DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2 Aug 2012
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. 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

3. The following values MUST be used in this 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

4. Rule off across the page on completion of each question.
5. Drawing instruments MUST be used for ALL the drawings.
6. NO part of a question must be done separately.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Write neatly and legibly.

QUESTION 1: DYNAMICS

1.1 Convert 27,5 m/s to km/h. (1)

1.2 A vehicle manufacturer claims that his vehicle can attain a velocity of 27,5 m/s within 5 seconds from stationary position. Assume a constant acceleration. Make a neat sketch of the graph depicting the movement. Use velocity in m/s for the vertical axis and seconds for the horizontal axis. (3)

Determine the following from the graph:

1.2.1 The acceleration (1)
1.2.2 The total distance travelled during the movement (1)
1.2.3 The distance travelled after 2 seconds (2)

1.3 The velocity of a body increases uniformly from 6 m/s to 28 m/s in 11 seconds.

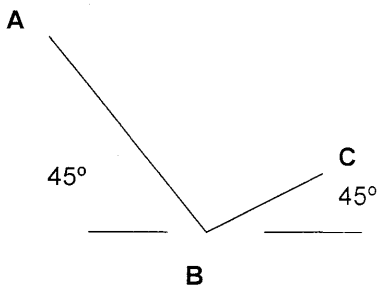
Determine:

1.3.1 The acceleration of the body (2)
1.3.2 The total distance travelled during the acceleration (2)

1.4 In the figure below, the distance AB is 100 m and the distance BC is 50 m.

Determine:

1.4.1 The distance from A to C (1)
1.4.2 The displacement from A to C (2)

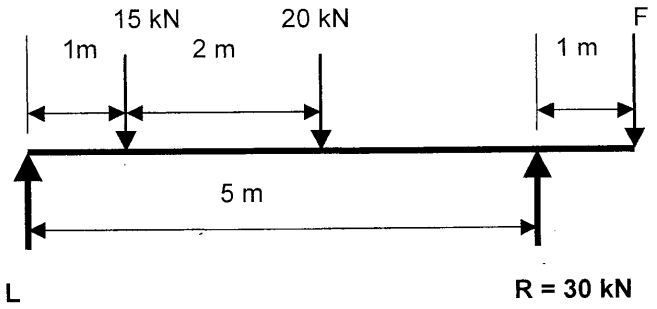


[15]

QUESTION 2: STATICS

2.1 Define the resultant of a system of forces. (2)

2.2 The horizontal beam shown below rests on two supports L and R and is loaded as shown. Ignore the weight of the beam.



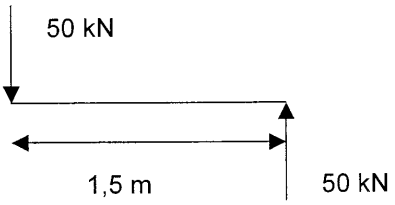
2.2.1 Determine the value of the unknown force F resting on the beam. (3)

2.2.2 Determine the value of the unknown reaction L. (2)

2.3 The vertical component of a force, acting at 35° to the horizontal is 40 N.

Determine the value of the force. (2)

2.4 Determine the turning point of the couple shown below.



(1)
[10]

QUESTION 3: ENERGY AND MOMENTUM

3.1 Define *potential energy.* (2)

3.2 A stone with a mass of 6 kg is thrown vertically upwards from the top of a building 35 m high with a starting velocity of 20 m/s.

Determine:

3.2.1 The time it will take the stone to reach its maximum height (2)

3.2.2 The potential energy of the stone at its highest point with reference to the bottom of the building (2)

3.2.3 The velocity with which the stone will hit the ground (2)

3.2.4 The momentum of the stone just before it hits the ground (1)
[9]

QUESTION 4: WORK POWER AND EFFICIENCY

4.1 Define *power.* (2)

4.2 A lathe with a weight of 50 kN is lifted through a height of 35 m by a cable with a weight of 150 N/m winding onto a drum.

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

4.2.2 Determine the total weight of the cable, by making use of the graph. (1)

4.2.3 Determine the work done in winding up the total length of cable with the lathe attached to it. (2)

4.2.4 Determine the power applied when the end of the cable and the lathe is 20 m from the drum and the velocity of lifting is 2 m/s. (2)
[10]

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Name THREE advantages of belt drives as compared to gear drives. (3)

5.2 A Weston differential pulley system, (also called differential pulley block), with an efficiency of 75%, has a mechanical advantage of 36. The large pulley has 24 slots.

Calculate the following:

5.2.1 The load that can be lifted in kg by an effort of 150 N (2)

5.2.2 The displacement ratio (velocity ratio) of the machine (2)

5.2.3 The number of slots in the smaller pulley (2)

5.3 A pulley with a diameter of 250 mm is driven by a flat belt. The tension in the tight side is 550 N, the tension ratio is 1 : 5 and the pulley rotates at 600 r/min.

Calculate the following:

5.3.1 The effective force in the belt (2)

5.3.2 The power transferred by the belt (2)

5.4 Make a neat, labelled sketch of a differential wheel and axle lifting machine with the ropes wound correctly. Clearly show where the load and effort is applied and label all diameters according to the formula:

$$VR = \frac{2D}{d_1 - d_2}$$ (4)

[17]

QUESTION 6: HYDRAULICS AND FRICTION

6.1 The gauge pressure on the body of a diver under the water is 820 kPa. The density of the water is 1 025 kg/m^3.

Calculate the following:

6.1.1 The depth of the diver under the water (2)

6.1.2 The absolute pressure on the diver's body (1)

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 – 6.2.2) in the ANSWER BOOK.

6.2.1 Friction is dependent on the area of the surfaces in contact (1)

6.2.2 Friction is dependent on the force between the surfaces in contact (1)

6.3 A body of mass 200 kg is pulled up a 28° plane at a constant speed by applying a force of 1 250 N.

Calculate the following:

6.3.1 The weight component parallel with the incline (1)

6.3.2 The weight component perpendicular to the incline (1)

6.3.3 The frictional force (1)

6.3.4 The coefficient of friction (2)
[10]

QUESTION 7: HEAT

7.1 What do you understand by the following:

The heat value of coal is 30 MJ/kg. (2)

7.2 A coal stove consumes 9 kg of coal per hour and is used to heat 600 kg of water, initially at 15 °C.

Calculate the following:

7.2.1 The total amount of heat liberated by the coal per hour (1)

7.2.2 The final temperature of the water if the heat transfer process is 70% efficient (3)

7.3 A copper pipe has a length of 6 m at 15 °C. Determine at what temperature it would have expanded by 3 mm. (2)

7.4 What is the effect of pressure on the boiling point of water? (2)
[10]

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 Define:

8.1.1 A *molecule* (2)

8.1.2 An *ion* (2)

8.2 Name the THREE fundamental constituents of an atom and state the charge of each. (3)

8.3 Name TWO uses of electroplating. (2)

[9]

QUESTION 9: ELECTRICITY

9.1 Two resistors of 6 Ω and 9 Ω are connected in parallel. This combination is now connected in series with a 13 Ω resistor.

Calculate the following:

9.1.1 The total resistance of the parallel connection (2)

9.1.2 The total resistance of the three resistors (1)

9.2 State the FOUR factors that influence the resistance of a conductor. (2)

9.3 Make a neat, labelled sketch of an apparatus that may be used to demonstrate electromagnetic induction (dynamically induced EMF). (3)

9.4 Identify the material that is 857 m long, has a cross sectional area of 15 mm^2 and has a resistance of 1,6 Ω at 20°C. (2)

[10]

TOTAL: 100