higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T520**(E)**(N17)T

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

17 November 2016 (X-Paper)
09:00–12:00

This question paper consists of 7 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. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. All the calculations should consist of at least THREE steps:
   - 4.1 The formula used or manipulation thereof
   - 4.2 Substitution of the given data in the formula
   - 4.3 The answer with the correct SI unit
5. The constant values, as they appear on the attachment information sheet, must be used when possible.
6. Keep subsections of questions together.
7. Rule off on completion of each question.
8. Drawing instruments must be used for all drawings/diagrams. ALL drawings/diagram must be fully labelled.
9. Use g = 9,8 m/s^2
10. Answers must be rounded off to THREE decimals.
11. Write neatly and legibly.

QUESTION 1: MOVEMENT

1.1 Calculate the final velocity in m/s of an object if it is moving in a straight line at a constant velocity of 60 km/h and then accelerates uniformly at 2 m/s^2 for 4 seconds. (3)

1.2 A crane hoists a load of 2,2 tons by means of a chain. The crane hoisting drum has a rotational frequency of 60 r/min and a diameter of 750 mm.

Calculate the following:

1.2.1 The torque required to hoist the load (1½)

1.2.2 The rope speed of the load in m/s (1½)

1.2.3 The work done by the crane (1½)

1.2.4 The power required for the load in kW (1½)

1.2.5 The efficiency of the crane if the crane motor uses 60 kW to drive the lifting hoist (2)

1.3 A cannon with a mass of 10 tons fires a bullet with a mass of 50 kg horizontally. The velocity of the bullet when it leaves the barrel of the cannon is 800 km/h.

Calculate the recoil velocity of the canon. (4)
[15]

QUESTION 2: MOMENTS

2.1 A beam ABCDE which rests horizontally is 12 m long and is supported at B and E. Support B is 3 m away from A and support E is at the right-hand side of the beam. The beam carries point loads of 15 kN and 1,02 tons at C and D respectively. The beam also carries a distributed load of 5 kN/m for 5 meters starting at A and ending at C. It also carries a second distributed load of 8 kN/m over the last 4 m between D and E.

2.1.1 Draw the beam, showing ALL critical values. (4)

2.1.2 Calculate the magnitude of supports B and E. (6)

2.1.3 Draw a shear-force diagram and fully label ALL critical values. (3)
[13]

QUESTION 3: FORCES

3.1 Explain the difference between a resultant force and an equilibrant force. (3)

3.2 Determine the magnitudes of the forces P and Q shown in FIGURE 2. The system is in equilibrium on the same plane.

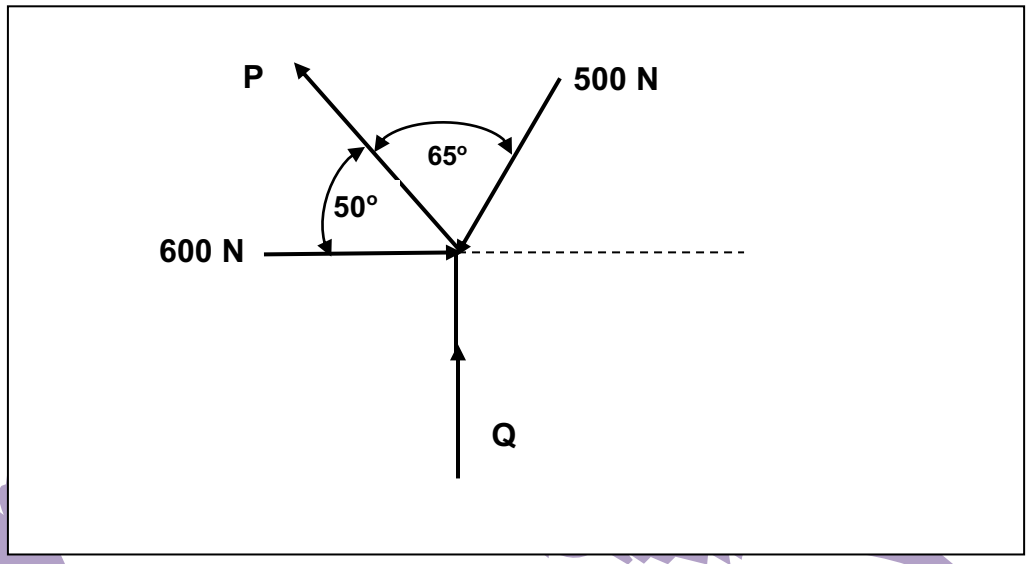

FIGURE 2 (8)

3.3 FIGURE 3 shows a structure of forces in equilibrium.

Analytically determine or calculate the magnitude and nature of the members AB and AC.

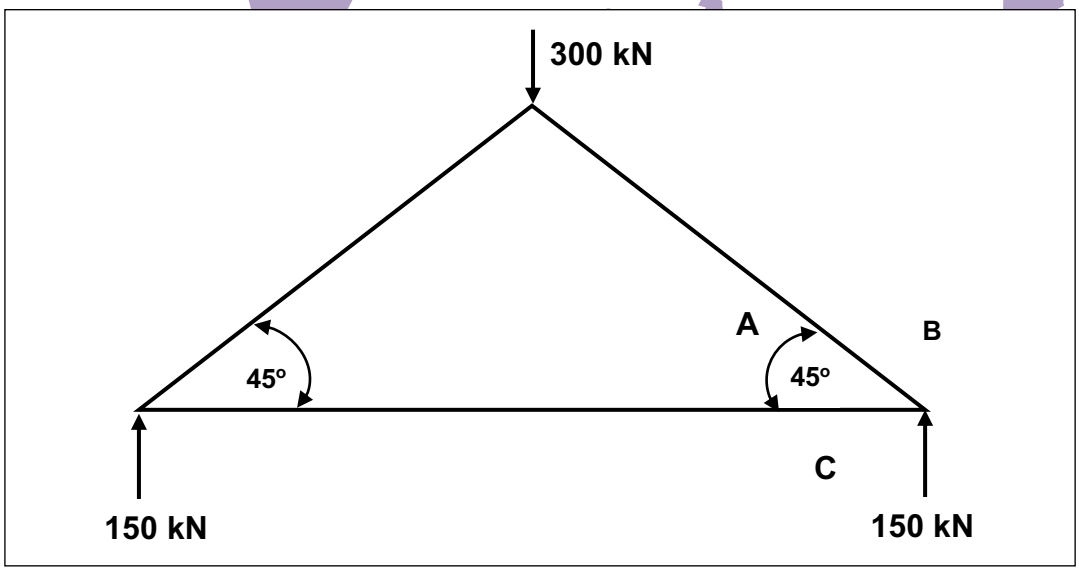

FIGURE 3 (4)

[15]

QUESTION 4: FRICTION

4.1 List ONE advantage of friction in practice. (1)

4.2 Name TWO disadvantages of friction in practice. (2)

4.3 Give the definition of *angle of rest*. (2)

4.4 A vehicle with a weight of 6 500 N is kept in equilibrium on an incline by means of a pulling force which is at an angle of 25° to the incline. The incline forms an angle of 35° to the horizontal plane. The coefficient of friction between the surfaces in contact is 0,3.

Determine the minimum supporting force to keep the object in equilibrium. (6)
[11]

QUESTION 5: HEAT

5.1 A home-made geyser with a volume of 200 ℓ of water is heated from 293 K to 87 °C by using coal. The calorific value of the coal is 26 MJ/kg and the specific heat capacity of water is 4,187 kJ/kg °C.

Determine the following:

5.1.1 The temperature change of the water

5.1.2 The quantity of heat required to heat the water

5.1.3 The quantity of coal required to heat the water

(3 × 2) (6)

5.2 An object with a total mass of 1 500 g and a temperature of 81 °C is placed in 2 200 mℓ of water with a temperature of 20 °C. The final temperature is 25 °C.

Determine the type of material used if the specific heat capacity of water is 4,2 kJ/kg °C. (3)

5.3 Use the steam tables to calculate the total enthalpy required for 1 kg wet steam for each of the following cases at the pressure of 1 400 kPa:

5.3.1 Wet steam with a dryness fraction of 0,94 (2)

5.3.2 Dry saturated steam (1)

5.3.3 Total heat of superheated steam if the temperature of the superheated steam is increased to 240 °C and an average specific heat capacity of 2,85 kJ/kg °C. Use the boiler pressure as 1 400 kPa. (2)
[14]

QUESTION 6: HYDRAULICS

6.1 The efficiency of a pump is 80%. The pump delivers a quantity of 15 m^3 water per hour.

Calculate the following:

6.1.1 The energy required if the water is pumped to a height of 8 m

6.1.2 The energy required if the water is pumped at a pressure of 600 kPa

(2 × 3) (6)

6.2 A hydraulic jack is required to lift an object. The diameter of the ram is 80 mm and that of the plunger is 20 mm. The mechanical advantage is 16 and the stroke length of the plunger is 25 mm.

Calculate the following:

6.2.1 The effort required for the jack to lift a mass of 1 500 kg if the mechanical efficiency is 80% (4)

6.2.2 The number of strokes required to lift the load 51,5 mm (2)

[12]

QUESTION 7: ELECTRICITY

7.1 In an electrical circuit SIX cells, each with an EMF of 1,5 volts and internal resistance of 0,15 ohms per cell, are connected in series. This battery is then connected to two lights which are connected in parallel having resistors of 6 ohms and 3 ohms.

Calculate the following:

7.1.1 The total resistance of the circuit (4)

7.1.2 The total current flow (2)

7.1.3 The internal potential drop in the battery (2)

7.2 The following appliances are used for a given period of time per day:

- Ten 60 Watt lamps, 4 hours per day
- Five 100 Watt lamps, 6 hours per day
- One 2 000 Watt stove, 1 hour per day
- Two computers using 75 Watt, 3 hours per day

Electricity costs R 1,63 per kWh.

Calculate the electricity cost for SEVEN days. (4)

7.3 A learner conducted an experiment in a laboratory using an electric current of 100 A. The experiment was done for 2 hours through a solution of copper sulphate using a copper anode. The electrochemical equivalent of copper is $3{,}294 \times 10^{-4}$ g/C.

Calculate the mass of the copper deposited. (2)
[14]

QUESTION 8: CHEMISTRY

Make a neat, labelled sketch and describe the function of electrolysis. **[6]**

TOTAL: 100

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FORMULA SHEETS

All the formulae needed are not necessarily included.

Any applicable formula may also be used.

$$W = F.s$$

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

$$\eta = \frac{Output}{Input}$$

$$F = m.a$$

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

$$\mu = \tan\theta$$

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

$$F_S = w\sin\theta$$

$$F_C = w\cos\theta$$

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

$$F_e = T_1 - T_2$$

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

$$P = F_e.v$$

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

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

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

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

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

$$m = I.z.t$$

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

$$v = u + a.t$$

$$M = F.\perp\ s$$

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

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

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

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

$$D_e = (D + t)$$

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

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

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

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

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

$$F_X = F\cos\theta$$

$$F_Y = F\sin\theta$$

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

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

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

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

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

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

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

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

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

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

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

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

$$\sum CWM = \sum ACWM$$

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

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

$$V = I \times R$$

INFORMATION SHEET

PHYSICAL CONSTANTS

QUANTITY	CONSTANTS
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^{-5}/˚C
Linear coefficient of expansion of aluminium	23 × 10^{-5}/˚C
Linear coefficient of expansion of steel	12 × 10^{-5}/˚C
Linear coefficient of expansion of lead	54 × 10^{-5}/˚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