T780(E)(J27)T
AUGUST 2005

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N1
(15070391)

27 July (X-Paper)
09:00 – 12:00

Drawing instruments will be required.
Calculators may be used.

This question paper consists of 6 pages, 2 diagram sheets and a formula sheet.

DEPARTMENT OF EDUCATION
REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF EDUCATION  
REPUBLIC OF SOUTH AFRICA  
NATIONAL CERTIFICATE  
ENGINEERING SCIENCE N1  
TIME: 3 HOURS  
MARKS: 100

Answer ALL the questions.

INSTRUCTIONS AND INFORMATION

1. Questions can be answered in any order.
2. Keep subsections of questions together.
3. Rule off on completion of each question.
4. ALL sketches should be drawn using suitable instruments.
5. Sketches should be neat and in proportion.
6. ALL calculations should consist of at least THREE steps:
   6.1 The correct appropriate formula or manipulation thereof
   6.2 Correct substitution of values
   6.3 The answer with the correct S.I. unit

\[
g = 9.8 \text{ m/s}^2  \\
1 \text{ m/s} = 3.6 \text{ km/h}
\]

QUESTION 1

1.1 Indicate whether the following quantities are scalar or vector:

1.1.1 Work
1.1.2 Weight
1.1.3 Speed
1.1.4 Heat
1.2 FIGURE 1 on DIAGRAM SHEET 1 shows three forces acting on a block. Calculate the equilibrant of the THREE forces.

1.3 Define the mass of an object.

1.4 FIGURE 2 on DIAGRAM SHEET 1 shows a device used for measuring temperature.

1.4.1 Label ALL the parts marked from A to H.
1.4.2 Name this device.

1.5 Define torque.

1.6 Describe the difference between work and power.

1.7 Describe what is meant by the specific heat capacity of steel is 500 J/kg °C.

1.8 Define Ohm's Law.

1.9 1.9.1 Define the resistivity of a material (conductor).
1.9.2 Give the basic S.I. unit for resistivity.

QUESTION 2

2.1 A current of 4 A flows for 5 minutes through a conductor. The supply voltage is 220 V. Calculate the following:

2.1.1 The resistance of the conductor
2.1.2 The electric energy consumed in kJ

2.2 Why is a voltmeter connected in parallel in a circuit?

2.3 Why is an ammeter connected in series in a circuit?

2.4 Describe what is meant by potential difference in a circuit.

2.5 Make neat sketches of the following electrical circuit components:

2.5.1 A galvanometer
2.5.2 A battery with three cells connected in series
2.5.3 A variable resistor
2.5.4 An open switch
QUESTION 3

3.1 FIGURE 3 on DIAGRAM SHEET 1 shows the resultant of two forces, one of which is unknown. Use the parallelogram of forces and determine the size of the unknown force F. Use a scale of 1 cm = 10 N. Show ALL the given information. (6)

3.2 The four forces acting on a lever are shown in FIGURE 4 on DIAGRAM SHEET 2. Use the law of moments and calculate the magnitude of the unknown force F. (4) [10]

QUESTION 4

4.1 A 1 m length of steel pipe at a temperature of 500 °C is cooled down to a temperature of 2 °C. The length of the pipe is now 0.997 m. Determine the following:

4.1.1 The change in temperature of the pipe (2)
4.1.2 The change in length of the pipe in mm (2)

4.2 Name the TWO substances in which heat is transferred by convection. (1)

4.3 Make a neat, fully labelled sketch of a general mercury thermometer. Show the TWO main markings on the temperature scale. (3)

4.4 A quantity of alcohol gives off 293 kJ of heat energy when its temperature decreases by 50 °C. The specific heat capacity of the alcohol is 2 930 J/kg °C. Calculate the mass of the alcohol in grams. (2) [10]

QUESTION 5

FIGURE 5 on DIAGRAM SHEET 2 shows the route covered by a race walker.

5.1 Use the diagram and calculate the distance walked in metres. (1)

5.2 Use vector addition and determine the magnitude in metres and direction that the walker has displaced himself/herself. He/She took 12 minutes to complete the journey. Show ALL values on the vector diagram. (Use scale 1 cm = 100 m). (5)
5.3 Calculate the speed of the walker in m/s. 

5.4 Calculate the velocity of the walker in m/s. 

QUESTION 6

6.1 FIGURE 6 on DIAGRAM SHEET 2 shows a sketch of a trembler bell. Label the parts A to F. 

6.2 Make a neat sketch of a solenoid: The following must be correctly included in the circuit. The correct positioning of the magnetic poles; the direction of the magnetic field flow; the correct connection of the cells in the circuit; the direction of conventional current flow and a closed switch. 

6.3 Arrange the following correctly under the headings conductor and insulators. German silver; brass; bakelite; mica 

6.4 Make a neat, labelled sketch of a bar magnet. 

QUESTION 7

7.1 Name the FOUR most important components of an atom and write their charge next to each corresponding component. 

7.2 Briefly explain the process of evaporation. 

7.3 Define an atom. 

7.4 Name the changes in phases that occur when water changes to ice. 

QUESTION 8

8.1 State what the area under the graph of a force - distance graph represents. 

8.2 Write the THREE changes in energy that occur during the following: 

8.2.1 When water from a dam is used to produce electricity in a hydro-electric power station 

8.2.2 When an electric stove is used to cook food
8.3 A force of 1.5 kN causes a van to travel at 100 km/h. Calculate the following. (Show ALL the steps):

8.3.1 The applied force in newtons

8.3.2 The velocity of the van in m/s

8.3.3 The power output of the van engine, required to maintain the velocity of 100 km/h

8.3.4 The work done by the van in 2 minutes, in MJ

QUESTION 9

9.1 An effort of 49 N is applied to a lever to lift a weight of 490 N through 20 cm. Calculate the following:

9.1.1 The mechanical advantage of the lever

9.1.2 The distance moved by the effort (in metres), if the displacement ratio of the lever is 15

9.2 Make a neat, labelled sketch of a thermocouple.

9.3 What effect of heat is demonstrated by a thermocouple?

9.4 State how heat is transmitted in the following media (substances):

9.4.1 Liquid
9.4.2 Solid
9.4.3 Vacuum
9.4.4 Gases

9.5 Explain what is meant by the displacement ratio of a machine is 10.

TOTAL: 100

***************
Fig. 4

Fig. 5

Fig. 6
ENGINEERING SCIENCE N1

FORMULA SHEET

Any applicable formula may also be used.

1. \( v = \frac{s}{t} \)
2. \( F = m.g \)
3. \( DR = \frac{E_{\text{dist.}}}{L_{\text{dist.}}} \)
4. \( MA = \frac{L}{E} \)
5. \( VR = \frac{D}{d} \)
6. \( \text{MOMENT} = F.s \)
7. \( T = F.R \)
8. \( W = F.S \)
9. \( P = \frac{W}{t} \)
10. \( P = F.v \)
11. \( Q = m.c. \Delta t \)
12. \( L_f = L_o + \Delta L \)
13. \( L_f = L_o - \Delta L \)
14. \( P = V.I \)
15. \( P = I^2R \)
16. \( P = \frac{V^2}{R} \)
17. \( Q = P.t \)
18. \( I = \frac{V}{R} \)
19. \( R_t = R_1 + R_2 \ldots \)
20. \( \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \ldots \)