higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T580**(E)**(M30)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

30 March 2016 (X-Paper)
09:00–12:00

Candidates need drawing instruments.

This question paper consists of 10 pages, 1 information sheet and 1 formula 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. All calculations should consist of at least THREE steps:

   2.1 The formula used or manipulation thereof
   2.2 Substitution of the given data in the formula
   2.3 The answer with the correct SI unit

3. The constant values, as they appear on the attachment information sheet, must be used wherever possible.

4. Number the answers according to the numbering system used in this question paper.

5. Keep subsections of questions together.

6. Rule off on completion of each question.

7. Drawing instruments must be used for all drawings/diagrams. All drawings/diagrams must be fully labelled.

8. Use g = 9,8 m/s^2.

9. Answers must be rounded off to THREE decimal places.

10. Write neatly and legibly.

QUESTION 1: MOVEMENT

1.1 A car travelling at 20 $m.s^{-1}$ applies its brakes and stops after 50 m.

Determine the following:

1.1.1 The average acceleration

1.1.2 The time taken to stop

(2 × 2) (4)

1.2 A Bricklayer throws a brick upwards to a next level to a bricklayer who misses the catch. The brick falls to the ground after 6 seconds.

Calculate the following:

1.2.1 The height that the brick reaches (3)

1.2.2 The total distance covered (1)

1.2.3 The velocity at which the brick hits the ground (1)

1.3 A motor vehicle with a mass of 2,5 tons accelerates uniformly from rest up an incline of 1 in 25 and reaches a speed of 55 km/h after 3 minutes.

Calculate the following:

1.3.1 The acceleration of the motor vehicle (2)

1.3.2 The kinetic energy of the motor vehicle after 3 minutes (2)

1.3.3 The gain in potential energy of the motor vehicle after 3 minutes (3)

[16]

QUESTION 2: MOMENTS

2.1 State the definition of a *force*. (2)

2.2 A uniform beam is 18 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 and 100 N 5m and 10 m from the left end respectively. The beam also carries a uniformly distributed load of 15 N/m over the first 6 m from the right end.

2.2.1 Calculate the reactions at the supports and test your answers. (5)

2.2.2 Draw the shear force diagram to scale. (4)

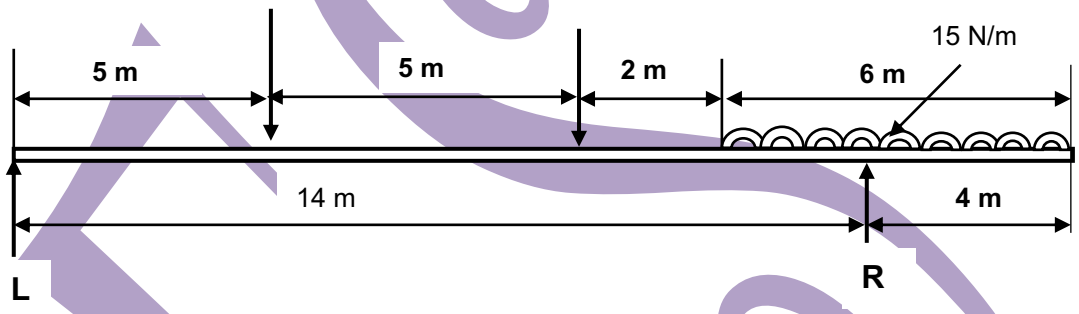

FIGURE 1

2.3 Calculate the turning moment about the fulcrum in FIGURE 2 below.

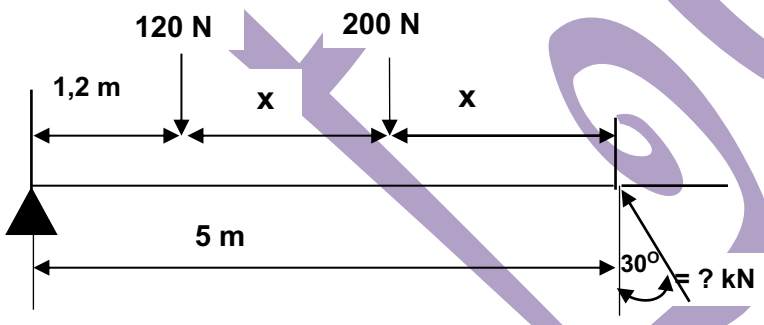

FIGURE 2

(2)
[13]

QUESTION 3: FORCES

3.1 State the definition of *equilibrant of forces*. (2)

3.2 Solve analytically the magnitude and direction of the resultant in FIGURE 3 below.

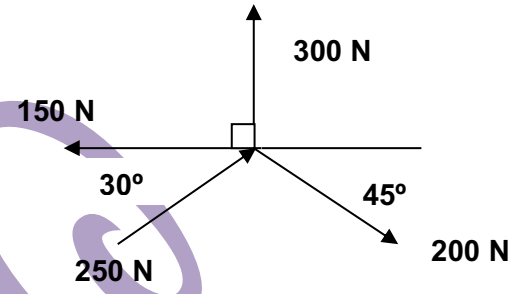

FIGURE 3 (4)

3.3 Three forces shown in FIGURE 4 below are in equilibrium.

Calculate the magnitude of the unknown forces analytically.

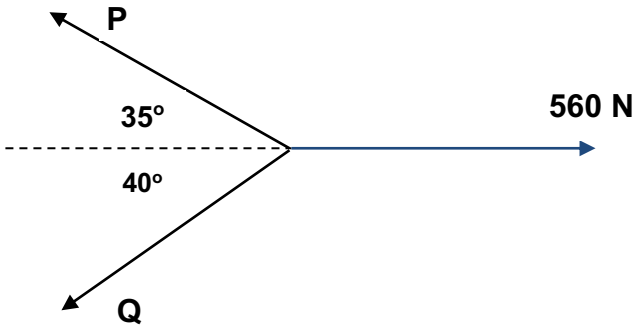

FIGURE 4 (5)

3.4 Calculate the nature and magnitude of forces with reference to the components AB and BC in the roof truss in FIGURE 5 below.

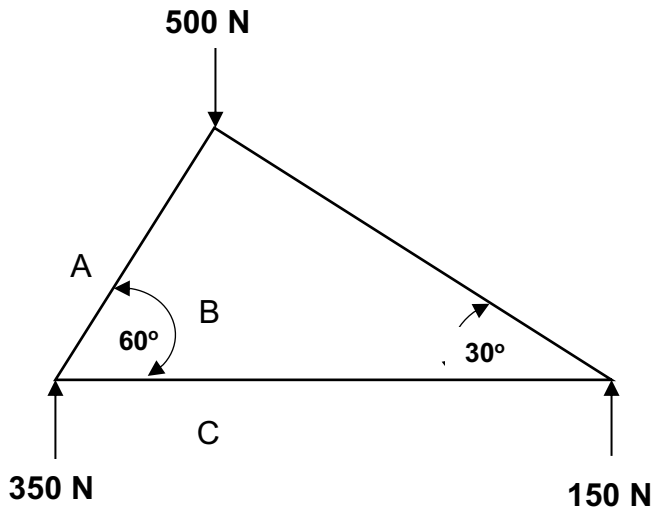

FIGURE 5

(4)
[15]

QUESTION 4: FRICTION

4.1 Distinguish between *static friction* and *kinetic friction*. (2)

4.2 Name TWO applications of friction. (2)

4.3 The weight of an object in FIGURE 6 below is 2 500 N. The object is placed on an inclined plane that forms an angle of 20° to the horizontal. The coefficient of friction is 0,4 for the surface.

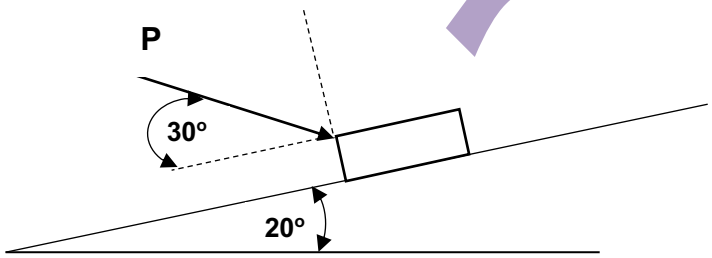

FIGURE 6

Calculate the following:

4.3.1 The pushing force P required to push the object upwards against the slope (6)

4.3.2 The angle in degrees that the plane must be raised so that the body will slide down by itself (1)
[11]

QUESTION 5: HEAT

5.1 Explain the law of conservation of energy. (2)

5.2 45 steel shafts are cooled down in 5 litres of oil. The initial temperature of the shafts is 180 °C and that of the oil 20 °C. Each shaft has a mass of 750 grams.

Calculate the final temperature of the mixture. Use the shc of steel as 500 J/kg °C and that of oil 1,5 kJ/kg °C. (4)

5.3 An overhead crane is used to carry a mould in a foundry workshop. The beam of the overhead crane has a length of 19 m at a temperature of 18 °C. After the moulding process the temperature of the beam of the overhead crane is expected to rise to 100 °C in the foundry.

Use the coefficient of linear expansion of the beam, which is 25 x 10^{-6}/°C.

Calculate the following:

5.3.1 The increase in temperature of the beam (1)

5.3.2 The expected expansion of the beam in mm (2)

5.3.3 The expected final length of the beam in metres (2)

5.4

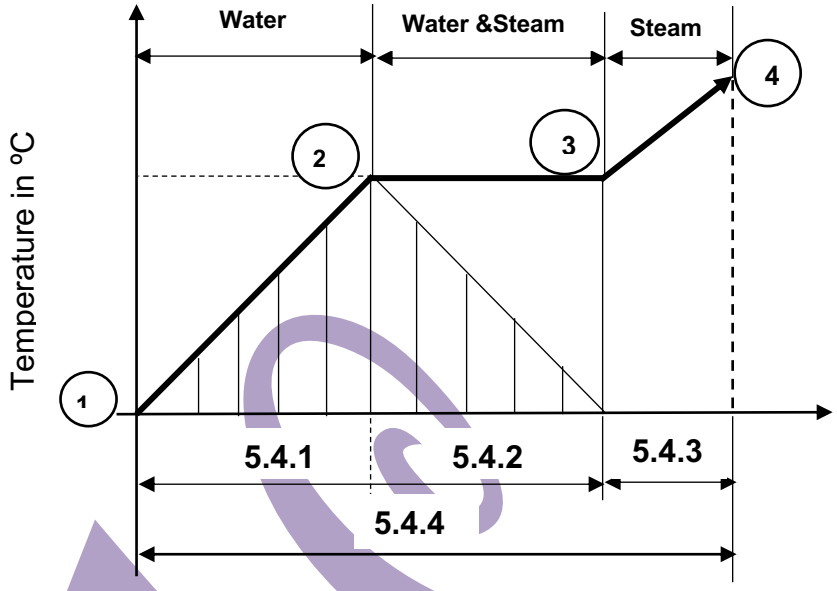

FIGURE 7

FIGURE 7 above shows a water-to-steam process.

Complete the process in FIGURE 7 by filling in the missing descriptions and symbols. Write only the description and the symbol next to the question number (5.4.1–5.4.4) in the ANSWER BOOK. (4)

[15]

QUESTION 6: HYDRAULICS

6.1 Explain the following terminology in hydraulics:

6.1.1 Hydraulics (2)

6.1.2 Hydrostatics (1)

6.1.3 Fluidity (2)

6.2 A single-action water pump with a piston diameter of 120 mm has to deliver $1,4 \times 10^{-3}$ m^3 water per stroke. The average force exerted on the piston is 2,4 kN per working stroke.

Calculate the following:

6.2.1 The pressure of the fluid during the working stroke (3)

6.2.2 The length of the stroke (2)

6.2.3 The work done per stroke length (2)

[12]

QUESTION 7: ELECTRICITY

7.1 Explain the concept *power factor*, and distinguish between a *high power* factor and a *low power factor*. (2)

7.2 An electrical circuit as shown in FIGURE 8 below consists of 4 cells connecting in series, each having an EMF of 4 volts and a internal resistance of 0,15 ohms per cell, connected in series.

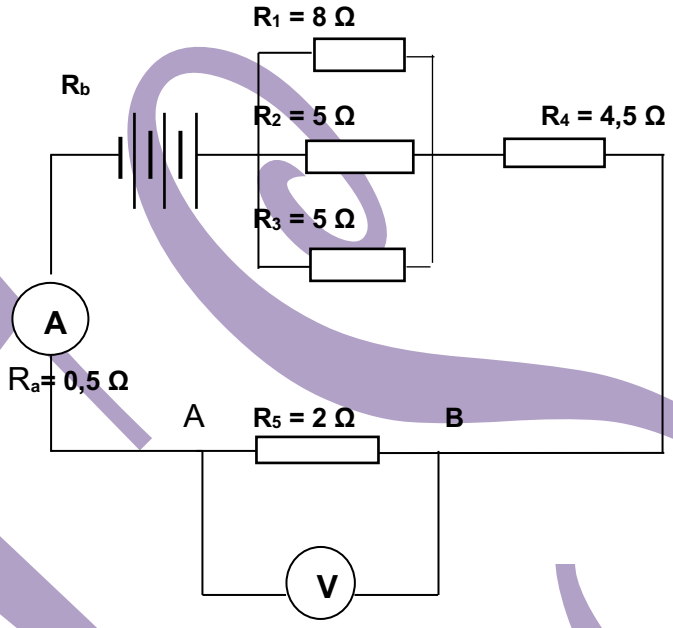

FIGURE 8

Calculate the following:

7.2.1 The total resistance of the circuit

7.2.2 The voltage across AB

(2 × 3) (6)

7.3 A single-phase transformer has a supply voltage of 220 V. The turn ratio of the primary to the secondary is 12 : 1. The secondary current at full load is 20 A and the secondary coil has 50 windings.

Calculate the following:

7.3.1 The secondary voltage

7.3.2 The primary current

(2 × 2) (4)
[12]

QUESTION 8: CHEMISTRY

8.1 Name TWO precautions to keep moisture and water away from metals which can corrode. (2)

8.2 Name the chemical composition of the following compounds:

8.2.1 Limestone (marble)

8.2.2 Caustic soda

(2 × 1) (2)

8.3 Name a non-metal that is a good conductor of electricity. (1)

8.4 Name ONE property of solder. (1)
[6]

TOTAL: 100

FORMULA SHEET

ENGINEERING SCIENCE N3

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

$W = F.s$

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

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

$F = m.a$

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

$\mu = \tan\theta$

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

$F_S = w\sin\theta$

$F_C = w\cos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e.v$

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

$W_\mu = F_\mu.s$

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

$\Delta E_K = \frac{1}{2}mv^2$

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

$m = I.z.t$

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

$v = u + a.t$

$M = F.\perp\ s$

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

$\frac{1}{R_{PAR}} = \frac{1}{R_2} + ... + \frac{1}{R_n}$

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

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

$D_e = (D + t)$

$h_{nat/wet} = h_f + xh_{fg}$

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

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

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

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

$F_X = F\cos\theta$

$F_Y = F\sin\theta$

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

$\sum F_X = F_1\sin\theta_1 + ... + F_n\sin\theta_n$

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

$\tan\Phi = \frac{\sum F_Y}{\sum F_X}$

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

$m.w.w = Q = m.hv$

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

$\Delta L = L_0.\alpha.\Delta t....L_f = L_0 \pm \Delta L$

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

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

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

$\sum \uparrow F = \sum \downarrow F$

$\sum CWM = \sum ACWM$

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

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

$V = I \times R$

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 platinum
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	17x 10^{-5}/^{0}C	Lineêre uitsettingskoëffisiënt van koper
Linear coefficient of expansion of aluminium	23 x 10^{-5}/^{0}C	Lineêre uitsettingskoëffisiënt van aluminium
Linear coefficient of expansion of steel	12 x 10^{-5}/^{0}C	Lineêre uitsettingskoëffisiënt van staal
Linear coefficient of expansion of lead	54 x 10^{-5}/^{0}C	Lineêre uitsettingskoëffisiënt van lood
Specific heat capacity of steam	2 100 J/kg.^{0}C	Spesifieke warmtekapasiteit van stoom
Specific heat capacity of water	4 187 J/kg.^{0}C	Spesifieke warmtekapasiteit van water
Specific heat capacity of aluminium	900 J/kg.^{0}C	Spesifieke warmtekapasiteit van aluminium
Specific heat capacity of oil	2 000 J/kg.^{0}C	Spesifieke warmtekapasiteit van olie
Specific heat capacity of steel	500 J/kg.^{0}C	Spesifieke warmtekapasiteit van staal
Specific heat capacity of copper	390 J/kg.^{0}C	Spesifieke warmtekapasiteit van koper