DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

APRIL 2012

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

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

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

6.   Drawing instruments MUST be used for ALL the drawings.

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

8.   Write neatly and legibly.

QUESTION 1

1.1　Copy TABLE 1 below neatly in the ANSWER BOOK and complete the basic SI-units as given in the example.

	QUANTITY	BASIC SI-UNIT
e.g.	Force	Newton
1.1.1	Velocity	
1.1.2	Momentum	
1.1.3	Displacement	
1.1.4	Velocity ratio (Displacement ratio)	
1.1.5	Work	
1.1.6	Pressure	
1.1.7	Temperature	

TABLE 1　　　　　　　　　　　　　　　　　(7)

1.2　Convert the following:

1.2.1　　15 m/s to km/h　　　　　　　　　　　　　(1)

1.2.2　　1 500 centimeters to meters　　　　　　　(1)

1.2.3　　500 Megapascal to Gigapascal　　　　　　(1)
　　　　　　　　　　　　　　　　　　　　　　[10]

QUESTION 2

2.1   FIGURE 1 below, shows a graph that depicts the velocity of a vehicle with respect to time. Movement takes place in a straight line.
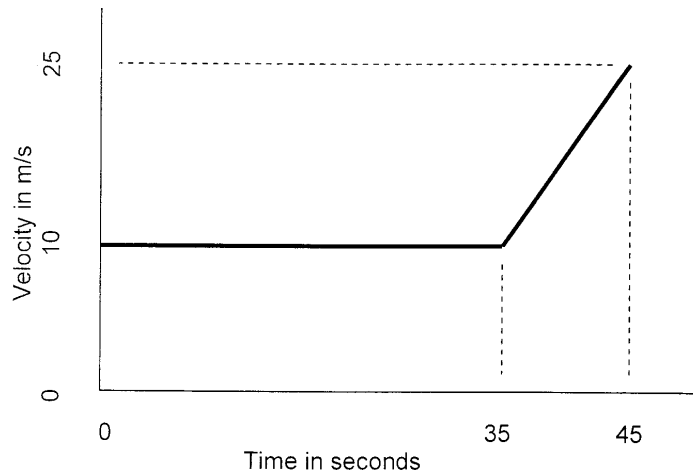

FIGURE 1

Determine the following from the graph above:

2.1.1   The acceleration of the vehicle   (2)

2.1.2   The velocity after 40 seconds   (2)

2.1.3   The total distance covered by the vehicle during the 45 seconds   (2)

2.1.4   The average velocity of the vehicle.   (1)

2.2   An truck is brought to rest from a velocity of 72 km/h over distance of 40 metres at a constant deceleration.

Determine the following:

2.2.1   The deceleration of the truck   .   (2)

2.2.2   The time taken for the deceleration   (1)
                                                                                                       [10]

QUESTION 3

3.1   Define the moment of a force.   (1)

3.2   FIGURE 2 below shows a horizontal beam resting on two supports L and R.
        The beam carries a 20 kN load at the left-hand end of the beam, a 30 kN load
        3 m from the support L and a 10 kN load at 4 m from the 30 kN load.
        L and R are 10 m apart.
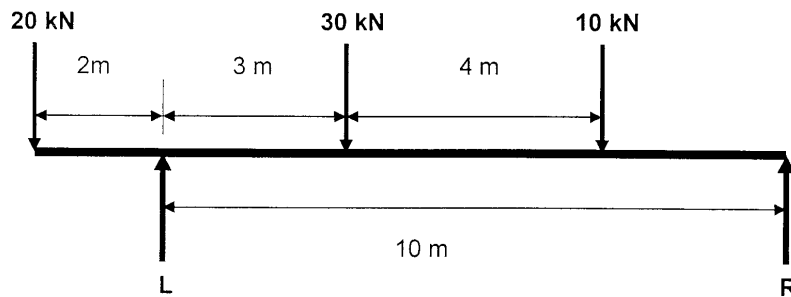   Ignore the self weight of the beam.

FIGURE 2

Determine the following:

3.2.1   The value of the reactions L and R, by taking moments about both
        supports.   (6)

3.2.2   Check the answer by balancing upward and downward forces.   (1)

3.3   An unknown force is inclined at 28 ° to the horizontal. The vertical component
        of the unknown force is 80 N. Determine the value of the unknown force. (2)
                                                                               [10]

QUESTION 4

4.1   Define *potential energy*.   (2)

4.2   A brick with a mass of 6 kg is dropped vertically from a certain height. It takes 4,5 seconds for the brick to reach the ground.

Determine the following:

4.2.1   The height from which the brick is dropped   (2)

4.2.2   The potential energy of the brick with reference to the ground the moment before the brick is dropped   (2)

4.2.3   The velocity with which the brick hits the ground   (2)

4.2.4   The momentum of the brick the moment before it hits the ground   (2)
[10]

QUESTION 5

5.1   Define *work*.   (1)

5.2   A person pushes with 100 N against a solid wall for 1 minute without the wall moving. Determine the work done on the wall.   (1)

5.3   A 60 kg mass is lifted vertically 52 m within 45 seconds.

Determine the following:

5.3.1   The work done in lifting the mass   (2)

5.3.2   The average power required to lift the mass   (2)

5.3.3   The efficiency of the lifting device if the input power is 1 000 Watt   (2)

5.4   A constant force of 80 N is applied on the circumference of a gear wheel that has a diameter of 300 mm. Calculate the work done on the gear wheel per single revolution.   (2)
[10]

QUESTION 6

6.1 Define *pressure* as applied by a liquid. (1)

6.2 A tank of diameter 3,0 m is filled with water. The gauge pressure at the bottom of the tank is 48,02 kPa.

Determine the following:

6.2.1 The absolute pressure at the bottom of the tank (1)

6.2.2 The height of water in the tank (2)

6.2.3 The force of water on the bottom of the tank (2)

6.3 A body of mass 120 kg is pulled up an incline at constant speed by an external force parallel to the incline. The incline has an angle of 28 ° to the horizontal. The coefficient of friction between the body and the incline is 0,33.

Determine the following:

6.3.1 The weight component perpendicular to the sliding plane (1)

6.3.2 The weight component parallel to the sliding plane (1)

6.3.3 The frictional force (1)

6.3.4 The external force pulling the body up the incline plane (2)
[11]

QUESTION 7

7.1 Make a neat sketch of a differential wheel and axle-lifting machine with the ropes wound correctly. Indicate ALL the diameters and show where the load and effort is applied. (4)

7.2 The following information refers to a belt drive:

The tension ratio between the tight and slack side of the belt = 2,8
The tension on the tight side = 2 400 N
The diameter of the driving pulley = 350 mm
The rotational frequency of the driving pulley = 1 500 r/min

Calculate the following:

7.2.1 The belt speed in m/s (1)

7.2.2   The tension on the slack side of the belt   (1)

7.2.3   The power transferred by the belt   (2)

7.3   State TWO disadvantages of belt drives compared to gear drives.   (2)
                                                                                [10]

QUESTION 8

8.1   Define, or explain in your own words, what is meant by the 'Heat value of
        petrol is 25 MJ/kg'.   (1)

8.2   A boiler has a power output of 1 500 kW and operates with an efficiency of
        79%.

        Calculate the following:

        8.2.1   The input power to the boiler   (2)

        8.2.2   The coal supply to the boiler in kg/min   (2)

8.3   5 MJ (Megajoules) of heat energy is supplied to 35 kg of water. If the initial
        temperature of the water was 16 °C, determine the final temperature.   (2)

8.4   An aluminium bar has a length of 10,01 m in the afternoon at a temperature of
        51 °C. In the early morning, the length was 10,00 m. What was the tempera-
        ture in the early morning?.   (3)
                                                                                [10]

QUESTION 9

9.1 The diagram below shows the temperature/enthalpy diagram for water depicting the change from water to superheated steam.


Enthalpy (heat energy)
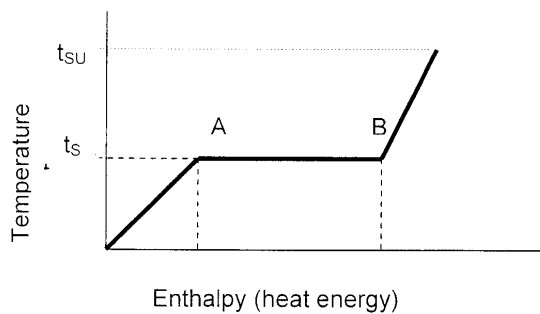
Refer to the diagram and answer the following questions:

9.1.1 What does t_{SU} represent? (1)

9.1.2 What does t_S represent? (1)

9.1.3 What does the length of line AB represent? (1)

9.2 What is the effect of pressure on the boiling point of water? (2)

9.3 What is the electrical charge on the nucleus of an atom? (1)

9.4 What is an ion? (1)

9.5 Define the term *electrolyte*. (2)

[9]

QUESTION 10

10.1   Two resistors, 4 Ω and 6 Ω are connected in series. Determine the resultant
        resistance of the series circuit.   (1)

10.2   In the diagram below, the resultant resistance between A and B is 4,5 Ω.
        Determine the value of the unknown resistor, X Ω.

                          6 Ω

            A   B

                          X Ω
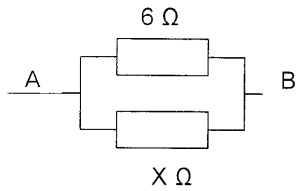
                                                                                       (2)

10.3   Make a neat, labelled sketch of an apparatus that may be used to
        demonstrate mutual induction.   (3)

10.4   Give TWO examples where mutual induction is used to advantage in practice.   (2)

10.5   A copper conductor, having a cross sectional area of 28,274 mm^2 has a
        resistance of 5,5 Ω at 20 °C. Determine the length of the conductor.   (2)
                                                                                      [10]

                                                        TOTAL: 100