higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

17 November 2022 (X-paper)
09:00–12:00

REQUIREMENTS: Steam tables

This question paper consists of 9 pages, an information sheet and a formula sheet of 2 pages.

068Q1E2217

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. Start each question on a new page.
5. Use only a black or a blue pen.
6. Write neatly and legibly.
7. Use g = 9,8m/s^2
8. Round off answers to THREE decimal places.
9. Provide answers in SI units.
10. Steam tables will be provided.

QUESTION 1: MOTION, POWER AND ENERGY

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Which ONE of the following always acts vertically downward to the surface on which a body is placed?

A Normal force
B Tension force
C Frictional force
D Gravitational force (1)

1.2 The tendency of an object to remain at rest or continue in its uniform motion in a straight line.

A Inertia
B Newton's second law
C Newton's third law
D Acceleration (1)

1.3 An object moves in a straight line with a uniform acceleration according to the law: $s = 10\,t - 2\,t^2$, where s is the displacement in metres and t is the time in seconds.
Calculate:

1.3.1 Displacement in 2 seconds (1)

1.3.2 Acceleration of the object (1)

1.3.3 Initial velocity of the object (1)

1.3.4 Time taken to complete 8 metres (3)

1.4 Two bodies, with masses of 3 kg and 5 kg move towards each other in a straight line, with velocities 2 m/s and 4 m/s respectively. The two bodies remain in contact with each other after colliding.
Calculate:

1.4.1 The final velocity and direction in which the bodies will move after the collision (3)

1.5 A body moves from rest in a straight line with uniform acceleration according to the law $v = 3 + 2\,t$ where v is the final velocity in m/s and t in seconds.
What is the initial velocity of the body? (2)

1.6 A flat belt moves at 72 km/h. The tension on the tight side is 500 N and the tension ratio is 5:1.

Calculate the power transmitted in kW. (3)

[16]

QUESTION 2: MOMENTS

2.1 State the difference between *force* and *load*. (2)

2.2 A beam of 12 m is supported by two supports. One support is at the left end and the other is 4 m from the right end. The beam carries a uniformly distributed load of 5 kg/m between the supports. The beam also carries the following loads: 70 N at 2 m from the left end and 50 N on the right end.

2.2.1 Draw a diagram showing all the details. (2)

2.2.2 Calculate the reaction at the supports. (4)

2.2.3 Using a suitable scale, draw a shear force diagram showing all the main values on the diagram. (4)

[12]

QUESTION 3

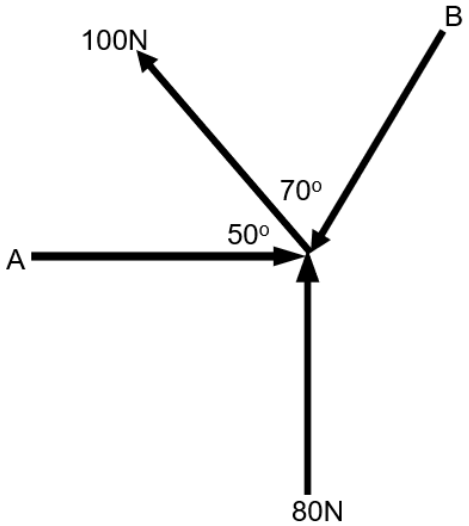
3.1 List TWO conditions of equilibrium of a system of forces. (2)

Various options are given as possible answers Question 3.2. Choose the answer and write only the letter (A–D) next to the question number (3.2) in the ANSWER BOOK.

3.2 Two forces acting on a point have a resultant force of 0 N
The forces:

A have equal magnitude and directions
B act perpendicular to each other
C have equal magnitude but opposite directions
D act in the same direction (1)

3.3 The diagram below shows four coplanar forces acting on a point. If this system of forces is in equilibrium determine the following:



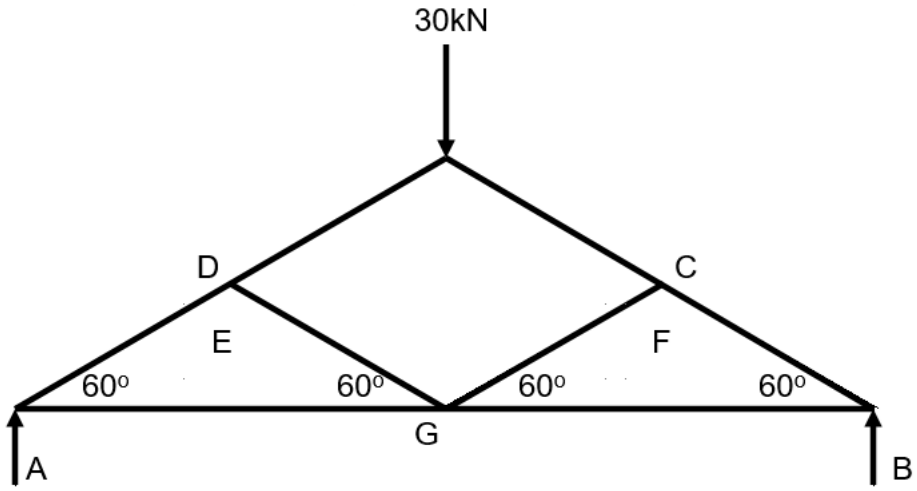
3.3.1 The sum of the horizontal components in terms of A and B (1)

3.3.2 The sum of the vertical components in terms of B (1)

3.3.3 The magnitude of A and B (4)

3.3.4 The magnitude of the equilibrant (1)

3.4 Study the diagram below and answer the questions that follow:



3.4.1 Determine the reactions of supports A and B. (2)

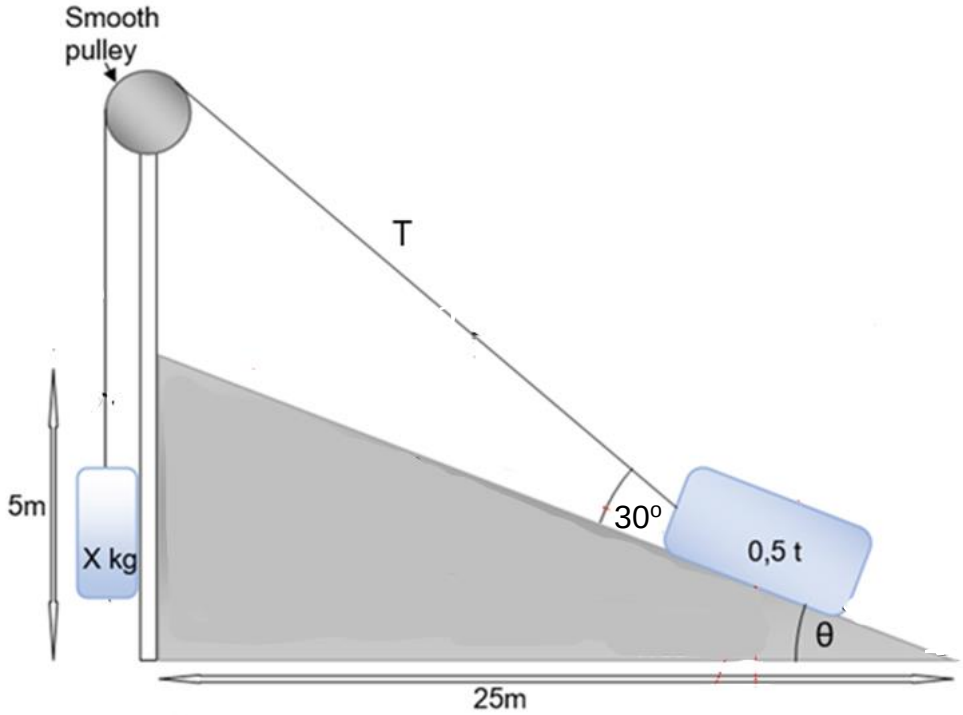
3.4.2 Determine the magnitude and nature of DE and EG. (4)

[16]

QUESTION 4: FRICTION

4.1 State TWO uses of friction in an engineering workshop and give ONE example for each answer. (4)

4.2 Study the diagram below and calculate the smallest value of X to move the 0,5 t block up the plane. The coefficient of friction is 0,25.



(7)

[11]

QUESTION 5: HEAT

5.1 The data provided refers to steam. Use steam tables to determine the condition of the steam.
Where the steam is wet calculate the dryness fraction.

5.1.1 P = 900 kPa t = 250 °C (1)

5.1.2 P = 2,5 MPa h = 2700 kJ/kg (3)

5.1.3 P = 9 MPa h = 2745 kJ/kg (1)

5.2 An engineer must design a steel door for a room. The wooden door frame opening is 1,2 m × 2,09 m. The designer designs a steel door of 1,19 m × 2,08 m.
If the temperature change is 20 °C calculate

5.2.1 The area of the frame (1)

5.2.2 The change in area of the door (2)

5.2.3 The final area of the door (2)

5.3 5.3.1 Give ONE advantage and ONE disadvantage of high specific heat capacity of water in engineering. (2)

5.3.2 A copper ball of 20 kg is heated to 350 °C and then dropped in 2 litres of water at 15 °C. Calculate the final temperature of the copper ball. (3)

[15]

QUESTION 6: HYDRAULICS

6.1 Explain the term *static head*. (2)

6.2 A single action suction pump has a ratio of diameter vs stroke length 3:4. If the work done by ONE stroke is 125 J, and the pump is used to pump water to a height of 8 m. Calculate the diameter as well as the stroke length of the piston. (4)

6.3 The following information pertains to a hydraulic press:

Force on the lever (f) = 25 N
Mechanical advantage (MA) = 18
Diameter of the plunger (d) = 25 mm
Diameter of the ram (D) = 105 mm
Stroke length (H) = 40 mm

Calculate:

6.3.1 The mass lifted by the hydraulic press (3)

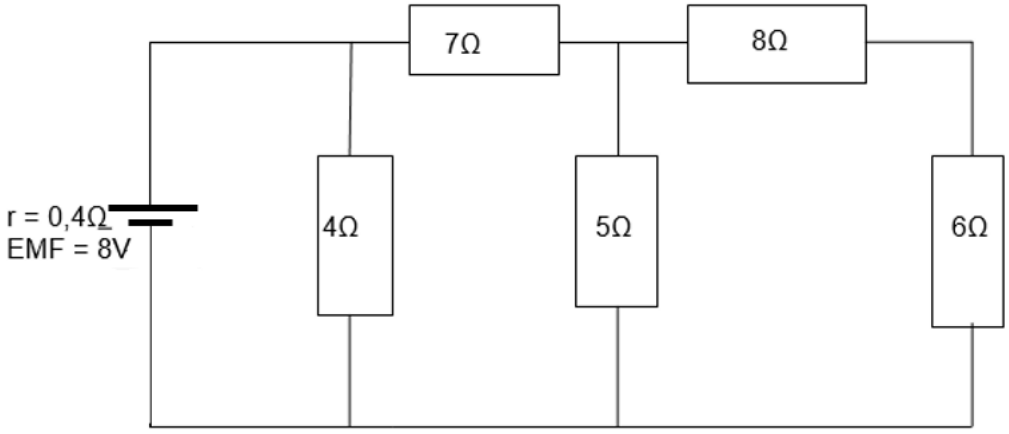
6.3.2 The distance moved by the ram after 60 working strokes (2)

[11]

QUESTION 7: ELECTRICITY

7.1 State ONE application of electrolysis. (1)

7.2 For the circuit diagram below, calculate:



7.2.1 Total resistance of the circuit (4)

7.2.2 Total current of the circuit (2)

7.2.3 Voltage drop at 5Ω resistor (6)

[13]

QUESTION 8

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–I) next to the question number (8.1–8.6) in the ANSWER BOOK.

COLUMN A		COLUMN B	
8.1	A mixture of 50% lead with 50% tin which melts at 200 °C to 250 °C.	A	low temperature
8.2	Consists of one atom calcium, one atom carbon and three atoms of oxygen	B	high temperature
8.3	Contain two s electrons in the outer energy level	C	steel
8.4	Atoms of different elements differ from each other concerning	D	solder
8.5	By protecting the metal with a layer or plastic or glass fibre -which condition will plastic not be suitable?	E	brass
8.6	Mixture of copper and zinc	F	limestone
		G	the structure of their core
		H	alkali earth metals
		I	table salt

(6 × 1) **[6]**

TOTAL: [100]

INFORMATION SHEET

PHYSICAL CONSTANTS

HOEVEELHEID	KONSTANTE CONSTANTS	QUANTITY
Atmosferiese druk	101,3 kPa	Atmospheric pressure
Digtheid van koper	8 900 kg/m^3	Density of copper
Digtheid van aluminium	2 770 kg/m^3	Density of aluminium
Digtheid van goud	19 000 kg/m^3	Density of gold
Digtheid van alkohol (etiel)	790 kg/m^3	Density of alcohol (ethyl)
Digtheid van kwik	13 600 kg/m^3	Density of mercury
Digtheid van platina	21 500 kg/m^3	Density of platinum
Digtheid van water	1 000 kg/m^3	Density of water
Digtheid van minerale olie	920 kg/m^3	Density of mineral oil
Digtheid van lug	1,05 kg/m^3	Density of air
Elektrochemiese ekwivalent van silwer	1,118 mg/C	Electrochemical equivalent of silver
Elektrochemiese ekwivalent van koper	0,329 mg/C	Electrochemical equivalent of copper
Swaartekragversnelling	9,8 m/s^2	Gravitational acceleration
Warmtewaarde van steenkool	30 MJ/kg	Heat value of coal
Warmtewaarde van antrasiet	35 MJ/kg	Heat value of anthracite
Warmtewaarde van petrol	45 MJ/kg	Heat value of petrol
Warmtewaarde van waterstof	140 MJ/kg	Heat value of hydrogen
Lineêre uitsettingskoëffisiënt van koper	17 × 10^{-6}/°C	Linear coefficient of expansion of copper
Lineêre uitsettingskoëffisiënt van aluminium	23 × 10^{-6}/°C	Linear coefficient of expansion of aluminium
Lineêre uitsettingskoëffisiënt van staal	12 × 10^{-6}/°C	Linear coefficient of expansion of steel
Lineêre uitsettingskoëffisiënt van lood	54 × 10^{-6}/°C	Linear coefficient of expansion of lead
Spesifieke warmtekapasiteit van stoom	2 100 J/kg.°C	Specific heat capacity of steam
Spesifieke warmtekapasiteit van water	4 187 J/kg.°C	Specific heat capacity of water
Spesifieke warmtekapasiteit van aluminium	900 J/kg.°C	Specific heat capacity of aluminium
Spesifieke warmtekapasiteit van olie	2 000 J/kg.°C	Specific heat capacity of oil
Spesifieke warmtekapasiteit van staal	500 J/kg.°C	Specific heat capacity of steel
Spesifieke warmtekapasiteit van koper	390 J/kg.°C	Specific heat capacity of copper

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \ . \ v$

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

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

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

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

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

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

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F \ . \perp s$

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

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

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

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

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

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

$$V = I \times R$$