DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100 NOVEMBER 2013

INSTRUCTIONS AND INFORMATION

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. Subsections of questions must be kept together.
5. Drawing instruments must be used for ALL the drawings.
6. ALL the calculations must consist of at least the following THREE steps:

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

7. The following values must be used in the question paper whenever applicable:

Gravitational acceleration	= 9,8 m/s^2
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/m^3
Specific heat capacity of water	= 4 187J/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 Ω .m
Resistivity of copper at 20 °C	= 0,000 000 018 Ω.m
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ω.m

8. Rule off on completion of each question.
9. Write neatly and legibly.

QUESTION 1: DINAMICS

1.1 Convert the following:

1.1.1 30 m/s to km/h

1.1.2 3 gig newton to mega newton

1.1.3 3 millimetres to micrometres

(3 × 1) (3)

1.2 The graph in FIGURE 1 shows the velocity of a vehicle with respect to time.

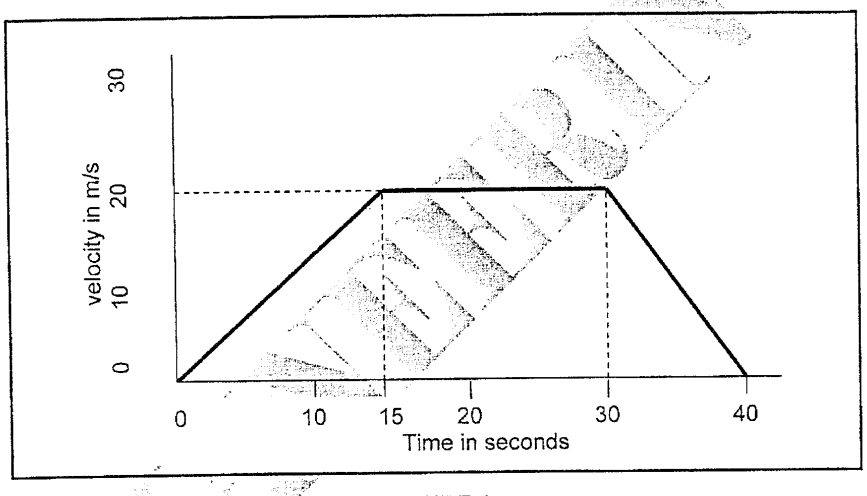


FIGURE 1

Determine the following:

1.2.1 The acceleration of the vehicle (2)

1.2.2 The deceleration of the vehicle (2)

1.2.3 The total displacement of the vehicle (3)

1.2.4 The average velocity of the vehicle during the 40 seconds (1)

1.3 The maximum deceleration of a truck is 8 m/s^2. The truck is travelling at 30 m/s.

Determine the following:

1.3.1 The minimum time needed for the truck to come to rest

1.3.2 The minimum distance needed for the truck to come to rest

(2 × 2) (4)
[15]

QUESTION 2: STATICS

2.1 Define the *equilibrant of a system of forces.* (2)

2.2 FIGURE 2 below shows a horizontal beam resting on two supports L and R. The beam carries a 50 kN load at the left-hand end, a 20 kN load 3 m from the support L and a 10 kN load at 4 m from the 20 kN load. L and R are 10 m apart.

Ignore the self-weight of the beam.

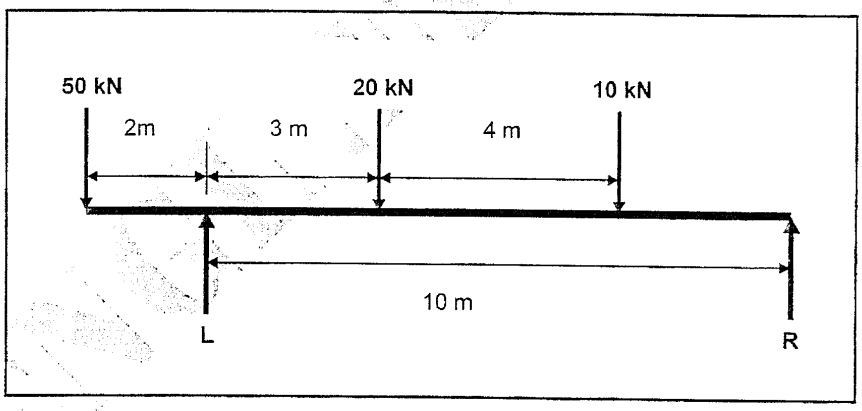


FIGURE 2

Determine the following:

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

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

2.3 An unknown force is inclined at 22° to the horizontal. The vertical component of the unknown force is 75 N.

Determine the value of the unknown force. (2)
[11]

QUESTION 3: ENERGY AND MOMENTUM

3.1 Define *potential energy.* (2)

3.2 A stone with a mass of 2 kg is thrown vertically upwards. It takes 5 seconds for the stone to reach the same height from which it was thrown.

Determine the following:

3.2.1 The velocity with which the stone was thrown (2)

3.2.2 The maximum height reached by the stone (2)

3.2.3 The potential energy of the stone at the maximum height with reference to the original position (1)

3.2.4 The momentum of the stone the moment it was thrown upwards (1)
[8]

QUESTION 4: WORK, POWER AND EFFICIENCY

4.1 Define *energy.* (1)

4.2 A load of 4 000 N is lifted to a height of 30 m by means of a chain that is wound onto a drum at the top. The chain has a weight of 20 N/m.

4.2.1 Make a neat sketch of the load-distance graph using the above information. (3)

Determine, by making use of the graph in QUESTION 4.2.1, the following:

4.2.2 The total weight of the chain (1)

4.2.3 The work done in winding the full length of the chain, with the load attached to the bottom of the chain, onto the drum (2)

4.2.4 The power applied when the end of the chain with the load is 15 m from the drum and the velocity is 2,2 m/s (2)

4.3 A constant pulling force of 80 N is applied to an object on an incline of 20° to the horizontal, in order for the object to move upwards at a constant velocity.

Calculate the mass of the object.

Ignore any friction. (2)
[11]

QUESTION 5: MECHANICAL PROPULSION AND CRANES

5.1 Define the *velocity ratio* of a lifting device. (2)

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

5.3 The diameters of a differential wheel and axle lifting machine are 480 mm, 320 mm and 300 mm respectively. The mechanical advantage is 16 when lifting a load of 900 N.

Calculate the following:

5.3.1 The effort required to lift the load of 900 N (1)

5.3.2 The velocity ratio of the machine (2)

5.3.3 The efficiency when lifting a load of 900 N (2)

5.4 FIGURE 3 below shows a gear drive consisting of FOUR gears.

Rotational speed of A = 1 950 RPM
No of teeth of B = 65
Rotational speed of B = 750 RPM
No of teeth of C = 20
No of teeth of D = 50

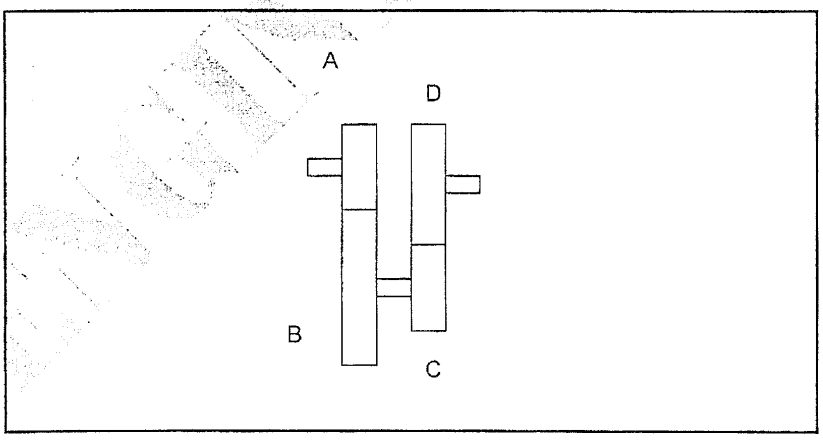


FIGURE 3

Determine the following:

5.4.1 The number of teeth of A

5.4.2 The rotational speed of D

(2 × 2) (4)

5.5 The gauge pressure at the bottom of a water tank is 58,8 kPa.

Determine the height of water in the tank. (2)
[17]

QUESTION 6: HYDRAULICS AND FRICTION

6.1 List TWO ways by which friction between moving parts may be reduced. (2)

6.2 A force of 40 N is required to pull a mass of 20 kg over a horizontal plane at constant velocity.

Determine the following:

6.2.1 The coefficient of friction

6.2.2 The friction angle

(2 × 1) (2)

6.3 A body with a mass of 14 kg is pulled at constant velocity down an incline with an angle of 11° to the horizontal. The coefficient of friction between the body and the inclined surface is 0,32.

Calculate the following:

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

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

6.3.3 The frictional force (1)

6.3.4 The external force required to pull the body down the inclined plane (2)
[9]

7.1 Define the *coefficient of linear expansion of a metal.* (2)

7.2 Give ONE example where linear expansion of metals is useful in practice. (1)

7.3 10 kg of coal is used to heat up 600 kg of water at an initial temperature of 15 °C.

Calculate the following:

7.3.1 The amount of heat released by the coal (2)

7.3.2 The final temperature of the water if the heat transfer process is 65% efficient (3)

7.4 A metal bar's length at 8 °C was found to be 5 m. After being heated to 78 °C the bar had expanded by 8,05 mm.

Determine the metal of the bar. An answer without calculation will NOT be accepted. (2)
[10]

QUESTION 8: PARTICLES STRUCTURE OF MATERIAL

8.1 Study FIGURE 4 below representing the temperature/enthalpy diagram for water/steam.

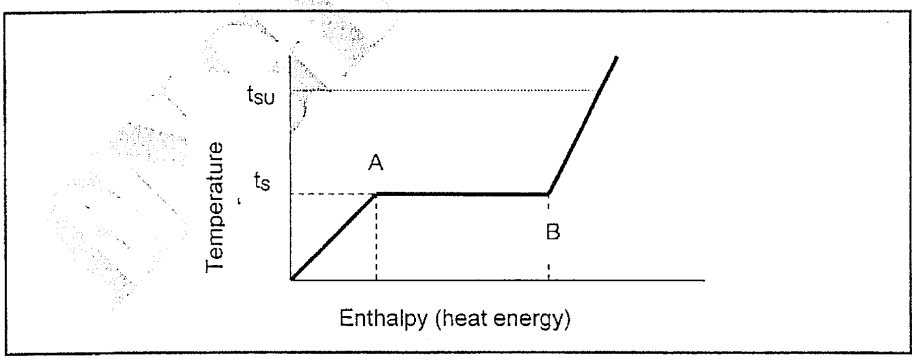


FIGURE 4

Answer the following:

8.1.1 What does t_{su} represent?

8.1.2 What does t_s represent?

8.1.3 What does line AB represent?

(3 × 1) (3)

8.2 Name the electrical charges of the electron and proton of an atom. (1)

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

8.4 Define the term *electrolyte*. (2)

8.5 How can distilled water be turned into an electrolyte? (1)
[8]

QUESTION 9: ELECTRICITY

9.1 The resistance of a conductor is influenced by four factors.

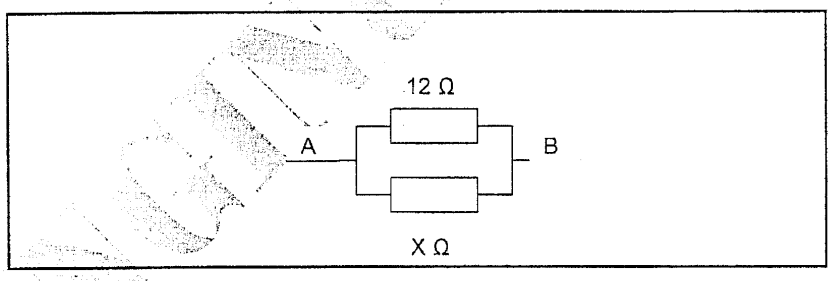
List these FOUR factors. (2)

9.2 TWO resistors, 3 Ω and 12 Ω, are connected in series.

Determine the resultant resistance of the series circuit. (1)

9.3 In the diagram below the resultant resistance between A and B is 3 Ω.

Determine the value of the unknown resistor, X Ω. (2)



DIAGRAM

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

9.5 Name ONE example where self-induction is used to advantage in practice. (1)

9.6 An aluminium conductor, having a cross-sectional area of 19,635 mm^2 (25 mm dia.) has a resistance of 1 Ω at 20 °C.

Determine the length of the conductor. (2)
[11]

TOTAL: 100