 1 MPa.

Calculate the following for 1 kg of steam:

6.4.1 The saturation temperature (1)

6.4.2 The enthalpy of the dry saturated steam (1)

6.4.3 The heat energy required to produce steam at dryness factor of 0,96 (2)

[10]

QUESTION 7: HYDAULICS

7.1 A single-acting pump with a plunger diameter of 100 mm and a stroke length of 15 cm is delivering water to a tank 100 m vertically above the ground level.

Calculate the following:

7.1.1 The pressure exerted by the plunger (2)

7.1.2 The work done per delivery stroke of the plunger (2)

7.1.3 The mass of water delivered after 10 strokes of the plunger (2)

7.2 A force of 380 N is exerted on a hydraulic press. The diameter of the plunger is 400 mm and the stroke length is 12 cm. The diameter of the ram is 800 mm.

Calculate the following:

7.2.1 The force exerted by the ram (2)

7.2.2 The distance moved by the ram per stroke of the plunger (2)

7.2.3 The distance moved by the ram after 15 pumping strokes of the plunger (1)

7.2.4 The mechanical advantages of the hydraulic press (2)
[13]

QUESTION 8: ELECTRICITY

8.1 A diesel generator produces an EMF of 240 V. A current of 25 A is delivered by the generator. Calculate the internal resistance. (2)

8.2 An electrical circuit consists of a battery with 2 cells in series each with EMF of 4,5 volts and internal resistance of 0,225 ohms each. The battery is connected in series with the ammeter with a resistance of 0,125 ohms, a resistor of 1,725 ohms and a radio with unknown resistance. The ammeter reading is 3 A.

Calculate the following:

8.2.1 The potential difference across the battery (2)

8.2.2 The total resistance of the circuit (1)

8.2.3 The resistance of the radio (2)

8.2.4 The potential difference across the radio (1)

8.3 A house uses the following appliances for the estimated time during a day:

- Two 60 Watt lamps, 4 hours per day
- Five 100 Watt lamps, 6 hours per day
- One 2 000 Watt stove, 1 hour per day
- Two 75 Watt computers, 3 hours per day

Calculate the electricity costs for SEVEN days if the rate is 8 cents per kWh. (3)

8.4 The distribution to a residential power line is 2 200 V. The voltage must be stepped down to 200 V for use within the residences. The secondary side of the transformer has 400 turns.

Calculate the following:

8.4.1 The voltage ratio (1)

8.4.2 The number of turns in the primary side (2)

8.5 A mass of 1 gram of copper is deposited on an electrode during an electrolysis experiment.

Calculate the magnitude of the current if the experiment was running for 1 hour. (2)
[16]

TOTAL: 100

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e . v$

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

$W_\mu = F_\mu . s$

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

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

$Q = I^2 . R . t$

$m = I . z . t$

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F . \perp s$

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 alcohol (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^{-6}/°C	Lineêre uitsettingskoëffisiënt van koper
Linear coefficient of expansion of aluminium	23 × 10^{-6}/°C	Lineêre uitsettingskoëffisiënt van aluminium
Linear coefficient of expansion of steel	12 × 10^{-6}/°C	Lineêre uitsettingskoëffisiënt van staal
Linear coefficient of expansion of lead	54 × 10^{-6}/°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