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education

Department:
Education
REPUBLIC OF SOUTH AFRICA

T740(E)(M31)T
APRIL 2010

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

31 March (X-Paper)
09:00 – 12:00

Drawing instruments may be used.

This question paper consists of 8 pages and a 2-page formula sheet.

DEPARTMENT OF EDUCATION
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 correctly 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 were ever 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/diagrams must be fully labelled.
9. One mark indicates one percentage point, that is 100 marks = 100%.
10. Use $g = 9,8\ m/s^2$.
11. Answers must be rounded off to THREE decimal places.
12. Write neatly and legibly.

QUESTION 1

1.1 State the *law of moments*. (2)

1.2 Define the *resultant force of a system of forces*. (1)

1.3 State TWO types of coefficient of friction. (1)

1.4 FIGURE 1 below shows a body mass of M kg. The body is pulled up the incline. The incline makes an angle of X° with the horizontal. Draw the diagram in the ANSWER BOOK and show ALL the forces, as well as the components of the forces with ALL directions on the drawing.

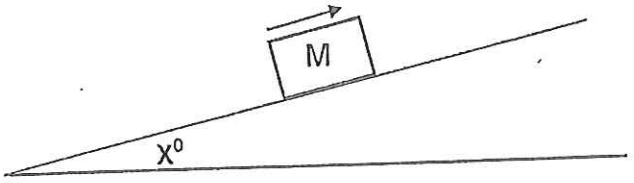

FIGURE 1 (3)

1.5 State the *law of conservation of heat energy*. (2)

1.6 Define *Pascal's law*. (2)

1.7 Define the *electromotive force* (EMF) of a battery/cell. (2)

1.8 Explain the term *reduction*. (1)

1.9 Name THREE precautions against corrosion on iron. (3)

1.10 Give the chemical formula for limestone. (1)
[18]

QUESTION 2: MOTION, POWER AND ENERGY

2.1 A body moves in a straight line with an uniform acceleration according to the law $v = 3 + 2t$, where v is the final velocity in metres per second and t is the time in seconds.

Calculate the following:

2.1.1 The initial velocity of the body (1)
2.1.2 The acceleration of the body (1)
2.1.3 The displacement after 4 seconds (2)

2.2 A motor-bike with a mass of 20 000 g accelerates on a horizontal road from rest to a velocity of 5 m/s in 10 seconds. The friction force is 90,165 N.

Determine the magnitude of the constant horizontal force exerted by the engine of the motorbike. (4)

2.3 A flat belt has a thickness of 4,35 mm and drives a pulley of a diesel motor with a diameter of 395 mm and rotates at 300 r/min. The tight side tension is 1 400 N and the tension ratio 3:1.

Consider the belt thickness and calculate the following:

2.3.1 The tension in the slack side (2)
2.3.2 The belt velocity (3)
2.3.3 The power transmitted in kW (2)
[15]

QUESTION 3: MOMENTS

3.1 FIGURE 2 below shows a light horizontal beam ABCDEF of a uniform cross-section, loaded as shown:

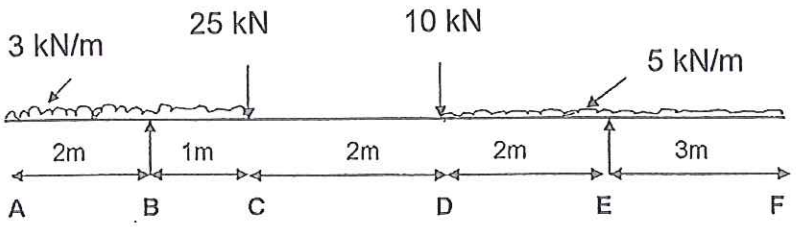

FIGURE 2

(4)

3.1.1 Calculate the reaction at the supports.

3.1.2 Draw a shear-force diagram, using a suitable scale. Show ALL the main values on the diagram.

(6)
[10]

QUESTION 4: FORCES

4.1 FIGURE 3 below shows a system of forces.

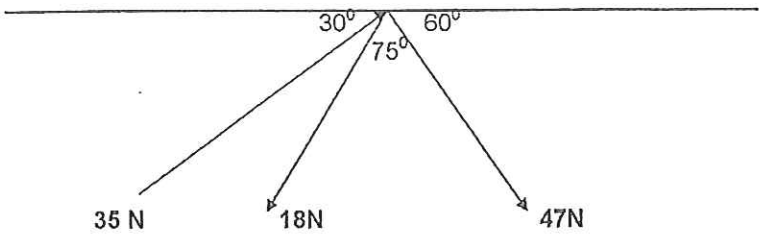

FIGURE 3

Calculate the following:

4.1.1 The sum of the horizontal components. Give the direction.
4.1.2 The sum of the vertical components. Give the reaction.
4.1.3 The magnitude and direction of the resultant. (9)

4.2 FIGURE 4 below shows a structure. Determine graphically or calculate the magnitude and nature of the forces in members AB and AC.

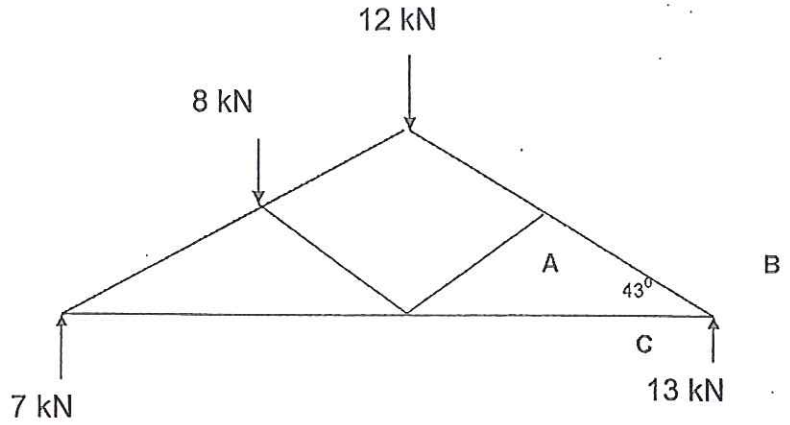

FIGURE 4

(6)
[15]

QUESTION 5: FRICTION

5.1 An iron block with a mass of 45 kg rests on an inclined plane of 16° to the horizontal. The force required to overcome the friction is 65 N.

Calculate the following:

5.1.1 The weight component perpendicular to the inclined plane. (1)
5.1.2 The coefficient of friction (2)

5.2 A body with a mass of 40 kg rest on horizontal plane. The coefficient of friction is 0,36. A force T with an angle of 22° to the horizontal pulls the body at a constant velocity.

Calculate the magnitude of force T. (4)
[7]

QUESTION 6: HEAT

6.1 A piece of steel with mass of 10 kg at a temperature of 89 °C is immersed in 5 litres of water at 17 °C. Calculate the final temperature of the water if no heat is lost. (4)

6.2 A cylinder open at both ends, has a diameter of 4.879 cm at 12 °C. Calculate the surface area when it is heated to 150 °C. (4)

6.3 The total enthalpy of 1 kg of wet steam is 2 465,563 kJ under a pressure of 2 300 kPa.

Calculate the dryness factor of steam. (3)
[11]

QUESTION 7: HYDRAULICS

7.1 Water flows out of a dam at a rate of 3 000 litres per minute. The dam is situated 100 metres above the electric turbine that is being driven by the falling water.

Calculate the following:

7.1.1 The kinetic energy of the water when it reaches the turbine. (2)

7.1.2 The electrical power generated by the turbine when only 80% of the energy stored in the falling water is converted into electrical energy. (3)

7.2 The following data refers to a hydraulic press:

Diameter of ram	=	125 mm
Mass lifted	=	1 ton
Diameter of the plunger	=	50 mm
Stroke length of plunger	=	200 mm

Ignore all losses and calculate the following:

7.2.1 The effort applied by the plunger
7.2.2 The distance moved by the ram per stroke
7.2.3 The work done after 10 strokes (6)
[11]

QUESTION 8: ELECTRICITY

8.1 An electrical circuit consists of three cells connecting in series, each having an EMF of 2 volts and internal resistance of 0,15 ohms, connected in series with a lamp of a resistance of 5 ohms.

Calculate the following:

8.1.1 The total EMF of the battery
8.1.2 The total internal resistance of the battery
8.1.3 The total resistance of the circuit
8.1.4 The current flow in the circuit
8.1.5 The potential difference of the battery (5)

8.2 An electrical kettle draws 8 amperes from 220 volts and takes 2 minutes to boil. The cost of electricity is 40 cents per kWh. How much will it cost to boil the kettle? (3)

8.3 A current of 15 A is allowed to flow through a solution of silvernitrate. Calculate the time required to cover a metal plate with a mass of 150 grams of silver. (2)

8.4 A single transformer has a primary voltage of 220 V and current of 21 A at full load. The secondary current is 7 A.

Calculate the following:

8.4.1 The turns ration primary to secondary (2)

8.4.2 The power if the power factor is 0,866 (2)

[14]

TOTAL: 100

FORMULA SHEET

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

$W = F.s$

$W = \rho.V$

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

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

$F = m.a$

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

$\mu = \tan\Phi$

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

$F_S = wsin\theta$

$F_C = wcos\theta$

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

$F_e = T_1 - T_2$

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

$P = F_e . v$

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

$W_\mu = F_\mu . s$

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

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

$Q = I^2 . R . t$

$m = I . z . t$

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

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

$D_e = (D + t)$

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

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

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

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

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

$F_X = Fcos\theta$

$F_Y = Fsin\theta$

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

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

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

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

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

$m.ww = Q = m.hv$

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

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

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

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

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

$v = u + a.t$

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

$M = F . \perp s$

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

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

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

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

$$R_{SER} = R_1 + \ldots R_n$$

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

$$V = I \times R$$