higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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AUGUST EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N4

(15070434)

22 July 2015 (Y-Paper)
13:00–16:00

This question paper consists of 6 pages, 1 diagram sheet and 1 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 according to the numbering system used in this question paper.
4. Subsections of questions should be kept together.
5 Rule off across the page on completion of each question.
6. ALL formulae should be shown in the answers.
7. Show ALL calculations.
8. Use only BLUE or BLACK ink.
9. ALL diagrams should be drawn in pencil.
10. The answers, where necessary, should be rounded off to THREE decimal places.
11. Take g = 9,8 m/s^2
12. Write neatly and legibly.

QUESTION 1

1.1 A bullet is fired at a velocity of 300 m/s with an angle of projection of 20^0.

Calculate the following:

1.1.1 The maximum height reached by the bullet (3)

1.1.2 The horizontal range of the bullet (2)

1.2 Two vehicles start simultaneously at a fork in a road. Vehicle A travels north-east at 90 km/h and vehicle B travels west at 110 km/h.

Calculate the velocity of vehicle A relative to the velocity of vehicle B in magnitude and direction. (5)

1.3 An aeroplane can travel at 200 km/h in still air. A wind is blowing at 60 km/h from the south-west.

Calculate the following:

1.3.1 The direction in which the pilot must steer in order to travel due north

1.3.2 The velocity of the aeroplane in relation to the ground

(2 x 2½) (5)

[15]

QUESTION 2

2.1 Define the term *angular velocity.* (1)

2.2 A wheel rotates at 900 r/min. The diameter of the wheel is 40 cm.

Calculate the following:

2.2.1 The angular velocity at any moment

2.2.2 The circumferential velocity of a point on the outside of the wheel at any moment

(2 x 2) (4)

2.3 A machine has a torque of 50 Nm at its spindle. The diameter of the spindle is 50 cm and the rotational frequency is 3 rad/s.

Calculate the following:

2.3.1 The work done by the machine in 25 seconds

2.3.2 The input power if the efficiency is 75%

(2 x 2) (4)

[9]

QUESTION 3

3.1 Define *Newton's first law of motion.* (2)

3.2 A motorcar is travelling on a horizontal road at a velocity of 54 km/h. The mass of the motorcar is 750 kg and the resistance to motion is 300 N. The motorcar stops over a distance of 35 m when the brakes are applied.

Calculate the following:

3.2.1 The deceleration (2)

3.2.2 The braking force (3)

3.3 A train starts from rest on the top of a 2% incline and runs 1 km down the incline under the force due to gravity only. The resistance against motion is constant at 60 N/ton.

Calculate the velocity of the train at the foot of the incline after 1 km by making use of the law of the conservation of energy.

HINT: Let the mass of the train be m.kg (5)
[12]

QUESTION 4

A beam ABCDE, with A on the left-hand side, is 13 m long and is simply supported at A and D. The lengths of the various portions are as follows:

AB = 6 m
BC = 3 m
CD = 2 m
DE = 2 m

There is a uniformly distributed load of 4 kN/m between A and B. A point load of 10 kN is at B and a point load of 15 kN is at C.

4.1 Make a neat, labelled drawing of the beam described. (2)

4.2 Calculate the reaction forces at support A and support D. (3)

4.3 Calculate the bending moments at point B, C, D and a point halfway between A and B. (4)

4.4 Draw the shearing force and bending moment diagrams with ALL the main values indicated on the diagrams. (5)

4.5 Calculate or determine the maximum bending moment. (1)
[15]

QUESTION 5

5.1 Define *Hooke's law.* (2)

5.2 A round bar of 25 mm diameter and a length of 0,6 m is machined to have a square section of 12 mm sides over the length of 0,4 m.

If the stress in the square section is not to exceed 250 MPa, calculate the following:

5.2.1 The stress in the round bar (4)

5.2.2 The total extension of the bar if Young's modulus for the material is 90 GPa (5)

5.3 A load of 50 kN causes a tensile stress of 25 MPa in a round cast iron bar. The original length of the bar is 3 m and Young's modulus is 100 GPa for this cast iron.

Calculate the diameter of the bar. (3)
[14]

QUESTION 6

6.1 Define *Charles-gas law* and draw a graph to illustrate your definition. (4)

6.2 The volume of a gas is 0,5 m^3 at a temperature of 29 ^{0}C and pressure of 209 kPa.

Calculate the volume of the gas at -17 ^{0}C and a pressure of 95 kPa. (3)

6.3 A water reservoir has an effective diameter of 10 m and an effective height of 25 m as shown in the FIGURE on the DIAGRAM SHEET (attached). The coefficient of the volume expansion of water is 207 x $10^{-6}/^0$C. A minimum night temperature of -10 ^{0}C and the maximum day temperature of 45 ^{0}C are expected. Expansion of the reservoir is to be ignored.

Calculate to what height the reservoir is to be filled for these conditions and assuming that the reservoir is not delivering any water. (8)
[15]

QUESTION 7

7.1 State THREE characteristics of a liquid or hydraulic fluid. (3)

7.2 The following data refer to a single-acting hydraulic press:

Plunger diameter	= 2 cm
Plunger stroke length	= 14 cm
Force applied to plunger	= 350 N
Diameter of the ram cylinder	= 7,5 cm

Calculate the following:

7.2.1 The volume of the liquid displaced after 10 pumping strokes of the plunger (2)

7.2.2 The distance moved by the ram after 10 pumping strokes (2)

7.2.3 Work done by the ram after 10 pumping strokes (3)

7.3 The crankshaft of a single-acting 3-cylinder water pump has plungers each having a diameter of 200 mm and a stroke length of 600 mm runs at 1 800 r/min.

Calculate the following:

7.3.1 The volume of water delivered in kℓ/h if there is a slip of 5% (3)

7.3.2 The input power to drive the pump if the efficiency is 90% and the static head is 32 m

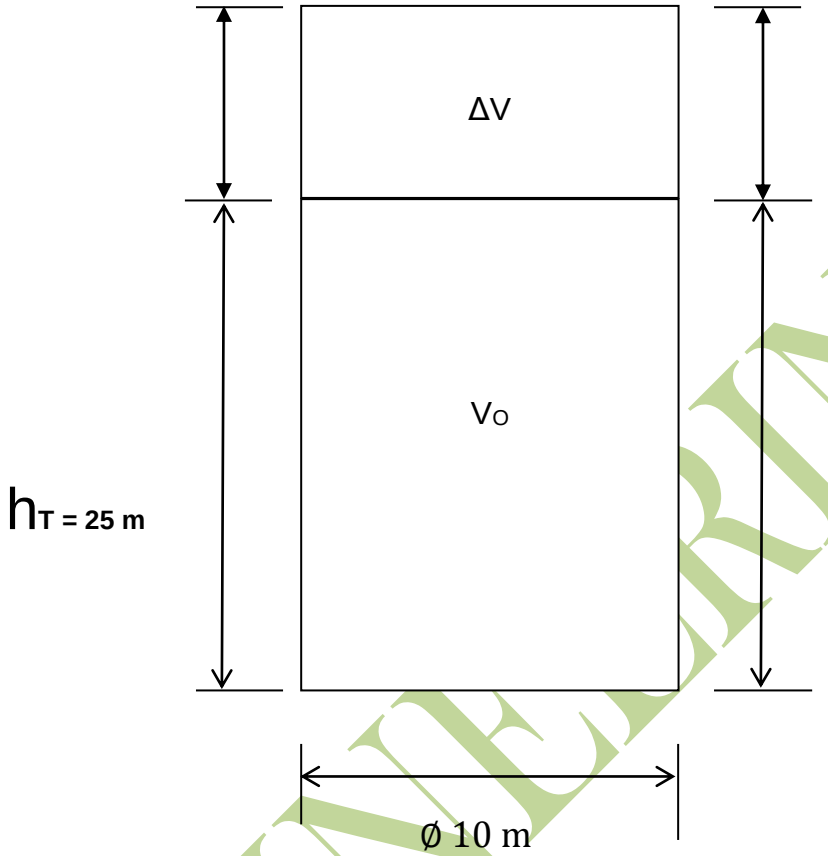
HINT: Use the density for water as 1 000 kg/m^3 (4)

7.4 The mass of a hydraulic accumulator is 2 tons. The diameter of the ram is 45 cm.

Calculate the pressure of the fluid. (3)
[20]

TOTAL: 100

DIAGRAM SHEET



FIGURE

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FORMULA SHEET

Any applicable formula may also be used.

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

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

$v = u + at$

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

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

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

$\omega = 2\pi N$

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

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

$\omega_2 = \omega_1 + \alpha t$

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

$v = \omega R$

$\theta = 2\pi n$

$S = R\theta$

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

$a = \alpha R$

$v = \pi DN$

$T = FR$

$AV = T\theta = WD$

$P = 2\pi NT$

$P = Fv$

$P = T\omega$

$F_a = ma$

$E_p = mgh$

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

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

$m = \rho \times vol$

$P = \rho gh$

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

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

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

$AV = mgh = WD$

$Q = mc\Delta t$

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

$\beta = 2\alpha$

$\gamma = 3\alpha$

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

$PV = mRT$

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

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

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

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

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

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