higher education & training

Department:
Higher Education and Training
**REPUBLIC OF SOUTH AFRICA**

T722(E)(N22)T
**NOVEMBER 2010**

NATIONAL CERTIFICATE

# ENGINEERING SCIENCE N1

(15070391)

**22 November (X-Paper)**
**09:00 – 12:00**

**Candidates will require drawing instruments.**

**Calculators may be used.**

**This question paper consists of 7 pages, 1 diagram sheet and 1 formula sheet.**

# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N1
TIME: 3 HOURS
MARKS: 100

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**INSTRUCTIONS AND INFORMATION**

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

NOTE: $g = 9{,}8\ m/s^2$
$1\ m/s = 3{,}6\ km/h$

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## QUESTION 1: DYNAMICS

1.1 Classify the forces in the following examples as a VECTOR or SCALAR. Write only 'vector' or 'scalar' next to the question number (1.1.1 - 1.1.4) in the answer book.

1.1.1 A truck with a mass of 5 tons.

1.1.2 A rock with a weight of 50 N.

1.1.3 A bullet travelling at a velocity of 550 m/s west.

1.1.4 Two towns, A and B, by a distance of 25 km along the road away from each other. (2)

1.2 A man in a rowboat on a river wants to row directly to the south of where he started on the north shore. The river flows directly east. Which ONE of the following arrows shows more or less the direction the man must row in?

A 

B 

C 

D  (1)

1.3 A body is released from a height of 28 m above the ground and it takes 2,4 seconds to reach the ground.

1.3.1 Plot a velocity/time graph for the falling body. Use a scale 1 cm = 1 s and 1 cm = 4 m. (2)

1.3.2 Determine the slope of the graph from the graph. (1)

1.3.3 What does the slope of the graph represent? (1)

1.4 A boat can sail at 27 $m.s^{-1}$ in still water. The boat must cross a river that flows at 9 $m.s^{-1}$ towards the east. If the boat crosses the river by going up stream at an angle of 23° South, what will the size and angle of the resulting velocity be? (3)

1.5 A person walks 1 km at 6 km/h, runs 1 km at 16 km/h and rides a bicycle for 1 km at 32 km/h. What is the person's average speed for the 3 km? (2)

1.6 A boy rides on his bicycle from point A to B and then to C as shown in FIGURE 1 on the attached DIAGRAM SHEET. Determine the boy's resultant velocity graphically using a parallelogram of forces. (2)
**[14]**

## QUESTION 2: STATICS

2.1 Define the following:

2.1.1 A force (1)
2.1.2 The law of moments (1)

2.2 Determine the following from FIGURE 2 on the attached DIAGRAM SHEET:

2.2.1 The size of force P (use scale 1 cm = 10 N) (2)
2.2.2 The angle of resultant Q (use scale 1 cm = 10 N) (2)

2.3 Calculate the magnitude of the force $x$, in FIGURE 3, DIAGRAM SHEET (attached), when the system is in equilibrium. (2)

2.4 Name ONE similarity and ONE difference between a resultant and an equilibrant of two or more forces. (2)

2.5 Draw a neat, diagrammatic sketch of a simple lever system. (3)

2.6 The mechanical advantage of a lever is 4. The load distance is 2 m long and the load is 300 N. (The system is frictionless).

Calculate for ideal situations the following:

2.6.1 The smallest force needed to lift the load (1)
2.6.2 The distance between the effort and the turning point (effort distance) (2)

2.7 Name TWO properties of a force. (2)
**[18]**

## QUESTION 3: ENERGY, WORK AND POWER

3.1 Name the energy transfer in the following cases:

3.1.1 A steam locomotive
3.1.2 A person that starts running the 100 m dash sprint
3.1.3 A nuclear power station
3.1.4 A street light burning (2)

3.2 A body with a mass of 20 kg is raised vertically through a height of 3,5 m.

3.2.1 Use scale 1 cm = 20 N and 2 cm = 1 m and draw the force/distance graph. (3)

Determine from the graph the work done in raising the body ...

3.2.2 to the top. (2)
3.2.3 the last 1,5 m. (1)

3.3 The power required to tow a trailer at a constant speed of 50 km/h on a level road is 30 kW.
Determine:

3.3.1 The force in the tow bar (2)
3.3.2 The work done in 2,5 minutes (2)
**[12]**

**QUESTION 4: HEAT**

4.1 State THREE advantages of a mercury thermometer and THREE advantages of an alcohol thermometer. (3)

4.2 Name THREE effects that heat have on a substance and give an example of each. (3)

4.3 Give TWO practical examples where a thermocoupling is used. (1)

4.4 State the THREE factors that will influence the linear expansion of substances. (3)

4.5 A builder's steel measuring tape is 40 m long at a temperature of 20 °C and changes to 40,137 m when the temperature increases to 76 °C.

Calculate the following:

4.5.1 Change in length in mm (1)
4.5.2 Change in temperature in °C (1)

4.6 Determine the specific heat capacity of a certain piece of metal, which has a mass of 20 kg. It was found by experiment that after the piece of metal received 1,85 MJ of energy its temperature rose by 230 °C. (2)

4.7 Explain in your own words the difference between heat capacity and specific heat capacity. (2)

4.8 What is the difference between heat and temperature? (2)
**[18]**

## QUESTION 5: PARTICLE STRUCTURE OF MATTER

5.1 What causes a substance to change phase? (1)

5.2 Name the THREE phases in which matter can exist and give an example of each. (3)

5.3 Draw a neat, labelled sketch of an atom. (4)

5.4 Movement of particles takes place in each of the THREE phases of matter. Compare this movement in each phase. (3)

5.5 Define *matter*. (1)
**[12]**

## QUESTION 6: ELECTRICITY

6.1 State the factors that will influence the resistance of a conductor. (3)

6.2 Define *Joule's law*. (1)

6.3 What is a *conductor?* (1)

6.4 What do the abbreviations AC and DC represent? (1)

6.5 Draw the symbols for the following:

6.5.1 Cell
6.5.2 Voltmeter
6.5.3 Ammeter
6.5.4 Resistor (2)

6.6 Define the term *resistance*. (1)

6.7 How will an increase in the applied voltage affect the current flow in a circuit? (1)

6.8 State THREE factors determining the amount of electrical energy. (3)

6.9 What will happen to the voltage in a parallel circuit? (1)

6.10 Three resistors of 5 Ω, 17 Ω and 19 Ω respectively are connected in series across a 220 V supply.

Calculate the following:

6.10.1 Total resistance of the combination (1)
6.10.2 The current flow through the circuit (1)
6.10.3 The voltage drop across the 5 Ω resistor (1)

6.11 A current of 1,8 A flows through the filament of a 24 V lamp.
What is the power rating of the lamp? (1)

6.12 Draw a neat, labelled sketch of a magnetic field around a bar magnet. (3)

6.13 Draw a neat, labelled sketch of a single-stroke electric bell. (3)

6.14 What effect will a rise in temperature have on the following substances:

6.14.1 Isolation materials like PVC
6.14.2 Alloys like brass (1)

6.15 Define the term *resistivity*. (1)
**[26]**

**TOTAL: 100**

**DIAGRAMSHEET**

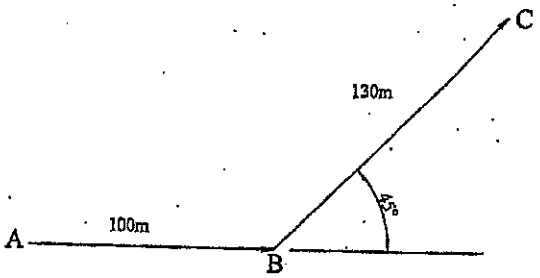


FIGURE 1

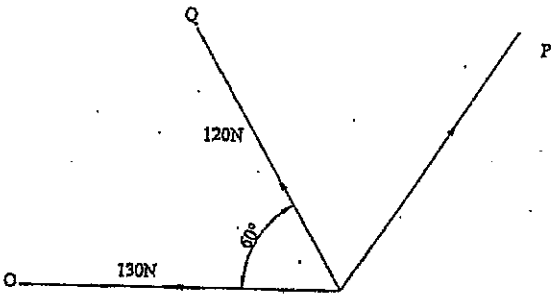


FIGURE 2

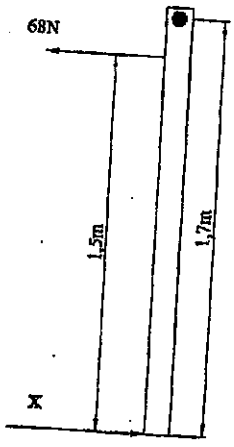


FIGURE 3

# ENGINEERING SCIENCE N1

## FORMULA SHEET

Any applicable formula may also be used.

1. $v = \frac{s}{t}$
2. $F = m.g$
3. $DR = \frac{E_{dist.}}{L_{dist.}}$ $\quad VV = \frac{M_{afst.}}{L_{afst.}}$
4. $MA = \frac{L}{E}$ $\quad HV = \frac{L}{M}$
5. $VR = \frac{D}{d}$ $\quad SV = \frac{D}{d}$
6. $MOMENT = F.s$
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. $P = I^2.R$
16. $P = \frac{V^2}{R}$
17. $Q = P.t$
18. $I = \frac{V}{R}$
19. $R_t = R_1 + R_2 \ldots$
20. $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$