higher education
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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T640**(E)**(A1)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

1 April 2019 (X-Paper)
09:00–12:00

REQUIREMENTS: Properties of water and steam (BOE 173)

Calculators may be used.

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

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. 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. All drawings/diagrams must be fully labelled and drawing instruments must 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.

QUESTION 1: MOTION, ENERGY AND POWER

1.1 Distinguish between *elastic collision* and *inelastic collision*. (2)

1.2 Two completely elastic balls of 2 kg and 5 kg respectively move in the same straight line but in opposite directions and collide. Before the collision the 2 kg ball moves at 4 m/s to the right and the 5 kg ball moves at 7 m/s to the left. After the collision the 2 kg ball moves at 3 m/s to the right.

Calculate the velocity and direction of the 5 kg ball after collision. (3)

1.3 In FIGURE 1 a graph is shown that represents the motion of a train at rest.

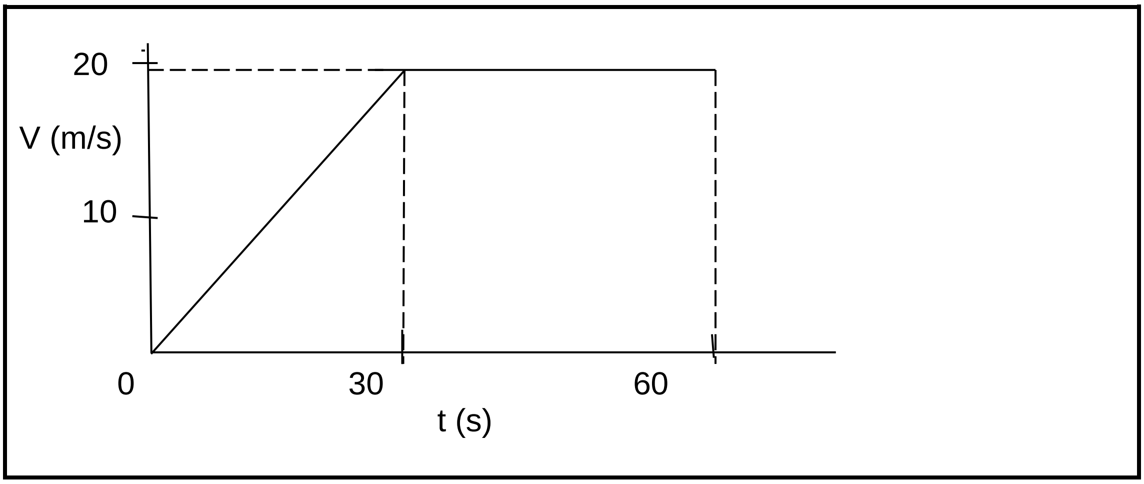


FIGURE 1

Determine:

1.3.1 The acceleration of the train during the first 30 seconds. (2)

1.3.2 The total distance the train has travelled after 60 seconds. (3)

1.4 The driver pulley of a diesel motor has a diameter of 6 cm and rotates at 300 r/min. The flat belt has a thickness of 5 mm. The tension in the tight side is 1 400 N and the tension ratio is 3:1.

Consider the belt thickness and calculate the following:

1.4.1 The tension in the slack side

1.4.2 The belt velocity in m/s

1.4.3 The power transmitted in kW

(3 × 2) (6)

[16]

QUESTION 2: MOMENTS

2.1 Define the *moment of a force*. (2)

2.2 FIGURE 2 shows the shear force diagram of a light horizontal beam ABCDE with a uniform cross section. All the values of the loads are in kN.

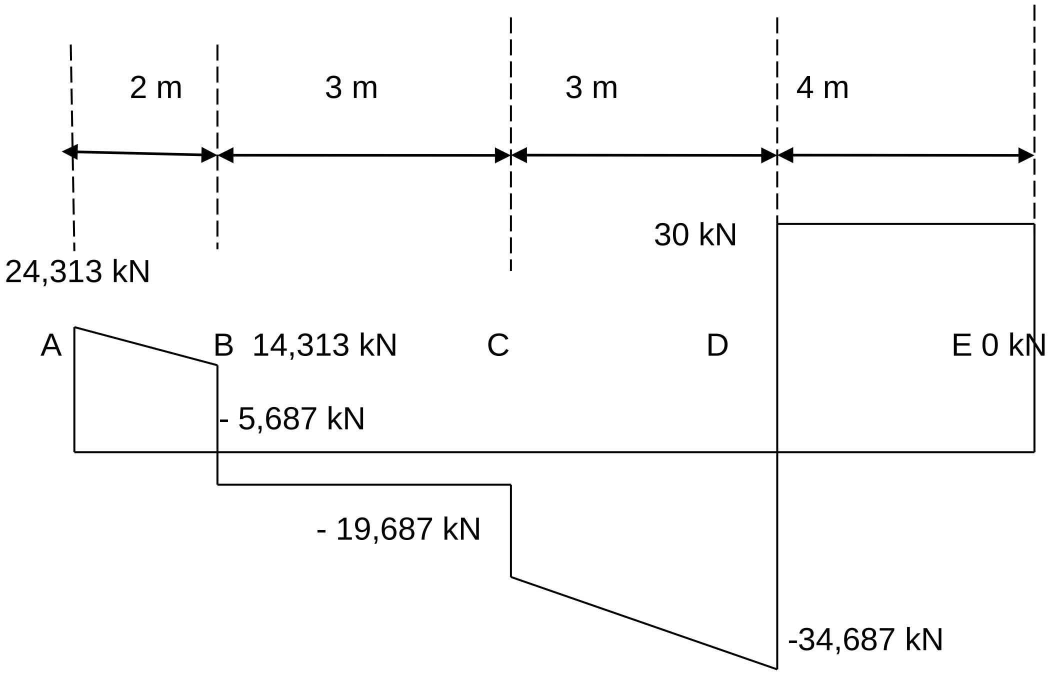


FIGURE 2

2.2.1 At which TWO positions is the beam supported and what is the magnitude of each support? (2)

2.2.2 Calculate the magnitude of the distributed loads between AB and CD. (4)

2.2.3 Draw the light horizontal beam ABCDE indicating ALL value loads and supports at the CORRECT positions. (4)

[12]

QUESTION 3: FORCES

3.1 Distinguish between the *equilibrant* and the *resultant force*. (2)

3.2 Two ropes support a mass with a weight of 500 N as shown in FIGURE 3.

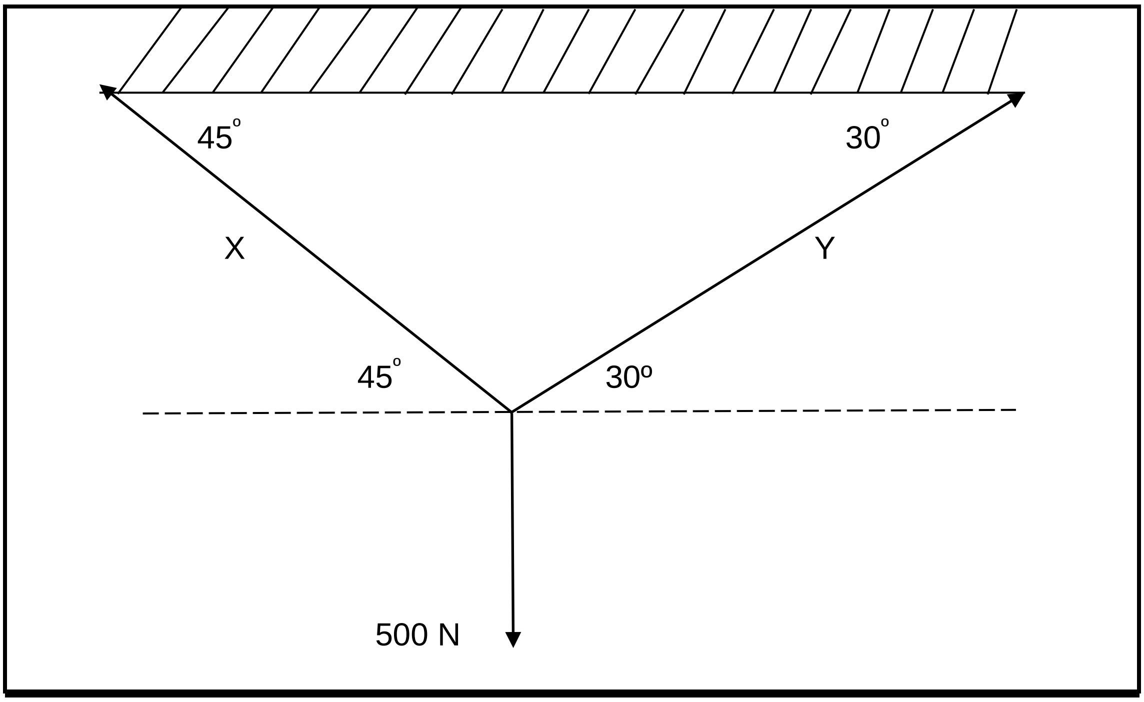
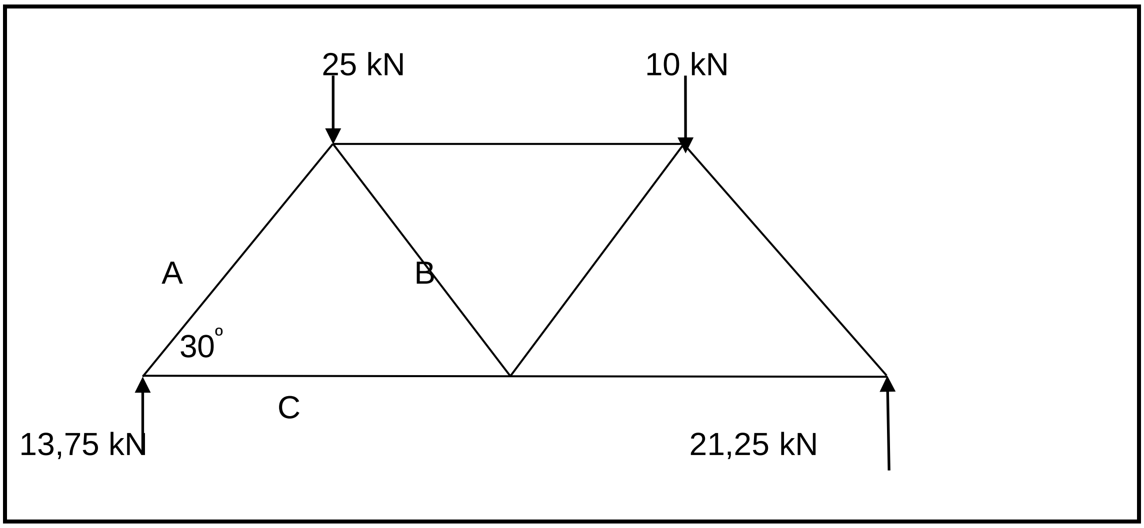


FIGURE 3

Calculate the tractive forces X and Y in the ropes. (6)

3.3 Name TWO conditions for STATIC equilibrium if the forces acting on the framework or object are in equilibrium. (2)

3.4 Determine the *magnitude* and *nature* of the forces in members AB and BC in the structure shown in FIGURE 4.



(4)

FIGURE 4

[14]

QUESTION 4: FRICTION

4.1 State THREE advantages of friction as applicable to engineering. (3)

4.2 A body with a mass of 80 kg is sliding at a constant velocity down an incline without any external force acting on it. The angle of inclination is 30°.

Calculate the following:

4.2.1 The weight component perpendicular to the sliding plane (2)

4.2.2 The weight component parallel to the sliding plane (2)

4.2.3 The friction force (1)

4.2.4 The coefficient of friction of the plane (2)

4.2.5 The external force required to pull the body up the plane at constant velocity (2)

[12]

QUESTION 5: HEAT

5.1 Explain what is meant by the *specific heat capacity* of a substance. (1)

5.2 The following data refer to a copper rod , 4 m in length, being heated through burning coal:

Initial temperature of the rod	= 20 °C
Amount of coal burned	= 750 g
Percentage of heat transferred to the rod	= 30%
Mass of the rod	= 6 kg

Calculate the following :

5.2.1 The heat energy transferred to the rod (2)

5.2.2 The final temperature of the rod (2)

5.2.3 The final length of the rod (3)

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

5.4 The total enthalpy of 1 kg of wet steam at a pressure of 900 kPa is 2 600 kJ.

Calculate the dryness factor of the steam. (2)

5.5 A mild steel bar with dimensions of 200 cm x 120 mm is heated from 15 $^{\circ}$C to 70 $^{\circ}$C and the area increases to 0,2430314 m^2.

Calculate from this the coefficient of linear expansion of steel. (4)
[15]

QUESTION 6: HYDRAULICS

6.1 Name TWO types of pressure readings which can be taken on a liquid. (2)

6.2 A hydraulic press has a plunger diameter of 25 mm. The force acting on the plunger is 70 N while the ram has a diameter of 12 cm.

Calculate the following:

6.2.1 Mass in kg that can be raised (4)

6.2.2 Pressure in the liquid (3)

6.2.3 Distance that the ram piston will rise after 20 strokes if the plunger stroke is 80 mm (3)
[12]

QUESTION 7: ELECTRICITY

7.1 What is meant by the EMF of a cell? (1)

7.2 A battery has an internal resistance of 0,8 Ω and is connected in series with a 4 Ω resistor and an unknown resistor. When the circuit is closed, the potential difference across the 4 Ω resistor is 8 V and that across the unknown resistor is 10 V.

Calculate the following:

7.2.1 Current through the resistors

7.2.2 Resistance of the unknown resistor

(2 × 2) (4)

7.3 A current of 8 A flows through a silver nitrate solution for 2 hours in order to electroplate an object. The electrochemical equivalent for silver is 0,001118 g/C.

Calculate the following:

7.3.1 Amount of electric charge required

7.3.2 Mass of silver deposited

(2 × 2) (4)

7.4 A single-phase transformer has a supply voltage of 220 V and a primary current of 3 A at full load. The secondary current is 0,2 A and there are 300 turns on the primary coil.

Calculate the following:

7.4.1 Turns ratio

7.4.2 Number of turns in the secondary

(2 × 2) (4)
[13]

QUESTION 8: CHEMISTRY

8.1 What is an ion? (1)

8.2 State THREE different types of corrosion. (3)

8.3 State TWO properties of brass. (2)
[6]

TOTAL: 100

ENGINEERING SCIENCE N3

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e\ .\ v$

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

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

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

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

$$m = I . z . t$$

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

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

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

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

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

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

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

$$V = I \times R$$

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

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

$$v = u + a.t$$

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

$$M = F . \perp s$$

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 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