higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

7 April 2021 (X-paper)
09:00–12:00

This question paper consists of 8 pages, 1 information sheet and a formula sheet of 2 pages.

062Q1A2107

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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 section on a new page.
5. Use only blue or black pen.
6. Write neatly and legibly.

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QUESTION 1: MOTION, POWER AND ENERGY

1.1 Complete the following sentences by writing only the missing words next to the question number (1.1.1–1.1.4) in the ANSWER BOOK.

1.1.1 A body will remain at rest or continue to move in a straight line with (a) … velocity unless acted upon by an (b) … force (2)

1.1.2 The area under a velocity-time graph represents … (1)

1.1.3 … is the change in position of an object with respect to another object or reference plane. (1)

1.1.4 The change in the … of a body is proportional to the force applied to the body and takes place in the direction of the applied force. (1)

1.2 A body with a mass of 7 kg is projected vertically upwards at a velocity of 12 m/s.

Determine the following:

1.2.1 The maximum height that the body will reach (2)

1.2.2 The kinetic energy when the body is 5 m above the ground (3)

1.2.3 The velocity when the body is 5 m above the ground (2)

1.3 A force of 450 N is applied to the end of a spanner. The perpendicular distance between the working line of the force and the centre line of the nut is 20 cm.

Determine the following:

1.3.1 The torque

1.3.2 The work done if the nut is turned through an angle of 30° while the torque stays constant

(2 × 2) (4)

[16]

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QUESTION 2: MOMENTS

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

2.2 Study the loaded beam ABCDE of a uniform cross section in FIGURE 1 below and answer the questions.

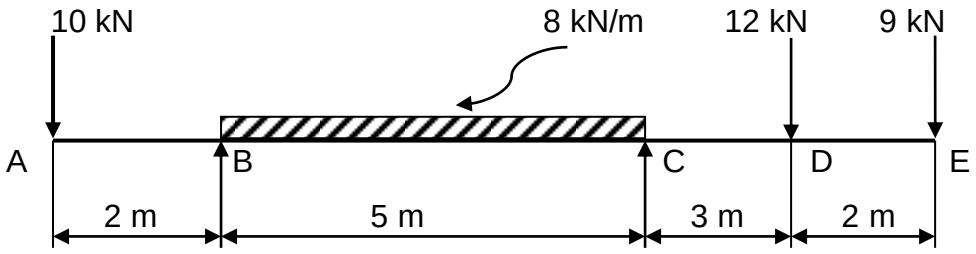


FIGURE 1

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

2.2.2 Draw a shear-force diagram, using a suitable scale. Show all the main values on the diagram. (4)

[11]

QUESTION 3: FORCES

3.1 Name THREE principles that will be applicable if more than three co-planar forces act on an object and the object remains in equilibrium. (3)

3.2 What is meant by the term *equilibrium*? (2)

3.3 Determine the magnitude of force W and force Q analytically if the system is in equilibrium as shown in FIGURE 2 below. (7)

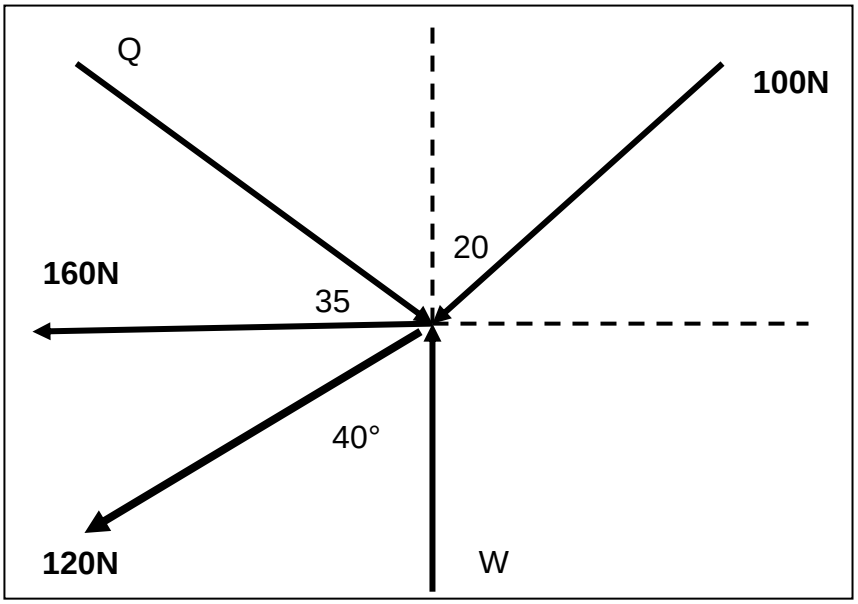


FIGURE 2

3.4 Calculate the magnitude of the unknown force shown in FIGURE 3 below.

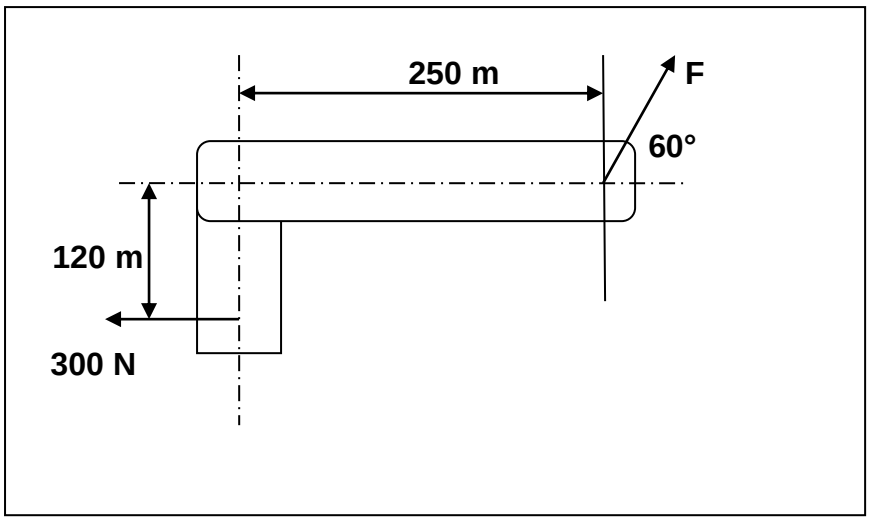


FIGURE 3 (4)

[16]

QUESTION 4: FRICTION

4.1 Explain the difference between *static friction* and *kinetic friction*. (4)

4.2 A minibus weighing 1 600 kg rests on a plane as shown in FIGURE 4 below.

Calculate the smallest force F needed to pull the mass up the incline of 25° if the coefficient of friction is 0,36.

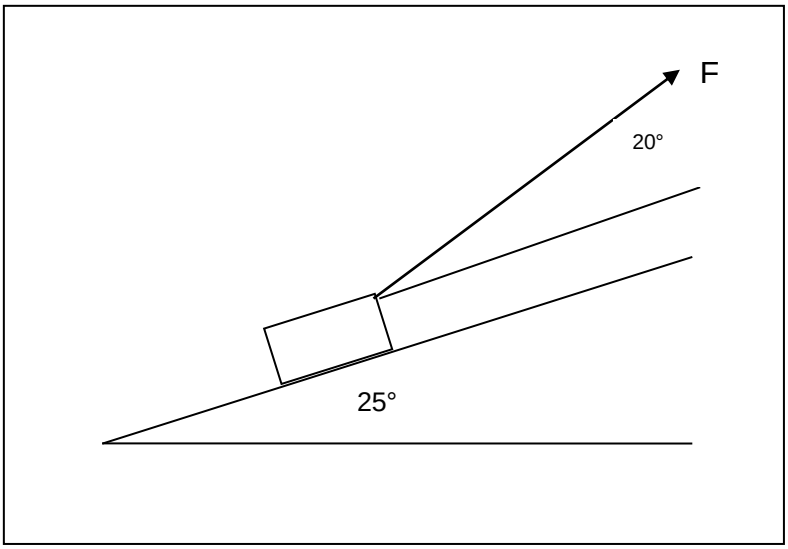


FIGURE 4

(6)
[10]

QUESTION 5: HEAT

5.1 Copper bars with a total mass of 9 kg are heated to 200 °C and immediately placed in 25 litres of water at 22 °C.

Determine the final temperature of the steel bars and the water. (4)

5.2 A rectangular brass sheet has dimensions of 55 cm × 35 cm at 30 °C.
The coefficient of linear expansion is 20×10^{-6}/°C.

If the sheet's temperature is raised to 80 °C, determine the following:

5.2.1 The area coefficient of expansion (1)

5.2.2 The increase in area at 80 °C in cm^2 (3)

5.2.3 The dimensions at 80 °C (4)

5.3 The dryness fraction of 1 kg wet steam is 0,83. This steam is generated at a boiler pressure of 1,1 MPa.

Determine the following specific enthalpy (heat energy):

5.3.1 The liquid at saturated temperature (h_f or sensible heat)

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5.3.2 The dry steam (h_g or total heat for dry steam)

5.3.3 To evaporate the liquid (h_{fg} or latent heat)

(3 × 1) (3)
[15]

QUESTION 6: HYDRAULICS

6.1 A variety of pumps are used to pump hydraulic fluids through a system.

Name TWO of these pumps. (2)

6.2 The following information refers to a single-acting hydraulic press:

Diameter of ram = 465 mm
Force applied to plunger = 360 kN
Diameter of the plunger = 120 mm
Plunger stroke = 0,02 m

If the mechanical efficiency of the hydraulic system is 70%, calculate the following:

6.2.1 The volume of the liquid displaced after 25 pumping strokes of the plunger in litres (3)

6.2.2 The distance that the ram piston will move after 25 pumping strokes in mm (2)

6.2.3 The force exerted by the ram piston (2)

6.2.4 The effort that must be applied to the lever in order to obtain a force of 360 N on the plunger if the mechanical advantage of the system is 8 (2)

6.2.5 The actual mechanical advantage of the system (2)
[13]

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QUESTION 7: ELECTRICITY

7.1 Three cells with an emf of 1,5 V and an internal resistance of 0,3 Ω are connected in series with an ammeter with a resistance of 0,4 Ω, a 0,6 Ω resistor and a radio. The ammeter reading is 2 A.

Calculate the following:

7.1.1 The resistance of the radio

7.1.2 The potential difference across the radio

(2 × 2) (4)

7.2 A 210 V electrical toaster is rated at 3,5 kW.

Calculate the following:

7.2.1 The rated current of the toaster (2)

7.2.2 The resistance of the heating element of the toaster (2)

7.2.3 The current that it would draw if the supply falls to 200 V (2)

7.2.4 The cost to toast a slice of bread at 220 V if it takes the toaster 5 minutes to toast a slice of bread and the cost of electricity is 64 cents per unit (3)

[13]

QUESTION 8: CHEMISTRY

8.1 Define *ionisation energy.* (2)

8.2 Name FOUR factors that increase the rate of corrosion. (4)

[6]

TOTAL: 100

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INFORMATION SHEET

PHYSICAL CONSTANTS

QUANTITY	CONSTANTS
Atmospheric pressure	101,3 kPa
Density of copper	8 900 kg/m^3
Density of aluminium	2 770 kg/m^3
Density of gold	19 000 kg/m^3
Density of alcohol (ethyl)	790 kg/m^3
Density of mercury	13 600 kg/m^3
Density of platinum	21 500 kg/m^3
Density of water	1 000 kg/m^3
Density of mineral oil	920 kg/m^3
Density of air	1,05 kg/m^3
Electrochemical equivalent of silver	1,118 mg/C
Electrochemical equivalent of copper	0,329 mg/C
Gravitational acceleration	9,8 m/s^2
Heat value of coal	30 MJ/kg
Heat value of anthracite	35 MJ/kg
Heat value of petrol	45 MJ/kg
Heat value of hydrogen	140 MJ/kg
Linear coefficient of expansion of copper	17 × 10^{-6}/°C
Linear coefficient of expansion of aluminium	23 × 10^{-6}/°C
Linear coefficient of expansion of steel	12 × 10^{-6}/°C
Linear coefficient of expansion of lead	54 × 10^{-6}/°C
Specific heat capacity of steam	2 100 J/kg.°C
Specific heat capacity of water	4 187 J/kg.°C
Specific heat capacity of aluminium	900 J/kg.°C
Specific heat capacity of oil	2 000 J/kg.°C
Specific heat capacity of steel	500 J/kg.°C
Specific heat capacity of copper	390 J/kg.°C

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FORMULA SHEET

Any other applicable formula may also be used.

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e \ . \ v$

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

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

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

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

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

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

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F \ . \perp s$

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

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

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

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

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

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

$$V = I \times R$$

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