higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770(**E**)(N22)T
NOVEMBER 2010

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N4

(15070434)

22 November (X-Paper)
09:00 – 12:00

This question paper consists of 6 pages, 2 diagram sheets and a 1-page formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Marks indicated are percentages obtainable.
5. Subsections of questions must be kept together.
6. Rule off across the page on completion of each question.
7. ALL formulas used must be written out. Show ALL intermediate steps.
8. Questions must be answered in blue or black ink.
9. ALL the sketches and diagrams must be done in pencil in the ANSWER BOOK.
10. $g = 9,8\ m/s^2$
11. Write neatly and legibly.

QUESTION 1

1.1 A ship that can cruise at 42 km/h in still waters, sets course due south west. It is driven off course by a current flowing west 22° north at a velocity of 72 km/h.

Calculate the following:

1.1.1 The resultant velocity in magnitude and direction (5)

1.1.2 The distance the ship will cruise after 5 hours (1)

1.2 A bullet is fired at an angle of 29° to horizontal at a velocity of 410 m/s.

Calculate the following:

1.2.1 The maximum height reached by the bullet (2)

1.2.2 The horizontal displacement when the bullet hits the ground (2)

1.3 Two vehicles start moving simultaneously at a fork in a road. Vehicle V travels at a speed of 125 km/h north-east. Vehicle W travels at 125 km/h directly east.

Calculate the velocity of vehicle W relative to the velocity of vehicle V in magnitude and direction. (5)
[15]

QUESTION 2

2.1 Define *angular displacement*. (2)

2.2 A point on the rim of a wheel with a diameter of 500 mm has a velocity of 200 km/h.

Calculate the following:

2.2.1 The revolutions per minute (rev/min) (3)

2.2.2 The angular velocity in rad/s at which the wheel is turning (2)

2.3 The engine of a vehicle develops 67 kW at a speed of 1 200 r/min.

Calculate the torque developed. (2)
[9]

QUESTION 3

3.1 Define *Newton's second law.* (2)

3.2 A motor car with a mass of 850 kg accelerates uniformly from rest up a gradient of 1 in 40 and reaches a speed of 60 km/h after 4 minutes.

Calculate the following:

3.2.1 The acceleration of the motor car (2)

3.2.2 The kinetic energy that the motor car possesses at the end of 4 minutes (2)

3.2.3 The gain in potential energy (6)
[12]

QUESTION 4

4.1 A beam ABCDE is 8 m long and is simply supported at the two ends as shown in FIGURE 1, DIAGRAM SHEET 1 (attached).

Calculate the following:

4.1.1 The reaction forces at A and E (3)

4.1.2 The bending moment at points B, C and D (3)

4.1.3 Draw the shear force and bending moment diagrams and show ALL the main values on the two diagrams. (No marks will be allocated if main values are NOT indicated on the diagrams). (5)

4.2 Calculate the position of the centre of gravity of the figure as shown in FIGURE 2, DIAGRAM SHEET 2 (attached), from the base A – A. (4)
[15]

QUESTION 5

5.1 State FIVE facts in connection with pressure exerted by fluids or liquids. (5)

5.2 The following data refers to a single acting hydraulic jack:

Diameter of the ram	= 510 mm
Diameter of the plunger	= 15% diameter of the ram
Plunger stroke length	= 100 mm
Mechanical advantage on the lever	= 25

Calculate the following:

5.2.1 The force to be applied to the lever to lift a load of 5 tons if the slip is 9% (4)

5.2.2 The number of pumping strokes needed to lift a load 410 mm if there is no slip (2)

5.3 The plungers of a three-cylinder pump have diameters of 12 cm and a stroke length of 50 cm. The pressure during the delivery stroke is 1 000 kPa.

Calculate the following:

5.3.1 The power required to drive the pump at 350 r/min if the efficiency of the motor is 90% (4)

5.3.2 The volume of the water delivered per minute in ℓ/min if there is a slip of 13% (5)
[20]

QUESTION 6

6.1 Name THREE types of stresses. (3)

6.2 A square aluminium bar is placed in tension by a force of 460 kN.

Calculate the dimensions of the bar if the stress is not to exceed 32 MPa. (3)

6.3 The following readings were obtained in a tensile test on a mild steel bar:

Load in kN	2,3	9,2	18,4	27,6	36,8
Extension in mm	0,0056	0,0246	0,0456	0,066	0,0896

Gauge length = 61 mm

Original diameter of the bar = 13,3 mm

6.3.1 Draw the load-extension graph for the given values. (4)

6.3.2 Determine Young's modulus of elasticity by means of the graph. (2)

6.3.3 Calculate the percentage reduction in area if the diameter of the rod was 7,32 mm at the fracture. (2)
[14]

QUESTION 7

7.1 Define *Charles' law.* (2)

7.2 What is the difference between Kelvin scale and Celsius scale? (2)

7.3 A steel plate with dimensions 80 cm × 40 cm × 20 cm is placed in an electrical furnace. The steel plate is heated from 37 °C to 410 °C. The coefficient of linear expansion on the steel plate is 19×10^{-6} /°C.

Calculate the following:

7.3.1 The expansion in the length of the plate in cm (2)

7.3.2 The area at the temperature of 410 °C of the 80 cm × 40 cm side in mm^2 (3)

7.3.3 The increase in volume in m^3 (3)

7.4 The volume of a gas is 0,493 m^3 at 73 °C and a pressure of 740 kPa.

Calculate the thermodynamic temperature of the gas if the volume is 0,0749 m^3 at a pressure of 1 300 kPa. (3)
[15]

TOTAL: 100

DIAGRAM SHEET 1

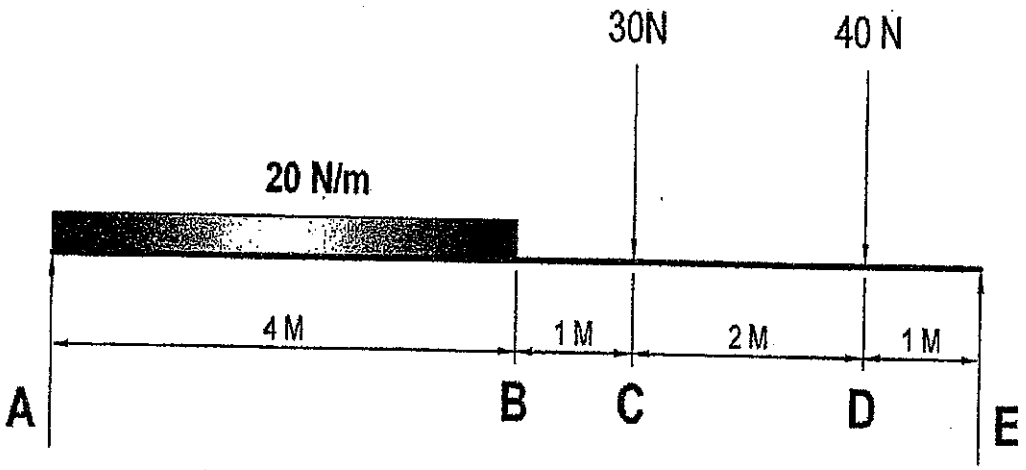

FIGURE 1

DIAGRAM SHEET 2

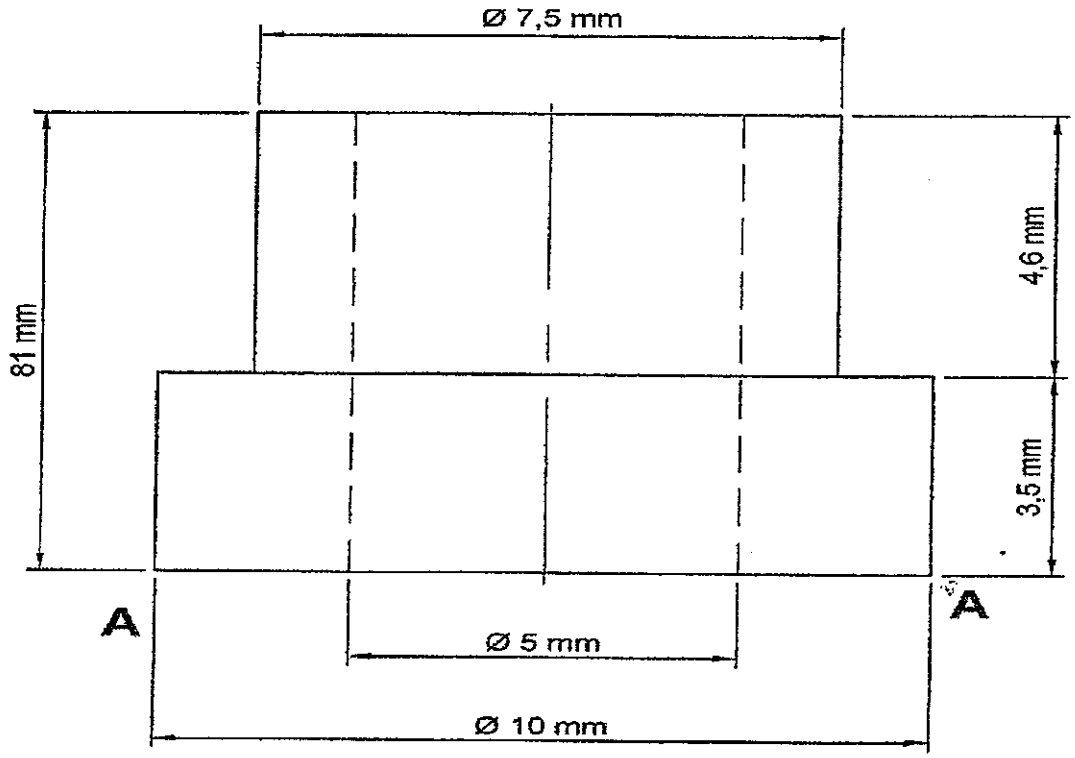

FIGURE 2

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FORMULA SHEET

Any applicable formula may also be used.

$$S = \frac{u+v}{2} \times t$$

$$\overline{V} = \frac{s}{t}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$v_g = \frac{u+v}{2}$$

$$\omega = 2\pi N$$

$$\omega = \frac{\theta}{t}$$

$$\theta = \frac{\omega_2 + \omega_1}{2} \times t$$

$$\omega_2 = \omega_1 + \alpha t$$

$$\theta = \omega_1 t + \frac{1}{2}\alpha t^2$$

$$v = \omega R$$

$$\theta = 2\pi n$$

$$S = R\theta$$

$$\alpha = \frac{\omega_2^2 - \omega_1^2}{2\theta}$$

$$a = \alpha R$$

$$v = \pi DN$$

$$T = FR$$

$$AV = T\theta = WD$$

$$P = 2\pi NT$$

$$P = Fv$$

$$P = T\omega$$

$$F_a = ma$$

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$P = \frac{F}{A}$$

$$m = \rho \times vol$$

$$P = \rho gh$$

$$\frac{W_r}{F_p} = \frac{D^2}{d^2}$$

$$W.D. = P \times V = A.V.$$

$$H.V. = \frac{F_p}{F_h} = M.A.$$

$$AV = mgh = WD$$

$$Q = mc\Delta t$$

$$\Delta l = l_o \alpha \Delta t$$

$$\beta = 2\alpha$$

$$\gamma = 3\alpha$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$PV = mRT$$

$$\epsilon = \frac{x}{l}$$

$$E = \frac{\sigma}{\epsilon}$$

$$\sigma = \frac{F}{A}$$

$$E = \frac{Fl}{Ax}$$

$$\overline{y} = \frac{A_1y_1 \pm A_2y_2 \ldots}{A_1 \pm A_2 \ldots}$$

$$\overline{y} = \frac{v_1y_1 \pm v_2y_2 \ldots}{v_1 \pm v_2 \ldots}$$