T580(E)(A7)T

APRIL EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

7 April 2015 (Y-Paper)
13:00–16:00

This question paper consists of 8 pages and 1 formula sheet.

Please turn over

1. Answer ALL the questions.

2. ALL the calculations should consist of at least the following THREE steps:

3. (a)The formula used or the manipulation thereof
   (b)The substitution of the given data in the formula
   (c)The answer together with the correct SI unit

4. Number the answers according to the numbering system used in this question paper.

5. The following values MUST be used in this question paper, whenever applicable:

Gravitational acceleration	= 9,8 m/s²
Atmospheric pressure	= 101,3 kPa
Heat value of petrol	= 25 MJ/kg
Heat value of coal	= 30 MJ/kg
Density of water	= 1 000 kg/m3
Specific heat capacity of water	= 4 187 J/kg °C
Specific heat capacity of steam	= 2 100 J/kg °C
Specific heat capacity of steel	= 500 J/kg °C
Specific heat capacity of copper	= 390 J/kg °C
Specific heat capacity of aluminium	= 900 J/kg °C
Linear coefficient of expansion of steel	= 0,000 012/°C
Linear coefficient of expansion of copper	= 0,000 017/°C
Linear coefficient of expansion of aluminium	= 0,000 023/°C
Resistivity of steel at 20 °C	= 0,000 000 155 Ωm
Resistivity of copper at 20 °C	= 0,000 000 018 Ωm
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ωm

6. Rule off on completion of each question.
7. Drawing instruments MUST be used for all the drawings.
8. Subsections of questions must be kept together.
9. Write neatly and legibly.

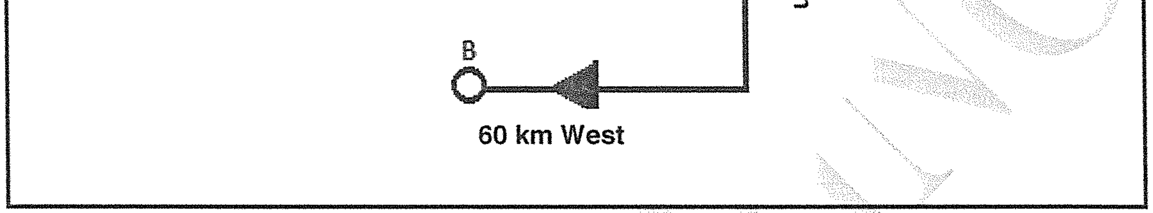

FIGURE 1

Calculate the following:

1.1.1 The distance travelled from A to B (1)

1.1.2 The displacement from A to B (Graphical method is excluded) (3)

1.1.3 The average speed from A to B (2)

1.1.4 The average velocity from A to B (2)

1.2 The maximum deceleration of a motorcar is 15 m/s^2. The motorcar is travelling at 120 km/h.

Calculate the following:

1.2.1 The time it takes for the motorcar to come to rest (2)

1.2.2 The absolute minimum distance needed for the motorcar to stop (2)

1.3 Explain the difference between *velocity* and *acceleration*. (3)
[15]

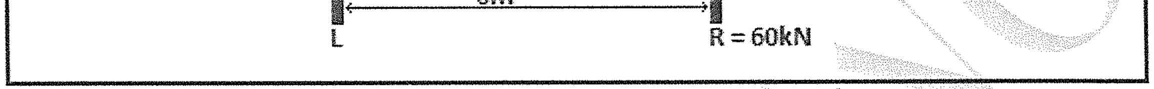

FIGURE 2

Determine the following:

2.2.1 The value of the unknown force F resting on the beam (3)

2.2.2 The value of the unknown reaction L (2)

2.3 Calculate the magnitude and direction of the equilibrant of the system of forces shown in FIGURE 3 below. (3)

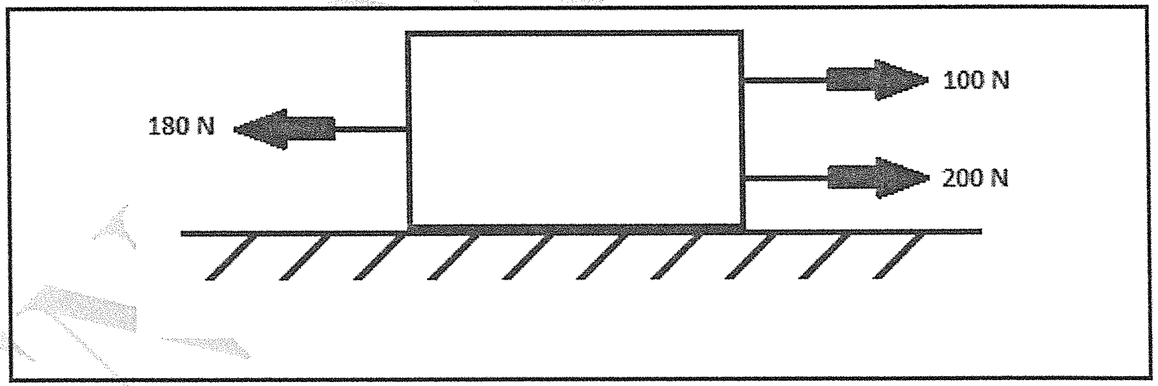

FIGURE 3

[10]

3.3 Calculate the potential energy of a motorcar of 1 000 kg that is standing on top of an incline of 15°. The length of the incline is 210 m long. (3)

3.4 A stone with a mass of 270 g travels at a velocity of 180 m/s.

Calculate the following:

3.4.1 The kinetic energy of the stone (2)

3.4.2 The momentum of the stone (2)
[12]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define the concept of *power*. (2)

4.2 A tractor applies a 9 500 N force over a distance of 90 m.

4.2.1 Draw a force/distance graph. (2)

4.2.2 Calculate the work done. (2)

4.3 Calculate the power required if a load of 2 000 kg is lifted 20 m high in a time of 40 seconds. (3)
[9]

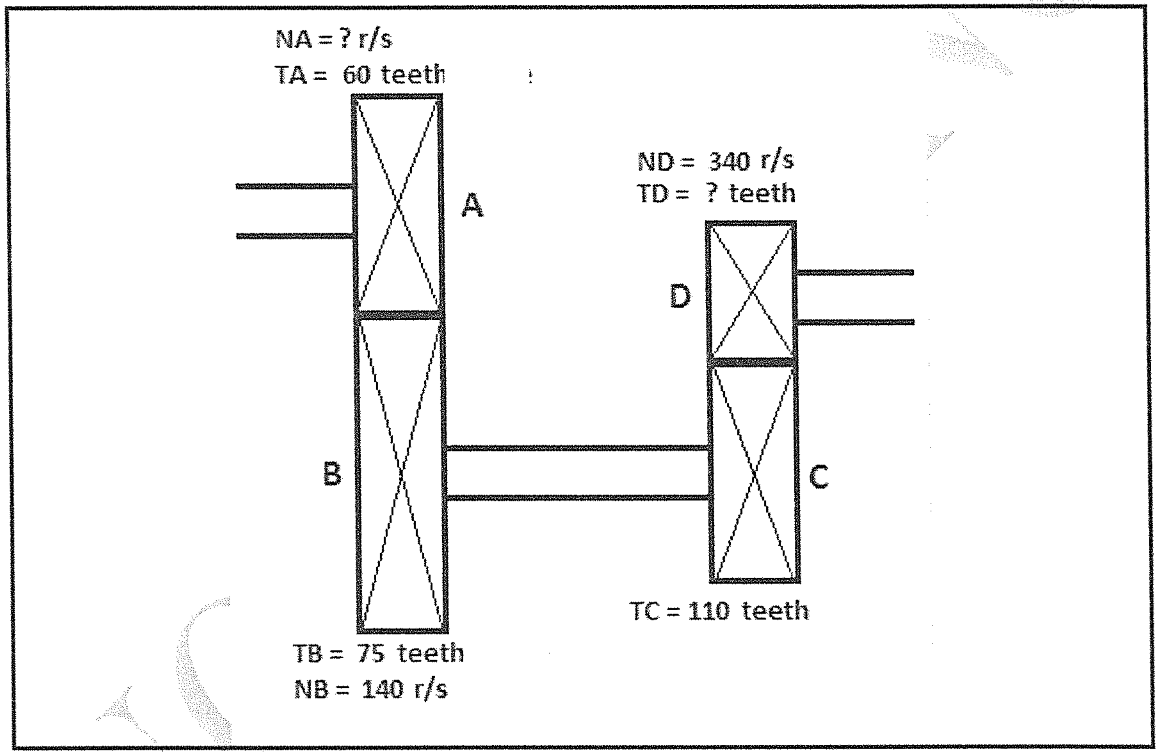

FIGURE 4

5.3 The ratio of the force of the tight side to the force in the slack side of a drive belt is 4:1. The force in the tight side is 600 N. The belt's velocity is 20 m/s.

Calculate the following:

5.3.1 The force in the slack side (2)

5.3.2 The effective force (1)

5.3.3 The power transmitted (2)

[11]

Please turn over

6.1.4 The external force required to hold the body stationary on the inclined plane (2)

6.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (6.2.1–6.2.3) in the ANSWER BOOK.

6.2.1 Kinetic friction is <u>larger</u> than static friction. (1)

6.2.2 Friction is dependent on the area of contact between surfaces. (1)

6.2.3 Friction is dependent on the sliding speed. (1)
[11]

QUESTION 7: HEAT

7.1 Explain what is understood by the '*heat value*' of a substance. (2)

7.2 A steel block with a mass of 5 000 kg is heated from 10 °C to 200 °C by burning 50 kg of coal.

Calculate the following:

7.2.1 The heat energy released by the coal in MJ (2)

7.2.2 The heat energy gained by the steel block in MJ (2)

7.2.3 The efficiency of the heat transfer process (2)

7.3 Define *specific heat capacity* of a substance. (2)

7.4 A steel nut is red hot at 750 °C and is cooled in a container with 790 g of water at 18 °C.

If the final temperature of the water is 29 °C, calculate the mass of the nut. (3)

7.5 A piece of copper wire of 29 m at 3 °C was heated to 52 °C during an experiment.

Calculate its new length. (2)
[15]

QUESTION 9: ELECTRICITY

9.1 Explain what is meant when a substance is referred to as a bad conductor of electricity and give ONE example. (2)

9.2 THREE equal resistors are connected in parallel. The total resistance of the circuit is 2,5 Ω.

Calculate the resistance of each resistor. (3)

9.3 Give ONE example where electromagnetic induction is used in practice. (1)

9.4 Calculate the resistivity of a conductor 10 km long with a resistance of 20 Ω and a diameter of 10 mm. (4)

[10]

TOTAL: 100

$$\eta = \frac{Uitset}{Inset} . 100\%$$

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

$$\mu = \tan\Phi$$

$$F_T = F_\mu \ldots \frac{horizontal}{horisontaal} \cdots a = 0$$

$$F_S = w\sin\theta$$

$$F_C = w\cos\theta$$

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

$$F_e = T_1 - T_2$$

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

$$P = F_e . v$$

$$v = \pi . d . n$$

$$n = \frac{N}{60}$$

$$N_A . T_A = N_B . T_B$$

$$SV = \frac{N_A}{N_Z} = VR$$

$$E_p = m.g.h.$$

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

$$E_T = E_p + E_K$$

$$VV = \frac{2D}{(d_1 - d_2)} = DR$$

$$VV = \frac{2D}{(D - d)} = DR$$

$$Q = m . c . \Delta t$$

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

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

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

$$l_f = l_o \pm \Delta l$$

$$1\ m/s = 3{,}6\ km/h$$

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

$$v = u + a.t$$

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

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

$$\Sigma \circlearrowleft M = \Sigma \circlearrowright M$$

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

$$p = \Delta.g.h$$

$$\frac{1}{R_{PAR}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

$$R_{SER} = R_1 + R_2 + \ldots + R_n$$

$$R = \frac{\rho . l}{a}$$

MARKING GUIDELINE

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This marking guideline consists of 9 pages.

$a = 64,031 km$ ✓ (2)

1.1.3 Speed

$V = s/t$

$= \frac{210}{5,5}$ ✓

$= 38,1818 km/hr$

$= 10,606 m/s$ ✓

(2)

1.1.4 Velocity

$V = s/t$

$= \frac{64,031}{5,5}$ ✓

$= 11,642 km/h$

$= 3,2328 m/s$ ✓

(2)

1.2 1.2.1 Time to come to rest

$t = \frac{v - u}{a}$

$= \frac{0 - 33,33}{-15}$ ✓

$= 2,222 s$ ✓

(2)

$= \frac{(0)^2 + (33,33)^2}{2\,(-15)}$ (2)

$= 37,02963$ m

1.3 Velocity is speed in given direction✓ or rate of change in displacement ✓while acceleration is the rate of change of velocity. ✓

(3)

[15]

QUESTION 2

2.1 A single force that replaces a system of forces✓ and still has the same effect as the forces acting together.✓ (2)

2.2 2.2.1 Take moments about L

$\sum cwm = \sum Acwm$

60 (6) = 15 (1) + 20 (4) + F (7) ✓

360 = 15 + 80 7 (F) ✓

F = 37, 857 kN ✓ (3)

2.2.2 Reaction L

$\sum F = \sum F$

L + R = 15 + 20 +37, 857

L + 60 = 72, 857 ✓

L = 12, 857 kN ✓ (2)

Please turn over

and kinetic energy is energy a body possesses due to its mass and velocity.✓ (2)

3.2 3.2.1 $V = u + gt$

$0 = u + (-9{,}8)\ 3{,}5$

$U = 34{,}\ 3$ m/s

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

$S = 34{,}\ 3\ (3{,}5) + \frac{1}{2}\ (-9{,}8)\ 3{,}5^2$ ✓

$S = 60{,}\ 025$ m ✓

OR

$V^2 = U^2 + 2as$

$0^2 = 34{,}\ 3^2 + 2\ (-9{,}8)\ S$

$S = 60{,}\ 025$ m (2)

3.2.2 S Total = S up + S down

$= 60{,}\ 025 + 60{,}\ 025$

$= 120{,}\ 05$ m ✓ (1)

3.3 $h = 210 \times \sin 15°$

$= 54{,}\ 352$ m ✓

$Ep = m \times g \times h$

$Ep = 1000 \times 9{,}8 \times 54{,}\ 352$ ✓

$Ep = 532649{,}\ 6$ J ✓

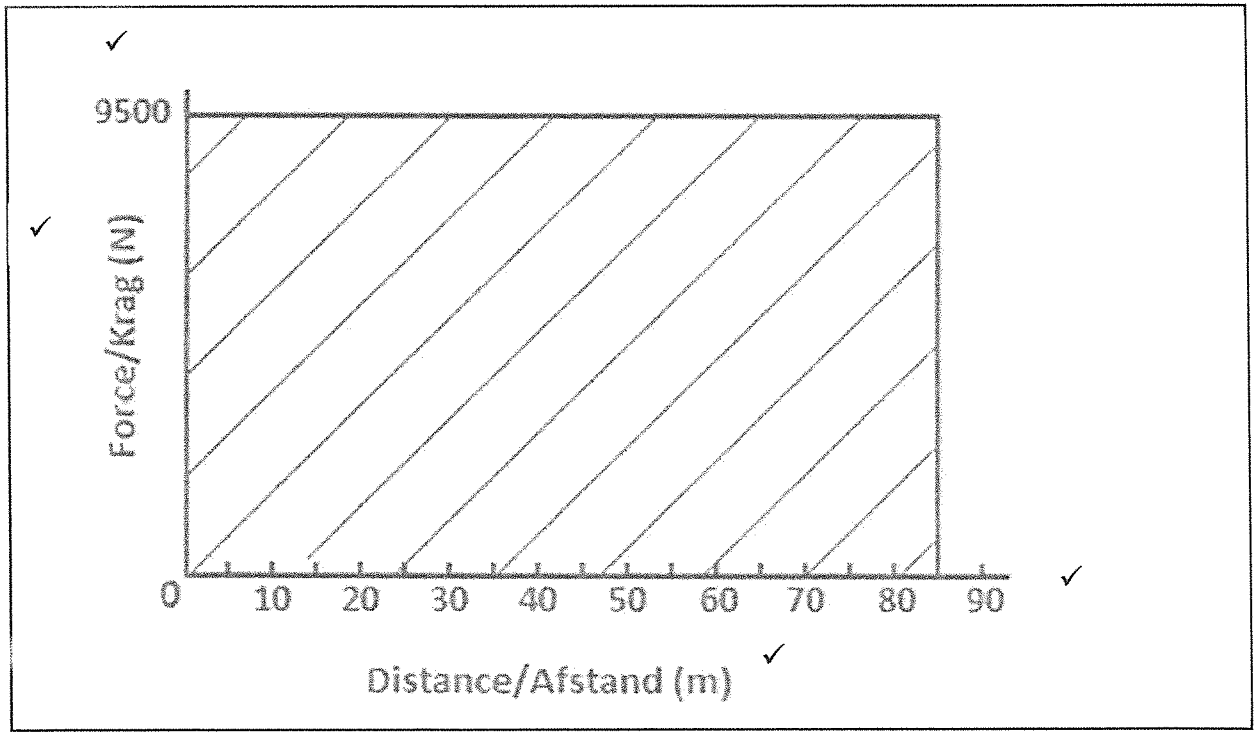
(3)

QUESTION 4

4.1 Rate at which work is done ✓per second. ✓ (2)

4.2 4.2.1 Force / Distance (2)

Force / Distance Graph



4.2.2 WD = F x S

= 9500 x 90 ✓

= 855 000 J or 855 kJ ✓ (2)

- More torque (power) ✓
- Less maintenance
- No slip — any two (2)

5.2 5.2.1 TA x NA = TB x NB

60 x NA = 75 x 140 ✓

NA = 175 r/s ✓ (2)

5.2.2 Tc x Nc = ND x TD N_8 = Nc = 140

110 x 140 = TD x 340 ✓

To = 45, 29 T use To = 45 T ✓ (2)

5.3 5.3.1 T1 = 4T2

600 = 4 x T2 ✓

T2 = 150 N ✓ (2)

5.3.2 Fe = T1 – T2

= 600 – 150

= 450 N ✓ (1)

5.3.3 Po = Fe x V

450 x 20 ✓

= 9 000 W ✓ (2)

[11]

$= 383, 6$ N ✓ (2)

6.1.3 $F\mu = \mu(NR)$

$= 0, 27 \times 568, 719$ ✓

$= 153, 554$ N ✓ (2)

6.1.4 $F + F\mu = FS$

$F = FS - F\mu$

$= 383, 6 - 153, 554$ ✓

$= 230, 046$ N ✓ (2)

6.2 6.2.1 False ✓ (1)

6.2.2 True ✓ (1)

6.2.3 False ✓ (1)

[11]

QUESTION 7

7.1 Amount of heat energy released✓ when 1 kg of a fuel is completely burnt. ✓ (2)

7.2 7.2.1 $Q = m \times HV$

$= 50 \times 30$ ✓

$= 1500$ MJ ✓ (2)

Please turn over

$= 4,75\ MJ$ (2)

7.2.3 $\eta\ \% = \frac{output}{Input} \times \frac{100}{1}$

$= \frac{475}{1500} \times 100$

$= 0,32\%$ (2)

7.3 The amount of heat energy required to heat 1 kg✓ of a substance by 1 °C.✓ (2)

7.4 Heat lost steel nut = Heat gained (water)

$m \times c \times \Delta t = m \times c \times \Delta t$

$ms \times 500 \times 721$ ✓ $= 0,79 \times 4\,187 \times 11$ ✓

$ms = 0,1\ kg$ ✓ (3)

7.5 Final length

$\Delta L = Lo \times \propto \times \Delta t$

$\Delta L = 29\,000 \times 0,000017 \times 49$

$\Delta L = 24,157\ mm$

$= 0,024157\ m$

$LF = Lo + \Delta L$

$= 29000 + 24,157$ ✓ $= 29\ m + 0,024157\ m$

$= 29024,157\ mm$ ✓ $= 29,024\ m$ (2)

[15]

QUESTION 8

8.1
- Neutron ✓
- Proton ✓ (2)

8.2
- Cathode - Negative (-) ✓
- Anode - Positive (+) ✓ (2)

$\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$

$\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R1} + \frac{1}{R1}$ ✓

$\frac{1}{5} = \frac{1+1+1}{R1}$

R1 = 3 x 2,5 ✓
R1 = 7,5Ω ✓ (3)

9.3
- Generate ignition spark ✓
- Transformers
- Generators

(Any 1 x 1) (1)

9.4 Calculate resistivity

$A = \frac{\pi}{4} d^2$

$= \frac{\pi}{4} 0,01^2$

$= 78,539 \times 10^{-6} m^2$ ✓

OR

$A = \pi r^2$

$= \pi (0,005)^2$

$= 7,8539 \times 10^{-5} m^2$

$R = \frac{p \times l}{A}$

$P = \frac{R \times A}{L}$

$P = \frac{20 \times 78,539 \times 10^{-6}}{10\,000}$ ✓ ✓

$= 0,157078 \times 10^{-6}$

$= 1,5708 \times 10^{-7}\ \Omega m$ ✓

(4)
[10]

TOTAL: 100