T570(E)(J30)T

AUGUST EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

30 July 2014 (Y-Paper)
13:00–16:00

REQUIREMENTS: Properties of water and steam (BOE-173)

Calculators may be used.

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

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 the 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. Drawing instruments must be used for all drawings/diagrams.

6. ALL drawings/diagrams must be fully labelled.

7. The constant values, as they appear on the attached information sheet, must be used wherever possible.

8. Keep subsections of questions together.

9. Start each question on a NEW page.

10. Use $g = 9{,}8\ m/s^2$

11. Answers must be rounded off to THREE decimal places.

12. Write neatly and legibly.

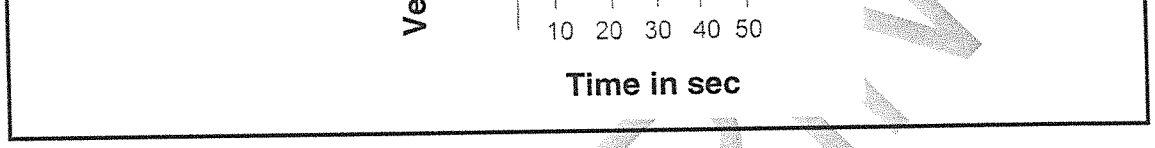

FIGURE 1

1.1.1 The acceleration (2)

1.1.2 The initial velocity (1)

1.1.3 The total displacement (2)

1.2 A tower is 24 m high. A stone is projected upwards from the tower with an initial velocity of 24, 5 m/s.

Calculate how long it would take for the stone to reach the ground at the foot of the tower. (4)

1.3 Describe the following terms: (3)

1.3.1 force (2)

1.3.2 mass. (1)

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

Calculate the recoil velocity of the cannon. (3)
[15]

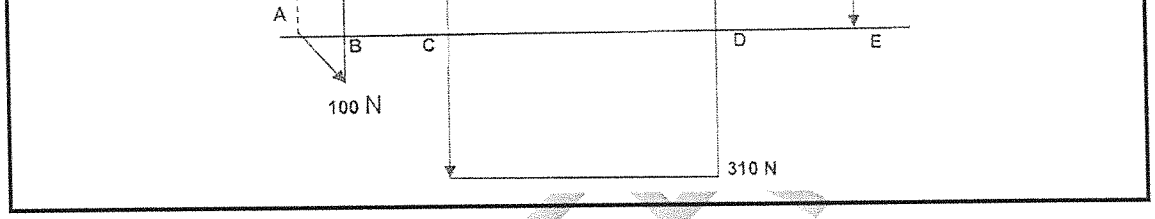

FIGURE 2

2.2.1 At which TWO positions is the beam supported and what is the magnitude of each support? (2)

2.2.2 Calculate the magnitude of the distributed load per meter length. (2)

2.3 FIGURE 3 below shows a light horizontal beam ABCD with a uniform cross section loaded as shown. The magnitude of support A is 32,222 kN.

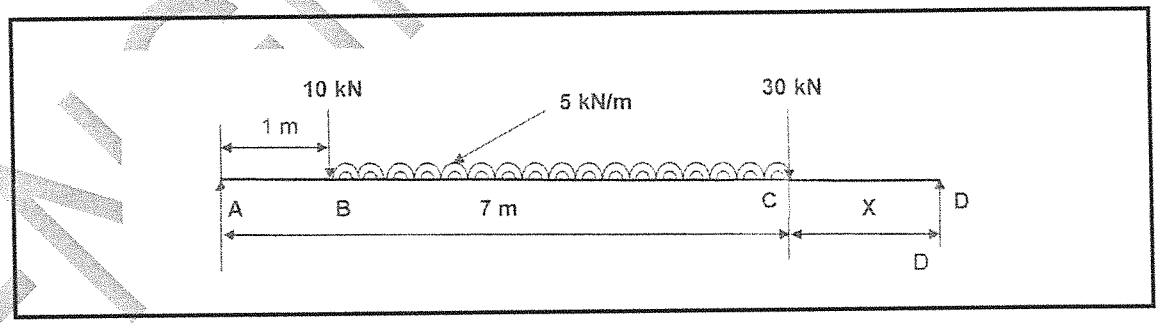

FIGURE 3

2.3.1 Calculate the magnitude of support D by using Newton's third law. (4)

2.3.2 Calculate the distance X by taking moments about support D. (4)
[14]

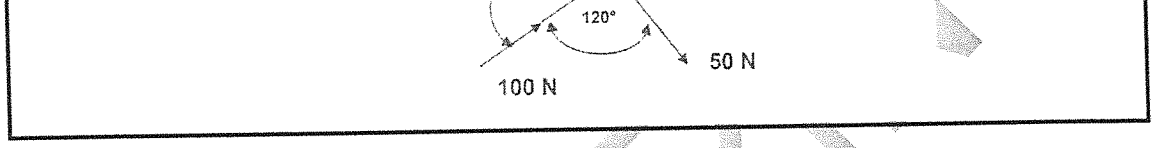

FIGURE 4

(8)

3.3 FIGURE 5 below shows a structure. Determine graphically or calculate the magnitude and nature of the forces in members PQ and PR.

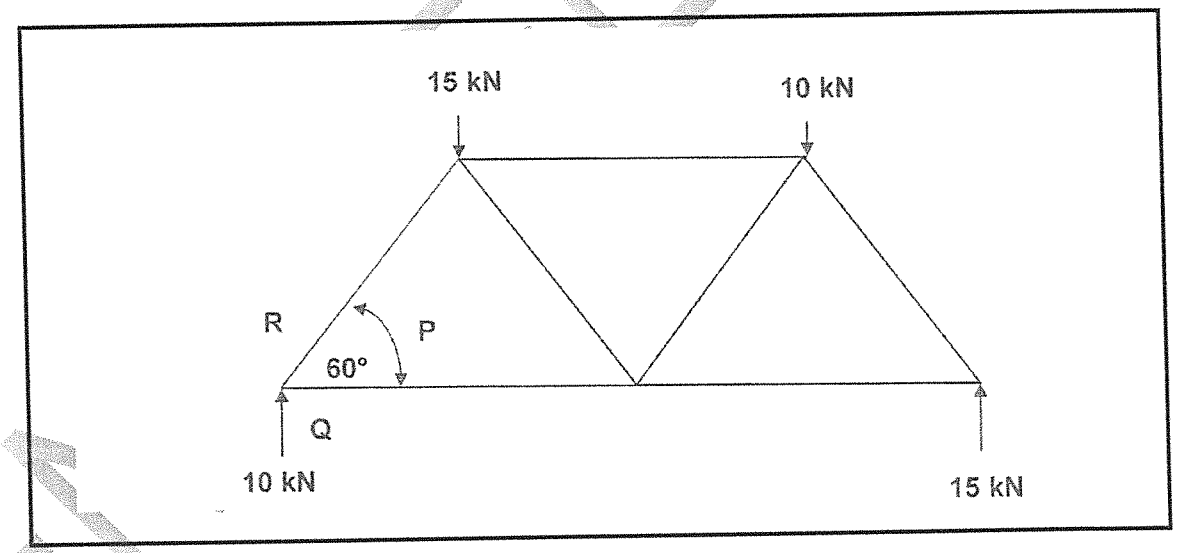

FIGURE 5

(4)
[14]

plane.

4.2.3 The smallest force required to pull the block upwards along the plane. (2)

4.2.4 The coefficient of friction. (2)

[12]

QUESTION 5: HEAT

5.1 Explain the term *heat value of a fuel.* (2)

5.2 Name THREE of the factors we have to take into account when we want to heat or cool something. (3)

5.3 5 kg of steel is immersed in water at 20^0C.

What mass of water is required if the final temperature is 40^0C? (5)

5.4 A volume of 250 ℓ of water is heated from 280^0 C to 360^0C by burning coal.

Calculate the following:

5.4.1 The change in temperature of the water (1)

5.4.2 The quantity of heat required (2)

5.4.3 The quantity of coal required (2)

[15]

if the efficiency is 85%. (3)

6.2.2 The number of strokes of the lever to lift the load 126 mm. (3)

6.3 The following data were given: An inside diameter of the water pipe is 50 mm and an effective head is 30 m.

Calculate the work done. (3)
[12]

QUESTION 7: ELECTRICITY

7.1 Four cells each having an emf of 1,5 V and an internal resistance of 0,5 Ω are connected in series. Two resistors of 6 Ω and 8 Ω respectively are connected in parallel and then across the terminals of the battery.

Calculate the following:

7.1.1 The current through each cell (3)

7.1.2 The terminal voltage of the battery (2)

7.1.3 The current through each resistor (2)

7.1.4 The internal voltage drop (2)

7.2 Define the term *ampere.* (2)

7.3 Define the term *potential difference.* (1)
[12]

Oxidation of a metal produces a (8.2.3) … (3)
[6]

TOTAL: 100

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

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

$$F = m.a$$

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

$$\mu = \tan\Phi$$

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

$$F_S = wsin\theta$$

$$F_C = wcos\theta$$

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

$$F_e = T_1 - T_2$$

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

$$P = F_e \,.\, v$$

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

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

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

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

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

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

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

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

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

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

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

$$F_X = Fcos\theta$$

$$F_Y = Fsin\theta$$

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

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

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

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

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

$$m.ww = Q = m.hv$$

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

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

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

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

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

$$v = u + a.t$$

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

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

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

$$V = I \times R$$

Density of gold	19 000 kg/m	Digtheid van goud
Density of alcohol (ethyl)	790 kg/m^3	Digtheid van alcohol (etiel)
Density of mercury	13 600 kg/m^3	Digtheid van kwik
Density of platinum	21 500 kg/m^3	Digtheid van platina
Density of water	1 000 kg/m^3	Digtheid van water
Density of mineral oil	920 kg/m^3	Digtheid van minerale olie
Density of air	1,05 kg/m^3	Digtheid van lug
Electrochemical equivalent of silver	1,118 mg/C	Elektrochemiese ekwivalent van silwer
Electrochemical equivalent of copper	0,329 mg/C	Elektrochemiese ekwivalent van koper
Gravitational acceleration	9,8 m/s^2	Swaartekragversnelling
Heat value of coal	30 MJ/kg	Warmtewaarde van steenkool
Heat value of anthracite	35 MJ/kg	Warmtewaarde van antrasiet
Heat value of petrol	45 MJ/kg	Warmtewaarde van petrol
Heat value of hydrogen	140 MJ/kg	Warmtewaarde van waterstof
Linear coefficient of expansion of copper	17×10^{-6}/°C	Lineêre uitsettingskoëffisiënt van koper
Linear coefficient of expansion of aluminium	23×10^{-6}/°C	Lineêre uitsettingskoëffisiënt van aluminium
Linear coefficient of expansion of steel	12×10^{-6}/°C	Lineêre uitsettingskoëffisiënt van staal
Linear coefficient of expansion of lead	54×10^{-6}/°C	Lineêre uitsettingskoëffisiënt van lood
Specific heat capacity of steam	2 100 J/kg.°C	Spesifieke warmtekapasiteit van stoom
Specific heat capacity of water	4 187 J/kg.°C	Spesifieke warmtekapasiteit van water
Specific heat capacity of aluminium	900 J/kg.°C	Spesifieke warmtekapasiteit van aluminium
Specific heat capacity of oil	2 000 J/kg.°C	Spesifieke warmtekapasiteit van olie
Specific heat capacity of steel	500 J/kg.°C	Spesifieke warmtekapasiteit van staal
Specific heat capacity of copper	390 J/kg.°C	Spesifieke warmtekapasiteit van koper

MARKING GUIDELINE

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30 JULY 2014

This marking guideline consists of 9 pages.

1.1.3 $\mu = 50$ m/s

or

$(50 \times 10) + (0.5 \times 50 \times 40)$ ✓

$= 500 + 1\,000$

$= 1\,500\ m$ ✓ (2)

1.2 $V = u + gt$

$t = \frac{V - \mu}{-g} = \frac{0 - 24,5}{-9,8}$

$= 2,5$ s ✓

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

$= 35,5 \times (2,5) + \frac{1}{2} (-9,8) (25)^2$

$= 61,25 - 30,625$

$= 30,62$ s ✓

$S = \mu t + \frac{1}{2} gt^2$

$(30,625 + 24) = + \frac{1}{2} gt^2$

$t = \sqrt{\frac{54,625 \times 2}{9,8}}$

$t = 3,339$ s ✓

Total time $= 2,5 + 3,339$

$= 5,839$ s ✓ (4)

1.3

1.3.1 Force is that influence which changes✓ or tends to change the state of rest of a body. ✓ (2)

1.3.2 Mass of object is the quantity of matter a body contains. ✓ (1)

1.4 $M_1V_1 = M_2V_2$

$10\,000 \times V_1$✓ $= 50 \times 800$ ✓

$V = 4$ m/s ✓ (3)

[15]

= 50 N/m ✓

Or

$\left(\frac{390-190}{4}\right)$

= 50N/m

(2)

2.3 2.3.1 Upward forces = Down forces

$F_{up} = F_{down}$

$F_A + F_D = 10 + (6 \times 5) + 30$ ✓

$32{,}222 + F_D = 10 + 30 + 30$ ✓

$F_D = 37{,}778$ ✓

(4)

2.3.2 Taking moments about A

$32{,}222\ (7 + x) = 10\ (6 + x) + 30\ (3 + x) + 30x$ ✓

$225{,}554 + 32{,}222x = 60 + 10x + 90 + 30x + 30x$ ✓

$x = 1{,}999 = 2\text{m}$ ✓

(4)
[14]

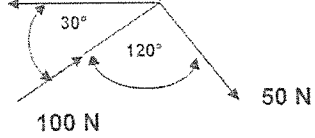
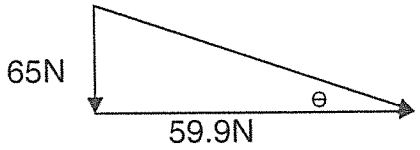


FIGURE 4

EHC = -70 + 100 Cos 30 + 50 Cos 30
= -70 + 86,603 + 43,301 ✓
= +59,904 N ✓ (2)

EVC = -90 – 50 Sin 30 + 100 Sin 30
= -90 – 25 + 50 ✓
= -65 N ✓ (2)



$R = \sqrt{(65)^2 + (59,904)^2}$
R = 88,394 N✓
$\Theta = \text{Tan}^{-1} \frac{65}{59,904}$✓
Θ = 47,336° ✓
R = 88,394N W 47,336° N✓ (4)

3.3 PR = 10/Sin 60^0 ✓

= 11.547 N ✓

PQ = Cos 60^0 X 11.547 ✓

= 5.774 N ✓ (4)
[14]

Fμ = 2000N

FIGURE 5

4.2.1 The weight component // with the plane

$W\sin\Theta = 750 \times 9{,}8 \times \sin 20$ ✓

$= 2513{,}848$ N✓ (2)

4.2.2 The weight component ⊥ with the plane

$W\cos\Theta = 750 + 9{,}8 \times \cos 20$ ✓

$= 6906{,}741$ N✓ (2)

4.2.3 $Fup = F\mu + W \sin \Theta$

$= 2000 + 2513{,}848$ ✓

$= 4513{,}848$ N✓ (2)

4.2.4 The coefficient of $F\mu = \mu W\cos\Theta$

$$\mu = \frac{F\mu}{W \cos \Theta}$$

$$= \frac{2\,000}{6\,906{,}741}$$ ✓

$= 0{,}289$ ✓

(2)

[12]

231 000 m = 1987200 ✓
M = 8,6 kg ✓
1 kg water = 1 ℓ
Volume = 8,6 ℓ ✓ (5)

5.4 250 kg
30 MJ/Kg
280 K
3 360 K

5.4.1 $\Delta t = t_2 - t_1$
$= 360 - 280$
$= 80\ °C$ ✓ (1)

5.4.2 $Q = ,M \times C \times \Delta t$
$Q = 250 \times 4187 \times 80$ ✓
$Q = 83740000\ J$
$Q = 83,74\ MJ$ ✓ (2)

5.4.3 $M = \frac{83\ MJ\ kg}{30\ MJ}$ ✓
$M = 2,791\ kg$ ✓ (2)
[15]

$$= \frac{\eta \times D^2}{}$$

$$= \frac{22\,540(0{,}020)^2}{0{,}85(0{,}1)^2} \quad \checkmark \quad \checkmark$$

$$= 1\,060{,}706\ N \quad \checkmark$$

(3)

6.2.2 No of strokes = $\frac{D^2 \times \text{height lifted}}{D^2 \times \text{strokes}}$

$= \frac{100^2 \times 126}{20^2 \times 5}$ ✓ ✓

= 63 strokes ✓ (3)

6.3 Θ = 50 mm

H = 30 Work done = volume x p x g x height

Work done = π d^2 x h x p x g x h ✓

= π x $(0{,}05)^2$ x 30 x 1000 x 9,8 x 30 ✓

= 17318 J ✓

= 17,318 kJ (3)

[12]

$\frac{2}{Rt} = 0{,}29167$ ✓

$Rt = 3{,}43\ \Omega$ ✓ (3)

7.1.2 $V = ?$

$V = E - Ir$

$= 6 - 1{,}105 \times 2$

$= 3.79\ V$

or

$V = I \times R$

$= 1{,}105 \times 3{,}43$ ✓

$= 3.79\ V$ ✓ (2)

7.1.3 $IR1 = \frac{V}{R_1}$

$= \frac{3{,}79}{6}$ ✓

$= 0{,}63\ A$ ✓

$IR_2 = \frac{V}{R_2}$

$= \frac{3{,}79}{8}$ ✓

$= 0{,}47\ A$ ✓ (2)

7.1.4 Vo linternal = Ir internal

$= 1{,}105 \times 2$ ✓

$= 2.21\ V$ ✓ (2)

7.2 The ampere is that constant current which if maintained in two straight parallel conductors of infinite length, ✓ of negligible cross section, and placed apart in a vacuum, would produce between these conductors, a force equal to 2×10^{-7} N/m of length. ✓ (2)

7.3 The potential difference is the difference in electric tension at the positive and negative poles of a cell. (1)

[12]

8.2 8.2.1 Chemical corrosion✓

8.2.2 Electrochemical corrosion✓

8.2.3 Metal oxide✓ (3)
[6]

TOTAL: 100