T721(E)(N17)T
NOVEMBER 2010

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

17 November (X-Paper)
09:00 – 12:00

This question paper consists of 8 pages and 1 formula sheet.
DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. ALL the calculations should consist of at least the following THREE steps:
   (a) The formula used or manipulation thereof
   (b) The substitution of the given data in formula
   (c) The answer together with the correct SI unit

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravitational acceleration</td>
<td>9.8 m/s²</td>
</tr>
<tr>
<td>Atmospheric pressure</td>
<td>101.3 kPa</td>
</tr>
<tr>
<td>Heat value of petrol</td>
<td>25 MJ/kg</td>
</tr>
<tr>
<td>Heat value of coal</td>
<td>30 MJ/kg</td>
</tr>
<tr>
<td>Density of water</td>
<td>1 000 kg/m³</td>
</tr>
<tr>
<td>Specific heat capacity of water</td>
<td>4 187 J/kg °C</td>
</tr>
<tr>
<td>Specific heat capacity of steam</td>
<td>2 100 J/kg °C</td>
</tr>
<tr>
<td>Specific heat capacity of steel</td>
<td>500 J/kg °C</td>
</tr>
<tr>
<td>Specific heat capacity of copper</td>
<td>390 J/kg °C</td>
</tr>
<tr>
<td>Specific heat capacity of aluminium</td>
<td>900 J/kg °C</td>
</tr>
<tr>
<td>Linear coefficient of expansion of steel</td>
<td>0,000 012/ °C</td>
</tr>
<tr>
<td>Linear coefficient of expansion of copper</td>
<td>0,000 017/ °C</td>
</tr>
<tr>
<td>Linear coefficient of expansion of aluminium</td>
<td>0,000 023/ °C</td>
</tr>
<tr>
<td>Resistivity of steel at 20 °C</td>
<td>0,000 000 155 Ω.m</td>
</tr>
<tr>
<td>Resistivity of copper at 20 °C</td>
<td>0,000 000 018 Ω.m</td>
</tr>
<tr>
<td>Resistivity of aluminium at 20 °C</td>
<td>0,000 000 028 Ω.m</td>
</tr>
</tbody>
</table>

6. Rule off across the page on completion of each question.

7. Drawing instruments must be used for ALL the drawings.

8. Marks indicate percentages


10. Write neatly and legibly.
QUESTION 1

1.1 Copy TABLE 1 below in the ANSWER BOOK and write the correct basic SI-unit in the RIGHT column. An example of force and newton is given:

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>BASIC SI-UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force</td>
<td>Newton</td>
</tr>
<tr>
<td>Heat</td>
<td></td>
</tr>
<tr>
<td>Displacement</td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td></td>
</tr>
<tr>
<td>Mechanical advantage</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td></td>
</tr>
<tr>
<td>Velocity ratio</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 1

1.2 Copy TABLE 2 below in the ANSWER BOOK and complete the table by filling in the correct numerical values in the RIGHT column. An example for kilo is given:

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>NUMERICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilo-</td>
<td>1 000 or $10^3$</td>
</tr>
<tr>
<td>Micro-</td>
<td></td>
</tr>
<tr>
<td>Milli-</td>
<td></td>
</tr>
<tr>
<td>Giga-</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2

QUESTION 2

2.1 Define the term acceleration.

2.2 A bus is travelling at a constant velocity of 20 m/s for 10 seconds and then brakes to decelerate evenly to 12 m/s in 6 seconds.

2.2.1 Draw the velocity-time graph for this motion.

Determine the following from the graph:

2.2.2 The deceleration of the bus

2.2.3 The total displacement that the bus has undergone
2.4.4 The average velocity of the bus during the total time

QUESTION 3

3.1 A light horizontal beam, as shown below, rests on two supports, L and R. The right hand support, (R) carries a load of 17.5 kN.

Calculate the following:

3.1.1 The value of L of the left hand support

3.1.2 The distance X, from the left hand support to the 10 kN load

![Figure 1]

**FIGURE 1**

3.2 Explain what is meant by the *equilibrant of a system of forces.*

3.3 Give ONE example where a couple is found in engineering practice.

3.4 Determine the horizontal component of a 20 kN load that is inclined at 30° to the horizontal.

QUESTION 4

4.1 Define *potential energy.*

4.2 A motor car of 1300 kg is standing at the top of a downhill of 18° that is 250 m long.

Determine the following:

4.2.1 The potential energy of the car at the top of the hill

4.2.2 The velocity that the car will reach at the bottom of the hill. (All losses, example, friction, wind etcetera must be ignored)
4.3 A bullet of 5 gram travels at 400 m/s.

Calculate the following:

4.3.1 The kinetic energy of the bullet

4.3.2 The momentum of the bullet

QUESTION 5

5.1 Define power.

5.2 FIGURE 2 below, shows a graph of a uniformly varying load against distance graph and is obtained when a platform is lifted by a 52 m long cable which is wound onto a drum at the top. The force axis represents the force in the cable where it touches the drum and the distance axis represents the length of cable already wound onto the drum.

Determine the following from the given drawing:

5.2.1 The weight of the cable per meter length

5.2.2 The work done in winding the total length of cable onto the drum with the platform attached to the end of the cable

5.2.3 The power required to drive the drum if the load is exactly halfway (26 m of cable is remaining) at 0.5 m/s

FIGURE 2
5.3 Determine the torque of a wrench if an effective force of 400 N is applied at a point 350 mm from the turning point. (2)

**QUESTION 6**

6.1 State TWO advantages of belt drives as compared to gear drives. (2)

6.2 A motor is used to drive a pulley with a diameter of 0.25 m by means of a belt. The belt speed is 20 m/s and the power transferred is 5 kW.

Determine the following:

6.2.1 The rotational frequency of the pulley (2)
6.2.2 The effective tension in the belt (2)

6.3 The diameter of the large pulley of a Weston differential pulley system, (Differential wheel and axle) is 145 mm and that of the small pulley is 130 mm. An effort of 200 N is needed to lift a load of 1200 N.

Determine the following:

6.3.1 The velocity ratio of the system (2)
6.3.2 The efficiency of the system (2)

**QUESTION 7**

7.1 Define Pascal. (2)

7.2 The gauge pressure on the body of a person under river water is 300 kPa while the absolute pressure on the same body is 398 kPa.

Determine the following:

7.2.1 The atmospheric pressure (1)
7.2.2 The depth of the person under water (2)

7.3 A 120 Newton force is required to pull a 20 kg mass along a plane up a slope. The component of the weight parallel to the plane is 65 N.

Determine the following:

7.3.1 The angle between the plane and the horizontal (2)
7.3.2 The coefficient of friction between the mass and the plane (3)
QUESTION 8

8.1 Define *heating value of fuel.*

8.2 A steam boiler uses 900 kg of coal per hour.

Determine the following:

8.2.1 The energy used up by the boiler per hour

8.2.2 The output power of the boiler (in megawatt) if the efficiency is 73%

8.3 Water with a mass of 200 kg and at a temperature of 25 °C, is being supplied with 30 MJ of heat energy.

Determine the final temperature of the water.

8.4 A copper pipe is 6 m long at 50 °C.

Determine its extension (in mm) at a temperature of 52 °C.

QUESTION 9

9.1 Explain what is meant by the term *saturated temperature of water.*

9.2 Explain the effect of pressure on the boiling point of water.

9.3 Make a neat sketch of an atom and name its components.

9.4 State TWO uses for electrolysis.

9.5 Describe how an atom obtains an electrical charge and what is such an atom called?

QUESTION 10

10.1 A circuit consists of two parallel resistances of 6 Ω and 12 Ω. This parallel pair is now connected in series with a 10 Ω resistor.

Determine the following:

10.1.1 The total resistance of the parallel connection

10.1.2 The total resistance of the circuit
10.2 Define, or explain in your own words, what is meant by the *resistivity* of a material.

10.3 Draw a neat, labelled sketch of a device that can be used to demonstrate electrical self-induction.

10.4 Give ONE example where self-induction is usefully employed in practice.

**TOTAL:** 100
ENGINEERING SCIENCE N2

FORMULA SHEET

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

\[ w = m \cdot g \]

\[ W = F \cdot s \]

\[ P = \frac{W}{t} \]

\[ \eta = \frac{\text{Output}}{\text{Input}} \times 100\% \]

\[ \eta = \frac{\text{Uitset}}{\text{Inset}} \times 100\% \]

\[ \mu = \frac{F_H}{N_R} \]

\[ \mu = \tan \Phi \]

\[ F_T = F_H \text{ ... horizontal} \]

\[ F_T = F_N \text{ ... horizontal} \]

\[ F_S = w \sin \theta \]

\[ F_C = w \cos \theta \]

\[ F_T = F_N \pm F_S \text{ ... } a = 0 \]

\[ F_e = T_1 - T_2 \]

\[ T_1 = \frac{\text{tension ratio}}{T_2} \text{ spanningsverhouding} \]

\[ P = F_e \cdot v \]

\[ v = \pi \cdot d \cdot n \]

\[ n = \frac{N}{60} \]

\[ N_A \cdot T_A = N_B \cdot T_B \]

\[ SV = \frac{N_1}{N_Z} = VR \]

\[ E_p = m.g.h. \]

\[ E_K = \frac{1}{2} \cdot m.v^2 \]

\[ E_T = E_p + E_K \]

\[ HV = \frac{L}{E} = MA \]

\[ VV = \frac{S_E}{S_L} = DR \]

\[ \frac{HV}{VV} \times 100\% = \eta = \frac{MA}{DR} \times 100\% \]

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

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

\[ Q = m \cdot c \cdot \Delta t \]

\[ m \cdot w \cdot w = Q = m \cdot hv \]

\[ P = \frac{Q}{t} \]

\[ \Delta l = l_o \cdot \alpha \cdot \Delta t \]

\[ l_f = l_o \pm \Delta l \]

\[ 1 \text{ m/s} = 3.6 \text{ km/h} \]

\[ s = ut + \frac{1}{2} \cdot a \cdot t^2 \]

\[ v = u + a \cdot t \]

\[ v^2 = u^2 + 2as \]

\[ \Sigma \uparrow F = \Sigma \downarrow F \]

\[ \Omega \uparrow M = \Omega \downarrow M \]

\[ P_{ABS} = P_{ATM} + P_{MET} \]

\[ p = \rho \cdot g \cdot h \]

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

\[ R_{SER} = R_1 + R_2 + \ldots + R_n \]

\[ R = \frac{\rho \cdot l}{a} \]