higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T640**(E)**(M29)T

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

29 March 2018 (X-Paper)
09:00–12:00

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

Calculators may be used.

This question paper consists of 6 pages, 2 formula sheets and 1 information sheet

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. All drawings/ diagrams must be fully labelled.
7. One mark indicates one percentage point, that is 100 marks = 100%
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 difference between a vector quantity and a scalar quantity. (2)

1.2 A lorry accelerates from rest to 2 m/s^2 in 25 seconds and travels in a westerly direction from point S to point T. From point T it then travels at a constant velocity for two minutes towards point U and then starts to brake and stops at point V, which is 100 m from point U.

Calculate:

1.2.1 Displacement from S to T (2)

1.2.2 Displacement from T to U (3)

1.2.3 Total distance travelled (1)

1.2.4 Time taken for the journey (4)

1.3 A lorry of 5 tons travels at 90 km/h and switches off its engine when reaching an incline of 10°.

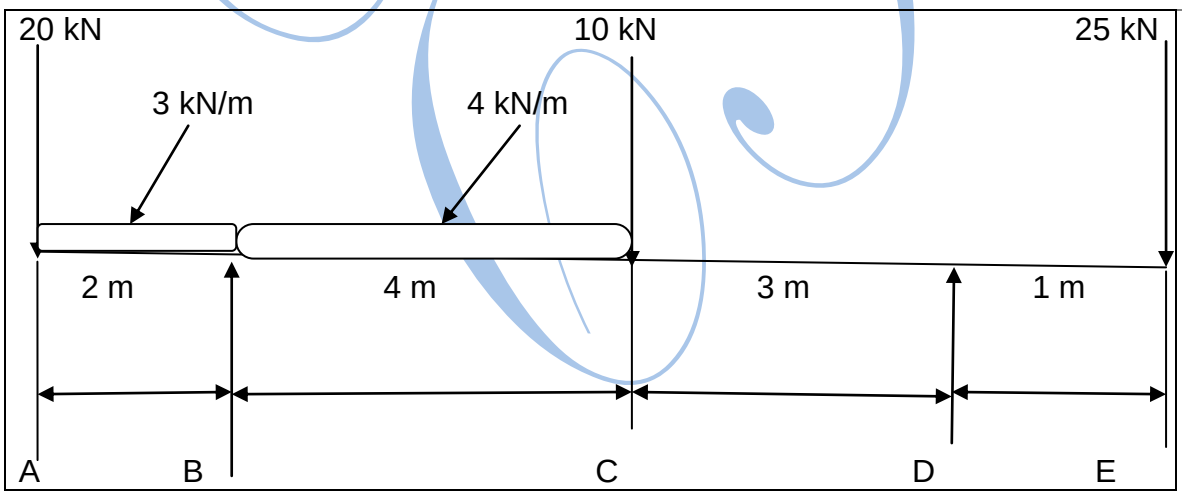
Calculate how far the lorry will travel up the incline if friction is not considered. (4)

[16]

QUESTION 2: MOMENTS

2.1 What is meant by *shear force*? (1)

2.2



The figure above shows a light horizontal beam A, B, C, D and E of uniform cross section, loaded as shown.

Calculate:

2.2.1 The reactions of the supports B and D. (6)

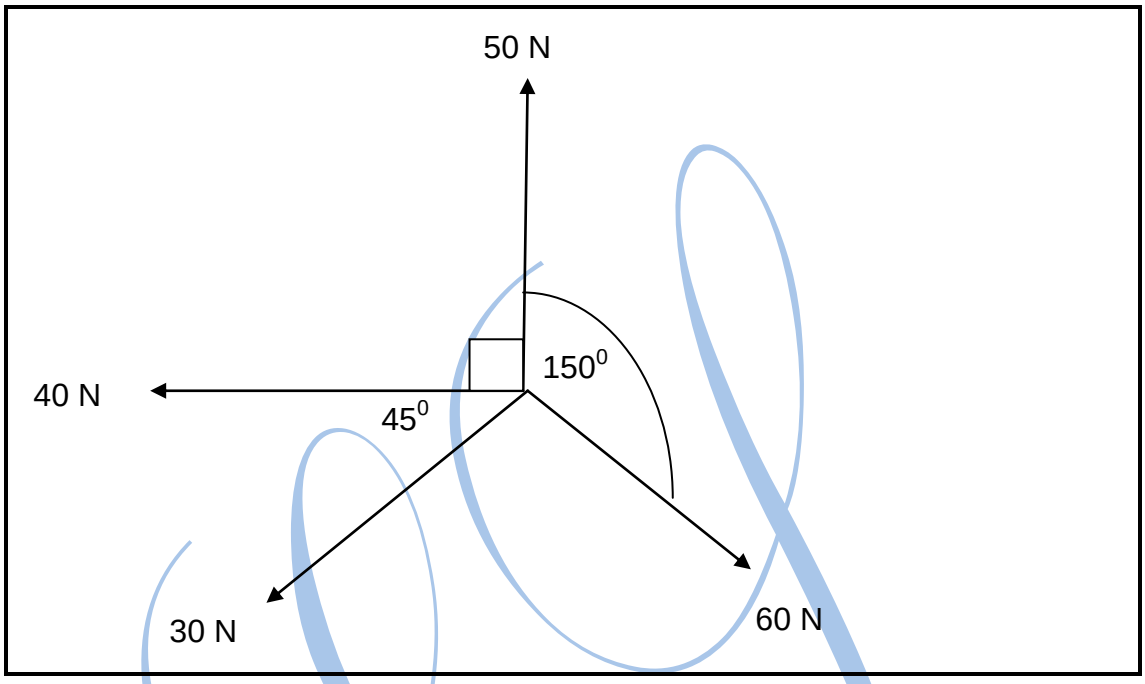
2.2.2 Draw a shear force diagram using a suitable scale. The diagram must be fully labelled. (4)

[11]

QUESTION 3: FORCES

3.1 Explain what is meant by the *resultant of a number of forces*. (2)

3.2



Calculate:

3.2.1 Sum of the horizontal components and direction (3)

3.2.2 Sum of the vertical components and direction (3)

3.2.3 Magnitude of the resultant (2)

[10]

QUESTION 4: FRICTION

4.1 What is meant by *angle of friction*? (1)

4.2 A body of mass 80 kg is placed on an incline of 30° with the horizontal .The coefficient of friction is 0,4. A force P making an angle of 60° with the plane is required to pull the body up the plane.

Calculate:

4.2.1 The component of P 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 P (5)

4.3 State THREE advantages of friction as applicable in engineering. (3)

[14]

QUESTION 5: HEAT

5.1 Give TWO advantages of steam. (2)

5.2 A fuel with a heat value of 42 MJ/kg was used in an engine that develops 15 kW. The test lasted for 45 minutes and a thermal efficiency of 45% was obtained.

Calculate:

5.2.1 Equivalent power of the fuel (2)

5.2.2 Heat energy dissipated by the fuel (2)

5.2.3 Mass of the fuel (2)

5.3 The following data refers to an aluminium rod, 200 cm in length, being heated by burning coal:

Initial temperature of the rod	=	25 °C
Amount of coal burned	=	750 g
Percentage of heat transferred to the rod	=	60%
Mass of the rod	=	10 000 g

Calculate:

5.3.1 The quantity of heat transferred to the rod (3)

5.3.2 Final temperature of the rod (2)

5.3.3 The final length of the rod (2)

[15]

QUESTION 6: HYDRAULICS

6.1 Write an equation for a suction head in terms of delivery head and static head. (1)

6.2 The following data refers to a single stroke pump, driven by a diesel engine, which has to deliver water to a reservoir above the pump:

Working pressure of pump	=	345 kPa
Volume of water delivered	=	25 m^3/hour
Output power of the diesel engine	=	9,45 kW

Calculate:

6.2.1 Maximum height of the reservoir above the pump (3)

6.2.2 Work done by the pump per minute (3)

6.2.3 Output power of the pump (2)

6.3 State Pascal's principle in words. (3)

[12]

QUESTION 7: ELECTRICITY

7.1 State Faraday's first law of electrolyses in words. (2)

7.2 A circuit consists of four cells each with an EMF of 1,5V, connected in series. Each cell has an internal resistance of 0, 5 Ω. Two resistors of 3 Ω and 6 Ω are connected in parallel to the circuit. The battery is now connected in series with a radio of 4 Ω and a loudspeaker of 2 Ω.

Calculate:

7.2.1 Total resistance of the circuit (4)

7.2.2 Current flow in the circuit (2)

7.2.3 Voltage drop across the loudspeaker (2)

7.3 A single-phase transformer has a supply voltage of 240 V and a primary current of 6 A at full load. The secondary current is 0, 4 A and there are 600 turns on the primary coil.

Calculate:

7.3.1 Number of turns on the secondary coil (2)

7.3.2 Secondary voltage (2)

7.3.3 Secondary power (2)

[16]

QUESTION 8: CHEMISTRY

8.1 Give the definition of *an ion* (1)

8.2 Give TWO examples of alkali earth metals. (2)

8.3 Complete the following statements by choosing the correct option in brackets. Write only the answer next to the question number (8.3.1–8.3.3) in the ANSWER BOOK.

Zinc is (8.3.1 smoother/harder/softer) than tin but (8.3.2 smoother/harder /softer) than copper.

Nitrogen is a colourless, odourless and tasteless gas and forms (8.3.3 95% / 60% / 79%) of the total volume of the air. (3)

(6)

TOTAL: 100

ENGINEERING SCIENCE N3

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \ . \ v$

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

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

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

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

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

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

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F \ . \perp s$

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

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

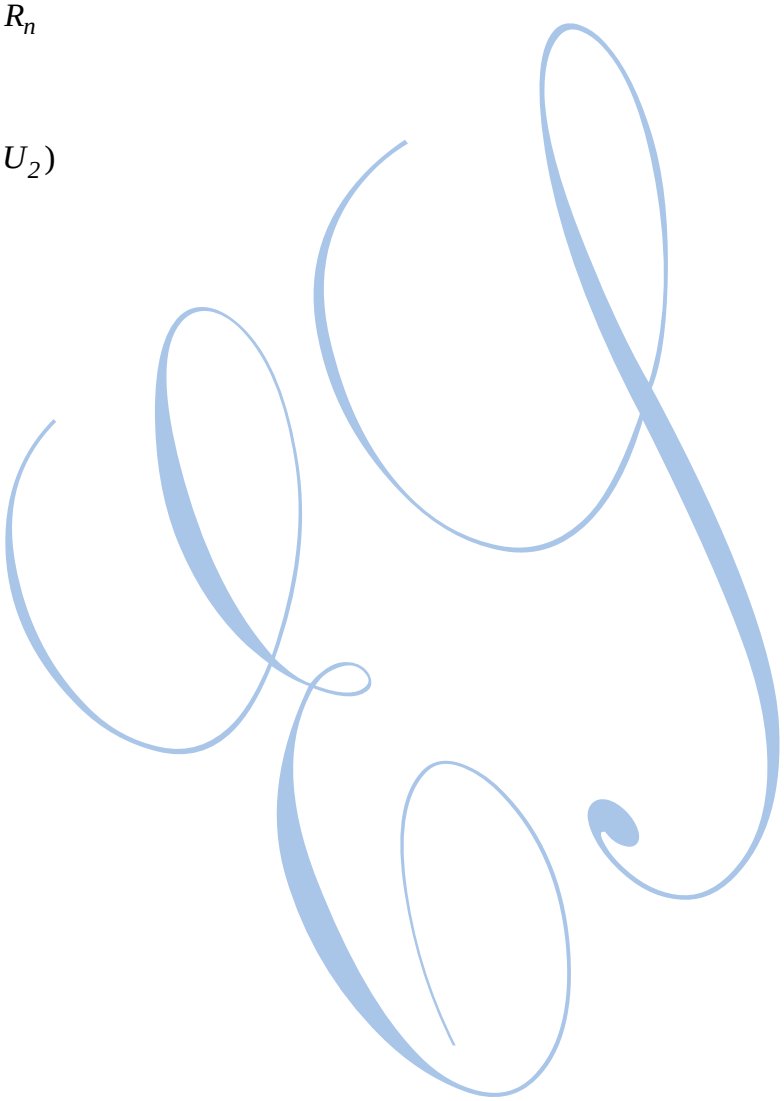
$$P = \delta \times g \times h$$

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

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

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

$$V = I \times R$$



INFORMATION SHEET

PHYSICAL CONSTANTS

QUANTITY	**CONSTANTS KONSTANTE**	**HOEVEELHEID**
Atmospheric pressure	101,3 kPa	Atmosferiesedruk
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 mineraleolie
Density of air	1,05 kg/m^3	Digtheid van lug
Electrochemical equivalent of silver	1,118 mg/C	Elektrochernieseekwivalent van silwer
Electrochemical equivalent of copper	0,329 mg/C	Elektrochemieseekwivalent 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	Lineêreuitsettingskoëffisiënt van koper
Linear coefficient of expansion of aluminium	23 × 10^{-5}/°C	Lineêreuitsettingskoëffisiënt van aluminium
Linear coefficient of expansion of steel	12 × 10^{-5}/°C	Lineêreuitsettingskoëffisiënt van staal
Linear coefficient of expansion of lead	54 × 10^{-5}/°C	Lineêreuitsettingskoëffisiënt van lood
Specific heat capacity of steam	2 100 J/kg.°C	Spesifiekewarmtekapasiteit van stoom
Specific heat capacity of water	4 187 J/kg.°C	Spesifiekewarmtekapasiteit van water
Specific heat capacity of aluminium	900 J/kg.°C	Spesifiekewarmtekapasiteit van aluminium
Specific heat capacity of oil	2 000 J/kg.°C	Spesifiekewarmtekapasiteit van olie
Specific heat capacity of steel	500 J/kg.°C	Spesifiekewarmtekapasiteit van staal
Specific heat capacity of copper	390 J/kg.°C	Spesifiekewarmtekapasiteit van koper